SPONSOR

Iron Mining Association of Minnesota
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TEST ITEM

Sulfide

STUDY TITLE

Hydroponics-Based Sulfide Toxicity Testing of Wild Rice (*Zizania palustris*) – Controlled Oxygen Headspace

DATA REQUIREMENT

Definitive Phase

STUDY DIRECTOR AND AUTHOR

Douglas J. Fort, Ph.D.

STUDY COMPLETION DATE

August 9, 2018

PERFORMING LABORATORY

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IMAM01-00428

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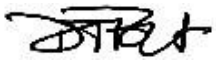
CERTIFICATION

The undersigned declare that this report provides an accurate evaluation of the data obtained from this study.

Study Director:



Douglas J. Fort, Ph.D., Study Director, FEL	8/9/2018 Date

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LIST OF ACRONYMS

ANOVA – analysis of variance
B – boron
ChV - Chronic value (geometric mean of NOEC and LOEC value)
DO – dissolved oxygen
dw – dry weight
EC – effective concentration
FEL – Fort Environmental Laboratories
IC – inhibitory concentration
KW ANOVA – ANOVA on ranks
L - liter
LC – lethal concentration
LOEC –lowest observed effects concentration
ET30 – time to 30% emergence
NOEC – no observed effects concentration
ORP – oxidation/reduction potential
PAH – polyaromatic hydrocarbon
SEM – standard error of the mean
SOP – standard operating procedure
SD – Study Day

1. SUMMARY

Guidelines:	Protocol IMAM01-00428
Study Initiation Date:	March 6, 2018
Experimental Start / End Dates:	March 14, 2018 / April 4, 2018
Test Treatments:	1) Sulfide Treatments - HS-1 (1:4 ammonia-N:nitrate-N) [control], 0.30, 1.56, 3.12, 7.78 mg/L sulfide in the presence of 0.8 or 2.8 mg/L Fe.
Time-Weighted Average (TWA) Test Concentrations (fresh solutions at renewal):	1) Sulfide Treatments - HS-1 (1:4 ammonia-N:nitrate-N) [control] <0.01, 0.38, 1.79, 3.33, and 7.94 mg/L sulfide each with 0.8 mg/L Fe; and 2) HS-1 (1:4 ammonia-N:nitrate-N) [control] <0.01, 0.38, 1.71, 3.39, and 7.71 mg/L sulfide each with 2.8 mg/L Fe.
Test System:	Seed
Source of Seeds:	Minnesota, USA
Summary of Endpoints:	See Table 1

1.1. METHOD

The definitive wild rice sulfide toxicity study was conducted in a static-renewal format in an environmental chamber equipped for hydroponic studies (Table 3) as prescribed by Fort et al. (1) and study ENVIO1-00352. Test solution (0.7 of total volume) was renewed daily. Each of the four replicates per solution contained two 1-L mesh-lined sub-baskets. Plastic mesh served as the medium on which the seeds were placed and served as physical support required for plants growing in hydroponic culture. Each sub-basket contained 40 seeds (80/replicate at T0, total seed number = 320 per treatment), which was adequate to evaluate concentration-response relationships and assess significant differences in the treatments relative to the control. The 10 study days (SD) were performed in the dark to promote mesocotyl emergence and mimic development-stimulating sediment light conditions.

Visual assessments only (i.e., no plants harvested) of the following endpoints were conducted at SD 10 following dark-phase exposure to evaluate:

- Activation expressed as % activation;
- Mesocotyl Emergence expressed as % emergence;

- Time to emergence expressed as the time to 30% emergence (ET30) at the replicate and treatment levels;
- Seedling survival expressed as % survival; and
- Phytoxicity expressed as % affected.

All baskets were evaluated for the following endpoints, as well as total plant biomass and signs of phytotoxicity during the free leaf stage at study conclusion (SD 21):

- Activation expressed as % activation;
- Mesocotyl Emergence expressed as % emergence;
- Time to emergence expressed as the time to 30% emergence (ET30) at the replicate and treatment levels;
- Seedling survival;
- Shoot (mesocotyl, coleoptile and primary leaf) weight expressed as dry weight, or dw;
- Shoot (mesocotyl, coleoptile and primary leaf) lengths;
- Root (seminal and rootlets) dw;
- Seminal Root length; and
- Free leaf number and biomass dw.

Since the frequency of mesocotyl emergence was not anticipated to be 100%, an acceptable frequency of mesocotyl emergence was determined from the MDP (ENVI01-00324 and 00351) and is listed in Table 5. In addition to the HS-1 (1:4) negative control and HS-1 controls containing the additional iron concentrations, a 100 mg B/L treatment in HS-1 (1:4) media was included as a positive control toxicant. For all endpoint assessments (Table 4), plants were carefully removed at the conclusion of exposure using watch maker forceps and placed into Petri dishes for each replicate to evaluate the appropriate endpoints. Each set was digitally photographed, and length measurements of shoots and roots were recorded using digitization to the nearest mm. Weights (dw at 105^{o}C) were recorded using an analytical balance capable of recording to the nearest 0.1 mg. The seminal root tissue was dissected from the seed, as well as the coleoptile and primary leaf (shoot) material, to specifically evaluate root tissue length (development).

1.2. RESULTS AND CONCLUSIONS

Results from the IMAM01-00428 study met the performance criteria established from Fort et al. (2017). Therefore, results from the study are considered valid. A summary of the 00428 results is provided in Tables 1 and 2. A consistent and anticipated adverse response to 100 mg B/L exposure was

noted. The pH was maintained at 6.0 to 7.5 s.u. in all replicates of the control and sulfide treatments, and ±0.5 s.u. within a given replicate for each daily measurement at T0 and T24 over the course of the study. DO levels were maintained at <2.0 mg/L in all treatments during the course of the study. Hydroponic chamber temperature was maintained at 21º ± 2ºC (day) and 12 ± 2ºC (night) in all replicates of control and treatments. The inter-replicate CV for both pre- and post-renewal TWA sulfide concentrations was ≤20% for each HS-1 control and associated sulfide treatments, indicating low variability between replicates of a given treatment or control. Free sulfide loss between 24-hour renewals ranged from 19.7 to 27.1% in the 0.8 mg Fe/L treatments, and 36.7% to 55.5% in the 2.8 mg Fe/L treatments, respectively based on TWA measurements. The loss was presumably due in part to degradation, but primarily complexation with Fe. These results demonstrate that iron reduces free sulfide concentrations, but not necessarily as a linear function of iron concentration.

Key findings from study 00428, expressed as nominal sulfide concentrations, included:

1.2.1. STUDY DAY 10

- Decreased emergence and increased median ET30, and the occurrence of phytotoxicity were observed in wild rice exposed to 100 mg B/L relative to the HS-1 control with 0.8 mg Fe/L.
- Sulfide exposure did not affect seed activation, seedling survival, or induce phytotoxicity at 7.78 mg/L in either of the Fe treatments.
- Emergence was the most sensitive endpoint, with respective SD 10 NOEC and LOEC values of 3.12 mg/L and 7.78 mg/L sulfide for both the 0.8 mg/L and 2.8 mg/L Fe treatments.
- IC25 and IC10 values were 2.19 (2.01-2.37) and 1.91 (1.61-2.26) mg/L sulfide for the 0.8 mg/L Fe treatment, respectively; and 5.21 (4.97-5.45) and 2.37 (2.34-2.40) mg/L sulfide for the 2.8 mg/L Fe treatment.

1.2.2. STUDY DAY 21

- Decreased emergence and increased median ET30, and the occurrence of phytotoxicity were observed in wild rice exposed to 100 mg B/L relative to the HS-1 control with 0.8 mg Fe/L.
- Sulfide exposure did not affect seed activation, seedling survival, root weight or length, free leaf number or weight, or induce phytotoxicity at 7.78 mg/L in either of the Fe treatments.
- Emergence (expressed as %) was the most sensitive endpoint, with respective SD 21 NOEC and LOEC values of 1.56 mg/L and 3.12 mg/L sulfide for the 0.8 mg/L Fe treatment; and 3.12 and 7.78 mg Fe/L for the 2.8 mg/L Fe treatment.
- SD 21 NOEC and LOEC values for both the percent emergence and ET30 were 1.56 mg/L and 3.12 mg/L sulfide for the 0.8 mg/L Fe treatment. SD 21 NOEC and LOEC values for percent emergence and ET30 were 3.12 and 7.78 sulfide, and 7.78 and >7.78 mg/L for the 2.8 mg/L Fe treatment, respectively.
- IC25 and IC10 values for emergence were 2.23 (2.13-2.33) and 1.55 (1.52-1.58) mg/L sulfide for the 0.8 mg/L Fe treatment, respectively; and 5.29 (5.13-5.45) and 2.38 (2.36-2.40) mg/L sulfide for the 2.8 mg/L Fe treatment.

- For shoot weight and length, SD 21 NOEC and LOEC values of 3.12 mg/L and 7.78 mg/L sulfide for the 0.8 and 2.8 mg/L Fe treatments; and 3.12 and 7.78 mg Fe/L for the 2.8 mg/L Fe treatment were observed.
- IC25 and IC10 values for shoot weight were 5.45 (5.40-5.50) and 4.52 (3.94-5.29) mg/L sulfide for the 0.8 mg/L Fe treatment, and 7.78 (7.60-8.00) and 4.91 (4.66-5.16) mg/L sulfide for the 2.8 mg/L Fe treatment.
- IC25 and IC10 values for shoot length were 7.70 (7.63-7.77) and 4.91 (4.42-5.40) mg/L sulfide for the 0.8 mg/L Fe treatment, and >7.78 and 5.57 (5.44-5.70) mg/L sulfide for the 2.8 mg/L Fe treatment.
- As observed in Fort et al. (1), the addition of 2.8 mg/L Fe reduced the toxicity (emergence) of sulfide, indicating that the concentration of oxygen in the headspace during mesocotyl emergence and early growth was not a significant factor in the sensitivity of wild rice to sulfide.

Table 1. Summary of Measurement Endpoints at SD 10[1]

Endpoint	Study Day 10 NOEC/LOEC (mg/L S^{2-})		ChV (mg/L S^{2-})[2]	IC25 (mg/L S^{2-})[3]	IC10 (mg/L S^{2-})[4]
	0.8 mg Fe/L	2.8 mg Fe/L	0.8/2.8 mg Fe/L	0.8/2.8 mg Fe/L	0.8/2.8 mg Fe/L
Activation	7.78/>7.78	7.78/>7.78	>7.78 / >7.78	>7.78/>7.8	>7.78/>7.8
Emergence (%)	3.12/7.78	3.12/7.78	4.93/4.93	2.19 (2.01-2.37)/5.21 (4.97-5.45)	1.91 (1.61-2.26)/2.37 (2.34-2.40)
Emergence (ET30)[5]	1.56/3.12	3.12/7.78	2.21/4.93	---/--- [---/---]	---/--- [---/---]
Survival	7.78/>7.78	7.78/>7.78	>7.78 / >7.78	>7.78/>7.8	>7.78/>7.8
Phytotoxicity	7.78/>7.78	7.78/>7.78	>7.78 / >7.78	>7.78/>7.8	>7.78/>7.8

[1] Nominal concentrations. Significance based on ANOVA or KW-ANOVA, $p \leq 0.05$.
[2] Chronic Value = geometric mean of NOEC and LOEC values.
[3] 25% inhibitory concentration determined by linear interpolation.
[4] 25% inhibitory concentration determined by linear interpolation.
[5] Time to 30% emergence. Significance based on Mann-Whitney U test, $p<0.05$.

Table 2. Summary of Measurement Endpoints at SD 21[1]

Endpoint	Study Day 21 NOEC/LOEC (mg/L S^{2-})		ChV (mg/L S^{2-})[2]	IC25 (mg/L S^{2-})[3]	IC10 (mg/L S^{2-})[4]
	0.8 mg Fe/L	2.8 mg Fe/L	0.8/2.8 mg Fe/L	0.8/2.8 mg Fe/L	0.8/2.8 mg Fe/L
Activation	7.78/>7.78	7.78/>7.78	>7.78 / >7.78	>7.78/>7.8	>7.78/>7.8
Emergence (%)	1.56/3.12	3.12/7.78	2.21/4.93	2.23 (2.13-2.33)/5.29 (5.13-5.45)	1.55 (1.52-1.58)/2.38 (2.33-2.45)
Emergence (ET30)[5]	1.56/3.12	7.78/>7.78	2.21/>7.78	---/--- [---/---]	---/--- [---/---]
Survival	7.78/>7.78	7.78/>7.78	>7.78 / >7.78	>7.78/>7.8	>7.78/>7.8
Root Weight	7.78/>7.78	7.78/>7.78	7.78/>7.78	7.78/>7.78	7.78/>7.78
Root Length	7.78/>7.78	7.78/>7.78	7.78/>7.78	7.78/>7.78	7.78/>7.78
Shoot Weight	3.12/7.78	3.12/7.78	4.93/4.93	5.45 (5.40-5.50)/7.8 (7.6-8.0)	4.52 (3.94-5.29)/4.91 (4.66-5.16)
Shoot Length	3.12/7.78	3.12/7.78	4.93/4.93	7.70 (7.63-7.77) />7.8	4.91 (4.42-5.40)/5.57(5.44-5.70)
Leaf Number	7.78/>7.78	7.78/>7.78	>7.78 / >7.78	>7.78/>7.8	>7.78/>7.8
Leaf Biomass	7.78/>7.78	7.78/>7.78	>7.78 / >7.78	>7.78/>7.8	>7.78/>7.8
Phytotoxicity	7.78/>7.78	7.78/>7.78	>7.78 / >7.78	>7.78/>7.8	>7.78/>7.8

[1] Nominal concentrations. Significance based on ANOVA or KW-ANOVA, $p \leq 0.05$.
[2] Chronic Value = geometric mean of NOEC and LOEC values.
[3] 25% inhibitory concentration determined by linear interpolation.
[4] 25% inhibitory concentration determined by linear interpolation.
[5] Time to 30% emergence. Significance based on Mann-Whitney U test, $p<0.05$.

2. INTRODUCTION

FEL was retained by the Iron Mining Association of Minnesota (IMAM) to conduct a study of sulfide toxicity to wild rice (*Zizania palustris*) using a partially hypoxic hydroponic exposure. An assessment of the ability of iron to reduce sulfide toxicity to wild rice was also performed. The study will ultimately be used to assist in understanding the role of water-column based sulfate in the toxicity of sediment porewater sulfide to wild rice. The sulfide toxicity threshold was determined to facilitate a better understanding of the role of iron in altering sulfide toxicity, and will be used to support the efforts to re-evaluate the State of Minnesota's sulfate water quality standard of 10 mg/L for wild rice waters. The study was conducted in accordance with the specifications identified in FEL's Quality Assurance Management Plan (QAMP) (2), relevant facility standard operating procedures (SOPs), and Study Protocol No. IMAM01-2 prepared for FEL Study No. IMAM01-00428.

The primary objective of the study IMAM01-00428 was to evaluate of standardized headspace oxygen used in the hydroponic design to provide a definitive toxicity evaluation of sulfide to wild rice. The oxygen levels in the headspace were maintained at concentrations (~4 mg/L) that might commonly be found in natural overlaying waters during wild rice's emergence into the water column. Concentration-response data, including No and Lowest Observed Effect Concentrations (NOEC and LOEC), chronic values (ChV), and 25% inhibitory concentrations for the effects of sulfide on wild rice were determined.

3. STUDY PERSONNEL

- Mr. Kurt Anderson, Minnesota Power – Sponsor Representative
- Dr. Douglas J. Fort, FEL – Study Director
- Ms. Deanne Fort, FEL – Manager, In-life study facility
- Mr. Kevin Todhunter, Technician
- Ms. Jennifer Staines, Technician
- Mr. Trenton Ging, Technician
- Ms. Elisabeth Alder, Technician

4. MATERIALS AND METHODS

4.1. DILUTION WATER

FEL used deionized water as the base water for this study. The deionized laboratory water was prepared by passing tap water through a four-filter system: a multimedia filter to remove suspended solids in the feed water; a 10 inch pre-treatment filter (5 μm) to remove any additional solids; a 3.6 ft^3 activated virgin carbon treatment filter to remove chlorine, ammonia, and higher molecular weight organics; 1.2 ft^3 cation, 1.2 ft^3 anion, and two 1.2 ft^3 mixed bed ion exchange polishing filters in series to deionize the water. Both polishing filters were equipped with conductivity detection systems. Water exceeding 5 μmhos/cm was signaled by a warning light. A 5 μm solid filter completed the water treatment process and ensures no solids are released during deionization. Seven water quality

characteristics of the laboratory water were monitored twice per month: pH, dissolved oxygen (DO), conductivity, hardness, alkalinity, ammonia, and residual oxidants. Additional water quality characteristics measured at least annually were iodide, polyaromatic hydrocarbons (PAHs), pesticides, and metals. The dilution water was most recently analyzed for pesticides, PAHs, and metals in February 2017, and all water quality measurements cited above met the U.S. EPA and American Society for Testing and Materials (ASTM) criteria for aquatic toxicity test culture water. Deionized water was used to prepare the culture media (modified HS-1) in accordance with Table 3. Basic water chemistry parameters such as pH, hardness, and conductivity were documented on a representative sample of each test medium evaluated.

4.2. TEST SUBSTANCE

Hydrated sodium sulfide ($Na_2S \cdot 9\ H_2O$, 99.99% pure, SigmaAldrich, St. Louis, MO, lot number MKBP2953V, expiration 7/2021) and ferric chloride ($FeCl_3$, 98.00%, Merck KGaA, lot number 018400, expiration 11/2018) were used throughout the study.

4.3. TEST SYSTEM

The test system was wild rice (*Zizania palustris*). Given that wild rice seeds were obtained from natural wild rice lake located in Central Minnesota, care was taken to ensure that damaged or deformed seeds were not selected for the experiment. Seeds were sieved through a #5 (4 mm) sieve followed by a #10 (2 mm) sieve to separate quality seeds from debris. Visual inspection was also conducted as seeds were loaded into test systems to ensure damaged, discolored, or deformed seeds were not utilized.

4.3.1. ORIGIN AND HANDLING

Wild rice was hand-harvested from Minnesota. The ziplock bag containing wild rice seed was sent to FEL on November 2, 2017 by Kurt Anderson and received by FEL on November 3, 2017. Upon receipt the wild rice seed was unpacked and stored at 4°C in the dark.

4.4. EXPOSURE SYSTEM

Test solutions were provided using a static-renewal design in 10 L hydroponic tanks. The renewal frequency was daily with 0.7 volume exchanges/day. Daily cleaning of the tanks using a turkey baster was performed during media renewal to remove biomass that may have grown during the course of the study. This helped minimize bio-fouling and maintained water quality, including ammonia accumulation, in the tanks. Care was taken not to disturb the seeds and seedlings.

The hydroponic tanks were plastic aquaria (approximate measurements of 35 x 20 x 15 cm deep) equipped with baskets with inert mesh to support the seeds and seedlings. Each of the four tanks per treatment contained two 1-L baskets to house seeds and seedlings evaluated on study day (SD) 10. In total, eight baskets within the four replicates of wild rice seeds were evaluated per treatment and control.

Water temperature was maintained at 21°±2°C (day) and 12±2°C (night). Test solution pH was maintained between 6 and 7.5 s.u. in the control and treatment exposures. Within a given replicate,

variation in pH was ±0.5 s.u. for each daily measurement at T0 and T24, and over the course of the study. This pH range was well within the range of conditions present where wild rice grows naturally. This range is also well within the range where the dynamic equilibrium between H_2S and HS^- shifts dramatically (~7.0), and these sulfur species are thought to differ in their toxicity. In order to maintain hypoxic (DO <2.0 mg/L) conditions within the hydroponic tanks, the HS-1 test medium was deoxygenated with N_2 gas, stored in a sealed carboy until used, and checked for oxygen concentration immediately prior to use. Each hydroponic tank was equipped with a 6-inch, small-bubble air stone to deliver a constant flow of N_2 gas to the tank and ensure hypoxic conditions were maintained. For hypoxic root growth and aerobic vegetative growth, the basket was placed in the hydroponic aquaria such that the seeds resided in the culture media approximately 1 cm below the air:media interface consistent with Fort et al. (1). The mesocotyl will develop in anaerobic conditions under this design. However, the emerged plant will grow in a controlled oxygen environmental chamber containing approximately 4 mg/L oxygen. Plastic wire mesh was placed inside the aquaria in such a manner as to provide a trellis to ensure the vegetative growth occurs above the hypoxic culture media. Sulfide-treated test solutions were prepared daily for use in renewal. Sulfide concentrations in the test solutions were measured prior to and following each daily media renewal using an ion-selective probe. The stability of sulfide in the culture media was aided by the N_2 gas balance in the media. Summaries of the test concentrations and study conditions are provided in Tables 4 and 5.

The diurnal temperature variation was controlled with gradual 2-hour ramped warm-up from 12±2ºC maintained from 2000 to 0400 hours to 21º±2ºC maintained from 0600 to 1800 hours with the corresponding 2-hour ramped cool down. During this period, the oxygen in the headspace was maintained at 4 mg/L. The combination of ramped diurnal temperature control and constant oxygen levels in the headspace allowed for control of oxygen levels in the hydroponic media to prevent oxygen saturation of the media.

4.4.1. EXPOSURE SYSTEM MAINTENANCE

Exposure tanks were siphoned on a daily basis to remove waste and any accumulated debris. Care was taken to minimize stress and trauma to the seeds/seedlings, especially during movement, cleaning of aquaria, and manipulation. Potentially stressful conditions and rapid changes in environmental conditions (light availability, temperature, pH, DO) were avoided.

4.5. WATER QUALITY ANALYSES

4.5.1. WATER (CULTURE) QUALITY ANALYSES

In each replicate tank, temperature and light intensity (lux) were measured daily throughout the 10-d study. DO (aqueous and headspace), pH, oxidation/reduction potential (ORP), and sulfide were measured twice daily (i.e., prior to and following solution renewal). DO, ORP, and sulfide measurements were conducted at the same water depth as seed exposure. Additionally, specific conductance (conductivity), total hardness, total alkalinity, total Fe, total residual oxidants, ammonia-nitrogen, sulfate, nitrate, and phosphate were measured in the media in a replicate of each treatment at SD 0, 7, 14, and 21 (conclusion) of the in-life phase.

4.6. TEST METHOD

The definitive wild rice sulfide toxicity study was conducted in a static-renewal format as prescribed by Fort et al. (1) and study ENVI01-00352 in an environmental chamber equipped for hydroponic studies (Table 5). Test solution (0.7 of total volume) was renewed daily. Each of the four replicates per solution contained two 1 L mesh-lined sub-baskets. The inert plastic mesh served as the medium on which the seeds were placed and served as a physical support required for hydroponic culture. Each basket contained 80 seeds (320 total per exposure condition), which was adequate to evaluate concentration-response relationships and assess significant differences in the treatments relative to their respective control (i.e., the HS-1 medium with a given iron concentration and no sulfide) (3,4). The study was performed in the dark to promote mesocotyl emergence and development.

Visual assessments only (i.e., no plants harvested) of the following endpoints (Table 6) were conducted at SD 10 following dark-phase exposure to evaluate:

- Activation expressed as % activation;
- Mesocotyl Emergence expressed as % emergence;
- Time to emergence expressed as the time to 30% emergence (ET30) at the replicate and treatment levels;
- Seedling survival expressed as % survival; and
- Phytotoxicity expressed as % affected.

All baskets were evaluated for the following endpoints, as well as, total plant biomass and signs of phytotoxicity during the free leaf stage at study conclusion (SD 21):

- Activation expressed a % activation;
- Mesocotyl Emergence expressed as % emergence;
- Time to emergence expressed as the time to 30% emergence (ET30) at the replicate and treatment levels;
- Seedling survival;
- Shoot (mesocotyl, coleoptile and primary leaf) weight expressed as dry weight, or dw;
- Shoot (mesocotyl, coleoptile and primary leaf) lengths;
- Root (seminal and rootlets) dw;
- Seminal Root length; and
- Free leaf number and biomass dw.

Since the frequency of mesocotyl emergence was not anticipated to be 100%, an acceptable frequency of mesocotyl emergence was determined from the MDP (ENVI01-00324 and 00351) and is listed in Table 7. In addition to the HS-1 (1:4) negative control and HS-1 controls containing the additional iron concentrations, a 100 mg B/L treatment in HS-1 (1:4) media was included as a positive control toxicant.

For all endpoint assessments (Table 6), plants were carefully removed at the conclusion of exposure using watch maker forceps and placed into Petri dishes for each replicate to evaluate the appropriate endpoints. Each set was digitally photographed, and length measurements of shoots and roots were recorded using digitization to the nearest mm. Weights (dw at 105^{o}C) were recorded using an analytical balance capable of recording to the nearest 0.1 mg. The seminal root tissue was dissected from the seed as well as the coleoptile and primary leaf (shoot) material to specifically evaluate root tissue length (development).

4.7. BIOLOGICAL ENDPOINTS / OBSERVATIONS

4.7.1. DATA COLLECTION AND BIOLOGICAL ENDPOINTS

Test data and daily observations were recorded in the study records. Study records included study tracking sheets, test information sheets, study calendars identifying major events, study logs for recording detailed observations and comments, activation, daily mesocotyl emergence, seedling survival, and test termination data sheets. Endpoints selected for the present study were based on those required by OECD Test No. 208 (5). The endpoints assessed were activation, mesocotyl emergence, and seedling survival (all of which were measured daily), and signs of phytotoxicity (wilting, chlorosis, stem and root rot). Table 3 provides an overview of the endpoints and the corresponding observation time points.

4.7.1.1. ACTIVATION

Activation was defined as the absorption of water by the seed and seed coat disruption. All seeds were evaluated for activation using a magnification lens. Activation data were presented as a percentage of the total seeds per sub-basket, by replicate, and by culture media (treatment).

4.7.1.2. MESOCOTYL EMERGENCE

Mesocotyl emergence was defined as the appearance of plant tissue in the form of shoots or roots from the germinated seed. Emergence data were presented as a percentage of the total germinated seeds per pot, by replicate, and by culture media (treatment) and as the time required for mesocotyl emergence expressed as the time to 30% emergence (ET30) in each replicate and treatment.

4.7.1.3. SEEDLING SURVIVAL

Survival only applied to seeds with emerged plant tissue. Mortality was defined as loss of living emerged plant tissue. Survival data were presented as a percentage of the total seeds with emerged plant tissue per basket, by replicate, and by culture media (treatment).

4.7.1.4. PHYTOTOXICITY (FREE LEAF PHASE)

Signs of phytotoxicity, including chlorosis of the leaves, darkening of the plant tissue (rot), wilting (loss of turgor pressure), and deformity were recorded and expressed as a percent of the seeds with emerged plant tissue. Because this endpoint was somewhat subjective and is a descriptive endpoint, peer-review was used to verify results.

4.7.2. DAY 0 TEST INITIATION AND SAMPLE COLLECTION

Treatment tanks were randomly assigned to a position in the exposure system in order to account for possible variations in temperature and light intensity. On study day 0, seeds selected for study were randomly placed in each pot such that five seeds were added to each pot in accordance with a randomized design chart until each sub-basket contained 40 seeds. Samples of the test solutions were collected and analyzed for parameters described in Table 5. Tables 5 and 6 also provides an overview of the endpoints and the corresponding observation time points.

4.8. DATA ANALYSIS

All data from in-life portions of the study were tabulated in spreadsheets. The experimental unit for the present study was the replicate. For measurement endpoints (i.e., weights and lengths), replicate level data were based on the mean value for all plants measured in that replicate with the exception of the ET30 data sets which were based on median values. The statistical tests used to compare the culture media to the sulfide and B positive control differed depending on the data type and distribution for each measurement endpoint. For determination of concentration-based endpoints (NOEC and LOEC numerical endpoints), data that were expressed as a percent or proportion were transformed using the arcsine square root prior to further analysis. For measurement endpoints, comparisons between the treatments and designated controls were performed using one-way analysis of variance (ANOVA) or a nonparametric equivalent (KW-ANOVA). In all cases, sulfide treatments sharing the same iron concentration were compared against a control condition containing that same concentration of iron. When the initial test was statistically significant, *post hoc* tests were Dunnett's test for parametric test and Dunn's test for non-parametric tests. Treatment median ET30 values were determined by deriving the median of replicate ET30 values.

5. RESULTS

The statistical analyses and raw data are presented as Appendices A and B, respectively. An assessment of study performance is provided in Table 6. The discussion below refers to nominal sulfide concentrations unless otherwise noted (e.g., in the case of sulfide loss as a function of iron concentration).

5.1. SULFIDE TOXICITY

A summary of water quality measurements and study parameters for the negative controls (HS-1 with each Fe concentration), positive control (boron, as boric acid), and Fe-sulfide treatments is presented in Table 8. The pH was maintained at 6 to 7.5 s.u. in all replicates of controls and treatments, and ±0.5 s.u. within a given replicate for each daily measurement over the course of the study. DO levels in the aquatic media were maintained at <1.0 mg/L in all treatments during the course of the study and at approximately 4 mg/L in the headspace chamber above the hydroponics chamber. Since the DO levels in the hydroponic media were maintained at <1 mg/L, no oxygen saturation occurred in the media. Hydroponic chamber temperature was maintained at 21º ± 2ºC (day) and 12 ± 2ºC (night) in all replicates of control and treatments. A summary of sulfide concentrations based on time-weighted average values measured following test solution renewal (T0) and immediately prior to renewal (T24), along with an evaluation of 24-hour sulfide losses in each treatment is presented in Table 9. The mean sulfide concentration was calculated in accordance with OECD methods, and takes into account the variation in instantaneous concentration over time so that the area under the time-weighted mean is equal to the area under the concentration curve (6). Because the time intervals for all measurement periods were the same (i.e., 24 hours), the time-weighted mean values in Table 8 are equivalent to the arithmetic mean values for the newly prepared (post-renewal) and 24-hour old (pre- renewal) test solutions. Inter-replicate percent coefficient of variation (CV) within the control or a given sulfide exposure was ≤20% in both pre- and post-test solution renewal samples based on TWA concentrations. The inter-replicate CV for 24-hour sulfide loss based on the TWA concentration was ≤20%. Free sulfide loss between 24-hour renewals ranged from 17.0 to 27.1% in the 0.8 mg Fe/L treatments, and 36.7% to 55.5% in the 2.8 mg Fe/L treatments, respectively based on TWA measurements. The loss was presumably due in part to degradation, but primarily complexation with Fe. The results indicate that nominal and measured sulfide concentrations in freshly-prepared test solutions were very similar, but that increased Fe reduced free sulfide concentrations, and that this decrease was not necessarily a linear function of iron concentrations.

5.1.1. STUDY DAY 10

5.1.1.1. SULFIDE WITH 0.8 OR 2.8 mg Fe/L

The effects of sulfide exposure on developing wild rice in the presence of 0.8 mg Fe/L are presented in Tables 10-12. Overall, the following findings were noted:

- A boric acid positive control was performed with the 0.8 mg Fe/L treatment series. ≥Decreased emergence and increased median ET30, and the occurrence of phytotoxicity were observed in wild rice exposed to 100 mg B/L relative to the HS-1 control with 0.8 mg Fe/L.

- Sulfide exposure did not affect seed activation, seedling survival, or induce phytotoxicity at 7.78 mg/L in either of the Fe treatments.
- Emergence was the most sensitive endpoint, with respective SD 10 NOEC and LOEC values of 3.12 mg/L and 7.78 mg/L sulfide for both the 0.8 mg/L and 2.8 mg/L Fe treatments.
- IC25 and IC10 values were 2.19 (2.01-2.37) and 1.91 (1.61-2.26) mg/L sulfide for the 0.8 mg/L Fe treatment, respectively; and 5.21 (4.97-5.45) and 2.37 (2.34-2.40) mg/L sulfide for the 2.8 mg/L Fe treatment.

5.1.2. STUDY DAY 21

5.1.2.1. SULFIDE WITH 0.8 OR 2.8 mg FE/L

- A boric acid positive control was performed with the 0.8 mg Fe/L treatment series. Decreased emergence and increased median ET30, and the occurrence of phytotoxicity were observed in wild rice exposed to 100 mg B/L relative to the HS-1 control with 0.8 mg Fe/L.
- Sulfide exposure did not affect seed activation, seedling survival, root weight or length, free leaf number or weight, or induce phytotoxicity at 7.78 mg/L in either of the Fe treatments.
- Emergence (expressed as %) was the most sensitive endpoint, with respective SD 21 NOEC and LOEC values of 1.56 mg/L and 3.12 mg/L sulfide for the 0.8 mg/L Fe treatment; and 3.12 and 7.78 mg/L sulfide for the 2.8 mg/L Fe treatment.
- Emergence (expressed as ET30) was the similarly sensitive to emergence express as %, with respective SD 21 NOEC and LOEC values of 1.56 mg/L and 3.12 mg/L sulfide for the 0.8 mg/L Fe treatment, respectively; and 7.78 and >7.78 mg/L sulfide for the 2.8 mg/L Fe treatment, respectively.
- IC25 and IC10 values for emergence were 2.23 (2.13-2.33) and 1.55 (1.52-1.58) mg/L sulfide for the 0.8 mg/L Fe treatment, respectively; and 5.29 (5.13-5.45) and 2.38 (2.36-2.40) mg/L sulfide for the 2.8 mg/L Fe treatment.
- For shoot weight and length, SD 21 NOEC and LOEC values of 3.12 mg/L and 7.78 mg/L sulfide for the 0.8 and 2.8 mg/L Fe treatments; and 3.12 and 7.78 mg /L sulfide for the 2.8 mg/L Fe treatment were observed.
- IC25 and IC10 values for shoot weight were 5.45 (5.40-5.50) and 4.52 (3.94-5.29) mg/L sulfide for the 0.8 mg/L Fe treatment, and 7.78 (7.60-8.00) and 4.91 (4.66-5.16) mg/L sulfide for the 2.8 mg/L Fe treatment.
- IC25 and IC10 values for shoot length were 7.70 (7.63-7.77) and 4.91 (4.42-5.40) mg/L sulfide for the 0.8 mg/L Fe treatment, and >7.78 and 5.57 (5.44-5.70) mg/L sulfide for the 2.8 mg/L Fe treatment.
- As observed in Fort et al. (1), the addition of 2.8 mg/L Fe reduced the toxicity (emergence) of sulfide, indicating that the concentration of oxygen in the headspace during mesocotyl emergence and early growth was not a significant factor in the sensitivity of wild rice to sulfide.

6. PERFORMANCE CRITERIA AND VALIDITY

Results from the 00428 study met the performance criteria established (Table 6).

7. DISCUSSION

Results from this study indicate that for the most sensitive endpoint (mesocotyl emergence), exposure of developing wild rice to sulfide at concentrations ≥3.12 mg/L sulfide was toxic based on assessment of NOEC and LOEC values in the presence of 0.8 mg/L Fe. However, exposure of developing wild rice to sulfide at concentrations ≥7.8 mg/L was necessary to significantly reduce emergence in the presence of 2.8 mg Fe/L based on the mesocotyl emergence, and shoot weight and length. Overall, mesocotyl emergence was the most consistently sensitive endpoint in the study, while seed activation, seedling survival, root growth, leaf number and biomass, and phytotoxicity were the least sensitive endpoints. Based on measured sulfide concentrations, Fe reduced free sulfide concentrations in the 2.8 mg Fe/L treatment relative to the 0.8 mg Fe/L treatment. These observations, combined with differences in wild rice responses to sulfide across the different iron concentrations, demonstrate the ability of Fe to reduce sulfide toxicity to wild rice. Further, the concentration of oxygen in the headspace during mesocotyl emergence and early growth was not a significant factor in the sensitivity of wild rice to sulfide.

8. CONCLUSION

As observed in Fort et al. (1), the addition of 2.8 mg/L Fe reduced the toxicity (emergence) of sulfide indicating that the depth of hydroponic exposure during mesocotyl emergence and early growth was not a significant factor in the sensitivity of wild rice to sulfide. In the present study, a greater effect of Fe in reducing the effects of sulfide on mesocotyl emergence was noted at SD 10 compared to Fort et al. (1) based on NOEC and LOEC values, but the IC25 values were comparable. Results from these studies demonstrated the concentration of oxygen in the headspace during mesocotyl emergence and early growth was not a significant factor in the sensitivity of wild rice to sulfide, and complexation with Fe is the primary mitigating factor in terms of sulfide toxicity.

9. REFERENCES

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5. OECD/OCDE. OECD Guideline for the Testing of Chemicals 208: Terrestrial plant test: Seedling emergence and seedling growth test. Organisation for Economic Co-operation and Development. July, 2006.

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TABLES

Table 3. Modified Hoagland's Solution – HS-1 with 1:4 Ammonia:Nitrate

Primary Ingredient	Media HS-1 (1:4) mL Stock/L
1 M NH_4H2PO_4	0.12
1 M NH_4NO_3	0.70
1 M KNO_3	1.10
1 M $Ca(NO_3)_2$	0.75
1M $MgSO_4$	0.50
Micronutrients (Stock B)	
0.556 g H_3BO_3	1.00
9.163 g $MnCl_2$ • 4 H2O	
0.219 g $ZnSO_4$ • 7 H2O	
0.077 g $CuSO_4$ • 5 H2O	
0.121 g Na_2MoO_4 • 2H2O	
2.417 g $FeCl_3$	

Table 4. Experimental Design[1]

Total Fe Concentration (mg/L)	Sulfide (mg/L)				
0.8 (HS-1)	0	0.3	1.56	3.1	7.8
2.8	0	0.3	1.56	3.1	7.8

[1] 100 mg B/L was also included with HS-1 only as a positive control.

Table 5. Experimental Conditions for Hydroponic Study – Definitive Phase

Test Substance		Sulfide
Test System (species)		*Zizania palustris* (wild rice)
Initial Stage		Seed, September 8, 2014seed lot from Little Round Lake (03-0302-00)
Exposure Period		21-d (mesocotyl emergence phase in dark) and 21-d (free leaf phase)
Selection Criteria		Seed uniformity, visual quality, and activation
Exposure System		Static-renewal (daily) in controlled environmental chambers under anaerobic aquatic phase and aerobic vegetative phase
Exposure Route		Water (hydroponics)
Exchange frequency		Daily, 0.7 volumes/day
Water Source		Deionized water
Media		HS-1 with 1:4 ammonia:nitrate
Seed Density		40 seeds/1 L sub-basket (320 seeds per treatment or control)
Test Vessel		1 L basket equipped with mesh bottom supports for seeds
Replication		1 L baskets equipped with mesh bottom supports for seeds
Vessel Placement		4 replicate tanks with each replicate containing a sub-divided 1 L basket. In total, there will be 40 seeds/sub-basket and 320 seeds/treatment at SD 0.
Positive Control		Boric Acid (100 mg B/L)
Test Performance Criteria (control)		See Table 4
Test Endpoints	Daily	Activation, mesocotyl emergence, seedling survival, and visual inspection of development (emergence and normalcy of development)
	SD 10	Activation, mesocotyl emergence (%, time to emergence [TTE] expressed as 30% [ET30] if possible), survival, and signs of phytotoxicity
	Conclusion	Activation, mesocotyl emergence (%, time to emergence [TTE] expressed as 30% [ET30] if possible), survival, shoot and seminal root length and weight, leaf number, second and free leaf biomass, and signs of phytotoxicity
Feeding	Nutrient/Micronutrients	HS-1 modified with 1:4 ammonia:nitrate
	Frequency	Daily, 0.7 volumes renewed
Lighting	Photoperiod	Dark through SD 10, then 16 h light:8 h dark
	Intensity (post SD 10)	5,000 ± 1,000 lux (measured daily at water surface)
Temperature		In all replicates, daily, 21º ± 2ºC (day), and nightly, 12 ± 2ºC (night)
pH, ORP, DO, and sulfide		2x per day in all replicates prior to and following renewal
Conductivity, alkalinity, hardness, ammonia, total Fe, nitrate, sulfate, phosphate, total residual oxidants		Initiation, Day 7, Day 14, and Day 21(conclusion) of study in a representative test replicate of each treatment.

Table 6. Observation Time Points for Primary Endpoints

Apical/Molecular/Biochemical Endpoints:	Daily	SD 10 Emergence Phase	SD 21 Free-Leaf Phase
Activation	●		
Survival	●		
Emergence	●		
Shoot[1] weight			●
Shoot length			●
Root[2] weight			●
Root length			●
Leaf number			●
Leaf biomass			●
Total plant biomass			●
Phytotoxicity		●	●

Table 7. General Test Performance Criteria

Criterion	Criterion	Acceptance (value, if appropriate)
Control activation	95%	√ (100%)
Control mesocotyl emergence	≥30% on SD 21	√ (44.4 and 45.6% in the 0.8 and 2.8 mg/L Fe controls)
Control survival	≥90%	√ (100%)
Positive control (BA) phytotoxicity	≥80%	√ (100%)
DO	<2.0 mg/L for the aquatic media and approximately 4 mg/L in the headspace above the chamber	√ (within range)
pH	6-7.5 in all replicates of control and treatments and ±0.5 s.u. within a given replicate for each daily measurement point at T0 and T24 and over the course of the study in a given replicate	√ (within range)
Water temperature	21º ± 2ºC (day), and nightly, 12 ± 2ºC (night) in all replicates of control and treatments	√ (within range)
Sulfide concentration	Inter-replicate CV ≤20% within each control or treatment condition at pre- or post-renewal time points based on TWA concentration; and ≤30% 24-hour sulfide loss in 0.8 mg Fe/L set (control) based on TWA concentration	√ (within range)

[1]Includes mesocotyl, coleoptile, and primary leaf measured combined for weight and individually by structure for length.
[2]Seminal roots and rootlets for weight and seminal root for length.

Table 8. Water Quality Summary

	Temp (ºC)		Light Intensity (lux)	pH		DO				ORP	
						Headspace		Aquatic			
	AM	PM		Pre-Renew	Post-Renew	Pre	Post	Pre	Post	Pre-Renew	Post-Renew
	HS-1 (1:4) Nutrient Media										
MIN	22.2	12.4	4210	6.4	6.5	3.8	3.8	0.6	0.5	53.0	53.2
MAX	22.5	12.9	4870	7.2	7.1	4.1	4.1	0.9	0.9	57.7	58.4
MEAN	22.3	12.7	4530	6.9	7.0	4.0	4.0	0.8	0.8	55.1	55.2
SEM	0.01	0.01	34	0.01	0.01	0.01	0.01	0.01	0.01	0.10	0.11
	100 mg/L Boric Acid Treatment										
MIN	22.2	12.3	4110	6.5	6.5	3.8	3.8	0.7	0.7	52.9	52.3
MAX	22.5	12.8	4990	7.1	7.0	4.1	4.1	0.9	0.9	56.7	56.9
MEAN	22.3	12.7	4597	6.9	7.0	4.0	4.0	0.8	0.8	54.5	54.9
SEM	0.01	0.01	43	0.01	0.01	0.01	0.01	0.01	0.01	0.08	0.11
	0.3 mg/L Sulfide 0.8 mg/L Fe										
MIN	22.2	12.4	4230	6.6	6.7	3.8	3.8	0.7	0.6	129.8	130.0
MAX	22.4	12.8	4930	7.5	7.2	4.1	4.1	0.9	0.9	139.4	140.6
MEAN	22.3	12.7	4496	6.9	6.9	3.9	4.0	0.8	0.8	132.1	132.6
SEM	0.01	0.01	29.12	0.01	0.01	0.01	0.01	0.01	0.01	0.25	0.25
	1.56 mg/L Sulfide 0.8 mg/L Fe										
MIN	22.2	12.3	4130	6.6	6.6	3.8	3.8	0.7	0.7	133.2	133.8
MAX	22.4	12.8	4840	7.0	7.0	4.2	4.1	0.9	0.9	144.6	145.6
MEAN	22.3	12.7	4445	6.9	6.9	3.9	4.0	0.8	0.8	139.0	139.0
SEM	0.01	0.01	21.73	0.01	0.01	0.01	0.01	0.01	0.01	0.20	0.20
	3.12 mg/L Sulfide 0.8 mg/L Fe										
MIN	22.2	12.3	4090	6.7	6.6	3.8	3.8	0.7	0.7	133.2	130.2
MAX	22.4	12.8	4830	7.2	7.2	4.1	4.1	0.9	0.9	150.2	150.7
MEAN	22.3	12.7	4430	6.8	6.9	3.9	4.0	0.8	0.8	142.7	142.1
SEM	0.01	0.01	21.21	0.01	0.01	0.01	0.01	0.01	0.01	0.26	0.36

Table 8. Water Quality Summary *(continued)*

	Temp (ºC)		Light Intensity (lux)	pH		DO				ORP	
						Headspace		Aquatic			
	AM	PM		Pre-Renew	Post-Renew	Pre	Post	Pre	Post	Pre-Renew	Post-Renew
	7.78 mg/L Sulfide 0.8 mg/L Fe										
MIN	22.2	12.4	4000	6.5	6.5	3.8	3.8	0.7	0.7	137.4	134.2
MAX	22.4	12.8	4710	7.4	7.3	4.1	4.1	0.9	0.9	156.2	157.3
MEAN	22.3	12.7	4389	6.8	6.8	3.9	4.0	0.8	0.8	150.6	151.2
SEM	0.01	0.01	24.56	0.02	0.02	0.01	0.01	0.01	0.01	0.31	0.33
	HS-1 (1:4) Nutrient Media 2.8 mg/L Fe										
MIN	22.2	12.4	4160	6.4	6.5	3.8	3.7	0.7	0.6	50.3	51.3
MAX	22.4	12.8	4930	7.1	7.0	4.1	4.1	0.9	0.9	58.4	57.5
MEAN	22.3	12.7	4480	6.9	6.9	4.0	4.0	0.8	0.8	55.0	55.2
SEM	0.01	0.01	24	0.01	0.02	0.01	0.01	0.01	0.01	0.14	0.11
	0.3 mg/L Sulfide 2.8 mg/L Fe										
MIN	22.2	12.4	4210	6.6	6.7	3.8	3.7	0.6	0.6	130.2	130.0
MAX	22.4	12.8	4930	7.0	7.0	4.1	4.1	0.9	0.9	138.7	141.3
MEAN	22.3	12.7	4460	6.8	6.9	3.9	3.9	0.8	0.8	132.3	132.7
SEM	0.01	0.01	18.98	0.01	0.01	0.01	0.01	0.01	0.01	0.19	0.24
	1.56 mg/L Sulfide 2.8 mg/L Fe										
MIN	22.2	12.3	4210	6.3	6.5	3.8	3.7	0.7	0.7	130.4	130.1
MAX	22.4	12.9	4830	7.0	7.0	4.1	4.4	0.9	0.9	144.7	145.1
MEAN	22.3	12.7	4528	6.8	6.8	4.0	3.9	0.8	0.8	138.8	139.0
SEM	0.01	0.01	21.54	0.01	0.01	0.01	0.01	0.01	0.01	0.24	0.26
	3.12 mg/L Sulfide 2.8 mg/L Fe										
MIN	22.2	12.4	4250	6.5	6.6	3.8	3.8	0.6	0.6	133.9	134.2
MAX	22.4	12.8	4860	7.0	7.0	4.1	4.1	0.9	0.9	149.1	149.5
MEAN	22.3	12.7	4558	6.8	6.8	3.9	3.9	0.8	0.8	142.4	142.7
SEM	0.01	0.01	29.00	0.01	0.01	0.01	0.01	0.01	0.01	0.26	0.32
	7.78 mg/L Sulfide 2.8 mg/L Fe										
MIN	22.2	12.4	4140	6.4	6.5	3.8	3.8	0.7	0.7	143.6	133.1
MAX	22.4	12.8	4990	6.9	7.0	4.1	4.1	0.9	0.9	155.7	157.8
MEAN	22.3	12.7	4601	6.7	6.7	4.0	4.0	0.8	0.8	150.7	151.0
SEM	0.01	0.01	41.04	0.01	0.01	0.01	0.01	0.01	0.01	0.22	0.41

Table 9. Summary of Measured Sulfide Concentrations

Treatment	Nominal Concentration (µM/mg/L)	Time-Weighted Average[1] (mg/L)				
		Post-Renewal (T0)[2]	CV (%)	Pre-Renewal (T24)[3]	CV (%)	Loss (%)
HS-1	0.0	<0.01	-	<0.01	-	-
100 mg B/L/wild rice	0.0	<0.01	-	<0.01	-	-
0.3 mg/L S^{2-}	0.3	0.38	10.13	0.30	4.59	21.61
1.56 mg/L S^{2-}	1.56	1.79	11.57	1.44	5.04	19.65
3.12 mg/L S^{2-}	3.12	3.33	11.44	2.42	9.32	27.12
7.78 mg/L S^{2-}	7.8	7.94	7.01	6.59	5.02	17.00
HS-1 2.8 mg/L Fe	0.0	<0.01	-	<0.01	-	-
0.3 mg/L S^{2-} 2.8 mg/L Fe	0.3	0.38	13.88	0.22	9.56	40.53
1.56 mg/L S^{2-} 2.8 mg/L Fe	1.56	1.71	12.78	1.08	8.65	36.65
3.12 mg/L S^{2-} 2.8 mg/L Fe	3.12	3.39	14.55	1.51	8.68	55.48
7.78 mg/L S^{2-} 2.8 mg/L Fe	7.8	7.71	12.21	4.25	8.06	44.93

[1] Analysis based on OECD method 211 (11).
[2] Time-weighted based on analysis of fresh test solutions.
[3] Time-weighted based on analysis of aged test solutions at T24 prior to renewal of fresh test solutions.

Table 10. Study Day 10 Endpoint Summary

Treatment	Rep	Per Replicate								
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emergence (%)	Seedling Survival (n)	Survival (%)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance (n)	Phytotox: Abnormal Appearance (%)
HS-1[1]	A	40	100.0	15	37.5	15.0	100.0	0	0	0.0
	B	40	100.0	14	35.0	14.0	100.0	0	0	0.0
	C	40	100.0	13	32.5	13.0	100.0	0	0	0.0
	D	40	100.0	15	37.5	15.0	100.0	0	0	0.0
	Mean:	**40**	**100**	**14.3**	**35.6**	**14.3**	**100.0**	**0**	**0**	**0.0**
	SEM:	**0.0**	**0.0**	**0.48**	**1.20**	**0.48**	**0.0**	**0.0**	**0.0**	**0.0**
100 mg/L BA	A	40	100.0	3	7.5	3.0	100.0	0	3	100.0
	B	40	100.0	3	7.5	3.0	100.0	0	3	100.0
	C	40	100.0	3	7.5	3.0	100.0	0	3	100.0
	D	40	100.0	3	7.5	3.0	100.0	0	3	100.0
	Mean:	**40**	**100**	**3.0**	**7.5**[2]	**3.0**	**100**	**0**	**3**	**100**[3]
	SEM:	**0.0**	**0.0**	**0.00**	**0.00**	**0.00**	**0.0**	**0.0**	**0.0**	**0.0**
0.3 mg/L S^{2-}	A	40	100.0	14	35.0	14.0	100.0	0	0	0.0
	B	40	100.0	12	30.0	12.0	100.0	0	0	0.0
	C	40	100.0	13	32.5	13.0	100.0	0	0	0.0
	D	40	100.0	14	35.0	14.0	100.0	0	0	0.0
	Mean:	**40**	**100**	**13.3**	**33.1**	**13.3**	**100**	**0**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.48**	**1.20**	**0.48**	**0.0**	**0.0**	**0.0**	**0.0**
1.56 mg/L S^{2-}	A	40	100.0	13	32.5	13.0	100.0	0	0	0.0
	B	40	100.0	13	32.5	13.0	100.0	0	0	0.0
	C	40	100.0	15	37.5	15.0	100.0	0	0	0.0
	D	40	100.0	12	30.0	12.0	100.0	0	0	0.0
	Mean:	**40**	**100**	**13.3**	**33.1**	**13.3**	**100**	**0**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.63**	**1.57**	**0.63**	**0.0**	**0.0**	**0.0**	**0.0**

[1]Contains 0.8 mg Fe/L. Statistical comparisons made to HS-1 with 0.8, 2.8 mg Fe/L controls depending on treatment set analyzed to hold the nominal Fe constant during analysis.
[2]Significantly less than 0.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).
[3]Significantly greater than 0.8 mg/L Fe HS-1 control (Mann-Whitney U test, $p=0.029$).

Table 10. Study Day 10 Endpoint Summary *(Continued)*

Treatment	Rep	Per Replicate								
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emergence (%)	Seedling Survival (n)	Survival (%)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance (n)	Phytotox: Abnormal Appearance (%)
3.12 mg/L S^{2-}	A	40	100.0	9	22.5	9.0	100.0	0	0	0.0
	B	40	100.0	9	22.5	9.0	100.0	0	0	0.0
	C	40	100.0	7	17.5	7.0	100.0	0	0	0.0
	D	40	100.0	8	20.0	8.0	100.0	0	0	0.0
	Mean:	**40**	**100**	**8.3**	**20.6**	**8.3**	**100**	**0**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.48**	**1.20**	**0.48**	**0.0**	**0.0**	**0.00**	**0.0**
7.78 mg/L S^{2-}	A	40	100.0	3	7.5	3.0	100.0	0	0	0.0
	B	40	100.0	3	7.5	3.0	100.0	0	0	0.0
	C	40	100.0	4	10.0	4.0	100.0	0	0	0.0
	D	40	100.0	3	7.5	3.0	100.0	0	0	0.0
	Mean:	**40**	**100**	**3.3**	**8.1**[1]	**3.3**	**100**	**0**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**0.0**	**0.00**	**0.0**
HS-1 2.8 mg/L Fe	A	40	100.0	13	32.5	13.0	100.0	0	0	0
	B	40	100.0	14	35.0	14.0	100.0	0	0	0
	C	40	100.0	14	35.0	14.0	100.0	0	0	0
	D	40	100.0	15	37.5	15.0	100.0	0	0	0
	Mean:	**40**	**100**	**14.0**	**35.0**	**14.0**	**100**	**0**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.41**	**1.02**	**0.41**	**0.0**	**0.0**	**0.00**	**0.0**
0.3 mg/L S^{2-} 2.8 mg/L Fe	A	40	100.0	16	40.0	16.0	100.0	0	0	0
	B	40	100.0	15	37.5	15.0	100.0	0	0	0
	C	40	100.0	15	37.5	15.0	100.0	0	0	0
	D	40	100.0	13	32.5	13.0	100.0	0	0	0
	Mean:	**40**	**100**	**14.8**	**36.9**	**14.8**	**100**	**0**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.63**	**1.57**	**0.63**	**0.0**	**0.0**	**0.00**	**0.0**

[1]Significantly less than 0.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).

Table 10. Study Day 10 Endpoint Summary *(Continued)*

Treatment	Rep	Per Replicate								
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emergence (%)	Seedling Survival (n)	Survival (%)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance (n)	Phytotox: Abnormal Appearance (%)
1.56 mg/L S^{2-} 2.8 mg/L Fe	A	40	100.0	13	32.5	13.0	100.0	0	0	0.0
	B	40	100.0	13	32.5	13.0	100.0	0	0	0.0
	C	40	100.0	14	35.0	14.0	100.0	0	0	0.0
	D	40	100.0	12	30.0	12.0	100.0	0	0	0.0
	Mean:	**40**	**100**	**13.0**	**32.5**	**13.0**	**100**	**0**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.41**	**1.02**	**0.41**	**0.0**	**0.0**	**0.00**	**0.0**
3.12 mg/L S^{2-} 2.8 mg/L Fe	A1	40	100.0	12	30.0	12.0	100.0	0	0	0.0
	A2	40	100.0	13	32.5	13.0	100.0	0	0	0.0
	B1	40	100.0	12	30.0	12.0	100.0	0	0	0.0
	B2	40	100.0	13	32.5	13.0	100.0	0	0	0.0
	Mean:	**40**	**100**	**12.5**	**31.3**	**12.5**	**100**	**0**	**0**	**0**
	SEM:	**0.0**	**0.0**	**0.29**	**0.72**	**0.29**	**0.0**	**0.0**	**0.00**	**0.0**
7.78 mg/L S^{2-} 2.8 mg/L Fe	A	40	100.0	8	20.0	8.0	100.0	0	0	0.0
	B	40	100.0	9	22.5	9.0	100.0	0	0	0.0
	C	40	100.0	7	17.5	7.0	100.0	0	0	0.0
	D	40	100.0	8	20.0	8.0	100.0	0	0	0.0
	Mean:	**40**	**100**	**8.0**	**20.0[1]**	**8.0**	**100**	**0**	**0**	**0**
	SEM:	**0.0**	**0.0**	**0.41**	**1.02**	**0.41**	**0.0**	**0.0**	**0.00**	**0.0**

[1]Significantly less than 2.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).

Table 11. Study Day 21 Endpoint Summary

Treatment	Rep	Per Replicate													
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emergence (%)	Seedling Survival (n)	Survival (%)	Mean Root Length (mm)	Mean Root Weight (g)	Mean Shoot Length (mm)	Mean Shoot Weight (g)	Mean Dried Leaf Weight (g)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance	
														(n)	(%)
HS-1[1]	A	40	100.0	18	45.0	18.0	100.0	34.2	0.0009	35.7	0.0038	0.0012	0.7	0	0.0
	B	40	100.0	18	45.0	18.0	100.0	31.7	0.0008	36.8	0.0045	0.0018	0.8	0	0.0
	C	40	100.0	16	40.0	16.0	100.0	33.6	0.0007	39.6	0.0034	0.0021	1.3	0	0.0
	D	40	100.0	19	47.5	19.0	100.0	32.3	0.0008	38.5	0.0033	0.0015	0.9	0	0.0
	Mean:	**40**	**100**	**17.8**	**44.4**	**17.8**	**100.0**	**32.9**	**0.0008**	**37.7**	**0.0037**	**0.0017**	**0.9**	**0**	**0.0**
	SEM:	**0.0**	**0.0**	**0.63**	**1.57**	**0.63**	**0.0**	**0.58**	**0.0000**	**0.86**	**0.0003**	**0.0002**	**0.1**	**0.0**	**0.0**
100 mg/L BA	A	40	100.0	5	12.5	5.0	100.0	28.5	0.0005	19.9	0.0016	0.0015	0.8	5	100.0
	B	40	100.0	5	12.5	5.0	100.0	40.1	0.0006	16.6	0.0013	0.0011	0.2	5	100.0
	C	40	100.0	4	10.0	4.0	100.0	23.6	0.0016	19.7	0.0018	0.0015	0.3	4	100.0
	D	40	100.0	3	7.5	3.0	100.0	33.5	0.0006	21.6	0.0030	0.0007	0.7	3	100.0
	Mean:	**40**	**100**	**4.3**	**10.6**[2]	**4.3**	**100**	**31.4**	**0.0008**	**19.5**[3]	**0.0019**	**0.0012**	**0.5**	**4.25**	**100**[4]
	SEM:	**0.0**	**0.0**	**0.48**	**1.20**	**0.48**	**0.0**	**3.53**	**0.0002**	**1.02**	**0.0004**	**0.0002**	**0.1**	**0.5**	**0.0**
0.3 mg/L S^{2-}	A	40	100.0	17	42.5	17.0	100.0	33.4	0.0010	28.4	0.0033	0.0036	0.2	0	0.0
	B	40	100.0	18	45.0	18.0	100.0	41.0	0.0011	45.9	0.0033	0.0025	0.4	0	0.0
	C	40	100.0	18	45.0	18.0	100.0	44.0	0.0012	29.1	0.0031	0.0014	1.2	0	0.0
	D	40	100.0	18	45.0	18.0	100.0	48.2	0.0009	35.8	0.0040	0.0009	1.2	0	0.0
	Mean:	**40**	**100**	**17.8**	**44.4**	**17.8**	**100**	**41.6**	**0.0010**	**34.8**	**0.0034**	**0.0021**	**0.8**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**3.12**	**0.0001**	**4.07**	**0.0002**	**0.0006**	**0.3**	**0.00**	**0.0**

[1]Contains 0.8 mg Fe/L. Statistical comparisons made to HS-1 with 0.8, 2.8 mg Fe/L controls depending on treatment set analyzed to hold the nominal Fe constant during analysis.
[2]Significantly less than 0.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).
[3]Significantly less than 0.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).
[4]Significantly greater than 0.8 mg/L Fe HS-1 control (Mann-Whitney U test, $p=0.029$).

Table 11. Study Day 21 Endpoint Summary *(Continued)*

Treatment	Rep	Per Replicate													
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emergence (%)	Seedling Survival (n)	Survival (%)	Mean Root Length (mm)	Mean Root Weight (g)	Mean Shoot Length (mm)	Mean Shoot Weight (g)	Mean Dried Leaf Weight (g)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance	
														(n)	(%)
1.56 mg/L S^{2-}	A	40	100.0	17	42.5	17.0	100.0	41.9	0.0007	52.0	0.0043	0.0018	0.9	0	0.0
	B	40	100.0	16	40.0	16.0	100.0	58.7	0.0007	42.0	0.0061	0.0041	0.3	0	0.0
	C	40	100.0	16	40.0	16.0	100.0	56.7	0.0007	58.2	0.0053	0.0017	0.4	0	0.0
	D	40	100.0	15	37.5	15.0	100.0	46.3	0.0007	56.1	0.0063	0.0011	0.5	0	0.0
	Mean:	**40**	**100**	**16.0**	**40.0**	**16.0**	**100**	**50.9**	**0.0007**	**52.1**	**0.0055**	**0.0022**	**0.5**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.41**	**1.02**	**0.41**	**0.0**	**4.06**	**0.0000**	**3.59**	**0.0004**	**0.0007**	**0.1**	**0.00**	**0.0**
3.12 mg/L S^{2-}	A	40	100.0	11	27.5	11.0	100.0	39.6	0.0007	51.1	0.0027	0.0025	0.5	0	0.0
	B	40	100.0	11	27.5	11.0	100.0	41.5	0.0009	54.4	0.0049	0.0029	0.4	0	0.0
	C	40	100.0	9	22.5	9.0	100.0	42.4	0.0010	46.3	0.0032	0.0018	0.7	0	0.0
	D	40	100.0	9	22.5	9.0	100.0	53.2	0.0009	45.7	0.0051	0.0008	0.2	0	0.0
	Mean:	**40**	**100**	**10.0**	**25.0**[1]	**10.0**	**100**	**44.2**	**0.0009**	**49.4**	**0.0040**	**0.0020**	**0.4**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.58**	**1.44**	**0.58**	**0.0**	**3.06**	**0.0001**	**2.06**	**0.0006**	**0.0005**	**0.1**	**0.00**	**0.0**
7.78 mg/L S^{2-}	A	40	100.0	5	12.5	5.0	100.0	40.5	0.0007	21.3	0.0019	0.0016	0.2	0	0.0
	B	40	100.0	4	10.0	4.0	100.0	29.4	0.0010	26.6	0.0027	0.0007	0.3	0	0.0
	C	40	100.0	5	12.5	5.0	100.0	49.8	0.0008	35.9	0.0013	0.0019	0.6	0	0.0
	D	40	100.0	5	12.5	5.0	100.0	34.8	0.0007	20.3	0.0021	0.0018	0.2	0	0.0
	Mean:	**40**	**100**	**4.8**	**11.9**[1]	**4.8**	**100**	**38.6**	**0.0008**	**26.0**[2]	**0.0020**[3]	**0.0015**	**0.3**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**4.37**	**0.0001**	**3.58**	**0.0003**	**0.0003**	**0.1**	**0.00**	**0.0**

[1]Significantly less than 0.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).
[2]Significantly less than 0.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).
[3]Significantly less than 0.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).

Table 11. Study Day 21 Endpoint Summary *(Continued)*

Treatment	Rep	Per Replicate													
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emergence (%)	Seedling Survival (n)	Survival (%)	Mean Root Length (mm)	Mean Root Weight (g)	Mean Shoot Length (mm)	Mean Shoot Weight (g)	Mean Dried Leaf Weight (g)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance	
														(n)	(%)
HS-1 2.8 mg/L Fe	A	40	100.0	18	45.0	18.0	100.0	40.9	0.0009	60.4	0.0052	0.0006	0.6	0	0
	B	40	100.0	19	47.5	19.0	100.0	35.4	0.0008	49.2	0.0041	0.0015	0.6	0	0
	C	40	100.0	18	45.0	18.0	100.0	46.0	0.0010	54.3	0.0038	0.0017	0.3	0	0
	D	40	100.0	18	45.0	18.0	100.0	36.9	0.0009	39.7	0.0051	0.0027	0.3	0	0
	Mean:	**40**	**100**	**18.3**	**45.6**	**18.3**	**100**	**39.8**	**0.0009**	**50.9**	**0.0046**	**0.0016**	**0.5**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**2.36**	**0.0000**	**4.38**	**0.0003**	**0.0004**	**0.1**	**0.00**	**0.0**
0.3 mg/L S^{2-} 2.8 mg/L Fe	A	40	100.0	19	47.5	19.0	100.0	40.3	0.0010	60.3	0.0038	0.0032	0.2	0	0
	B	40	100.0	18	45.0	18.0	100.0	47.6	0.0009	40.5	0.0046	0.0020	0.5	0	0
	C	40	100.0	19	47.5	19.0	100.0	57.2	0.0009	39.6	0.0035	0.0009	1.3	0	0
	D	40	100.0	18	45.0	18.0	100.0	46.2	0.0009	38.5	0.0030	0.0012	1.1	0	0
	Mean:	**40**	**100**	**18.5**	**46.3**	**18.5**	**100**	**47.8**	**0.0009**	**44.7**	**0.0037**	**0.0018**	**0.8**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.29**	**0.72**	**0.29**	**0.0**	**3.50**	**0.0000**	**5.21**	**0.0003**	**0.0005**	**0.3**	**0.00**	**0.0**
1.56 mg/L S^{2-} 2.8 mg/L Fe	A	40	100.0	17	42.5	17.0	100.0	42.8	0.0008	62.4	0.0041	0.0019	1.0	0	0.0
	B	40	100.0	17	42.5	17.0	100.0	42.8	0.0008	60.3	0.0055	0.0048	0.6	0	0.0
	C	40	100.0	18	45.0	18.0	100.0	54.7	0.0008	38.8	0.0029	0.0024	1.4	0	0.0
	D	40	100.0	17	42.5	17.0	100.0	45.1	0.0008	49.9	0.0037	0.0016	2.0	0	0.0
	Mean:	**40**	**100**	**17.3**	**43.1**	**17.3**	**100**	**46.4**	**0.0008**	**52.9**	**0.0040**	**0.0027**	**1.2**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**2.82**	**0.0000**	**5.42**	**0.0005**	**0.0007**	**0.3**	**0.00**	**0.0**

Table 11. Study Day 21 Endpoint Summary *(Continued)*

Treatment	Rep	Per Replicate													
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emergence (%)	Seedling Survival (n)	Survival (%)	Mean Root Length (mm)	Mean Root Weight (g)	Mean Shoot Length (mm)	Mean Shoot Weight (g)	Mean Dried Leaf Weight (g)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance	
														(n)	(%)
3.12 mg/L S^{2-} 2.8 mg/L Fe	A	40	100.0	16	40.0	16.0	100.0	50.4	0.0008	50.7	0.0040	0.0031	0.2	0	0.0
	B	40	100.0	15	37.5	15.0	100.0	39.8	0.0008	50.8	0.0050	0.0023	0.4	0	0.0
	C	40	100.0	16	40.0	16.0	100.0	54.6	0.0009	42.1	0.0052	0.0012	0.6	0	0.0
	D	40	100.0	16	40.0	16.0	100.0	44.6	0.0008	44.9	0.0048	0.0028	0.7	0	0.0
	Mean:	**40**	**100**	**15.8**	**39.4**	**15.8**	**100**	**47.3**	**0.0008**	**47.1**	**0.0048**	**0.0023**	**0.5**	**0**	**0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**3.25**	**0.0000**	**2.16**	**0.0003**	**0.0004**	**0.1**	**0.00**	**0.0**
7.78 mg/L S^{2-} 2.8 mg/L Fe	A	40	100.0	10	25.0	10.0	100.0	34.2	0.0007	37.1	0.0033	0.0014	0.4	0	0.0
	B	40	100.0	12	30.0	12.0	100.0	34.8	0.0008	47.8	0.0035	0.0035	0.1	0	0.0
	C	40	100.0	10	25.0	10.0	100.0	36.6	0.0008	41.9	0.0030	0.0009	0.3	0	0.0
	D	40	100.0	10	25.0	10.0	100.0	32.4	0.0006	32.6	0.0030	-	0.0	0	0.0
	Mean:	**40**	**100**	**10.5**	**26.3[1]**	**10.5**	**100**	**34.5**	**0.0007**	**39.9[2]**	**0.0032[3]**	**0.0019**	**0.2**	**0**	**0**
	SEM:	**0.0**	**0.0**	**0.50**	**1.25**	**0.50**	**0.0**	**0.87**	**0.0001**	**3.26**	**0.0001**	**0.0008**	**0.1**	**0.00**	**0.0**

[1]Significantly less than 0.8 mg/L Fe HS-1 control (KW-ANOVA, Dunnett's test, $p<0.05$).
[2]Significantly less than 0.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).
[3]Significantly less than 0.8 mg/L Fe HS-1 control (ANOVA, Dunnett's test, $p<0.05$).

Table 12. Median Emergence Time (MET) in Wild Rice on SD21[1]

Median Emergence Time (d)											
Replicate	**HS-1**	**100 mg/L BA**	**0.3 mg/L S^{2-} 0.8 mg/L Fe**	**1.56 mg/L S^{2-} 0.8 mg/L Fe**	**3.12 mg/L S^{2-} 0.8 mg/L Fe**	**7.78 mg/L S^{2-} 0.8 mg/L Fe**	**HS-1 2.8 mg/L Fe**	**0.3 mg/L S^{2-} 2.8 mg/L Fe**	**1.56 mg/L S^{2-} 2.8 mg/L Fe**	**3.12 mg/L S^{2-} 2.8 mg/L Fe**	**7.78 mg/L S^{2-} 2.8 mg/L Fe**
Rep A	9	>21	9	10	>21	>21	10	9	9	9	>21
Rep B	10	>21	10	10	>21	>21	9	9	10	10	>21
Rep C	9	>21	10	9	>21	>21	9	9	9	10	20
Rep D	9	>21	9	10	>21	>21	9	10	10	10	>21
Median	**9**	**>21[2]**	**9.5**	**10**	**>21[3]**	**>21[4]**	**9**	**9**	**9.5**	**10**	**>21[5]**

[1]Based on time (in days) required to achieve 30% emergence.
[2]Significantly greater than 0.8 mg/L Fe HS-1 control (Mann-Whitney U test, p=0.029).
[3]Significantly greater than 0.8 mg/L Fe HS-1 control (Mann-Whitney U test, p=0.029).
[4]Significantly greater than 0.8 mg/L Fe HS-1 control (Mann-Whitney U test, p=0.029).
[5]Significantly greater than 0.8 mg/L Fe HS-1 control (t-test, p<0.001).

Appendix A. Raw Data and Statistical Analyses

FEL

Tier 1 Parameters
100 mg/L BA

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.5			7.0		4.0		0.8		56.8			0.0	0.0	
	B	22.3		12.6			7.0		4.0		0.8		55.5			0.0	0.0	
	C	22.3		12.3			7.0		4.0		0.7		55.4			0.0	0.0	
	D	22.3		12.4			7.0		4.0		0.8		56.1			0.0	0.0	
1	A	22.3	22.4	12.6		7.0	7.0	4.0	3.9	0.7	0.8	55.3	56.5	0.0	0.0	0.0	0.0	
	B	22.3	22.4	12.5		7.0	7.0	3.9	3.9	0.8	0.9	54.6	56.9	0.0	0.0	0.0	0.0	
	C	22.5	22.5	12.5		7.0	7.0	4.1	4.0	0.8	0.7	54.5	55.1	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.4		7.1	7.0	4.1	4.0	0.8	0.8	55.2	54.1	0.0	0.0	0.0	0.0	
2	A	22.3	22.2	12.6		7.0	7.0	4.1	4.0	0.8	0.7	53.4	54.1	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.5		7.0	6.9	4.0	3.9	0.7	0.8	54.1	53.9	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7		7.0	7.0	4.0	3.9	0.8	0.7	55.1	55.9	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.8		7.0	6.9	3.9	4.0	0.7	0.7	56.2	55.7	0.0	0.0	0.0	0.0	
3	A	22.4	22.3	12.6		7.0	6.9	3.8	3.9	0.8	0.7	55.6	56.4	0.0	0.0	0.0	0.0	
	B	22.4	22.2	12.6		7.0	6.9	4.1	4.0	0.9	0.7	54.7	55.9	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.7		7.0	7.0	4.0	3.9	0.9	0.7	53.3	54.2	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.6		7.0	7.0	3.8	3.8	0.7	0.7	54.7	53.9	0.0	0.0	0.0	0.0	
4	A	22.4	22.3	12.8		6.9	7.0	4.0	4.0	0.7	0.8	54.6	55.1	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.6		6.9	7.0	4.0	4.1	0.9	0.8	55.2	54.3	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.7		7.0	7.0	3.8	3.9	0.7	0.8	53.7	54.0	0.0	0.0	0.0	0.0	
	D	22.4	22.2	12.6		6.9	7.0	4.0	3.9	0.8	0.9	54.1	55.2	0.0	0.0	0.0	0.0	
5	A	22.3	22.2	12.7		6.9	7.0	4.0	4.1	0.9	0.8	53.2	54.2	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.8		7.0	7.0	4.1	4.0	0.9	0.8	54.6	53.2	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7		7.0	7.0	4.1	4.1	0.8	0.8	55.0	52.3	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.7		7.0	7.0	4.0	4.0	0.7	0.8	55.2	55.9	0.0	0.0	0.0	0.0	
6	A	22.3	22.3	12.6		6.9	7.0	4.0	3.9	0.7	0.7	54.6	53.9	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.6		6.9	7.0	4.0	3.9	0.7	0.7	55.0	54.8	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.6		6.9	7.0	4.0	4.1	0.8	0.8	53.9	55.1	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.6		6.9	7.0	4.0	4.1	0.7	0.7	54.0	55.3	0.0	0.0	0.0	0.0	
7	A	22.3	22.2	12.6		6.9	7.0	3.9	4.0	0.8	0.7	54.6	53.8	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.7		6.9	7.0	4.0	4.0	0.7	0.8	55.2	53.4	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.7		6.9	7.0	4.0	3.8	0.9	0.8	53.8	54.1	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.8		7.0	7.0	4.0	3.8	0.9	0.9	54.3	56.1	0.0	0.0	0.0	0.0	
8	A	22.4	22.3	12.8		6.9	7.0	4.0	3.9	0.7	0.9	53.6	54.1	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6		6.9	7.0	4.0	3.9	0.7	0.9	54.6	55.2	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.6		7.0	7.0	4.0	4.0	0.7	0.8	53.8	54.1	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.6		7.0	7.0	3.9	4.0	0.7	0.8	54.0	54.9	0.0	0.0	0.0	0.0	
9	A	22.3	22.2	12.7		7.0	7.0	4.1	3.8	0.8	0.7	54.6	56.2	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.8		7.0	7.0	3.9	3.9	0.9	0.7	54.3	55.4	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.7		6.9	7.0	3.9	4.0	0.8	0.9	55.1	56.2	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.7		7.0	7.0	4.0	3.9	0.8	0.7	54.9	55.3	0.0	0.0	0.0	0.0	
10	A	22.4	22.3	12.6		6.7	7.0	4.0	3.9	0.7	0.8	54.3	54.7	0.0	0.0	0.0	0.0	
	B	22.3	22.3	12.8		6.5	6.6	3.8	3.9	0.7	0.8	55.1	55.2	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6		7.0	7.0	4.0	4.1	0.7	0.8	55.7	55.9	0.0	0.0	0.0	0.0	
	D	22.3	22.4	12.8		7.0	7.0	4.0	4.0	0.7	0.7	56.7	56.9	0.0	0.0	0.0	0.0	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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Tier 1 Parameters

100 mg/L BA

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
11	A	22.3	22.2	12.8	4370.0	6.8	7.0	3.8	4.1	0.7	0.8	54.1	56.7	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.8	4970.0	7.0	7.0	3.8	4.0	0.8	0.9	55.7	56.3	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.8	4380.0	6.9	6.8	3.9	4.1	0.8	0.8	54.8	56.9	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.6	4540.0	6.9	6.9	3.8	3.9	0.7	0.7	55.7	56.8	0.0	0.0	0.0	0.0	
12	A	22.4	22.3	12.6	4600.0	7.0	7.0	4.1	4.0	0.8	0.7	53.7	55.6	0.0	0.0	0.0	0.0	
	B	22.4	22.2	12.7	4710.0	7.0	6.9	4.0	4.1	0.7	0.7	53.5	54.8	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6	4590.0	6.9	7.0	4.1	3.8	0.8	0.7	53.8	54.6	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.6	4630.0	6.9	7.0	4.0	3.9	0.9	0.7	55.1	54.2	0.0	0.0	0.0	0.0	
13	A	22.4	22.3	12.6	4990.0	6.9	7.0	4.0	4.1	0.8	0.7	53.6	54.6	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6	4890.0	7.0	7.0	4.1	4.1	0.7	0.7	52.9	53.7	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6	4910.0	6.9	7.0	4.0	4.1	0.9	0.7	55.5	54.2	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.7	4930.0	6.8	7.0	4.0	4.1	0.8	0.8	54.4	55.3	0.0	0.0	0.0	0.0	
14	A	22.4	22.3	12.6	4450.0	7.0	7.0	4.1	4.1	0.7	0.8	54.1	53.2	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.7	4620.0	7.0	7.0	3.9	4.0	0.7	0.8	53.8	54.0	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6	4350.0	7.0	7.0	4.1	4.0	0.7	0.8	54.5	55.1	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.7	4290.0	7.0	7.0	4.1	4.0	0.7	0.9	55.2	55.7	0.0	0.0	0.0	0.0	
15	A	22.3	22.2	12.7	4250.0	6.9	7.0	4.0	3.9	0.7	0.9	53.8	54.1	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.8	4270.0	6.9	7.0	3.8	3.9	0.9	0.9	54.6	54.2	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.7	4300.0	6.9	7.0	4.0	3.8	0.7	0.7	53.6	54.7	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.7	4520.0	6.9	7.0	4.0	3.9	0.8	0.7	54.3	53.7	0.0	0.0	0.0	0.0	
16	A	22.4	22.3	12.6	4270.0	7.0	7.0	4.0	4.0	0.9	0.9	54.6	53.8	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.7	4300.0	7.0	7.0	3.8	4.0	0.7	0.9	53.8	55.1	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.6	4350.0	7.0	7.0	4.0	4.1	0.8	0.9	52.9	53.8	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.7	4270.0	7.0	7.0	3.9	4.1	0.7	0.7	54.8	54.7	0.0	0.0	0.0	0.0	
17	A	22.4	22.3	12.6	4110.0	6.9	6.8	4.0	3.8	0.7	0.7	53.6	53.8	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.8	4800.0	6.9	6.8	4.1	3.8	0.7	0.7	53.6	53.8	0.0	0.0	0.0	0.0	
	C	22.3	22.3	12.7	4350.0	7.1	7.0	4.0	3.8	0.7	0.7	54.6	53.8	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.7	4270.0	7.1	7.0	4.0	3.8	0.7	0.7	54.6	53.8	0.0	0.0	0.0	0.0	
18	A	22.2	22.2	12.6	4910.0	6.9	6.7	3.9	3.8	0.8	0.8	54.1	53.7	0.0	0.0	0.0	0.0	
	B	22.2	22.2	12.6	4950.0	6.9	6.5	3.9	3.8	0.8	0.8	56.1	53.7	0.0	0.0	0.0	0.0	
	C	22.2	22.2	12.7	4730.0	7.1	7.0	3.8	3.9	0.8	0.7	55.6	54.6	0.0	0.0	0.0	0.0	
	D	22.2	22.2	12.7	4790.0	7.1	7.0	3.8	3.9	0.8	0.7	54.8	54.6	0.0	0.0	0.0	0.0	
19	A	22.4	22.3	12.8	4980.0	6.8	7.0	4.0	4.1	0.9	0.9	54.3	55.1	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.7	4980.0	6.9	7.0	3.9	3.8	0.8	0.7	53.4	54.4	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7	4930.0	6.7	6.9	4.1	4.0	0.8	0.9	53.9	55.3	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.8	4920.0	6.9	7.0	3.9	4.0	0.9	0.8	55.1	54.9	0.0	0.0	0.0	0.0	
20	A	22.4	22.3	12.6	4340.0	7.0	7.0	4.0	4.0	0.7	0.9	54.8	55.1	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.7	4370.0	7.0	7.0	4.0	3.9	0.8	0.8	54.3	54.8	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7	4300.0	7.0	7.0	4.1	4.0	0.8	0.7	54.1	55.1	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.6	4270.0	7.0	7.0	4.0	4.1	0.7	0.9	54.3	55.3	0.0	0.0	0.0	0.0	
21	A	22.3	22.2		4950.0	7.0		3.9		0.8		54.9		0.0	0.0			
	B	22.3	22.2		4830.0	6.8		3.9		0.7		53.4		0.0	0.0			
	C	22.3	22.2		4890.0	6.9		3.8		0.7		53.7		0.0	0.0			
	D	22.4	22.3		4860.0	7.0		4.0		0.7		55.4		0.0	0.0			
	MIN	22.2	22.2	12.3	4110	6.5	6.5	3.8	3.8	0.7	0.7	52.9	52.3	0.0	0.00	0.0	0.00	
	MAX	22.5	22.5	12.8	4990	7.1	7.0	4.1	4.1	0.9	0.9	56.7	56.9	0.0	0.00	0.0	0.00	
	MEAN	22.3	22.3	12.7	4597	6.9	7.0	4.0	4.0	0.8	0.8	54.5	54.9	0.0	0.000	0.0	0.00	
	SEM	0.01	0.01	0.01	43	0.01	0.01	0.01	0.01	0.01	0.01	0.08	0.11	0.00	0.000	0.00	0.000	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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Tier 1 Parameters

HS-1 (1:4) 0.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.6			7.0		4.1		0.9		55.7			0.0	0.0	
	B	22.3		12.4			7.0		4.1		0.9		56.8			0.0	0.0	
	C	22.3		12.4			7.1		4.1		0.8		56.1			0.0	0.0	
	D	22.3		12.5			7.0		4.1		0.7		57.2			0.0	0.0	
1	A	22.4	22.5	12.7		7.0	7.0	4.1	4.0	0.6	0.5	57.2	58.2	0.0	0.0	0.0	0.0	
	B	22.2	22.3	12.6		7.1	7.0	3.9	4.0	0.7	0.8	53.9	54.2	0.0	0.0	0.0	0.0	
	C	22.4	22.4	12.4		7.0	7.0	4.0	3.9	0.9	0.8	55.6	57.3	0.0	0.0	0.0	0.0	
	D	22.5	22.4	12.5		7.0	7.0	4.0	4.1	0.7	0.7	56.9	55.3	0.0	0.0	0.0	0.0	
2	A	22.3	22.3	12.6		7.0	7.0	4.1	4.0	0.9	0.9	53.8	54.6	0.0	0.0	0.0	0.0	
	B	22.3	22.3	12.6		7.0	7.0	4.1	3.9	0.8	0.9	57.3	58.4	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7		6.9	7.0	3.8	3.9	0.8	0.7	54.8	55.3	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.7		6.9	7.0	3.9	4.0	0.7	0.7	56.2	55.7	0.0	0.0	0.0	0.0	
3	A	22.4	22.3	12.7		7.0	7.0	3.8	3.9	0.7	0.7	54.8	55.5	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6		7.0	7.0	3.8	3.8	0.8	0.8	54.9	55.2	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6		7.0	7.0	4.0	3.8	0.8	0.7	54.1	55.3	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.8		6.9	6.9	4.0	4.0	0.7	0.7	54.6	55.1	0.0	0.0	0.0	0.0	
4	A	22.4	22.3	12.8		6.9	6.9	4.0	4.1	0.8	0.7	55.8	54.6	0.0	0.0	0.0	0.0	
	B	22.3	22.4	12.8		6.9	7.0	4.0	4.1	0.9	0.8	56.7	55.1	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.7		7.0	7.0	3.9	3.9	0.8	0.7	55.2	54.7	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.7		6.9	6.9	3.9	3.8	0.7	0.7	54.2	54.7	0.0	0.0	0.0	0.0	
5	A	22.3	22.2	12.8		6.9	7.0	3.8	4.1	0.9	0.8	55.7	54.7	0.0	0.0	0.0	0.0	
	B	22.4	22.2	12.7		6.9	7.0	3.9	4.1	0.8	0.9	55.1	55.6	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.7		6.9	6.9	4.0	4.0	0.7	0.8	54.7	53.8	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.6		7.0	7.0	4.0	3.8	0.7	0.9	55.0	54.7	0.0	0.0	0.0	0.0	
6	A	22.3	22.3	12.7		6.9	7.0	4.0	4.0	0.7	0.8	55.1	54.8	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.6		6.9	7.0	4.0	4.0	0.7	0.9	56.2	54.5	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7		6.9	7.0	4.0	4.0	0.7	0.7	55.0	54.7	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.6		6.9	7.0	3.9	3.9	0.8	0.7	55.1	53.2	0.0	0.0	0.0	0.0	
7	A	22.4	22.3	12.6		6.8	7.0	3.8	4.0	0.8	0.8	55.6	55.1	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.7		7.0	7.0	3.8	4.0	0.8	0.7	54.5	55.9	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.7		7.0	7.0	4.0	3.8	0.9	0.8	53.9	54.6	0.0	0.0	0.0	0.0	
	D	22.4	22.2	12.8		7.0	7.0	4.0	3.8	0.7	0.7	53.7	55.9	0.0	0.0	0.0	0.0	
8	A	22.3	22.3	12.8		6.9	7.0	4.0	3.9	0.7	0.9	54.2	54.7	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6		7.0	7.0	4.0	3.9	0.8	0.7	54.2	54.6	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.6		7.0	7.0	4.1	4.0	0.7	0.7	53.6	55.2	0.0	0.0	0.0	0.0	
	D	22.4	22.2	12.7		7.0	7.0	4.0	4.1	0.7	0.8	55.5	56.0	0.0	0.0	0.0	0.0	
9	A	22.4	22.3	12.7		6.9	7.0	4.1	3.8	0.7	0.9	54.8	55.7	0.0	0.0	0.0	0.0	
	B	22.3	22.3	12.8		6.9	6.9	3.8	4.0	0.7	0.8	55.1	56.0	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7		6.9	7.0	4.1	4.0	0.8	0.7	54.7	55.9	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.8		7.0	6.9	4.1	3.8	0.8	0.8	54.8	54.8	0.0	0.0	0.0	0.0	
10	A	22.4	22.3	12.7		6.7	6.8	4.0	3.9	0.8	0.9	53.6	54.1	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.7		6.4	6.5	3.9	3.8	0.8	0.9	54.3	54.9	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.7		6.9	7.0	4.1	4.0	0.7	0.7	55.6	55.9	0.0	0.0	0.0	0.0	
	D	22.3	22.4	12.8		6.9	7.0	3.9	4.0	0.7	0.7	57.7	58.3	0.0	0.0	0.0	0.0	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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Tier 1 Parameters

HS-1 (1:4) 0.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
11	A	22.4	22.3	12.9	4430.0	6.8	6.9	4.1	4.0	0.7	0.7	55.5	56.8	0.0	0.0	0.0	0.0	
	B	22.3	22.4	12.8	4820.0	7.0	6.9	4.1	4.1	0.7	0.8	54.7	55.3	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7	4370.0	6.9	6.8	4.0	4.0	0.8	0.9	55.5	56.8	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.6	4780.0	6.9	6.9	4.0	4.1	0.7	0.8	56.5	56.8	0.0	0.0	0.0	0.0	
12	A	22.4	22.2	12.6	4350.0	7.0	7.0	4.1	4.0	0.7	0.7	55.4	54.2	0.0	0.0	0.0	0.0	
	B	22.4	22.2	12.7	4710.0	7.0	6.9	4.0	4.1	0.7	0.7	53.5	54.8	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.7	4510.0	6.9	7.0	4.1	3.8	0.8	0.7	53.8	54.6	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.7	4580.0	6.9	7.0	4.0	3.9	0.7	0.8	56.0	55.7	0.0	0.0	0.0	0.0	
13	A	22.4	22.3	12.8	4860.0	6.9	7.0	4.0	4.1	0.8	0.7	53.6	54.6	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6	4720.0	7.0	7.0	4.0	4.0	0.7	0.8	55.1	54.9	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7	4850.0	7.0	7.0	3.9	4.0	0.7	0.8	54.7	55.8	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.8	4760.0	6.8	7.0	3.8	4.0	0.9	0.7	55.9	55.7	0.0	0.0	0.0	0.0	
14	A	22.4	22.3	12.7	4610.0	6.9	7.0	4.0	4.0	0.8	0.8	55.3	54.7	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6	4210.0	6.9	7.0	4.0	3.8	0.9	0.9	54.9	54.7	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.7	4390.0	7.0	7.0	4.0	4.0	0.8	0.9	55.1	55.3	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.7	4310.0	7.0	7.0	4.0	3.9	0.9	0.7	54.8	55.0	0.0	0.0	0.0	0.0	
15	A	22.4	22.3	12.7	4310.0	6.9	6.9	4.1	3.8	0.8	0.9	54.6	56.0	0.0	0.0	0.0	0.0	
	B	22.4	22.2	12.7	4290.0	6.9	7.0	3.9	3.8	0.8	0.7	54.9	55.0	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6	4320.0	6.9	7.0	4.1	3.9	0.9	0.8	55.1	54.2	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.6	4470.0	7.0	7.0	4.1	4.0	0.8	0.8	55.6	54.8	0.0	0.0	0.0	0.0	
16	A	22.3	22.3	12.7	4310.0	6.9	7.0	4.0	3.9	0.9	0.9	55.1	55.6	0.0	0.0	0.0	0.0	
	B	22.3	22.3	12.7	4350.0	7.0	7.0	3.8	3.9	0.8	0.8	54.1	54.7	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.6	4370.0	7.0	6.9	4.1	4.1	0.9	0.9	54.3	53.4	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.6	4310.0	7.0	6.9	4.0	4.0	0.7	0.9	53.0	54.9	0.0	0.0	0.0	0.0	
17	A	22.4	22.3	12.7	4270.0	7.2	6.9	4.1	3.8	0.9	0.8	55.1	54.8	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.8	4610.0	7.1	6.9	4.1	3.8	0.9	0.8	55.1	54.8	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7	4370.0	7.0	6.8	4.1	3.8	0.9	0.8	55.1	54.3	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.7	4390.0	6.9	6.8	4.1	3.8	0.9	0.8	55.1	54.3	0.0	0.0	0.0	0.0	
18	A	22.2	22.2	12.6	4850.0	7.1	6.9	4.0	3.8	0.8	0.8	54.6	54.5	0.0	0.0	0.0	0.0	
	B	22.2	22.2	12.6	4670.0	7.1	6.9	4.0	3.8	0.8	0.8	55.9	54.5	0.0	0.0	0.0	0.0	
	C	22.2	22.2	12.7	4340.0	6.8	6.8	4.0	3.9	0.9	0.7	54.2	54.3	0.0	0.0	0.0	0.0	
	D	22.2	22.2	12.7	4280.0	6.7	6.7	4.0	3.9	0.9	0.7	55.7	55.4	0.0	0.0	0.0	0.0	
19	A	22.4	22.3	12.7	4800.0	6.8	7.0	4.0	3.9	0.8	0.8	55.5	54.9	0.0	0.0	0.0	0.0	
	B	22.3	22.3	12.8	4800.0	6.8	6.9	4.0	3.9	0.9	0.8	55.3	54.8	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.6	4850.0	6.7	6.9	4.0	3.9	0.7	0.9	55.1	55.9	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.8	4810.0	6.8	6.9	3.8	4.1	0.8	0.9	55.9	55.7	0.0	0.0	0.0	0.0	
20	A	22.4	22.3	12.7	4290.0	7.0	7.0	4.1	3.9	0.8	0.9	55.0	54.3	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6	4330.0	6.9	7.0	4.0	4.0	0.7	0.9	54.7	55.1	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7	4260.0	7.0	7.0	4.1	4.0	0.8	0.9	55.6	54.9	0.0	0.0	0.0	0.0	
	D	22.4	22.2	12.7	4300.0	7.0	7.0	3.8	4.0	0.8	0.7	55.5	54.8	0.0	0.0	0.0	0.0	
21	A	22.4	22.3		4870.0	6.9		4.0		0.7		55.3		0.0	0.0			
	B	22.3	22.2		4710.0	6.8		3.8		0.7		54.1		0.0	0.0			
	C	22.3	22.2		4810.0	7.0		3.9		0.8		54.9		0.0	0.0			
	D	22.4	22.3		4710.0	6.9		3.9		0.8		55.9		0.0	0.0			
	MIN	22.2	22.2	12.4	4210	6.4	6.5	3.8	3.8	0.6	0.5	53.0	53.2	0.0	0.00	0.0	0.00	
	MAX	22.5	22.5	12.9	4870	7.2	7.1	4.1	4.1	0.9	0.9	57.7	58.4	0.0	0.00	0.0	0.00	
	MEAN	22.3	22.3	12.7	4530	6.9	7.0	4.0	4.0	0.8	0.8	55.1	55.2	0.0	0.00	0.0	0.00	
	SEM	0.01	0.01	0.01	34	0.01	0.01	0.01	0.01	0.01	0.01	0.10	0.11	0.00	0.000	0.00	0.000	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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Tier 1 Parameters

0.3 mg/L S2- 0.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.5			6.9		4.0		0.7		132.5			724.2	0.283	
	B	22.3		12.5			6.9		3.9		0.7		134.3			723.3	0.262	
	C	22.3		12.5			6.9		3.9		0.7		132.5			722.2	0.238	
	D	22.4		12.4			6.9		4.0		0.6		134.3			723.6	0.269	
1	A	22.2	22.2	12.7		6.9	6.9	3.9	3.9	0.8	0.7	132.5	133.5	721.3	0.29	724.9	0.38	
	B	22.3	22.3	12.6		6.9	6.8	4.0	3.9	0.9	0.8	130.8	131.8	720.7	0.27	725.1	0.39	
	C	22.4	22.4	12.5		6.9	6.8	4.0	4.0	0.8	0.9	131.6	133.5	721.7	0.30	724.2	0.36	
	D	22.4	22.3	12.4		6.9	6.8	4.0	4.1	0.8	0.8	133.1	131.8	721.2	0.29	724.6	0.38	
2	A	22.3	22.2	12.5		7.0	6.9	3.8	3.9	0.9	0.9	132.6	133.4	720.5	0.28	723.5	0.35	
	B	22.4	22.2	12.7		6.9	7.0	4.0	3.9	0.9	0.9	130.8	131.2	720.7	0.28	725.1	0.40	
	C	22.3	22.3	12.6		7.0	7.0	3.8	3.9	0.9	0.7	132.3	134.5	721.2	0.30	724.2	0.37	
	D	22.3	22.2	12.7		7.0	7.0	4.0	3.9	0.8	0.9	135.4	136.0	721.2	0.30	724.2	0.37	
3	A	22.3	22.3	12.7		7.0	6.9	4.0	3.9	0.7	0.8	131.6	132.8	720.5	0.28	724.2	0.38	
	B	22.3	22.2	12.7		6.9	7.0	3.9	3.9	0.7	0.7	130.8	132.6	720.7	0.29	725.1	0.41	
	C	22.3	22.2	12.6		6.9	7.0	3.8	4.0	0.8	0.8	131.6	130.2	721.3	0.30	724.5	0.39	
	D	22.3	22.2	12.6		6.9	6.9	4.1	4.1	0.8	0.8	130.2	132.0	721.3	0.30	723.6	0.36	
4	A	22.4	22.3	12.7		7.0	7.0	3.8	4.1	0.7	0.7	132.0	131.7	720.4	0.27	724.0	0.36	
	B	22.4	22.4	12.8		6.9	7.0	3.9	3.8	0.9	0.8	131.0	130.7	721.7	0.30	725.1	0.39	
	C	22.3	22.3	12.7		6.9	7.0	4.0	4.0	0.8	0.9	130.1	131.6	721.8	0.30	725.2	0.39	
	D	22.3	22.3	12.8		7.0	6.9	3.8	3.8	0.7	0.9	131.8	130.2	721.3	0.29	721.2	0.29	
5	A	22.4	22.2	12.6		7.0	7.0	3.9	3.9	0.9	0.7	131.8	130.9	720.1	0.28	724.2	0.38	
	B	22.4	22.3	12.7		6.9	7.0	3.8	3.9	0.9	0.8	132.0	131.6	720.7	0.29	725.5	0.42	
	C	22.4	22.3	12.6		6.8	6.9	3.8	4.0	0.7	0.7	132.3	130.1	722.2	0.33	725.2	0.41	
	D	22.3	22.2	12.7		6.9	7.0	3.9	3.8	0.9	0.9	130.5	132.0	721.3	0.31	723.2	0.35	
6	A	22.3	22.2	12.7		6.9	7.0	4.1	4.0	0.8	0.9	131.2	130.7	720.3	0.28	724.2	0.38	
	B	22.3	22.2	12.6		6.9	7.0	3.9	4.0	0.7	0.9	130.5	133.2	720.7	0.29	725.3	0.41	
	C	22.3	22.2	12.7		6.9	6.9	4.1	4.1	0.7	0.7	132.6	130.8	723.4	0.35	726.1	0.44	
	D	22.3	22.2	12.7		6.8	6.9	3.9	3.9	0.7	0.9	130.2	133.2	721.3	0.30	723.4	0.35	
7	A	22.4	22.3	12.8		6.9	6.8	3.8	4.0	0.9	0.8	130.3	131.1	721.4	0.30	723.1	0.34	
	B	22.3	22.2	12.8		7.0	7.0	3.8	3.9	0.9	0.8	131.6	130.0	720.7	0.28	725.3	0.40	
	C	22.4	22.2	12.8		7.0	6.9	3.8	3.8	0.8	0.9	130.4	131.2	721.2	0.29	724.0	0.36	
	D	22.4	22.3	12.7		7.0	7.0	3.9	3.9	0.8	0.7	132.9	130.0	721.5	0.30	723.4	0.35	
8	A	22.3	22.3	12.6		7.0	6.9	3.9	4.0	0.9	0.8	130.9	133.5	721.8	0.29	725.4	0.38	
	B	22.4	22.2	12.8		7.0	6.9	3.9	4.0	0.7	0.7	131.9	132.3	720.7	0.27	725.5	0.39	
	C	22.4	22.2	12.6		6.9	7.0	4.1	4.0	0.8	0.9	130.2	130.6	722.0	0.29	724.0	0.34	
	D	22.3	22.2	12.6		7.0	6.9	4.0	4.1	0.7	0.7	131.8	130.9	721.5	0.28	723.4	0.33	
9	A	22.3	22.3	12.6		6.9	7.0	3.9	4.0	0.8	0.8	138.5	139.6	720.7	0.28	725.6	0.42	
	B	22.4	22.3	12.6		7.0	7.0	3.8	3.9	0.8	0.9	130.2	131.3	720.7	0.28	725.5	0.41	
	C	22.4	22.3	12.8		7.0	6.8	4.1	3.9	0.9	0.8	130.2	131.3	721.0	0.29	724.3	0.38	
	D	22.3	22.2	12.8		7.0	6.9	4.0	4.0	0.7	0.8	130.5	131.2	722.5	0.33	723.4	0.35	
10	A	22.3	22.2	12.7		6.8	6.8	3.9	4.0	0.9	0.7	133.6	132.8	720.4	0.29	725.2	0.42	
	B	22.3	22.2	12.7		6.6	6.7	4.0	3.9	0.8	0.8	130.3	132.4	720.3	0.28	725.5	0.43	
	C	22.4	22.3	12.6		7.0	6.9	3.9	4.0	0.8	0.9	129.8	133.6	721.3	0.31	724.5	0.39	
	D	22.4	22.4	12.8		6.9	6.9	3.8	3.9	0.8	0.9	138.9	133.6	721.1	0.30	723.4	0.36	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

0.3 mg/L S2- 0.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
11	A	22.4	22.3	12.6	4310.0	6.9	7.0	3.9	3.9	0.8	0.9	138.3	139.5	721.4	0.3	724.2	0.4	
	B	22.3	22.2	12.7	4750.0	6.9	6.8	3.9	3.9	0.8	0.7	136.8	137.1	720.3	0.3	725.5	0.4	
	C	22.3	22.2	12.7	4930.0	6.8	6.7	4.0	3.9	0.7	0.8	138.4	140.6	721.3	0.3	725.5	0.4	
	D	22.3	22.2	12.7	4630.0	6.8	6.8	4.0	4.1	0.8	0.9	139.4	140.1	721.1	0.3	723.4	0.4	
12	A	22.3	22.2	12.8	4410.0	6.9	6.8	3.8	3.8	0.7	0.8	132.0	130.7	722.4	0.3	724.7	0.4	
	B	22.4	22.3	12.6	4350.0	6.8	6.9	4.0	3.9	0.8	0.8	130.7	131.4	720.3	0.3	725.5	0.4	
	C	22.3	22.3	12.7	4430.0	6.9	6.9	4.0	4.0	0.7	0.9	130.7	131.3	722.3	0.3	723.5	0.4	
	D	22.3	22.2	12.8	4610.0	6.8	6.8	3.9	4.1	0.7	0.9	130.9	131.6	721.1	0.3	723.4	0.4	
13	A	22.3	22.2	12.6	4620.0	6.8	6.9	3.9	4.0	0.9	0.8	130.7	131.2	723.4	0.4	724.1	0.4	
	B	22.4	22.3	12.6	4550.0	6.9	6.9	3.9	4.0	0.8	0.7	130.9	131.0	720.3	0.3	725.5	0.4	
	C	22.4	22.3	12.8	4770.0	7.0	6.9	4.0	4.1	0.7	0.7	134.8	131.2	722.9	0.3	722.5	0.3	
	D	22.3	22.2	12.6	4460.0	6.8	6.9	3.9	3.9	0.7	0.7	136.7	132.3	721.1	0.3	723.4	0.4	
14	A	22.4	22.2	12.8	4530.0	6.9	6.9	3.9	3.8	0.8	0.9	130.6	131.8	725.4	0.4	722.1	0.3	
	B	22.3	22.2	12.7	4350.0	6.9	6.9	4.1	3.9	0.8	0.9	132.7	130.8	720.3	0.3	725.5	0.4	
	C	22.4	22.3	12.7	4290.0	6.9	7.0	3.8	4.0	0.7	0.7	132.3	131.4	720.9	0.3	722.5	0.3	
	D	22.3	22.3	12.7	4320.0	6.9	6.9	3.9	3.9	0.8	0.8	130.6	131.1	721.1	0.3	725.4	0.4	
15	A	22.4	22.3	12.6	4290.0	6.9	6.9	4.0	4.1	0.8	0.9	130.7	131.2	724.4	0.4	723.1	0.4	
	B	22.4	22.2	12.6	4330.0	6.8	6.9	3.9	4.1	0.8	0.8	130.7	132.4	720.3	0.3	725.5	0.4	
	C	22.4	22.2	12.6	4280.0	6.8	6.9	4.0	3.8	0.8	0.9	130.6	131.6	720.9	0.3	724.5	0.4	
	D	22.4	22.2	12.7	4290.0	6.8	7.0	3.8	4.0	0.9	0.7	131.7	130.9	722.1	0.3	725.4	0.4	
16	A	22.3	22.3	12.7	4540.0	6.9	6.9	3.8	4.1	0.7	0.9	130.8	131.3	723.4	0.4	724.1	0.4	
	B	22.3	22.2	12.6	4460.0	6.9	6.9	4.0	3.9	0.8	0.9	130.0	131.8	720.3	0.3	725.5	0.4	
	C	22.3	22.2	12.8	4280.0	6.9	6.9	3.8	3.9	0.7	0.8	130.6	133.4	720.1	0.3	724.5	0.4	
	D	22.3	22.3	12.8	4390.0	6.9	6.9	4.1	4.1	0.9	0.9	132.2	131.0	722.1	0.3	727.4	0.5	
17	A	22.3	22.3	12.6	4310.0	7.0	7.2	3.8	3.9	0.9	0.9	130.6	133.4	721.4	0.3	725.1	0.4	
	B	22.4	22.3	12.7	4630.0	7.0	7.2	3.8	3.9	0.9	0.9	131.6	133.4	720.3	0.3	725.5	0.4	
	C	22.4	22.2	12.6	4270.0	7.0	7.2	4.1	3.9	0.8	0.7	130.6	133.7	720.1	0.3	724.5	0.4	
	D	22.4	22.3	12.6	4310.0	7.0	7.2	4.1	3.9	0.8	0.7	130.6	133.7	720.1	0.3	727.4	0.5	
18	A	22.3	22.2	12.6	4770.0	7.5	7.1	4.0	3.9	0.9	0.8	132.1	132.2	720.4	0.3	722.1	0.3	
	B	22.3	22.2	12.6	4640.0	7.4	7.2	4.0	3.9	0.9	0.8	130.0	132.2	720.3	0.3	725.5	0.4	
	C	22.3	22.2	12.7	4230.0	7.1	7.1	4.0	3.9	0.7	0.8	130.7	131.8	720.1	0.3	724.5	0.4	
	D	22.3	22.2	12.6	4570.0	7.1	7.1	4.0	3.9	0.7	0.8	134.1	134.6	720.1	0.3	725.4	0.4	
19	A	22.4	22.3	12.8	4570.0	6.8	6.9	3.9	4.0	0.7	0.9	133.6	131.7	721.4	0.3	724.1	0.4	
	B	22.3	22.3	12.7	4760.0	6.8	7.0	3.8	3.9	0.8	0.9	131.9	133.6	720.3	0.3	725.5	0.4	
	C	22.4	22.3	12.6	4820.0	6.7	7.0	3.9	4.0	0.8	0.9	131.7	135.6	722.1	0.3	724.5	0.4	
	D	22.4	22.3	12.7	4760.0	6.9	6.9	3.8	4.0	0.8	0.7	135.6	138.8	720.1	0.3	725.4	0.4	
20	A	22.3	22.2	12.8	4360.0	6.9	6.9	3.8	3.9	0.8	0.7	132.6	130.7	721.2	0.3	724.1	0.4	
	B	22.4	22.2	12.7	4280.0	6.9	6.9	3.8	4.0	0.7	0.9	130.6	132.3	720.3	0.3	725.5	0.4	
	C	22.4	22.3	12.6	4350.0	6.9	6.9	3.8	4.1	0.9	0.8	130.2	131.3	721.1	0.3	723.5	0.4	
	D	22.3	22.2	12.6	4290.0	6.9	6.9	3.9	3.9	0.9	0.7	132.3	130.7	720.1	0.3	725.4	0.4	
21	A	22.3	22.2		4700.0	7.0		4.0		0.7		135.6		720.2	0.3			
	B	22.3	22.3		4630.0	6.8		3.9		0.8		133.7		720.3	0.3			
	C	22.3	22.3		4760.0	6.8		3.9		0.8		131.6		721.1	0.3			
	D	22.3	22.3		4650.0	7.0		3.8		0.9		134.7		720.1	0.3			
MIN		22.2	**22.2**	**12.4**	**4230**	**6.6**	**6.7**	**3.8**	**3.8**	**0.7**	**0.6**	**129.8**	**130.0**	**720.1**	**0.27**	**721.2**	**0.24**	
MAX		22.4	**22.4**	**12.8**	**4930**	**7.5**	**7.2**	**4.1**	**4.1**	**0.9**	**0.9**	**139.4**	**140.6**	**725.4**	**0.42**	**727.4**	**0.49**	
MEAN		22.3	**22.3**	**12.7**	**4496**	**6.9**	**6.9**	**3.9**	**4.0**	**0.8**	**0.8**	**132.1**	**132.6**	**721.2**	**0.30**	**724.5**	**0.38**	
SEM		0.01	0.01	0.01	29.12	0.01	0.01	0.01	0.01	0.01	0.01	0.25	0.25	0.11	0.003	0.12	0.005	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

1.56 mg/L S2- 0.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.4			6.8		4.1		0.8		138.1			744.5	1.64	
	B	22.3		12.5			6.8		4.0		0.7		139.5			740.9	1.20	
	C	22.3		12.3			6.8		4.0		0.9		136.6			742.7	1.40	
	D	22.3		12.5			6.8		3.9		0.8		139.5			741.4	1.25	
1	A	22.2	22.3	12.8		6.8	6.8	4.1	4.0	0.9	0.8	139.8	140.1	742.8	1.62	744.9	1.91	
	B	22.3	22.4	12.5		6.8	6.8	4.1	4.0	0.7	0.8	138.7	139.3	741.6	1.47	742.9	1.63	
	C	22.4	22.4	12.4		6.8	6.7	3.9	4.0	0.7	0.8	138.7	140.2	740.2	1.31	743.0	1.64	
	D	22.4	22.3	12.5		6.8	6.7	4.1	4.1	0.9	0.8	138.5	137.5	740.6	1.36	743.4	1.70	
2	A	22.3	22.2	12.6		6.9	7.0	3.9	3.8	0.8	0.9	140.1	141.3	742.7	1.55	744.9	1.84	
	B	22.4	22.2	12.5		6.9	6.9	4.0	4.0	0.9	0.8	139.2	138.4	741.6	1.42	742.7	1.55	
	C	22.3	22.2	12.6		7.0	6.9	3.9	3.9	0.9	0.8	136.7	135.8	740.2	1.28	743.0	1.59	
	D	22.3	22.2	12.7		7.0	7.0	3.8	3.8	0.8	0.9	139.2	142.4	740.4	1.30	743.0	1.59	
3	A	22.3	22.2	12.7		6.9	6.9	3.9	4.0	0.9	0.9	137.8	139.7	742.5	1.55	744.9	1.86	
	B	22.3	22.3	12.7		7.0	7.0	3.8	3.8	0.7	0.8	136.6	138.1	741.2	1.40	742.7	1.57	
	C	22.3	22.2	12.8		6.8	6.9	3.9	4.1	0.7	0.9	138.5	139.8	742.2	1.51	743.2	1.64	
	D	22.3	22.2	12.7		7.0	6.9	4.1	4.1	0.8	0.7	139.7	140.5	740.6	1.34	743.0	1.61	
4	A	22.3	22.3	12.8		7.0	7.0	3.9	3.8	0.7	0.8	139.7	138.2	742.1	1.45	744.9	1.79	
	B	22.4	22.4	12.7		7.0	6.9	3.8	3.9	0.8	0.7	138.2	139.8	741.2	1.35	742.7	1.52	
	C	22.3	22.2	12.8		6.8	6.8	3.8	3.9	0.9	0.9	137.6	139.3	740.3	1.26	743.1	1.56	
	D	22.4	22.4	12.8		7.0	6.9	4.1	3.9	0.7	0.9	139.7	140.3	740.8	1.31	743.0	1.55	
5	A	22.4	22.3	12.6		7.0	7.0	4.0	4.1	0.7	0.8	137.6	138.8	742.8	1.57	744.7	1.81	
	B	22.3	22.3	12.8		7.0	6.9	3.8	4.1	0.8	0.8	139.0	140.2	741.2	1.39	742.7	1.56	
	C	22.4	22.3	12.6		6.9	6.9	3.9	4.0	0.8	0.8	139.3	138.2	740.3	1.30	744.4	1.77	
	D	22.3	22.3	12.7		6.9	6.9	3.8	3.9	0.8	0.8	136.7	139.2	742.7	1.56	743.2	1.62	
6	A	22.4	22.3	12.6		6.8	7.0	4.0	4.1	0.8	0.9	138.4	139.7	742.3	1.50	744.7	1.80	
	B	22.3	22.2	12.7		6.8	6.9	3.9	3.9	0.8	0.7	137.9	140.6	741.4	1.40	742.7	1.55	
	C	22.4	22.2	12.7		6.9	6.9	4.0	3.9	0.8	0.9	139.8	140.9	740.3	1.29	743.6	1.66	
	D	22.4	22.3	12.7		6.9	6.9	4.0	3.9	0.7	0.8	139.3	137.0	740.5	1.31	743.2	1.61	
7	A	22.4	22.3	12.8		7.0	6.9	3.9	3.8	0.9	0.7	139.8	137.2	743.3	1.62	744.3	1.75	
	B	22.4	22.3	12.8		6.9	6.9	3.8	4.0	0.9	0.9	140.2	141.5	741.6	1.42	743.7	1.67	
	C	22.3	22.2	12.8		7.0	7.0	3.8	3.9	0.8	0.7	137.8	138.8	740.3	1.28	743.3	1.62	
	D	22.4	22.3	12.7		6.9	6.9	3.8	3.9	0.8	0.7	140.2	138.7	740.7	1.32	743.2	1.61	
8	A	22.3	22.2	12.6		7.0	6.9	3.9	4.0	0.7	0.7	137.8	139.4	742.2	1.42	746.3	1.96	
	B	22.3	22.3	12.7		6.9	7.0	3.9	4.0	0.8	0.8	140.2	138.7	741.4	1.33	742.7	1.48	
	C	22.3	22.3	12.7		6.8	6.8	4.0	4.1	0.7	0.9	139.1	137.8	740.1	1.21	743.4	1.56	
	D	22.3	22.2	12.7		6.8	6.9	4.1	3.9	0.8	0.9	140.2	138.5	740.5	1.24	743.2	1.54	
9	A	22.3	22.2	12.8		7.0	7.0	3.9	4.0	0.8	0.8	138.5	139.6	742.2	1.50	744.3	1.77	
	B	22.4	22.3	12.7		7.0	7.0	4.0	3.9	0.8	0.7	138.7	138.5	741.4	1.41	742.5	1.54	
	C	22.4	22.3	12.6		7.0	6.9	4.0	3.9	0.9	0.8	139.8	138.4	740.1	1.28	743.4	1.65	
	D	22.4	22.2	12.6		6.9	6.8	3.9	4.0	0.8	0.9	137.6	138.1	741.5	1.42	743.2	1.62	
10	A	22.4	22.3	12.6		6.9	6.8	3.8	3.9	0.7	0.8	136.7	138.9	741.7	1.50	744.3	1.84	
	B	22.3	22.2	12.7		6.6	6.6	4.0	3.9	0.7	0.8	141.7	144.5	741.4	1.47	743.7	1.76	
	C	22.4	22.2	12.6		6.9	6.9	4.0	3.9	0.7	0.9	140.1	138.2	740.8	1.40	743.2	1.69	
	D	22.4	22.4	12.8		6.8	6.9	3.9	4.0	0.9	0.7	137.2	138.5	740.5	1.37	743.2	1.69	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

1.56 mg/L S2- 0.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
11	A	22.3	22.4	12.7	4480.0	6.8	6.8	3.9	3.8	0.7	0.9	140.2	141.7	741.1	1.4	744.3	1.8	
	B	22.3	22.2	12.6	4440.0	6.8	6.9	3.8	3.9	0.8	0.9	136.3	137.4	741.4	1.5	743.7	1.8	
	C	22.3	22.3	12.7	4720.0	6.9	6.8	3.9	4.0	0.7	0.8	133.2	138.6	741.8	1.5	743.2	1.7	
	D	22.4	22.3	12.7	4700.0	6.8	6.8	3.8	3.9	0.8	0.9	142.3	142.3	740.5	1.4	743.8	1.8	
12	A	22.3	22.2	12.8	4220.0	6.8	6.8	3.8	3.9	0.9	0.8	139.6	138.7	740.1	1.3	744.3	1.8	
	B	22.3	22.3	12.6	4420.0	6.9	6.7	3.9	4.1	0.9	0.9	137.5	138.8	741.4	1.5	744.7	1.9	
	C	22.4	22.3	12.8	4500.0	6.8	6.8	4.1	4.0	0.8	0.8	138.6	139.0	741.8	1.5	743.2	1.7	
	D	22.4	22.2	12.6	4540.0	6.8	6.9	3.9	4.0	0.8	0.9	139.7	138.3	742.5	1.6	745.8	2.1	
13	A	22.3	22.2	12.6	4440.0	6.7	6.8	3.9	4.1	0.7	0.9	139.8	138.7	740.1	1.3	745.3	2.0	
	B	22.3	22.3	12.7	4300.0	6.9	6.9	3.8	3.9	0.9	0.7	139.2	138.6	742.4	1.6	744.7	1.9	
	C	22.4	22.2	12.6	4370.0	6.6	6.8	3.8	3.9	0.8	0.9	144.6	141.5	742.8	1.6	743.2	1.7	
	D	22.4	22.2	12.6	4310.0	6.7	6.9	3.9	3.9	0.7	0.8	143.9	139.0	742.5	1.6	745.8	2.1	
14	A	22.3	22.2	12.7	4590.0	6.8	6.9	4.0	4.0	0.7	0.7	137.7	139.0	742.1	1.6	745.3	2.0	
	B	22.3	22.2	12.8	4310.0	6.8	6.9	4.1	4.1	0.7	0.7	139.5	138.9	742.4	1.6	744.7	1.9	
	C	22.3	22.2	12.8	4410.0	6.8	6.9	3.9	4.1	0.9	0.7	139.6	138.8	740.8	1.4	743.2	1.7	
	D	22.3	22.2	12.6	4450.0	6.8	6.9	3.8	3.8	0.8	0.8	137.1	139.7	742.5	1.6	746.8	2.2	
15	A	22.4	22.2	12.6	4340.0	6.8	6.9	3.9	3.8	0.8	0.8	139.8	138.7	742.1	1.6	745.3	2.0	
	B	22.3	22.2	12.7	4280.0	6.8	6.8	3.8	4.1	0.7	0.9	138.8	137.9	742.4	1.6	746.7	2.2	
	C	22.3	22.2	12.8	4460.0	6.7	6.8	3.9	4.0	0.8	0.9	139.8	138.8	741.8	1.5	743.2	1.7	
	D	22.3	22.2	12.7	4310.0	6.8	6.8	3.8	3.9	0.9	0.7	139.0	137.9	743.5	1.7	746.8	2.2	
16	A	22.3	22.2	12.7	4460.0	6.9	6.9	3.8	4.1	0.8	0.7	139.7	138.4	740.1	1.3	746.3	2.1	
	B	22.3	22.3	12.6	4450.0	6.8	6.9	4.0	4.1	0.9	0.7	138.8	139.0	742.4	1.6	746.7	2.2	
	C	22.3	22.2	12.7	4290.0	6.8	6.9	4.1	3.9	0.7	0.7	136.9	138.8	741.8	1.5	743.2	1.7	
	D	22.3	22.3	12.6	4360.0	6.8	6.7	4.1	3.8	0.8	0.8	139.8	138.2	743.5	1.7	746.8	2.2	
17	A	22.3	22.3	12.6	4290.0	6.8	6.8	3.9	3.9	0.8	0.7	139.8	135.6	740.1	1.3	747.3	2.3	
	B	22.3	22.3	12.6	4490.0	6.8	6.8	4.0	3.9	0.8	0.7	140.1	135.6	742.4	1.6	746.7	2.2	
	C	22.4	22.3	12.6	4290.0	6.8	6.8	4.2	3.9	0.8	0.8	137.7	133.8	740.8	1.4	743.2	1.7	
	D	22.4	22.3	12.6	4490.0	6.8	6.8	4.2	3.9	0.7	0.8	137.7	133.8	741.5	1.5	746.8	2.2	
18	A	22.3	22.3	12.6	4370.0	6.8	7.0	3.8	3.9	0.8	0.8	138.8	139.6	740.1	1.3	746.3	2.1	
	B	22.3	22.3	12.6	4130.0	6.8	7.0	3.8	3.9	0.8	0.8	137.8	139.6	740.4	1.4	746.7	2.2	
	C	22.3	22.3	12.7	4840.0	6.8	6.9	3.9	3.8	0.7	0.8	137.8	137.2	740.8	1.4	743.2	1.7	
	D	22.3	22.3	12.6	4440.0	6.8	6.9	3.9	3.8	0.7	0.9	138.9	137.2	741.5	1.5	745.8	2.1	
19	A	22.4	22.2	12.7	4490.0	6.9	6.8	3.9	3.8	0.7	0.9	140.4	139.8	740.8	1.4	745.3	2.0	
	B	22.3	22.3	12.8	4510.0	6.8	6.8	3.8	4.1	0.7	0.9	140.9	139.7	740.4	1.4	746.7	2.2	
	C	22.4	22.3	12.7	4730.0	6.8	7.0	3.9	4.0	0.9	0.7	133.5	138.7	740.8	1.4	743.2	1.7	
	D	22.3	22.2	12.6	4640.0	6.8	6.8	3.9	3.9	0.7	0.9	143.4	145.6	740.5	1.4	743.8	1.8	
20	A	22.4	22.3	12.6	4470.0	6.8	6.9	4.0	4.1	0.7	0.8	138.7	139.4	741.8	1.5	744.3	1.8	
	B	22.3	22.2	12.8	4290.0	6.8	6.9	3.9	3.8	0.9	0.8	138.8	139.5	740.4	1.4	746.7	2.2	
	C	22.4	22.3	12.7	4390.0	6.8	6.9	3.9	4.0	0.9	0.7	138.8	139.4	740.1	1.3	743.2	1.7	
	D	22.3	22.2	12.6	4400.0	6.9	6.9	3.8	4.0	0.7	0.8	139.6	138.5	740.5	1.4	742.8	1.6	
21	A	22.3	22.2		4630.0	6.9		3.8		0.8		140.7		741.5	1.5			
	B	22.3	22.3		4490.0	6.9		4.1		0.9		139.9		740.0	1.3			
	C	22.4	22.3		4500.0	6.8		3.8		0.7		135.8		740.1	1.3			
	D	22.4	22.3		4530.0	6.8		3.8		0.9		141.2		740.3	1.3			
	MIN	22.2	22.2	12.3	4130	6.6	6.6	3.8	3.8	0.7	0.7	133.2	133.8	740.0	1.21	740.9	1.20	
	MAX	22.4	22.4	12.8	4840	7.0	7.0	4.2	4.1	0.9	0.9	144.6	145.6	743.5	1.73	747.3	2.32	
	MEAN	22.3	22.3	12.7	4445	6.9	6.9	3.9	4.0	0.8	0.8	139.0	139.0	741.3	1.43	744.2	1.79	
	SEM	0.01	0.01	0.01	21.73	0.01	0.01	0.01	0.01	0.01	0.01	0.20	0.20	0.10	0.013	0.16	0.027	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

3.12 mg/L S2- 0.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.6			6.7		4.0		0.8		144.7			744.6	1.65	
	B	22.3		12.6			6.7		4.0		0.8		146.2			752.8	3.36	
	C	22.4		12.4			6.6		4.1		0.7		143.8			751.1	2.90	
	D	22.3		12.5			6.7		4.0		0.9		146.2			754.0	3.73	
1	A	22.2	22.3	12.8		6.7	6.7	4.0	4.1	0.8	0.9	142.9	144.9	748.9	2.64	752.6	3.55	
	B	22.3	22.3	12.6		6.7	6.7	4.0	4.1	0.7	0.7	142.6	144.8	749.5	2.77	751.6	3.27	
	C	22.4	22.4	12.3		6.7	6.6	3.8	4.0	0.8	0.9	144.9	145.6	748.9	2.64	752.1	3.41	
	D	22.5	22.4	12.4		6.8	6.7	3.9	4.0	0.7	0.8	145.8	143.6	749.5	2.77	753.5	3.81	
2	A	22.4	22.2	12.7		7.0	7.0	3.8	3.9	0.8	0.8	149.8	150.7	748.5	2.43	752.2	3.23	
	B	22.4	22.2	12.8		7.0	7.0	3.9	4.1	0.8	0.7	147.6	147.5	749.1	2.54	751.6	3.08	
	C	22.4	22.3	12.7		6.9	7.0	4.1	4.0	0.9	0.9	145.0	144.6	748.9	2.50	750.3	2.79	
	D	22.4	22.3	12.5		6.9	7.0	3.9	3.8	0.9	0.7	143.4	144.2	749.5	2.62	753.5	3.57	
3	A	22.3	22.3	12.6		7.0	7.0	3.8	4.0	0.7	0.9	143.0	144.7	748.5	2.46	752.8	3.43	
	B	22.3	22.2	12.8		7.0	7.0	3.9	4.1	0.8	0.9	142.4	143.9	749.0	2.56	751.6	3.13	
	C	22.3	22.2	12.6		6.9	6.8	3.8	4.0	0.8	0.8	141.0	143.7	748.9	2.54	750.5	2.87	
	D	22.3	22.2	12.7		6.8	6.8	4.1	3.9	0.7	0.9	143.2	142.6	748.1	2.39	753.5	3.62	
4	A	22.3	22.2	12.6		6.8	7.0	3.8	3.9	0.9	0.8	142.6	141.7	748.0	2.28	752.4	3.19	
	B	22.3	22.3	12.7		7.0	6.8	3.9	3.8	0.7	0.7	141.7	142.6	749.4	2.54	751.1	2.89	
	C	22.4	22.2	12.7		6.8	6.8	3.9	4.0	0.9	0.8	142.8	141.8	748.7	2.40	750.8	2.82	
	D	22.3	22.4	12.7		6.8	6.9	4.0	4.1	0.9	0.8	140.7	143.5	749.8	2.62	753.5	3.48	
5	A	22.3	22.2	12.6		6.9	6.9	3.9	4.0	0.9	0.9	142.2	141.7	748.0	2.33	752.4	3.25	
	B	22.3	22.2	12.6		6.9	7.0	4.0	4.1	0.8	0.9	141.7	142.7	749.1	2.53	751.3	2.99	
	C	22.3	22.3	12.7		7.0	6.9	4.0	3.8	0.9	0.9	140.4	141.3	749.7	2.65	750.2	2.75	
	D	22.3	22.3	12.8		6.9	6.9	3.8	4.1	0.9	0.7	142.8	141.0	749.1	2.53	753.8	3.62	
6	A	22.4	22.3	12.6		6.8	6.9	3.9	3.9	0.8	0.7	142.3	141.6	748.0	2.32	753.5	3.52	
	B	22.4	22.3	12.6		6.8	6.9	4.0	4.1	0.8	0.8	140.2	143.8	749.8	2.66	751.3	2.98	
	C	22.3	22.3	12.7		6.8	6.9	4.1	3.9	0.8	0.9	142.6	141.5	748.7	2.44	750.2	2.74	
	D	22.4	22.3	12.7		6.8	7.0	4.1	3.9	0.8	0.8	142.6	140.5	749.5	2.60	753.2	3.44	
7	A	22.3	22.2	12.6		6.9	6.8	4.0	3.8	0.9	0.9	141.7	143.8	749.0	2.51	754.5	3.84	
	B	22.4	22.3	12.6		6.8	6.8	3.9	3.8	0.9	0.9	142.3	142.4	749.3	2.57	751.4	3.02	
	C	22.3	22.3	12.6		6.9	7.0	3.9	3.9	0.7	0.7	140.2	141.1	748.7	2.46	750.2	2.76	
	D	22.3	22.3	12.8		6.8	6.9	3.8	4.0	0.9	0.8	141.8	142.2	748.5	2.42	753.5	3.56	
8	A	22.4	22.2	12.7		6.9	6.8	4.1	3.9	0.7	0.7	142.8	141.1	748.9	2.40	752.5	3.17	
	B	22.3	22.3	12.7		6.8	6.8	4.1	3.9	0.9	0.8	142.9	141.8	749.3	2.47	751.6	2.96	
	C	22.3	22.3	12.6		6.8	6.8	3.9	4.0	0.7	0.9	142.0	141.9	749.3	2.47	750.5	2.71	
	D	22.4	22.3	12.6		6.9	6.8	3.9	3.9	0.9	0.7	141.8	140.6	749.5	2.51	753.5	3.43	
9	A	22.3	22.2	12.6		6.9	6.9	3.8	3.9	0.9	0.9	142.2	143.4	748.0	2.35	753.3	3.54	
	B	22.3	22.2	12.7		6.9	7.0	4.0	4.1	0.7	0.9	141.4	141.9	749.5	2.64	751.6	3.10	
	C	22.4	22.2	12.7		6.9	6.8	3.8	4.1	0.8	0.7	142.7	141.5	749.3	2.60	750.5	2.85	
	D	22.4	22.3	12.7		6.9	6.7	3.8	3.9	0.9	0.7	142.3	140.0	749.5	2.64	753.1	3.49	
10	A	22.3	22.3	12.8		6.8	6.7	3.9	4.0	0.9	0.7	140.9	140.8	748.3	2.51	752.1	3.37	
	B	22.3	22.2	12.8		6.8	6.8	3.9	4.0	0.8	0.7	146.6	145.4	749.5	2.76	751.6	3.24	
	C	22.3	22.3	12.7		6.7	6.7	3.8	3.9	0.9	0.8	139.3	137.8	748.7	2.59	750.5	2.98	
	D	22.3	22.4	12.7		6.8	6.9	4.0	4.1	0.8	0.8	145.8	140.6	749.5	2.76	753.1	3.64	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

3.12 mg/L S2- 0.8 mg/L Fe

IMAM01-00428

Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Headspace DO Pre-Renew	Headspace DO Post-Renew	Aquatic DO Pre-Renew	Aquatic DO Post-Renew	Pre-Renew ORP	Post-Renew ORP	Sulfide, mV Reading (mV)	Sulfide, Calc Conc (mg/L)	Sulfide, mV Reading (mV)	Sulfide, Calc Conc (mg/L)	Comments/Observations
11	A	22.4	22.3	12.8	4730.0	6.8	7.0	4.0	3.9	0.9	0.7	133.2	134.6	748.7	2.6	752.1	3.4	
	B	22.4	22.2	12.6	4230.0	7.0	6.8	3.9	3.8	0.9	0.9	146.6	148.5	749.5	2.8	751.6	3.2	
	C	22.4	22.2	12.6	4650.0	6.9	6.8	3.8	3.9	0.7	0.8	140.2	142.4	748.7	2.6	750.5	3.0	
	D	22.3	22.3	12.7	4660.0	6.8	6.8	3.8	3.9	0.8	0.9	142.3	142.3	749.5	2.8	755.1	4.3	
12	A	22.4	22.3	12.6	4500.0	6.8	6.8	4.1	4.1	0.8	0.7	141.2	140.3	748.7	2.6	752.1	3.4	
	B	22.3	22.2	12.7	4290.0	6.7	6.7	3.8	4.0	0.9	0.8	140.6	141.9	749.5	2.8	752.6	3.5	
	C	22.4	22.2	12.8	4600.0	6.7	6.8	3.9	4.1	0.7	0.9	140.2	141.1	748.7	2.6	750.5	3.0	
	D	22.4	22.2	12.6	4470.0	6.8	6.8	3.8	4.0	0.8	0.7	141.4	140.9	747.5	2.4	754.1	3.9	
13	A	22.4	22.3	12.7	4350.0	6.7	6.7	4.1	4.0	0.7	0.9	142.3	141.0	749.7	2.8	753.1	3.6	
	B	22.3	22.2	12.8	4090.0	6.7	6.8	3.8	3.8	0.7	0.9	141.7	141.5	749.5	2.8	752.6	3.5	
	C	22.3	22.3	12.6	4240.0	6.7	6.8	3.8	3.9	0.8	0.9	144.6	141.5	748.7	2.6	752.5	3.5	
	D	22.3	22.2	12.7	4380.0	6.7	6.7	4.1	4.1	0.8	0.9	149.6	141.2	745.5	2.0	754.1	3.9	
14	A	22.3	22.2	12.7	4620.0	6.7	6.8	4.0	4.1	0.9	0.7	141.2	140.3	749.7	2.8	753.1	3.6	
	B	22.3	22.2	12.8	4390.0	6.8	6.8	3.9	4.1	0.7	0.8	142.4	142.7	747.5	2.4	752.6	3.5	
	C	22.3	22.2	12.6	4400.0	6.7	6.8	4.1	3.8	0.8	0.8	142.1	141.0	748.7	2.6	752.5	3.5	
	D	22.4	22.2	12.8	4400.0	6.7	6.9	4.0	3.9	0.7	0.9	141.3	140.4	745.5	2.0	754.1	3.9	
15	A	22.3	22.2	12.7	4420.0	6.7	6.8	3.9	3.8	0.9	0.7	141.7	140.3	749.7	2.8	755.1	4.3	
	B	22.3	22.3	12.8	4370.0	6.8	6.8	4.1	3.9	0.9	0.9	142.0	140.7	748.5	2.5	752.6	3.5	
	C	22.4	22.3	12.6	4490.0	6.7	6.8	3.9	4.0	0.9	0.8	142.7	140.2	748.7	2.6	752.5	3.5	
	D	22.3	22.2	12.8	4390.0	6.7	6.8	3.8	4.1	0.7	0.9	142.3	140.7	745.5	2.0	754.1	3.9	
16	A	22.3	22.2	12.6	4420.0	6.8	6.9	3.9	3.9	0.9	0.7	141.2	140.7	749.7	2.8	755.1	4.3	
	B	22.3	22.2	12.8	4510.0	6.8	6.8	4.1	4.0	0.8	0.8	142.7	141.0	748.5	2.5	750.6	3.0	
	C	22.3	22.3	12.7	4430.0	6.7	6.8	3.8	3.8	0.9	0.7	140.7	142.2	746.7	2.2	752.5	3.5	
	D	22.4	22.3	12.6	4490.0	6.7	6.7	4.0	3.9	0.8	0.7	143.4	142.1	745.5	2.0	751.1	3.1	
17	A	22.3	22.2	12.7	4460.0	6.9	7.1	4.1	3.8	0.8	0.8	142.7	141.8	747.7	2.4	755.1	4.3	
	B	22.3	22.3	12.7	4460.0	7.0	7.1	4.1	3.8	0.8	0.8	143.1	142.3	748.5	2.5	752.6	3.5	
	C	22.4	22.3	12.7	4280.0	7.1	7.1	3.9	4.0	0.9	0.8	141.3	139.6	746.7	2.2	752.5	3.5	
	D	22.4	22.2	12.7	4500.0	7.1	7.1	3.9	4.0	0.7	0.8	141.3	139.6	745.5	2.0	751.1	3.1	
18	A	22.3	22.3	12.6	4240.0	7.1	7.2	3.8	3.9	0.7	0.8	141.1	138.7	745.7	2.1	754.1	3.9	
	B	22.3	22.3	12.6	4830.0	7.2	7.2	3.8	3.9	0.7	0.8	142.2	138.7	746.5	2.2	752.6	3.5	
	C	22.3	22.3	12.6	4370.0	7.1	7.2	4.1	3.9	0.9	0.8	143.0	130.3	746.7	2.2	751.5	3.2	
	D	22.4	22.3	12.6	4320.0	7.1	7.2	4.1	3.9	0.9	0.9	141.9	130.2	745.5	2.0	751.1	3.1	
19	A	22.3	22.2	12.6	4470.0	6.7	6.9	3.8	4.0	0.7	0.8	150.2	149.9	745.7	2.1	752.1	3.4	
	B	22.3	22.3	12.6	4300.0	6.8	6.8	3.9	4.0	0.7	0.9	141.6	138.5	744.5	1.9	752.6	3.5	
	C	22.4	22.3	12.6	4610.0	6.9	6.8	4.0	3.9	0.9	0.8	147.9	149.5	746.7	2.2	753.5	3.8	
	D	22.3	22.2	12.7	4500.0	6.9	6.8	4.1	3.9	0.8	0.8	146.3	148.9	745.5	2.0	751.1	3.1	
20	A	22.3	22.2	12.6	4510.0	6.7	6.8	4.0	4.0	0.9	0.9	141.9	141.6	745.7	2.1	750.1	2.9	
	B	22.4	22.2	12.8	4420.0	6.8	6.9	4.1	3.8	0.7	0.7	142.5	140.9	742.5	1.6	752.6	3.5	
	C	22.4	22.2	12.8	4310.0	6.7	6.7	3.8	3.9	0.8	0.7	141.1	140.3	746.7	2.2	753.5	3.8	
	D	22.4	22.3	12.8	4380.0	6.7	6.8	4.1	4.1	0.8	0.8	143.2	141.2	745.5	2.0	751.1	3.1	
21	A	22.3	22.2		4400.0	6.8		3.8		0.9		143.1		745.1	2.0			
	B	22.4	22.3		4330.0	7.0		4.1		0.8		142.7		742.5	1.6			
	C	22.3	22.2		4420.0	6.7		4.1		0.7		141.7		745.7	2.1			
	D	22.4	22.3		4310.0	7.0		3.8		0.8		145.6		745.5	2.0			
	MIN	22.2	**22.2**	**12.3**	**4090**	**6.7**	**6.6**	**3.8**	**3.8**	**0.7**	**0.7**	**133.2**	**130.2**	**742.5**	**1.60**	**744.6**	**1.65**	
	MAX	22.5	**22.4**	**12.8**	**4830**	**7.2**	**7.2**	**4.1**	**4.1**	**0.9**	**0.9**	**150.2**	**150.7**	**749.8**	**2.80**	**755.1**	**4.26**	
	MEAN	22.3	**22.3**	**12.7**	**4430**	**6.8**	**6.9**	**3.9**	**4.0**	**0.8**	**0.8**	**142.7**	**142.1**	**748.0**	**2.42**	**752.3**	**3.35**	
	SEM	0.01	0.01	0.01	21.21	0.01	0.01	0.01	0.01	0.01	0.01	0.26	0.36	0.19	0.031	0.17	0.046	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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Tier 1 Parameters

7.80 mg/L S2- 0.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.5			6.6		4.0		0.8		155.6			763.5	8.48	
	B	22.3		12.5			6.5		4.0		0.9		157.3			762.9	8.05	
	C	22.3		12.4			6.5		3.9		0.8		151.9			763.8	8.70	
	D	22.3		12.4			6.6		4.1		0.7		155.5			763.1	8.19	
1	A	22.2	22.3	12.7		6.5	6.6	4.0	4.0	0.7	0.8	151.5	153.7	760.1	6.47	763.4	8.43	
	B	22.4	22.3	12.5		6.6	6.6	4.0	4.0	0.8	0.9	151.8	155.5	760.3	6.58	763.9	8.78	
	C	22.4	22.4	12.4		6.6	6.5	3.8	4.0	0.9	0.7	152.7	154.8	760.2	6.52	762.5	7.85	
	D	22.4	22.3	12.5		6.6	6.6	4.0	3.9	0.9	0.8	156.2	152.9	760.4	6.63	763.1	8.23	
2	A	22.4	22.2	12.8		6.8	6.8	4.0	4.0	0.7	0.8	154.3	155.1	760.2	5.98	763.4	7.65	
	B	22.4	22.2	12.6		6.9	6.9	3.8	3.9	0.7	0.7	149.8	151.3	760.3	6.03	763.5	7.71	
	C	22.4	22.3	12.8		6.9	6.9	4.1	4.0	0.8	0.7	149.8	150.1	760.0	5.89	762.7	7.25	
	D	22.4	22.3	12.6		6.8	6.8	4.0	3.8	0.7	0.9	150.8	151.2	760.4	6.07	763.0	7.42	
3	A	22.3	22.3	12.6		6.8	6.9	3.8	3.8	0.8	0.9	151.2	153.1	763.0	7.53	763.4	7.77	
	B	22.3	22.3	12.6		6.9	6.9	4.0	4.1	0.9	0.9	150.6	152.2	760.5	6.21	763.4	7.77	
	C	22.3	22.3	12.7		7.0	7.0	4.0	4.0	0.9	0.7	149.0	151.2	760.1	6.02	762.5	7.24	
	D	22.3	22.3	12.6		6.9	6.8	3.9	3.9	0.8	0.9	156.0	153.8	760.4	6.16	763.1	7.59	
4	A	22.4	22.2	12.6		6.9	6.9	3.8	4.1	0.9	0.9	151.9	150.4	763.1	7.27	763.1	7.27	
	B	22.3	22.3	12.7		6.8	6.8	3.8	3.9	0.7	0.8	150.0	151.5	760.5	5.95	763.5	7.50	
	C	22.4	22.3	12.7		6.8	6.9	3.9	4.1	0.7	0.7	151.9	150.7	760.7	6.05	762.5	6.94	
	D	22.3	22.2	12.7		6.8	6.9	3.8	4.0	0.9	0.7	147.8	152.2	760.5	5.95	763.0	7.22	
5	A	22.4	22.3	12.7		6.8	6.9	4.1	3.8	0.8	0.7	150.3	152.3	763.1	7.33	763.4	7.50	
	B	22.3	22.2	12.7		6.8	6.9	4.0	4.0	0.7	0.7	148.3	150.0	760.3	5.93	763.2	7.39	
	C	22.3	22.3	12.8		7.0	6.8	4.1	3.9	0.9	0.7	150.6	151.6	760.1	5.84	762.5	7.00	
	D	22.4	22.3	12.8		6.8	6.8	3.9	4.0	0.7	0.7	150.9	151.7	762.0	6.74	761.3	6.39	
6	A	22.4	22.3	12.6		6.9	6.9	3.9	3.9	0.8	0.9	151.6	150.2	763.1	7.33	764.7	8.28	
	B	22.4	22.3	12.7		6.8	7.0	4.1	4.0	0.9	0.7	153.4	152.7	760.0	5.79	763.2	7.39	
	C	22.3	22.3	12.6		6.8	6.9	3.9	3.9	0.9	0.7	150.9	149.9	761.1	6.29	762.5	7.00	
	D	22.4	22.3	12.7		6.8	6.8	4.1	4.0	0.7	0.9	149.5	151.1	760.2	5.88	763.6	7.62	
7	A	22.4	22.2	12.7		6.9	6.9	4.0	3.9	0.8	0.9	152.2	149.7	763.1	7.47	763.7	7.83	
	B	22.4	22.3	12.6		6.8	6.9	3.8	3.8	0.7	0.9	149.7	150.7	760.0	5.88	764.6	8.39	
	C	22.4	22.3	12.6		6.9	7.0	4.0	3.8	0.8	0.9	153.9	150.9	760.5	6.11	762.5	7.13	
	D	22.3	22.3	12.6		6.8	7.0	3.9	4.0	0.7	0.9	150.4	149.5	761.2	6.45	763.8	7.89	
8	A	22.4	22.2	12.6		6.9	6.9	4.1	4.1	0.8	0.8	151.1	150.6	763.3	7.37	763.9	7.72	
	B	22.3	22.3	12.6		6.9	6.8	4.1	4.1	0.9	0.8	150.0	153.3	760.0	5.70	763.6	7.54	
	C	22.3	22.3	12.6		6.8	6.8	3.9	3.9	0.8	0.7	148.7	150.8	760.5	5.92	762.7	7.03	
	D	22.3	22.3	12.8		6.9	6.9	3.9	3.9	0.7	0.8	151.7	152.0	760.2	5.79	765.4	8.68	
9	A	22.4	22.3	12.6		6.8	6.9	4.1	3.9	0.9	0.7	149.8	152.3	763.1	7.57	763.9	8.04	
	B	22.4	22.3	12.6		6.9	6.8	3.9	4.1	0.7	0.8	150.3	153.4	760.0	5.95	763.6	7.85	
	C	22.3	22.2	12.6		6.8	6.7	3.9	4.0	0.7	0.7	153.6	152.6	760.9	6.38	762.3	7.10	
	D	22.3	22.2	12.6		6.8	6.7	4.1	4.1	0.9	0.7	149.9	150.7	761.5	6.69	763.4	7.73	
10	A	22.3	22.3	12.6		6.7	6.7	3.8	3.9	0.8	0.9	149.8	150.7	763.1	7.93	763.9	8.44	
	B	22.4	22.3	12.7		6.9	7.0	3.8	3.9	0.9	0.8	148.6	150.9	760.2	6.33	763.2	7.99	
	C	22.4	22.3	12.6		6.8	6.8	3.8	4.1	0.9	0.8	147.5	150.5	760.3	6.38	762.3	7.45	
	D	22.4	22.4	12.7		6.8	6.8	3.9	4.1	0.7	0.9	153.3	155.4	760.8	6.63	764.0	8.50	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

7.80 mg/L S2- 0.8 mg/L Fe

IMAM01-00428

Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Headspace DO Pre-Renew	Headspace DO Post-Renew	Aquatic DO Pre-Renew	Aquatic DO Post-Renew	Pre-Renew ORP	Post-Renew ORP	Sulfide, mV Reading (mV)	Sulfide, Calc Conc (mg/L)	Sulfide, mV Reading (mV)	Sulfide, Calc Conc (mg/L)	Comments/Observations
11	A	22.4	22.2	12.7	4640.0	6.9	6.7	3.8	3.8	0.8	0.8	149.8	151.3	763.1	7.9	763.9	8.4	
	B	22.4	22.3	12.6	4000.0	6.9	7.0	3.8	3.9	0.9	0.7	149.4	150.7	761.2	6.8	763.2	8.0	
	C	22.4	22.3	12.7	4340.0	6.8	6.7	3.8	3.9	0.9	0.8	151.3	154.2	760.3	6.4	763.3	8.1	
	D	22.4	22.2	12.6	4620.0	6.7	6.7	3.9	3.8	0.8	0.9	150.3	151.5	760.8	6.6	764.0	8.5	
12	A	22.3	22.2	12.8	4390.0	6.7	6.6	3.9	4.1	0.7	0.7	150.4	151.9	764.1	8.6	763.9	8.4	
	B	22.4	22.2	12.6	4380.0	6.6	6.7	3.9	4.1	0.7	0.7	151.8	150.7	761.2	6.8	763.6	8.2	
	C	22.3	22.2	12.6	4580.0	6.7	6.8	3.9	4.1	0.9	0.8	151.2	150.4	761.3	6.9	764.3	8.7	
	D	22.4	22.3	12.7	4710.0	6.6	6.7	4.1	3.8	0.7	0.8	149.5	150.0	761.8	7.2	764.0	8.5	
13	A	22.4	22.2	12.8	4010.0	6.6	6.7	4.1	3.8	0.8	0.9	151.6	152.3	762.1	7.3	763.9	8.4	
	B	22.4	22.2	12.8	4260.0	6.7	6.8	4.1	3.9	0.8	0.9	150.4	152.2	761.2	6.8	763.6	8.2	
	C	22.3	22.3	12.7	4120.0	6.7	6.7	4.1	4.0	0.9	0.9	149.1	153.0	761.3	6.9	764.3	8.7	
	D	22.3	22.2	12.6	4200.0	6.7	6.6	3.8	4.1	0.9	0.8	138.7	153.6	762.8	7.7	763.0	7.9	
14	A	22.3	22.2	12.6	4430.0	6.7	6.6	3.8	4.0	0.9	0.8	152.7	154.9	761.1	6.8	763.9	8.4	
	B	22.4	22.3	12.6	4410.0	6.7	6.8	3.8	3.8	0.8	0.8	149.8	150.5	761.2	6.8	764.6	8.9	
	C	22.4	22.2	12.6	4520.0	6.7	6.8	4.1	3.8	0.9	0.9	151.7	150.5	761.3	6.9	764.3	8.7	
	D	22.3	22.3	12.6	4560.0	6.7	6.8	4.1	4.1	0.7	0.8	154.4	152.9	760.8	6.6	762.0	7.3	
15	A	22.4	22.2	12.8	4510.0	6.6	6.8	4.0	3.9	0.8	0.7	150.1	151.1	763.1	7.9	764.9	9.1	
	B	22.4	22.3	12.8	4380.0	6.6	6.8	4.1	3.8	0.8	0.7	149.9	151.3	760.2	6.3	764.6	8.9	
	C	22.4	22.3	12.7	4350.0	6.7	6.6	3.8	3.9	0.7	0.7	155.0	151.7	761.3	6.9	765.3	9.4	
	D	22.4	22.3	12.8	4530.0	6.6	6.7	4.1	4.0	0.9	0.9	151.1	150.2	760.1	6.3	762.8	7.7	
16	A	22.3	22.2	12.7	4450.0	6.6	6.7	3.9	4.0	0.7	0.8	149.6	151.3	763.1	7.9	762.9	7.8	
	B	22.4	22.2	12.8	4590.0	6.7	6.7	4.1	4.0	0.8	0.8	150.6	152.2	760.1	6.3	764.6	8.9	
	C	22.3	22.3	12.8	4490.0	6.6	6.6	3.8	4.0	0.7	0.8	151.3	154.1	760.3	6.4	763.3	8.1	
	D	22.4	22.2	12.7	4300.0	6.7	6.6	3.9	3.8	0.8	0.8	150.7	151.0	760.1	6.3	761.8	7.2	
17	A	22.4	22.3	12.8	4450.0	7.3	7.1	4.1	4.0	0.8	0.9	155.0	149.9	761.1	6.8	763.9	8.4	
	B	22.3	22.3	12.8	4450.0	7.2	7.1	4.1	4.0	0.8	0.9	155.0	150.2	760.1	6.3	764.6	8.9	
	C	22.4	22.3	12.8	4490.0	7.2	7.0	3.8	4.0	0.9	0.9	153.7	150.6	760.3	6.4	763.3	8.1	
	D	22.3	22.2	12.8	4500.0	7.2	7.0	3.8	4.0	0.7	0.8	141.3	139.6	760.1	6.3	763.8	8.4	
18	A	22.3	22.3	12.7	4210.0	7.4	7.3	3.8	3.8	0.7	0.8	150.9	146.4	760.1	6.3	762.9	7.8	
	B	22.4	22.3	12.7	4300.0	7.4	7.3	3.8	3.9	0.7	0.8	149.5	147.6	760.2	6.3	764.6	8.9	
	C	22.2	22.2	12.6	4460.0	7.4	7.3	3.9	4.0	0.8	0.7	151.9	150.7	760.3	6.4	763.3	8.1	
	D	22.3	22.2	12.6	4000.0	7.3	7.2	3.9	4.0	0.8	0.7	150.7	143.2	760.1	6.3	762.8	7.7	
19	A	22.4	22.2	12.6	4340.0	6.7	6.7	3.9	4.0	0.8	0.7	151.7	150.3	760.1	6.3	763.9	8.4	
	B	22.4	22.3	12.6	4290.0	6.7	6.8	4.0	3.9	0.7	0.7	149.4	150.1	762.2	7.4	764.6	8.9	
	C	22.4	22.3	12.6	4530.0	6.9	6.9	3.9	4.1	0.9	0.7	149.6	151.2	760.3	6.4	763.3	8.1	
	D	22.3	22.2	12.6	4410.0	6.9	6.8	4.1	4.0	0.8	0.7	137.4	134.2	760.1	6.3	762.2	7.4	
20	A	22.4	22.3	12.7	4430.0	6.7	6.8	3.9	4.1	0.9	0.9	151.3	150.9	760.1	6.3	762.9	7.8	
	B	22.4	22.3	12.8	4500.0	6.6	6.7	4.0	3.8	0.7	0.7	152.0	150.9	761.2	6.8	764.6	8.9	
	C	22.3	22.2	12.6	4440.0	6.6	6.7	3.8	3.9	0.7	0.8	151.3	150.5	760.3	6.4	762.3	7.5	
	D	22.4	22.2	12.8	4350.0	6.6	6.7	4.1	3.8	0.7	0.7	150.6	150.4	760.1	6.3	762.2	7.4	
21	A	22.3	22.2		4360.0	6.8		4.1		0.7		149.9		760.0	6.2			
	B	22.4	22.2		4240.0	6.9		4.1		0.9		150.8		760.2	6.3			
	C	22.4	22.2		4310.0	6.8		3.9		0.8		150.2		760.5	6.5			
	D	22.3	22.2		4290.0	6.9		3.9		0.7		150.3		760.2	6.3			
MIN		22.2	**22.2**	**12.4**	**4000**	**6.5**	**6.5**	**3.8**	**3.8**	**0.7**	**0.7**	**137.4**	**134.2**	**760.0**	**5.70**	**761.3**	**6.39**	
MAX		22.4	**22.4**	**12.8**	**4710**	**7.4**	**7.3**	**4.1**	**4.1**	**0.9**	**0.9**	**156.2**	**157.3**	**764.1**	**8.57**	**765.4**	**9.41**	
MEAN		22.4	**22.3**	**12.7**	**4389**	**6.8**	**6.8**	**3.9**	**4.0**	**0.8**	**0.8**	**150.6**	**151.2**	**761.0**	**6.58**	**763.4**	**7.99**	
SEM		0.01	0.01	0.01	24.56	0.02	0.02	0.01	0.01	0.01	0.01	0.31	0.33	0.12	0.066	0.09	0.067	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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Tier 1 Parameters

HS-1 (1:4) 2.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.5			7.0		4.1		0.9		56.2			0.0	0.0	
	B	22.3		12.5			7.0		3.9		0.7		57.5			0.0	0.0	
	C	22.3		12.5			7.0		4.0		0.7		57.0			0.0	0.0	
	D	22.3		12.5			7.0		4.0		0.8		54.9			0.0	0.0	
1	A	22.3	22.3	12.7		7.1	7.0	4.1	4.0	0.8	0.7	56.4	57.2	0.0	0.0	0.0	0.0	
	B	22.3	22.4	12.5		7.0	6.9	4.1	4.0	0.7	0.8	53.5	54.6	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.5		7.0	7.0	4.0	4.1	0.7	0.6	55.8	56.3	0.0	0.0	0.0	0.0	
	D	22.5	22.4	12.4		7.0	7.0	3.9	4.0	0.7	0.7	57.1	56.2	0.0	0.0	0.0	0.0	
2	A	22.3	22.2	12.7		6.8	6.8	4.0	4.0	0.8	0.7	54.1	55.0	0.0	0.0	0.0	0.0	
	B	22.3	22.3	12.6		6.8	6.8	4.1	4.0	0.7	0.7	55.4	56.0	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6		6.8	6.8	4.1	4.1	0.8	0.9	54.6	54.3	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.5		6.8	6.8	4.1	3.9	0.8	0.7	55.9	56.4	0.0	0.0	0.0	0.0	
3	A	22.4	22.2	12.8		6.9	6.9	3.9	3.8	0.8	0.7	55.3	53.8	0.0	0.0	0.0	0.0	
	B	22.4	22.2	12.7		6.7	6.8	4.0	3.8	0.7	0.8	53.9	55.0	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.7		7.0	7.0	3.9	4.0	0.8	0.8	55.2	55.9	0.0	0.0	0.0	0.0	
	D	22.4	22.2	12.6		6.8	6.8	4.0	3.8	0.9	0.8	55.1	56.7	0.0	0.0	0.0	0.0	
4	A	22.3	22.3	12.7		6.8	6.9	3.8	4.0	0.7	0.8	54.0	55.3	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.7		6.7	6.8	4.0	4.1	0.8	0.9	55.5	56.1	0.0	0.0	0.0	0.0	
	C	22.3	22.3	12.8		6.9	6.8	3.9	4.0	0.7	0.7	54.3	55.2	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.8		6.7	6.8	3.8	3.9	0.8	0.8	56.3	55.4	0.0	0.0	0.0	0.0	
5	A	22.4	22.3	12.8		6.9	6.8	4.1	3.8	0.8	0.7	54.4	56.5	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6		6.9	6.8	4.1	4.0	0.7	0.7	56.2	55.4	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.8		6.9	6.8	4.1	3.8	0.7	0.9	54.3	53.4	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.8		6.9	6.8	4.1	4.1	0.8	0.7	56.1	55.8	0.0	0.0	0.0	0.0	
6	A	22.3	22.3	12.7		6.9	7.0	4.1	4.0	0.8	0.9	56.7	55.4	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.7		6.9	6.8	4.1	4.1	0.9	0.7	53.8	55.0	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6		6.9	6.9	3.9	4.0	0.9	0.7	55.7	54.3	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.6		6.9	6.9	4.0	4.0	0.7	0.7	56.1	55.8	0.0	0.0	0.0	0.0	
7	A	22.4	22.3	12.8		6.8	6.9	3.9	3.8	0.7	0.9	53.9	55.0	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.6		6.9	6.9	4.0	4.0	0.7	0.7	55.1	54.6	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.7		6.9	6.9	4.0	4.0	0.7	0.9	54.0	55.6	0.0	0.0	0.0	0.0	
	D	22.4	22.2	12.6		6.9	6.9	4.0	3.8	0.7	0.8	55.2	54.8	0.0	0.0	0.0	0.0	
8	A	22.4	22.2	12.8		6.8	6.8	4.1	4.1	0.8	0.9	55.0	55.8	0.0	0.0	0.0	0.0	
	B	22.4	22.2	12.7		6.9	6.9	4.0	4.1	0.7	0.9	54.7	55.1	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.7		6.9	6.7	4.1	3.9	0.8	0.7	55.6	53.7	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.8		6.8	6.8	3.8	4.0	0.9	0.9	56.0	55.7	0.0	0.0	0.0	0.0	
9	A	22.3	22.3	12.8		6.8	6.9	4.0	4.1	0.7	0.7	54.2	55.3	0.0	0.0	0.0	0.0	
	B	22.4	22.4	12.8		6.8	7.0	3.9	3.8	0.9	0.9	56.2	55.8	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.6		6.9	7.0	4.1	4.1	0.8	0.8	54.2	55.7	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.6		6.8	6.8	3.8	4.0	0.8	0.7	54.9	55.6	0.0	0.0	0.0	0.0	
10	A	22.3	22.2	12.6		6.4	6.5	3.8	3.9	0.7	0.8	54.6	53.9	0.0	0.0	0.0	0.0	
	B	22.3	22.3	12.6		7.0	6.9	4.1	4.0	0.8	0.9	52.9	54.5	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6		6.8	6.8	4.0	3.9	0.9	0.7	55.8	52.7	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.6		6.6	6.7	4.0	4.0	0.8	0.9	56.3	53.9	0.0	0.0	0.0	0.0	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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Tier 1 Parameters

HS-1 (1:4) 2.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
11	A	22.3	22.3	12.8	4530.0	6.9	6.7	4.1	4.0	0.9	0.8	53.4	55.2	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.8	4160.0	7.0	7.0	4.0	3.9	0.8	0.9	50.3	51.3	0.0	0.0	0.0	0.0	
	C	22.3	22.3	12.8	4260.0	6.8	6.7	3.8	3.9	0.8	0.7	51.7	55.4	0.0	0.0	0.0	0.0	
	D	22.4	22.2	12.6	4600.0	6.8	6.7	3.9	3.8	0.9	0.9	56.3	56.8	0.0	0.0	0.0	0.0	
12	A	22.4	22.3	12.7	4250.0	6.9	6.9	4.1	4.1	0.7	0.9	54.7	55.5	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.8	4610.0	7.0	7.0	4.1	3.9	0.8	0.7	56.1	55.0	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.6	4620.0	7.0	7.0	4.0	3.8	0.7	0.9	54.4	56.2	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.7	4450.0	7.0	7.0	4.1	3.9	0.9	0.8	54.7	55.4	0.0	0.0	0.0	0.0	
13	A	22.3	22.2	12.8	4290.0	7.0	7.0	4.0	3.8	0.9	0.7	54.7	55.3	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6	4480.0	6.9	7.0	4.1	4.0	0.8	0.8	55.3	56.2	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.7	4390.0	6.7	7.0	3.9	4.0	0.8	0.9	53.9	54.7	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.8	4390.0	7.0	7.0	3.8	3.8	0.8	0.7	54.6	54.2	0.0	0.0	0.0	0.0	
14	A	22.3	22.3	12.6	4410.0	7.0	7.0	3.8	3.9	0.8	0.9	54.3	55.7	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6	4480.0	7.0	7.0	4.0	4.0	0.9	0.9	56.1	54.3	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.8	4610.0	7.0	7.0	4.1	4.0	0.7	0.8	54.1	54.6	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.6	4600.0	7.0	7.0	4.0	4.0	0.8	0.7	55.7	54.6	0.0	0.0	0.0	0.0	
15	A	22.4	22.2	12.7	4590.0	6.9	7.0	3.8	4.1	0.9	0.9	55.0	54.3	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.8	4560.0	6.9	7.0	4.1	4.0	0.9	0.7	54.3	55.1	0.0	0.0	0.0	0.0	
	C	22.4	22.3	12.6	4550.0	7.0	7.0	3.8	4.1	0.7	0.7	55.5	54.2	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.8	4580.0	6.9	7.0	4.1	3.8	0.9	0.9	54.7	55.0	0.0	0.0	0.0	0.0	
16	A	22.3	22.2	12.6	4380.0	7.0	7.0	4.1	4.0	0.7	0.7	54.7	52.9	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6	4610.0	7.0	7.0	3.9	3.8	0.7	0.8	54.7	55.6	0.0	0.0	0.0	0.0	
	C	22.3	22.3	12.8	4520.0	7.0	7.0	3.9	4.0	0.9	0.9	54.7	55.0	0.0	0.0	0.0	0.0	
	D	22.4	22.2	12.6	4570.0	7.0	7.0	3.9	3.8	0.7	0.7	55.6	54.3	0.0	0.0	0.0	0.0	
17	A	22.4	22.3	12.8	4450.0	6.8	6.6	4.1	4.0	0.9	0.9	55.7	56.8	0.0	0.0	0.0	0.0	
	B	22.3	22.3	12.8	4310.0	6.8	6.6	4.1	4.0	0.9	0.9	56.7	56.7	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.8	4480.0	6.9	6.8	4.0	4.1	0.8	0.9	56.7	55.7	0.0	0.0	0.0	0.0	
	D	22.3	22.3	12.8	4590.0	6.9	6.8	3.9	4.1	0.9	0.9	56.7	55.7	0.0	0.0	0.0	0.0	
18	A	22.4	22.3	12.7	4930.0	6.6	6.5	3.8	3.7	0.9	0.7	55.7	54.6	0.0	0.0	0.0	0.0	
	B	22.4	22.2	12.7	4930.0	6.6	6.5	3.8	3.8	0.9	0.7	58.4	56.2	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.6	4350.0	6.6	6.5	4.1	4.0	0.9	0.9	55.6	54.6	0.0	0.0	0.0	0.0	
	D	22.3	22.2	12.8	4610.0	6.6	6.5	4.1	4.0	0.9	0.9	55.0	54.6	0.0	0.0	0.0	0.0	
19	A	22.3	22.2	12.7	4410.0	6.7	6.8	4.0	4.1	0.9	0.7	54.7	55.2	0.0	0.0	0.0	0.0	
	B	22.3	22.2	12.7	4580.0	6.8	6.7	3.9	4.0	0.7	0.8	55.3	55.5	0.0	0.0	0.0	0.0	
	C	22.3	22.2	12.6	4380.0	6.9	6.8	4.1	3.9	0.9	0.7	55.7	54.9	0.0	0.0	0.0	0.0	
	D	22.4	22.3	12.7	4300.0	6.9	6.5	4.0	3.8	0.9	0.8	55.5	54.6	0.0	0.0	0.0	0.0	
20	A	22.4	22.2	12.7	4370.0	7.0	7.0	3.8	3.8	0.8	0.8	54.6	55.1	0.0	0.0	0.0	0.0	
	B	22.4	22.3	12.6	4570.0	7.0	7.0	3.8	3.9	0.8	0.8	54.1	55.4	0.0	0.0	0.0	0.0	
	C	22.4	22.2	12.6	4520.0	7.0	7.0	4.0	3.8	0.7	0.8	56.2	54.8	0.0	0.0	0.0	0.0	
	D	22.4	22.2	12.8	4500.0	7.0	7.0	4.0	3.9	0.9	0.8	54.7	55.0	0.0	0.0	0.0	0.0	
21	A	22.4	22.3		4270.0	6.7		3.9		0.8		55.5		0.0	0.0			
	B	22.3	22.3		4440.0	6.9		3.9		0.9		52.6		0.0	0.0			
	C	22.3	22.3		4290.0	6.8		3.9		0.9		54.8		0.0	0.0			
	D	22.4	22.3		4330.0	6.9		3.9		0.8		50.7		0.0	0.0			
	MIN	22.3	22.2	12.4	4160	6.4	6.5	3.8	3.7	0.7	0.6	50.3	51.3	0.0	0.00	0.0	0.00	
	MAX	22.5	22.4	12.8	4930	7.1	7.0	4.1	4.1	0.9	0.9	58.4	57.5	0.0	0.00	0.0	0.00	
	MEAN	22.4	22.3	12.7	4480	6.9	6.9	4.0	4.0	0.8	0.8	55.0	55.2	0.0	0.00	0.0	0.00	
	SEM	0.01	0.01	0.01	24	0.01	0.02	0.01	0.01	0.01	0.01	0.14	0.11	0.00	0.000	0.00	0.000	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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Tier 1 Parameters

0.3 mg/L S2- 2.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.5			6.9		3.9		0.8		133.5			723.5	0.27	
	B	22.3		12.6			6.8		4.0		0.8		133.3			724.3	0.29	
	C	22.3		12.4			6.9		4.1		0.7		133.3			724.8	0.30	
	D	22.3		12.5			6.9		4.0		0.7		131.9			723.3	0.26	
1	A	22.3	22.4	12.6		6.8	6.8	4.0	3.9	0.9	0.6	133.1	135.9	717.0	0.20	723.1	0.33	
	B	22.3	22.3	12.6		6.8	6.8	4.0	3.9	0.8	0.9	131.1	133.9	717.4	0.21	725.2	0.39	
	C	22.5	22.4	12.4		6.9	6.9	4.1	4.1	0.8	0.7	130.9	134.1	717.3	0.21	723.8	0.35	
	D	22.4	22.3	12.5		6.9	6.8	3.9	4.0	0.6	0.8	131.6	130.9	718.5	0.23	724.1	0.36	
2	A	22.4	22.3	12.6		6.9	6.8	3.8	3.8	0.8	0.8	134.8	136.7	717.0	0.21	723.2	0.34	
	B	22.3	22.3	12.7		6.8	6.8	4.0	4.0	0.8	0.7	131.3	132.4	718.4	0.24	725.2	0.40	
	C	22.3	22.2	12.5		6.9	6.9	3.9	4.0	0.7	0.8	130.6	132.4	717.1	0.22	723.8	0.36	
	D	22.3	22.2	12.6		6.8	6.9	3.9	3.8	0.9	0.8	130.3	132.4	718.8	0.25	724.3	0.37	
3	A	22.4	22.3	12.8		6.8	6.9	4.1	4.0	0.8	0.8	130.9	132.8	717.2	0.22	723.7	0.36	
	B	22.4	22.3	12.8		6.8	6.8	4.0	3.9	0.8	0.8	133.5	132.6	718.4	0.24	725.2	0.41	
	C	22.4	22.3	12.7		6.8	6.9	4.0	3.8	0.7	0.8	132.3	130.0	717.1	0.22	723.4	0.36	
	D	22.4	22.3	12.7		6.7	6.7	3.9	3.8	0.7	0.7	131.2	130.2	717.3	0.22	724.3	0.38	
4	A	22.4	22.3	12.8		6.8	6.8	3.8	4.0	0.9	0.7	130.6	133.2	717.0	0.21	723.1	0.34	
	B	22.3	22.2	12.6		6.8	6.8	4.1	4.0	0.9	0.9	132.5	131.4	718.4	0.23	725.2	0.39	
	C	22.3	22.4	12.8		6.8	6.8	4.1	3.9	0.8	0.9	132.6	133.7	717.1	0.21	723.7	0.35	
	D	22.3	22.2	12.7		6.8	6.8	3.9	4.0	0.7	0.9	134.1	132.2	718.4	0.23	724.3	0.37	
5	A	22.4	22.3	12.7		6.9	6.8	3.8	3.9	0.8	0.8	130.9	133.4	717.1	0.22	723.1	0.35	
	B	22.4	22.3	12.6		6.9	6.8	3.9	3.8	0.7	0.8	133.2	130.9	718.4	0.25	725.7	0.43	
	C	22.4	22.2	12.8		6.9	6.7	3.9	4.1	0.7	0.9	132.2	131.1	717.3	0.23	723.9	0.37	
	D	22.3	22.2	12.7		6.8	6.7	4.0	4.1	0.7	0.8	133.2	131.3	718.4	0.25	724.3	0.39	
6	A	22.3	22.2	12.7		6.8	6.9	4.0	3.9	0.7	0.8	131.8	130.3	717.3	0.22	723.4	0.35	
	B	22.4	22.3	12.7		6.9	6.9	4.0	4.1	0.8	0.7	132.8	130.6	718.4	0.24	725.7	0.42	
	C	22.4	22.3	12.7		6.9	6.8	4.0	4.0	0.7	0.8	130.4	133.3	715.5	0.19	723.6	0.36	
	D	22.3	22.2	12.6		6.9	6.8	4.1	3.9	0.8	0.7	132.3	131.4	718.4	0.24	724.3	0.38	
7	A	22.3	22.3	12.8		6.8	6.9	3.8	4.0	0.7	0.9	132.0	130.4	718.3	0.23	725.1	0.40	
	B	22.3	22.2	12.7		6.9	6.9	4.0	3.9	0.9	0.8	132.2	130.9	718.4	0.24	725.7	0.42	
	C	22.3	22.2	12.7		6.8	6.8	3.9	4.0	0.7	0.8	131.4	132.3	718.5	0.24	723.2	0.34	
	D	22.4	22.2	12.7		6.9	6.8	3.9	4.0	0.7	0.8	130.2	132.6	718.4	0.24	724.3	0.37	
8	A	22.3	22.3	12.8		6.7	6.7	4.0	3.9	0.9	0.7	131.4	130.9	716.1	0.19	723.5	0.33	
	B	22.4	22.3	12.8		6.7	6.9	4.0	3.9	0.7	0.7	131.8	132.5	719.4	0.24	724.7	0.36	
	C	22.4	22.3	12.7		6.7	6.8	3.9	3.8	0.9	0.8	132.2	133.4	717.5	0.21	723.4	0.33	
	D	22.3	22.2	12.8		6.7	6.7	4.1	3.8	0.7	0.9	130.7	132.3	718.1	0.22	724.3	0.35	
9	A	22.4	22.3	12.8		6.9	6.9	4.0	3.9	0.8	0.7	130.2	130.9	717.6	0.22	724.5	0.38	
	B	22.3	22.4	12.8		6.9	6.9	3.8	3.8	0.7	0.7	131.6	130.6	718.4	0.24	725.2	0.40	
	C	22.3	22.2	12.6		6.7	6.9	4.1	4.1	0.8	0.7	131.1	130.7	717.6	0.22	723.4	0.35	
	D	22.3	22.3	12.7		6.7	6.8	3.8	3.9	0.8	0.8	130.7	132.8	718.2	0.23	724.3	0.38	
10	A	22.3	22.2	12.6		6.6	6.7	4.0	4.0	0.9	0.9	138.7	137.1	717.6	0.23	724.5	0.39	
	B	22.3	22.3	12.6		7.0	6.8	4.0	4.1	0.8	0.7	133.3	134.8	718.5	0.25	725.6	0.43	
	C	22.3	22.3	12.7		6.7	6.8	3.9	3.8	0.8	0.9	133.9	138.6	717.9	0.24	723.4	0.36	
	D	22.4	22.4	12.8		6.7	6.9	4.0	3.9	0.9	0.8	130.8	132.8	718.2	0.24	724.3	0.39	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

FEL

Tier 1 Parameters

0.3 mg/L S2- 2.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
11	A	22.3	22.3	12.7	4320.0	6.7	6.9	3.8	4.0	0.8	0.7	137.6	138.7	717.6	0.2	724.8	0.4	
	B	22.4	22.3	12.7	4390.0	6.9	6.9	3.9	3.8	0.7	0.8	133.2	134.6	718.5	0.2	725.6	0.4	
	C	22.3	22.3	12.8	4470.0	6.7	6.8	3.8	4.0	0.7	0.7	136.6	141.3	717.9	0.2	724.4	0.4	
	D	22.4	22.2	12.7	4510.0	6.9	6.8	3.9	4.0	0.9	0.8	138.4	139.9	718.2	0.2	724.3	0.4	
12	A	22.3	22.2	12.7	4210.0	6.9	6.9	3.9	4.0	0.7	0.9	130.8	132.8	718.6	0.2	725.8	0.4	
	B	22.3	22.3	12.8	4520.0	7.0	6.9	4.1	3.8	0.7	0.8	132.9	131.1	718.5	0.2	725.6	0.4	
	C	22.3	22.3	12.7	4340.0	6.9	7.0	3.8	3.8	0.7	0.9	133.3	131.2	717.9	0.2	724.4	0.4	
	D	22.4	22.3	12.6	4530.0	7.0	6.9	4.0	3.8	0.9	0.9	130.7	131.2	718.9	0.3	723.3	0.4	
13	A	22.3	22.2	12.6	4360.0	6.9	7.0	3.8	3.9	0.9	0.7	130.5	131.7	717.6	0.2	725.8	0.4	
	B	22.3	22.3	12.8	4530.0	6.9	6.9	3.9	4.1	0.8	0.8	131.7	130.7	718.5	0.2	725.6	0.4	
	C	22.4	22.2	12.6	4410.0	6.8	7.0	3.9	3.8	0.8	0.7	130.3	131.3	717.9	0.2	725.4	0.4	
	D	22.4	22.3	12.8	4530.0	7.0	7.0	3.8	3.8	0.8	0.7	130.3	131.3	719.9	0.3	723.3	0.4	
14	A	22.4	22.3	12.7	4510.0	6.9	7.0	4.1	3.8	0.7	0.9	132.3	131.6	716.6	0.2	725.1	0.4	
	B	22.4	22.2	12.7	4370.0	7.0	7.0	3.9	4.0	0.7	0.9	130.7	131.8	718.5	0.2	725.6	0.4	
	C	22.3	22.3	12.8	4570.0	6.9	7.0	4.1	3.9	0.7	0.7	134.2	132.3	715.9	0.2	725.4	0.4	
	D	22.4	22.2	12.7	4630.0	7.0	7.0	4.0	4.0	0.8	0.7	130.8	132.3	719.9	0.3	724.3	0.4	
15	A	22.4	22.3	12.8	4530.0	6.9	7.0	3.9	4.0	0.7	0.8	132.3	133.0	716.6	0.2	723.1	0.4	
	B	22.3	22.2	12.6	4510.0	6.8	7.0	4.1	4.0	0.9	0.8	131.7	133.4	718.5	0.2	725.6	0.4	
	C	22.3	22.2	12.6	4570.0	6.9	7.0	4.1	4.0	0.8	0.8	132.3	131.1	716.9	0.2	725.4	0.4	
	D	22.4	22.3	12.6	4500.0	6.9	7.0	3.9	3.8	0.7	0.7	131.3	130.7	719.9	0.3	722.3	0.3	
16	A	22.4	22.2	12.7	4290.0	6.9	6.9	4.0	3.9	0.8	0.7	131.3	130.4	714.6	0.2	724.1	0.4	
	B	22.4	22.3	12.7	4340.0	6.9	7.0	3.8	3.8	0.9	0.8	133.2	132.2	718.5	0.2	725.6	0.4	
	C	22.3	22.3	12.6	4470.0	6.9	7.0	3.8	4.0	0.8	0.8	130.8	132.3	716.9	0.2	725.4	0.4	
	D	22.3	22.3	12.6	4510.0	6.9	6.9	4.0	4.0	0.7	0.7	130.8	131.9	717.9	0.2	722.3	0.3	
17	A	22.4	22.3	12.6	4490.0	6.9	6.9	3.9	4.0	0.7	0.8	133.6	134.7	713.6	0.2	724.1	0.4	
	B	22.3	22.2	12.6	4380.0	6.9	6.9	3.9	3.9	0.7	0.8	133.6	133.8	718.5	0.2	725.6	0.4	
	C	22.3	22.3	12.7	4470.0	7.0	6.9	4.0	4.1	0.7	0.8	133.5	132.4	716.9	0.2	725.4	0.4	
	D	22.3	22.3	12.7	4400.0	7.0	7.0	3.9	4.0	0.7	0.8	133.5	132.4	716.9	0.2	722.3	0.3	
18	A	22.4	22.3	12.7	4240.0	6.7	6.7	3.9	3.7	0.8	0.7	133.2	131.2	712.6	0.2	721.1	0.3	
	B	22.3	22.2	12.5	4350.0	6.9	6.9	3.9	3.7	0.8	0.7	136.2	133.3	714.5	0.2	725.6	0.4	
	C	22.4	22.3	12.8	4230.0	6.7	6.7	3.9	4.0	0.8	0.9	133.8	132.7	716.9	0.2	725.4	0.4	
	D	22.4	22.3	12.8	4930.0	6.7	6.8	3.9	4.1	0.8	0.8	131.1	132.9	714.9	0.2	722.3	0.3	
19	A	22.3	22.2	12.8	4580.0	6.8	6.7	4.1	3.8	0.9	0.7	132.9	133.4	713.6	0.2	722.1	0.3	
	B	22.4	22.2	12.6	4670.0	6.7	6.9	4.0	3.9	0.9	0.7	133.1	134.3	714.5	0.2	725.6	0.4	
	C	22.3	22.2	12.7	4470.0	6.8	7.0	4.0	3.8	0.7	0.8	133.3	138.6	716.9	0.2	725.4	0.4	
	D	22.4	22.3	12.7	4500.0	6.8	6.7	3.9	3.8	0.8	0.8	133.7	133.3	714.9	0.2	723.3	0.4	
20	A	22.3	22.2	12.6	4350.0	6.9	7.0	3.9	3.8	0.7	0.8	132.3	130.1	712.6	0.2	721.1	0.3	
	B	22.3	22.2	12.6	4460.0	6.9	7.0	3.8	4.0	0.8	0.9	132.3	130.0	714.5	0.2	725.6	0.4	
	C	22.3	22.3	12.6	4500.0	6.9	7.0	4.1	3.9	0.8	0.9	130.2	132.3	716.9	0.2	725.4	0.4	
	D	22.3	22.3	12.8	4480.0	6.9	7.0	3.8	3.8	0.8	0.9	132.5	130.6	714.2	0.2	721.3	0.3	
21	A	22.3	22.2		4390.0	6.8		3.9		0.9		133.6		711.6	0.1			
	B	22.4	22.2		4510.0	6.9		4.0		0.7		130.3		714.5	0.2			
	C	22.3	22.3		4470.0	7.0		3.9		0.9		132.6		716.9	0.2			
	D	22.3	22.3		4430.0	6.9		3.8		0.8		131.4		713.2	0.2			
MIN		22.3	**22.2**	**12.4**	**4210**	**6.6**	**6.7**	**3.8**	**3.7**	**0.6**	**0.6**	**130.2**	**130.0**	**711.6**	**0.14**	**721.1**	**0.26**	
MAX		22.5	**22.4**	**12.8**	**4930**	**7.0**	**7.0**	**4.1**	**4.1**	**0.9**	**0.9**	**138.7**	**141.3**	**719.9**	**0.28**	**725.8**	**0.44**	
MEAN		22.3	**22.3**	**12.7**	**4460**	**6.8**	**6.9**	**3.9**	**3.9**	**0.8**	**0.8**	**132.3**	**132.7**	**717.2**	**0.22**	**724.3**	**0.38**	
SEM		0.01	0.01	0.01	18.98	0.01	0.01	0.01	0.01	0.01	0.01	0.19	0.24	0.19	0.003	0.13	0.005	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

1.56 mg/L S2- 2.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.4			6.7		4.0		0.8		139.1			745.0	1.71	
	B	22.3		12.5			6.7		3.9		0.8		140.1			743.9	1.56	
	C	22.3		12.4			6.8		4.0		0.8		137.0			742.5	1.38	
	D	22.3		12.3			6.8		3.9		0.8		137.2			743.1	1.45	
1	A	22.3	22.3	12.7		6.7	6.7	4.1	4.0	0.8	0.7	138.7	140.1	738.5	1.15	744.0	1.78	
	B	22.3	22.3	12.5		6.7	6.7	4.0	4.0	0.7	0.7	138.5	140.1	738.0	1.10	742.6	1.59	
	C	22.4	22.3	12.5		6.8	6.7	4.1	4.0	0.7	0.8	139.2	140.2	737.2	1.03	743.5	1.71	
	D	22.4	22.3	12.4		6.8	6.7	4.0	3.9	0.8	0.9	138.5	137.2	737.0	1.02	743.1	1.66	
2	A	22.4	22.3	12.7		6.9	6.9	4.0	3.9	0.7	0.7	138.7	139.0	738.2	1.10	744.2	1.74	
	B	22.4	22.3	12.8		6.8	6.8	3.9	4.0	0.8	0.8	140.4	141.6	738.0	1.08	742.3	1.50	
	C	22.3	22.2	12.5		6.7	6.8	4.0	4.0	0.7	0.9	131.9	133.4	737.3	1.02	743.5	1.65	
	D	22.3	22.2	12.7		6.8	6.8	3.8	3.8	0.7	0.8	131.9	135.3	737.0	1.00	743.5	1.65	
3	A	22.4	22.3	12.6		6.8	6.8	4.1	4.0	0.7	0.7	138.4	139.5	738.2	1.11	744.2	1.77	
	B	22.4	22.3	12.6		6.8	6.7	4.1	4.0	0.7	0.8	139.7	138.9	738.0	1.10	742.3	1.53	
	C	22.4	22.2	12.7		6.8	6.9	3.9	3.9	0.8	0.9	140.1	137.6	736.5	0.98	743.2	1.64	
	D	22.4	22.3	12.8		6.7	6.7	3.8	4.1	0.8	0.7	140.2	141.3	737.0	1.01	743.4	1.66	
4	A	22.4	22.3	12.8		6.7	6.8	4.1	3.9	0.8	0.8	137.8	138.4	738.4	1.09	744.2	1.70	
	B	22.4	22.2	12.8		6.7	6.8	4.1	4.4	0.9	0.7	139.7	140.3	738.2	1.07	742.5	1.49	
	C	22.4	22.2	12.6		6.7	6.8	4.0	3.9	0.9	0.8	138.8	139.3	737.5	1.02	743.6	1.62	
	D	22.4	22.2	12.8		6.7	6.7	3.8	3.8	0.8	0.8	140.2	138.6	737.3	1.00	743.3	1.59	
5	A	22.4	22.2	12.6		6.9	6.9	3.8	3.9	0.8	0.9	138.5	139.7	739.4	1.21	744.5	1.79	
	B	22.4	22.3	12.7		6.8	6.9	4.0	3.9	0.8	0.9	140.2	137.3	738.2	1.11	742.5	1.53	
	C	22.3	22.3	12.6		6.9	6.8	3.9	4.1	0.8	0.8	139.6	139.5	737.5	1.05	743.8	1.69	
	D	22.3	22.2	12.7		6.9	6.7	3.9	4.1	0.8	0.9	140.7	140.2	737.1	1.02	743.3	1.63	
6	A	22.3	22.3	12.7		6.8	6.8	4.1	4.1	0.9	0.8	139.9	138.4	738.6	1.13	744.1	1.72	
	B	22.3	22.2	12.6		6.8	7.0	4.1	3.9	0.7	0.8	137.7	139.8	738.4	1.11	743.5	1.64	
	C	22.4	22.3	12.7		6.9	6.8	4.0	4.0	0.7	0.8	130.4	133.3	737.5	1.04	743.1	1.59	
	D	22.4	22.2	12.7		6.8	6.8	4.0	3.9	0.9	0.8	138.7	139.3	735.3	0.88	743.5	1.64	
7	A	22.3	22.3	12.8		6.9	6.8	3.9	3.8	0.8	0.7	137.7	138.8	738.6	1.12	744.4	1.76	
	B	22.4	22.2	12.8		6.8	6.9	3.9	3.9	0.8	0.8	138.5	139.3	738.4	1.11	742.5	1.52	
	C	22.4	22.3	12.6		6.8	6.9	3.9	3.8	0.9	0.8	139.5	137.5	737.5	1.03	744.1	1.72	
	D	22.4	22.2	12.7		6.8	6.8	4.0	3.9	0.8	0.7	139.7	140.1	737.3	1.02	743.1	1.59	
8	A	22.3	22.2	12.8		6.7	6.7	3.8	3.8	0.7	0.7	138.8	137.7	738.6	1.07	744.4	1.69	
	B	22.3	22.3	12.8		6.7	6.8	4.1	3.9	0.7	0.7	139.8	140.6	738.4	1.06	742.7	1.48	
	C	22.3	22.2	12.8		6.7	6.8	3.8	4.0	0.9	0.9	139.3	140.2	737.2	0.96	743.1	1.52	
	D	22.4	22.2	12.7		6.7	6.8	4.0	3.8	0.7	0.8	138.4	139.4	737.3	0.97	744.5	1.70	
9	A	22.3	22.4	12.6		6.7	6.8	3.9	3.8	0.8	0.8	137.6	139.6	738.6	1.14	744.4	1.78	
	B	22.3	22.4	12.6		6.8	6.9	4.1	3.9	0.7	0.7	138.5	139.1	738.7	1.15	742.2	1.50	
	C	22.3	22.3	12.6		6.9	6.9	4.0	3.8	0.9	0.7	140.0	137.8	737.2	1.02	743.1	1.61	
	D	22.4	22.3	12.6		6.9	6.8	4.0	3.9	0.9	0.8	138.6	139.9	738.5	1.13	743.5	1.66	
10	A	22.4	22.2	12.7		6.9	6.7	4.1	4.0	0.7	0.8	144.7	142.3	738.6	1.18	744.4	1.85	
	B	22.3	22.3	12.6		6.7	6.7	3.8	3.9	0.9	0.8	140.3	143.7	738.9	1.21	743.2	1.69	
	C	22.3	22.4	12.8		6.6	6.7	4.0	3.8	0.8	0.9	137.8	140.5	737.5	1.08	743.5	1.73	
	D	22.4	22.4	12.8		6.6	6.8	3.8	3.9	0.9	0.9	137.3	139.3	737.5	1.08	743.5	1.73	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

1.56 mg/L S2- 2.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
11	A	22.3	22.3	12.7	4650.0	6.7	6.8	3.9	4.1	0.7	0.7	138.5	139.3	738.6	1.2	744.4	1.9	
	B	22.3	22.3	12.7	4700.0	6.6	6.6	4.1	3.9	0.7	0.7	142.1	142.8	739.9	1.3	745.2	2.0	
	C	22.3	22.3	12.6	4410.0	6.7	6.7	4.0	4.1	0.8	0.8	142.8	144.7	737.5	1.1	743.5	1.7	
	D	22.3	22.2	12.8	4650.0	6.8	6.9	4.0	3.9	0.8	0.7	143.6	145.1	737.5	1.1	743.5	1.7	
12	A	22.4	22.3	12.6	4220.0	6.7	6.8	4.0	3.9	0.9	0.9	139.7	137.9	738.6	1.2	744.4	1.9	
	B	22.3	22.2	12.7	4590.0	6.8	6.8	3.9	3.8	0.7	0.8	138.8	139.7	739.9	1.3	742.2	1.6	
	C	22.4	22.3	12.8	4380.0	6.9	6.9	3.8	3.9	0.8	0.8	139.5	138.7	738.5	1.2	743.5	1.7	
	D	22.4	22.3	12.8	4360.0	6.8	6.9	4.0	3.9	0.8	0.7	139.2	140.4	739.5	1.3	743.5	1.7	
13	A	22.4	22.3	12.7	4580.0	6.9	6.9	3.9	4.0	0.9	0.8	137.9	139.1	738.6	1.2	744.4	1.9	
	B	22.4	22.3	12.8	4770.0	6.8	6.8	3.8	4.0	0.9	0.7	138.5	139.8	739.9	1.3	742.2	1.6	
	C	22.4	22.2	12.8	4630.0	6.9	6.9	3.8	3.8	0.9	0.9	139.2	137.5	739.5	1.3	741.5	1.5	
	D	22.3	22.2	12.8	4600.0	6.9	6.8	3.9	4.0	0.7	0.8	136.6	138.7	739.5	1.3	743.5	1.7	
14	A	22.4	22.3	12.6	4500.0	6.9	6.9	4.1	3.8	0.8	0.7	139.9	138.1	735.6	0.9	744.4	1.9	
	B	22.4	22.2	12.6	4280.0	6.8	6.9	4.0	4.0	0.8	0.7	139.4	140.0	739.9	1.3	742.2	1.6	
	C	22.3	22.3	12.7	4530.0	6.9	6.9	3.9	3.9	0.7	0.8	137.6	138.9	739.5	1.3	743.5	1.7	
	D	22.4	22.3	12.6	4590.0	6.8	6.9	3.9	3.9	0.8	0.7	137.9	138.4	739.5	1.3	743.5	1.7	
15	A	22.3	22.3	12.8	4470.0	6.8	6.9	3.8	4.0	0.7	0.7	138.7	139.8	733.6	0.8	745.4	2.0	
	B	22.3	22.3	12.6	4470.0	6.8	6.9	3.9	4.1	0.7	0.8	139.9	138.8	739.9	1.3	742.2	1.6	
	C	22.3	22.2	12.8	4610.0	6.9	6.9	3.8	3.9	0.9	0.8	137.6	138.9	739.5	1.3	745.5	2.0	
	D	22.3	22.3	12.8	4430.0	6.9	7.0	4.0	3.8	0.7	0.8	138.5	137.5	739.5	1.3	744.5	1.9	
16	A	22.4	22.2	12.6	4330.0	6.8	6.9	4.1	3.8	0.8	0.9	137.6	139.9	733.6	0.8	746.4	2.2	
	B	22.3	22.3	12.6	4380.0	6.9	6.8	3.8	3.9	0.7	0.9	139.9	139.1	736.9	1.0	742.2	1.6	
	C	22.4	22.2	12.6	4500.0	6.9	6.9	4.0	3.9	0.8	0.7	139.9	138.7	739.5	1.3	747.5	2.4	
	D	22.3	22.3	12.7	4480.0	6.9	6.8	3.8	4.0	0.9	0.8	132.3	138.7	739.5	1.3	744.5	1.9	
17	A	22.4	22.2	12.7	4560.0	6.7	6.5	3.8	3.9	0.7	0.8	137.8	141.2	733.6	0.8	745.4	2.0	
	B	22.4	22.2	12.7	4210.0	6.7	6.5	3.9	3.9	0.7	0.8	138.0	139.6	736.9	1.0	742.2	1.6	
	C	22.4	22.3	12.8	4490.0	6.9	6.5	4.0	3.9	0.8	0.7	140.2	139.1	738.5	1.2	747.5	2.4	
	D	22.3	22.3	12.8	4460.0	6.9	6.5	4.0	3.9	0.7	0.7	140.2	139.1	739.5	1.3	745.5	2.0	
18	A	22.3	22.2	12.8	4360.0	6.3	6.9	4.0	3.9	0.8	0.7	135.7	136.8	733.6	0.8	743.4	1.7	
	B	22.3	22.3	12.5	4700.0	6.3	6.9	4.0	3.7	0.8	0.7	141.0	136.8	735.9	1.0	742.2	1.6	
	C	22.4	22.3	12.9	4560.0	6.9	7.0	4.1	4.1	0.8	0.9	139.7	130.1	738.5	1.2	745.5	2.0	
	D	22.4	22.3	12.7	4700.0	7.0	7.0	4.1	4.0	0.8	0.7	139.7	130.1	736.5	1.0	745.5	2.0	
19	A	22.3	22.3	12.7	4630.0	6.7	6.8	4.0	3.8	0.7	0.8	136.8	135.6	733.6	0.8	743.4	1.7	
	B	22.4	22.3	12.8	4830.0	6.9	6.9	4.0	3.9	0.8	0.8	139.1	141.8	734.9	0.9	742.2	1.6	
	C	22.3	22.2	12.8	4590.0	6.8	6.9	3.9	3.8	0.8	0.8	138.5	141.4	738.5	1.2	745.5	2.0	
	D	22.4	22.3	12.8	4780.0	6.8	6.7	3.8	3.9	0.8	0.7	138.9	143.5	736.5	1.0	746.5	2.2	
20	A	22.4	22.3	12.8	4400.0	6.9	6.9	4.0	4.0	0.8	0.8	139.9	138.3	733.6	0.8	742.4	1.6	
	B	22.3	22.3	12.8	4490.0	6.8	6.9	3.9	3.9	0.9	0.7	142.4	140.8	733.9	0.8	742.2	1.6	
	C	22.4	22.3	12.7	4480.0	6.9	6.9	3.8	3.9	0.7	0.7	137.5	138.8	738.5	1.2	745.5	2.0	
	D	22.4	22.3	12.7	4460.0	6.8	6.9	4.1	3.8	0.9	0.7	139.7	137.5	735.5	0.9	744.5	1.9	
21	A	22.3	22.2		4540.0	6.8		3.8		0.9		140.2		732.6	0.7			
	B	22.4	22.2		4660.0	7.0		3.8		0.8		138.3		733.9	0.8			
	C	22.3	22.3		4650.0	6.9		4.0		0.9		138.9		737.5	1.1			
	D	22.4	22.2		4580.0	6.9		4.0		0.9		138.8		735.5	0.9			
	MIN	22.3	**22.2**	**12.3**	**4210**	**6.3**	**6.5**	**3.8**	**3.7**	**0.7**	**0.7**	**130.4**	**130.1**	**732.6**	**0.74**	**741.5**	**1.38**	
	MAX	22.4	**22.4**	**12.9**	**4830**	**7.0**	**7.0**	**4.1**	**4.4**	**0.9**	**0.9**	**144.7**	**145.1**	**739.9**	**1.31**	**747.5**	**2.36**	
	MEAN	22.4	**22.3**	**12.7**	**4528**	**6.8**	**6.8**	**4.0**	**3.9**	**0.8**	**0.8**	**138.8**	**139.0**	**737.6**	**1.08**	**743.8**	**1.73**	
	SEM	0.01	0.01	0.01	21.54	0.01	0.01	0.01	0.01	0.01	0.01	0.24	0.26	0.20	0.016	0.13	0.021	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

3.12 mg/L S2- 2.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.5			6.6		4.0		0.9		145.8			752.6	3.30	
	B	22.3		12.5			6.6		3.9		0.9		146.8			751.2	2.93	
	C	22.3		12.5			6.7		4.0		0.9		144.4			752.5	3.28	
	D	22.3		12.4			6.7		4.0		0.8		144.4			753.0	3.42	
1	A	22.3	22.4	12.7		6.6	6.6	4.0	4.1	0.8	0.6	144.8	146.8	742.1	1.53	752.0	3.38	
	B	22.3	22.3	12.5		6.6	6.6	4.1	4.1	0.6	0.8	142.7	144.8	743.0	1.64	751.4	3.22	
	C	22.4	22.3	12.4		6.6	6.6	4.0	4.1	0.8	0.7	144.8	146.8	740.6	1.36	752.0	3.38	
	D	22.4	22.3	12.5		6.7	6.7	4.1	4.1	0.8	0.7	141.1	140.1	742.2	1.54	753.0	3.66	
2	A	22.3	22.2	12.6		6.8	6.9	3.9	4.0	0.7	0.8	146.8	147.9	742.1	1.48	752.0	3.18	
	B	22.4	22.3	12.8		6.7	6.8	3.8	4.0	0.8	0.9	146.4	147.8	743.1	1.60	751.4	3.03	
	C	22.4	22.2	12.6		6.7	6.8	4.1	4.1	0.8	0.8	138.0	137.6	740.6	1.32	752.0	3.18	
	D	22.4	22.3	12.8		6.7	6.8	3.8	3.9	0.8	0.7	140.5	142.7	742.5	1.53	753.6	3.59	
3	A	22.3	22.3	12.7		6.7	6.8	4.0	4.1	0.7	0.8	142.2	141.4	742.1	1.50	752.3	3.30	
	B	22.3	22.2	12.7		6.8	6.7	3.8	4.1	0.7	0.8	143.3	142.3	743.6	1.69	751.4	3.08	
	C	22.3	22.3	12.8		6.7	6.8	3.8	3.9	0.9	0.9	147.5	149.5	741.6	1.45	752.3	3.30	
	D	22.3	22.3	12.8		6.7	6.7	3.8	4.1	0.9	0.7	148.1	147.9	742.7	1.57	753.3	3.56	
4	A	22.4	22.4	12.8		6.8	6.7	4.0	3.9	0.7	0.9	140.9	143.2	742.4	1.48	752.5	3.22	
	B	22.4	22.3	12.6		6.7	6.7	4.0	4.1	0.8	0.8	143.2	142.7	743.1	1.56	751.5	2.98	
	C	22.4	22.3	12.7		6.8	6.7	4.1	4.1	0.7	0.8	141.7	140.1	740.2	1.25	752.3	3.17	
	D	22.4	22.2	12.6		6.8	6.7	3.8	3.8	0.7	0.7	141.8	144.5	742.7	1.52	753.5	3.48	
5	A	22.4	22.2	12.8		6.8	6.8	3.8	4.1	0.7	0.9	140.1	142.5	743.4	1.64	752.5	3.28	
	B	22.3	22.2	12.7		6.8	6.7	4.0	4.0	0.8	0.8	142.9	143.4	743.6	1.67	753.6	3.56	
	C	22.3	22.2	12.7		6.9	6.7	3.9	3.8	0.7	0.7	143.8	142.6	740.5	1.32	752.3	3.23	
	D	22.4	22.3	12.6		6.8	6.8	3.8	4.0	0.8	0.8	144.0	147.6	742.7	1.56	753.7	3.59	
6	A	22.4	22.3	12.7		6.8	6.9	4.1	4.1	0.7	0.8	141.0	142.4	742.4	1.51	752.5	3.26	
	B	22.3	22.2	12.6		6.8	6.8	4.0	3.9	0.8	0.9	143.1	141.9	743.2	1.61	751.6	3.05	
	C	22.3	22.2	12.7		6.8	6.9	4.0	3.9	0.8	0.9	141.9	144.7	740.2	1.28	754.3	3.75	
	D	22.4	22.3	12.7		6.9	6.8	3.9	4.0	0.7	0.9	141.8	142.9	741.7	1.43	755.7	4.17	
7	A	22.3	22.3	12.6		6.8	6.8	3.9	3.8	0.7	0.8	143.0	141.1	742.4	1.51	752.5	3.29	
	B	22.4	22.2	12.6		6.8	6.8	3.8	3.8	0.9	0.7	143.4	140.8	743.2	1.61	753.3	3.50	
	C	22.4	22.3	12.7		6.9	6.8	4.0	3.9	0.8	0.8	142.6	141.9	740.2	1.27	752.3	3.24	
	D	22.3	22.3	12.8		6.8	6.8	3.8	3.8	0.9	0.7	142.2	143.3	743.7	1.67	756.2	4.38	
8	A	22.3	22.2	12.6		6.6	6.6	3.9	3.8	0.9	0.8	142.5	141.7	743.4	1.56	752.5	3.17	
	B	22.4	22.2	12.7		6.8	6.6	3.9	3.8	0.8	0.7	143.3	144.5	743.5	1.57	751.5	2.94	
	C	22.3	22.3	12.8		6.6	6.7	4.0	4.0	0.7	0.7	141.4	140.9	741.2	1.31	752.3	3.12	
	D	22.4	22.2	12.8		6.6	6.7	4.0	4.0	0.8	0.7	143.2	141.9	742.7	1.48	755.2	3.92	
9	A	22.4	22.4	12.6		6.7	6.8	3.9	4.0	0.8	0.7	137.5	142.7	742.4	1.53	752.1	3.23	
	B	22.4	22.3	12.6		6.7	6.8	4.1	4.0	0.7	0.8	142.0	143.7	743.5	1.66	751.5	3.08	
	C	22.4	22.3	12.7		6.8	6.8	3.9	3.9	0.7	0.8	140.9	142.8	740.1	1.28	752.3	3.28	
	D	22.4	22.2	12.7		6.9	6.9	4.1	3.9	0.7	0.7	142.4	141.5	742.7	1.56	753.2	3.51	
10	A	22.4	22.3	12.8		6.9	6.8	4.1	3.9	0.8	0.9	141.1	138.6	742.1	1.55	752.7	3.53	
	B	22.3	22.3	12.6		6.8	6.9	4.0	3.9	0.7	0.8	146.8	145.1	743.5	1.73	751.5	3.22	
	C	22.3	22.3	12.7		6.7	6.7	3.8	3.9	0.9	0.8	139.3	137.8	740.0	1.32	752.3	3.43	
	D	22.4	22.4	12.7		6.6	6.7	3.9	4.0	0.8	0.7	145.8	140.7	743.7	1.76	753.2	3.67	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

3.12 mg/L S2- 2.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
11	A	22.3	22.4	12.6	4380.0	6.6	6.6	3.9	3.9	0.9	0.7	141.7	141.9	742.1	1.6	752.7	3.5	
	B	22.3	22.4	12.8	4800.0	6.8	6.7	4.0	4.0	0.8	0.9	145.5	147.3	744.5	1.9	752.5	3.5	
	C	22.3	22.3	12.6	4380.0	6.7	6.7	4.0	3.9	0.8	0.7	141.7	145.7	740.0	1.3	752.3	3.4	
	D	22.3	22.3	12.7	4730.0	6.9	6.9	4.0	4.0	0.9	0.8	133.9	136.1	743.7	1.8	753.2	3.7	
12	A	22.3	22.3	12.6	4450.0	6.6	6.8	4.0	3.9	0.8	0.9	141.1	140.4	742.1	1.6	754.7	4.1	
	B	22.3	22.2	12.6	4300.0	6.8	6.8	3.8	3.8	0.8	0.9	141.7	142.3	744.5	1.9	752.5	3.5	
	C	22.4	22.2	12.7	4290.0	6.7	6.8	4.0	4.1	0.9	0.8	141.6	140.5	740.0	1.3	752.3	3.4	
	D	22.3	22.3	12.8	4510.0	6.7	6.9	3.9	3.8	0.8	0.7	142.5	141.8	745.7	2.1	753.2	3.7	
13	A	22.4	22.3	12.7	4830.0	6.8	6.7	3.9	4.0	0.9	0.7	143.0	142.4	742.1	1.6	754.7	4.1	
	B	22.4	22.3	12.8	4770.0	6.8	6.8	3.8	4.0	0.9	0.7	138.5	139.8	744.5	1.9	750.5	3.0	
	C	22.4	22.3	12.8	4850.0	6.9	6.8	4.0	3.9	0.8	0.8	139.9	142.2	742.0	1.5	751.3	3.2	
	D	22.4	22.2	12.6	4830.0	6.9	6.8	3.8	4.1	0.8	0.9	144.7	142.7	745.7	2.1	753.2	3.7	
14	A	22.4	22.3	12.8	4450.0	6.7	6.8	3.8	3.9	0.9	0.9	142.5	141.4	742.1	1.6	754.7	4.1	
	B	22.3	22.2	12.6	4340.0	6.8	6.8	4.1	3.9	0.7	0.7	140.8	142.4	744.5	1.9	750.5	3.0	
	C	22.3	22.2	12.8	4420.0	6.9	6.9	3.8	4.0	0.8	0.7	140.1	141.2	740.0	1.3	753.3	3.7	
	D	22.4	22.3	12.7	4470.0	6.8	6.9	3.9	3.9	0.7	0.8	140.5	142.7	745.7	2.1	753.2	3.7	
15	A	22.3	22.3	12.7	4490.0	6.8	6.8	4.0	3.9	0.9	0.7	141.2	140.6	741.1	1.4	754.7	4.1	
	B	22.3	22.3	12.7	4520.0	6.7	6.8	3.8	3.9	0.7	0.7	142.2	141.6	744.5	1.9	751.5	3.2	
	C	22.4	22.3	12.8	4400.0	6.8	6.8	3.9	3.8	0.8	0.7	140.4	141.5	740.0	1.3	753.3	3.7	
	D	22.4	22.3	12.6	4360.0	6.7	6.8	3.8	3.9	0.7	0.8	140.4	142.2	743.7	1.8	751.2	3.1	
16	A	22.3	22.3	12.6	4570.0	6.7	6.8	4.0	3.9	0.9	0.8	142.3	141.6	741.1	1.4	754.7	4.1	
	B	22.3	22.3	12.7	4290.0	6.8	6.8	4.0	4.1	0.7	0.9	143.0	141.4	740.5	1.4	753.5	3.8	
	C	22.3	22.2	12.7	4500.0	6.7	6.8	4.0	3.8	0.7	0.8	141.1	140.5	740.0	1.3	753.3	3.7	
	D	22.3	22.2	12.6	4340.0	6.7	6.8	4.1	4.1	0.8	0.9	142.7	140.6	743.7	1.8	751.2	3.1	
17	A	22.4	22.2	12.6	4570.0	6.9	6.8	3.9	3.8	0.8	0.7	144.0	143.8	740.1	1.3	754.7	4.1	
	B	22.4	22.2	12.6	4250.0	6.9	6.8	3.9	3.8	0.8	0.7	139.8	144.8	740.5	1.4	754.5	4.1	
	C	22.4	22.2	12.8	4500.0	6.7	6.7	4.0	3.8	0.9	0.7	142.6	141.1	740.0	1.3	753.3	3.7	
	D	22.4	22.2	12.8	4410.0	6.7	6.7	4.0	3.8	0.9	0.7	142.6	141.1	740.7	1.4	750.2	2.9	
18	A	22.3	22.2	12.5	4580.0	7.0	7.0	4.0	3.9	0.9	0.9	149.1	148.2	740.1	1.3	752.7	3.5	
	B	22.3	22.3	12.5	4840.0	6.8	6.9	4.0	3.9	0.9	0.9	143.3	148.2	740.5	1.4	752.5	3.5	
	C	22.4	22.3	12.7	4630.0	6.6	6.8	3.8	3.9	0.8	0.7	140.4	134.2	740.0	1.3	753.3	3.7	
	D	22.4	22.3	12.7	4800.0	6.5	6.8	3.8	3.9	0.8	0.8	142.3	134.2	740.1	1.3	750.2	2.9	
19	A	22.4	22.3	12.8	4700.0	6.8	6.9	3.9	3.8	0.9	0.9	143.6	144.5	741.1	1.4	752.7	3.5	
	B	22.4	22.2	12.8	4860.0	6.8	6.9	3.9	3.8	0.8	0.7	145.2	139.9	740.5	1.4	752.5	3.5	
	C	22.4	22.3	12.8	4730.0	6.7	6.8	3.9	3.8	0.8	0.8	146.4	147.7	740.0	1.3	752.3	3.4	
	D	22.3	22.2	12.7	4830.0	6.9	6.8	3.8	3.9	0.7	0.9	146.6	147.7	739.1	1.2	750.2	2.9	
20	A	22.3	22.3	12.8	4420.0	6.7	6.8	3.9	3.9	0.7	0.7	140.2	141.7	740.1	1.3	752.7	3.5	
	B	22.4	22.3	12.7	4380.0	6.7	6.8	4.1	4.1	0.7	0.7	144.6	142.4	740.5	1.4	751.5	3.2	
	C	22.4	22.3	12.6	4390.0	6.9	6.8	4.0	4.0	0.9	0.8	140.3	143.3	740.0	1.3	751.3	3.2	
	D	22.3	22.3	12.7	4410.0	6.8	6.9	3.9	4.0	0.8	0.8	140.8	142.3	739.1	1.2	750.2	2.9	
21	A	22.3	22.2		4680.0	6.8		4.0		0.7		142.2		740.2	1.3			
	B	22.3	22.3		4780.0	6.8		3.8		0.7		139.1		740.5	1.4			
	C	22.3	22.3		4830.0	6.9		3.9		0.8		143.1		739.0	1.2			
	D	22.4	22.3		4670.0	6.9		3.9		0.8		141.9		739.1	1.2			
MIN		22.3	**22.2**	**12.4**	**4250**	**6.5**	**6.6**	**3.8**	**3.8**	**0.6**	**0.6**	**133.9**	**134.2**	**739.0**	**1.22**	**750.2**	**2.91**	
MAX		22.4	**22.4**	**12.8**	**4860**	**7.0**	**7.0**	**4.1**	**4.1**	**0.9**	**0.9**	**149.1**	**149.5**	**745.7**	**2.05**	**756.2**	**4.38**	
MEAN		22.4	**22.3**	**12.7**	**4558**	**6.8**	**6.8**	**3.9**	**3.9**	**0.8**	**0.8**	**142.4**	**142.7**	**741.9**	**1.50**	**752.6**	**3.44**	
SEM		0.01	0.01	0.01	29.00	0.01	0.01	0.01	0.01	0.01	0.01	0.26	0.32	0.19	0.022	0.14	0.038	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

7.80 mg/L S2- 2.8 mg/L Fe

IMAM01-00428

								Headspace DO		Aquatic DO				Sulfide,		Sulfide,		
Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Pre-Renew	Post-Renew	Pre-Renew	Post-Renew	Pre-Renew ORP	Post-Renew ORP	mV Reading (mV)	Calc Conc (mg/L)	mV Reading (mV)	Calc Conc (mg/L)	Comments/Observations
0	A	22.3		12.5			6.5		4.1		0.9		154.2			763.3	8.34	
	B	22.3		12.5			6.6		4.0		0.8		156.0			763.9	8.78	
	C	22.3		12.4			6.5		3.9		0.7		152.5			762.2	7.58	
	D	22.3		12.4			6.6		4.0		0.8		151.5			762.4	7.71	
1	A	22.3	22.3	12.7		6.5	6.6	4.1	4.1	0.7	0.7	152.9	154.3	755.1	4.33	763.2	8.30	
	B	22.2	22.3	12.6		6.5	6.6	4.0	4.1	0.8	0.8	153.8	156.8	754.4	4.10	763.9	8.78	
	C	22.5	22.4	12.6		6.5	6.6	4.0	4.1	0.9	0.8	153.6	153.9	756.3	4.77	762.0	7.54	
	D	22.5	22.4	12.5		6.6	6.5	4.1	4.0	0.7	0.9	151.8	150.8	754.1	4.00	762.4	7.78	
2	A	22.3	22.3	12.5		6.8	6.8	4.1	4.0	0.9	0.8	155.7	157.8	755.1	4.03	763.5	7.71	
	B	22.3	22.3	12.7		6.8	6.8	3.8	3.8	0.8	0.9	151.0	153.4	755.1	4.03	763.3	7.60	
	C	22.4	22.2	12.7		6.7	6.7	4.0	3.9	0.7	0.7	143.6	149.4	756.3	4.43	762.0	6.87	
	D	22.3	22.2	12.6		6.7	6.7	4.0	4.0	0.7	0.8	152.1	155.8	755.3	4.10	762.3	7.03	
3	A	22.3	22.3	12.8		6.8	6.7	3.9	4.0	0.9	0.7	150.5	152.3	755.1	4.09	763.7	7.95	
	B	22.3	22.3	12.8		6.8	6.8	3.9	4.0	0.9	0.7	149.0	151.3	754.0	3.76	763.6	7.89	
	C	22.3	22.3	12.8		6.7	6.7	3.9	3.8	0.7	0.9	151.4	153.7	755.3	4.16	762.8	7.41	
	D	22.3	22.2	12.6		6.8	6.7	4.1	3.8	0.9	0.8	152.4	150.4	755.4	4.19	764.1	8.20	
4	A	22.4	22.3	12.8		6.7	6.7	4.1	4.0	0.8	0.7	149.9	152.6	755.2	3.96	763.2	7.33	
	B	22.4	22.3	12.6		6.7	6.7	4.1	4.1	0.7	0.8	149.9	152.7	754.3	3.70	763.2	7.33	
	C	22.4	22.3	12.8		6.8	6.7	4.0	4.0	0.7	0.8	150.9	149.2	756.1	4.25	762.4	6.89	
	D	22.4	22.3	12.7		6.8	6.7	4.0	3.8	0.9	0.7	154.6	153.2	755.5	4.05	762.7	7.05	
5	A	22.3	22.2	12.8		6.8	6.7	4.0	4.1	0.7	0.7	149.4	151.9	755.3	4.05	763.4	7.50	
	B	22.3	22.2	12.6		6.8	6.7	4.1	3.9	0.9	0.9	152.5	150.4	752.0	3.16	765.2	8.60	
	C	22.4	22.3	12.6		6.8	6.7	4.0	4.0	0.7	0.8	149.7	150.4	756.4	4.41	762.2	6.85	
	D	22.3	22.3	12.7		6.8	6.7	3.9	3.9	0.8	0.8	151.9	153.4	752.1	3.18	764.2	7.97	
6	A	22.4	22.3	12.6		6.8	6.8	4.1	4.0	0.9	0.8	148.8	151.3	755.3	4.04	763.5	7.56	
	B	22.3	22.2	12.7		6.9	6.8	4.0	3.9	0.8	0.7	150.1	151.1	754.2	3.72	763.2	7.39	
	C	22.3	22.2	12.7		6.8	6.9	4.0	3.9	0.9	0.7	151.2	154.6	756.2	4.33	763.5	7.56	
	D	22.3	22.2	12.7		6.8	6.8	3.9	4.1	0.7	0.7	151.6	152.6	753.3	3.47	764.2	7.97	
7	A	22.4	22.3	12.7		6.8	6.8	4.0	3.8	0.9	0.8	151.4	152.6	755.3	4.09	763.5	7.71	
	B	22.3	22.3	12.7		6.8	6.8	3.9	3.8	0.9	0.8	153.2	150.7	754.2	3.76	764.4	8.26	
	C	22.3	22.3	12.7		6.8	6.8	4.0	3.8	0.9	0.7	151.0	150.9	757.2	4.74	762.5	7.13	
	D	22.3	22.2	12.6		6.8	6.8	3.8	3.9	0.9	0.8	151.1	154.3	753.3	3.50	762.9	7.36	
8	A	22.3	22.2	12.7		6.6	6.7	3.9	3.9	0.9	0.9	149.7	152.2	756.1	4.20	761.7	6.50	
	B	22.4	22.3	12.6		6.7	6.6	3.9	4.0	0.8	0.8	150.1	152.3	754.2	3.62	765.9	9.03	
	C	22.3	22.2	12.6		6.7	6.6	4.0	3.9	0.7	0.7	149.5	150.7	757.4	4.65	762.7	7.03	
	D	22.4	22.3	12.6		6.6	6.7	4.1	3.9	0.8	0.7	150.7	152.8	757.3	4.61	764.2	7.90	
9	A	22.3	22.3	12.7		6.7	6.8	3.9	4.1	0.9	0.9	152.7	150.8	756.1	4.40	763.8	7.97	
	B	22.4	22.3	12.7		6.7	6.6	4.1	3.9	0.7	0.9	151.7	152.2	754.5	3.89	763.4	7.73	
	C	22.4	22.3	12.7		6.9	6.8	3.9	3.8	0.7	0.9	150.5	152.6	756.6	4.58	762.7	7.32	
	D	22.4	22.2	12.7		6.8	6.8	4.0	4.0	0.8	0.9	152.5	150.3	754.4	3.86	763.0	7.50	
10	A	22.4	22.3	12.8		6.7	6.6	3.9	4.1	0.7	0.9	150.6	149.8	756.1	4.60	764.4	8.77	
	B	22.3	22.3	12.6		6.8	6.9	4.0	3.9	0.7	0.8	146.8	145.1	754.5	4.06	763.4	8.12	
	C	22.3	22.4	12.8		6.7	6.6	4.0	3.9	0.7	0.7	146.7	150.4	756.1	4.60	762.5	7.57	
	D	22.4	22.4	12.7		6.6	6.7	4.0	4.1	0.7	0.8	151.2	154.3	756.9	4.90	762.8	7.75	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

Tier 1 Parameters

7.80 mg/L S2- 2.8 mg/L Fe

IMAM01-00428

Study Day	Rep	Water Bath (C)	AM Temp (C)	PM Temp (C)	Light Intensity (lux)	Pre-Renew pH	Post-Renew pH	Headspace DO Pre-Renew	Headspace DO Post-Renew	Aquatic DO Pre-Renew	Aquatic DO Post-Renew	Pre-Renew ORP	Post-Renew ORP	Sulfide, mV Reading (mV)	Sulfide, Calc Conc (mg/L)	Sulfide, mV Reading (mV)	Sulfide, Calc Conc (mg/L)	Comments/Observations
11	A	22.4	22.3	12.7	4920.0	6.6	6.7	4.0	4.0	0.8	0.9	149.1	150.4	756.1	4.6	765.4	9.5	
	B	22.3	22.3	12.6	4980.0	6.6	6.7	4.0	4.0	0.7	0.9	149.5	148.6	755.9	4.5	763.4	8.1	
	C	22.3	22.2	12.6	4440.0	6.7	6.8	3.9	4.0	0.8	0.9	146.8	148.1	756.1	4.6	762.5	7.6	
	D	22.3	22.3	12.6	4800.0	6.9	6.9	3.8	3.9	0.8	0.9	152.5	152.7	757.9	5.3	763.8	8.4	
12	A	22.3	22.3	12.6	4410.0	6.6	6.7	3.8	3.9	0.8	0.8	149.0	152.1	756.6	4.8	764.4	8.8	
	B	22.4	22.3	12.6	4390.0	6.7	6.6	4.0	3.9	0.7	0.7	151.3	150.7	755.9	4.5	763.4	8.1	
	C	22.4	22.2	12.6	4190.0	6.6	6.7	4.1	4.0	0.7	0.7	150.8	151.3	756.7	4.8	762.5	7.6	
	D	22.3	22.3	12.7	4490.0	6.7	6.7	3.8	3.9	0.7	0.8	151.6	150.7	755.9	4.5	764.9	9.1	
13	A	22.3	22.2	12.8	4950.0	6.6	6.7	4.0	3.8	0.8	0.8	150.7	151.6	756.8	4.9	763.4	8.1	
	B	22.3	22.2	12.7	4900.0	6.7	6.7	3.9	3.9	0.8	0.9	149.9	153.2	755.9	4.5	763.4	8.1	
	C	22.3	22.2	12.6	4890.0	6.9	6.6	3.9	3.8	0.7	0.8	148.7	151.7	756.7	4.8	762.5	7.6	
	D	22.4	22.2	12.7	4920.0	6.9	6.7	3.8	4.1	0.9	0.7	150.0	151.7	756.9	4.9	762.9	7.8	
14	A	22.4	22.3	12.8	4390.0	6.7	6.7	3.9	4.1	0.7	0.8	150.1	153.2	755.8	4.5	764.4	8.8	
	B	22.3	22.3	12.7	4500.0	6.7	6.8	3.9	3.9	0.9	0.8	151.2	150.6	755.9	4.5	765.4	9.5	
	C	22.4	22.2	12.6	4380.0	6.7	6.7	3.9	4.1	0.8	0.9	153.6	152.1	756.7	4.8	760.5	6.5	
	D	22.3	22.2	12.6	4420.0	6.7	6.8	4.0	4.0	0.9	0.9	150.7	151.8	756.1	4.6	760.9	6.7	
15	A	22.3	22.3	12.6	4400.0	6.8	6.8	4.0	3.8	0.8	0.8	153.3	152.2	755.8	4.5	762.4	7.5	
	B	22.4	22.3	12.7	4410.0	6.7	6.7	3.8	3.8	0.9	0.7	151.3	150.7	756.9	4.9	765.4	9.5	
	C	22.4	22.3	12.6	4460.0	6.7	6.7	4.0	3.9	0.8	0.9	149.9	150.6	756.7	4.8	760.5	6.5	
	D	22.3	22.2	12.7	4320.0	6.7	6.7	3.9	4.1	0.8	0.9	151.3	150.3	757.1	5.0	760.1	6.3	
16	A	22.3	22.2	12.8	4490.0	6.7	6.8	3.9	4.0	0.7	0.8	151.8	152.7	752.8	3.6	763.4	8.1	
	B	22.3	22.2	12.8	4400.0	6.7	6.6	4.0	4.1	0.7	0.7	151.5	150.5	756.9	4.9	765.4	9.5	
	C	22.3	22.3	12.6	4540.0	6.6	6.7	3.9	4.1	0.9	0.9	150.6	152.3	756.7	4.8	764.5	8.8	
	D	22.4	22.2	12.8	4380.0	6.6	6.6	3.9	3.9	0.9	0.7	150.6	152.3	755.1	4.3	760.1	6.3	
17	A	22.4	22.2	12.6	4210.0	6.7	6.7	4.0	4.1	0.8	0.7	144.7	143.9	751.8	3.3	764.4	8.8	
	B	22.4	22.3	12.6	4140.0	6.7	6.6	4.0	4.1	0.8	0.7	144.7	143.9	756.9	4.9	763.4	8.1	
	C	22.4	22.2	12.6	4500.0	6.6	6.6	4.1	3.9	0.7	0.9	150.1	145.2	756.7	4.8	764.5	8.8	
	D	22.4	22.3	12.6	4220.0	6.6	6.6	4.0	3.9	0.8	0.9	150.1	145.2	753.1	3.6	761.1	6.8	
18	A	22.2	22.2	12.5	4980.0	6.5	6.6	3.9	3.8	0.7	0.8	150.9	149.6	750.8	3.0	761.4	6.9	
	B	22.2	22.2	12.5	4930.0	6.5	6.6	3.9	3.8	0.7	0.8	153.4	149.6	756.9	4.9	763.4	8.1	
	C	22.3	22.2	12.6	4290.0	6.4	6.6	3.8	3.9	0.7	0.7	152.1	133.1	756.7	4.8	764.5	8.8	
	D	22.3	22.2	12.6	4890.0	6.4	6.6	3.8	4.0	0.7	0.7	150.7	133.1	752.1	3.4	761.1	6.8	
19	A	22.4	22.2	12.8	4890.0	6.9	6.9	3.9	3.9	0.9	0.8	149.7	149.9	750.8	3.0	762.4	7.5	
	B	22.4	22.3	12.8	4990.0	6.8	6.9	4.1	4.0	0.9	0.7	150.7	149.9	756.9	4.9	763.4	8.1	
	C	22.3	22.3	12.6	4890.0	6.8	7.0	4.0	3.8	0.7	0.7	150.1	149.9	756.7	4.8	762.5	7.6	
	D	22.3	22.2	12.8	4910.0	6.9	6.7	3.9	4.0	0.8	0.9	149.8	150.1	752.1	3.4	764.1	8.6	
20	A	22.3	22.2	12.6	4530.0	6.7	6.8	4.1	4.1	0.9	0.8	149.8	152.5	750.1	2.9	761.4	6.9	
	B	22.4	22.3	12.7	4320.0	6.7	6.8	4.1	4.1	0.8	0.8	153.8	151.5	756.9	4.9	763.4	8.1	
	C	22.3	22.2	12.8	4400.0	6.7	6.8	4.0	3.9	0.9	0.8	152.9	151.9	756.7	4.8	764.5	8.8	
	D	22.4	22.3	12.7	4490.0	6.7	6.7	3.9	4.1	0.7	0.9	150.0	151.4	751.1	3.1	762.1	7.3	
21	A	22.4	22.3		4810.0	6.9		3.8		0.9		151.0		749.1	2.7			
	B	22.4	22.2		4900.0	6.8		4.0		0.8		149.7		755.9	4.5			
	C	22.4	22.2		4910.0	6.9		3.9		0.7		149.9		755.7	4.5			
	D	22.3	22.3		4860.0	6.9		3.9		0.8		150.6		751.5	3.2			
	MIN	22.2	**22.2**	**12.4**	**4140**	**6.4**	**6.5**	**3.8**	**3.8**	**0.7**	**0.7**	**143.6**	**133.1**	**749.1**	**2.67**	**760.1**	**6.28**	
	MAX	22.5	**22.4**	**12.8**	**4990**	**6.9**	**7.0**	**4.1**	**4.1**	**0.9**	**0.9**	**155.7**	**157.8**	**757.9**	**5.29**	**765.9**	**9.48**	
	MEAN	22.3	**22.3**	**12.7**	**4601**	**6.7**	**6.7**	**4.0**	**4.0**	**0.8**	**0.8**	**150.7**	**151.0**	**755.2**	**4.24**	**763.2**	**7.83**	
	SEM	0.01	0.01	0.01	41.04	0.01	0.01	0.01	0.01	0.01	0.01	0.22	0.41	0.21	0.065	0.13	0.084	

Temp Range = AM19-23 PM 10-14
Light Intensity = 0 through SD10 then 4000-6000 lux

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FEL

IMAM01-00428 - Endpoint Data Summary

Treatment	Rep	Per Replicate							
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emerg-ence (%)	Seedling Survival (n)	Survival (%)	Phytotox: Abnormal Appearance (n)	Phytotox: Abnormal Appearance (%)
HS-1 (1:4) 0.8 mg/L Fe	A	40	100.0	15	37.5	15.0	100.0	0	0.0
	B	40	100.0	14	35.0	14.0	100.0	0	0.0
	C	40	100.0	13	32.5	13.0	100.0	0	0.0
	D	40	100.0	15	37.5	15.0	100.0	0	0.0
	Mean:	**40**	**100**	**14.3**	**35.6**	**14.3**	**100.0**	**0**	**0.0**
	SEM:	**0.0**	**0.0**	**0.48**	**1.20**	**0.48**	**0.0**	**0.0**	**0.0**
0.3 mg/L Sulfide 0.8 mg/L Fe	A	40	100.0	14	35.0	14.0	100.0	0	0.0
	B	40	100.0	12	30.0	12.0	100.0	0	0.0
	C	40	100.0	13	32.5	13.0	100.0	0	0.0
	D	40	100.0	14	35.0	14.0	100.0	0	0.0
	Mean:	**40**	**100**	**13.3**	**33.1**	**13.3**	**100**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.48**	**1.20**	**0.48**	**0.0**	**0.00**	**0.0**
1.56 mg/L Sulfide 0.8 mg/L Fe	A	40	100.0	13	32.5	13.0	100.0	0	0.0
	B	40	100.0	13	32.5	13.0	100.0	0	0.0
	C	40	100.0	15	37.5	15.0	100.0	0	0.0
	D	40	100.0	12	30.0	12.0	100.0	0	0.0
	Mean:	**40**	**100**	**13.3**	**33.1**	**13.3**	**100**	**0**	**0**
	SEM:	**0.0**	**0.0**	**0.63**	**1.57**	**0.63**	**0.0**	**0.0**	**0.0**
3.12 mg/L Sulfide 0.8 mg/L Fe	A	40	100.0	9	22.5	9.0	100.0	0	0.0
	B	40	100.0	9	22.5	9.0	100.0	0	0.0
	C	40	100.0	7	17.5	7.0	100.0	0	0.0
	D	40	100.0	8	20.0	8.0	100.0	0	0.0
	Mean:	**40**	**100**	**8.3**	**20.6**	**8.3**	**100**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.48**	**1.20**	**0.48**	**0.0**	**0.00**	**0.0**

FEL

IMAM01-00428 - Endpoint Data Summary

Treatment	Rep	Per Replicate							
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emerg-ence (%)	Seedling Survival (n)	Survival (%)	Phytotox: Abnormal Appearance (n)	Phytotox: Abnormal Appearance (%)
7.80 mg/L Sulfide 0.8 mg/L Fe	A	40	100.0	3	7.5	3.0	100.0	0	0.0
	B	40	100.0	3	7.5	3.0	100.0	0	0.0
	C	40	100.0	4	10.0	4.0	100.0	0	0.0
	D	40	100.0	3	7.5	3.0	100.0	0	0.0
	Mean:	**40**	**100**	**3.3**	**8.1**	**3.3**	**100.0**	**0**	**0.0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**0.0**	**0.0**
HS-1 (1:4) 2.8 mg/L Fe	A	40	100.0	13	32.5	13.0	100.0	0	0.0
	B	40	100.0	14	35.0	14.0	100.0	0	0.0
	C	40	100.0	14	35.0	14.0	100.0	0	0.0
	D	40	100.0	15	37.5	15.0	100.0	0	0.0
	Mean:	**40**	**100**	**14.0**	**35.0**	**14.0**	**100**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.41**	**1.02**	**0.41**	**0.0**	**0.00**	**0.0**
0.3 mg/L Sulfide 2.8 mg/L Fe	A	40	100.0	16	40.0	16.0	100.0	0	0.0
	B	40	100.0	15	37.5	15.0	100.0	0	0.0
	C	40	100.0	15	37.5	15.0	100.0	0	0.0
	D	40	100.0	13	32.5	13.0	100.0	0	0.0
	Mean:	**40**	**100**	**14.8**	**36.9**	**14.8**	**100**	**0**	**0**
	SEM:	**0.0**	**0.0**	**0.63**	**1.57**	**0.63**	**0.0**	**0.0**	**0.0**
1.56 mg/L Sulfide 2.8 mg/L Fe	A	40	100.0	13	32.5	13.0	100.0	0	0.0
	B	40	100.0	13	32.5	13.0	100.0	0	0.0
	C	40	100.0	14	35.0	14.0	100.0	0	0.0
	D	40	100.0	12	30.0	12.0	100.0	0	0.0
	Mean:	**40**	**100**	**13.0**	**32.5**	**13.0**	**100**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.41**	**1.02**	**0.41**	**0.0**	**0.00**	**0.0**

FEL

IMAM01-00428 - Endpoint Data Summary

Treatment	Rep	Per Replicate							
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emerg-ence (%)	Seedling Survival (n)	Survival (%)	Phytotox: Abnormal Appearance (n)	Phytotox: Abnormal Appearance (%)
3.12 mg/L Sulfide 2.8 mg/L Fe	A	40	100.0	12	30.0	12.0	100.0	0	0.0
	B	40	100.0	13	32.5	13.0	100.0	0	0.0
	C	40	100.0	12	30.0	12.0	100.0	0	0.0
	D	40	100.0	13	32.5	13.0	100.0	0	0.0
	Mean:	**40**	**100**	**12.5**	**31.3**	**12.5**	**100.0**	**0**	**0.0**
	SEM:	**0.0**	**0.0**	**0.29**	**0.72**	**0.29**	**0.0**	**0.0**	**0.0**
7.80 mg/L Sulfide 2.8 mg/L Fe	A	40	100.0	8	20.0	8.0	100.0	0	0.0
	B	40	100.0	9	22.5	9.0	100.0	0	0.0
	C	40	100.0	7	17.5	7.0	100.0	0	0.0
	D	40	100.0	8	20.0	8.0	100.0	0	0.0
	Mean:	**40**	**100**	**8.0**	**20.0**	**8.0**	**100**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.41**	**1.02**	**0.41**	**0.0**	**0.00**	**0.0**
HS-1 (1:4) 100 mg/L BA	A	40	100.0	3	7.5	3.0	100.0	3	100.0
	B	40	100.0	3	7.5	3.0	100.0	3	100.0
	C	40	100.0	3	7.5	3.0	100.0	3	100.0
	D	40	100.0	3	7.5	3.0	100.0	3	100.0
	Mean:	**40**	**100**	**3.0**	**7.5**	**3.0**	**100**	**3**	**100**
	SEM:	**0.0**	**0.0**	**0.00**	**0.00**	**0.00**	**0.0**	**0.0**	**0.0**

FEL

	Median Emergence Time (d)										
	HS-1	100 mg/L BA	0.3 mg/L S^{2-} 0.8 mg/L Fe	1.56 mg/L S^{2-} 0.8 mg/L Fe	3.12 mg/L S^{2-} 0.8 mg/L Fe	7.8 mg/L S^{2-} 0.8 mg/L Fe	HS-1 2.8 mg/L Fe	0.3 mg/L S^{2-} 2.8 mg/L Fe	1.56 mg/L S^{2-} 2.8 mg/L Fe	3.12 mg/L S^{2-} 2.8 mg/L Fe	7.8 mg/L S^{2-} 2.8 mg/L Fe
Rep A	9	>10	9	10	>10	<10	10	9	9	9	>10
Rep B	10	>10	10	10	>10	<10	9	9	10	10	>10
Rep C	9	>10	10	9	>10	<10	9	9	9	10	>10
Rep D	9	>10	9	10	>10	<10	9	10	10	10	>10
Median	**9**	**>10**	**9.5**	**10**	**>10**	**>10**	**9**	**9**	**9.5**	**10**	**>10**
SEM	**0.3**	**0.0**	**0.3**	**0.3**	**0.0**	**0.0**	**0.3**	**0.3**	**0.3**	**0.3**	**0.0**

Takedown Data

Client/Project-WO No: SQME01-0042

Date	Tech Initials	Treatment	Rep No.	Seed No.	Shoot Wt (g)	Root Wt (g)	Dried Leaf Biomass Wt (g)	Shoot Length (mm)	Root Length (mm)	Phytotoxicity (Y or N)	Free Leaf No.	Comments
			A	1	0.0042	0.0012	0.0008	18.631148	32.703	N	3.0	
			A	2	0.0035	0.0011	0.0013	23.671756	62.1470	N	2.0	
			A	3	0.0052	0.0014	0.0012	17.325894	10.6475	N	3.0	
			A	4	0.0044	0.0012	0.0007	20.590865	60.6369	N	3.0	
			A	5	0.0064	0.0008	0.0022	19.512056	16.4322	N	2.0	
			A	6	0.0038	0.0008		18.288254	5.1602	N	0.0	
			A	7	0.0030	0.0010		18.116374	43.4460	N	0.0	
			A	8	0.0053	0.0014		30.090278	67.8163	N	0.0	
			A	9	0.0020	0.0011		36.877029	37.6544	N	0.0	
		HS-1 (1:4)	A	10	0.0031	0.0008		35.488192	83.5627	N	0.0	
		0.8 mg/L Fe	A	11	0.0026	0.0014		36.717222	10.6087	N	0.0	
			A	12	0.0030	0.0007		47.816158	39.1929	N	0.0	
			A	13	0.0038	0.0009		32.794515	9.8883	N	0.0	
			A	14	0.0063	0.0004		37.731344	8.6197	N	0.0	
			A	15	0.0025	0.0005		111.30976	17.5064	N	0.0	
			A	16	0.0037	0.0003		69.408123	39.663584	N	0.0	
			A	17	0.0026	0.0002		47.161184	25.675709	N	0.0	
			A	18	0.0033	0.0003		21.760438	44.593407	N	0.0	
			A	19								
			A	20								
Averages					**0.0038**	**0.0009**	**0.0012**	**35.7384**	**34.2197**		**0.7**	
			B	1	0.0034	0.0005	0.0005	36.603938	45.1285	N	2.0	
			B	2	0.0085	0.0005	0.0024	25.562819	30.2918	N	2.0	
			B	3	0.0055	0.0004	0.0022	28.554384	23.2522	N	3.0	
			B	4	0.0060	0.0009	0.0019	33.720866	33.7631	N	3.0	
			B	5	0.0035	0.0007	0.0029	21.993042	25.9961	N	2.0	
			B	6	0.0075	0.0006	0.0010	18.757691	62.5091	N	3.0	
			B	7	0.0088	0.0006		30.011186	27.5592	N	0.0	
			B	8	0.0055	0.0004		29.03412	24.1910	N	0.0	
			B	9	0.0051	0.0008		19.16154	42.2733	N	0.0	
		HS-1 (1:4)	B	10	0.0034	0.0007		72.503676	19.7650	N	0.0	

		0.8 mg/L Fe	B	11	0.0031	0.0023		39.1344	22.2069	N	0.0	
			B	12	0.0010	0.0010		48.2392	12.5801	N	0.0	
			B	13	0.0028	0.0010		36.1383	33.4022	N	0.0	
			B	14	0.0043	0.0012		36.4765	37.2525	N	0.0	
			B	15	0.0023	0.0011		59.2719	32.0955	N	0.0	
			B	16	0.0031	0.0009		71.9233	45.2064	N	0.0	
			B	17	0.0043	0.0007		27.7357	8.9921	N	0.0	
			B	18	0.0022	0.0003		27.8859	44.2985	N	0.0	
			B	19								
			B	20								
Averages					**0.0045**	**0.0008**	**0.0018**	**36.8171**	**31.7091**		**0.8**	
			C	1	0.0042	0.0009	0.0017	30.998899	17.8803	N	3.0	
			C	2	0.0046	0.0009	0.0018	15.915404	36.8468	N	3.0	
			C	3	0.0072	0.0012	0.0039	19.6011	18.9056	N	3.0	
			C	4	0.0040	0.0010	0.0035	20.235455	49.3550	N	3.0	
			C	5	0.0032	0.0007	0.0021	23.527622	35.0009	N	3.0	
			C	6	0.0043	0.0003	0.0008	34.826765	16.3938	N	3.0	
			C	7	0.0048	0.0004	0.0009	18.296627	32.3665	N	3.0	
			C	8	0.0037	0.0007		92.678863	30.8475	N	0.0	
			C	9	0.0032	0.0008		22.61763	31.0659	N	0.0	
		HS-1 (1:4)	C	10	0.0014	0.0009		28.738878	20.4229	N	0.0	
		0.8 mg/L Fe	C	11	0.0051	0.0006		31.977843	62.5592	N	0.0	
			C	12	0.0021	0.0004		35.547568	27.5410	N	0.0	
			C	13	0.0017	0.0003		41.76152	44.9625	N	0.0	
			C	14	0.0018	0.0007		112.4216	62.9783	N	0.0	
			C	15	0.0016	0.0010		38.2465	28.9653	N	0.0	
			C	16	0.0012	0.0011		66.146429	21.66131	N	0.0	
			C	17								
			C	18								
			C	19								
			C	20								
Averages					**0.0034**	**0.0007**	**0.0021**	**39.5962**	**33.6096**		**1.3**	
			D	1	0.0050	0.0013	0.0024	23.5776	51.1505	N	3.0	
			D	2	0.0028	0.0005	0.0010	25.9259	15.2474	N	3.0	
			D	3	0.0035	0.0002	0.0012	28.5475	48.6635	N	3.0	
			D	4	0.0024	0.0003	0.0018	35.7506	45.0622	N	3.0	
			D	5	0.0032	0.0004	0.0022	41.8594	50.0983	N	3.0	
			D	6	0.0053	0.0006	0.0004	33.4614	16.0500	N	2.0	
			D	7	0.0060	0.0011		18.5513	46.2350	N	0.0	
			D	8	0.0013	0.0010		13.3171	17.0121	N	0.0	

			D	9	0.0066	0.0016		51.3432	28.7825		N	0.0	
		HS-1 (1:4)	D	10	0.0032	0.0008		15.4026	11.2814		N	0.0	
		0.8 mg/L Fe	D	11	0.0022	0.0007		32.1128	46.3011		N	0.0	
			D	12	0.0035	0.0014		61.9679	12.3266		N	0.0	
			D	13	0.0033	0.0008		66.8497	49.8044		N	0.0	
			D	14	0.0029	0.0019		62.6956	39.9166		N	0.0	
			D	15	0.0021	0.0003		26.7018	68.5369		N	0.0	
			D	16	0.0022	0.0002		49.9874	20.8007		N	0.0	
			D	17	0.0026	0.0003		82.6348	18.1430		N	0.0	
			D	18	0.0030	0.0005		47.343	18.143		N	0.0	
			D	19	0.0015	0.0007		12.849	9.232		N	0.0	
			D	20									
Averages					**0.0033**	**0.0008**	**0.0015**	**38.4673**	**32.2520**			**0.9**	
			A	1	0.0063	0.0010	0.0036	22.0473	26.4567		N	3.0	
			A	2	0.0051	0.0005		15.9247	18.5679		N	0.0	
			A	3	0.0010	0.0003		31.0462	13.9288		N	0.0	
			A	4	0.0048	0.0009		24.3100	37.3214		N	0.0	
			A	5	0.0059	0.0011		24.145	37.490		N	0.0	
			A	6	0.0046	0.0028		30.973	45.612		N	0.0	
			A	7	0.0044	0.0020		19.067	24.250		N	0.0	
			A	8	0.0033	0.0013		15.747	33.034		N	0.0	
			A	9	0.0037	0.0007		25.457	34.248		N	0.0	
		0.3 mg/L S^{2-}	A	10	0.0025	0.0008		29.747	39.027		N	0.0	
		0.8 mg/L Fe	A	11	0.0021	0.0007		20.490	46.922		N	0.0	
			A	12	0.0016	0.0007		18.463	34.395		N	0.0	
			A	13	0.0011	0.0008		58.621	34.001		N	0.0	
			A	14	0.0012	0.0014		16.118	42.755		N	0.0	
			A	15	0.0038	0.0008		46.174	53.972		N	0.0	
			A	16	0.0026	0.0007		48.047	37.149		N	0.0	
			A	17	0.0021	0.0005		36.129	8.131		N	0.0	
			A	18									
			A	19									
			A	20									
Averages					**0.0033**	**0.0010**	**0.0036**	**28.3827**	**33.3683**			**0.2**	
			B	1	0.0068	0.0015	0.0026	24.2269	37.6163		N	3.0	
			B	2	0.0047	0.0015	0.0035	36.5216	29.4128		N	2.0	
			B	3	0.0051	0.0011	0.0014	43.0563	43.8019		N	3.0	
			B	4	0.0043	0.0012		42.1702	36.8591		N	0.0	
			B	5	0.0039	0.0015		24.4885	87.3088		N	0.0	
			B	6	0.0021	0.0013		59.326	23.304		N	0.0	

			B	7	0.0018	0.0016		21.537	58.376	N	0.0	
			B	8	0.0024	0.0007		27.310	44.154	N	0.0	
			B	9	0.0028	0.0004		82.965	72.093	N	0.0	
		0.3 mg/L S^{2-}	B	10	0.0016	0.0009		18.958	39.987	N	0.0	
		0.8 mg/L Fe	B	11	0.0009	0.0010		44.203	36.681	N	0.0	
			B	12	0.0018	0.0012		80.676	38.578	N	0.0	
			B	13	0.0012	0.0006		34.012	49.848	N	0.0	
			B	14	0.0011	0.0008		53.403	40.576	N	0.0	
			B	15	0.0043	0.0004		25.828	27.421	N	0.0	
			B	16	0.0056	0.0005		20.611	45.046	N	0.0	
			B	17	0.0042	0.0010		163.858	20.633	N	0.0	
			B	18	0.0040	0.0018		23.663	6.823	N	0.0	
			B	19								
			B	20								
Averages					**0.0033**	**0.0011**	**0.0025**	**45.9341**	**41.0288**		**0.4**	
			C	1	0.0039	0.0019	0.0009	62.0759	24.5796	N	3.0	
			C	2	0.0047	0.0023	0.0019	26.7018	32.1989	N	3.0	
			C	3	0.0031	0.0018	0.0026	30.2105	56.7046	N	3.0	
			C	4	0.0028	0.0016	0.0010	20.5156	18.2664	N	2.0	
			C	5	0.0026	0.0013	0.0018	21.804	158.651	N	2.0	
			C	6	0.0015	0.0009	0.0018	17.434	38.701	N	3.0	
			C	7	0.0011	0.0015	0.0006	38.442	38.405	N	3.0	
			C	8	0.0016	0.0010	0.0003	23.008	38.894	N	3.0	
			C	9	0.0018	0.0017		49.156	52.933	N	0.0	
		0.3 mg/L S^{2-}	C	10	0.0022	0.0019		35.771	21.089	N	0.0	
		0.8 mg/L Fe	C	11	0.0024	0.0003		26.074	22.775	N	0.0	
			C	12	0.0023	0.0006		24.770	25.823	N	0.0	
			C	13	0.0029	0.0004		21.659	86.825	N	0.0	
			C	14	0.0048	0.0004		30.846	39.635	N	0.0	
			C	15	0.0051	0.0007		27.266	49.937	N	0.0	
			C	16	0.0054	0.0005		29.060	59.884	N	0.0	
			C	17	0.0046	0.0009		22.577	17.255	N	0.0	
			C	18	0.0029	0.0016		16.418	9.376	N	0.0	
			C	19								
			C	20								
Averages					**0.0031**	**0.0012**	**0.0014**	**29.0994**	**43.9962**		**1.2**	
			D	1	0.0073	0.0010	0.0028	28.9328	36.9060	N	3.0	
			D	2	0.0066	0.0008	0.0007	46.8287	35.9312	N	3.0	
			D	3	0.0078	0.0005	0.0006	76.8191	20.0252	N	2.0	
			D	4	0.0061	0.0009	0.0010	16.1183	23.4675	N	2.0	

			D	5	0.0055	0.0011	0.0004	18.3536	52.3389	N	3.0	
			D	6	0.0043	0.0009	0.0005	26.2225	69.9908	N	2.0	
			D	7	0.0030	0.0007	0.0004	33.952	20.685	N	3.0	
			D	8	0.0018	0.0009	0.0006	18.888	39.366	N	3.0	
			D	9	0.0025	0.0006		25.638	73.418	N	0.0	
		0.3 mg/L S^{2-}	D	10	0.0027	0.0012		16.958	49.751	N	0.0	
		0.8 mg/L Fe	D	11	0.0013	0.0010		33.726	48.494	N	0.0	
			D	12	0.0012	0.0009		42.954	31.785	N	0.0	
			D	13	0.0029	0.0014		51.329	68.094	N	0.0	
			D	14	0.0033	0.0012		55.008	88.101	N	0.0	
			D	15	0.0041	0.0006		72.671	63.383	N	0.0	
			D	16	0.0043	0.0004		17.767	71.440	N	0.0	
			D	17	0.0037	0.0008		13.191	56.424	N	0.0	
			D	18	0.0039	0.0007		49.379	17.525	N	0.0	
			D	19								
			D	20								
Averages					**0.0040**	**0.0009**	**0.0009**	**35.8186**	**48.1737**		**1.2**	
			A	1	0.0077	0.0017	0.0043	25.3832	25.6455	N	2.0	
			A	2	0.0035	0.0009	0.0009	36.1834	42.8760	N	2.0	
			A	3	0.0051	0.0007	0.0012	29.2339	23.1702	N	3.0	
			A	4	0.0044	0.0006	0.0009	31.0371	41.4951	N	2.0	
			A	5	0.0064	0.0006	0.0020	28.6729	84.8609	N	2.0	
			A	6	0.0038	0.0008	0.0039	42.9336	47.5591	N	2.0	
			A	7	0.0030	0.0007	0.0009	69.515	36.415	N	2.0	
			A	8	0.0053	0.0006	0.0011	31.968	44.550	N	1.0	
			A	9	0.0020	0.0006	0.0008	132.540	6.834	N	0.0	
		1.56 mg/L S^{2-}	A	10	0.0031	0.0005		45.630	49.572	N	0.0	
		0.8 mg/L Fe	A	11	0.0076	0.0002		37.771	23.664	N	0.0	
			A	12	0.0030	0.0007		47.595	41.905	N	0.0	
			A	13	0.0038	0.0003		23.334	39.829	N	0.0	
			A	14	0.0063	0.0007		124.893	35.889	N	0.0	
			A	15	0.0025	0.0004		78.496	75.515	N	0.0	
			A	16	0.0037	0.0008		39.270	64.140	N	0.0	
			A	17	0.0026	0.0007		58.956	28.402	N	0.0	
			A	18								
			A	19								
			A	20								
Averages					**0.0043**	**0.0007**	**0.0018**	**51.9653**	**41.9012**		**0.9**	
			B	1	0.0085	0.0004	0.0043	32.6339	41.8782	N	2.0	
			B	2	0.0055	0.0002	0.0062	22.0270	97.2236	N	2.0	

			B	3	0.0060	0.0005	0.0018	32.8950	53.9006	N	1.0	
			B	4	0.0035	0.0008		20.9386	60.9930	N	0.0	
			B	5	0.0075	0.0008		27.4735	22.2838	N	0.0	
			B	6	0.0088	0.0006		31.9010	67.2947	N	0.0	
			B	7	0.0055	0.0006		22.5177	49.5507	N	0.0	
			B	8	0.0071	0.0007		25.227	23.992	N	0.0	
			B	9	0.0058	0.0009		45.023	48.287	N	0.0	
		1.56 mg/L S^{2-}	B	10	0.0057	0.0010		37.848	137.909	N	0.0	
		0.8 mg/L Fe	B	11	0.0062	0.0011		47.835	44.479	N	0.0	
			B	12	0.0064	0.0005		23.657	82.724	N	0.0	
			B	13	0.0070	0.0003		38.884	42.682	N	0.0	
			B	14	0.0057	0.0006		79.602	31.536	N	0.0	
			B	15	0.0045	0.0007		125.451	78.766	N	0.0	
			B	16	0.0040	0.0007		58.370	56.397	N	0.0	
			B	17								
			B	18								
			B	19								
			B	20								
Averages					**0.0061**	**0.0007**	**0.0041**	**42.0177**	**58.7435**		**0.3**	
			C	1	0.0044	0.0002	0.0033	34.5777	29.8129	N	2.0	
			C	2	0.0058	0.0008	0.0011	27.3235	33.5391	N	2.0	
			C	3	0.0088	0.0006	0.0012	31.4770	33.4098	N	1.0	
			C	4	0.0049	0.0006	0.0013	74.0873	15.0099	N	1.0	
			C	5	0.0087	0.0007		33.3166	95.0545	N	0.0	
			C	6	0.0050	0.0008		27.3309	18.2933	N	0.0	
			C	7	0.0095	0.0009		63.6412	118.6919	N	0.0	
			C	8	0.0099	0.0005		26.1553	112.3542	N	0.0	
			C	9	0.0047	0.0013		37.786	45.419	N	0.0	
		1.56 mg/L S^{2-}	C	10	0.0041	0.0010		57.500	118.031	N	0.0	
		0.8 mg/L Fe	C	11	0.0034	0.0005		56.237	12.438	N	0.0	
			C	12	0.0047	0.0006		89.617	34.789	N	0.0	
			C	13	0.0031	0.0006		111.704	52.736	N	0.0	
			C	14	0.0058	0.0007		41.389	63.346	N	0.0	
			C	15	0.0007	0.0008		106.774	95.458	N	0.0	
			C	16	0.0020	0.0009		112.620	29.450	N	0.0	
			C	17								
			C	18								
			C	19								
			C	20								
Averages					**0.0053**	**0.0007**	**0.0017**	**58.2210**	**56.7395**		**0.4**	

			D	1	0.0077	0.0005	0.0026	33.5480	51.75		N	2.0	
			D	2	0.0057	0.0004	0.0011	54.9562	63.0283		N	2.0	
			D	3	0.0128	0.0004	0.0005	28.0425	96.2842		N	2.0	
			D	4	0.0081	0.0006	0.0003	28.6317	22.5105		N	1.0	
			D	5	0.0022	0.0008		33.2736	66.6849		N	0.0	
			D	6	0.0126	0.0010		24.6084	50.4871		N	0.0	
			D	7	0.0070	0.0008		20.141	24.013		N	0.0	
			D	8	0.0064	0.0009		171.759	42.065		N	0.0	
			D	9	0.0033	0.0007		40.146	40.496		N	0.0	
		1.56 mg/L S^{2-}	D	10	0.0072	0.0006		39.348	83.678		N	0.0	
		0.8 mg/L Fe	D	11	0.0049	0.0006		52.192	34.900		N	0.0	
			D	12	0.0048	0.0007		60.278	14.721		N	0.0	
			D	13	0.0033	0.0005		143.512	45.088		N	0.0	
			D	14	0.0041	0.0006		46.034	40.133		N	0.0	
			D	15	0.0047	0.0009		64.375	19.065		N	0.0	
			D	16									
			D	17									
			D	18									
			D	19									
			D	20									
Averages					**0.0063**	**0.0007**	**0.0011**	**56.0563**	**46.3266**			**0.5**	
			A	1	0.0031	0.0007	0.0059	42.5416	36.0622		N	2.0	
			A	2	0.0024	0.0006	0.0006	38.1373	21.3393		N	1.0	
			A	3	0.0036	0.0006	0.0009	56.3349	38.8939		N	2.0	
			A	4	0.0032	0.0008		20.2094	93.1530		N	0.0	
			A	5	0.0032	0.0007		44.8254	30.8295		N	0.0	
			A	6	0.0020	0.0009		24.4545	14.2441		N	0.0	
			A	7	0.0036	0.0011		94.9190	17.0625		N	0.0	
			A	8	0.0036	0.0008		56.6626	40.7980		N	0.0	
			A	9	0.0016	0.0007		36.8632	24.1834		N	0.0	
		3.12 mg/L S^{2-}	A	10	0.0011	0.0006		111.7650	48.5123		N	0.0	
		0.8 mg/L Fe	A	11	0.0019	0.0004		35.9312	70.9390		N	0.0	
			A	12									
			A	13									
			A	14									
			A	15									
			A	16									
			A	17									
			A	18									
			A	19									

			A	20								
Averages					**0.0027**	**0.0007**	**0.0025**	**51.1495**	**39.6379**		**0.5**	
			B	1	0.0069	0.0002	0.0042	23.7725	33.2656	N	2.0	
			B	2	0.0048	0.0007	0.0010	50.7653	57.3389	N	1.0	
			B	3	0.0076	0.0006	0.0034	34.0996	18.2186	N	1.0	
			B	4	0.0053	0.0006		11.0379	40.9504	N	0.0	
			B	5	0.0034	0.0007		30.2180	32.7346	N	0.0	
			B	6	0.0049	0.0006		183.5730	33.7329	N	0.0	
			B	7	0.0037	0.0015		42.9540	52.0024	N	0.0	
			B	8	0.0075	0.0013		77.0007	50.2502	N	0.0	
			B	9	0.0043	0.0011		38.2118	64.1908	N	0.0	
		3.12 mg/L S^{2-}	B	10	0.0028	0.0017		12.2294	13.3284	N	0.0	
		0.8 mg/L Fe	B	11	0.0032	0.0010		94.1917	60.0989	N	0.0	
			B	12								
			B	13								
			B	14								
			B	15								
			B	16								
			B	17								
			B	18								
			B	19								
			B	20								
Averages					**0.0049**	**0.0009**	**0.0029**	**54.3685**	**41.4647**		**0.4**	
			C	1	0.0050	0.0009	0.0013	38.3638	34.7796	N	1.0	
			C	2	0.0023	0.0010	0.0012	20.8510	78.1845	N	1.0	
			C	3	0.0048	0.0012	0.0014	40.6923	53.0990	N	1.0	
			C	4	0.0048	0.0016	0.0015	29.4492	49.5938	N	2.0	
			C	5	0.0029	0.0015	0.0037	26.1447	37.8281	N	1.0	
			C	6	0.0027	0.0005		51.5959	35.5162	N	0.0	
			C	7	0.0020	0.0004		23.2702	55.0071	N	0.0	
			C	8	0.0031	0.0006		101.3775	24.2625	N	0.0	
			C	9	0.0012	0.0011		84.9942	12.8964	N	0.0	
		3.12 mg/L S^{2-}	C	10								
		0.8 mg/L Fe	C	11								
			C	12								
			C	13								
			C	14								
			C	15								
			C	16								
			C	17								

			C	18															
			C	19															
			C	20															
Averages					**0.0032**	**0.0010**	**0.0018**	**46.3043**	**42.3519**										**0.7**
			D	1	0.0054	0.0013	0.0009	23.6579	44.1575								N	1.0	
			D	2	0.0042	0.0018	0.0006	37.2869	42.8772								N	1.0	
			D	3	0.0031	0.0014		32.4044	41.8497								N	0.0	
			D	4	0.0072	0.0008		52.2488	79.5578								N	0.0	
			D	5	0.0063	0.0006		65.2466	78.8075								N	0.0	
			D	6	0.0089	0.0007		60.8193	59.3229								N	0.0	
			D	7	0.0030	0.0004		54.0061	20.2988								N	0.0	
			D	8	0.0044	0.0006		42.7969	52.8190								N	0.0	
			D	9	0.0031	0.0008		42.9657	58.8470								N	0.0	
		3.12 mg/L S^{2-} 0.8 mg/L Fe	D	10															
			D	11															
			D	12															
			D	13															
			D	14															
			D	15															
			D	16															
			D	17															
			D	18															
			D	19															
			D	20															
Averages					**0.0051**	**0.0009**	**0.0008**	**45.7147**	**53.1708**										**0.2**

FEL

IMAM01-00428 - Endpoint Data Summary

Treatment	Rep	Per Replicate													
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emerg-ence (%)	Seedling Survival (n)	Survival (%)	Mean Root Length (mm)	Mean Root Weight (g)	Mean Shoot Length (mm)	Mean Shoot Weight (g)	Mean Dried Leaf Weight (g)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance (n)	Phytotox: Abnormal Appearance (%)
HS-1 (1:4) 0.8 mg/L Fe	A	40	100.0	18	45.0	18.0	100.0	34.2	0.0009	35.7	0.0038	0.0012	0.7	0	0.0
	B	40	100.0	18	45.0	18.0	100.0	31.7	0.0008	36.8	0.0045	0.0018	0.8	0	0.0
	C	40	100.0	16	40.0	16.0	100.0	33.6	0.0007	39.6	0.0034	0.0021	1.3	0	0.0
	D	40	100.0	19	47.5	19.0	100.0	32.3	0.0008	38.5	0.0033	0.0015	0.9	0	0.0
	Mean:	**40**	**100**	**17.8**	**44.4**	**17.8**	**100.0**	**32.9**	**0.0008**	**37.7**	**0.0037**	**0.0017**	**0.9**	**0**	**0.0**
	SEM:	**0.0**	**0.0**	**0.63**	**1.57**	**0.63**	**0.0**	**0.58**	**0.0000**	**0.86**	**0.0003**	**0.0002**	**0.1**	**0.0**	**0.0**
0.3 mg/L Sulfide 0.8 mg/L Fe	A	40	100.0	17	42.5	17.0	100.0	33.4	0.0010	28.4	0.0033	0.0036	0.2	0	0.0
	B	40	100.0	18	45.0	18.0	100.0	41.0	0.0011	45.9	0.0033	0.0025	0.4	0	0.0
	C	40	100.0	18	45.0	18.0	100.0	44.0	0.0012	29.1	0.0031	0.0014	1.2	0	0.0
	D	40	100.0	18	45.0	18.0	100.0	48.2	0.0009	35.8	0.0040	0.0009	1.2	0	0.0
	Mean:	**40**	**100**	**17.8**	**44.4**	**17.8**	**100**	**41.6**	**0.0010**	**34.8**	**0.0034**	**0.0021**	**0.8**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**3.12**	**0.0001**	**4.07**	**0.0002**	**0.0006**	**0.3**	**0.00**	**0.0**
1.56 mg/L Sulfide 0.8 mg/L Fe	A	40	100.0	17	42.5	17.0	100.0	41.9	0.0007	52.0	0.0043	0.0018	0.9	0	0.0
	B	40	100.0	16	40.0	16.0	100.0	58.7	0.0007	42.0	0.0061	0.0041	0.3	0	0.0
	C	40	100.0	16	40.0	16.0	100.0	56.7	0.0007	58.2	0.0053	0.0017	0.4	0	0.0
	D	40	100.0	15	37.5	15.0	100.0	46.3	0.0007	56.1	0.0063	0.0011	0.5	0	0.0
	Mean:	**40**	**100**	**16.0**	**40.0**	**16.0**	**100**	**50.9**	**0.0007**	**52.1**	**0.0055**	**0.0022**	**0.5**	**0**	**0**
	SEM:	**0.0**	**0.0**	**0.41**	**1.02**	**0.41**	**0.0**	**4.06**	**0.0000**	**3.59**	**0.0004**	**0.0007**	**0.1**	**0.0**	**0.0**
3.12 mg/L Sulfide 0.8 mg/L Fe	A	40	100.0	11	27.5	11.0	100.0	39.6	0.0007	51.1	0.0027	0.0025	0.5	0	0.0
	B	40	100.0	11	27.5	11.0	100.0	41.5	0.0009	54.4	0.0049	0.0029	0.4	0	0.0
	C	40	100.0	9	22.5	9.0	100.0	42.4	0.0010	46.3	0.0032	0.0018	0.7	0	0.0
	D	40	100.0	9	22.5	9.0	100.0	53.2	0.0009	45.7	0.0051	0.0008	0.2	0	0.0
	Mean:	**40**	**100**	**10.0**	**25.0**	**10.0**	**100**	**44.2**	**0.0009**	**49.4**	**0.0040**	**0.0020**	**0.4**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.58**	**1.44**	**0.58**	**0.0**	**3.06**	**0.0001**	**2.06**	**0.0006**	**0.0005**	**0.1**	**0.00**	**0.0**

Takedown Data

Client/Project-WO No: SQME01-00428

Date	Tech Initials	Treatment	Rep No.	Seed No.	Shoot Wt (g)	Root Wt (g)	Biomass Wt (g)	Shoot Length (mm)	Root Length (mm)	Phytotoxicity (Y or N)	Free Leaf No.	Comments
			A	1	0.0020	0.0009	0.0016	23.0772	47.6920	N	1.0	
			A	2	0.0043	0.0010		31.7811	28.0725	N	0.0	
			A	3	0.0005	0.0008		21.8647	65.1174	N	0.0	
			A	4	0.0009	0.0004		10.2885	17.0225	N	0.0	
			A	5	0.0020	0.0006		19.6545	44.7841	N	0.0	
			A	6								
			A	7								
			A	8								
			A	9								
		7.8 mg/L S^{2-}	A	10								
		0.8 mg/L Fe	A	11								
			A	12								
			A	13								
			A	14								
			A	15								
			A	16								
			A	17								
			A	18								
			A	19								
			A	20								
Averages					**0.0019**	**0.0007**	**0.0016**	**21.3332**	**40.5377**		**0.2**	
			B	1	0.0028	0.0008	0.0007	47.1999	25.7231	N	1.0	
			B	2	0.0013	0.0011		23.8033	30.2482	N	0.0	
			B	3	0.0027	0.0015		13.8055	38.2239	N	0.0	
			B	4	0.0040	0.0007		21.6018	23.4542	N	0.0	
			B	5								
			B	6								
			B	7								
			B	8								
			B	9								
		7.8 mg/L S^{2-}	B	10								

		0.8 mg/L Fe	B	11								
			B	12								
			B	13								
			B	14								
			B	15								
			B	16								
			B	17								
			B	18								
			B	19								
			B	20								
Averages					**0.0027**	**0.0010**	**0.0007**	**26.6026**	**29.4124**		**0.3**	
			C	1	0.0019	0.0006	0.0006	23.0512	58.1199	N	1.0	
			C	2	0.0018	0.0005	0.0031	69.1964	29.9465	N	2.0	
			C	3	0.0019	0.0009		48.4580	30.9133	N	0.0	
			C	4	0.0002	0.0010		21.2475	59.5752	N	0.0	
			C	5	0.0008	0.0012		17.7433	70.6918	N	0.0	
			C	6								
			C	7								
			C	8								
			C	9								
		7.8 mg/L S^{2-}	C	10								
		0.8 mg/L Fe	C	11								
			C	12								
			C	13								
			C	14								
			C	15								
			C	16								
			C	17								
			C	18								
			C	19								
			C	20								
Averages					**0.0013**	**0.0008**	**0.0019**	**35.9393**	**49.8493**		**0.6**	
			D	1	0.0004	0.0003	0.0018	31.3042	34.3050	N	1.0	
			D	2	0.0056	0.0009		10.1774	52.1065	N	0.0	
			D	3	0.0029	0.0009		5.8928	10.4626	N	0.0	
			D	4	0.0012	0.0007		32.0567	40.1932	N	0.0	
			D	5	0.0004	0.0006		21.9126	36.8716	N	0.0	
			D	6								
			D	7								
			D	8								

			D	9								
		7.8 mg/L S^{2-}	D	10								
		0.8 mg/L Fe	D	11								
			D	12								
			D	13								
			D	14								
			D	15								
			D	16								
			D	17								
			D	18								
			D	19								
			D	20								
Averages					**0.0021**	**0.0007**	**0.0018**	**20.2687**	**34.7878**		**0.2**	
			A	1	0.0061	0.0010	0.0007	21.861	128.414	N	2.0	
			A	2	0.0075	0.0009	0.0005	29.167	32.502	N	3.0	
			A	3	0.0088	0.0017	0.0006	35.406	48.296	N	3.0	
			A	4	0.0031	0.0013	0.0007	22.033	37.649	N	3.0	
			A	5	0.0082	0.0011		74.203	27.657	N	0.0	
			A	6	0.0047	0.0004		45.746	57.250	N	0.0	
			A	7	0.0081	0.0007		96.325	51.461	N	0.0	
			A	8	0.0076	0.0010		139.254	29.281	N	0.0	
			A	9	0.0076	0.0007		97.170	48.285	N	0.0	
		HS-1 (1:4)	A	10	0.0045	0.0008		30.096	37.601	N	0.0	
		2.8 mg/L Fe	A	11	0.0026	0.0011		55.600	85.082	N	0.0	
			A	12	0.0034	0.0013		46.430	10.810	N	0.0	
			A	13	0.0038	0.0012		39.769	37.996	N	0.0	
			A	14	0.0027	0.0009		40.153	11.072	N	0.0	
			A	15	0.0034	0.0006		34.893	15.980	N	0.0	
			A	16	0.0058	0.0003		100.264	41.174	N	0.0	
			A	17	0.0024	0.0004		91.325	25.681	N	0.0	
			A	18	0.0027	0.0005		86.766	9.831	N	0.0	
			A	19								
			A	20								
Averages					**0.0052**	**0.0009**	**0.0006**	**60.3589**	**40.8901**		**0.6**	
			B	1	0.0037	0.0009	0.0018	28.768	39.833	N	3.0	
			B	2	0.0027	0.0007	0.0011	34.340	41.412	N	3.0	
			B	3	0.0058	0.0009	0.0018	58.184	34.993	N	3.0	
			B	4	0.0054	0.0011	0.0011	33.841	29.767	N	3.0	
			B	5	0.0014	0.0015		28.049	54.578	N	0.0	
			B	6	0.0041	0.0010		105.613	70.912	N	0.0	

			B	7	0.0070	0.0007		21.402	60.481		N	0.0	
			B	8	0.0050	0.0005		66.178	11.027		N	0.0	
			B	9	0.0050	0.0003		34.517	10.030		N	0.0	
		HS-1 (1:4)	B	10	0.0057	0.0002		46.055	10.901		N	0.0	
		2.8 mg/L Fe	B	11	0.0047	0.0004		23.650	43.728		N	0.0	
			B	12	0.0064	0.0008		26.456	44.797		N	0.0	
			B	13	0.0061	0.0006		33.019	43.278		N	0.0	
			B	14	0.0042	0.0011		84.208	21.730		N	0.0	
			B	15	0.0029	0.0009		84.314	24.888		N	0.0	
			B	16	0.0017	0.0013		42.196	48.224		N	0.0	
			B	17	0.0033	0.0010		55.806	29.354		N	0.0	
			B	18	0.0019	0.0005		64.264	32.045		N	0.0	
			B	19	0.0018	0.0006		63.615	20.551		N	0.0	
			B	20									
Averages					**0.0041**	**0.0008**	**0.0015**	**49.1828**	**35.3963**			**0.6**	
			C	1	0.0041	0.0017	0.0012	26.265	40.023		N	3.0	
			C	2	0.0074	0.0021	0.0021	19.109	49.924		N	3.0	
			C	3	0.0033	0.0016		66.957	60.995		N	0.0	
			C	4	0.0023	0.0014		34.617	32.336		N	0.0	
			C	5	0.0029	0.0011		64.663	42.030		N	0.0	
			C	6	0.0042	0.0009		36.508	60.679		N	0.0	
			C	7	0.0046	0.0006		26.422	38.402		N	0.0	
			C	8	0.0029	0.0002		157.582	47.464		N	0.0	
			C	9	0.0053	0.0007		95.537	47.640		N	0.0	
		HS-1 (1:4)	C	10	0.0024	0.0006		26.247	62.962		N	0.0	
		2.8 mg/L Fe	C	11	0.0063	0.0005		26.120	32.681		N	0.0	
			C	12	0.0018	0.0010		135.463	10.102		N	0.0	
			C	13	0.0049	0.0011		45.515	77.934		N	0.0	
			C	14	0.0021	0.0013		32.012	83.914		N	0.0	
			C	15	0.0051	0.0011		84.604	33.650		N	0.0	
			C	16	0.0032	0.0007		37.962	15.948		N	0.0	
			C	17	0.0031	0.0006		16.537	59.029		N	0.0	
			C	18	0.0025	0.0002		44.930	31.577		N	0.0	
			C	19									
			C	20									
Averages					**0.0038**	**0.0010**	**0.0017**	**54.2806**	**45.9605**			**0.3**	
			D	1	0.0047	0.0017	0.0037	35.933	26.375		N	2.0	
			D	2	0.0034	0.0013	0.0023	23.856	36.391		N	3.0	
			D	3	0.0057	0.0011	0.0020	24.777	17.511		N	0.0	
			D	4	0.0038	0.0017		34.611	43.470		N	0.0	

			D	5	0.0044	0.0009		120.272	71.144	N	0.0	
			D	6	0.0062	0.0005		51.076	35.172	N	0.0	
			D	7	0.0058	0.0013		19.219	53.813	N	0.0	
			D	8	0.0044	0.0004		18.577	38.102	N	0.0	
			D	9	0.0029	0.0006		91.229	62.419	N	0.0	
		HS-1 (1:4)	D	10	0.0043	0.0006		36.461	31.706	N	0.0	
		2.8 mg/L Fe	D	11	0.0042	0.0001		38.859	19.422	N	0.0	
			D	12	0.0070	0.0009		19.682	23.343	N	0.0	
			D	13	0.0024	0.0008		28.387	22.828	N	0.0	
			D	14	0.0031	0.0011		36.787	17.148	N	0.0	
			D	15	0.0039	0.0005		63.154	32.991	N	0.0	
			D	16	0.0058	0.0007		20.914	67.804	N	0.0	
			D	17	0.0075	0.0006		23.230	17.820	N	0.0	
			D	18	0.0130	0.0011		27.099	47.329	N	0.0	
			D	19								
			D	20								
Averages					**0.0051**	**0.0009**	**0.0027**	**39.6734**	**36.9327**		**0.3**	
			A	1	0.0071	0.0015	0.0032	39.376	33.0389	N	3.0	
			A	2	0.0034	0.0017		34.854	71.3667	N	0.0	
			A	3	0.0042	0.0023		55.251	48.5804	N	0.0	
			A	4	0.0031	0.0018		32.499	58.0359	N	0.0	
			A	5	0.0015	0.0011		36.729	80.1993	N	0.0	
			A	6	0.0037	0.0005		48.35	76.2793	N	0.0	
			A	7	0.0055	0.0007		36.469	22.2499	N	0.0	
			A	8	0.0043	0.0010		43.142	19.9579	N	0.0	
			A	9	0.0036	0.0012		51.775	7.5988	N	0.0	
		0.3 mg/L S^{2-}	A	10	0.0061	0.0004		42.689	7.75078	N	0.0	
		2.8 mg/L Fe	A	11	0.0043	0.0003		163.9	29.7515	N	0.0	
			A	12	0.0029	0.0008		68.668	45.4612	N	0.0	
			A	13	0.0057	0.0006		52.283	23.3683	N	0.0	
			A	14	0.0020	0.0006		68.863	19.9041	N	0.0	
			A	15	0.0039	0.0007		74.353	24.8406	N	0.0	
			A	16	0.0026	0.0005		70.694	46.5891	N	0.0	
			A	17	0.0030	0.0009		97.06	30.7381	N	0.0	
			A	18	0.0029	0.0012		92.92	80.268	N	0.0	
			A	19	0.0025	0.0013		36.064	40.1604	N	0.0	
			A	20								
Averages					**0.0038**	**0.0010**	**0.0032**	**60.3126**	**40.3231**		**0.2**	
			B	1	0.0030	0.0018	0.0015	44.512	82.4979	N	3.0	
			B	2	0.0036	0.0017	0.0034	43.266	72.231	N	3.0	

			B	3	0.0052	0.0013	0.0011	36.362	42.1315		N	3.0	
			B	4	0.0035	0.0008		63.121	30.7086		N	0.0	
			B	5	0.0054	0.0012		39.342	116.462		N	0.0	
			B	6	0.0083	0.0011		25.155	26.9576		N	0.0	
			B	7	0.0050	0.0009		38.272	85.3123		N	0.0	
			B	8	0.0056	0.0007		36.915	91.0913		N	0.0	
			B	9	0.0109	0.0007		20.745	95.466		N	0.0	
		0.3 mg/L S^{2-}	B	10	0.0045	0.0007		29.496	12.4007		N	0.0	
		2.8 mg/L Fe	B	11	0.0052	0.0001		47.702	20.832		N	0.0	
			B	12	0.0061	0.0003		35.893	13.1825		N	0.0	
			B	13	0.0033	0.0002		41.623	22.8523		N	0.0	
			B	14	0.0018	0.0008		33.276	19.9171		N	0.0	
			B	15	0.0028	0.0006		66.937	20.937		N	0.0	
			B	16	0.0024	0.0009		66.523	20.4953		N	0.0	
			B	17	0.0027	0.0012		40.831	42.4075		N	0.0	
			B	18	0.0031	0.0003		18.655	41.6119		N	0.0	
			B	19									
			B	20									
Averages					**0.0046**	**0.0009**	**0.0020**	**40.4793**	**47.6386**			**0.5**	
			C	1	0.0022	0.0019	0.0018	36.673	86.8371		N	3.0	
			C	2	0.0034	0.0013	0.0004	19.219	42.5255		N	3.0	
			C	3	0.0023	0.0004	0.0002	27.14	26.6057		N	3.0	
			C	4	0.0069	0.0012	0.0007	20.027	80.9088		N	2.0	
			C	5	0.0027	0.0011	0.0008	18.023	82.9471		N	2.0	
			C	6	0.0041	0.0009	0.0005	54.443	84.9406		N	3.0	
			C	7	0.0022	0.0006	0.0011	34.143	71.4123		N	3.0	
			C	8	0.0036	0.0007	0.0015	19.511	42.046		N	3.0	
			C	9	0.0018	0.0006	0.0012	72.834	41.0201		N	3.0	
		0.3 mg/L S^{2-}	C	10	0.0074	0.0007		60.408	97.2183		N	0.0	
		2.8 mg/L Fe	C	11	0.0051	0.0007		44.468	38.7404		N	0.0	
			C	12	0.0046	0.0009		29.138	19.7674		N	0.0	
			C	13	0.0041	0.0007		33.455	103.373		N	0.0	
			C	14	0.0040	0.0007		50.384	38.1623		N	0.0	
			C	15	0.0031	0.0008		89.111	50.3032		N	0.0	
			C	16	0.0018	0.0010		19.974	62.267		N	0.0	
			C	17	0.0037	0.0012		44.208	63.5476		N	0.0	
			C	18	0.0025	0.0009		61.039	42.9378		N	0.0	
			C	19	0.0017	0.0005		18.163	11.6559		N	0.0	
			C	20									
Averages					**0.0035**	**0.0009**	**0.0009**	**39.5979**	**57.2219**			**1.3**	

		D	1	0.0039	0.0013	0.0010	26.287	63.0655	N	3.0					
		D	2	0.0049	0.0017	0.0022	37.241	41.7103	N	2.0					
		D	3	0.0039	0.0019	0.0015	23.618	44.3572	N	3.0					
		D	4	0.0039	0.0012	0.0021	30.213	78.6664	N	3.0					
		D	5	0.0039	0.0006	0.0004	28.705	61.1354	N	3.0					
		D	6	0.0042	0.0007	0.0002	29.36	49.0108	N	2.0					
		D	7	0.0032	0.0003	0.0011	31.503	47.5445	N	3.0					
		D	8	0.0046	0.0007		21.546	40.2636	N	0.0					
		D	9	0.0027	0.0009		37.085	35.2709	N	0.0					
		D	10	0.0033	0.0014		23.403	43.7121	N	0.0					
		D	11	0.0032	0.0011		15.652	24.6999	N	0.0					
		D	12	0.0017	0.0007		22.648	35.429	N	0.0					
		D	13	0.0017	0.0006		51.788	37.9009	N	0.0					
		D	14	0.0026	0.0009		68.22	60.3727	N	0.0					
		D	15	0.0026	0.0010		55.209	32.1059	N	0.0					
		D	16	0.0017	0.0009		62.086	94.7199	N	0.0					
		D	17	0.0015	0.0007		90.284	23.7098	N	0.0					
		D	18	0.0012	0.0003		38.072	17.1346	N	0.0					
		D	19												
		D	20												
	Averages			**0.0030**	**0.0009**	**0.0012**	**38.4955**	**46.1561**		**1.1**					
0.3 mg/L S^{2-} 2.8 mg/L Fe															
		A	1	0.0018	0.0015	0.0014	27.203	32.9337	N	3.0					
		A	2	0.0052	0.0019	0.0027	21.507	30.9842	N	3.0					
		A	3	0.0045	0.0013	0.0006	28.079	22.0731	N	2.0					
		A	4	0.0044	0.0011	0.0021	35.53	32.5534	N	3.0					
		A	5	0.0053	0.0008	0.0032	19.667	33.6167	N	3.0					
		A	6	0.0030	0.0006	0.0012	27.22	28.6113	N	3.0					
		A	7	0.0069	0.0004		70.968	18.6026	N	0.0					
		A	8	0.0043	0.0002		27.45	33.0263	N	0.0					
		A	9	0.0060	0.0004		124.78	45.5893	N	0.0					
		A	10	0.0056	0.0007		90.953	43.5604	N	0.0					
		A	11	0.0066	0.0008		39.961	38.535	N	0.0					
		A	12	0.0029	0.0011		14.512	66.3675	N	0.0					
		A	13	0.0032	0.0009		130.34	51.1195	N	0.0					
		A	14	0.0028	0.0006		89.326	99.6718	N	0.0					
		A	15	0.0033	0.0006		116.08	40.3706	N	0.0					
		A	16	0.0023	0.0003		92.307	30.0858	N	0.0					
		A	17	0.0017	0.0002		105.57	80.5274	N	0.0					
		A	18												
		A	19												
1.56 mg/L S^{2-} 2.8 mg/L Fe															

			A	20											
	Averages				**0.0041**	**0.0008**	**0.0019**	**62.4386**	**42.8370**				**1.0**		
			B	1	0.0069	0.0021	0.0064	36.171	60.9427		N	3.0			
			B	2	0.0035	0.0016	0.0062	115.92	42.7416		N	3.0			
			B	3	0.0047	0.0013	0.0055	21.535	97.5251		N	2.0			
			B	4	0.0036	0.0011	0.0009	79.88	37.0174		N	2.0			
			B	5	0.0095	0.0005		22.83	50.6582		N	0.0			
			B	6	0.0089	0.0003		32.528	50.9615		N	0.0			
			B	7	0.0077	0.0007		43.854	45.1186		N	0.0			
			B	8	0.0060	0.0009		101.24	33.2432		N	0.0			
			B	9	0.0046	0.0010		95.851	56.7481		N	0.0			
			B	10	0.0025	0.0009		84.615	29.3126		N	0.0			
			B	11	0.0033	0.0008		33.608	36.8779		N	0.0			
			B	12	0.0079	0.0006		35.577	20.5944		N	0.0			
			B	13	0.0034	0.0003		34.423	25.516		N	0.0			
			B	14	0.0019	0.0002		52.683	44.1931		N	0.0			
			B	15	0.0046	0.0003		76.462	48.0478		N	0.0			
			B	16	0.0013	0.0004		60.844	19.7949		N	0.0			
			B	17	0.0130	0.0004		96.614	29.0718		N	0.0			
			B	18											
			B	19											
			B	20											
	Averages				**0.0055**	**0.0008**	**0.0048**	**60.2729**	**42.8450**				**0.6**		
			C	1	0.0038	0.0015	0.0040	41.108	59.2108		N	3.0			
			C	2	0.0028	0.0013	0.0043	20.677	70.4545		N	3.0			
			C	3	0.0029	0.0009	0.0009	20.664	53.4736		N	2.0			
			C	4	0.0037	0.0007	0.0062	27.044	65.3406		N	3.0			
			C	5	0.0034	0.0009	0.0028	31.795	55.9309		N	3.0			
			C	6	0.0024	0.0010	0.0013	31.493	59.4893		N	3.0			
			C	7	0.0016	0.0013	0.0005	52.305	75.7177		N	3.0			
			C	8	0.0051	0.0006	0.0012	56.11	57.9448		N	2.0			
			C	9	0.0051	0.0004	0.0007	57.144	35.9622		N	3.0			
			C	10	0.0029	0.0004		16.968	33.4442		N	0.0			
			C	11	0.0034	0.0002		19.948	43.4423		N	0.0			
			C	12	0.0020	0.0005		31.11	81.9434		N	0.0			
			C	13	0.0027	0.0007		40.66	53.122		N	0.0			
			C	14	0.0013	0.0009		37.153	81.811		N	0.0			
			C	15	0.0015	0.0006		77.042	36.1448		N	0.0			
			C	16	0.0024	0.0006		61.978	43.7671		N	0.0			
			C	17	0.0028	0.0005		15.358	57.2181		N	0.0			

1.56 mg/L S^{2-}
2.8 mg/L Fe

1.56 mg/L S^{2-}
2.8 mg/L Fe

			C	18	0.0017	0.0011		59.92	19.8683		N	0.0			
			C	19											
			C	20											
Averages					**0.0029**	**0.0008**	**0.0024**	**38.8044**	**54.6825**						**1.4**
			D	1	0.0055	0.0006	0.0007	23.035	65.8529		N	3.0			
			D	2	0.0017	0.0004	0.0004	19.519	21.8301		N	3.0			
			D	3	0.0064	0.0009	0.0006	45.517	83.7984		N	3.0			
			D	4	0.0071	0.0011	0.0008	49.776	41.0438		N	2.0			
			D	5	0.0034	0.0013	0.0009	22.187	25.1347		N	3.0			
			D	6	0.0040	0.0006	0.0043	48.635	41.6834		N	3.0			
			D	7	0.0038	0.0004	0.0015	71.021	55.5321		N	3.0			
			D	8	0.0065	0.0005	0.0018	57.689	45.0458		N	3.0			
			D	9	0.0039	0.0012	0.0019	82.108	35.6951		N	3.0			
		1.56 mg/L S^{2-}	D	10	0.0035	0.0009	0.0056	32.004	28.7209		N	3.0			
		2.8 mg/L Fe	D	11	0.0032	0.0008	0.0006	33.429	18.4545		N	2.0			
			D	12	0.0017	0.0008	0.0005	49.835	38.484		N	3.0			
			D	13	0.0021	0.0005		35.69	12.4999		N	0.0			
			D	14	0.0034	0.0003		46.231	58.203		N	0.0			
			D	15	0.0030	0.0009		27.797	28.1251		N	0.0			
			D	16	0.0023	0.0012		48.493	85.2949		N	0.0			
			D	17	0.0013	0.0010		155.87	81.5897		N	0.0			
			D	18											
			D	19											
			D	20											
Averages					**0.0037**	**0.0008**	**0.0016**	**49.9316**	**45.1170**						**2.0**

FEL

IMAM01-00428 - Endpoint Data Summary

Treatment	Rep	Per Replicate													
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emerg-ence (%)	Seedling Survival (n)	Survival (%)	Mean Root Length (mm)	Mean Root Weight (g)	Mean Shoot Length (mm)	Mean Shoot Weight (g)	Mean Dried Leaf Weight (g)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance (n)	Phytotox: Abnormal Appearance (%)
7.80 mg/L Sulfide 0.8 mg/L Fe	A	40	100.0	5	12.5	5.0	100.0	40.5	0.0007	21.3	0.0019	0.0016	0.2	0	0.0
	B	40	100.0	4	10.0	4.0	100.0	29.4	0.0010	26.6	0.0027	0.0007	0.3	0	0.0
	C	40	100.0	5	12.5	5.0	100.0	49.8	0.0008	35.9	0.0013	0.0019	0.6	0	0.0
	D	40	100.0	5	12.5	5.0	100.0	34.8	0.0007	20.3	0.0021	0.0018	0.2	0	0.0
	Mean:	**40**	**100**	**4.8**	**11.9**	**4.8**	**100.0**	**38.6**	**0.0008**	**26.0**	**0.0020**	**0.0015**	**0.3**	**0**	**0.0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**4.37**	**0.0001**	**3.58**	**0.0003**	**0.0003**	**0.1**	**0.0**	**0.0**
HS-1 (1:4) 2.8 mg/L Fe	A	40	100.0	18	45.0	18.0	100.0	40.9	0.0009	60.4	0.0052	0.0006	0.6	0	0.0
	B	40	100.0	19	47.5	19.0	100.0	35.4	0.0008	49.2	0.0041	0.0015	0.6	0	0.0
	C	40	100.0	18	45.0	18.0	100.0	46.0	0.0010	54.3	0.0038	0.0017	0.3	0	0.0
	D	40	100.0	18	45.0	18.0	100.0	36.9	0.0009	39.7	0.0051	0.0027	0.3	0	0.0
	Mean:	**40**	**100**	**18.3**	**45.6**	**18.3**	**100**	**39.8**	**0.0009**	**50.9**	**0.0046**	**0.0016**	**0.5**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**2.36**	**0.0000**	**4.38**	**0.0003**	**0.0004**	**0.1**	**0.00**	**0.0**
0.3 mg/L Sulfide 2.8 mg/L Fe	A	40	100.0	19	47.5	19.0	100.0	40.3	0.0010	60.3	0.0038	0.0032	0.2	0	0.0
	B	40	100.0	18	45.0	18.0	100.0	47.6	0.0009	40.5	0.0046	0.0020	0.5	0	0.0
	C	40	100.0	19	47.5	19.0	100.0	57.2	0.0009	39.6	0.0035	0.0009	1.3	0	0.0
	D	40	100.0	18	45.0	18.0	100.0	46.2	0.0009	38.5	0.0030	0.0012	1.1	0	0.0
	Mean:	**40**	**100**	**18.5**	**46.3**	**18.5**	**100**	**47.8**	**0.0009**	**44.7**	**0.0037**	**0.0018**	**0.8**	**0**	**0**
	SEM:	**0.0**	**0.0**	**0.29**	**0.72**	**0.29**	**0.0**	**3.50**	**0.0000**	**5.21**	**0.0003**	**0.0005**	**0.3**	**0.0**	**0.0**
1.56 mg/L Sulfide 2.8 mg/L Fe	A	40	100.0	17	42.5	17.0	100.0	42.8	0.0008	62.4	0.0041	0.0019	1.0	0	0.0
	B	40	100.0	17	42.5	17.0	100.0	42.8	0.0008	60.3	0.0055	0.0048	0.6	0	0.0
	C	40	100.0	18	45.0	18.0	100.0	54.7	0.0008	38.8	0.0029	0.0024	1.4	0	0.0
	D	40	100.0	17	42.5	17.0	100.0	45.1	0.0008	49.9	0.0037	0.0016	2.0	0	0.0
	Mean:	**40**	**100**	**17.3**	**43.1**	**17.3**	**100**	**46.4**	**0.0008**	**52.9**	**0.0040**	**0.0027**	**1.2**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**2.82**	**0.0000**	**5.42**	**0.0005**	**0.0007**	**0.3**	**0.00**	**0.0**

Takedown Data

Client/Project-WO No: SQME01-0042

Date	Tech Initials	Treatment	Rep No.	Seed No.	Shoot Wt (g)	Root Wt (g)	Dried Leaf Biomass Wt (g)	Shoot Length (mm)	Root Length (mm)	Phytotoxicity (Y or N)	Free Leaf No.	Comments
			A	1	0.0058	0.0013	0.0031	24.0925	46.1863	N	3.0	
			A	2	0.0050	0.0006		81.5954	63.9586	N	0.0	
			A	3	0.0039	0.0010		52.5120	53.8337	N	0.0	
			A	4	0.0028	0.0013		45.7858	88.0574	N	0.0	
			A	5	0.0024	0.0012		35.8193	46.2956	N	0.0	
			A	6	0.0021	0.0004		33.2250	56.4758	N	0.0	
			A	7	0.0020	0.0009		41.7537	54.0704	N	0.0	
			A	8	0.0043	0.0006		38.4893	33.2415	N	0.0	
			A	9	0.0042	0.0006		20.6557	33.059	N	0.0	
		3.12 mg/L S^{2-}	A	10	0.0099	0.0009		32.4739	16.6314	N	0.0	
		2.8 mg/L Fe	A	11	0.0030	0.0002		80.9596	34.361	N	0.0	
			A	12	0.0035	0.0003		35.8939	78.8453	N	0.0	
			A	13	0.0045	0.0006		104.7522	46.1526	N	0.0	
			A	14	0.0027	0.0007		80.0043	37.9848	N	0.0	
			A	15	0.0044	0.0006		53.5902	69.2245	N	0.0	
			A	16	0.0034	0.0009		49.0154	48.078	N	0.0	
			A	17								
			A	18								
			A	19								
			A	20								
Averages					**0.0040**	**0.0008**	**0.0031**	**50.6636**	**50.4035**		**0.2**	
			B	1	0.0025	0.0012	0.0021	20.3154	35.0396	N	3.0	
			B	2	0.0078	0.0010	0.0024	50.5231	40.7955	N	3.0	
			B	3	0.0032	0.0004		22.8929	86.6394	N	0.0	
			B	4	0.0098	0.0009		29.2149	40.5775	N	0.0	
			B	5	0.0033	0.0003		29.7976	59.461	N	0.0	
			B	6	0.0082	0.0005		27.7391	44.9502	N	0.0	
			B	7	0.0041	0.0004		82.3695	37.2621	N	0.0	
			B	8	0.0020	0.0003		25.3566	20.7361	N	0.0	
			B	9	0.0060	0.0004		114.616	21.9315	N	0.0	
		3.12 mg/L S^{2-}	B	10	0.0078	0.0009		73.1348	29.1302	N	0.0	

		2.8 mg/L Fe	B	11	0.0038	0.0012		23.1567	52.6096		N	0.0	
			B	12	0.0075	0.0015		45.7343	22.0366		N	0.0	
			B	13	0.0031	0.0017		32.524	47.5346		N	0.0	
			B	14	0.0031	0.0002		77.4703	25.7399		N	0.0	
			B	15	0.0032	0.0008		106.786	32.3611		N	0.0	
			B	16									
			B	17									
			B	18									
			B	19									
			B	20									
Averages					**0.0050**	**0.0008**	**0.0023**	**50.7754**	**39.7870**			**0.4**	
			C	1	0.0064	0.0011	0.0010	25.9654	86.8584		N	2.0	
			C	2	0.0055	0.0006	0.0015	18.1148	51.2234		N	2.0	
			C	3	0.0037	0.0005	0.0018	15.4083	36.5438		N	3.0	
			C	4	0.0059	0.0013	0.0003	21.5039	83.006		N	3.0	
			C	5	0.0055	0.0007		48.1556	24.6456		N	0.0	
			C	6	0.0042	0.0005		34.7162	73.5461		N	0.0	
			C	7	0.0050	0.0006		63.5173	120.577		N	0.0	
			C	8	0.0055	0.0009		23.9992	50.1408		N	0.0	
			C	9	0.0069	0.0012		34.642	44.676		N	0.0	
		3.12 mg/L S^{2-}	C	10	0.0047	0.0018		49.8422	47.1643		N	0.0	
		2.8 mg/L Fe	C	11	0.0130	0.0016		19.5484	38.7955		N	0.0	
			C	12	0.0043	0.0012		41.1743	17.815		N	0.0	
			C	13	0.0032	0.0011		66.9811	61.9465		N	0.0	
			C	14	0.0044	0.0005		119.711	10.1408		N	0.0	
			C	15	0.0031	0.0003		31.3759	77.8814		N	0.0	
			C	16	0.0024	0.0004		58.8373	48.5433		N	0.0	
			C	17									
			C	18									
			C	19									
			C	20									
Averages					**0.0052**	**0.0009**	**0.0012**	**42.0933**	**54.5940**			**0.6**	
			D	1	0.0058	0.0008	0.0030	20.595	44.1795		N	3.0	
			D	2	0.0075	0.0011	0.0021	30.8834	66.8449		N	3.0	
			D	3	0.0066	0.0006	0.0009	28.2344	53.8574		N	3.0	
			D	4	0.0059	0.0005	0.0050	28.1287	53.649		N	2.0	
			D	5	0.0052	0.0006		34.4189	64.5426		N	0.0	
			D	6	0.0038	0.0013		104.053	41.9627		N	0.0	
			D	7	0.0044	0.0012		37.2378	45.6644		N	0.0	
			D	8	0.0066	0.0010		63.6369	24.3838		N	0.0	

			D	9	0.0031	0.0016		22.277	31.3165	N	0.0		
		3.12 mg/L S^{2-} 2.8 mg/L Fe	D	10	0.0043	0.0004		29.1552	41.9704	N	0.0		
			D	11	0.0056	0.0004		36.6092	44.6053	N	0.0		
			D	12	0.0042	0.0007		43.5181	56.9806	N	0.0		
			D	13	0.0031	0.0006		111.662	17.0674	N	0.0		
			D	14	0.0044	0.0006		32.9307	23.9898	N	0.0		
			D	15	0.0025	0.0007		31.4483	63.1686	N	0.0		
			D	16	0.0033	0.0003		63.6361	39.2455	N	0.0		
			D	17									
			D	18									
			D	19									
			D	20									
Averages					**0.0048**	**0.0008**	**0.0028**	**44.9016**	**44.5893**		**0.7**		
			A	1	0.0057	0.0008	0.0034	29.6207	20.9019	N	2.0		
			A	2	0.0051	0.0006	0.0005	33.8007	17.3484	N	1.0		
			A	3	0.0060	0.0004	0.0002	33.7584	13.8559	N	1.0		
			A	4	0.0026	0.0005		29.2423	43.0734	N	0.0		
			A	5	0.0028	0.0006		66.504	54.573	N	0.0		
			A	6	0.0031	0.0007		63.738	20.175	N	0.0		
			A	7	0.0027	0.0009		20.537	24.299	N	0.0		
			A	8	0.0021	0.0010		17.512	51.299	N	0.0		
			A	9	0.0013	0.0012		46.847	37.304	N	0.0		
		7.8 mg/L S^{2-} 2.8 mg/L Fe	A	10	0.0017	0.0004		29.016	58.695	N	0.0		
			A	11									
			A	12									
			A	13									
			A	14									
			A	15									
			A	16									
			A	17									
			A	18									
			A	19									
			A	20									
Averages					**0.0033**	**0.0007**	**0.0014**	**37.0576**	**34.1525**		**0.4**		
			B	1	0.0013	0.0013	0.0035	54.5041	40.687	N	1.0		
			B	2	0.0061	0.0015		36.4063	16.343	N	0.0		
			B	3	0.0015	0.0018		19.3161	26.489	N	0.0		
			B	4	0.0049	0.0005		33.9506	49.100	N	0.0		
			B	5	0.0032	0.0003		34.684	20.782	N	0.0		
			B	6	0.0033	0.0002		25.509	39.518	N	0.0		

			B	7	0.0045	0.0004		119.775	20.662		N	0.0	
			B	8	0.0045	0.0003		30.837	49.603		N	0.0	
			B	9	0.0060	0.0011		63.953	46.785		N	0.0	
		7.8 mg/L S^{2-}	B	10	0.0028	0.0010		27.514	23.580		N	0.0	
		2.8 mg/L Fe	B	11	0.0021	0.0009		93.148	60.548		N	0.0	
			B	12	0.0014	0.0008		34.427	23.013		N	0.0	
			B	13									
			B	14									
			B	15									
			B	16									
			B	17									
			B	18									
			B	19									
			B	20									
Averages					**0.0035**	**0.0008**	**0.0035**	**47.8353**	**34.7591**			**0.1**	
			C	1	0.0031	0.0013	0.0017	28.8099	14.9529		N	2.0	
			C	2	0.0043	0.0011	0.0001	32.5847	40.3003		N	1.0	
			C	3	0.0038	0.0009		53.2869	32.1688		N	0.0	
			C	4	0.0053	0.0006		36.647	83.711		N	0.0	
			C	5	0.0033	0.0006		54.035	26.414		N	0.0	
			C	6	0.0025	0.0003		46.342	59.390		N	0.0	
			C	7	0.0029	0.0009		32.722	16.010		N	0.0	
			C	8	0.0021	0.0002		66.314	38.217		N	0.0	
			C	9	0.0012	0.0009		44.672	30.294		N	0.0	
		7.8 mg/L S^{2-}	C	10	0.0019	0.0012		23.609	24.296		N	0.0	
		2.8 mg/L Fe	C	11									
			C	12									
			C	13									
			C	14									
			C	15									
			C	16									
			C	17									
			C	18									
			C	19									
			C	20									
Averages					**0.0030**	**0.0008**	**0.0009**	**41.9023**	**36.5754**			**0.3**	
			D	1	0.0025	0.0013		19.2118	20.261		N	0.0	
			D	2	0.0023	0.0014		19.8376	23.803		N	0.0	
			D	3	0.0045	0.0005		50.1205	63.510		N	0.0	
			D	4	0.0021	0.0003		23.3101	27.171		N	0.0	

			D	5	0.0022	0.0001		45.078	47.052		N	0.0	
			D	6	0.0046	0.0002		27.691	37.573		N	0.0	
			D	7	0.0039	0.0006		37.185	22.712		N	0.0	
			D	8	0.0026	0.0005		21.118	41.699		N	0.0	
			D	9	0.0023	0.0007		39.655	19.345		N	0.0	
		7.8 mg/L S^{2-}	D	10	0.0025	0.0003		43.194	20.568		N	0.0	
		2.8 mg/L Fe	D	11									
			D	12									
			D	13									
			D	14									
			D	15									
			D	16									
			D	17									
			D	18									
			D	19									
			D	20									
Averages					**0.0030**	**0.0006**	**#DIV/0!**	**32.6400**	**32.3692**			**0.0**	
			A	1	0.0020	0.0010	0.0010	15.3999	32.0717		Y	1.0	
			A	2	0.0043	0.0007	0.0013	39.2296	27.4266		Y	1.0	
			A	3	0.0002	0.0003	0.0034	17.6397	20.2585		Y	1.0	
			A	4	0.0009	0.0002	0.0002	17.716	32.9657		Y	1.0	
			A	5	0.0007	0.0004		9.380	29.713		Y	0.0	
			A	6									
			A	7									
			A	8									
			A	9									
		HS-1 (1:4)	A	10									
		100 mg/L BA	A	11									
			A	12									
			A	13									
			A	14									
			A	15									
			A	16									
			A	17									
			A	18									
			A	19									
			A	20									
Averages					**0.0016**	**0.0005**	**0.0015**	**19.8731**	**28.4870**			**0.8**	
			B	1	0.0019	0.0005	0.0011	13.7317	40.7641		Y	1.0	
			B	2	0.0021	0.0007		16.4797	35.1991		Y	0.0	

			B	3	0.0010	0.0004		24.3873	34.8623	Y	0.0	
			B	4	0.0012	0.0003		17.1556	64.2392	Y	0.0	
			B	5	0.0005	0.0012		11.494	25.508	Y	0.0	
			B	6								
			B	7								
			B	8								
			B	9								
		HS-1 (1:4)	B	10								
		100 mg/L BA	B	11								
			B	12								
			B	13								
			B	14								
			B	15								
			B	16								
			B	17								
			B	18								
			B	19								
			B	20								
Averages					**0.0013**	**0.0006**	**0.0011**	**16.6496**	**40.1145**		**0.2**	
			C	1	0.0032	0.0007	0.0015	17.4098	20.6761	Y	1.0	
			C	2	0.0008	0.0009		21.2816	19.4452	Y	0.0	
			C	3	0.0012	0.0013		14.0953	21.3617	Y	0.0	
			C	4	0.0021	0.0033		26.117	32.841	Y	0.0	
			C	5								
			C	6								
			C	7								
			C	8								
			C	9								
		HS-1 (1:4)	C	10								
		100 mg/L BA	C	11								
			C	12								
			C	13								
			C	14								
			C	15								
			C	16								
			C	17								
			C	18								
			C	19								
			C	20								
Averages					**0.0018**	**0.0016**	**0.0015**	**19.7258**	**23.5810**		**0.3**	

		HS-1 (1:4) 100 mg/L BA	D	1	0.0032	0.0005	0.0006	17.8038	31.0403		Y	1.0	
			D	2	0.0043	0.0006	0.0007	21.3231	28.8181		Y	1.0	
			D	3	0.0014	0.0007		25.584	40.6013		Y	0.0	
			D	4									
			D	5									
			D	6									
			D	7									
			D	8									
			D	9									
			D	10									
			D	11									
			D	12									
			D	13									
			D	14									
			D	15									
			D	16									
			D	17									
			D	18									
			D	19									
			D	20									
Averages					**0.0030**	**0.0006**	**0.0007**	**21.5703**	**33.4866**			**0.7**	

FEL

IMAM01-00428 - Endpoint Data Summary

Treatment	Rep	Per Replicate													
		Activated Seed (n)	Activation (%)	Mesocotyl Emerged (n)	Mesocotyl Emerg-ence (%)	Seedling Survival (n)	Survival (%)	Mean Root Length (mm)	Mean Root Weight (g)	Mean Shoot Length (mm)	Mean Shoot Weight (g)	Mean Dried Leaf Weight (g)	Mean Free Leaf (n)	Phytotox: Abnormal Appearance (n)	Phytotox: Abnormal Appearance (%)
3.12 mg/L Sulfide 2.8 mg/L Fe	A	40	100.0	16	40.0	16.0	100.0	50.4	0.0008	50.7	0.0040	0.0031	0.2	0	0.0
	B	40	100.0	15	37.5	15.0	100.0	39.8	0.0008	50.8	0.0050	0.0023	0.4	0	0.0
	C	40	100.0	16	40.0	16.0	100.0	54.6	0.0009	42.1	0.0052	0.0012	0.6	0	0.0
	D	40	100.0	16	40.0	16.0	100.0	44.6	0.0008	44.9	0.0048	0.0028	0.7	0	0.0
	Mean:	**40**	**100**	**15.8**	**39.4**	**15.8**	**100.0**	**47.3**	**0.0008**	**47.1**	**0.0048**	**0.0023**	**0.5**	**0**	**0.0**
	SEM:	**0.0**	**0.0**	**0.25**	**0.63**	**0.25**	**0.0**	**3.25**	**0.0000**	**2.16**	**0.0003**	**0.0004**	**0.1**	**0.0**	**0.0**
7.80 mg/L Sulfide 2.8 mg/L Fe	A	40	100.0	10	25.0	10.0	100.0	34.2	0.0007	37.1	0.0033	0.0014	0.4	0	0.0
	B	40	100.0	12	30.0	12.0	100.0	34.8	0.0008	47.8	0.0035	0.0035	0.1	0	0.0
	C	40	100.0	10	25.0	10.0	100.0	36.6	0.0008	41.9	0.0030	0.0009	0.3	0	0.0
	D	40	100.0	10	25.0	10.0	100.0	32.4	0.0006	32.6	0.0030		0.0	0	0.0
	Mean:	**40**	**100**	**10.5**	**26.3**	**10.5**	**100**	**34.5**	**0.0007**	**39.9**	**0.0032**	**0.0019**	**0.2**	**0.0**	**0**
	SEM:	**0.0**	**0.0**	**0.50**	**1.25**	**0.50**	**0.0**	**0.87**	**0.0001**	**3.26**	**0.0001**	**0.0008**	**0.1**	**0.00**	**0.0**
HS-1 (1:4) 100 mg/L BA	A	40	100.0	5	12.5	5.0	100.0	28.5	0.0005	19.9	0.0016	0.0015	0.8	5	100.0
	B	40	100.0	5	12.5	5.0	100.0	40.1	0.0006	16.6	0.0013	0.0011	0.2	5	100.0
	C	40	100.0	4	10.0	4.0	100.0	23.6	0.0016	19.7	0.0018	0.0015	0.3	4	100.0
	D	40	100.0	3	7.5	3.0	100.0	33.5	0.0006	21.6	0.0030	0.0007	0.7	3	100.0
	Mean:	**40**	**100**	**4.3**	**10.6**	**4.3**	**100**	**31.4**	**0.0008**	**19.5**	**0.0019**	**0.0012**	**0.5**	**4.25**	**100**
	SEM:	**0.0**	**0.0**	**0.48**	**1.20**	**0.48**	**0.0**	**3.53**	**0.0002**	**1.02**	**0.0004**	**0.0002**	**0.1**	**0.5**	**0.0**

FEL

	Median Emergence Time (d)											
	HS-1	100 mg/L BA	0.3 mg/L S^{2-} 0.8 mg/L Fe	1.56 mg/L S^{2-} 0.8 mg/L Fe	3.12 mg/L S^{2-} 0.8 mg/L Fe	7.8 mg/L S^{2-} 0.8 mg/L Fe	HS-1 2.8 mg/L Fe	0.3 mg/L S^{2-} 2.8 mg/L Fe	1.56 mg/L S^{2-} 2.8 mg/L Fe	3.12 mg/L S^{2-} 2.8 mg/L Fe	7.8 mg/L S^{2-} 2.8 mg/L Fe
Rep A	9	>21	9	10	>21	<21	10	9	9	9	>21
Rep B	10	>21	10	10	>21	<21	9	9	10	10	20
Rep C	9	>21	10	9	>21	<21	9	9	9	10	>21
Rep D	9	>21	9	10	>21	<21	9	10	10	10	>21
Median	**9**	**>21**	**9.5**	**10**	**>21**	**>21**	**9**	**9**	**9.5**	**10**	**>21**
SEM	**0.3**	**0.0**	**0.3**	**0.3**	**0.0**	**0.0**	**0.3**	**0.3**	**0.3**	**0.3**	**0.0**

Descriptive Statistics: Monday, April 02, 2018, 11:18:54 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emergence Descr

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	0.356	0.024	0.012	0.038
100 mg/L BA	4	0	0.075	0.000	0.000	0.000
0.3 mg/L	4	0	0.331	0.024	0.012	0.038
1.56 mg/L	4	0	0.331	0.032	0.016	0.050
3.12 mg/L	4	0	0.206	0.024	0.012	0.038
7.8 mg/L	4	0	0.081	0.013	0.006	0.020
HS-1 2.8	4	0	0.350	0.020	0.010	0.033
0.3 mg/L 2.8	4	0	0.369	0.032	0.016	0.050
1.56 mg/L 2.8	4	0	0.325	0.020	0.010	0.033
3.12 mg/L 2.8	4	0	0.320	0.014	0.007	0.022
7.8 mg/L 2.8	4	0	0.200	0.020	0.010	0.033

Column	Range	Max	Min	Median	25%	75%
HS-1	0.050	0.375	0.325	0.362	0.338	0.375
100 mg/L BA	0.000	0.075	0.075	0.075	0.075	0.075
0.3 mg/L	0.050	0.350	0.300	0.338	0.313	0.350
1.56 mg/L	0.075	0.375	0.300	0.325	0.313	0.350
3.12 mg/L	0.050	0.225	0.175	0.213	0.188	0.225
7.8 mg/L	0.025	0.100	0.075	0.075	0.075	0.088
HS-1 2.8	0.050	0.375	0.325	0.350	0.338	0.362
0.3 mg/L 2.8	0.075	0.400	0.325	0.375	0.350	0.388
1.56 mg/L 2.8	0.050	0.350	0.300	0.325	0.313	0.338
3.12 mg/L 2.8	0.030	0.330	0.300	0.325	0.313	0.328
7.8 mg/L 2.8	0.050	0.225	0.175	0.200	0.188	0.213

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	-0.855	-1.289	0.283	0.289	0.863	0.272
100 mg/L BA	0.000	-6.000	0	<0.001	0	<0.001
0.3 mg/L	-0.855	-1.289	0.283	0.289	0.863	0.272
1.56 mg/L	1.129	2.227	0.329	0.138	0.895	0.406
3.12 mg/L	-0.855	-1.289	0.283	0.289	0.863	0.272
7.8 mg/L	2.000	4.000	0.441	0.006	0.63	0.001
HS-1 2.8	0.000	1.500	0.25	0.432	0.945	0.683
0.3 mg/L 2.8	-1.129	2.227	0.329	0.138	0.895	0.406
1.56 mg/L 2.8	0.000	1.500	0.25	0.432	0.945	0.683
3.12 mg/L 2.8	-1.813	3.483	0.394	0.03	0.773	0.062
7.8 mg/L 2.8	0.000	1.500	0.25	0.432	0.945	0.683

Column	Sum	Sum of Squares
HS-1	1.425	0.509
100 mg/L BA	0.3	0.0225
0.3 mg/L	1.325	0.441
1.56 mg/L	1.325	0.442
3.12 mg/L	0.825	0.172
7.8 mg/L	0.325	0.0269
HS-1 2.8	1.4	0.491
0.3 mg/L 2.8	1.475	0.547
1.56 mg/L 2.8	1.3	0.424
3.12 mg/L 2.8	1.28	0.41
7.8 mg/L 2.8	0.8	0.161

One Way Analysis of Variance Monday, April 02, 2018, 11:19:33 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emergence -100 BA ANOVA

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Monday, April 02, 2018, 11:19:33 AM

Data source: Emergence in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.362	0.331	0.375
0.3 mg/L	4	0	0.338	0.306	0.350
1.56 mg/L	4	0	0.325	0.306	0.362
3.12 mg/L	4	0	0.213	0.181	0.225
7.8 mg/L	4	0	0.075	0.075	0.0938
100 mg/L BA	4	0	0.075	0.075	0.075

H = 20.459 with 5 degrees of freedom. (P = 0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.
Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparison	Diff of Ranks	q'	P<0.05
100 mg/L BA vs HS-1	66.5	3.325	Yes
7.8 mg/L vs HS-1	62.5	3.125	Yes
3.12 mg/L vs HS-1	40.5	2.025	No
1.56 mg/L vs HS-1	13	0.65	Do Not Test
0.3 mg/L vs HS-1	12.500	0.625	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance Monday, April 02, 2018, 11:20:20 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emergence 0.8 ANOV

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Monday, April 02, 2018, 11:20:20 AM

Data source: Emergence in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.362	0.331	0.375
0.3 mg/L	4	0	0.338	0.306	0.350
1.56 mg/L	4	0	0.325	0.306	0.362
3.12 mg/L	4	0	0.213	0.181	0.225
7.8 mg/L	4	0	0.075	0.075	0.0938

H = 15.687 with 4 degrees of freedom. (P = 0.003)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.003)

To isolate the group or groups that differ from the others use a multiple comparison procedure.
Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparison	Diff of Ranks	q'	P<0.05
7.8 mg/L vs HS-1	56.5	3.377	Yes
3.12 mg/L vs HS-1	40.5	2.420	No
1.56 mg/L vs HS-1	13	0.777	Do Not Test
0.3 mg/L vs HS-1	12.500	0.747	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance Monday, April 02, 2018, 11:20:53 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emergence 2.8 ANOV

Normality Test (Shapiro-Wilk) Passed (P = 0.110)

Equal Variance Test: Passed (P = 0.912)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	0.350	0.0204	0.0102
0.3 mg/L 2.8	4	0	0.369	0.0315	0.0157
1.56 mg/L 2.8	4	0	0.325	0.0204	0.0102
3.12 mg/L 2.8	4	0	0.320	0.0135	0.00677
7.8 mg/L 2.8	4	0	0.200	0.0204	0.0102

Source of Variation	DF	SS	MS	F	P
Between Groups	4	0.0698	0.0174	35.987	<0.001
Residual	15	0.00727	0.000485		
Total	19	0.077			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 2.8 vs. 7.8 mg/L 2.8	0.15	9.637	--	Yes
HS-1 2.8 vs. 3.12 mg/L 2.8	0.03	1.927	--	No
HS-1 2.8 vs. 1.56 mg/L 2.8	0.025	1.606	--	Do Not Test
HS-1 2.8 vs. 0.3 mg/L 2.8	0.019	1.205	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

t-test Monday, April 02, 2018, 11:22:40 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emerg HS-1 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.427)

Equal Variance Test: Passed (P = 0.537)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.356	0.0239	0.012
HS-1 2.8	4	0	0.35	0.0204	0.0102

Difference 0.00625

t = 0.397 with 6 degrees of freedom. (P = 0.705)

95 percent confidence interval for difference of means: -0.0322 to 0.0447

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference

Power of performed test with alpha = 0.050: 0.050
The power of the performed test (0.050) is below the desired power of 0.800.

Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

t-test Monday, April 02, 2018, 11:24:22 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emerg 0.3 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.408)

Equal Variance Test: Passed (P = 1.000)

Group Name	N	Missing	Mean	Std Dev	SEM
0.3 mg/L	4	0	0.331	0.0239	0.012
0.3 mg/L 2.8	4	0	0.369	0.0315	0.0157

Difference -0.0375

t = -1.897 with 6 degrees of freedom. (P = 0.107)

95 percent confidence interval for difference of means: -0.0859 to 0.0109

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference

Power of performed test with alpha = 0.050: 0.267
The power of the performed test (0.267) is below the desired power of 0.800.

Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

t-test Monday, April 02, 2018, 11:24:58 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emerg 1.56 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.517)

Equal Variance Test: Passed (P = 0.670)

Group Name	N	Missing	Mean	Std Dev	SEM
1.56 mg/L	4	0	0.331	0.0315	0.0157
1.56 mg/L 2.8	4	0	0.325	0.0204	0.0102

Difference 0.0063

t = 0.333 with 6 degrees of freedom. (P = 0.750)

95 percent confidence interval for difference of means: -0.0396 to 0.0521

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.750).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.

Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

t-test Monday, April 02, 2018, 11:25:34 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emerg 3.12 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.331)

Equal Variance Test: Passed (P = 0.240)

Group Name	N	Missing	Mean	Std Dev	SEM
3.12 mg/L	4	0	0.206	0.0239	0.012
3.12 mg/L 2.8	4	0	0.32	0.0135	0.00677

Difference -0.1140

t = -8.273 with 6 degrees of freedom. (P = <0.001)

95 percent confidence interval for difference of means: -0.147 to -0.0801

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

t-test Monday, April 02, 2018, 11:26:00 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emerg 7.8 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.374)

Equal Variance Test: Passed (P = 0.537)

Group Name	N	Missing	Mean	Std Dev	SEM
7.8 mg/L	4	0	0.0813	0.0125	0.00625
7.8 mg/L 2.8	4	0	0.200	0.0204	0.0102

Difference -0.1190

t = -9.922 with 6 degrees of freedom. (P = <0.001)

95 percent confidence interval for difference of means: -0.148 to -0.0895

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

t-test Monday, April 02, 2018, 11:26:25 AM

Data source: Emergence in 00428_Stats.JNB SD10 Emerg HS-1vsBA t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.089)

Equal Variance Test: Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 11:26:25 AM

Data source: Emergence in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.362	0.331	0.375
100 mg/L BA	4	0	0.075	0.075	0.075

Mann-Whitney U Statistic= 0.000

T = 26.000 n(small)= 4 n(big)= 4 P(est.)= 0.020 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

Descriptive Statistics: Monday, April 02, 2018, 11:52:01 AM

Data source: Phytotoxicity in 00428_Stats.JNB SD10 Phytotox Descr

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	0.000	0.000	0.000	0.000
0.3 mg/L	4	0	0.000	0.000	0.000	0.000
1.56 mg/L	4	0	0.000	0.000	0.000	0.000
3.12 mg/L	4	0	0.000	0.000	0.000	0.000
7.8 mg/L	4	0	0.000	0.000	0.000	0.000
HS-1 2.8	4	0	0.000	0.000	0.000	0.000
0.3 mg/L 2.8	4	0	0.000	0.000	0.000	0.000
1.56 mg/L 2.8	4	0	0.000	0.000	0.000	0.000
3.12 mg/L 2.8	4	0	0.000	0.000	0.000	0.000
7.8 mg/L 2.8	4	0	0.000	0.000	0.000	0.000
100 mg/L BA	4	0	1.000	0.000	0.000	0.000

Column	Range	Max	Min	Median	25%	75%
HS-1	0.000	0.000	0.000	0.000	0.000	0.000
0.3 mg/L	0.000	0.000	0.000	0.000	0.000	0.000
1.56 mg/L	0.000	0.000	0.000	0.000	0.000	0.000
3.12 mg/L	0.000	0.000	0.000	0.000	0.000	0.000
7.8 mg/L	0.000	0.000	0.000	0.000	0.000	0.000
HS-1 2.8	0.000	0.000	0.000	0.000	0.000	0.000
0.3 mg/L 2.8	0.000	0.000	0.000	0.000	0.000	0.000
1.56 mg/L 2.8	0.000	0.000	0.000	0.000	0.000	0.000
3.12 mg/L 2.8	0.000	0.000	0.000	0.000	0.000	0.000
7.8 mg/L 2.8	0.000	0.000	0.000	0.000	0.000	0.000
100 mg/L BA	0.000	1.000	1.000	1.000	1.000	1.000

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	0.000	-6.000	0	<0.001	0	<0.001
0.3 mg/L	0.000	-6.000	0	<0.001	0	<0.001
1.56 mg/L	0.000	-6.000	0	<0.001	0	<0.001
3.12 mg/L	0.000	-6.000	0	<0.001	0	<0.001
7.8 mg/L	0.000	-6.000	0	<0.001	0	<0.001
HS-1 2.8	0.000	-6.000	0	<0.001	0	<0.001
0.3 mg/L 2.8	0.000	-6.000	0	<0.001	0	<0.001
1.56 mg/L 2.8	0.000	-6.000	0	<0.001	0	<0.001
3.12 mg/L 2.8	0.000	-6.000	0	<0.001	0	<0.001
7.8 mg/L 2.8	0.000	-6.000	0	<0.001	0	<0.001
100 mg/L BA	0.000	-6.000	0	<0.001	0	<0.001

Column	Sum	Sum of Squares
HS-1	0	0
0.3 mg/L	0	0
1.56 mg/L	0	0
3.12 mg/L	0	0
7.8 mg/L	0	0
HS-1 2.8	0	0
0.3 mg/L 2.8	0	0
1.56 mg/L 2.8	0	0
3.12 mg/L 2.8	0	0
7.8 mg/L 2.8	0	0
100 mg/L BA	4	4

One Way Analysis of Variance Monday, April 02, 2018, 11:52:50 AM

Data source: Phytotoxicity in 00428_Stats.JNB SD10 Phytotox -100 BA ANOVA

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Monday, April 02, 2018, 11:52:50 AM

Data source: Phytotoxicity in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.000	0.000	0.000
0.3 mg/L	4	0	0.000	0.000	0.000
1.56 mg/L	4	0	0.000	0.000	0.000
3.12 mg/L	4	0	0.000	0.000	0.000
7.8 mg/L	4	0	0.000	0.000	0.000
100 mg/L BA	4	0	1.571	1.571	1.571

H = 23.000 with 5 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.
Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparison	Diff of Ranks	q'	P<0.05
100 mg/L BA vs HS-1	48.000	2.400	No
0.3 mg/L vs HS-1	0.000	0.000	Do Not Test
1.56 mg/L vs HS-1	0.000	0.000	Do Not Test
3.12 mg/L vs HS-1	0.000	0.000	Do Not Test
7.8 mg/L vs HS-1	0.000	0.000	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance Monday, April 02, 2018, 11:53:47 AM

Data source: Phytotoxicity in 00428_Stats.JNB SD10 Phytotox 0.8 ANOVA

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Monday, April 02, 2018, 11:53:47 AM

Data source: Phytotoxicity in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.000	0.000	0.000
0.3 mg/L	4	0	0.000	0.000	0.000
1.56 mg/L	4	0	0.000	0.000	0.000
3.12 mg/L	4	0	0.000	0.000	0.000
7.8 mg/L	4	0	0.000	0.000	0.000

H = 0.000 with 4 degrees of freedom. (P = 1.000)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 1.000)

One Way Analysis of Variance Monday, April 02, 2018, 11:54:12 AM

Data source: Phytotoxicity in 00428_Stats.JNB SD10 Phytotox 2.8 ANOVA

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Monday, April 02, 2018, 11:54:12 AM

Data source: Phytotoxicity in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1 2.8	4	0	0.000	0.000	0.000
0.3 mg/L 2.8	4	0	0.000	0.000	0.000
1.56 mg/L 2.8	4	0	0.000	0.000	0.000
3.12 mg/L 2.8	4	0	0.000	0.000	0.000
7.8 mg/L 2.8	4	0	0.000	0.000	0.000

H = 0.000 with 4 degrees of freedom. (P = 1.000)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 1.000)

t-test Monday, April 02, 2018, 11:55:28 AM

Data source: Phytotoxicity in 00428_Stats.JNB SD10 Phytotox HS-1vsBA t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 11:55:28 AM

Data source: Phytotoxicity in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.000	0.000	0.000
100 mg/L BA	4	0	1.571	1.571	1.571

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.013 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

Descriptive Statistics: Monday, April 02, 2018, 10:51:38 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 Descr

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	9.250	0.500	0.250	0.796
100 mg/L BA	4	0	11.000	0.000	0.000	0.000
0.3 mg/L	4	0	9.500	0.577	0.289	0.919
1.56 mg/L	4	0	9.750	0.500	0.250	0.796
3.12 mg/L	4	0	11.000	0.000	0.000	0.000
7.8 mg/L	4	0	11.000	0.000	0.000	0.000
HS-1 2.8	4	0	9.250	0.500	0.250	0.796
0.3 mg/L 2.8	4	0	9.250	0.500	0.250	0.796
1.56 mg/L 2.8	4	0	9.500	0.577	0.289	0.919
3.12 mg/L 2.8	4	0	9.750	0.500	0.250	0.796
7.8 mg/L 2.8	4	0	11.000	0.000	0.000	0.000

Column	Range	Max	Min	Median	25%	75%
HS-1	1.000	10.000	9.000	9.000	9.000	9.500
100 mg/L BA	0.000	11.000	11.000	11.000	11.000	11.000
0.3 mg/L	1.000	10.000	9.000	9.500	9.000	10.000
1.56 mg/L	1.000	10.000	9.000	10.000	9.500	10.000
3.12 mg/L	0.000	11.000	11.000	11.000	11.000	11.000
7.8 mg/L	0.000	11.000	11.000	11.000	11.000	11.000
HS-1 2.8	1.000	10.000	9.000	9.000	9.000	9.500
0.3 mg/L 2.8	1.000	10.000	9.000	9.000	9.000	9.500
1.56 mg/L 2.8	1.000	10.000	9.000	9.500	9.000	10.000
3.12 mg/L 2.8	1.000	10.000	9.000	10.000	9.500	10.000
7.8 mg/L 2.8	0.000	11.000	11.000	11.000	11.000	11.000

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	2.000	4.000	0.441	0.006	0.63	0.001
100 mg/L BA	0.000	-6.000	0	<0.001	0	<0.001
0.3 mg/L	0.000	-6.000	0.307	0.203	0.729	0.024
1.56 mg/L	-2.000	4.000	0.441	0.006	0.630	0.001
3.12 mg/L	0.000	-6.000	0.000	<0.001	0.000	<0.001
7.8 mg/L	0.000	-6.000	0	<0.001	0	<0.001
HS-1 2.8	2.000	4.000	0.441	0.006	0.63	0.001
0.3 mg/L 2.8	2.000	4.000	0.441	0.006	0.630	0.001
1.56 mg/L 2.8	0.000	-6.000	0.307	0.203	0.729	0.024
3.12 mg/L 2.8	-2.000	4.000	0.441	0.006	0.630	0.001
7.8 mg/L 2.8	0.000	-6.000	0.000	<0.001	0.000	<0.001

Column	Sum	Sum of Squares
HS-1	37.000	343.000
100 mg/L BA	44.000	484.000
0.3 mg/L	38.000	362.000
1.56 mg/L	39.000	381.000
3.12 mg/L	44.000	484.000
7.8 mg/L	44.000	484.000
HS-1 2.8	37.000	343.000
0.3 mg/L 2.8	37.000	343.000
1.56 mg/L 2.8	38.000	362.000
3.12 mg/L 2.8	39.000	381.000
7.8 mg/L 2.8	44.000	484.000

t-test Monday, April 02, 2018, 11:00:52 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 11:00:52 AM

Data source: ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	9.000	9.000	9.750
HS-1 2.8	4	0	9.000	9.000	9.750

Mann-Whitney U Statistic= 8.000

T = 18.000 n(small)= 4 n(big)= 4 P(est.)= 0.849 P(exact)= 1.000

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 1.000)

t-test Monday, April 02, 2018, 11:01:18 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 0.3 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.356)

Group Name	N	Missing	Mean	Std Dev	SEM
0.3 mg/L	4	0	9.500	0.577	0.289
0.3 mg/L 2.8	4	0	9.250	0.500	0.250

Difference 0.250

t = 0.655 with 6 degrees of freedom. (P = 0.537)

95 percent confidence interval for difference of means: -0.684 to 1.184

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.537).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Monday, April 02, 2018, 11:01:49 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 1.56 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.356)

Group Name	N	Missing	Mean	Std Dev	SEM
1.56 mg/L	4	0	9.750	0.500	0.250
1.56 mg/L 2.8	4	0	9.500	0.577	0.289

Difference 0.250

t = 0.655 with 6 degrees of freedom. (P = 0.537)

95 percent confidence interval for difference of means: -0.684 to 1.184

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.537).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Monday, April 02, 2018, 11:02:24 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 3.12 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 11:02:24 AM

Data source: ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
3.12 mg/L	4	0	11.000	11.000	11.000
3.12 mg/L 2.8	4	0	10.000	9.250	10.000

Mann-Whitney U Statistic= 0.000

T = 26.000 n(small)= 4 n(big)= 4 P(est.)= 0.018 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

t-test Monday, April 02, 2018, 11:02:41 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 7.8 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 11:02:41 AM

Data source: ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
7.8 mg/L	4	0	11.000	11.000	11.000
7.8 mg/L 2.8	4	0	11.000	11.000	11.000

Mann-Whitney U Statistic= 8.000

T = 18.000 n(small)= 4 n(big)= 4 P(est.)= 1.000 P(exact)= 1.000

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 1.000)

t-test Monday, April 02, 2018, 10:55:27 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1vBA t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 10:55:27 AM

Data source: ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	9.000	9.000	9.750
100 mg/L BA	4	0	11.000	11.000	11.000

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.018 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

t-test Monday, April 02, 2018, 10:56:16 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1v0.3 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.356)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	9.250	0.500	0.250
0.3 mg/L	4	0	9.500	0.577	0.289

Difference -0.250

t = -0.655 with 6 degrees of freedom. (P = 0.537)

95 percent confidence interval for difference of means: -1.184 to 0.684

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.537).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Monday, April 02, 2018, 10:56:42 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1v1.56 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.522)

Equal Variance Test: Passed (P = 1.000)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	9.250	0.500	0.250
1.56 mg/L	4	0	9.750	0.500	0.250

Difference -0.500

t = -1.414 with 6 degrees of freedom. (P = 0.207)

95 percent confidence interval for difference of means: -1.365 to 0.365

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.207).

Power of performed test with alpha = 0.050: 0.131

The power of the performed test (0.131) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Monday, April 02, 2018, 10:57:08 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1v3.12 t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 10:57:08 AM

Data source: ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	9.000	9.000	9.750
3.12 mg/L	4	0	11.000	11.000	11.000

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.018 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

t-test Monday, April 02, 2018, 10:57:48 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1v7.8 t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 10:57:48 AM

Data source: ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	9.000	9.000	9.750
7.8 mg/L	4	0	11.000	11.000	11.000

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.018 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

t-test Monday, April 02, 2018, 10:58:39 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1 2.8v0.3 2.8

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 10:58:39 AM

Data source: ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1 2.8	4	0	9.000	9.000	9.750
0.3 mg/L 2.8	4	0	9.000	9.000	9.750

Mann-Whitney U Statistic= 8.000

T = 18.000 n(small)= 4 n(big)= 4 P(est.)= 0.849 P(exact)= 1.000

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically

t-test Monday, April 02, 2018, 10:59:11 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1 2.8v1.56 2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.356)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	9.250	0.500	0.250
1.56 mg/L 2.8	4	0	9.500	0.577	0.289

Difference -0.250

t = -0.655 with 6 degrees of freedom. (P = 0.537)

95 percent confidence interval for difference of means: -1.184 to 0.684

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.537).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Monday, April 02, 2018, 10:59:35 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1 2.8v3.12 2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.522)

Equal Variance Test: Passed (P = 1.000)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	9.250	0.500	0.250
3.12 mg/L 2.8	4	0	9.750	0.500	0.250

Difference -0.500

t = -1.414 with 6 degrees of freedom. (P = 0.207)

95 percent confidence interval for difference of means: -1.365 to 0.365

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.207).

Power of performed test with alpha = 0.050: 0.131

The power of the performed test (0.131) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Monday, April 02, 2018, 11:00:02 AM

Data source: ET30 in 00428_Stats.JNB SD10 ET30 HS-1 2.8v7.8 2.8

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Monday, April 02, 2018, 11:00:02 AM

Data source: ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1 2.8	4	0	9.000	9.000	9.750
7.8 mg/L 2.8	4	0	11.000	11.000	11.000

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.018 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

Descriptive Statistics: Wednesday, April 18, 2018, 11:10:57 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emergence Descr

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	0.444	0.032	0.016	0.050
0.3 mg/L	4	0	0.444	0.013	0.006	0.020
1.56 mg/L	4	0	0.400	0.020	0.010	0.033
3.12 mg/L	4	0	0.250	0.029	0.014	0.046
7.8 mg/L	4	0	0.119	0.013	0.006	0.020
HS-1 2.8	4	0	0.456	0.013	0.006	0.020
0.3 mg/L 2.8	4	0	0.463	0.014	0.007	0.023
1.56 mg/L 2.8	4	0	0.431	0.013	0.006	0.020
3.12 mg/L 2.8	4	0	0.394	0.013	0.006	0.020
7.8 mg/L 2.8	4	0	0.263	0.025	0.013	0.040
100 mg/L BA	4	0	0.106	0.024	0.012	0.038

Column	Range	Max	Min	Median	25%	75%
HS-1	0.075	0.475	0.400	0.450	0.425	0.463
0.3 mg/L	0.025	0.450	0.425	0.450	0.438	0.450
1.56 mg/L	0.050	0.425	0.375	0.400	0.388	0.412
3.12 mg/L	0.050	0.275	0.225	0.250	0.225	0.275
7.8 mg/L	0.025	0.125	0.100	0.125	0.113	0.125
HS-1 2.8	0.025	0.475	0.450	0.450	0.450	0.463
0.3 mg/L 2.8	0.025	0.475	0.450	0.463	0.450	0.475
1.56 mg/L 2.8	0.025	0.450	0.425	0.425	0.425	0.438
3.12 mg/L 2.8	0.025	0.400	0.375	0.400	0.388	0.400
7.8 mg/L 2.8	0.050	0.300	0.250	0.250	0.250	0.275
100 mg/L BA	0.050	0.125	0.075	0.113	0.088	0.125

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	-1.129	2.227	0.329	0.138	0.895	0.406
0.3 mg/L	-2.000	4.000	0.441	0.006	0.63	0.001
1.56 mg/L	0.000	1.500	0.25	0.432	0.945	0.683
3.12 mg/L	0.000	-6.000	0.307	0.203	0.729	0.024
7.8 mg/L	-2.000	4.000	0.441	0.006	0.63	0.001
HS-1 2.8	2.000	4.000	0.441	0.006	0.63	0.001
0.3 mg/L 2.8	0.000	-6.000	0.307	0.203	0.729	0.024
1.56 mg/L 2.8	2.000	4.000	0.441	0.006	0.63	0.001
3.12 mg/L 2.8	-2.000	4.000	0.441	0.006	0.63	0.001
7.8 mg/L 2.8	2.000	4.000	0.441	0.006	0.63	0.001
100 mg/L BA	-0.855	-1.289	0.283	0.289	0.863	0.272

Column	Sum	Sum of Squares
HS-1	1.775	0.791
0.3 mg/L	1.775	0.788
1.56 mg/L	1.600	0.641
3.12 mg/L	1.000	0.253
7.8 mg/L	0.475	0.0569
HS-1 2.8	1.825	0.833
0.3 mg/L 2.8	1.850	0.856
1.56 mg/L 2.8	1.725	0.744
3.12 mg/L 2.8	1.575	0.621
7.8 mg/L 2.8	1.050	0.277
100 mg/L BA	0.425	0.0469

One Way Analysis of Variance Wednesday, April 18, 2018, 11:18:42 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emergence -100 BA ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.098)

Equal Variance Test: Passed (P = 0.394)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.444	0.0315	0.0157
0.3 mg/L	4	0	0.444	0.0125	0.00625
1.56 mg/L	4	0	0.400	0.0204	0.0102
3.12 mg/L	4	0	0.250	0.0289	0.0144
7.8 mg/L	4	0	0.119	0.0125	0.00625
100 mg/L BA	4	0	0.106	0.0239	0.0120

Source of Variation	DF	SS	MS	F	P
Between Groups	5	0.496	0.0992	190.44	<0.001
Residual	18	0.00937	0.000521		
Total	23	0.505			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 vs. 100 mg/L BA	0.338	20.914	--	Yes
HS-1 vs. 7.8 mg/L	0.325	20.14	--	Yes
HS-1 vs. 3.12 mg/L	0.194	12.006	--	Yes
HS-1 vs. 1.56 mg/L	0.0437	2.711	--	No
HS-1 vs. 0.3 mg/L	0.000	0.000	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance Wednesday, April 18, 2018, 11:24:25 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emergence 0.8 ANOV

Normality Test (Shapiro-Wilk) Passed (P = 0.061)

Equal Variance Test: Passed (P = 0.346)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.444	0.0315	0.0157
0.3 mg/L	4	0	0.444	0.0125	0.00625
1.56 mg/L	4	0	0.400	0.0204	0.0102
3.12 mg/L	4	0	0.250	0.0289	0.0144
7.8 mg/L	4	0	0.119	0.0125	0.0063

Source of Variation	DF	SS	MS	F	P
Between Groups	4	0.327	0.0818	160.255	<0.001
Residual	15	0.00766	0.00051		
Total	19	0.335			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 vs. 7.8 mg/L	0.325	20.344	--	Yes
HS-1 vs. 3.12 mg/L	0.194	12.128	--	Yes
HS-1 vs. 1.56 mg/L	0.0437	2.739	--	Yes
HS-1 vs. 0.3 mg/L	0.000	0.000	--	No

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

One Way Analysis of Variance Wednesday, April 18, 2018, 11:26:33 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emergence 2.8 ANOV

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Wednesday, April 18, 2018, 11:26:33 AM

Data source: Emergence in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1 2.8	4	0	0.450	0.450	0.469
0.3 mg/L 2.8	4	0	0.463	0.450	0.475
1.56 mg/L 2.8	4	0	0.425	0.425	0.444
3.12 mg/L 2.8	4	0	0.400	0.381	0.400
7.8 mg/L 2.8	4	0	0.250	0.250	0.287

H = 17.318 with 4 degrees of freedom. (P = 0.002)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.002)

To isolate the group or groups that differ from the others use a multiple comparison procedure.
Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparison	Diff of Ranks	q'	P<0.05
7.8 mg/L 2.8 vs HS-1 2.8	52.500	3.137	Yes
3.12 mg/L 2.8 vs HS-1 2.8	36.500	2.181	No
1.56 mg/L 2.8 vs HS-1 2.8	18.000	1.076	Do Not Test
0.3 mg/L 2.8 vs HS-1 2.8	4.500	0.269	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

t-test Wednesday, April 18, 2018, 11:50:51 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emerg HS-1 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.416)

Equal Variance Test: Passed (P = 0.390)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.444	0.0315	0.0157
HS-1 2.8	4	0	0.456	0.0125	0.00625

Difference -0.0125

t = -0.739 with 6 degrees of freedom. (P = 0.488)

95 percent confidence interval for difference of means: -0.0539 to 0.0289

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.488).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.

Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

t-test Wednesday, April 18, 2018, 11:51:39 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emerg 0.3 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.356)

Group Name	N	Missing	Mean	Std Dev	SEM
0.3 mg/L	4	0	0.444	0.0125	0.00625
0.3 mg/L 2.8	4	0	0.463	0.0144	0.00722

Difference -0.0188

t = -1.964 with 6 degrees of freedom. (P = 0.097)

95 percent confidence interval for difference of means: -0.0421 to 0.00461

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.097).

Power of performed test with alpha = 0.050: 0.289

The power of the performed test (0.289) is below the desired power of 0.800.

Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

t-test Wednesday, April 18, 2018, 11:52:16 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emerg 1.56 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.374)

Equal Variance Test: Passed (P = 0.537)

Group Name	N	Missing	Mean	Std Dev	SEM
1.56 mg/L	4	0	0.4	0.0204	0.0102
1.56 mg/L 2.8	4	0	0.431	0.0125	0.00625

Difference -0.0313

t = -2.611 with 6 degrees of freedom. (P = 0.040)

95 percent confidence interval for difference of means: -0.0605 to -0.00197

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = 0.040).

Power of performed test with alpha = 0.050: 0.523

t-test Wednesday, April 18, 2018, 11:53:35 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emerg 3.12 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.113)

Equal Variance Test: Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Wednesday, April 18, 2018, 11:53:35 AM

Data source: Emergence in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
3.12 mg/L	4	0	0.25	0.225	0.275
3.12 mg/L 2.8	4	0	0.400	0.381	0.400

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.025 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

t-test Wednesday, April 18, 2018, 11:54:05 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emerg 7.8 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.071)

Equal Variance Test: Passed (P = 0.670)

Group Name	N	Missing	Mean	Std Dev	SEM
7.8 mg/L	4	0	0.119	0.0125	0.00625
7.8 mg/L 2.8	4	0	0.263	0.0250	0.0125

Difference -0.1440

t = -10.286 with 6 degrees of freedom. (P = <0.001)

95 percent confidence interval for difference of means: -0.178 to -0.110

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

t-test Wednesday, April 18, 2018, 11:54:33 AM

Data source: Emergence in 00428_Stats.JNB SD21 Emerg HS-1vsBA t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.408)

Equal Variance Test: Passed (P = 1.000)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.444	0.0315	0.0157
100 mg/L BA	4	0	0.106	0.0239	0.012

Difference 0.337

t = 17.076 with 6 degrees of freedom. (P = <0.001)

95 percent confidence interval for difference of means: 0.289 to 0.386

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Descriptive Statistics: Wednesday, April 18, 2018, 1:33:25 PM

Data source: Phytotoxicity in 00428_Stats.JNB SD21 Phytotox Descr

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	0.000	0.000	0.000	0.000
0.3 mg/L	4	0	0.000	0.000	0.000	0.000
1.56 mg/L	4	0	0.000	0.000	0.000	0.000
3.12 mg/L	4	0	0.000	0.000	0.000	0.000
7.8 mg/L	4	0	0.000	0.000	0.000	0.000
HS-1 2.8	4	0	0.000	0.000	0.000	0.000
0.3 mg/L 2.8	4	0	0.000	0.000	0.000	0.000
1.56 mg/L 2.8	4	0	0.000	0.000	0.000	0.000
3.12 mg/L 2.8	4	0	0.000	0.000	0.000	0.000
7.8 mg/L 2.8	4	0	0.000	0.000	0.000	0.000
100 mg/L BA	4	0	1.000	0.000	0.000	0.000

Column	Range	Max	Min	Median	25%	75%
HS-1	0.000	0.000	0.000	0.000	0.000	0.000
0.3 mg/L	0.000	0.000	0.000	0.000	0.000	0.000
1.56 mg/L	0.000	0.000	0.000	0.000	0.000	0.000
3.12 mg/L	0.000	0.000	0.000	0.000	0.000	0.000
7.8 mg/L	0.000	0.000	0.000	0.000	0.000	0.000
HS-1 2.8	0.000	0.000	0.000	0.000	0.000	0.000
0.3 mg/L 2.8	0.000	0.000	0.000	0.000	0.000	0.000
1.56 mg/L 2.8	0.000	0.000	0.000	0.000	0.000	0.000
3.12 mg/L 2.8	0.000	0.000	0.000	0.000	0.000	0.000
7.8 mg/L 2.8	0.000	0.000	0.000	0.000	0.000	0.000
100 mg/L BA	0.000	1.000	1.000	1.000	1.000	1.000

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	0.000	-6.000	0	<0.001	0	<0.001
0.3 mg/L	0.000	-6.000	0	<0.001	0	<0.001
1.56 mg/L	0.000	-6.000	0	<0.001	0	<0.001
3.12 mg/L	0.000	-6.000	0	<0.001	0	<0.001
7.8 mg/L	0.000	-6.000	0	<0.001	0	<0.001
HS-1 2.8	0.000	-6.000	0	<0.001	0	<0.001
0.3 mg/L 2.8	0.000	-6.000	0	<0.001	0	<0.001
1.56 mg/L 2.8	0.000	-6.000	0	<0.001	0	<0.001
3.12 mg/L 2.8	0.000	-6.000	0	<0.001	0	<0.001
7.8 mg/L 2.8	0.000	-6.000	0	<0.001	0	<0.001
100 mg/L BA	0.000	-6.000	0	<0.001	0	<0.001

Column	Sum	Sum of Squares
HS-1	0	0
0.3 mg/L	0	0
1.56 mg/L	0	0
3.12 mg/L	0	0
7.8 mg/L	0	0
HS-1 2.8	0	0
0.3 mg/L 2.8	0	0
1.56 mg/L 2.8	0	0
3.12 mg/L 2.8	0	0
7.8 mg/L 2.8	0	0
100 mg/L BA	4	4

One Way Analysis of Variance Wednesday, April 18, 2018, 1:34:32 PM

Data source: Phytotoxicity in 00428_Stats.JNB SD21 Phytotox -100 BA ANOVA

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Wednesday, April 18, 2018, 1:34:32 PM

Data source: Phytotoxicity in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.000	0.000	0.000
0.3 mg/L	4	0	0.000	0.000	0.000
1.56 mg/L	4	0	0.000	0.000	0.000
3.12 mg/L	4	0	0.000	0.000	0.000
7.8 mg/L	4	0	0.000	0.000	0.000
100 mg/L BA	4	0	1.571	1.571	1.571

H = 23.000 with 5 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparison	Diff of Ranks	q'	P<0.05
100 mg/L BA vs HS-1	48.000	2.400	No
0.3 mg/L vs HS-1	0.000	0.000	Do Not Test
1.56 mg/L vs HS-1	0.000	0.000	Do Not Test
3.12 mg/L vs HS-1	0.000	0.000	Do Not Test
7.8 mg/L vs HS-1	0.000	0.000	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance Wednesday, April 18, 2018, 1:37:09 PM

Data source: Phytotoxicity in 00428_Stats.JNB SD21 Phytotox 0.8 ANOVA

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Wednesday, April 18, 2018, 1:37:09 PM

Data source: Phytotoxicity in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.000	0.000	0.000
0.3 mg/L	4	0	0.000	0.000	0.000
1.56 mg/L	4	0	0.000	0.000	0.000
3.12 mg/L	4	0	0.000	0.000	0.000
7.8 mg/L	4	0	0.000	0.000	0.000

H = 0.000 with 4 degrees of freedom. (P = 1.000)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 1.000)

One Way Analysis of Variance Wednesday, April 18, 2018, 1:37:45 PM

Data source: Phytotoxicity in 00428_Stats.JNB SD21 Phytotox 2.8 ANOVA

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Wednesday, April 18, 2018, 1:37:45 PM

Data source: Phytotoxicity in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1 2.8	4	0	0.000	0.000	0.000
0.3 mg/L 2.8	4	0	0.000	0.000	0.000
1.56 mg/L 2.8	4	0	0.000	0.000	0.000
3.12 mg/L 2.8	4	0	0.000	0.000	0.000
7.8 mg/L 2.8	4	0	0.000	0.000	0.000

H = 0.000 with 4 degrees of freedom. (P = 1.000)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 1.000)

t-test Wednesday, April 18, 2018, 1:38:26 PM

Data source: Phytotoxicity in 00428_Stats.JNB SD21 Phytotox HS-1vsBA t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Wednesday, April 18, 2018, 1:38:26 PM

Data source: Phytotoxicity in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.000	0.000	0.000
100 mg/L BA	4	0	1.571	1.571	1.571

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.013 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

Descriptive Statistics: Thursday, June 14, 2018, 3:42:56 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Length Descriptive

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	32.948	1.165	0.583	1.854
0.3 mg/L	4	0	41.642	6.246	3.123	9.939
1.56 mg/L	4	0	50.928	8.114	4.057	12.911
3.12 mg/L	4	0	44.156	6.115	3.057	9.730
7.8 mg/L	4	0	38.647	8.741	4.371	13.910
HS-1 2.8	4	0	39.795	4.717	2.359	7.506
0.3 mg/L 2.8	4	0	47.835	7.010	3.505	11.154
1.56 mg/L 2.8	4	0	46.370	5.644	2.822	8.981
3.12 mg/L 2.8	4	0	47.343	6.497	3.248	10.338
7.8 mg/L 2.8	4	0	34.464	1.735	0.867	2.761
100 mg/L BA	4	0	31.417	7.069	3.535	11.248

Column	Range	Max	Min	Median	25%	75%
HS-1	2.511	34.220	31.709	32.931	31.981	33.915
0.3 mg/L	14.805	48.174	33.368	42.513	37.199	46.085
1.56 mg/L	16.842	58.743	41.901	51.533	44.114	57.741
3.12 mg/L	13.533	53.171	39.638	41.908	40.551	47.761
7.8 mg/L	20.437	49.849	29.412	37.663	32.100	45.194
HS-1 2.8	10.564	45.960	35.396	38.911	36.164	43.425
0.3 mg/L 2.8	16.899	57.222	40.323	46.897	43.240	52.430
1.56 mg/L 2.8	11.846	54.683	42.837	43.981	42.841	49.900
3.12 mg/L 2.8	14.807	54.594	39.787	47.496	42.188	52.499
7.8 mg/L 2.8	4.206	36.575	32.369	34.456	33.261	35.667
100 mg/L BA	16.533	40.115	23.581	30.987	26.034	36.801

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	0.047	-3.745	0.225	0.542	0.935	0.621
0.3 mg/L	-0.752	0.817	0.211	0.596	0.973	0.857
1.56 mg/L	-0.199	-4.303	0.263	0.374	0.897	0.414
3.12 mg/L	1.793	3.386	0.366	0.065	0.796	0.095
7.8 mg/L	0.567	-0.224	0.171	0.699	0.982	0.912
HS-1 2.8	0.808	-0.789	0.228	0.528	0.939	0.65
0.3 mg/L 2.8	0.771	1.628	0.261	0.382	0.954	0.743
1.56 mg/L 2.8	1.796	3.205	0.338	0.116	0.759	0.047
3.12 mg/L 2.8	-0.103	-1.956	0.181	0.682	0.981	0.906
7.8 mg/L 2.8	0.027	0.902	0.182	0.679	0.991	0.963
100 mg/L BA	0.303	-0.706	0.161	0.708	0.992	0.967

Column	Sum	Sum of Squares
HS-1	131.79	4346.244
0.3 mg/L	166.567	7053.185
1.56 mg/L	203.711	10572.033
3.12 mg/L	176.625	7911.308
7.8 mg/L	154.587	6203.54
HS-1 2.8	159.18	6401.291
0.3 mg/L 2.8	191.340	9300.122
1.56 mg/L 2.8	185.481	8696.42
3.12 mg/L 2.8	189.374	9092.224
7.8 mg/L 2.8	137.856	4760.12
100 mg/L BA	125.669	4098.102

One Way Analysis of Variance Thursday, June 14, 2018, 3:51:22 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Length -100 BA ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.456)

Equal Variance Test: Passed (P = 0.251)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	32.948	1.1650	0.5830
0.3 mg/L	4	0	41.642	6.2460	3.12300
1.56 mg/L	4	0	50.928	8.1140	4.0570
3.12 mg/L	4	0	44.156	6.1150	3.0570
7.8 mg/L	4	0	38.647	8.7410	4.37100
100 mg/L BA	4	0	31.417	7.0690	3.5350

Source of Variation	DF	SS	MS	F	P
Between Groups	5	1058.418	211.684	4.704	0.006
Residual	18	809.954	44.997		
Total	23	1868.372			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.006).

Power of performed test with alpha = 0.050: 0.834

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 vs. 1.56 mg/L	17.98	3.791	--	Yes
HS-1 vs. 3.12 mg/L	11.209	2.363	--	No
HS-1 vs. 0.3 mg/L	8.694	1.833	--	Do Not Test
HS-1 vs. 7.8 mg/L	5.699	1.202	--	Do Not Test
HS-1 vs. 100 mg/L BA	1.530	0.323	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance Thursday, June 14, 2018, 3:52:55 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Length 0.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.667)

Equal Variance Test: Passed (P = 0.194)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	32.948	1.1650	0.5830
0.3 mg/L	4	0	41.642	6.2460	3.12300
1.56 mg/L	4	0	50.928	8.1140	4.0570
3.12 mg/L	4	0	44.156	6.1150	3.0570
7.8 mg/L	4	0	38.647	8.7410	4.3710

Source of Variation	DF	SS	MS	F	P
Between Groups	4	708.432	177.108	4.025	0.021
Residual	15	660.037	44.002		
Total	19	1368.469			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.021).

Power of performed test with alpha = 0.050: 0.657

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 vs. 1.56 mg/L	17.98	3.833	--	Yes
HS-1 vs. 3.12 mg/L	11.209	2.390	--	No
HS-1 vs. 0.3 mg/L	8.694	1.854	--	Do Not Test
HS-1 vs. 7.8 mg/L	5.699	1.215	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance Thursday, June 14, 2018, 3:54:14 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Length 2.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.305)

Equal Variance Test: Passed (P = 0.555)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	39.795	4.717	2.359
0.3 mg/L 2.8	4	0	47.835	7.010	3.505
1.56 mg/L 2.8	4	0	46.370	5.644	2.822
3.12 mg/L 2.8	4	0	47.343	6.497	3.248
7.8 mg/L 2.8	4	0	34.464	1.735	0.867

Source of Variation	DF	SS	MS	F	P
Between Groups	4	546.422	136.606	4.601	0.013
Residual	15	445.381	29.692		
Total	19	991.803			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.013).

Power of performed test with alpha = 0.050: 0.744

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 2.8 vs. 0.3 mg/L 2.8	8.040	2.087	--	No
HS-1 2.8 vs. 3.12 mg/L 2.8	7.549	1.959	--	Do Not Test
HS-1 2.8 vs. 1.56 mg/L 2.8	6.575	1.707	--	Do Not Test
HS-1 2.8 vs. 7.8 mg/L 2.8	5.331	1.384	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

t-test Thursday, June 14, 2018, 3:55:11 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Leng HS-1 0.8v2.8 t-t

Normality Test (Shapiro-Wilk) Passed (P = 0.670)

Equal Variance Test: Passed (P = 0.070)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	32.948	1.165	0.583
HS-1 2.8	4	0	39.795	4.717	2.359

Difference -6.847

t = -2.818 with 6 degrees of freedom. (P = 0.030)

95 percent confidence interval for difference of means: -12.792 to -0.903

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = 0.030).

Power of performed test with alpha = 0.050: 0.598

t-test Thursday, June 14, 2018, 3:56:02 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Leng 0.3 0.8v2.8 t-te

Normality Test (Shapiro-Wilk) Passed (P = 0.721)

Equal Variance Test: Passed (P = 0.961)

Group Name	N	Missing	Mean	Std Dev	SEM
0.3 mg/L	4	0	41.642	6.246	3.123
0.3 mg/L 2.8	4	0	47.835	7.01	3.505

Difference -6.1930

t = -1.319 with 6 degrees of freedom. (P = 0.235)

95 percent confidence interval for difference of means: -17.680 to 5.293

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.235).

Power of performed test with alpha = 0.050: 0.109

The power of the performed test (0.109) is below the desired power of 0.800.

Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 3:56:31 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Leng 1.56 0.8v2.8 t-t

Normality Test (Shapiro-Wilk) Passed (P = 0.253)

Equal Variance Test: Passed (P = 0.255)

Group Name	N	Missing	Mean	Std Dev	SEM
1.56 mg/L	4	0	50.928	8.114	4.057
1.56 mg/L 2.8	4	0	46.37	5.644	2.822

Difference 4.5570

t = 0.922 with 6 degrees of freedom. (P = 0.392)

95 percent confidence interval for difference of means: -7.535 to 16.650

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.392).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 3:57:13 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Leng 3.12 0.8v2.8 t-t

Normality Test (Shapiro-Wilk) Passed (P = 0.425)

Equal Variance Test: Passed (P = 0.612)

Group Name	N	Missing	Mean	Std Dev	SEM
3.12 mg/L	4	0	44.156	6.115	3.057
3.12 mg/L 2.8	4	0	47.343	6.497	3.248

Difference -3.1870

t = -0.714 with 6 degrees of freedom. (P = 0.502)

95 percent confidence interval for difference of means: -14.103 to 7.728

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.502).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 3:57:46 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Leng 7.8 0.8v2.8 t-te

Normality Test (Shapiro-Wilk) Passed (P = 0.637)

Equal Variance Test: Passed (P = 0.061)

Group Name	N	Missing	Mean	Std Dev	SEM
7.8 mg/L	4	0	38.647	8.741	4.371
7.8 mg/L 2.8	4	0	34.464	1.7350	0.867

Difference 4.1830

t = 0.939 with 6 degrees of freedom. (P = 0.384)

95 percent confidence interval for difference of means: -6.721 to 15.086

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.384).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 3:58:13 PM

Data source: Root Length in 00428_Stats.JNB SD21 Root Leng HS-1vsBA t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.721)

Equal Variance Test: Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Thursday, June 14, 2018, 3:58:13 PM

Data source: Root Length in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	32.931	31.845	34.067
100 mg/L BA	4	0	30.987	24.808	38.458

Mann-Whitney U Statistic= 6.000

T = 20.000 n(small)= 4 n(big)= 4 P(est.)= 0.665 P(exact)= 0.686

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.686)

Descriptive Statistics: Thursday, June 14, 2018, 3:42:15 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight Descriptive

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	0.001	0.000	0.000	0.000
0.3 mg/L	4	0	0.001	0.000	0.000	0.000
1.56 mg/L	4	0	0.001	0.000	0.000	0.000
3.12 mg/L	4	0	0.001	0.000	0.000	0.000
7.8 mg/L	4	0	0.001	0.000	0.000	0.000
HS-1 2.8	4	0	0.001	0.000	0.000	0.000
0.3 mg/L 2.8	4	0	0.001	0.000	0.000	0.000
1.56 mg/L 2.8	4	0	0.001	0.000	0.000	0.000
3.12 mg/L 2.8	4	0	0.001	0.000	0.000	0.000
7.8 mg/L 2.8	4	0	0.001	0.000	0.000	0.000
100 mg/L BA	4	0	0.001	0.000	0.000	0.001

Column	Range	Max	Min	Median	25%	75%
HS-1	0.000	0.001	0.001	0.001	0.001	0.001
0.3 mg/L	0.000	0.001	0.001	0.001	0.001	0.001
1.56 mg/L	0.000	0.001	0.001	0.001	0.001	0.001
3.12 mg/L	0.000	0.001	0.001	0.001	0.001	0.001
7.8 mg/L	0.000	0.001	0.001	0.001	0.001	0.001
HS-1 2.8	0.000	0.001	0.001	0.001	0.001	0.001
0.3 mg/L 2.8	0.000	0.001	0.001	0.001	0.001	0.001
1.56 mg/L 2.8	0.000	0.001	0.001	0.001	0.001	0.001
3.12 mg/L 2.8	0.000	0.001	0.001	0.001	0.001	0.001
7.8 mg/L 2.8	0.000	0.001	0.001	0.001	0.001	0.001
100 mg/L BA	0.001	0.002	0.001	0.001	0.001	0.001

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	0.554	-1.179	0.204	0.618	0.968	0.827
0.3 mg/L	-0.060	0.633	0.17	0.7	0.996	0.985
1.56 mg/L	1.179	1.850	0.27	0.342	0.928	0.581
3.12 mg/L	-1.628	2.935	0.335	0.123	0.846	0.213
7.8 mg/L	0.989	0.376	0.205	0.617	0.941	0.661
HS-1 2.8	-0.218	1.526	0.264	0.368	0.943	0.673
0.3 mg/L 2.8	0.544	-1.062	0.199	0.636	0.971	0.849
1.56 mg/L 2.8	-2.000	4.000	0.441	0.006	0.63	0.001
3.12 mg/L 2.8	1.836	3.528	0.383	0.041	0.775	0.065
7.8 mg/L 2.8	-0.782	-0.693	0.219	0.565	0.948	0.704
100 mg/L BA	1.952	3.852	0.411	0.017	0.711	0.016

Column	Sum	Sum of Squares
HS-1	0.00318	0.00000254
0.3 mg/L	0.00411	0.00000427
1.56 mg/L	0.003	0.00000184
3.12 mg/L	0.004	0.00000317
7.8 mg/L	0.00329	0.00000277
HS-1 2.8	0.00352	0.00000312
0.3 mg/L 2.8	0.004	0.0000034
1.56 mg/L 2.8	0.00315	0.00000248
3.12 mg/L 2.8	0.0032	0.00000258
7.8 mg/L 2.8	0.003	0.0000022
100 mg/L BA	0.00329	0.00000342

One Way Analysis of Variance Thursday, June 14, 2018, 3:59:33 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight -100 BA ANOVA

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Thursday, June 14, 2018, 3:59:33 PM

Data source: Root Weight in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.000790	0.000750	0.000849
0.3 mg/L	4	0	0.00103	0.000900	0.00115
1.56 mg/L	4	0	0.000672	0.000654	0.000708
3.12 mg/L	4	0	0.000921	0.000766	0.000967
7.8 mg/L	4	0	0.000790	0.000695	0.000979
100 mg/L BA	4	0	0.000610	0.000540	0.00132

H = 10.930 with 5 degrees of freedom. (P = 0.053)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.053)

One Way Analysis of Variance Thursday, June 14, 2018, 4:01:11 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight 0.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.609)

Equal Variance Test: Passed (P = 0.332)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.000796	0.0000515	0.0000258
0.3 mg/L	4	0	0.00103	0.000131	0.0000656
1.56 mg/L	4	0	0.000678	0.0000293	0.0000146
3.12 mg/L	4	0	0.000885	0.000115	0.0000573
7.8 mg/L	4	0	0.000821	0.000151	0.0000755

Source of Variation	DF	SS	MS	F	P
Between Groups	4	2.61E-07	6.53E-08	5.758	0.005
Residual	15	1.7E-07	1.13E-08		
Total	19	4.31E-07			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.005).

Power of performed test with alpha = 0.050: 0.868

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 vs. 0.3 mg/L	0.00023	3.059	--	Yes
HS-1 vs. 1.56 mg/L	0.000118	1.569	--	No
HS-1 vs. 3.12 mg/L	0.0000885	1.176	--	Do Not Test
HS-1 vs. 7.8 mg/L	0.000	0.334	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance Thursday, June 14, 2018, 4:02:19 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight 2.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.347)

Equal Variance Test: Passed (P = 0.167)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	0.000881	0.0000724	0.0000362
0.3 mg/L 2.8	4	0	0.000920	0.0000678	0.0000339
1.56 mg/L 2.8	4	0	0.000787	2.45E-06	0.00000123
3.12 mg/L 2.8	4	0	0.000801	0.0000625	0.0000313
7.8 mg/L 2.8	4	0	0.000735	0.000111	0.0000557

Source of Variation	DF	SS	MS	F	P
Between Groups	4	8.83E-08	2.21E-08	4.218	0.017
Residual	15	7.85E-08	0.000		
Total	19	1.67E-07			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.017).

Power of performed test with alpha = 0.050: 0.688

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 2.8 vs. 7.8 mg/L 2.8	0.000	2.84	--	Yes
HS-1 2.8 vs. 1.56 mg/L 2.8	0.000	1.831	--	No
HS-1 2.8 vs. 3.12 mg/L 2.8	0.000	1.553	--	Do Not Test
HS-1 2.8 vs. 0.3 mg/L 2.8	0.000	0.760	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

t-test Thursday, June 14, 2018, 4:10:50 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight HS-1 0.8v2.8 t

Normality Test (Shapiro-Wilk) Passed (P = 0.921)

Equal Variance Test: Passed (P = 0.885)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.000796	5.15E-05	2.58E-05
HS-1 2.8	4	0	0.000881	7.24E-05	3.62E-05

Difference -8.5E-05

t = -1.904 with 6 degrees of freedom. (P = 0.106)

95 percent confidence interval for difference of means: -0.000193 to 0.0000241

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.106).

Power of performed test with alpha = 0.050: 0.269

The power of the performed test (0.269) is below the desired power of 0.800.

Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:11:33 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight 0.3 0.8v2.8 t

Normality Test (Shapiro-Wilk) Passed (P = 0.995)

Equal Variance Test: Passed (P = 0.360)

Group Name	N	Missing	Mean	Std Dev	SEM
0.3 mg/L	4	0	0.00103	0.000131	6.56E-05
0.3 mg/L 2.8	4	0	0.00092	6.78E-05	3.39E-05

Difference 0.000107

t = 1.446 with 6 degrees of freedom. (P = 0.198)

95 percent confidence interval for difference of means: -0.0000740 to 0.000288

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.198).

Power of performed test with alpha = 0.050: 0.138

The power of the performed test (0.138) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:11:57 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight 1.56 0.8v2.8 t

Normality Test (Shapiro-Wilk) Passed (P = 0.069)

Equal Variance Test: Passed (P = 0.117)

Group Name	N	Missing	Mean	Std Dev	SEM
1.56 mg/L	4	0	0.000678	2.93E-05	1.46E-05
1.56 mg/L 2.8	4	0	0.000787	2.45E-06	1.23E-06

Difference -0.0001

t = -7.417 with 6 degrees of freedom. (P = <0.001)

95 percent confidence interval for difference of means: -0.000145 to -0.0000731

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

t-test Thursday, June 14, 2018, 4:15:28 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight 3.12 0.8v2.8 t

Normality Test (Shapiro-Wilk) Passed (P = 0.397)

Equal Variance Test: Passed (P = 0.528)

Group Name	N	Missing	Mean	Std Dev	SEM
3.12 mg/L	4	0	0.000885	0.000115	5.73E-05
3.12 mg/L 2.8	4	0	0.000801	6.25E-05	3.13E-05

Difference 0.0001

t = 1.278 with 6 degrees of freedom. (P = 0.249)

95 percent confidence interval for difference of means: -0.0000763 to 0.000243

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.249).

Power of performed test with alpha = 0.050: 0.100

The power of the performed test (0.100) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:15:49 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight 7.8 0.8v2.8 t

Normality Test (Shapiro-Wilk) Passed (P = 0.756)

Equal Variance Test: Passed (P = 0.637)

Group Name	N	Missing	Mean	Std Dev	SEM
7.8 mg/L	4	0	0.000821	0.000151	7.55E-05
7.8 mg/L 2.8	4	0	0.001	0.0001	5.57E-05

Difference 0.0001

t = 0.915 with 6 degrees of freedom. (P = 0.396)

95 percent confidence interval for difference of means: -0.000144 to 0.000315

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.396).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:16:15 PM

Data source: Root Weight in 00428_Stats.JNB SD21 Root Weight HS-1vsBA t

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Thursday, June 14, 2018, 4:16:15 PM

Data source: Root Weight in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.00079	0.00075	0.000849
100 mg/L BA	4	0	0.00061	0.00054	0.00132

Mann-Whitney U Statistic= 4.000

T = 22.000 n(small)= 4 n(big)= 4 P(est.)= 0.312 P(exact)= 0.343

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.343)

Descriptive Statistics: Thursday, June 14, 2018, 3:41:45 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Length Descriptive

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	37.655	1.713	0.857	2.726
0.3 mg/L	4	0	34.809	8.138	4.069	12.949
1.56 mg/L	4	0	52.065	7.183	3.591	11.430
3.12 mg/L	4	0	49.384	4.119	2.060	6.555
7.8 mg/L	4	0	26.036	7.159	3.580	11.392
HS-1 2.8	4	0	50.874	8.754	4.377	13.929
0.3 mg/L 2.8	4	0	44.721	10.426	5.213	16.590
1.56 mg/L 2.8	4	0	52.862	10.845	5.422	17.257
3.12 mg/L 2.8	4	0	47.108	4.325	2.162	6.881
7.8 mg/L 2.8	4	0	39.859	6.526	3.263	10.384
100 mg/L BA	4	0	19.455	2.049	1.024	3.260

Column	Range	Max	Min	Median	25%	75%
HS-1	3.858	39.596	35.738	37.642	36.278	39.032
0.3 mg/L	17.551	45.934	28.383	32.459	28.741	40.876
1.56 mg/L	16.203	58.221	42.018	54.011	46.992	57.139
3.12 mg/L	8.654	54.369	45.715	48.727	46.010	52.759
7.8 mg/L	15.671	35.939	20.269	23.968	20.801	31.271
HS-1 2.8	20.685	60.359	39.673	51.732	44.428	57.320
0.3 mg/L 2.8	21.817	60.313	38.495	40.039	39.047	50.396
1.56 mg/L 2.8	23.634	62.439	38.804	55.102	44.368	61.356
3.12 mg/L 2.8	8.682	50.775	42.093	47.783	43.497	50.720
7.8 mg/L 2.8	15.195	47.835	32.640	39.480	34.849	44.869
100 mg/L BA	4.921	21.570	16.650	19.799	18.188	20.722

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	0.030	-2.421	0.188	0.668	0.972	0.856
0.3 mg/L	1.146	0.247	0.259	0.394	0.874	0.315
1.56 mg/L	-1.291	1.377	0.244	0.457	0.902	0.441
3.12 mg/L	0.483	-3.104	0.273	0.333	0.896	0.411
7.8 mg/L	1.227	0.728	0.244	0.457	0.882	0.347
HS-1 2.8	-0.514	0.110	0.173	0.695	0.987	0.943
0.3 mg/L 2.8	1.964	3.881	0.408	0.019	0.703	0.013
1.56 mg/L 2.8	-0.793	-1.318	0.253	0.42	0.915	0.507
3.12 mg/L 2.8	-0.352	-4.000	0.294	0.246	0.855	0.242
7.8 mg/L 2.8	0.283	-0.923	0.166	0.704	0.99	0.96
100 mg/L BA	-0.970	2.009	0.303	0.217	0.921	0.545

Column	Sum	Sum of Squares
HS-1	150.619	5680.323
0.3 mg/L	139.235	5045.263
1.56 mg/L	208.260	10997.877
3.12 mg/L	197.537	9806.126
7.8 mg/L	104.144	2865.261
HS-1 2.8	203.496	10582.508
0.3 mg/L 2.8	178.885	8326.08
1.56 mg/L 2.8	211.447	11530.339
3.12 mg/L 2.8	188.434	8932.942
7.8 mg/L 2.8	159.435	6482.655
100 mg/L BA	77.819	1526.537

One Way Analysis of Variance Thursday, June 14, 2018, 4:18:13 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Length -100 BA ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.806)

Equal Variance Test: Passed (P = 0.267)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	37.655	1.7130	0.8570
0.3 mg/L	4	0	34.809	8.1380	4.06900
1.56 mg/L	4	0	52.065	7.1830	3.5910
3.12 mg/L	4	0	49.384	4.1190	2.0600
7.8 mg/L	4	0	26.036	7.1590	3.58000
100 mg/L BA	4	0	19.455	2.0490	1.0240

Source of Variation	DF	SS	MS	F	P
Between Groups	5	3249.921	649.984	20.188	<0.001
Residual	18	579.548	32.197		
Total	23	3829.469			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 vs. 100 mg/L BA	18.2	4.536	--	Yes
HS-1 vs. 1.56 mg/L	14.41	3.592	--	Yes
HS-1 vs. 3.12 mg/L	11.73	2.923	--	Yes
HS-1 vs. 7.8 mg/L	11.619	2.896	--	Yes
HS-1 vs. 0.3 mg/L	2.846	0.709	--	No

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

One Way Analysis of Variance Thursday, June 14, 2018, 4:18:45 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Length 0.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.905)

Equal Variance Test: Passed (P = 0.439)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	37.655	1.7130	0.8570
0.3 mg/L	4	0	34.809	8.1380	4.06900
1.56 mg/L	4	0	52.065	7.1830	3.5910
3.12 mg/L	4	0	49.384	4.1190	2.0600
7.8 mg/L	4	0	26.036	7.1590	3.5800

Source of Variation	DF	SS	MS	F	P
Between Groups	4	1844.296	461.074	12.199	<0.001
Residual	15	566.956	37.797		
Total	19	2411.252			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 0.999

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 vs. 1.56 mg/L	14.41	3.315	--	Yes
HS-1 vs. 3.12 mg/L	11.73	2.698	--	No
HS-1 vs. 7.8 mg/L	11.619	2.673	--	Do Not Test
HS-1 vs. 0.3 mg/L	2.846	0.655	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance Thursday, June 14, 2018, 4:19:06 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Length 2.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.894)

Equal Variance Test: Passed (P = 0.793)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	50.874	8.754	4.377
0.3 mg/L 2.8	4	0	44.721	10.4260	5.2130
1.56 mg/L 2.8	4	0	52.862	10.845	5.422
3.12 mg/L 2.8	4	0	47.108	4.3250	2.16200
7.8 mg/L 2.8	4	0	39.859	6.526	3.263

Source of Variation	DF	SS	MS	F	P
Between Groups	4	422.134	105.534	1.449	0.267
Residual	15	1092.677	72.845		
Total	19	1514.812			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.267).

Power of performed test with alpha = 0.050: 0.125

The power of the performed test (0.125) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:19:25 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Leng HS-1 0.8v2.8 t

Normality Test (Shapiro-Wilk) Passed (P = 0.551)

Equal Variance Test: Passed (P = 0.077)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	37.655	1.713	0.857
HS-1 2.8	4	0	50.874	8.754	4.377

Difference -13.219

t = -2.964 with 6 degrees of freedom. (P = 0.025)

95 percent confidence interval for difference of means: -24.132 to -2.306

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = 0.025).

Power of performed test with alpha = 0.050: 0.648

t-test Thursday, June 14, 2018, 4:19:54 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Leng 0.3 0.8v2.8 t

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Thursday, June 14, 2018, 4:19:54 PM

Data source: Shoot Length in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
0.3 mg/L	4	0	32.459	28.562	43.405
0.3 mg/L 2.8	4	0	40.039	38.771	55.354

Mann-Whitney U Statistic= 3.000

T = 13.000 n(small)= 4 n(big)= 4 P(est.)= 0.194 P(exact)= 0.200

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.200)

t-test Thursday, June 14, 2018, 4:20:15 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Leng 1.56 0.8v2.8 t

Normality Test (Shapiro-Wilk) Passed (P = 0.454)

Equal Variance Test: Passed (P = 0.373)

Group Name	N	Missing	Mean	Std Dev	SEM
1.56 mg/L	4	0	52.065	7.183	3.591
1.56 mg/L 2.8	4	0	52.862	10.845	5.422

Difference -0.7970

t = -0.123 with 6 degrees of freedom. (P = 0.906)

95 percent confidence interval for difference of means: -16.711 to 15.118

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.906).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:20:37 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Leng 3.12 0.8v2.8 t

Normality Test (Shapiro-Wilk) Passed (P = 0.232)

Equal Variance Test: Passed (P = 0.827)

Group Name	N	Missing	Mean	Std Dev	SEM
3.12 mg/L	4	0	49.384	4.119	2.06
3.12 mg/L 2.8	4	0	47.108	4.325	2.162

Difference 2.2760

t = 0.762 with 6 degrees of freedom. (P = 0.475)

95 percent confidence interval for difference of means: -5.032 to 9.583

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.475).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:21:06 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Leng 7.8 0.8v2.8 t

Normality Test (Shapiro-Wilk) Passed (P = 0.416)

Equal Variance Test: Passed (P = 0.937)

Group Name	N	Missing	Mean	Std Dev	SEM
7.8 mg/L	4	0	26.036	7.159	3.58
7.8 mg/L 2.8	4	0	39.859	6.5260	3.263

Difference -13.8230

t = -2.854 with 6 degrees of freedom. (P = 0.029)

95 percent confidence interval for difference of means: -25.675 to -1.971

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = 0.029).

Power of performed test with alpha = 0.050: 0.610

t-test Thursday, June 14, 2018, 4:21:27 PM

Data source: Shoot Length in 00428_Stats.JNB SD21 Shoot Leng HS-1vsBA t

Normality Test (Shapiro-Wilk) Passed (P = 0.653)

Equal Variance Test: Passed (P = 0.896)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	37.655	1.713	0.857
100 mg/L BA	4	0	19.455	2.049	1.024

Difference 18.200

t = 13.630 with 6 degrees of freedom. (P = <0.001)

95 percent confidence interval for difference of means: 14.933 to 21.467

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Descriptive Statistics: Thursday, June 14, 2018, 3:40:56 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight Descriptive

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	0.004	0.001	0.000	0.001
0.3 mg/L	4	0	0.003	0.000	0.000	0.001
1.56 mg/L	4	0	0.006	0.001	0.000	0.001
3.12 mg/L	4	0	0.004	0.001	0.001	0.002
7.8 mg/L	4	0	0.002	0.001	0.000	0.001
HS-1 2.8	4	0	0.005	0.001	0.000	0.001
0.3 mg/L 2.8	4	0	0.004	0.001	0.000	0.001
1.56 mg/L 2.8	4	0	0.004	0.001	0.001	0.002
3.12 mg/L 2.8	4	0	0.005	0.001	0.000	0.001
7.8 mg/L 2.8	4	0	0.003	0.000	0.000	0.000
100 mg/L BA	4	0	0.002	0.001	0.000	0.001

Column	Range	Max	Min	Median	25%	75%
HS-1	0.001	0.004	0.003	0.004	0.003	0.004
0.3 mg/L	0.001	0.004	0.003	0.003	0.003	0.004
1.56 mg/L	0.002	0.006	0.004	0.006	0.005	0.006
3.12 mg/L	0.002	0.005	0.003	0.004	0.003	0.005
7.8 mg/L	0.001	0.003	0.001	0.002	0.002	0.002
HS-1 2.8	0.001	0.005	0.004	0.005	0.004	0.005
0.3 mg/L 2.8	0.002	0.005	0.003	0.004	0.003	0.004
1.56 mg/L 2.8	0.003	0.005	0.003	0.004	0.003	0.005
3.12 mg/L 2.8	0.001	0.005	0.004	0.005	0.004	0.005
7.8 mg/L 2.8	0.001	0.003	0.003	0.003	0.003	0.003
100 mg/L BA	0.002	0.003	0.001	0.002	0.001	0.002

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	1.077	0.022	0.249	0.438	0.896	0.41
0.3 mg/L	1.715	3.221	0.362	0.072	0.817	0.136
1.56 mg/L	-0.917	-0.578	0.241	0.472	0.919	0.534
3.12 mg/L	-0.157	-5.009	0.289	0.268	0.847	0.216
7.8 mg/L	-0.052	1.109	0.197	0.641	0.985	0.931
HS-1 2.8	-0.210	-4.784	0.296	0.24	0.84	0.196
0.3 mg/L 2.8	0.594	0.889	0.209	0.601	0.981	0.906
1.56 mg/L 2.8	0.700	1.131	0.225	0.54	0.973	0.857
3.12 mg/L 2.8	-1.314	1.708	0.26	0.387	0.907	0.465
7.8 mg/L 2.8	0.238	-3.393	0.237	0.488	0.935	0.627
100 mg/L BA	1.541	2.632	0.313	0.183	0.868	0.289

Column	Sum	Sum of Squares
HS-1	0.015	0.0000568
0.3 mg/L	0.0137	0.0000472
1.56 mg/L	0.022	0.000125
3.12 mg/L	0.016	0.0000675
7.8 mg/L	0.00806	0.0000172
HS-1 2.8	0.0183	0.0000847
0.3 mg/L 2.8	0.015	0.0000572
1.56 mg/L 2.8	0.0161	0.0000688
3.12 mg/L 2.8	0.019	0.0000913
7.8 mg/L 2.8	0.013	0.0000409
100 mg/L BA	0.00775	0.0000166

One Way Analysis of Variance Thursday, June 14, 2018, 4:22:47 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight -100 BA ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.352)

Equal Variance Test: Passed (P = 0.109)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.003740	0.000533	0.000267
0.3 mg/L	4	0	0.003420	0.000410	0.000205
1.56 mg/L	4	0	0.005530	0.000895	0.000448
3.12 mg/L	4	0	0.003970	0.001220	0.000609
7.8 mg/L	4	0	0.002010	0.000567	0.000284
100 mg/L BA	4	0	0.001940	0.000714	0.000357

Source of Variation	DF	SS	MS	F	P
Between Groups	5	0.0000361	7.21E-06	12.122	<0.001
Residual	18	0.0000107	5.95E-07		
Total	23	0.0000468			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 vs. 100 mg/L BA	0.0018	3.301	--	Yes
HS-1 vs. 1.56 mg/L	0.00179	3.281	--	Yes
HS-1 vs. 7.8 mg/L	0.00172	3.16	--	Yes
HS-1 vs. 0.3 mg/L	0.000322	0.59	--	No
HS-1 vs. 3.12 mg/L	0.00023	0.423	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance Thursday, June 14, 2018, 4:24:09 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight 0.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.530)

Equal Variance Test: Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Thursday, June 14, 2018, 4:24:09 PM

Data source: Shoot Weight in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	0.00360	0.00332	0.00430
0.3 mg/L	4	0	0.00328	0.00313	0.00384
1.56 mg/L	4	0	0.00573	0.00459	0.00627
3.12 mg/L	4	0	0.00407	0.00280	0.00504
7.8 mg/L	4	0	0.00202	0.00148	0.00255

H = 13.257 with 4 degrees of freedom. (P = 0.010)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.010)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparison	Diff of Ranks	q'	P<0.05
7.8 mg/L vs HS-1	36.000	2.151	No
1.56 mg/L vs HS-1	24.000	1.434	Do Not Test
0.3 mg/L vs HS-1	10.000	0.598	Do Not Test
3.12 mg/L vs HS-1	3.000	0.179	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance Thursday, June 14, 2018, 4:24:44 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight 2.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.984)

Equal Variance Test: Passed (P = 0.360)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	0.004560	0.000695	0.000348
0.3 mg/L 2.8	4	0	0.003740	0.000643	0.000321
1.56 mg/L 2.8	4	0	0.004040	0.001100	0.000549
3.12 mg/L 2.8	4	0	0.004760	0.000542	0.000271
7.8 mg/L 2.8	4	0	0.003190	0.000239	0.000119

Source of Variation	DF	SS	MS	F	P
Between Groups	4	6.37E-06	1.59E-06	3.251	0.042
Residual	15	7.35E-06	0.000		
Total	19	0.0000137			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.042).

Power of performed test with alpha = 0.050: 0.512

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor:

Comparison	Diff of Means	q'	P	P<0.050
HS-1 2.8 vs. 7.8 mg/L 2.8	0.001	2.771	--	Yes
HS-1 2.8 vs. 0.3 mg/L 2.8	0.001	1.664	--	No
HS-1 2.8 vs. 1.56 mg/L 2.8	0.001	1.062	--	Do Not Test
HS-1 2.8 vs. 3.12 mg/L 2.8	0.000	0.388	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

t-test Thursday, June 14, 2018, 4:25:03 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight HS-1 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.214)

Equal Variance Test: Passed (P = 0.326)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.00374	0.000533	0.000267
HS-1 2.8	4	0	0.00456	0.000695	0.000348

Difference -0.00083

t = -1.882 with 6 degrees of freedom. (P = 0.109)

95 percent confidence interval for difference of means: -0.00190 to 0.000247

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.109).

Power of performed test with alpha = 0.050: 0.262

The power of the performed test (0.262) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:25:32 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight 0.3 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.508)

Equal Variance Test: Passed (P = 0.444)

Group Name	N	Missing	Mean	Std Dev	SEM
0.3 mg/L	4	0	0.00342	0.00041	0.000205
0.3 mg/L 2.8	4	0	0.00374	0.000643	0.000321

Difference -0.0003

t = -0.848 with 6 degrees of freedom. (P = 0.429)

95 percent confidence interval for difference of means: -0.00126 to 0.000609

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.429).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:25:51 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight 1.56 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.740)

Equal Variance Test: Passed (P = 0.863)

Group Name	N	Missing	Mean	Std Dev	SEM
1.56 mg/L	4	0	0.00553	0.000895	0.000448
1.56 mg/L 2.8	4	0	0.00404	0.0011	0.000549

Difference 0.0015

t = 2.105 with 6 degrees of freedom. (P = 0.080)

95 percent confidence interval for difference of means: -0.000242 to 0.00322

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.080).

Power of performed test with alpha = 0.050: 0.338

The power of the performed test (0.338) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:26:17 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight 3.12 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.596)

Equal Variance Test: Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Thursday, June 14, 2018, 4:26:17 PM

Data source: Shoot Weight in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
3.12 mg/L	4	0	0.00407	0.0028	0.00504
3.12 mg/L 2.8	4	0	0.005	0.00419	0.005

Mann-Whitney U Statistic= 5.000

T = 15.000 n(small)= 4 n(big)= 4 P(est.)= 0.470 P(exact)= 0.486

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.486)

t-test Thursday, June 14, 2018, 4:26:42 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight 7.8 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.959)

Equal Variance Test: Passed (P = 0.336)

Group Name	N	Missing	Mean	Std Dev	SEM
7.8 mg/L	4	0	0.00201	0.000567	0.000284
7.8 mg/L 2.8	4	0	0.003	0.0002	0.000119

Difference -0.0012

t = -3.824 with 6 degrees of freedom. (P = 0.009)

95 percent confidence interval for difference of means: -0.00193 to -0.000424

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = 0.009).

Power of performed test with alpha = 0.050: 0.874

t-test Thursday, June 14, 2018, 4:27:09 PM

Data source: Shoot Weight in 00428_Stats.JNB SD21 Shoot Weight HS-1vsBA t

Normality Test (Shapiro-Wilk) Passed (P = 0.156)

Equal Variance Test: Passed (P = 0.860)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.00374	0.000533	0.000267
100 mg/L BA	4	0	0.002	0.000714	0.000357

Difference 0.002

t = 4.041 with 6 degrees of freedom. (P = 0.007)

95 percent confidence interval for difference of means: 0.000710 to 0.00289

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = 0.007).

Power of performed test with alpha = 0.050: 0.909

Descriptive Statistics: Thursday, June 14, 2018, 3:40:02 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight Descriptive

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	0.002	0.000	0.000	0.001
0.3 mg/L	4	0	0.002	0.001	0.001	0.002
1.56 mg/L	4	0	0.002	0.001	0.001	0.002
3.12 mg/L	4	0	0.002	0.001	0.000	0.001
7.8 mg/L	4	0	0.001	0.001	0.000	0.001
HS-1 2.8	4	0	0.002	0.001	0.000	0.001
0.3 mg/L 2.8	4	0	0.002	0.001	0.001	0.002
1.56 mg/L 2.8	4	0	0.003	0.001	0.001	0.002
3.12 mg/L 2.8	4	0	0.002	0.001	0.000	0.001
7.8 mg/L 2.8	3	0	0.002	0.001	0.001	0.003
100 mg/L BA	4	0	0.001	0.000	0.000	0.001

Column	Range	Max	Min	Median	25%	75%
HS-1	0.001	0.002	0.001	0.002	0.001	0.002
0.3 mg/L	0.003	0.004	0.001	0.002	0.001	0.003
1.56 mg/L	0.003	0.004	0.001	0.002	0.001	0.003
3.12 mg/L	0.002	0.003	0.001	0.002	0.001	0.003
7.8 mg/L	0.001	0.002	0.001	0.002	0.001	0.002
HS-1 2.8	0.002	0.003	0.001	0.002	0.001	0.002
0.3 mg/L 2.8	0.002	0.003	0.001	0.002	0.001	0.003
1.56 mg/L 2.8	0.003	0.005	0.002	0.002	0.002	0.004
3.12 mg/L 2.8	0.002	0.003	0.001	0.003	0.002	0.003
7.8 mg/L 2.8	0.003	0.004	0.001	0.001	0.001	0.003
100 mg/L BA	0.001	0.002	0.001	0.001	0.001	0.001

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	0.071	-1.647	0.17	0.701	0.986	0.939
0.3 mg/L	0.519	-1.827	0.223	0.548	0.955	0.746
1.56 mg/L	1.685	3.182	0.371	0.057	0.816	0.134
3.12 mg/L	-0.862	-0.028	0.202	0.625	0.953	0.734
7.8 mg/L	-1.770	3.121	0.333	0.127	0.787	0.081
HS-1 2.8	0.335	1.285	0.225	0.54	0.976	0.88
0.3 mg/L 2.8	0.973	-0.106	0.227	0.532	0.928	0.581
1.56 mg/L 2.8	1.686	2.828	0.316	0.173	0.819	0.142
3.12 mg/L 2.8	-1.085	0.860	0.221	0.558	0.935	0.624
7.8 mg/L 2.8	1.514	--	0.322	0.241	0.88	0.323
100 mg/L BA	-0.976	-0.634	0.269	0.347	0.877	0.326

Column	Sum	Sum of Squares
HS-1	0.00666	0.0000115
0.3 mg/L	0.00834	0.0000218
1.56 mg/L	0.009	0.0000242
3.12 mg/L	0.008	0.0000182
7.8 mg/L	0.00595	0.00000971
HS-1 2.8	0.00639	0.0000123
0.3 mg/L 2.8	0.007	0.0000165
1.56 mg/L 2.8	0.0107	0.0000346
3.12 mg/L 2.8	0.00925	0.0000236
7.8 mg/L 2.8	0.006	0.0000149
100 mg/L BA	0.00473	0.00000606

One Way Analysis of Variance Thursday, June 14, 2018, 4:28:30 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight -100 BA ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.359)

Equal Variance Test: Passed (P = 0.462)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.00166	0.0004	0.0002
0.3 mg/L	4	0	0.002	0.0012	0.00061
1.56 mg/L	4	0	0.002	0.0013	0.0007
3.12 mg/L	4	0	0.002	0.0009	0.0005
7.8 mg/L	4	0	0.001	0.0005	0.00027
100 mg/L BA	4	0	0.001	0.0004	0.0002

Source of Variation	DF	SS	MS	F	P
Between Groups	5	2.99E-06	5.99E-07	0.773	0.582
Residual	18	0.0000139	7.75E-07		
Total	23	0.0000169			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.582).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

One Way Analysis of Variance Thursday, June 14, 2018, 4:28:55 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight 0.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.480)

Equal Variance Test: Passed (P = 0.520)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.00166	0.0004	0.0002
0.3 mg/L	4	0	0.002	0.0012	0.00061
1.56 mg/L	4	0	0.002	0.0013	0.0007
3.12 mg/L	4	0	0.002	0.0009	0.0005
7.8 mg/L	4	0	0.001	0.0005	0.0003

Source of Variation	DF	SS	MS	F	P
Between Groups	4	1.37E-06	3.43E-07	0.382	0.818
Residual	15	0.0000135	8.98E-07		
Total	19	0.0000148			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.818).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

One Way Analysis of Variance Thursday, June 14, 2018, 4:29:28 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight 2.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.101)

Equal Variance Test: Passed (P = 0.816)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0.000000	0.001600	0.000839	0.000420
0.3 mg/L 2.8	4	0.000000	0.001830	0.001020	0.000511
1.56 mg/L 2.8	4	0.000000	0.002670	0.001430	0.000713
3.12 mg/L 2.8	4	0.000000	0.002310	0.000850	0.000425
7.8 mg/L 2.8	3	0.000000	0.001920	0.001390	0.000800

Source of Variation	DF	SS	MS	F	P
Between Groups	4	2.86E-06	7.16E-07	0.578	0.684
Residual	14	0.0000174	0.000		
Total	18	0.0000202			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.684).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:30:08 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight HS-1 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.952)

Equal Variance Test: Passed (P = 0.378)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.00166	0.000374	0.000187
HS-1 2.8	4	0	0.0016	0.000839	0.00042

Difference 6.62E-05

t = 0.144 with 6 degrees of freedom. (P = 0.890)

95 percent confidence interval for difference of means: -0.00106 to 0.00119

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.890).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:30:29 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight 0.3 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.306)

Equal Variance Test: Passed (P = 0.628)

Group Name	N	Missing	Mean	Std Dev	SEM
0.3 mg/L	4	0	0.00208	0.00122	0.000609
0.3 mg/L 2.8	4	0	0.00183	0.00102	0.000511

Difference 0.0003

t = 0.318 with 6 degrees of freedom. (P = 0.761)

95 percent confidence interval for difference of means: -0.00169 to 0.00220

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.761).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:31:54 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight 1.56 0.8v2.8

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Thursday, June 14, 2018, 4:31:54 PM

Data source: Leaf Weight in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
1.56 mg/L	4	0	0.00175	0.00127	0.00352
1.56 mg/L 2.8	4	0	0.00215	0.00169	0.00417

Mann-Whitney U Statistic= 5.000

T = 15.000 n(small)= 4 n(big)= 4 P(est.)= 0.470 P(exact)= 0.486

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.486)

t-test Thursday, June 14, 2018, 4:32:27 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight 3.12 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.185)

Equal Variance Test: Passed (P = 0.836)

Group Name	N	Missing	Mean	Std Dev	SEM
3.12 mg/L	4	0	0.00198	0.000924	0.000462
3.12 mg/L 2.8	4	0	0.00231	0.00085	0.000425

Difference -0.0003

t = -0.536 with 6 degrees of freedom. (P = 0.611)

95 percent confidence interval for difference of means: -0.00187 to 0.00120

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.611).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:32:45 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight 7.8 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.546)

Equal Variance Test: Passed (P = 0.189)

Group Name	N	Missing	Mean	Std Dev	SEM
7.8 mg/L	4	0	0.00149	0.000536	0.000268
7.8 mg/L 2.8	3	0	0.002	0.0014	0.0008

Difference -0.0004

t = -0.587 with 5 degrees of freedom. (P = 0.583)

95 percent confidence interval for difference of means: -0.00234 to 0.00147

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.583).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 14, 2018, 4:33:18 PM

Data source: Leaf Weight in 00428_Stats.JNB SD21 Leaf Weight HS-1vsBA

Normality Test (Shapiro-Wilk) Passed (P = 0.521)

Equal Variance Test: Passed (P = 0.932)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.00166	0.000374	0.000187
100 mg/L BA	4	0	0.001	0.000399	0.000199

Difference 0.000483

t = 1.767 with 6 degrees of freedom. (P = 0.128)

95 percent confidence interval for difference of means: -0.000186 to 0.00115

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.128).

Power of performed test with alpha = 0.050: 0.226

The power of the performed test (0.226) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

Descriptive Statistics: Thursday, June 21, 2018, 11:59:59 AM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number Descriptive

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	0.941	0.258	0.129	0.410
0.3 mg/L	4	0	0.752	0.522	0.261	0.831
1.56 mg/L	4	0	0.524	0.285	0.143	0.454
3.12 mg/L	4	0	0.427	0.186	0.093	0.296
7.8 mg/L	4	0	0.313	0.193	0.097	0.307
HS-1 2.8	4	0	0.463	0.184	0.092	0.293
0.3 mg/L 2.8	4	0	0.757	0.525	0.262	0.835
1.56 mg/L 2.8	4	0	1.244	0.601	0.300	0.956
3.12 mg/L 2.8	4	0	0.475	0.228	0.114	0.363
7.8 mg/L 2.8	4	0	0.196	0.186	0.093	0.296
100 mg/L BA	4	0	0.479	0.299	0.150	0.476

Column	Range	Max	Min	Median	25%	75%
HS-1	0.590	1.313	0.722	0.864	0.778	1.104
0.3 mg/L	1.046	1.222	0.176	0.806	0.310	1.194
1.56 mg/L	0.629	0.941	0.313	0.421	0.344	0.704
3.12 mg/L	0.444	0.667	0.222	0.409	0.293	0.561
7.8 mg/L	0.400	0.600	0.200	0.225	0.200	0.425
HS-1 2.8	0.354	0.632	0.278	0.472	0.306	0.621
0.3 mg/L 2.8	1.158	1.316	0.158	0.778	0.329	1.186
1.56 mg/L 2.8	1.412	2.000	0.588	1.194	0.794	1.694
3.12 mg/L 2.8	0.500	0.688	0.188	0.512	0.294	0.656
7.8 mg/L 2.8	0.400	0.400	0.000	0.192	0.042	0.350
100 mg/L BA	0.600	0.800	0.200	0.458	0.225	0.733

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	1.540	2.707	0.321	0.16	0.867	0.284
0.3 mg/L	-0.213	-4.678	0.286	0.278	0.859	0.258
1.56 mg/L	1.715	3.009	0.329	0.136	0.819	0.141
3.12 mg/L	0.517	0.548	0.191	0.66	0.987	0.94
7.8 mg/L	1.914	3.680	0.377	0.048	0.717	0.018
HS-1 2.8	-0.068	-5.489	0.289	0.267	0.825	0.155
0.3 mg/L 2.8	-0.146	-3.015	0.215	0.58	0.955	0.745
1.56 mg/L 2.8	0.424	-0.295	0.158	0.71	0.99	0.957
3.12 mg/L 2.8	-0.631	-1.892	0.245	0.456	0.931	0.601
7.8 mg/L 2.8	0.074	-3.744	0.228	0.53	0.934	0.617
100 mg/L BA	0.145	-4.904	0.278	0.31	0.864	0.275

Column	Sum	Sum of Squares
HS-1	3.763	3.739
0.3 mg/L	3.01	3.084
1.56 mg/L	2.095	1.342
3.12 mg/L	1.707	0.833
7.8 mg/L	1.25	0.503
HS-1 2.8	1.854	0.961
0.3 mg/L 2.8	3.029	3.12
1.56 mg/L 2.8	4.977	7.275
3.12 mg/L 2.8	1.9	1.058
7.8 mg/L 2.8	0.783	0.257
100 mg/L BA	1.917	1.187

One Way Analysis of Variance Thursday, June 21, 2018, 12:00:42 PM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number -100 BA ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.127)

Equal Variance Test: Passed (P = 0.086)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.941	0.2580	0.1290
0.3 mg/L	4	0	0.752	0.5220	0.26100
1.56 mg/L	4	0	0.524	0.2850	0.1430
3.12 mg/L	4	0	0.427	0.1860	0.0932
7.8 mg/L	4	0	0.313	0.1930	0.09660
100 mg/L BA	4	0	0.479	0.2990	0.1500

Source of Variation	DF	SS	MS	F	P
Between Groups	5	1.071	0.214	2.208	0.099
Residual	18	1.747	0.0971		
Total	23	2.819			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.099).

Power of performed test with alpha = 0.050: 0.325

The power of the performed test (0.325) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

One Way Analysis of Variance Thursday, June 21, 2018, 12:02:21 PM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number 0.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.108)

Equal Variance Test: Passed (P = 0.095)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.941	0.2580	0.1290
0.3 mg/L	4	0	0.752	0.5220	0.26100
1.56 mg/L	4	0	0.524	0.2850	0.1430
3.12 mg/L	4	0	0.427	0.1860	0.0932
7.8 mg/L	4	0	0.313	0.1930	0.0966

Source of Variation	DF	SS	MS	F	P
Between Groups	4	1.03	0.257	2.611	0.078
Residual	15	1.479	0.0986		
Total	19	2.508			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.078).

Power of performed test with alpha = 0.050: 0.374

The power of the performed test (0.374) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

One Way Analysis of Variance Thursday, June 21, 2018, 12:03:55 PM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number 2.8 ANOVA

Normality Test (Shapiro-Wilk) Passed (P = 0.650)

Equal Variance Test: Failed (P < 0.050)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks Thursday, June 21, 2018, 12:03:55 PM

Data source: Leaf Number in 00428_Stats.JNB

Group	N	Missing	Median	0.250	0.750
HS-1 2.8	4	0	0.472	0.292	0.626
0.3 mg/L 2.8	4	0	0.778	0.243	1.251
1.56 mg/L 2.8	4	0	1.194	0.691	1.847
3.12 mg/L 2.8	4	0	0.512	0.241	0.672
7.8 mg/L 2.8	4	0	0.192	0.0208	0.375

H = 8.796 with 4 degrees of freedom. (P = 0.066)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.066)

t-test Thursday, June 21, 2018, 12:05:40 PM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number HS-1 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.302)

Equal Variance Test: Passed (P = 0.961)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.941	0.258	0.129
HS-1 2.8	4	0	0.463	0.184	0.092

Difference 0.477

t = 3.013 with 6 degrees of freedom. (P = 0.024)

95 percent confidence interval for difference of means: 0.0897 to 0.865

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = 0.024).

Power of performed test with alpha = 0.050: 0.664

t-test Thursday, June 21, 2018, 12:06:00 PM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number 0.3 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.119)

Equal Variance Test: Passed (P = 0.905)

Group Name	N	Missing	Mean	Std Dev	SEM
0.3 mg/L	4	0	0.752	0.522	0.261
0.3 mg/L 2.8	4	0	0.757	0.525	0.262

Difference -0.0049

t = -0.0131 with 6 degrees of freedom. (P = 0.990)

95 percent confidence interval for difference of means: -0.911 to 0.901

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.990).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 21, 2018, 12:06:27 PM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number 1.56 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.851)

Equal Variance Test: Passed (P = 0.207)

Group Name	N	Missing	Mean	Std Dev	SEM
1.56 mg/L	4	0	0.524	0.285	0.143
1.56 mg/L 2.8	4	0	1.244	0.601	0.3

Difference -0.7200

t = -2.167 with 6 degrees of freedom. (P = 0.073)

95 percent confidence interval for difference of means: -1.534 to 0.0931

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.073).

Power of performed test with alpha = 0.050: 0.360

The power of the performed test (0.360) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 21, 2018, 12:06:55 PM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number 3.12 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.653)

Equal Variance Test: Passed (P = 0.540)

Group Name	N	Missing	Mean	Std Dev	SEM
3.12 mg/L	4	0	0.427	0.186	0.0932
3.12 mg/L 2.8	4	0	0.475	0.228	0.114

Difference -0.0482

t = -0.328 with 6 degrees of freedom. (P = 0.754)

95 percent confidence interval for difference of means: -0.408 to 0.312

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.754).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 21, 2018, 12:07:17 PM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number 7.8 0.8v2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.157)

Equal Variance Test: Passed (P = 0.665)

Group Name	N	Missing	Mean	Std Dev	SEM
7.8 mg/L	4	0	0.313	0.193	0.0966
7.8 mg/L 2.8	4	0	0.196	0.1860	0.0929

Difference 0.1170

t = 0.871 with 6 degrees of freedom. (P = 0.417)

95 percent confidence interval for difference of means: -0.211 to 0.445

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.417).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 21, 2018, 12:07:45 PM

Data source: Leaf Number in 00428_Stats.JNB SD21 Leaf Number HS-1vsBA

Normality Test (Shapiro-Wilk) Passed (P = 0.195)

Equal Variance Test: Passed (P = 0.412)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	0.941	0.258	0.129
100 mg/L BA	4	0	0.479	0.299	0.15

Difference 0.462000

t = 2.337 with 6 degrees of freedom. (P = 0.058)

95 percent confidence interval for difference of means: -0.0218 to 0.945

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.058).

Power of performed test with alpha = 0.050: 0.421

The power of the performed test (0.421) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

Descriptive Statistics: Thursday, June 21, 2018, 12:13:42 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 Descriptive

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
HS-1	4	0	9.250	0.500	0.250	0.796
0.3 mg/L	4	0	9.500	0.577	0.289	0.919
1.56 mg/L	4	0	9.750	0.500	0.250	0.796
3.12 mg/L	4	0	22.000	0.000	0.000	0.000
7.8 mg/L	4	0	22.000	0.000	0.000	0.000
HS-1 2.8	4	0	9.250	0.500	0.250	0.796
0.3 mg/L 2.8	4	0	9.250	0.500	0.250	0.796
1.56 mg/L 2.8	4	0	9.500	0.577	0.289	0.919
3.12 mg/L 2.8	4	0	9.750	0.500	0.250	0.796
7.8 mg/L 2.8	4	0	21.500	1.000	0.500	1.591
100 mg/L BA	4	0	22.000	0.000	0.000	0.000

Column	Range	Max	Min	Median	25%	75%
HS-1	1.000	10.000	9.000	9.000	9.000	9.500
0.3 mg/L	1.000	10.000	9.000	9.500	9.000	10.000
1.56 mg/L	1.000	10.000	9.000	10.000	9.500	10.000
3.12 mg/L	0.000	22.000	22.000	22.000	22.000	22.000
7.8 mg/L	0.000	22.000	22.000	22.000	22.000	22.000
HS-1 2.8	1.000	10.000	9.000	9.000	9.000	9.500
0.3 mg/L 2.8	1.000	10.000	9.000	9.000	9.000	9.500
1.56 mg/L 2.8	1.000	10.000	9.000	9.500	9.000	10.000
3.12 mg/L 2.8	1.000	10.000	9.000	10.000	9.500	10.000
7.8 mg/L 2.8	2.000	22.000	20.000	22.000	21.000	22.000
100 mg/L BA	0.000	22.000	22.000	22.000	22.000	22.000

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	SWilk W	SWilk Prob
HS-1	2.000	4.000	0.441	0.006	0.63	0.001
0.3 mg/L	0.000	-6.000	0.307	0.203	0.729	0.024
1.56 mg/L	-2.000	4.000	0.441	0.006	0.63	0.001
3.12 mg/L	0.000	-6.000	0	<0.001	0	<0.001
7.8 mg/L	0.000	-6.000	0	<0.001	0	<0.001
HS-1 2.8	2.000	4.000	0.441	0.006	0.63	0.001
0.3 mg/L 2.8	2.000	4.000	0.441	0.006	0.63	0.001
1.56 mg/L 2.8	0.000	-6.000	0.307	0.203	0.729	0.024
3.12 mg/L 2.8	-2.000	4.000	0.441	0.006	0.63	0.001
7.8 mg/L 2.8	-2.000	4.000	0.441	0.006	0.63	0.001
100 mg/L BA	0.000	-6.000	0	<0.001	0	<0.001

Column	Sum	Sum of Squares
HS-1	37	343
0.3 mg/L	38	362
1.56 mg/L	39.000	381
3.12 mg/L	88.000	1936
7.8 mg/L	88	1936
HS-1 2.8	37	343
0.3 mg/L 2.8	37.000	343
1.56 mg/L 2.8	38	362
3.12 mg/L 2.8	39	381
7.8 mg/L 2.8	86.000	1852
100 mg/L BA	88	1936

t-test Friday, June 22, 2018, 12:04:38 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1 vs 0.3 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.356)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	9.250	0.500	0.250
0.3 mg/L	4	0	9.500	0.577	0.289

Difference -0.25

t = -0.655 with 6 degrees of freedom. (P = 0.537)

95 percent confidence interval for difference of means: -1.184 to 0.684

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.537).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Friday, June 22, 2018, 12:05:45 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1 vs 1.56 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.522)

Equal Variance Test: Passed (P = 1.000)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1	4	0	9.250	0.500	0.250
1.56 mg/L	4	0	9.750	0.500	0.250

Difference -0.5000

t = -1.414 with 6 degrees of freedom. (P = 0.207)

95 percent confidence interval for difference of means: -1.365 to 0.365

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.207).

Power of performed test with alpha = 0.050: 0.131

The power of the performed test (0.131) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Friday, June 22, 2018, 12:06:20 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1 vs 3.12 t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Friday, June 22, 2018, 12:06:20 PM

Data source: SD 21 ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	9.000	9.000	9.750
3.12 mg/L	4	0	22.000	22.000	22.000

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.018 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

t-test Friday, June 22, 2018, 12:07:03 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1 vs 7.8 t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Friday, June 22, 2018, 12:07:03 PM

Data source: SD 21 ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	9.000	9.000	9.750
7.8 mg/L	4	0	22.000	22.000	22.000

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.018 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

t-test Thursday, June 21, 2018, 12:21:33 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1vsBA t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Thursday, June 21, 2018, 12:21:33 PM

Data source: SD 21 ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	9.000	9.000	9.750
100 mg/L BA	4	0	22.000	22.000	22.000

Mann-Whitney U Statistic= 0.000

T = 10.000 n(small)= 4 n(big)= 4 P(est.)= 0.018 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

t-test Friday, June 22, 2018, 12:07:34 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1 2.8 vs 0.3 2.8

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Friday, June 22, 2018, 12:07:34 PM

Data source: SD 21 ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1 2.8	4	0	9.000	9.000	9.750
0.3 mg/L 2.8	4	0	9.000	9.000	9.750

Mann-Whitney U Statistic= 8.000

T = 18.000 n(small)= 4 n(big)= 4 P(est.)= 0.849 P(exact)= 1.000

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 1.000)

t-test Friday, June 22, 2018, 12:08:02 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1 2.8 vs 1.56 2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.356)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	9.250	0.500	0.250
1.56 mg/L 2.8	4	0	9.500	0.577	0.289

Difference -0.2500

t = -0.655 with 6 degrees of freedom. (P = 0.537)

95 percent confidence interval for difference of means: -1.184 to 0.684

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.537).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Friday, June 22, 2018, 12:11:45 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1 2.8 vs 3.12 2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.522)

Equal Variance Test: Passed (P = 1.000)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	9.250	0.500	0.250
3.12 mg/L 2.8	4	0	9.750	0.500	0.250

Difference -0.5000

t = -1.414 with 6 degrees of freedom. (P = 0.207)

95 percent confidence interval for difference of means: -1.365 to 0.365

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.207).

Power of performed test with alpha = 0.050: 0.131

The power of the performed test (0.131) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Friday, June 22, 2018, 12:12:12 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1 2.8 vs 7.8 2.8

Normality Test (Shapiro-Wilk) Passed (P = 0.071)

Equal Variance Test: Passed (P = 0.670)

Group Name	N	Missing	Mean	Std Dev	SEM
HS-1 2.8	4	0	9.250	0.500	0.250
7.8 mg/L 2.8	4	0	21.500	1.000	0.500

Difference -12.2500

t = -21.913 with 6 degrees of freedom. (P = <0.001)

95 percent confidence interval for difference of means: -13.618 to -10.882

The difference in the mean values of the two groups is greater than would be expected by chance; there is a statistically significant difference between the input groups (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

t-test Thursday, June 21, 2018, 12:16:49 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 HS-1 0.8 vs 2.8 t-te

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Thursday, June 21, 2018, 12:16:49 PM

Data source: SD 21 ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
HS-1	4	0	9.000	9.000	9.750
HS-1 2.8	4	0	9.000	9.000	9.750

Mann-Whitney U Statistic= 8.000

T = 18.000 n(small)= 4 n(big)= 4 P(est.)= 0.849 P(exact)= 1.000

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 1.000)

t-test Thursday, June 21, 2018, 12:17:07 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 0.3 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.356)

Group Name	N	Missing	Mean	Std Dev	SEM
0.3 mg/L	4	0	9.500	0.577	0.289
0.3 mg/L 2.8	4	0	9.250	0.500	0.250

Difference 0.2500

t = 0.655 with 6 degrees of freedom. (P = 0.537)

95 percent confidence interval for difference of means: -0.684 to 1.184

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.537).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 21, 2018, 12:17:30 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 1.56 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.356)

Group Name	N	Missing	Mean	Std Dev	SEM
1.56 mg/L	4	0	9.750	0.500	0.250
1.56 mg/L 2.8	4	0	9.500	0.577	0.289

Difference 0.2500

t = 0.655 with 6 degrees of freedom. (P = 0.537)

95 percent confidence interval for difference of means: -0.684 to 1.184

The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.537).

Power of performed test with alpha = 0.050: 0.050

The power of the performed test (0.050) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists.
Negative results should be interpreted cautiously.

t-test Thursday, June 21, 2018, 12:19:58 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 3.12 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Thursday, June 21, 2018, 12:19:58 PM

Data source: SD 21 ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
3.12 mg/L	4	0	22.000	22.000	22.000
3.12 mg/L 2.8	4	0	10.000	9.250	10.000

Mann-Whitney U Statistic= 0.000

T = 26.000 n(small)= 4 n(big)= 4 P(est.)= 0.018 P(exact)= 0.029

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.029)

t-test Thursday, June 21, 2018, 12:21:11 PM

Data source: SD 21 ET30 in 00428_Stats.JNB SD21 MET30 7.8 0.8v2.8 t-test

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Test execution ended by user request, Rank Sum Test begun

Mann-Whitney Rank Sum Test Thursday, June 21, 2018, 12:21:11 PM

Data source: SD 21 ET30 in 00428_Stats.JNB

Group	N	Missing	Median	25%	75%
7.8 mg/L	4	0	22.000	22.000	22.000
7.8 mg/L 2.8	4	0	22.000	20.500	22.000

Mann-Whitney U Statistic= 6.000

T = 20.000 n(small)= 4 n(big)= 4 P(est.)= 0.453 P(exact)= 0.686

The difference in the median values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.686)

Appendix B. Fort et al. (2017)

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TOXICITY OF SULFIDE TO EARLY LIFE STAGES OF WILD RICE (*ZIZANIA PALUSTRIS*)

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Abstract: The sensitivity of wild rice (*Zizania palustris*) to sulfide is not well understood. Because sulfate in surface waters is reduced to sulfide by anaerobic bacteria in sediments and historical information indicated that 10 mg/L sulfate in Minnesota (USA) surface water reduced *Z. palustris* abundance, the Minnesota Pollution Control Agency established 10 mg/L sulfate as a water quality criterion in 1973. A 21-d daily-renewal hydroponic study was conducted to evaluate sulfide toxicity to wild rice and the potential mitigation of sulfide toxicity by iron (Fe). The hydroponic design used hypoxic test media for seed and root exposure and aerobic headspace for the vegetative portion of the plant. Test concentrations were 0.3, 1.6, 3.1, 7.8, and 12.5 mg/L sulfide in test media with 0.8, 2.8, and 10.8 mg/L total Fe used to evaluate the impact of iron on sulfide toxicity. Visual assessments (i.e., no plants harvested) of seed activation, mesocotyl emergence, seedling survival, and phytoxicity were conducted 10 d after dark-phase exposure. Each treatment was also evaluated for time to 30% emergence (ET30), total plant biomass, root and shoot lengths, and signs of phytotoxicity at study conclusion (21 d). The results indicate that exposure of developing wild rice to sulfide at $\geq$3.1 mg sulfide/L in the presence of 0.8 mg/L Fe reduced mesocotyl emergence. Sulfide toxicity was mitigated by the addition of Fe at 2.8 mg/L and 10.8 mg/L relative to the control value of 0.8 mg Fe/L, demonstrating the importance of iron in mitigating sulfide toxicity to wild rice. Ultimately, determination of site-specific sulfate criteria taking into account factors that alter toxicity, including sediment Fe and organic carbon, are necessary. *Environ Toxicol Chem* 2017;36:2217–2226. © 2017 SETAC

Keywords: Wild rice Sulfide Toxicity Iron Hydroponics

INTRODUCTION

Historically, the impacts of sulfate, and thus sulfide, toxicity to wild rice (*Zizania palustris L.*) in Minnesota (USA) have been addressed by using the surface water sulfate water quality standard of 10 mg/L established by the Minnesota Pollution Control Agency [1,2]. To address the practicality of this standard, an initial 21-d hydroponic study was previously performed [3] to determine the toxicity of sulfate to wild rice seeds and seedlings. The results suggested that sulfate does not adversely affect germination and early development of wild rice at concentrations <5000 mg/L over a 21-d hydroponic exposure period. Some effects found at high sulfate concentrations were also observed in osmotically equivalent chloride treatments, and some sulfate-specific stimulatory effects may be attributable to the effects of sulfate as a plant nutrient. Two endpoints, shoot length and leaf number, appeared to have sulfate-specific toxic responses; however, the remainder of the observed responses were likely the result of a general conductivity-induced stress and not specifically the result of sulfate. Root length appeared to be an especially sensitive endpoint to conductivity-related stress induced by chloride-dominated salt solutions [3].

Sulfate in surface waters is reduced to sulfide by anaerobic bacteria in sediments, and sulfide is known to be much more toxic to aquatic organisms than sulfate. As an extension of the original hydroponics study [3], which examined sulfate toxicity to developing wild rice, sulfide toxicity to early life stage wild rice was evaluated under varying iron (Fe) concentrations representative of those known to be present in sediment porewaters in Minnesota. The sulfide toxicity threshold under varying Fe concentrations was determined, to facilitate a better understanding of the role of Fe in altering sulfide toxicity. The primary objective of the present study was to determine the toxicity of sulfide to wild rice seeds and seedlings from the State of Minnesota. Preliminary studies were conducted to determine the most appropriate culture media and test conditions, identify sensitive test endpoints, establish a statistically valid experimental design, and determine appropriate sulfide exposure concentrations for the range of wild rice response endpoints selected. These findings will be used to further understand the possible impact of sulfate released into the environment and subsequently reduced to sulfide under varying sediment conditions, and support the efforts to re-evaluate the State of Minnesota's wild rice sulfate water quality standard of 10 mg/L [2]. Concentration–response data, including 25% inhibitory concentrations (IC25) values, and no- and lowest-observed-effect concentrations (NOEC and LOEC) for the effects of sulfide on wild rice were determined.

MATERIALS AND METHODS

Preliminary studies

Preliminary range-finding studies were conducted to establish the testing conditions necessary to maintain a hydroponic exposure to sulfide, and to determine appropriate sulfide and Fe concentrations for the definitive study. A daily-renewal hydroponic system utilizing a modified Hoagland's solution (HS-1; [4,5]) was used to test the effects of sulfide on 10

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biological endpoints in wild rice seeds and seedlings over 21 d. A summary of the experimental design and conditions is provided in Table 1.

Hydroponic media and test materials

Modified HS-1 solution [4] contained 25% ammonium (molar basis) in a mixture of ammonium and nitrate [3], and served as the base medium and diluent for all test exposures in the definitive study. Deionized water was used to prepare all solutions, and was routinely tested to ensure the absence of various organic and inorganic contaminants. The modified HS-1 macronutrients consisted of 2.55 mM NO_3^-, 0.92 mM NH_4^+, 0.12 mM $H_2PO_4^-$, 1.10 mM K^+, and 0.75 mM Ca^{2+}, 0.50 mM Mg^{2+}, and 0.50 mM SO_4^{2-}. Micronutrients included 46.3 μM boron (B), 14.9 μM Fe, 0.76 μM zinc, 0.31 μM copper, 9 μM manganese, and 0.50 μM molybdenum. The sulfide toxicity threshold under varying iron concentrations was determined, to facilitate a better understanding of the role of iron in altering sulfide toxicity. All salts were reagent-grade materials obtained from SigmaAldrich (St. Louis, MO; >98% pure). Hydrated sodium sulfide ($Na_2S \cdot 9\ H_2O$, 99.99% pure, Sigma-Aldrich) and ferric chloride ($FeCl_3$, 98.00%, Merck) were used throughout the present study. The sulfide and Fe treatments are identified in Table 1. In addition to the HS-1 (1:4 ammonium:nitrate) negative control (0.8 mg Fe/L), and HS-1 controls containing additional iron (2.8 mg and 10.8 mg Fe/L), a 100-mg boron (B)/L treatment in HS-1 (1:4) media was included as a positive control toxicant. Boron was selected as a positive control based on use in the initial hydroponic study evaluating the toxicity of sulfate and chloride [3].

Wild rice seeds

Wild rice seeds were hand-harvested from Little Round Lake in Becker County, Minnesota (USA; 46°58′13.32″N and 95°44′44.49″W), sieved through a 4-mm mesh, and then sieved through a 2-mm mesh to remove debris. Seeds were stored at 4 °C in the dark prior to test initiation. The percentage of emergence at day 21 in preliminary studies was 47.5%, and was thus considered acceptable for use based on both preliminary studies and Fort et al. [3], as a relatively modest proportion of *Zizania palustris* germinate (criteria set at ≥30%).

Exposure system

Based on the results of preliminary testing, a sulfide exposure series of 0.3, 1.6, 3.1, 7.8, and 12.5 mg/L sulfide was utilized. Test solutions were provided using a static-renewal design in 10-L hydroponic tanks. The hydroponic tanks were plastic aquaria (~35 cm × 20 cm × 15 cm deep). Each tank was equipped with 1-L baskets with inert mesh to support the seeds and seedlings. One-liter baskets to house seeds and seedlings evaluated on day 10 (visual assessments only) and day 21 (study termination, all endpoints) were placed in each of the 4 replicate tanks per treatment or control. Exposure media were replaced daily using a 70% renewal rate. Treatment tanks were randomly assigned to a position in the exposure system to account for possible variations in temperature and light intensity. Seeds selected for study were

Table 1. Experimental conditions for hydroponic evaluation of sulfide toxicity and impact of iron in *Zizania palustris*

Test substance	Sulfide (suspected toxicant) and iron (suspected to interact with sulfide)
Test concentrations	Sulfide series: <0.1 (control), 0.3, 1.6, 3.1, 7.8, 12.5 mg/L. Each sulfide series run with either 0.8, 2.8, or 10.8 mg/L Fe
Test system (species)	*Zizania palustris* (wild rice)
Initial stage	Seed, September 8, 2014 seed lot from Little Round Lake (03-0302-00)
Exposure period	10-d (mesocotyl emergence phase in dark) and 21-d (free leaf phase). Total exposure period 21 d
Selection criteria	Seed uniformity, visual quality, and activation
Exposure system	Static-renewal (daily) in controlled environmental chambers under anaerobic aquatic phase and aerobic vegetative (shoot) phase
Exposure route	Water (hydroponics)
Test vessel	10-L chamber with 1-L sub-basket equipped with mesh bottom supports for seeds
Exchange frequency	Daily, 0.7 volumes/d
Water source	Deionized water
Media	HS-1[a] modified with 1:4 ammonia:nitrate
Replication	4/treatment
Seed density	80 seeds/replicate (320 seeds/ treatment or control)
Vessel placement	Tanks are placed randomly throughout the experimental area
Positive control	Boric acid (100 mg B/L)
Test performance criteria (control)	See Table 6
Test endpoints	
Daily	Activation, mesocotyl emergence, seedling survival, and visual inspection of development (emergence and normalcy of development)
SD 10	Activation, mesocotyl emergence (%), survival, leaf number, and signs of phytotoxicity
Conclusion (SD 21)	Activation, mesocotyl emergence (%, time to 30% emergence [ET30] if possible), survival, shoot and seminal root length and weight, leaf number, second and free leaf biomass, and signs of phytotoxicity
Feeding	
Nutrient/micronutrients	HS-1 modified with 1:4 ammonia:nitrate and either 0.8, 2.8, or 10.8 mg Fe/L
Frequency	Daily, 0.7 volumes renewed
Lighting	
Photoperiod	Dark through SD 10, then 16-h light:8-h dark
Intensity (post SD 10)	5000 ± 1000 lux (measured daily at water surface)
Temperature	In all replicates, daily, 21 ± 2 °C (day), and nightly, 12 °C ± 2 °C (night)
pH, ORP, DO, and sulfide	2×/d in all replicates prior to and following renewal
Conductivity, alkalinity, hardness, ammonia, total Fe, nitrate, sulfate, phosphate, total residual oxidants	Initiation (SD 0), SD 7, SD 14, and SD 21 (conclusion) of study in a representative test replicate of each treatment

[a]Modified Hoaglund's solution.
ORP = oxidation-reduction potential; DO = dissolved oxygen; SD = standard deviation; HS-1 = Hoagland's solution.

randomly placed in each basket such that 5 seeds were added to each insert basket in accordance with a randomized design chart until each basket contained 80 seeds/replicate (320 total per exposure condition), which was adequate to evaluate concentration–response relationships and assess significant differences in the treatments relative to their respective control (i.e., the HS-1 medium with a given Fe concentration and no sulfide). For the first 10 d of the present study, the seeds were kept in the dark to promote mesocotyl emergence and development. Following the 10-d dark-phase germination and development phase, a combination of incandescent and fluorescent plant growlights was used to provide a 16:8-h light:dark photoperiod at an intensity of 5000 ± 1000 lux (lumens/m^2) at the surface of the culture media and plants.

Water temperature was maintained at 21 ± 2 °C (day) and 12 ± 2 °C (night). Test solution pH was maintained between 6.0 and 7.5 s.u. in all exposures. Within a given replicate, variation in pH was ±0.5 s.u. for each daily measurement at time 0 (renewal) and time 24 (immediately prior to subsequent renewal), and over the course of the study. This pH range is well within the range of conditions where wild rice grows naturally. Hypoxic (dissolved oxygen < 2.0 mg/L) conditions were maintained within the hydroponic tanks; the HS-1 test medium was deoxygenated with N_2 gas, stored in a sealed carboy until use, and checked for oxygen concentration immediately prior to use. Each hydroponic tank was equipped with a 6-inch, small-bubble air stone to deliver a constant flow of N_2 gas to the tank and ensure hypoxic conditions were maintained. For hypoxic root growth and aerobic vegetative growth, the basket was placed in the hydroponic aquaria such that the seeds resided in the culture media approximately 1 cm below the air:media interface. Seeds germinated under hypoxic conditions and mesocotyls developed in aerobic conditions under this design. Plastic wire mesh was placed inside the aquaria to provide a trellis to support vegetative growth above the hypoxic culture media. Sulfide-treated test solutions were prepared daily for use in renewal. Sulfide concentrations in the test solutions were measured prior to and following each daily media renewal using an ion-selective probe. Sulfide stability in the culture media was aided by the N_2 gas balance. A summary of the present study conditions is provided in Table 1.

Water quality analyses

In each replicate tank, temperature and light intensity (lux) were measured daily throughout the 21-d study. The dissolved oxygen (aqueous and headspace; US Environmental Protection Agency [USEPA] method 360.1 [6]), pH, oxidation-reduction potential, and sulfide were measured twice daily (i.e., prior to and following solution renewal). The dissolved oxygen, oxidation-reduction potential, and sulfide (USEPA method 9215 [7]) measurements were conducted at the same water depth as seed exposure. In addition, specific conductance (conductivity; USEPA method 120.1 [8]), total hardness (USEPA method 130.2 [9]), total alkalinity (USEPA method 310.1 [10]), total iron (USEPA method 8008 [11]), total residual oxidants (USEPA method 330.5 [12]), ammonia-nitrogen (USEPA method 350.2 [13]), sulfate (USEPA method 375.4 [14]), nitrate (USEPA method 353.2 [15]), and phosphate (USEPA method 365.2 [16]) were measured in the media in a replicate of each treatment on days 0, 7, 14, and 21 (conclusion) of the study [17]. Time-weighted average sulfide concentrations were calculated in accordance with methods of the Organisation for Economic Co-operation and Development, and accounted for the variation in instantaneous concentration over time so that the area under the time-weighted average is equal to the area under the concentration curve [18].

Data collection and biological endpoints

Visual assessments only (i.e., no plants harvested) of the following endpoints (Table 2) were conducted on day 10 following dark-phase exposure to evaluate: activation (germination), mesocotyl emergence, time to emergence (expressed as the time to 30% emergence [ET30]), seedling survival, free leaf number, and abnormal development including chlorosis (phytotoxicity). Signs of chlorosis and stem or root rot were based on observation using a dissecting microscope as needed. The use of an ET30 was based on previous studies [3] of wild rice emergence revealing that in normal-appearing seeds, between 30% and 60% of mesocotyls emerged over the course of a trial. The mesocotyl emergence acceptance frequency was set at 30% in the previous study with sulfate [3] and the present study. All subbaskets were evaluated for the endpoints mentioned, as well as the following 5 endpoints at study conclusion (day 21): shoot (mesocotyl, coleoptiles, and primary leaf) weight, shoot (mesocotyl, coleoptiles, and primary leaf) length, root (seminal and rootlets) weight, seminal root length, and free leaf biomass. All weights were expressed as dry weight recorded to the nearest 0.1 mg by drying the individual parts of each seedling together in an aluminum pan in an oven at 105 °C for 24 h.

Data analysis

The experimental unit was the replicate and $\alpha = 0.05$. For measurement endpoints (i.e., weights and lengths), replicate level data were based on the mean value for all plants measured in that replicate with the exception of the ET30 data sets, which were based on median values. The statistical tests used to compare the culture media with the sulfide and B positive control differed depending on the data type and distribution for each measurement endpoint. No outliers were identified (Grubbs's test). Data that were expressed as a percentage or proportion were transformed using the arcsine square root before further analysis. No other transformations were used. The IC25 and 95% confidence intervals for appropriate endpoints were determined by linear interpolation. Normal distribution (Shapiro–Wilks' test, $\alpha = 0.05$) and equivalence of variances (Levene's test, $\alpha = 0.05$) were performed to determine parametric data sets. For measurement endpoints, comparisons between the treatments and designated controls were performed using one-way analysis of variance (ANOVA) or a nonparametric equivalent (Kruskal–Wallis ANOVA). In all cases, sulfide treatments sharing the same Fe concentration were compared against a control condition containing that same iron concentration. When the initial test was statistically significant, post hoc tests were performed, including the Bonferroni *t* test for parametric test and Dunn's nonparametric test. Treatment median ET30 values were determined by deriving the median of replicate ET 30 values. The ET30 values for each treatment were compared with their respective controls using a Mann–Whitney *U* test.

RESULTS

Exposure conditions and sulfide concentrations

Exposure solution pH was maintained at 6.0 to 7.5 s.u. in all replicates of controls and treatments and was ±0.5 s.u. within a given replicate for each daily measurement. The dissolved oxygen concentrations were maintained at <2.0 mg/L in all

Table 2. Effects of sulfide on hydroponic development and growth of *Zizania palustris* endpoints following 10-d exposure

Treatment		Response[a]				
Sulfide[b] (mg/L)	Iron (mg/L)	Seed activation (%)	Mesocotyl emergence (%)	Seedling survival (%)	Mean free leaf (no.)	Abnormal appearance (%)
<0.01 (negative control)	0.8[c]	100.0 (0.0)	29.1 (0.46)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
<0.01 (positive control)[d]	0.8	100.0 (0.0)	8.4[e] (0.66)	100.0 (0.0)	0.0 (0.0)	100[f](0.0)
0.3	0.8	100.0 (0.0)	28.8 (0.47)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
1.6	0.8	100.0 (0.0)	27.8 (0.74)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
3.1	0.8	100.0 (0.0)	24.1 (0.46)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
7.8	0.8	100.0 (0.0)	14.4[g] (0.63)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
12.5	0.8	100.0 (0.0)	0.0[g] (0.00)	– (–)	– (–)	– (–)
<0.01 (negative control)	2.8	100.0 (0.0)	28.1 (0.63)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
0.3	2.8	100.0 (0.0)	27.5 (0.67)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
1.6	2.8	100.0 (0.0)	26.9 (0.63)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
3.1	2.8	100.0 (0.0)	25.0 (0.47)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
7.8	2.8	100.0 (0.0)	15.6[h] (0.63)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
12.5	2.8	100.0 (0.0)	0.0[h] (0.00)	– (–)	– (–)	– (–)
<0.01 (negative control)	10.8	100.0 (0.0)	28.8 (0.67)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
0.3	10.8	100.0 (0.0)	29.1 (0.46)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
1.6	10.8	100.0 (0.0)	27.2 (0.74)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
3.1	10.8	100.0 (0.0)	26.9 (0.63)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
7.8	10.8	100.0 (0.0)	22.2[i] (1.00)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)
12.5	10.8	100.0 (0.0)	13.8[i] (0.47)	100.0 (0.0)	0.0 (0.0)	0.0 (0.0)

[a]Mean with standard error of the mean below. Mean of 4 replicates/treatment with 80 seeds/replicate (320 seeds/treatment).
[b]Nominal sulfide concentration.
[c]HS-1 contains 0.8 mg Fe/L. Statistical comparisons made with HS-1 with 0.8, 2.8, or 10.8 mg Fe/L controls depending on treatment set analyzed to hold the nominal Fe constant during analysis.
[d]100 mg/L boric acid (positive control).
[e]Significantly less than HS-1 with 0.8 mg Fe/L, *t* test, $p < 0.001$.
[f]Significantly greater than HS-1 with 0.8 mg Fe/L, *t* test, $p < 0.001$.
[g]Significantly less than HS-1 with 0.8 mg Fe/L, Kruskal–Wallis-analysis of variance, Dunn's test, $p < 0.05$.
[h]Significantly less than HS-1 with 2.8 mg Fe/L, Kruskal–Wallis-analysis of variance, Dunn's test, $p < 0.05$.
[i]Significantly less than HS-1 with 10.8 mg Fe/L, Kruskal–Wallis-analysis of variance, Dunn's test, $p < 0.05$.
HS-1 = Hoagland's solution.

treatments, and hydroponic chamber temperatures were maintained at 21 ± 2 °C (day) and 12 ± 2 °C (night) in all replicates of controls and treatments. A summary of sulfide concentrations based on time-weighted average values measured following test solution renewal (T0) and immediately prior to renewal (T24), along with an evaluation of 24-h sulfide losses in each treatment is presented in Table 3. Inter-replicate percentage coefficient of variation (CV) within the control or a given sulfide exposure was ≤6% in pre- and post-test solution renewal samples based on time-weighted average concentrations. The interreplicate CV for 24-h sulfide loss based on the time-weighted average concentration was ≤30%. Sulfide loss between 24-h renewals ranged from 15.2 to 23.5% in the 0.8 mg Fe/L treatments, 29.9 to 55.6% in the 2.8 mg Fe/L treatments, and 87.6 to 95.4% in the 10.8 mg Fe/L treatments. The results indicate that nominal and measured sulfide concentrations in freshly prepared test solutions were very similar, but that increased Fe reduced free sulfide concentrations in a manner that was not necessarily a linear function of iron concentrations.

Control and positive control performance

The control (HS-1) seed activation, mesocotyl emergence, and seedling survival were >95%, >30%, and >90%, respectively; on study days 10 (Table 2) and 21 (Table 4), which met validity criteria previously established for hydroponic studies [3]. The HS-1 control plants were compared against those grown in a 100 mg/L B positive control known to induce phytotoxicity. The occurrence of 100% phytotoxicity indicated compliance with the pre-established test acceptability criterion of ≥80% [3]. In contrast, HS-1 plants exhibited no phytotoxicity. Decreased emergence, root length and weight, and free leaf weight, an increase in the median ET30, and phytotoxicity were observed in wild rice exposed to 100 mg B/L relative to the HS-1 control with 0.8 mg Fe/L.

Sulfide toxicity with 0.8 mg Fe/L

Study day 10. Exposure of wild rice to 7.8 and 12.5 mg/L sulfide decreased emergence relative to the HS-1 control with 0.8 mg Fe/L. Free leaf number was 0 in the control and all treatments (Table 2).

Study day 21. Decreased emergence, root length and weight, and free leaf weight, an increase in the median ET 30, and phytotoxicity were observed in wild rice exposed to 100 mg B/L relative to the HS-1 control with 0.8 mg Fe/L (Table 4). Exposure of wild rice to 3.1, 7.8, and 12.5 mg/L sulfide decreased emergence at day 21 relative to the HS-1 control with 0.8 mg Fe/L. Emergence was greater in seeds exposed to 12.5 mg/L sulfide with 10.8 mg Fe/L than in treatments with 0.8 and 2.8 mg Fe/L. Seeds exposed to 12.5 mg/L sulfide exhibited 21.3% emergence in the presence of 10.8 mg/L Fe compared with no emergence occurring in this same sulfide concentration in the 2 lower Fe conditions. Root length, shoot length, root biomass, shoot biomass, secondary leaf biomass, and leaf number were 0 in seedlings exposed to 12.5 mg/L sulfide with 0.8 mg Fe/L, as a result of no emergence. The ET30 (Table 5) generally increased with increasing sulfide concentration in the 0.8 mg/L Fe series (i.e., longer emergence times indicate toxicity), ranging from a median of 10 d in the control to >21 d in the 7.8 and 12.5 mg/L sulfide treatments. The ET30 values were significantly greater in the 7.8 and 12.5 mg/L sulfide treatments than in other sulfide treatments with these Fe treatments.

Overall, mesocotyl emergence was the most sensitive endpoint, and activation, seedling survival, and phytotoxicity

Table 3. Measured sulfide concentrations in hydroponic chambers at renewal and 24-h post renewal

Treatment	Time-weighted average[a] (mg/L)				
	Post renewal (T0)[b]	CV (%)	Pre-renewal (T24)[c]	CV (%)	Loss (%)
HS-1[d]	<0.01	–	<0.01	–	–
100 mg B/L/wild rice	<0.01	–	<0.01	–	–
0.3 mg/L Sulfide	0.34	1.1	0.26	1.3	23.5
1.6 mg/L Sulfide	1.56	0.8	1.31	3.1	16.0
3.1 mg/L Sulfide	3.29	1.5	2.53	2.9	23.1
7.8 mg/L Sulfide	7.71	0.7	6.54	5.4	15.2
12.5 mg/L Sulfide	12.52	1.5	10.52	3.8	16.0
HS-1d + 2.8 mg/L Fe	<0.01	–	<0.01	–	–
0.3 mg/L Sulfide + 2.8 mg/L Fe	0.31	2.1	0.20	1.3	35.5
1.6 mg/L Sulfide + 2.8 mg/L Fe	1.48	1.8	1.00	1.4	32.4
3.1 mg/L Sulfide + 2.8 mg/L Fe	3.20	1.3	1.42	2.0	55.6
7.8 mg/L Sulfide + 2.8 mg/L Fe	7.49	1.3	4.13	1.6	44.9
12.5 mg/L Sulfide + 2.8 mg/L Fe	11.91	1.5	8.35	0.9	29.9
HS-1[d] + 10.8 mg/L Fe	<0.01	–	<0.01	–	–
0.3 mg/L Sulfide + 10.8 mg/L Fe	0.33	1.3	0.02	0.0	93.9
1.6 mg/L Sulfide + 10.8 mg/L Fe	1.52	1.2	0.07	3.4	95.4
3.1 mg/L Sulfide + 10.8 mg/L Fe	3.21	1.1	0.31	3.6	90.3
7.8 mg/L Sulfide + 10.8 mg/L Fe	7.25	2.2	0.68	1.5	90.6
12.5 mg/L Sulfide + 10.8 mg/L Fe	11.75	1.6	1.46	3.5	87.6

[a]Analysis based on Organisation for Economic Co-operation and Development method 211 [6].
[b]Time-weighted average based on analysis of fresh test solutions. Limit of detection = 0.01 mg/L.
[c]Time-weighted average based on analysis of 24 h aged test solutions at prior to renewal of fresh test solutions.
[d]Modified Hoagland's solution.
HS-1 = Hoagland's solution; CV = coefficient of variation.

were the least sensitive endpoints. No emergence occurred in the 12.5 mg/L sulfide treatment containing 0.8 mg Fe/L.

Sulfide toxicity with 2.8 or 10.8 mg Fe/L

Study day 10. Exposure of wild rice to 7.8 or 12.5 mg/L sulfide significantly decreased emergence relative to the HS-1 control in both the 2.8 mg and 10.8 mg Fe/L treatments (Table 2). Leaf number was 0 in the controls and all treatments for both the 2.8 mg and 10.8 mg Fe/L treatments.

Study day 21. Exposure of wild rice to 7.8 or 12.5 mg/L sulfide significantly decreased emergence relative to the HS-1 control in both the 2.8 and 10.8 mg Fe/L treatments (Table 4). Evaluation of the effect of iron concentration on emergence at a given sulfide concentration indicated that the addition of 10.8 mg Fe/L significantly reduced the effects of sulfide on mesocotyl emergence in the 7.8 mg/L sulfide treatments (ANOVA, Bonferroni t test, $p < 0.001$) and 400 μM (Kruskal–Wallis–ANOVA, Dunn's test, $p < 0.05$), compared with equivalent sulfide treatments with the addition of 0.8 and 2.8 mg Fe/L. In the 2.8 mg Fe/L treatment series, the median ET30 ranged from 12 d in the control to >21 d in the 12.5 mg/L sulfide treatment (Table 6). The ET30 values were significantly greater in the 7.8 and 12.5 mg/L sulfide treatments than in other sulfide treatments with these iron treatments. In terms of plants exposed to 10.8 mg Fe/L (Table 6), the median ET30 ranged from 10 d in the control to >21 d in the 12.5 mg/L sulfide treatment. The ET30 values generally increased with increasing sulfide concentrations for these iron concentrations, and the median ET30 values for 7.8 and 12.5 mg/L sulfide were significantly greater than in other sulfide treatments (Mann–Whitney U test, $p \leq 0.005$; Table 5). In addition, the ET30 decreased in the 3.1 mg/L sulfide treatment with increasing Fe concentration (Mann–Whitney U test, $p \leq 0.05$). Root length, shoot length, root biomass, shoot biomass, secondary leaf biomass, and leaf number were all 0 in seedlings exposed to 12.5 mg/L sulfide with 2.8 mg Fe/L (Table 4). This was because of the lack of emergence in the 12.5 mg/L sulfide with 2.8 mg Fe/L treatment. However, these effects were not observed in the presence of 10.8 mg Fe/L.

Overall, mesocotyl emergence was the most sensitive endpoint, whereas activation, seedling survival, and phytotoxity were the least sensitive endpoints. No emergence occurred at 12.5 mg/L sulfide in the presence of 2.8 mg Fe/L. Mesocotyl emergence, seedling growth, and survival were recorded at 12.5 mg/L sulfide with 10.8 mg Fe/L. Thus, emergence and all root and shoot measures were greater in seeds germinated and grown in the presence of 12.5 mg/L sulfide and 10.8 mg Fe/L than in those exposed to the same amount of sulfide with either 0.8 or 2.8 mg Fe/L. The formation of a fine layer of black plaque was detected on the seminal roots of rice seedlings exposed to 7.8 mg/L sulfide with 2.8 or 10.8 mg/L Fe and 12.5 mg/L sulfide with 10.8 mg/L Fe (Figure 1). The layer of plaque when removed did not produce sufficient material to analyze or investigate further. Sulfide NOEC, LOEC, chronic values (the geometric mean of the NOEC and LOEC values), and IC25 values for each Fe concentration on day 10 and day 21 are presented in Table 6.

DISCUSSION

Mesocotyl emergence was the most sensitive endpoint at sulfide concentrations ≥3.1 mg/L with 0.8 mg/L Fe and an IC25 value of 3.9 (3.5–4.3) mg/L sulfide. However, exposure of developing wild rice to sulfide concentrations ≥7.8 mg/L (with additions of 2.8 mg and 10.8 mg Fe/L and IC25 values of 7.1 [6.5–7.7] and 9.3 [8.8–9.8] mg/L, respectively) was required to significantly reduce mesocotyl emergence. Furthermore, addition of 10.8 mg/L Fe resulted in reduction of sulfide toxicity compared with lower Fe concentration treatments, based on emergence, changes in median ET30 values, and greater percentage of emergence in seeds exposed to 12.5 mg/L sulfide.

Seed activation, seedling survival, and phytotoxicity were the least sensitive endpoints. Root and shoot growth endpoints were less sensitive than emergence endpoints. The day-21 sulfide chronic values in the 0.8 mg Fe/L series ranged from 2.2 mg/L sulfide for emergence to >12.5 mg/L sulfide for

Table 4. Effects of sulfide on hydroponic development and growth of *Zizania palustris* endpoints after 21-d exposure

Treatment		Response[a]									
Sulfide[b] (mg/L)	Iron (mg/L)	Seed activation (%)	Mesocotyl emergence (%)	Seedling survival (%)	Mean seminal root biomass (g, dry wt)	Mean seminal root length (cm)	Mean shoot biomass (g, dry wt)	Mean shoot length (cm)	Mean 2° leaf biomass (g, dry wt)	Mean free leaf (no.)	Abnormal appearance (%)
<0.01 (negative control)	0.8[c]	100.0 (0.0)	44.1 (0.46)	100.0 (0.0)	0.0016 (0.0002)	6.588 (0.301)	0.0044 (0.0003)	2.567 (0.123)	0.0088 (0.0007)	2.8 (0.2)	0.0 (0.0)
<0.01 (positive control)[d]	0.8	100.0 (0.0)	8.8[e] (0.47)	100.0 (0.0)	0.0010[f] (0.0001)	3.566[f] (0.218)	0.0039 (0.0004)	2.330 (0.150)	0.0057[g] (0.0010)	2.5 (0.4)	100[h] (0.0)
0.3	0.8	100.0 (0.0)	43.1 (0.41)	100.0 (0.0)	0.0016 (0.0001)	6.012 (0.229)	0.0038 (0.0002)	2.456 (0.116)	0.0084 (0.0011)	2.7 (0.3)	0.0 (0.0)
1.6	0.8	100.0 (0.0)	41.6 (0.66)	100.0 (0.0)	0.0020 (0.0002)	5.453 (0.238)	0.0035 (0.0002)	2.309 (0.076)	0.0068 (0.0006)	3.0 (0.2)	0.0 (0.0)
3.1	0.8	100.0 (0.0)	36.6[i] (0.66)	100.0 (0.0)	0.0016 (0.0002)	5.434 (0.345)	0.0038 (0.0002)	2.468 (0.092)	0.0075 (0.0009)	2.8 (0.1)	0.0 (0.0)
7.8	0.8	100.0 (0.0)	24.4[i] (0.41)	100.0 (0.0)	0.0014 (0.0002)	4.915 (0.386)	0.0040 (0.0003)	2.840 (0.098)	0.0081 (0.0009)	3.6 (0.3)	0.0 (0.0)
12.5	0.8	100.0 (0.0)	0.0[j] (0.00)	– (–)	– (–)	– (–)	– (–)	– (–)	– (–)	– (–)	– (–)
<0.01 (negative control)	2.8	100.0 (0.0)	45.0 (0.67)	100.0 (0.0)	0.0016 (0.0001)	4.790 (0.155)	0.0042 (0.0003)	2.511 (0.078)	0.0073 (0.0008)	3.2 (0.2)	0.0 (0.0)
0.3	2.8	100.0 (0.0)	43.4 (0.46)	100.0 (0.0)	0.0019 (0.0002)	5.315 (0.283)	0.0041 (0.0004)	2.531 (0.075)	0.0069 (0.0009)	3.1 (0.2)	0.0 (0.0)
1.6	2.8	100.0 (0.0)	40.9 (0.46)	100.0 (0.0)	0.0017 (0.0001)	5.890 (0.427)	0.0043 (0.0004)	2.571 (0.136)	0.0074 (0.0009)	3.7 (0.2)	0.0 (0.0)
3.1	2.8	100.0 (0.0)	40.0 (0.67)	100.0 (0.0)	0.0014 (0.0001)	5.506 (0.290)	0.0038 (0.0002)	2.615 (0.125)	0.0066 (0.0008)	3.1 (0.2)	0.0 (0.0)
7.8	2.8	100.0 (0.0)	32.8[j] (0.57)	100.0 (0.0)	0.0013 (0.0001)	5.127 (0.403)	0.0035 (0.0005)	2.331 (0.131)	0.0066 (0.0010)	2.6 (0.3)	0.0 (0.0)
12.5	2.8	100.0 (0.0)	0.0[k] (0.00)	– (–)	– (–)	– (–)	– (–)	– (–)	– (–)	– (–)	– (–)
<0.01 (negative control)	0.8	100.0 (0.0)	46.3 (0.47)	100.0 (0.0)	0.0016 (0.0001)	5.356 (0.299)	0.0035 (0.0002)	2.431 (0.112)	0.0072 (0.0009)	2.9 (0.2)	0.0 (0.0)
0.3	10.8	100.0 (0.0)	45.9 (0.46)	100.0 (0.0)	0.0012 (0.0001)	5.120 (0.285)	0.0034 (0.0001)	2.293 (0.124)	0.0073 (0.0005)	2.5 (0.2)	0.0 (0.0)
1.6	10.8	100.0 (0.0)	43.4 (0.66)	100.0 (0.0)	0.0014 (0.0001)	4.576 (0.221)	0.0032 (0.0002)	1.962 (0.071)	0.0061 (0.0006)	2.8 (0.3)	0.0 (0.0)
3.1	10.8	100.0 (0.0)	45.6 (0.63)	100.0 (0.0)	0.0015 (0.0001)	5.402 (0.078)	0.0041 (0.0002)	2.784 (0.080)	0.0082 (0.0004)	3.3 (0.2)	0.0 (0.0)
7.8	10.8	100.0 (0.0)	41.9[l] (0.63)	100.0 (0.0)	0.0015 (0.0001)	4.640 (0.287)	0.0038 (0.0002)	2.542 (0.065)	0.0078 (0.0005)	2.9 (0.1)	0.0 (0.0)
12.5	10.8	100.0 (0.0)	21.3[m] (0.67)	100.0 (0.0)	0.0014 (0.0001)	5.522 (0.288)	0.0038 (0.0003)	2.776 (0.120)	0.0091 (0.0007)	3.3 (0.1)	0.0 (0.0)

[a]Mean with standard error of the mean below. Mean of 4 replicates/treatment with 80 seeds/replicate (320 seeds/treatment).
[b]Nominal sulfide concentration.
[c]HS-1 contains 0.8 mg Fe/L. Statistical comparisons made without HS-1 with 0.8, 2.8, or 10.8 mg Fe/L controls depending on treatment set analyzed to hold the nominal Fe constant during analysis.
[d]100 mg/L boric acid (positive control).
[e]Significantly less than HS-1 with 0.8 mg Fe/L, t test, $p < 0.001$.
[f]Significantly less than HS-1 with 0.8 mg Fe/L, t test, $p = 0.005$.
[g]Significantly less than HS-1 with 0.8 mg Fe/L, t test, $p = 0.025$.
[h]Significantly greater than HS-1 with 0.8 mg Fe/L, t test, $p < 0.001$.
[i]Significantly less than HS-1 with 0.8 mg Fe/L, Kruskal–Wallis-analysis of variance, Dunn's test, $p < 0.05$.
[j]Significantly less than HS-1 with 2.8 mg Fe/L, Kruskal–Wallis-analysis of variance, Dunn's test, $p < 0.05$.
[k]Significantly less than HS-1 with 2.8 mg Fe/L, Kruskal–Wallis-analysis of variance, Dunn's test, $p < 0.05$.
[l]Significantly less than HS-1 with 10.8 mg Fe/L, Kruskal–Wallis-analysis of variance, Dunn's test, $p < 0.05$.
[m]Significantly less than HS-1 with 10.8 mg Fe/L, Kruskal–Wallis-analysis of variance, Dunn's test, $p < 0.05$.
HS-1 = Hoagland's solution.

seed activation, survival, and phytotoxicity endpoints. The sulfide chronic values for replicates exposed to 2.8 mg and 10.8 mg Fe/L ranged from 4.9 mg/L sulfide for emergence to >12.5 mg/L sulfide for seed activation, survival, and phytotoxicity endpoints, providing evidence of a trend toward decreased sulfide toxicity with increased Fe concentration. Historical studies of sulfide toxicity were reviewed by Lamers et al. [19]. Although no studies with wild rice were included, studies with *Oryza sativa* (Asian rice) in hydroponic culture showed reduced productivity at 5 mg/L sulfide [20] and 0.9 mg/L sulfide [21], and radial oxygen loss and reduced at nutrient uptake at 0.3 to 1.9 mg/L sulfide [22]. More recently, Pastor et al. [23] demonstrated sulfide toxicity to wild rice at 0.3 mg/L sulfide, which was markedly less than that found in the present study.

Table 5. Median emergence time endpoint in wild rice exposed to sulfide in the presence of iron on day 21[a]

	Median emergence time (d)						
Treatment iron (mg/L)	HS-1[b]	100 mg/L BA[c]	0.3 mg/L S^{2-}	1.6 mg/L S^{2-}	3.1 mg/L S^{2-}	7.8 mg/L S^{2-}	12.5 mg/L S^{2-}
0.8	10	>21[d]	11	12	15	>21[d]	>21[d]
2.8	12	–	12	12	12[e]	19[f]	>21[d]
10.8	10	–	10	12	12[e]	15[g]	>21[b]

[a]Based on time (in days) required to achieve 30% emergence.
[b]Negative control.
[c]Boric acid, positive control.
[d]Significantly greater than HS-1with 0.8 mg Fe/L, Mann–Whitney U test, $p < 0.001$.
[e]Significantly less than 3.1 mg/L sulfide with 0.8 mg Fe/L, Mann–Whitney U test, $p \leq 0.05$.
[f]Significantly greater than HS-1with 2.8 mg Fe/L, Mann–Whitney U test, $p = 0.005$.
[g]Significantly greater than HS-1with 10.8 mg Fe/L Mann–Whitney U test, $p = 0.001$.
BA = boric acid; HS-1 = Hoagland's solution.

Table 6. Summary of numerical endpoints determined on days 10 and 21[a]

	Day 10				Day 21			
Endpoint	NOEC[b] (mg/L S^{2-})	LOEC[c] (mg/L S^{2-})	ChV[d] (mg/L S^{2-})	IC25[e] (mg/L S^{2-})	NOEC (mg/L S^{2-})	LOEC (mg/L S^{2-})	ChV (mg/L S^{2-})	IC25 (mg/L S^{2-})
Sulfide + 0.8 mg Fe/L								
Activation	12.5	>12.5	>12.5	>12.5	12.5	>12.5	>12.5	>12.5
Emergence (%)[f]	3.1	7.8	4.9	3.5 (3.1–3.9)	1.6	3.1	2.2	3.9 (3.5–4.3)
Emergence (ET30)[f]	–	–	–	–	3.1	7.8	4.9	–
Survival	12.5	>12.5	>12.5	>7.8[g]	12.5	>12.5	>12.5	>7.8[g]
Shoot weight	–	–	–	–	7.8	12.5	9.8	>7.8[g]
Shoot length	–	–	–	–	7.8	12.5	9.8	>7.8[g]
Root weight	–	–	–	–	7.8	12.5	9.8	>7.8[g]
Root length	–	–	–	–	7.8	12.5	9.8	7.6 (7.1–8.1)
Leaf number	12.5	>12.5	>12.5	>7.8[g]	7.8	12.5	9.8	>7.8[g]
Leaf biomass	–	–	–	–	7.8	12.5	9.8	>7.8[g]
Phytotoxicity	12.5	>12.5	>12.5	>7.8[g]	12.5	>12.5	>12.5	>7.8[g]
Sulfide + 2.8 mg Fe/L								
Activation	12.5	>12.5	>12.5	>12.5	12.5	>12.5	>12.5	>12.5
Emergence (%)[f]	3.1	7.8	4.9	5.7 (5.3–6.1)	3.1	7.8	4.9	7.1 (6.5–7.7)
Emergence (ET30)[f]	–	–	–	–	3.1	7.8	4.9	–
Survival	12.5	>12.5	>12.5	>7.8[g]	12.5	>12.5	>12.5	>7.8[g]
Shoot weight	–	–	–	–	7.8	12.5	9.8	>7.8[g]
Shoot length	–	–	–	–	7.8	12.5	9.8	>7.8[g]
Root weight	–	–	–	–	7.8	12.5	9.8	>7.8[g]
Root length	–	–	–	–	7.8	12.5	9.8	>7.8[g]
Leaf number	12.5	>12.5	>12.5	>7.8[g]	7.8	12.5	9.8	>7.8[g]
Leaf biomass	–	–	–	–	7.8	12.5	9.8	>7.8[g]
Phytotoxicity	12.5	>12.5	>12.5	>7.8[g]	12.5	>12.5	>12.5	>7.8[g]
Sulfide + 10.8 mg Fe/L								
Activation	12.5	>12.5	>12.5	–	12.5	>12.5	>12.5	>12.5
Emergence (%)	3.1	7.8	4.9	8.5 (8.2–8.8)	3.1	7.8	4.9	9.3 (8.8–9.8)
Emergence (ET30)	–	–	–	–	3.1	7.8	4.9	–
Shoot weight	–	–	–	>12.5[g]	12.5	>12.5	>12.5	>12.5[g]
Shoot length	–	–	–	–	12.5	>12.5	>12.5	>12.5[g]
Root weight	–	–	–	–	12.5	>12.5	>12.5	>12.5[g]
Root length	–	–	–	–	12.5	>12.5	>12.5	>12.5[g]
Leaf number	12.5	>12.5	>12.5	>12.5[g]	12.5	>12.5	>12.5	>12.5[g]
Leaf biomass	–	–	–	–	12.5	>12.5	>12.5	>12.5[g]
Phytotoxicity	12.5	>12.5	>12.5	>12.5[g]	12.5	>12.5	>12.5	>12.5[g]

[a]Nominal concentrations.
[b]No-observed-effects concentration.
[c]Lowest-observed-effects concentration.
[d]Chronic value (geometric mean of NOEC and LOEC value). Represents the estimated threshold of toxicity.
[e]25% inhibitory concentration determined by linear interpolation with 95% confidence intervals in parentheses.
[f]No emergence recorded at 12.5 mg S^{2-}/L.
[g]Reported as greater than highest concentration in which mesocotyl emergence was observed. No emergence was noted in the 12.5 mg S^{2-}/L treatment with either 0.8 or 2.8 mg Fe/L.
NOEC = no-observed-effects concentration; LOEC = lowest-observed-effects concentration; ChV = chronic values; IC25 = 25% inhibitory concentration; ET30 = time to 30% emergence.

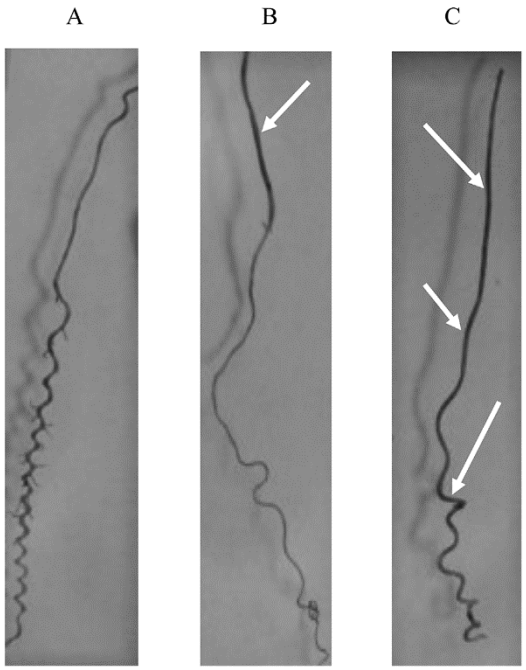

Figure 1. Representative seminal roots from (**A**) HS-1 control containing <0.01 mg/L sulfide and 0.8 mg/L Fe, (**B**) 7.8 mg/L sulfide with 2.8 mg/L Fe, and (**C**) 7.8 mg/L sulfide with 10.8 mg/L Fe. Note normal root fibers and absence of iron sulfide (FeS) plaque in seminal root from the control (**A**), increase in the formation of FeS plaque at the upper region (arrow) of the root in seminal root from the 7.8 mg/L sulfide with 2.8 mg/L Fe treatment (**B**), and more widespread FeS plaque (arrows) formed on the seminal root from the 7.8 mg/L sulfide with 10.8 mg/L Fe treatment (**C**).

However, the effects measured were on juvenile seedling growth and development using seedlings produced from seeds that were allowed to germinate and grow to 1 to 2 cm (over 5–7 d) in aerobic deionized water, whereas the present study initiated exposure in ungerminated seeds. Both studies utilized a modified Hoagland's solution [4,5], with the studies by Pastor et al. [23] containing one-fifth strength solution and 5 mM piperazine-N,N′-bis buffer and the present study using modified HS-1 solution [4] containing 25% ammonium (molar basis) in a mixture of ammonium and nitrate. The hydroponics design [24] used total hypoxia to maintain sulfide levels, but exposed the vegetative portion of the rice plants to levels of sulfide much greater than would be expected in nature. The design of the hydroponics system used in the present study allowed the seed, mesocotyl, and early primary leaf (shoot) to be exposed to the hypoxic media with sulfide, which was supported by peer review of studies supporting the re-evaluation of the State of Minnesota's surface water quality standard for sulfate [1,2]. More ecologically realistic test conditions were recommended by peer review [24], and thus the basis for the design was a scaled-down model of ponds in which wild rice grows naturally. The primary differences between the laboratory hydroponics study and rice growing naturally were the lack of sediment in the simplified, but highly controlled hydroponics and omission of the floating leaf phase. In the case of the hydroponics, allowing a floating leaf phase would have resulted in artificially greater exposure to sulfide because of the high levels of sulfide in the media, which are not generally present at the surface of pond water. Oxidation of free sulfide in the water column resulting from greater oxygen levels naturally reduces free sulfide levels exposed to the floating leaves of wild rice.

Based on measured sulfide concentrations, Fe substantially reduced free sulfide concentrations in the 10.8 mg Fe/L treatment relative to the 0.8 mg Fe/L treatment. The effect of 2.8 mg Fe/L on free sulfide concentrations fell between the 0.8 and 10.8 mg Fe/L treatments. These observations, combined with differences in wild rice responses to sulfide across different iron concentrations, demonstrate the ability of Fe to reduce sulfide toxicity to wild rice. Free sulfide loss between 24-h renewals ranged from 19.6 to 23.5% with 0.8 mg Fe/L, 32.4 to 55.6% with 2.8 mg Fe/L, and 87.6 to 95.4% with 10.8 mg Fe/L, based on time-weighted average measurements. The loss was presumably partly the result of degradation, but primarily complexation with iron. These results provide evidence that Fe reduces free sulfide concentrations, but not necessarily as a linear function of Fe concentration [25–27]. Sulfide levels in pond sediment are determined by sulfate levels, availability, temperature, oxidation-reduction potential, pH, total organic carbon, Fe^{2+} levels, and speciation [21,28]. In some cases, sediment Fe^{2+} concentration may be inadequate to detoxify the sulfide by deposition of iron sulfide (FeS), and only some sediment will exist as FeS, even with large amounts of Fe. Although less toxic than sulfide, FeS can adversely affect the root systems of aquatic plants. Sensitivity of grass species (including wild rice) to sulfide has been studied for many years. Since the late 1950s, sulfide phytotoxicity has been described historically by rotting roots, black (FeS plaque) root, leaf discoloration, and poor growth and yield [29–31] because of sulfide-induced nutritional deficiencies resulting from poor uptake and utilization of critical nutrients [20,22,29–33]. These deficiencies result in potential inhibition of various oxidases, compromising metabolic capacity, inducing oxidative stress, and reducing gas exchange [34–38] in the root systems. Detoxification of sulfide by rice requires radial oxygen loss from roots to the rhizosphere as described by Armstrong and Armstrong [29]. These investigators provided the first specific anatomical assessment of radial oxygen loss inhibition by sulfide, blockage of vascular systems, and inhibition of lateral root emergence in rice, which correspond to the toxicological impact on the rice plant. Armstrong and Armstrong [29] found that adventitious and fine lateral roots of rice exposed to sulfide had reduced radial oxygen loss to the rhizosphere atomically characterized as being thickened, resulting in inhibition of the apical cortical gas space system. More recent studies [39,40] have demonstrated mitochondria-based detoxification of sulfide primarily in the roots. Functional isoforms of O-acetylserine-(thiol)lyase C (OASTL), specifically OAS-C, detoxify sulfide primarily in the roots [41] by catalyzing the conversion of sulfide and O-acetylserine to cysteine.

In the present study, black plaque was found on the seminal roots exposed to >7.8 mg/L sulfide and 2.8 or 10.8 mg/L Fe. However, root blackening is often observed in plants growing in sulfide-laden sediment. In the present hydroponics study, limited root blackening was found, as expected, because sediment cofactors such as organic carbon and microbial flora are likely required to facilitate the process. Although it is plausible that OAS-C was responsible for detoxifying a portion of the sulfide to which the wild rice seedlings were exposed in the present study; based on the daily rate of sulfide decay (~30%), the seedlings were still exposed to a significantly high level of free sulfide during the study. Thus, enzymatic sulfide detoxification in the roots cannot explain the decreased toxicity of sulfide we observed even at

the lower Fe concentration on a physiological level. Sulfide toxicity to wild rice is also tissue dependent, with the mesocotyl and roots being less susceptible to free sulfide toxicity and the photosynthetic portion being more susceptible to sulfide. On a larger scale, to properly evaluate sulfide toxicity to wild rice, both free sulfide and complexed sulfide need to be considered, based on the appearance of black plaque on the roots of wild rice seedlings from the higher sulfide and Fe treatments and the reduction in free sulfide toxicity by Fe found in the present study.

CONCLUSIONS

The results of the present study indicate that exposure of developing wild rice (mesocotyl emergence) to sulfide-induced toxicity $\geq$3.1 mg/L sulfide in the presence of 0.8 mg Fe/L, and $\geq$7.8 mg/L sulfide in the presence of 2.8 or 10.8 mg Fe/L at study day 21. Mesocotyl emergence was the most sensitive endpoint, and growth endpoints were less sensitive. Increasing Fe concentrations reduced the toxic effects of sulfide to wild rice. Ultimately, determination of site-specific sulfate criteria considering factors that alter toxicity, including sediment Fe and organic carbon, are necessary to adequately address the potential impact of sulfate in surface waters. Additional study of the larger significance of the hydroponics study is warranted, taking into account an aquatic life cycle evaluation of sediment sulfide toxicity to wild rice using a sediment microcosm.

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Data availability—Data, associated metadata, and calculation tools are available from the corresponding author (djfort@fortlabs.com)

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