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Effect of sea weed extract as liquid biostimulant on the productivity and profitability of transplanted rice (*Oryza sativa*)

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Abstract
A field experiment was carried out during *rabi*, 2016-17 at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry Union territory to elucidate the performance of sea weed extract as liquid biostimulant on the productivity and profitability of transplanted rice. The experiment was laid out in a randomized complete block design with five treatments and four replications. The treatments tested were T_1: RDF (150:50:50 kg NPK ha^{-1}), T_2: T_1 + LBS6 @ 1 ml l^{-1}, T_3: T_1 + LBS6 @ 0.75 ml l^{-1}, T_4: Location specific (RDF + Foliar spray of 1% Urea + 2% DAP + 1% MOP at panicle initiation stage and 10 days later) and T_5: Absolute control. The results of the experiment revealed that all the nutrient management practices significantly improved the rice productivity over absolute control. Among the nutrient management practices, application of recommended fertilizer dose (150:50:50 kg NPK ha^{-1}) and foliar spray of LBS6 @ 1 ml l^{-1} thrice at the time of pulling out of seedling in the nursery and 30 and 60 days after transplanting in the main field resulted in higher yield attributes, yield, harvest index and economic returns.

Keywords: Liquid bio stimulant, sea weed extract, transplanted rice

Introduction
The indiscriminate use of fertilizers had resulted in the gradual decrease in the productivity and sustainability of the agricultural system. Hence, balanced application of fertilizer or nutrient management is the pre requisite for the sustainable crop production (Arun *et al*., 2019) [1]. Marine bioactive substances extracted from marine algae are used as biostimulants in agricultural and horticultural crops, and many beneficial effects, in the terms of enhancement of yield and quality of crops and effectiveness of conventional mineral fertilizers (Rathore *et al*., 2009) [2]. The liquid biostimulant contains a wide variety of plant growth promoting elicitors such as auxins, cytokinins and betaines, amino acids, micro and macro nutrients and carbohydrates (Begum *et al*., 2018) [3] which influences shoot and root system development, plant vigour and enhanced photosynthetic activity (IIRR, 2018) [4]. Liquid extracts obtained from seaweeds have recently gained importance as foliar sprays for many crops including various grasses, cereals, flowers and vegetable species. Rice is the staple food of our country and critically important for food security. Keeping these facts in view, the present investigation was undertaken to find out the appropriate dose of liquid biostimulant formulation (LBS6) for enhancing the productivity and profitability of transplanted rice.

Materials and Methods
A field experiment was carried out during *Rabi*, 2016-17 at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry Union territory. The soil of the experimental site was sandy clay loam in texture, low in available nitrogen (186.0 kg ha^{-1}), and medium in available phosphorus (15.8 kg ha^{-1}) and potassium (213.0 kg ha^{-1}). The experiment was laid out in a randomized complete block design with five treatments and four replications. The treatments tested were T_1: RDF (150: 50:50 kg ha^{-1} NPK), T_2: T_1+ LBS6 @ 1 ml l^{-1}, T_3: T_1 + LBS6 @ 0.75 ml l^{-1}, T_4: Location specific (RDF + Foliar spray of 1% Urea + 2% DAP + 1% MOP at panicle initiation stage and 10 days later) and T_5: Absolute control (without NPK).
All the plots were surrounded by buffer channels to prevent seepage between plots. The medium duration rice variety ADT 46 (135 days) was transplanted at the spacing of 20 cm x 15 cm. The crop was raised under puddled lowland condition with recommended package of practices except nutrient management. 150: 50: 50 kg NPK ha^{-1} was adopted as the

recommended dose of fertilizer (RDF). Nitrogen and potassium were applied in four splits *viz*., 25 percent each at basal, active tillering, panicle initiation and flowering. The entire dose of phosphorus was applied as basal before transplanting. As per the treatment schedule, LBS6 was foliar applied thrice with the spray volume of 500 lit ha^{-1} using knapsack sprayer, fitted with flat-fan nozzle. LBS6 was applied first in nursery at the time of pulling out of seedling and two more foliar sprays in the main field at 30 and 60 days after transplanting.

The yield attributes were recorded at the time of harvest as per the procedure suggested by Yoshida *et al.* (1976) [5]. The crop was harvested when most of the plants turned yellow and attained physiological maturity. The plants from the net plot area were harvested, threshed and winnowed. Grain and straw from each net plot were sun dried, weighed and expressed in t ha^{-1}. The grain yield was adjusted to 14 percent moisture content. Data on yield attributes, yield and harvest index were subjected to statistical scrutiny as suggested by Gomez and Gomez (2010) [6]. The economics were worked out by taking into account the prevailing market prices of inputs and the produce at the time of experimentation.

Results and Discussion

Effect of liquid bio stimulant on yield attributes

The nutrient management practices significantly influenced the yield attributes *viz*., number of panicles m^{-2}, number of grains per panicle and panicle weight of rice, whilst no significant difference was observed in test weight due to nutrient management practices. The treatments receiving nutrients were significantly superior to absolute control. Application of recommended fertilizer dose (150:50:50 kg NPK ha^{-1}) and foliar spray of LBS6 @ 1 ml l^{-1} thrice at the time of pulling out of seedling in the nursery and 30 and 60 days after transplanting in the main field was found to be superior by registering higher yield attributes *viz*., number of panicles m^{-2}, grains per panicle and panicle weight, which was comparable with all other nutrient management practices receiving nutrients. Similar results were obtained by Gomathi *et al*. (2017) [7] and Sahana *et al*. (2018) [8].

Table 1: Effect of liquid bio stimulant on the yield attributes of rice

Treatments	Panicles m^{-2}	Grains $panicle^{-1}$	Panicle weight (g)	Test weight (g)
T_1: RDF	526	104	3.37	25.12
T_2: T_1+ LBS6 @ 1 ml l^{-1}	568	126	3.46	25.35
T_3: T_1+ LBS6 @ 0.75 ml l^{-1}	553	117	3.34	25.12
T_4: Location specific	544	118	3.54	25.82
T_5: Absolute control	427	89	2.77	25.68
SEd	39	10	0.12	0.78
CD (5%)	86	21	0.26	NS

Effect of liquid bio stimulant on yield and harvest index

The nutrient management practices significantly influenced the yield and harvest index. Application of recommended dose of fertilizer and foliar spray of LBS @ 1 ml l^{-1} registered higher grain yield (5.70 t ha^{-1}) which was comparable with all the treatments receiving nutrients except application of recommended dose of fertilizer alone. Straw yield (7.33 t ha^{-1}) and harvest index (43.8%) was found to be maximum with application of recommended dose of fertilizer and foliar spray of LBS @ 1 ml l^{-1} and all treatments receiving nutrients are comparable with each other. The superiority of nutrient applied treatments to absolute control could be attributed to better availability of nutrients at the time of crop requirement and improved yield attributes. This result is in corroboration with Kavitha *et al*. (2008) [9].

Table 2: Effect of liquid bio stimulant on the yield and harvest index of rice

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
T_1: RDF	4.95	7.15	40.9
T_2: T_1+ LBS6 @ 1 ml l^{-1}	5.70	7.33	43.8
T_3: T_1+ LBS6 @ 0.75 ml l^{-1}	5.39	7.30	42.5
T_4: Location specific	5.59	7.30	43.3
T_5: Absolute control	3.58	5.95	37.5
SEd	0.31	0.23	1.5
CD (5%)	0.67	0.51	3.3

Effect of liquid bio stimulant on economics

The highest cost of cultivation incurred in the application of recommended dose of fertilizer and foliar spray of LBS @ 1 ml l^{-1} however it registered the highest gross and net return and B: C ratio due to the attainment of more yield.

Table 3: Effect of liquid bio stimulant on the economics of rice cultivation

Treatments	Total cost (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
T_1: RDF	28949	76450	47501	2.6
T_2: T_1+ LBS6 @ 1 ml l^{-1}	30212	87125	56913	2.9
T_3: T_1+ LBS6 @ 0.75 ml l^{-1}	30046	82813	52766	2.8
T_4: Location specific	30520	85525	55005	2.8
T_5: Absolute control	22960	56000	33040	2.4

Conclusion

From the results of the present investigation, it is concluded that the integrated nutrient management practices improved productivity and greater economic returns over absolute control. Among the nutrient management practices, the combined application of recommended fertilizer dose (150:50:50 kg NPK ha^{-1}) and foliar spray of LBS6 @ 1 ml l^{-1} thrice at the time of pulling out of seedling in the nursery and 30 and 60 days after transplanting in the main field can be recommended for realizing higher yield and economic returns in the transplanted puddled lowland rice during *rabi* season in the tail end of Cauvery Delta Zone.

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