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Influence of methods of sowing and seaweed (*Kappaphycus alvarezii*) extract on yield and economics of wheat (*Trticum aestivum* L.)

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Abstract
A field experiment was carried out during *Rabi* season of 2020 – 21 at crop research farm of SHUATS, Prayagraj to study about the Influence of methods of sowing and seaweed (*Kappaphycus alvarezii*) extract on growth and yield of Wheat (*Triticum aestivum* L.). The experiment was laid out in randomized block design by keeping three sowing methods, i.e. S1 - Broadcasting, S2 – Line sowing and S3 – System of Wheat Intensification and Seaweed extract (*Kappaphycus alvarezii*) and which was replicated three times. Results revealed with the treatment of Line sowing +7.5% K sap recorded significantly higher in grain yield (3.57 t/ha) and stover yield (5.07 t/ha). Results revealed with the treatment of SWI + 7.5% K sap number of tillers per plant (9.80), number of effective tillers per plant (9.53), number of grains per spike (56.33), test weight (36.99 g), and harvest index (41.48%). However, net returns (76624.00 INR/ ha) and B:C ratio (2.51) was also obtained with the application of Line sowing +7.5% K sap. Therefore authors concluded that s Line sowing +7.5% K sap can produce more grains and will be economically effective.

Keywords: Broadcasting, line sowing, system of wheat intensification, seaweed extract, yield and economic

Introduction
Wheat (*Triticum aestivum* L.) is one of the important leading cereal crops which ranks first among world food crops, measured either by cultivated area (211.06 million ha) or by the production (566.8 million t) achieved (Jagshoran *et al*., 2004) [7]. Wheat, with its root ramifying into the depths of human culture has an evolutionary history parallel with history of human civilization itself. Even today, it decides the feast or famine for millions of people. Wheat attained its premier position by virtue of its unique protein gluten, which is responsible for bread making properties of wheat flour. It is highly nutritious cereal food stuff and its amino acid yield per acre far exceeds that of animal products (Mac Gillivray and Basley, 1962) [8].

Broadcasting method produced the most effective spatial arrangements. However, there was no consistent relationship between any of the spatial arrangements and subsequent yield performance (Abbas *et al.*, 2009) [1]. It is particular use in establishing dense plant spacing, as for cover crops and lawns. In comparison to traditional drill planting, broadcast seedling will require 10-20% more seed. It is simple, faster and easier than traditional row sowing. It works best for plants that do not require singular spacing or that are more easily thinned later.

Line sowing is being practised with proper row spacing, which besides facilitating inter-culture and convenient herbicide application for effective and effective weed control, help intercropping and reducing the seed rate per hectare without any adverse effect on the final grain yield (Naryana *et al.*, 2019). Line sowing is an advisable sowing method due to its uniform population per unit area. As seed are placed at a uniform depth and covered with soil, high germination and uniform stands are expected.

System of Wheat intensification is a new concept and goes with the system of rice intensification (SRI) principle. In case of SWI, all agronomic principles of SRI are put into practices and integrated with package of practices of wheat crop. The technology which has high potentiality to provide high wheat yield per drop of water and per kg of agricultural inputs (fertilizer, seed etc.) and application of other SRI principle to wheat crop, is known as system of wheat intensification (Dhar *et al*., 2014) [3].

Seaweed extract is a new generation natural organic fertilizer containing highly effective

nutrients, which promotes growth and yield as well as enhances the resistant ability of many crop from biotic and abiotic stresses. Unlike chemical fertilizers, extract derived from seaweeds are biodegradable, non toxic, non polluting and non hazardous to human, animal and birds (Dhargalkar and Pereira, 2005) [4] besides having low cost of production. Seaweed extract also contains alginates which bound the soil particles and form aggregates resulting in better soil structure to grow crops and also contribute to cure the ill effect of modern chemical agriculture. Seaweed has been preferred not only due to their nitrogen, phosphorus, potash and micronutrients content, but also it contains some metabolites similar to plant growth regulators like 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 and stimulate photosynthesis. Application of K*appaphycus alvarezii* and *Gracilaria edulis* extracts has been reported to enhance nutrient uptake by wheat (Shah *et al*., 2013) [11], which may be due to presence of many organic compounds and natural chelating compound (*i.e.* manitol) in sap, which mobilize the fixed nutrients to the plant in available form. Seaweed sap is also a rich source of potassium and phosphorus.

Materials and Methods

Site selection and soil analysis

The experiment was carried out during Rabi season of 2020-2021, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The Crop Research Farm is situated at 25º24‘41.27” N latitude, 81°50‘56” E longitude and 98 m altitude above the mean sea level. The experiment was carried out on sandy clay loam soil of eastern Uttar Pradesh condition. The experimental soil was nearly neutral in soil reaction (pH – 7.4), low in organic carbon (0.306%), medium in available Nitrogen (225 kg/ha), medium in available Phosphorous (13.90 kg/ha) and medium in available Potassium (243.5 kg/ha).

Experimental design and treatment combinations

The experiment was laid out in Randomized Block Design with 3 replications. Total 9 treatments comprised all possible combinations of methods of sowing (Broadcasting, Line sowng and SWI) and foliar spray of sea weed @ 0%, 5% and 7.5% respectively. $T_{1.}$ Broadcasting + 0% K Sap, $T_{2.}$ Broadcasting + 5% K Sap, $T_{3.}$ Broadcasting + 7.5% K Sap, $T_{4.}$ Line sowing + 0% K Sap, $T_{5.}$ Line sowing + 5% K Sap, $T_{6.}$ Line sowing + 7.5% K Sap, $T_{7.}$ SWI + 0% K Sap, $T_{8.}$ SWI + 5% K Sap, $T_{9.}$ SWI + 7.5% K Sap.

Fertilizer application and Trait Measurement

The amount of different fertilizers required to supply the needed quantities of nutrients were calculated on per plot basis. The field observation on plant height, no. of tillers, dry weight, grain and stover yields were recorded. In order to workout the most profitable treatment, the economics of each treatment was workout on the basis of prevalent market prices of the inputs and outputs.

Statistical Analysis

The experimental data analysed statistically by applying the technique of analysis of variance (ANOVA) prescribed for the design to test the significance of overall difference among treatments by the F test and conclusion were drawn at 0.05% probability level (Gomez and Gomez, 1984).

Results and Discussion

Influence of methods of sowing and seaweed (*Kappaphycus alvarezii*) extract on Yield attributes and Yield of wheat (*Trticum aestivum* L.)

Yield attributes

Effective tillers per plant

Treatment combination of SWI + 7.5% K sap was recorded maximum number of effective tillers (9.53). However, treatment combination of SWI + 5% K sap was statistically at par with SWI + 7.5% K sap.

Grains/spike

Treatment combination of SWI + 7.5% K sap was recorded maximum grains/spike (56.33). However, treatment combination of SWI + 5% K sap was statistically at par with SWI + 7.5% K sap.

It might be due to the results revealed that better yield attributes and grain yield of wheat could be attained only when full recommended fertilizer dose is applied. Comparing the conventional system of fertilization with other treatment combinations, full RF dose and closer plant spacing with wider line distance increases the grain yield by50.5% followed by 18.2% over conventional method. The results suggest that the adoption of SWI methods by maintaining appropriate plant spacing and nutrient management could greatly enhance wheat production in the subtropical regions. Rakib *et al.* (2016) [10].

Test weight (g)

Treatment combination of Line Sowing + 7.5% K sap was recorded maximum test weight (36.99 g). However, treatment combination of SWI + 7.5% K sap was statistically at par with Line Sowing + 7.5% K sap.

Yield

Grain yield (t/ha): Treatment combination of Line sowing + 7.5% K sap was recorded maximum grain yield (3.57 t/ha). However, treatment combination of SWI + 7.5% K sap & Line sowing + 5% K sap were statistically at par with Line sowing + 7.5% K sap.

Stover yield (t/ha)

Treatment combination of Line sowing + 7.5% K sap was recorded maximum stover yield (5.07 t/ha). However, treatment combination of SWI + 7.5% K sap & Line sowing + 5% K sap were statistically at par with Line sowing + 7.5% K sap.

Harvest Index (%)

Treatment combination of SWI + 7.5% K sap was recorded maximum stover yield (41.48%). However, treatment combination of Line sowing + 7.5% K sap, Line sowing + 5% K sap & Line sowing + 0% K sap were statistically at par with SWI + 7.5% K sap.

Increase in yield may be due to presence of plant growth regulator in sap as well as the minerals element present in the seaweed extract, which increased the rate of photosynthesis & delayed the senescence of the leaves & ultimately enhanced the supply of photosynthate available for grain filling, thus resulting in bolder grain & consequently higher grain yield

(Beckett & Staden 1990) [2]. Application of K-sap produced maximum and significantly higher straw yield of rice. The better yield and growth attributes with K-sap will led to higher grain and straw yield of rice with K-sap. This was in conformity with the finding of (Singh *et al.*, 2015) [12]

Economics

Maximum net returns (INR 76,624.00/ha) and B:C ratio (2.51) was obtained with the application of Line sowing + 7.5% K sap which was significantly superior over rest of the treatments.

Table 1: Influence of methods of sowing and seaweed (*Kappaphycus alvarezii*) extract on Yield attributes, Yield and Economics of wheat

Treatments	Yield attributes			Yield			Economics	
	Effective tillers	Grains/spike	Test weight	Grain yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)	Net returns (INR ha^{-1})	B:C Ratio
Broadcasting +0% K sap	5.2	35.33	26.11	2.17	4.24	33.82	35,465.00	1.20
Broadcasting +5% K sap	4.73	37.33	28.72	2.34	4.47	34.34	38,722.00	1.23
Broadcasting +7.5% K sap	4.47	38.33	26.42	2.53	4.71	34.99	43,849.00	1.37
Line sowing +0% K sap	6.03	40.67	31.60	3.16	4.66	40.37	66,740.00	2.38
Line sowing +5% K sap	6.07	43.33	27.31	3.45	4.90	41.32	73,597.00	2.46
Line sowing +7.5% K sap	6.23	44.00	36.99	3.57	5.07	41.30	76,624.00	2.51
SWI + 0% K sap	9.03	48.67	32.10	2.79	4.29	39.39	56,165.00	2.04
SWI + 5% K sap	9.20	54.67	33.51	3.00	4.51	39.98	60,622.00	2.06
SWI + 7.5% K sap	9.53	56.33	36.03	3.48	4.91	41.48	74,449.00	2.49
S.Em (±)	0.13	1.84	0.53	0.05	0.07	0.42		
CD (p=0.05)	0.38	5.47	1.59	0.15	0.197	1.25		

Conclusion

On the basis of one season experimentation treatment combination with Line sowing + 7.5% K sap was found more productive (3.57 t/ha) as well as economic (76,624.00 INR/ha).

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