ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
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PROJECT TITLE: Evaluating the value of seaweed extracts as biostimulants in the California rice production system

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

In the past few years, several pest control advisers and rice growers have expressed interest in using seaweed-derived products to improve crop performance and increase yield. In California, registration of seaweed-derived products as biostimulants does not require performance data, therefore growers and pest control advisers rely on information developed by technical, sales and marketing representatives of the industry selling the products.

Trials conducted in California in the past two years and information available in published studies indicate that seaweed-derived products may be beneficial in rice production when growing conditions are less than optimal due to biotic or abiotic stress factors. The objective of this project was to evaluate commercially available seaweed-derived products marketed to rice production in the field under the presence of biotic and abiotic stress factors.

Materials and Methods

Products tested

Table 1 shows products selected for testing. These products were selected because of positive results observed during 2016 trials. All these products are commercially available and used in California commercial rice production. Label rates were used. The label recommended timing of application varied with product; however, all products recommended more than one application. Two applications were made by product, the first one between tillering and PI, and the second between booting and early heading.

All labels listed not only the seaweed species from which the product was derived, but also other nutrients present. Not all products were tested in all trials. The trial at the Rice Experiment Station in Biggs only included three products.

Table 1. Products used in trials

Product	Seaweed species	Rate/acre	Nutrient content
Acadian	*Ascophyllum nodosum*	64 fl oz	0.1-0-5
Kelpak	*Ecklonia maxima*	48 fl oz	0-0-1
SuperFifty	*Ascophyllum nodosum*	8 fl oz	0-0-8
Triggrr	Kelp and others	16 fl oz	0-0-1
Heaset	*Ascophyllum nodosum*	16 fl oz	6-0-0, Mg 5.42%

<u>Trials and parameters evaluated</u>

Three trials were conducted. Two of the sites, Davis and Yuba, were selected because of a history of low yields attributed to cooler temperatures during PI. The trial at Biggs included the application of the herbicide Shark on 28 June at 8 oz/a with the intent to produce injury on the rice and evaluate the effect of the seaweed products at ameliorating the injury.

Table 2. Trials conducted during 2017

Trial	Location	Variety	Planting date	First application	Second application	Disease sampling date	Harvest date
1	Davis	M-206	22 May	6 July	17 August	20 Sept	13 Oct
2	Yuba	M-206	23 May	23 June	11 Aug	15 Sept	17 Oct
3	Biggs	M-206	5 June	29 June	18 August	25 Sept	24 Oct

Treatments were applied with a CO_2 backpack sprayer. To assess stem rot and aggregate sheath spot incidence and severity, tiller samples were taken from each plot right before or after the field was drained for harvest. Samples consisted of a subsample of tillers cut below the water level randomly from the front, middle, and back of each plot. A subset of 10 tillers per sample and disease were used to rate stem rot and aggregate sheath spot incidence and severity using the scales presented in table 3. To calculate disease incidence and severity, the following formulas were used:

- % disease incidence = (number of tillers in categories 1-4) / total tillers*100
- Disease severity = [∑(number of tillers per category*category)] / total tillers

Kernel smut was observed at the Yuba trial. To evaluate kernel smut, the number of panicles with visible signs of kernel smut of a total of 10 panicles was used to calculate the percentage incidence of kernel smut. All trials were harvested using a small plot combine.

Table 3. Stem rot and aggregate sheath spot disease severity scale

Scale	Stem rot	Aggregate sheath spot
0	No disease	No disease
1	Disease lesions on outer leaf sheath	Disease affecting second leaf below flag leaf or lower
2	Disease lessions have penetrated into inner leaf sheaths	Disease affecting leaf below flag leaf
3	Disease lesions on culm	Disease affecting flag leaf
4	Culm is rotted though	Disease affecting panicle

The Yuba and Davis trials were conducted as a randomized complete block with 6 treatments and 4 replications. The Biggs trial was conducted as a split-plot, with two main plots (Shark treated or not), four sub-plots (Acadian, Kelpak, SuperFifty and untreated) and four replications. Analysis of variance was used to detect differences among treatment means for parameters evaluated. The Least Significant Difference (LSD) test or contrasts were used to compare means of treated plots to untreated plots. The level of α used for all analyses was 0.05.

Results and Discussion

Davis

Stem rot and aggregate sheath spot incidence and severity were very low in this trial. Stem rot disease parameters were not affected by the treatments. Contrasts showed that Kelpak, SuperFifty and Headset significantly reduced the incidence and severity of aggregate sheath spot when compared to levels in untreated plots. Grain moisture and yield were not significantly affected by the treatments.

Table 4. Disease incidence and severity for the Davis trial.

Treatment	Stem rot		Aggregate sheath spot	
	Incidence (%)	Severity	Incidence (%)	Severity
Acadian	25.00	5.00	5.00	0.08
Kelpak	17.50	0.00	0.00*	0.00*
SuperFifty	15.00	0.00	0.00*	0.00*
Triggrr	20.00	15.00	15.00	0.23
HeadSet	15.00	0.00	0.00*	0.00*
Untreated	22.50	12.50	12.50	0.20

*Significantly different from untreated

Table 5. Grain moisture content at harvest and yield for the Davis trial.

Treatment	Harvest moisture (%)	Yield (lb/a @ 14% MC)
Acadian	17.56	7,442
Kelpak	17.88	7,121
SuperFifty	17.69	7,290
Triggrr	17.82	7,057
HeadSet	17.90	7,107
Untreated	17.58	7,445

Yuba

In the Yuba trial, stem rot incidence was high and severity was moderate, while aggregate sheath spot incidence was moderate and severity was low. In this trial, kernel smut was observed during the disease evaluations. Stem rot was not affected by the treatments. Aggregate sheath spot incidence tended (contrast P=0.148) to be lower in plots treated with SuperFifty than in untreated plots. Aggregate sheath spot severity was significantly lower in plots treated with SuperFifty than in untreated plots. Kernel smut incidence was significantly reduced with Kelpak when compared to untreated plots. Acadian had a low kernel smut incidence value as well, however, it was not significantly (P=0.138) different than untreated plots. Grain moisture and yield were not significantly affected by the treatments.

Table 6. Disease incidence and severity for the Yuba trial.

	Stem rot		Kernel smut	Aggregate sheath spot	
Treatment	Incidence (%)	Severity	Incidence (%)	Incidence (%)	Severity
Acadian	92.50	2.30	12.50	35.00	0.55
Kelpak	67.50	1.38	7.50*	50.00	0.85
SuperFifty	72.50	1.65	20.00	22.50	0.38*
Triggrr	90.00	1.93	17.50	45.00	0.73
HeadSet	90.00	2.48	15.00	32.50	0.58
Untreated	80.00	1.73	26.67	36.67	0.77

*Significantly different from untreated

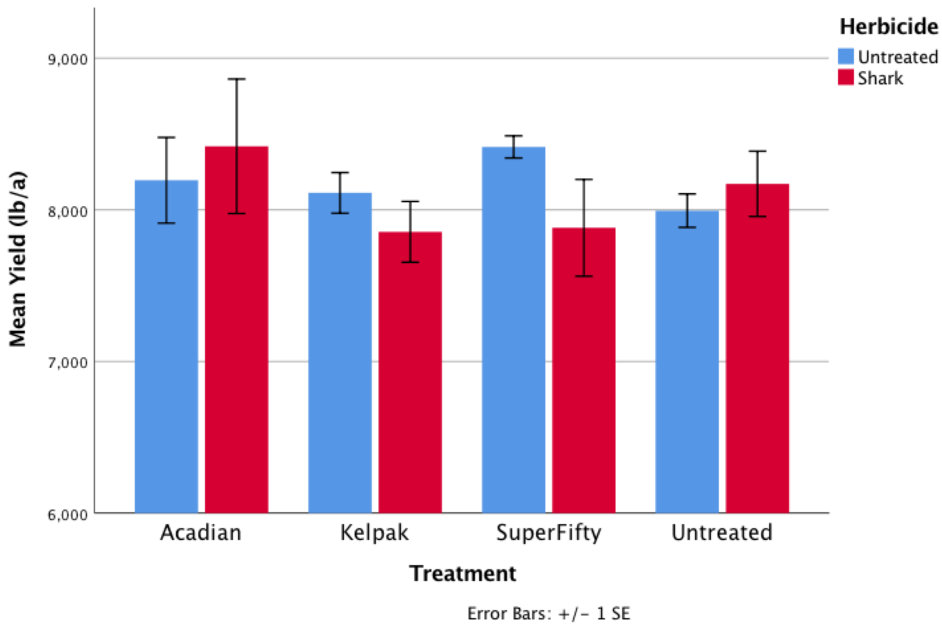
Table 7. Grain moisture content at harvest and yield for the Yuba trial.

Treatment	Harvest moisture (%)	Yield (lb/a @ 14% MC)
Acadian	12.17	7,975
Kelpak	11.92	8,084
SuperFifty	11.70	8,152
Triggrr	11.89	7,928
HeadSet	11.75	8,058
Untreated	11.85	7,777

Biggs

In the Biggs trial, the effect of the application of Shark on the plots did not produce the desired effect. The product was hard to spray; it did not dissolve in the spray bottle adequately. As a result, a lot of the product probably did not go into solution and stayed in the solid phase, or was distributed unevenly. Most likely, the amount of the herbicide actually sprayed was much less than the desired 8 oz/a.

Had the herbicide Shark injured the plots to the point of reducing yield, the yield on the seaweed-untreated plots treated with Shark would have been significantly lower than the yield of the seaweed-untreated plots not treated with Shark. This was not observed. However, on the plots treated with SuperFifty, when they were not treated with Shark, yields tended to be higher (P=0.124).



As mentioned before, the application of Shark had problems. It is possible that some plots received less than the desired rate and others receive more. The SuperFifty plots may have received the intended rate of Shark or more; this would explain the reduction in yield on these plots. Nevertheless, it is difficult to evaluate the effect of the seaweed product since the seaweed-untreated plots did not respond as expected to the Shark.

When averaging herbicide treated and untreated plots, none of the parameters evaluated were significantly affected by the seaweed treatments. However, yield from plots treated with Acadian tended to be higher than from untreated plots (contrast P=0.236). This difference was 300 lbs/a.

Table 8. Disease incidence and severity for the Biggs trial.

Treatment	Stem rot		Aggregate sheath spot	
	Incidence (%)	Severity	Incidence (%)	Severity
Acadian	91.67	2.50	36.67	0.38
Kelpak	92.50	2.55	38.57	0.41
SuperFifty	91.48	2.46	44.31	0.51
Untreated	91.23	2.48	40.57	0.50

Table 9. Grain moisture content at harvest and yield for the Biggs trial.

Treatment	Harvest moisture (%)	Yield (lb/a @ 14% MC)
Acadian	16.91	8,307
Kelpak	16.98	7,983
SuperFifty	17.38	8,148
Untreated	17.09	8,083

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS

Three field trials were conducted in 2017. Products that had resulted in yield gains and disease reduction in previous years were used. In 2017, aggregate sheath spot levels were significantly reduced in two of the trials with Kelpak, SuperFifty and Headset; kernel smut level was reduced in one trial by Kelpak and Acadian. However, it is important to notice that disease levels in the trials were low.

Past research has shown that aggregate sheath spot is affected by potassium levels. The seaweed-derived products tested contain potassium. Possibly, these small amounts of potassium may aid in reducing disease levels under the conditions of the trials.

Yields were not significantly increased by the treatments, but a weak trend to higher yields was observed in plots treated with Acadian in one trial. Unfortunately, the stress factors planned for the trials did not materialize. Temperatures in the two cool temperature locations chosen did not drop below the threshold for blanking due to a warmer than usual year. The application of Shark did not produce injury in herbicide treated plots. These problems may explain the lack of significant yield increases this year.

For the past four years, I have conducted trials with seaweed-derived products. In several trials, weak trends to increase yield with some of the products were observed. Significant yield increases were only found in one trial in 2017. Reductions in disease levels were significant, but testing has been done under low disease pressure. The products did not respond consistently across locations; there seems to be quite a bit of variability on their effect on rice. Overall, I believe seaweed derived products can benefit rice production. Growers and PCAs that want to include them in their program should test them in their locations over several years to find the ones that can offer the most benefit.