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Effect of Seaweed Bioformulations In Relieving Biotic and Abiotic Stress in Rice

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ABSTRACT

A Field experiment was conducted during *kharif* 2016-17 to study the effect of tropical red seaweed (*Kappaphycus alvarezii*) bioformulations (LBS 6 and LBD 1 in relieving the fungicidal stress and imparting the resistance to blast disease) in rice. Foliar application of LBS6 @ 1 ml/l was found to be statistically superior in improving growth and yield parameters *viz.,* plant height (74.05 cm), total number of tillers (23.80 average), number of panicles (23.50 average), straw (5.91 kg/plot) and grain weight (6.05 kg/plot) which was followed by carbendazim 50 %WP + LBS6. There was 49.50 per cent straw and 51.76 per cent grain yield increase over control in LBS 6 @ 1ml/ l treated plot. While LBD 1 @ 2 ml/l was found to be effective in suppressing the disease by 40.46 per cent which was on par with the standard check tricychlozole (35.68 %).

Keywords: Tropical seaweeds, Bioformulations, LBS6, LBD1, Tricyclazole and Carbendazim

RICE (*Oryza sativa*) is an important cereal crop known for high nutritional quality and staple food for large population of the world. In India rice is grown in 433.88 lakh ha with the production of 104.32 million tones and the productivity of 2404 kg/ha (Anon., 2016). Biotic and abiotic stresses are the primary constraints in rice production worldwide. Among biotic stresses, rice blast caused by *Magnaporthe oryzae* is a serious threat with yield losses up to 60-100 per cent (Yashaswini *et al.,* 2017). Blast disease is managed through either resistant varieties or by the application of fungicides. Consequences of heavy usage of pesticides specifically fungicides leads to fungicidal stress. Hence, modern agriculture aims to reduce the pesticide inputs and the antagonistic effect of fungicides without reducing the yield and quality. One of the strategies to reduce the pesticidal usage is through application of organic molecules like seaweeds.

Tropical red seaweeds are macro algae, able to activate plant metabolism and improves plant performance in a short period of time and in a cheaper way. These are the biostimulants which can be applied as foliar spray for enhancing the plant growth, tolerance to abiotic stress, photosynthetic activity and also provide resistance to many diseases as they serve as a source of large number of compounds such as laminarin, fucans, ulvans and carrageenans, which all act as elicitor molecules against pathogens (Shukla *et al.,* 2016) thereby improving the yield and productivity in many crops (Sharma *et al.,* 2014). Many of these extracts are also able to counteract the effect of biotic and abiotic stresses, enhancing quality and crop yield by stimulating plant physiological processes (Ziosi *et al*., 2013).

Therefore, the current investigation was carried out to know the role of tropical red seaweed (*Kappaphycus alvarezii*) bioformulations (LBD1 as defence activator and LBS6 growth stimulant) in relieving the fungicidal stress and imparting the blast disease resistance in rice.

MATERIAL AND METHODS

Experimental design

In order to determine the possible effect of seaweed bioformulations in relieving the fungicidal stress, field experiment was conducted during the *kharif* 2016-17 at ZARS, V.C. Farm, Mandya. Rice variety IR-64 was used in the experiment which is susceptible to blast disease. The net plot size of 5 m^2 was maintained for each replication with 20 cm distance between rows and 15 cm between plants. Total of 13 treatments were selected and laid out as per Random Complete Block Design (RCBD).

Stress induction

Fungicidal stress was induced by spraying of selected fungicides at the interval of 15 days to rice in field condition. First spray was taken at 15 days after transplanting. Total four sprays were taken up in the study. Treatment details and dosages are furnished below. Observations *viz.,* disease severity, growth and yield parameters were taken in to consideration.

Disease severity

After the second spray, plots were inspected periodically until harvest to determine the severity of blast disease. Five random plants per plot were selected to assess the severity of the disease. Assessment of blast was carried out by 0-9 scale (*Standard Evaluation System*, 1996).

Growth and yield parameters

In each trial plot an area of 1 m^2 was randomly selected. Meter square and whole plots were harvested individually and the grain as well as straw yields were determined using electronic balance. Sub-samples of randomly selected five plants were taken from every plot to determine the plant height, total number of tillers, productive tillers, number of panicles, panicle length and weight. Analysis and interpretation of the experimental data was performed as per RCBD.

Experimental details

T_1:Tricyclazole 75 %WP @ 0.6g/l

T_2: Carbendazim 50 %WP @ 1.0 g/l

T_3: LBS6 @ 1.0 ml/l

T_4: LBD1 @ 2.0 ml/l

T_5: Tricyclazole 75 %WP + LBS6 @ 0.6g+1.0ml/l

T_6: Tricyclazole 75 %WP + LBS6 @ 0.4g+1.0 ml/l

T_7: Tricyclazole 75 %WP + LBD1 @ 0.4g+1 ml/l

T_8: Tricyclazole 75 %WP + LBD1 @ 0.4 g+2 ml/l

T_9: Carbendazim 50 %WP + LBS6 @ 1.0g+1ml/l

T_{10}:Carbendazim 50 %WP + LBS6 @ 0.6g+1.0 ml/l

T_{11}:Carbendazim 50 %WP + LBD1 @ 0.6 g+1 ml/l

T_{12}: Carbendazim 50 %WP + LBD1 @ 0.6 g+2 ml/l

T_{13}: Untreated check (water spray)

RESULTS AND DISCUSSION

Effect of seaweed bioformulations on blast disease

Seaweed bioformulations were shown to be very effective against many plant diseases by activating the defence related genes and provided resistance against many pathogens. The results revealed that, there was significant difference between the treatments as compared to control. Higher disease severity of 77.97 per cent was recorded in untreated plots (Table 1). Disease severity was found to be less in tricyclazole 75 %WP treated plot (35.68 %) followed by LBD1 treated plot (40.46 %). It was observed that LBD1 was on par with the fungicide in controlling the disease. Severity of the disease was higher in plots treated with carbendazim 50 %WP @ 1 g/l (62.069 %). Whereas, T_{12} (carbendazim 50 %WP @ 0.6g/l

TABLE 1

Effect of seaweed bioformulations on the severity of the rice neck blast disease

Treatments	Per cent disease	Per cent decrease over control
T_1	35.68 (36.64) *	54.24
T_2	62.06 (51.99)	20.39
T_3	50.91 (45.50)	34.70
T_4	40.46 (39.48)	48.10
T_5	57.11 (49.07)	26.74
T_6	52.12 (46.19)	33.15
T_7	46.53 (42.99)	40.32
T_8	43.14 (41.04)	44.67
T_9	60.95 (51.31)	21.82
T_{10}	62.92 (52.60)	19.29
T_{11}	57.90 (49.56)	25.73
T_{12}	47.96 (43.81)	38.48
T_{13}	77.97 (62.06)	
SEm±	2.203	
C.D at 5%	6.406	
CV %	5.820	

*Figures in parenthesis are arcsine transformed values and LBD1 @ 2ml/ l) showed lower disease severity (47.96 %) compared to fungicide alone. While the seaweed bioformulation LBS6 recorded disease severity of 50.91 per cent which was found to be superior compared to untreated plot (34.70 %). However, there was no significant difference in disease severity between combination of LBS6 with both fungicides. Tricyclazole 75 %WP recorded 54.24 per cent disease decrease over control which was followed by LBD1 with per cent disease decrease of 48.10 per cent over control.

Disease severity was found to be significantly less in seaweed bioformulation LBD1@ 2ml/l treated plot which was on par with the fungicide tricychlazole. When carbendazim was combined with LBD-1, disease severity was found to be less, which directly implies that LBD-1 had increased the efficacy of the fungicide in reducing the disease. Oligosaccharides and carrageenans present in the seaweed bioformulations induced plant defence responses by modulating the activity of different defence pathways, including salicylate, jasmonate and ethylene signalling pathways. The results are in agreement with findings of Ali *et al.* (2016) who reported that the foliar application with 0.5 per cent seaweed extract reduced diseases caused by *Alternaria solani* and *Xanthomonas campestris* pv. *vesicatoria* by up to 63.00 per cent and 44.00 per cent respectively in tomato. Presence of iota (i), lambda (λ) and kappa (κ) carrageenan in seaweeds decreased the replication and symptom expression of Tomato Chlorotic Dwarf Viroid (TCDVd) in tomato. There was up regulation of defense related genes *viz.,* allene oxide synthase (AOS), lipoxygenase (LOX) and PR1, suggesting that λ-carrageenan induced defense against TCDVd in tomato (Sangha *et al.,* 2015).

Effect of seaweed bioformulations on growth parameters

The results of growth parameters *viz.,* plant height, total and productive tillers suggested that, there was significant difference between the treatments compared to control (Table 2).

TABLE 2

Effect of seaweed bioformulations on growth parameters

Treatments	Plant height(cm)	Total no. of tillers	No. of productive tillers
T_1	72.10	19.50	15.70
T_2	72.85	20.80	18.00
T_3	74.05	23.80	21.40
T_4	72.15	20.20	18.80
T_5	72.00	19.40	18.20
T_6	72.40	19.90	16.80
T_7	71.90	20.30	18.00
T_8	71.85	20.50	17.80
T_9	72.85	22.40	19.70
T_{10}	73.10	22.00	19.30
T_{11}	71.40	19.30	16.00
T_{12}	71.80	18.30	16.70
T_{13}	69.10	16.00	14.40
SEm±	1.04	1.25	0.96
C.D at 5%	3.03	3.64	2.80
CV%	2.04	8.79	7.67

Highest plant height was recorded in LBS6 treated plants (74.05 cm) followed by carbendazim 50 %WP + LBS6 @ 0.6 g + 1 ml/l (73.10 cm). However, there was no significant difference between sole application of both tricyclazole 75 % WP and carbendazim 50 % WP. Reduced plant height of 69.10 cm was recorded in untreated plots.

LBS6 treated plants showed higher number of tillers as well as higher productive tillers (23.80 and 21.40 respectively). On an average 22.40 and 19.70 number of total tillers and productive tillers respectively were recorded in T_9 (carbendazim 50 %WP @ 1 g/l + LBS6 @ 1 ml/l) where as carbendazim 50 %WP alone recorded 20.80 total tillers and 18.00 productive tillers respectively. Untreated check recorded lower number of total tillers (16.00) and with average of productive tillers 14.40 (Fig. 1). In present experiment, the results of growth parameters *viz.,* plant height, total and

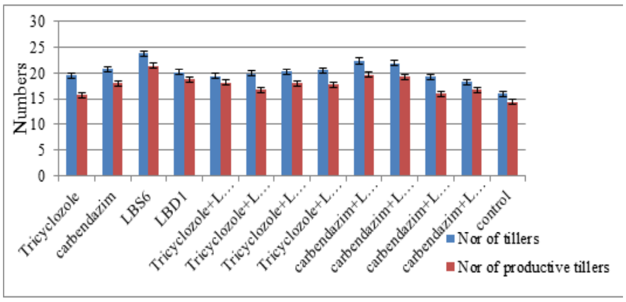

Fig.1 : Effect of seaweed bioformulations on tillers

productive tillers suggested that, there was significant difference between the treatments compared to control. Foliar spray of seaweeds might have increased the sugar biosynthesis and was also associated with an increase in chlorophyll content, net photosynthesis and quantum efficiency of photosystem II leading to the more growth which is directly proportional to the plant biomass.

The results are in confirmation with the work of Petrozza *et al.,* 2013 who demonstrated that seaweed treated on drought-stressed tomato cv. Ikram increased plant biomass and enhanced root development and also reported that the seaweed bioformulations were able to normalize plant growth under abiotic stresses.

Effect of seaweed bioformulations on yield parameters

The yield parameter results of randomly selected five plants revealed that LBS6 and the combination of carbendazim 50 %WP + LBS6 were effective. Number of panicles recorded higher in T_{10} (average of 23.90/ plant). LBS 6 treated plants showed average of 23.50 panicles/plants (Table 3 and Fig. 2). Among all the treatments lowest number of panicles were recorded in untreated check (15.60/plants).

Highest length of panicles was observed in plants treated with LBS6 @ 1 ml/l (15.17 cm) followed by T_6 (tricyclazole 75 %WP @ 0.4 g/l + LBS6 @ 1 ml/l).

Whereas, weight of the panicles was higher in LBS 6 @ 1ml/l treated plants with 30.50 g which was followed by T_7 (carbendazim 50 %WP + LBS6). Untreated check recorded reduced panicle length as well as weight (14.13 cm and 21.70 g respectively).

TABLE 3

Effect of seaweed bioformulations on panicles

Treatments	No. of panicles	Panicle length (cm)	Panicle weight (g)
T_1	16.20	14.68	23.50
T_2	19.80	14.88	26.20
T_3	23.50	15.17	30.50
T_4	21.70	14.73	27.80
T_5	22.90	14.87	28.00
T_6	22.40	14.89	28.60
T_7	20.70	14.30	27.60
T_8	19.50	14.17	26.80
T_9	22.60	14.73	29.50
T_{10}	23.90	14.68	28.50
T_{11}	21.30	14.19	24.50
T_{12}	20.90	14.43	23.80
T_{13}	15.60	14.13	21.70
SEm±	1.00	0.20	0.99
C.D at 5%	2.91	0.58	2.89
CV %	6.76	1.92	4.90

Significant differences with respect to the grain and straw yield was observed in treated plants when compared to untreated control. Highest straw weight of 22.90 g was recorded in T_{10} (carbendazim 50 %WP @ 0.6 g/l + LBS6 @ 1 ml/l) whereas grain weight was higher in LBS 6 @ 1ml/l treated plants (27.71 g). Tricyclazole 75 %WP alone recorded 18.50 g and 21.66 g straw and grain weight respectively (Table 4). Whereas combination of fungicide and seaweed bioformulations *i.e.,* T_5 (tricyclazole 75 %WP @ 0.6

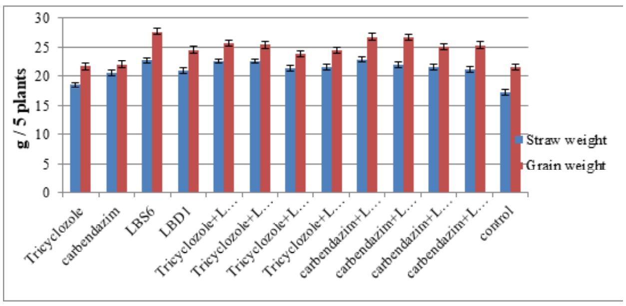

Fig.2 : Effect of seaweed bioformulations on yield parameters

TABLE 4

Effect of seaweed bioformulations on yield parameters

Treatments	Average of 5 plants in grams		Meter square area(kg)		whole plot (kg)		% increase over control	
	Straw weight	Grain weight	Straw weight	Grain weight	Straw weight	Grain weight	Straw weight	Grain weight
T_1	18.50	21.66	1.80	1.81	5.14	5.32	30.131	33.479
T_2	20.60	22.02	1.74	1.76	5.31	5.34	34.330	33.952
T_3	22.70	27.71	1.98	2.06	5.91	6.05	49.504	51.760
T_4	20.90	24.54	1.64	1.65	5.13	5.23	29.863	31.320
T_5	22.60	25.65	1.92	1.93	5.83	5.86	47.537	47.019
T_6	22.60	25.39	1.86	1.88	5.70	5.75	44.314	44.242
T_7	21.30	23.88	1.58	1.68	5.15	5.46	30.341	37.095
T_8	21.50	24.44	1.66	1.68	5.23	5.39	32.368	35.204
T_9	22.60	26.72	1.91	1.95	5.83	5.89	47.386	47.924
T_{10}	22.90	26.64	1.90	1.98	5.87	5.91	48.571	48.348
T_{11}	21.50	25.03	1.67	1.59	5.34	5.28	35.224	32.460
T_{12}	21.10	25.33	1.59	1.60	5.22	5.25	32.181	31.878
T_{13}	17.20	21.54	1.12	1.13	3.95	3.98		
SEm±	1.08	1.04	0.07	0.08	0.17	0.17		
C.D at 5%	3.14	3.04	0.21	0.23	0.49	0.49		
CV%	4.09	5.43	6.11	6.50	6.69	6.61		

g/l + LBS6 @ 1 ml/l), T_6 (tricyclazole 75 %WP @ 0.4 g/l + LBS6 @ 1 ml/l), T_7 (tricyclazole 75 %WP @ 0.4 g/l + LBD1 @ 1 ml/l) and T_8 (tricyclazole 75 %WP @ 0.4 g/l + LBD1 @ 2 ml/l) recorded higher straw and grain weight compared to fungicide alone (Table 4).

Data in the m^2 area of each plot revealed that the highest straw weight of 1.98 kg was recorded in LBS 6 @ 1ml/l treated plots (Table 4) followed by tricyclazole 75 %WP @ 0.6 g/l + LBS6 @ 1ml/l (1.92 kg) and carbendazim 50 %WP @ 1 g/l + LBS6 @ 1ml/l (1.91kg). However, there was no significant difference between these two treatments. Highest grain weight of 2.06 kg was recorded in T_3 (LBS 6 @ 1ml/l) treated m^2 plots followed by carbendazim 50 %WP 0.6 g/l + LBS6 1 ml/l (1.98 kg). Both straw and grain weight was significantly lower in untreated check.

In whole plot, highest straw and grain weight of 5.91 kg/5 m^2 plot and 6.05 kg/5 m^2 plot respectively was observed in LBS 6 followed by carbendazim 50 %WP @ 0.6 g/l + LBS 6 @ 1 ml/l (5.87 kg/plot and 5.91 kg/plot respectively). However there was no significant difference between these two treatments. Straw weight of T_{10} was higher than T_3 when average of 5 plants was considered.

Tricyclazole 75 %WP recorded yield of 5.14 kg straw and 5.32 kg grain (Table 4). When the same fungicide was combined with seaweed bioformulations (tricyclazole 75 %WP @ 0.6 g/l + LBS6 @ 1 ml/l, tricyclazole 75 %WP @ 0.4 g/l+ LBS6 @ 1 ml/l, tricyclazole 75 %WP @ 0.4 g/l + LBD1 @ 1 ml/l and tricyclazole 75 %WP @ 0.4 g/l + LBD1 @ 2 ml/l) it recorded higher straw and grain yield compared to sole application of fungicide. Carbendazim 50 %WP @ 1 g/l treated plots recorded 5.31 kg and 5.34 kg straw and the grain yield respectively, wherein combination of LBS 6 with carbendazim 50 %WP increased yield by 13 per cent. LBD 1 treated plot recorded straw and the grain yield of 5.13 kg/plot and 5.23 kg/plot, respectively. An increase in 49.50 per cent straw and 51.76 per cent grain yield over control was observed in LBS 6 @ 1ml/l treated plot, which was followed by carbendazim 50 %WP @ 0.6 g/l + LBS 6 @ 1ml/l with per cent yield increase of 48.34 over control.

Increased yields are also attributed to stimulation of mineral nutrient uptake with increased accumulation of macro and micro nutrients. Seaweeds contain cytokinins and auxins or other hormone-like substances which helps in enhancement of plant growth, tolerance to abiotic stress, increased photosynthetic activity and finally improving the yield and productivity of many crops (Sunarpi *et al*., 2010). Similar results were obtained by Kavitha *et al.,* 2008 who reported that spraying of seaweed extract @ 0.3 per cent on rice twice at 50 per cent flowering and at milk stages recorded significantly higher growth and yield attributes and was followed by spraying of seaweed extract @ 0.3 per cent at milk stage. Spraying of seaweed extract @ 0.3 per cent at fifty per cent flowering and milk stages recorded 26 per cent higher grain yield (6055 kg ha^{-1}) when compared to control (4432 kg ha^{-1}). The results are also agreement with work of Sunarpi *et al.,* 2010 who recorded rice plants treated with seaweed extract had higher number of panicles with an average number of panicles of 26.33, while the control plants has only 18 units. Seaweed extract-treated plants were capable to produce more grain (seed) per penicle. Control plants were capable of producing 160.11 grain per penicle, while the plants which were given *Hydroclthrus* spp. seaweed extract produced 171.11 grains per penicle.

The results showed that seaweed bioformulations improves the efficiency when used in combination with fungicides. Based on field data it is concluded that LBS6 @ 1ml/l was found to be effective which was followed by carbendazim 50 %WP @ 0.6 g/l + LBS 6 @ 1ml/l. Disease severity was found to be less in LBD1 treated plot which was on par with the standard check fungicide tricychlazole.

Present study of foliar application of seaweed bioformulations showed that the application of seaweeds which are rich in oligosaccharides had a biostimulation effect on plant height, number of tillers and productive tillers. Seaweed oligosaccharides stimulate plant height by enhancing carbon and nitrogen assimilation, basal metabolism and cell division. Oligosaccharides and carrageenans present in the seaweed bioformulations induced plant defence responses which led to the reduction in the blast disease severity. All the parameters in the study directly reflected on the yield. Increased plant height, enhanced number of tillers, more number of panicles and reduced disease severity increased the straw and grain weight ultimately leading to more yield. Hence the combination of both seaweed bioformulation and fungicides showed synergistic effect and these bioformulations can be effectively utilised as anti-stress agents to reduce the fungicidal stress and improves the straw and grain yield.

References

ALI, N., ANTONIO, R., ADESH, R. AND JAYARAMAN, J., 2016, Ascophyllum extract application causes reduction of disease levels in field tomatoes grown in a tropical environment. *Crop Protect.*, **83** : 67 - 75

ANONYMOUS, 2016, Annual report (2016-17), Department of agriculture, cooperation and farmers welfare, New Delhi, p. 3

KAVITHA, M. P., GANESARAJA, V. AND PAULPANDI, V. K., 2008, Effect of foliar spraying of sea weed extract on growth and yield of rice (*Oryza sativa* L.). *Agric. Sci. Digest,* **28** : 127 - 129.

PETROZZA, A., SUMMERER, S., DI TOMMASO, G., DI TOMMASO, D. AND PIAGGESI, A., 2013, An evaluation of tomato plant root development and morpho-physiological response treated with VIVA by image analysis. *Acta Hortic.,* **1009** : 155 - 159.

SANGHA, J. S., SAVEETHA, K., WAJAHATULLAH, K., NAVRATAN, S. B., RUDRA, P. S., ALAN, T. C. AND BALAKRISHNAN, P., 2015, λ-Carrageenan suppresses tomato chlorotic dwarf viroid (TCDVd) replication and symptom expression in tomatoes. *Mar. Drugs*, **13** : 2875 - 2889.

SHARMA, H. S., FLEMING, C., SELBY, C., RAO, J. R. AND MARTIN, T., 2014, Plant biostimulants: a review on the processing of macroalgae and use of extracts for crop management to reduce abiotic and biotic stresses. *J. Appl. Phycol.,* **26** : 465 - 490.

SHUKLA, P. S., TUDOR, B., ALAN, T. C. AND BALAKRISHNAN, P., 2016, Carrageenans from red seaweeds as promoters of growth and elicitors of defense response in plants. *Front. Mar. Sci.,* **3** : 81.

SUNARPI, AHMAD, J., RINA, K., NUR, I. J. AND ALUH, N., 2010, Effect of seaweed bioformulations on growth and yield of rice plants. *Bio. Sci.,* **2** : 73 - 77.

YASHASWINI, C. H., NARAYAN, R. P., PUSHPAVATI, B., SRINIVASA, R. AND SESHU, M. M., 2017, Prevalence of rice blast (*Magnaporthe oryzae*) incidence in south India. *Bull. Env. Pharmacol. Life Sci.,* **6** : 370 - 373

ZIOSI, V., ZANDOLI, R. AND DI NARDO, A., 2013, Biological activity of different botanical extracts as evaluated by means of an array of *in vitro* and *in vivo* bioassays. *Acta. Hortic.,* **1009** : 61 - 66.

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