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Seaweed Extract can Boon the Yield Performances and Profitability of Wheat (*Triticum aestivum*)

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ABSTRACT: The study highlighted the assessment of suitable dose of seaweed extract in wheat as seed treatment and foliar application at different vegetative stage with different doses @ 2ml litre^{-1} and 4ml litre^{-1} under irrigated field conditions. The result revealed that foliar application of seaweed extract @ 4ml litre^{-1} at tillering & heading stage was observed significantly higher yield of wheat (Biological yield, grain and straw yield) and was at par with foliar application of seaweed extract @ 2ml litre^{-1} water at tillering & heading stage. Although main plot treatments did not show any significant influence on the performance of wheat. Significantly higher Gross Return and Net Return were obtained by foliar application of seaweed extract at tillering and heading stage @ 4ml litre^{-1} and the maximum B:C ratio was obtained from foliar application of seaweed extract @ 2ml litre^{-1} at heading stage. Based on one season of experimentation it can be concluded that foliar application of seaweed extract @ 2ml litre^{-1} as well as 4ml litre^{-1} both at tillering and heading stage (T_5 and T_6) were found equally effective for yield performance of the wheat crop. Similarly, these treatments were found to be effective in achieving higher Gross Return and Net Return and the maximum B:C ratio was obtained from foliar application of seaweed extract @ 2ml litre^{-1} at heading stage, although it was at par with the application of seaweed extract concentration @ 4ml litre^{-1} and 2ml litre^{-1} at tillering and heading stage. Therefore, foliar application of seaweed extract would be beneficial for getting the yield as well as profitability advantage of wheat.

Keywords: Seaweed extract, wheat, foliar application.

INTRODUCTION

Wheat (*Triticum aestivum* L.), together with maize and rice, is one of the top three cereal crops in terms of global production. Wheat, maize, and rice contribute more than half of the world's calories and protein (Biodiversity International 2007). There is increasing pressure to produce enough food as the world population grows and demand for foods with superior nutritional and health values rises. On the other hand, essential nutrients required for crop growth are steadily depleting from the soils, which results in lower crop yields per unit area of land. Although optimum use of chemical fertilizers can increase the crop's growth and yields, and their overuse has various side effects, including hardening the soil, decreasing soil fertility, strengthening pesticides, and polluting water. Moreover, these chemicals affect the soil microbiome composition, making plants more susceptible to diseases, and have a significant impact on plant health, posing a major threat to consumers as well as the entire ecosystem in the long term. Therefore, modern agricultural practice is seeking alternatives to chemical fertilizers. To fall the ill effect of overuse of agrochemical on humans and the environment, as well as to meet the fertilizer demand of resource-poor farmers, there is the requirement of a shift from chemical-based conventional farming methods to organic, alternative and low input sustainable agriculture (Bhatia, 2002). Seaweed extract is a new generation natural organic fertilizer that contains highly effective nutrients that stimulates vegetative growth and production while also improving biotic and abiotic stress resistance in many crops. Seaweed extract too grasps alginates which bound the soil particles and form aggregates resultant in healthier soil structure to nurture crops and similarly subsidize to remedy the harsh effect of modern chemical agriculture. Unlike chemical fertilizers, extract derived from seaweeds are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animals and birds (Dhargalkar

and Untawale 1983) besides having a low cost of production. It is a growth-promoting product derived from the sap of red and brown algae. Seaweed includes macroscopic, multicellular, marine algae. Macroalgae include phaeophyta- brown algae, rhodophyta - red algae and chlorophyta-green algae. Seaweed components are nutrient, amino acids, vitamins, complex polysaccharides, cytokinin, auxin, abscisic acid (ABA) like growth substances. Seaweed and seaweed-derived products have been widely used as bio-stimulants in crop production due to the presence of multiple growth regulators such as cytokinin, auxins, gibberellins, betaines, as well as the presence of micro-nutrients such as Ca, K, P, and micro-nutrients like Fe, Cu, Zn, B, Mn, Co, and Mo, which are necessary for plant growth and development. Seaweed has been favoured not individual owing to their nitrogen, phosphorus, potash and micronutrients content, but also it contains some metabolites that act as plant growth regulators similar indole compounds which help the development of plant roots and buds; cytokinines are hormones which helps in rapid growth by the process of cell division, when it is applied as a foliar spray on the leaves, rejuvenate stimulate photosynthesis.

Foliar spray it is directly assimilated by crop foliage within limited hours after application, as well as it is used as green manure, compost etc. The advantageous properties of seaweed are early seed germination, improved crop performances, elevated resistance to biotic and abiotic stress. It works on a metabolic bio-enhancer which stimulates internal growth and development processes in plants. So, utilization of seaweeds and their extract will be useful for achieving higher agricultural production. Therefore, it is high time to strengthen the research programme on such sources which may prove an important substitute for chemical fertilizer for not only to maximize production but also to make the soil and environment sustainable.

MATERIAL AND METHOD

The experimental trial was carried out during *Rabi* season of 2019 at research farm of Bihar Agricultural University, Sabour, Bhagalpur. The soil had a texturally classified in sandy loam that have a neutral pH (7.2), with 0.55 percent organic carbon, 192.45 kg ha^{-1} accessible nitrogen, 16.80 kg ha^{-1} phosphorus, and 165 kg ha^{-1} potassium.The climate prevailed during the crop season at Sabour was cool and bright. The maximum temperature varied from 18.8- 36.1°C while minimum temperature was 7.7°C to 24.8°C. Overall season of this region was favorable for the proper growth and development of the wheat crop. The experimental trial was laid out in split plot design and that conducting three replication. In main plot there were two treatments present, S_1: without seed treatment and S_2: seed treatment with seaweed extract @ 3ml kg^{-1}, however in sub plot there were six treatments, T_1: foliar application of seaweed extract @ 2ml $litre^{-1}$ water at tillering stage, T_2: foliar application of seaweed extract @ 4ml $litre^{-1}$ water at tillering stage, T_3: foliar application of seaweed extract @ 2ml $litre^{-1}$ water at heading stage, T_4: foliar application of seaweed extract @ 4ml $litre^{-1}$ water at heading stage, T_5: foliar application of seaweed extract @ 2ml $litre^{-1}$ water at tillering & heading stage, T_6: foliar application of seaweed extract @ 4ml $litre^{-1}$ water at tillering& heading stage. The recommended dose of fertilizer (RDF) i.e., N, P_2O_5 and K_2O was 150, 60 and 40 kg ha^{-1} respectively. IFFCO has introduced indigenous manufactured seaweed extract from red algae (*Kappaphycus* spp.) and brown algae (*Sargassum* spp.) for Indian farmers after extensive crop trials. Product applied named as 'Sagarika' is available both in liquid and granular form and is catering to the farmers of different agroclimatic regions of the country. Two concentrations i.e., 2ml $litre^{-1}$and 4ml $litre^{-1}$ were applied each at the tillering stage and heading stage. Wheat variety HD 2967 was sown in the last week of November with row to row spacing was 20 cm. Yield data collected after the harvesting the wheat through general procedure and data were subjected to statistical analysis as prescribed by Gomez and Gomez, (1984) and significant effects were presented. The economics were computed on the basis of prevailing market rates of produce and agro-inputs. The Net Return was calculated by subtracting total cost of cultivation from Gross Return. The Benefit: Cost ratio was calculated by dividing the Net Return by the Cost of Cultivation.

RESULTS AND DISCUSSION

A. Yield and yield attributing characters

The foliar spray of seaweed extract that showed a positive response on yield attributing parameters i.e., number of spikes per m^2 and number of grains per spike. The main plot treatments (S_1 and S_2) that did showed the significant changes in yield attributes from the result finding of first year trail. However among sub plot treatment, maximum number of grains $spikes^{-1}$ (313) and number of spikes per m^2 (57) was obtained by the foliar spray of seaweed extract @ 4ml $litre^{-1}$ (T_6) at two different stages *i.e*, tillering and heading stage (Table 1). Parmanick *et al.*, (2004) obtained the similar finding. The study from the first year finding, seaweed extract did not exert any significant influence on length of spikes and test weight. Although better vegetative growth along with higher yield traits was found mainly due to higher absorption of nutrients with increased photosynthate accumulation and high biomass production. Rathore *et al.*, (2009); Pramanick *et al*., (2013); Pramanick *et al*., (2014); Singh *et al*., (2015a) noticed enhancement in the yield occurred by the application of seaweed extract that promotes the photosynthetic rate and delay senescence of leaves.

B. Grain and straw yield

Seaweed extract played a crucial role for gaining maximum grain and straw yield i.e., 4.43 and 6.40 t ha^{-1} respectively by using the foliar spray of seaweed extract @ 4ml $litre^{-1}$ at tillering and heading stage (T_6). The treatment S_1 and S_2 in main plot did not showed any significant increment in grain and straw yield by using treated and non-treated seed with seaweed extract. Kumari *et al*., (2013) noticed that higher grain yield was obtained by applying the seaweed extract (4ml $litre^{-1}$) at two different stages at tillering and heading stage that enhances the greater availability of nutrient, improvement of soil environment resulting in higher root proliferation leading to better absorption of moisture and nutrient . The result of first year trial that are mentioned in Table 2, two foliar spray of seaweed extract @ 4 ml $litre^{-1}$ (T_6) gave the better response as compare with single spray of @ 4ml $litre^{-1}$ (T_2 and T_4). The better growth and yield attributes with seaweed extract will lead to higher grain and straw yield of wheat with 4 ml $litre^{-1}$. This above statement conformity with the finding of Singh *et al*., (2015b); Kavitha *et al.,* (2008).

Table 1: Effect of seed treatment and foliar application of seaweed extract on number of spikes m^{-2} number of grains per spike, 1000 grain weight (g) and length of the spike (cm) of wheat.

Treatments		No. of spikes m^2	No. of grains per Spike	1000 grain wt. (g)	Length of the spike (cm)
A	**Main Plot (Seed treatment): 02**				
S_1	Without seed treatment with seaweed extract	301	46	41.36	14.63
S_2	Seed treatment with seaweed extract @ 3 ml kg^{-1} seed	306	59	41.49	15.54
	SEm (±)	9	5	0.72	0.37
	CD at 5 %	NS	NS	NS	NS
B	**Sub-plot (Foliar application): 06**				
T_1	Foliar application of seaweed extract @ 2ml $litre^{-1}$water at tillering stage	289	47	40.41	14.35
T_2	Foliar application of seaweed extract @ 4ml $litre^{-1}$water at tillering stage	299	50	41.70	14.74
T_3	Foliar application of seaweed extract @ 2ml $litre^{-1}$water at heading stage	311	52	40.67	15.02
T_4	Foliar application of seaweed extract @ 4ml $litre^{-1}$water at heading stage	302	53	41.03	15.26
T_5	Foliar application of seaweed extract @ 2ml $litre^{-1}$water at tillering & heading stage.	308	55	41.85	15.47
T_6	Foliar application of seaweed extract @ 4ml $litre^{-1}$water at tillering & heading stage.	313	57	42.90	15.66
	SE(m) ±	7	3	1.09	0.45
	CD at 5%	21	10	NS	NS
	Interaction	NS	NS	NS	NS

Table 2: Effect of seed treatment and foliar application of seaweed extract on Grain yield (t ha^{-1}) straw yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index (%) of wheat at different stages.

Treatments		Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
A	**Main Plot (Seed treatment): 02**				
S_1	Without seed treatment with seaweed extract	4.14	6.02	10.15	40.80
S_2	Seed treatment with seaweed extract @ 3ml kg^{-1} seed	4.20	6.16	10.36	40.56
	SEm (±)	0.08	0.08	0.12	0.51
	CD at 5 %	NS	NS	NS	NS
B	**Sub-plot (Foliar application): 06**				
T_1	Foliar application of seaweed extract @ 2ml $litre^{-1}$ water at tillering stage	3.99	5.61	9.59	41.56
T_2	Foliar application of seaweed extract @ 4ml $litre^{-1}$ water at tillering stage	4.10	5.99	10.08	40.58
T_3	Foliar application of seaweed extract @ 2ml $litre^{-1}$ water at heading stage	4.11	6.13	10.24	40.06
T_4	Foliar application of seaweed extract @ 4ml $litre^{-1}$ water at heading stage	4.14	6.14	10.28	40.22
T_5	Foliar application of seaweed extract @ 2ml $litre^{-1}$ water at tillering& heading stage.	4.25	6.25	10.50	40.56
T_6	Foliar application of seaweed extract @ 4ml $litre^{-1}$ water at tillering& heading stage.	4.43	6.40	10.83	40.90
	SE(m) ±	0.13	0.22	0.23	1.33
	CD at 5 %	0.40	0.64	0.69	NS
	Interaction	NS	NS	NS	NS

C. Economics

Wheat crop with foliar application of seaweed extract @4ml litre^{-1} at tillering and heading stage gave significantly higher gross return (119502.69 ₹ ha^{-1}) and net return (82957.15 ₹ha^{-1}) than foliar application of seaweed extract @ 2ml litre^{-1} at tillering and heading stage (Table 3). Benefit: Cost ratio of wheat increased with increasing level of seaweed extract concentration up to 2ml litre^{-1} to 4ml litre^{-1}. Maximum B: C ratio was obtained from foliar application of seaweed extract @ 2ml litre^{-1} at heading stage, although it was at par with the application of seaweed extract concentration @ 4ml litre^{-1} and 2ml litre^{-1} at tillering and heading stage. The similar finding was obtained by Pramanick *et al.*, (2014).

Table 3: Effect of seed treatment and foliar application of seaweed extract on Cost of Cultivation (₹ ha^{-1}), Gross Return (₹ ha^{-1}), Net Return (₹ ha^{-1}) and Return ₹ invested (B: C) of wheat production.

Treatments		Cost of cultivation (₹ ha^{-1})	Gross Return (₹ ha^{-1})	Net Return (₹ ha^{-1})	Return invested (B:C)
A	**Main Plot (Seed treatment): 02**				
S_1	Without seed treatment with seaweed extract	33280.33	105878.70	72598.37	2.19
S_2	Seed treatment with seaweed extract @ 3ml kg^{-1} seed	33820.33	108408.62	74754.95	2.22
	SEm (±)		1847.13	1847.13	0.056
	CD at 5 %		NS	NS	NS
B	**Sub-plot (Foliar application): 06**				
T_1	Foliar application of seaweed extract @ 2ml litre^{-1} water at tillering stage	32053.00	101998.58	69945.58	2.18
T_2	Foliar application of seaweed extract @ 4ml litre^{-1} water at tillering stage	33453.00	105779.04	72326.04	2.18
T_3	Foliar application of seaweed extract @ 2ml litre^{-1} water at heading stage	32053.00	107625.55	75572.55	2.38
T_4	Foliar application of seaweed extract @ 4ml litre^{-1} water at heading stage	33453.00	105554.45	72101.45	2.17
T_5	Foliar application of seaweed extract @ 2ml litre^{-1} water at tillering& heading stage.	33745.00	107893.65	74148.65	2.22
T_6	Foliar application of seaweed extract @ 4ml litre^{-1} water at tillering& heading stage.	36545.00	119502.69	82957.15	2.27
	SE(m)±		2715.16	2715.16	0.059
	CD at 5 %		7009.73	7009.73	0.175
	Interaction		NS	NS	NS

Fig. 1. Field view of experimental plot.

Fig. 2. Ceptometer operating in research field for obtaining LAI value.

CONCLUSION

Based on the finding of the present study, it may be revealed that @ 4ml litre^{-1} foliar application of seaweed extract along with water at tillering and heading stage (T_6) improved the yield attributing characters and yield. T_6 also helps in gaining the maximum Gross and Net Returns.

Seaweed extract concentration act as the source of micro-elements as well as growth regulators (Cytokinins, GA, Auxine etc.). These plant growth regulators play an important role in effective increment in the wheat yield.

FUTURE SCOPE

Seaweed extract have been shown much interest over the past few years as biofertilizers of various plants for improving plant growth and the yield of crops. These extracts can be added directly to the soil or with irrigation water, while foliar spraying is a popular and widely used method of applying seaweed extracts.

— The efficacy of different seaweed extract on crops preferably horticultural crops should be taken under future scope of research.

— The use of seaweed as a biofertilizer could potentially help to mitigate the adverse effects of main nutrient deficiencies, diminishing the use of chemical fertilizers.

— Research on the impact of all tested seaweed extract on system based practices in different agro-climatic region should be considered in future.

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Conflict of Interest. Nil.

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