ANNUAL REPORT COMPREHENSIVE RESEARCH ON RICE January 1, 2019 - December 31, 2019

PROJECT TITLE: Biophysical Treatment of Rice Seeds for Enhancing Early Plant Growth

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PRINCIPAL CHICO STATE INVESTIGATORS:

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COOPERATORS: Lundberg Family Farms

LEVEL OF 2019 FUNDING: $13,215

OBJECTIVES AND EXPERIMENTS CONDUCTED, BY LOCATION, TO ACCOMPLISH OBJECTIVES:

In this first year, our objectives were to expand our research on the accelerated early plant growth of rice to include both field and greenhouse trials. To this end we conducted a number of experiments.

1. Enhanced germination rate: on campus at Chico State, our team tested the biophysical treatment on S-102 seeds. A series of seven tightly controlled experiments were conducted to quantify the accelerated germination rates from said treatment. Both control and treated seeds hit the water at the same time and were held at the same temperature during 24 hour treatment. Afterwards, each set was placed in petri dishes and monitored around the clock to identify germination.

2. Early plant-growth vigor: at Lundberg Family Farms, our team worked closely with research staff to plant, grow, and monitor rice plants both treated and untreated for the three varieties M-206, Akita, and S-102. Greenhouse trials consisted of planting seeds in plastic tubs with soil and water consistent with farming practices. The field trial consisted of eighteen 4'x 6' plots divided by three varieties and each having 3 controls and 3 treated plots. Periodic samples were taken and measured to compare rates of growth. Finally the field trial was harvested and processed to identify yield per acre. Currently, the most recent greenhouse trial is nearing harvest, and the data will be finalized and shared in the coming weeks.

SUMMARY OF 2019 RESEARCH, BY OBJECTIVE:

Regarding the germination rate study, Figure 1 below illustrates a consistent shift in germination time due to the biophysical treatment. Day1 marks 24 hours after being submerged in water and the end of treatment for those seeds being subjected to vibration. At such time, an initial check for germination sees zero percent germinated. However by Day2, we see a head-start of almost 10% by the treated seeds. This percent difference is consistent until reaching Day5. Most importantly, the standard deviation remained remarkably small for a seven trial average which provides a high degree of confidence in germination rate enhancement. Indeed this seems to be an indication of early accelerated growth.

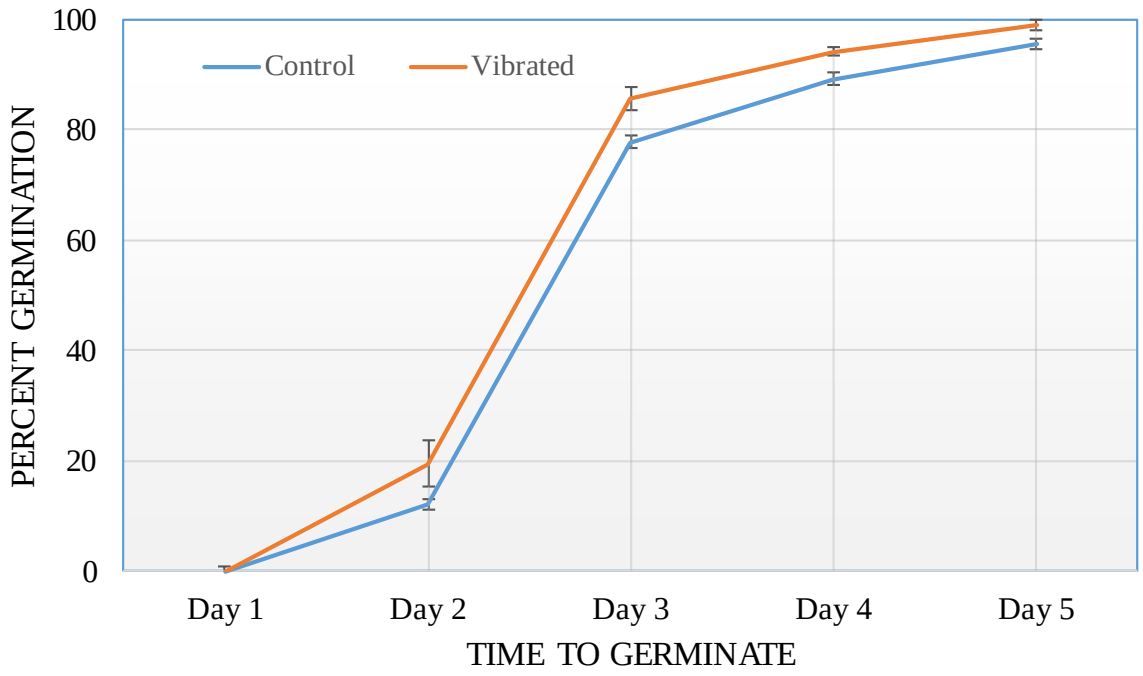

Figure 1. S-102 germination rates averaged over seven trials.

Crucial to this research however, is that the rice seedlings not only get a head-start with quicker germination rates, but also exhibit an improved early growth or seedling vigor. The greenhouse and field trials sought to access these characteristics by the measurement of length for both roots and shoots. The initial greenhouse and field trial were a parallel test. Accordingly, all eighteen plots in the field were sampled and compared to the matching set within the greenhouse. Five plants were randomly harvested from each of the 18 field plots and the respective greenhouse tub. Table 1 through Table 3 on the subsequent pages show the average length and standard deviation for roots and shoots.

In Table 1, the M-206 length measurements are given side-by-side for control (Ctrl) and treated plants (Vib). For the field measurements, the average root and shoot lengths were mostly larger for the control; however, the exact opposite was found for the greenhouse samples. Regarding Akita, the results are given in Table 2. These results were less consistent with the greater average length measurements switching back and forth between controls and treated for both greenhouse and field.

Table 1. First trial of M-206; (a) in field and (b) in greenhouse.

(a)

	1 Week (inches)		4 Weeks (inches)	
Field (M-206)	Ctrl	Vib	Ctrl	Vib
Root avg.	1.77	1.51	5.60	5.98
Root std.	0.34	0.37	0.87	1.39
Shoot avg.	2.97	2.69	13.25	12.94
Shoot std.	0.27	0.64	0.90	0.97

(b)

	1 Week (inches)		4 Weeks (inches)	
GH (M-206)	Ctrl	Vib	Ctrl	Vib
Root avg.	1.86	1.90	10.66	11.05
Root std.	0.66	1.18	1.76	1.14
Shoot avg.	1.64	2.20	15.43	16.88
Shoot std.	0.51	0.62	2.45	2.10

Table 2. First trial of Akita; (a) in field and (b) in greenhouse.

(a)

	1 Week (inches)		4 Weeks (inches)	
Field (Akita)	Ctrl	Vib	Ctrl	Vib
Root avg.	2.18	2.13	5.14	5.85
Root std.	0.36	0.50	1.78	0.96
Shoot avg.	3.66	3.24	11.68	12.55
Shoot std.	0.75	0.92	0.86	0.80

(b)

	1 Week (inches)		4 Weeks (inches)	
GH (Akita)	Ctrl	Vib	Ctrl	Vib
Root avg.	2.17	2.60	10.24	9.55
Root std.	0.77	0.92	2.20	2.23
Shoot avg.	1.94	1.99	14.12	13.96
Shoot std.	0.48	0.55	2.03	1.82

Table 3. First trial of S-102; (a) in field and (b) in greenhouse.

(a)

	1 Week (inches)		4 Weeks (inches)	
Field (S-102)	Ctrl	Vib	Ctrl	Vib
Root avg.	2.01	2.20	6.64	5.64
Root std.	0.53	0.67	0.97	1.10
Shoot avg.	3.37	3.70	14.04	13.70
Shoot std.	0.62	1.56	1.10	0.90

(b)

	1 Week (inches)		4 Weeks (inches)	
GH (S-102)	Ctrl	Vib	Ctrl	Vib
Root avg.	3.01	2.65	10.81	10.16
Root std.	0.75	1.16	2.49	1.77
Shoot avg.	2.99	3.07	15.77	16.69
Shoot std.	0.63	0.84	2.27	1.34

In Table 3, the S-102 results for the control and treated seeds were also less consistent. Week1 in the field has both the shoots and roots of the treated at greater lengths, but at week4 this is opposite. Regarding the greenhouse trial, the shoots of the treated seeds are consistently longer. However, the opposite was found for the roots of the treated.

Unfortunately, the number of seeds planted in this first greenhouse trial was not sufficient to keep pace and survive our destructive sampling. As a result, this initial greenhouse trial was not carried to harvest. On the other hand, the field plots did survive and were later harvested to give yield numbers. The results are given in Table 4 on the following page. The organization scheme is divided into the three main categories for the said varieties of seeds. Each variety had six plots with three being control and three being treated for a total of eighteen plots. Upon harvest a single height measurement was taken as a gage of tallest plant and is described in the third column. The next two columns are the dry paddy rice weight, Wt (lbs), and the dry moisture content, MC (%), respectively. Next, the yield numbers are given per acre and finally the classification of each plot is given as Ctrl or Vib. Interestingly, there was significant variability in both the control and treated plots for each of the three varieties. As such, there may be diminished confidence in this trial to assess the benefits of our biophysical treatment on rice seeds.

Much was learned in the way of experimental variables and quality control from this first greenhouse and field trial. Having this in mind, our team conducted additional greenhouse trials at Lundberg which are soon ready for harvest. The initial results from these were statistically significant, and the final data set including harvest will be made available to the RRB as soon as finalized.

Table 4. Harvest results for first field trial, M-206, Akita, and S-102.

Variety	Plot	Ht (in)	Wt (lbs)	MC (%)	Yield (lbs/acre)	Treatment
M-206	1	36	4.1	12.6	7,563	Vib
	2	33	4.4	14.2	7,967	Ctrl
	3	35	4.3	13.4	7,859	Ctrl
	4	33	3.3	13.2	6,045	Vib
	5	35	3.7	13.2	6,778	Vib
	6	33	3.7	13.2	6,778	Ctrl
Akita	7	29	1.4	12.7	2,579	Vib
	8	32	1.4	12.4	2,588	Ctrl
	9	29	1.4	12.3	2,591	Ctrl
	10	31	1.4	12.7	2,579	Vib
	11	33	1.9	12.1	3,525	Ctrl
	12	31	1.9	12.4	3,513	Vib
S-102	13	30	4.3	13.4	7,859	Vib
	14	31	3.6	12.9	6,618	Ctrl
	15	34	3.3	13.2	6,045	Ctrl
	16	32	3.7	13.2	6,778	Vib
	17	30	3.5	12.9	6,434	Vib
	18	30	4.1	12.8	7,545	Ctrl

PUBLICATIONS OR REPORTS: None

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

1. We documented, to a high degree of confidence, the germination rate increase as a result of our biophysical treatment. This has been a consistent observation since the beginning of our research, but now have achieved statistically significant results to support said response. Moreover, post germination observations have shown a substantially improved seedling vigor for the treated seeds over the control.

2. We conducted multiple greenhouse trials and our first field trial to observe any continued benefit after germination. Initial results were found to be inconsistent due to an apparent lack of experimental control and preparedness. Moving forward, subsequent greenhouse trials were better realized and the results from which suggest a remarkable growth advantage in treated seeds.