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Performance of autumn maize crop as influenced by seaweed saps

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Abstract
A field experiment was carried out at Crop Research Centre of Rajendra Agricultural University, Pusa, Samastipur, Bihar out to evaluate the performance of two sea weed liquid fertilizers extracted from 'Kappaphycus" and "Gracilaria" on Autumn Maize. The experiment was carried out on Autumn Maize because of yield gaps and largest cropped area so that the benefits of Seaweed Liquid Fertilizers, if any be disseminated among larger maize growing farming community. The experiment was carried out in RBD with 10 treatments. The treatments consisted of RDF (Recommended Dose of Fertilizer for Maize Crop) N: P: K: 120: 75: 50 and Zn @ 5 Kg/ha along with 3 sprays of K sap, G sap and water as control. Spraying of saps was done at knee high, tasselling and silking stage. Maize cultivar 900 M gold was used. The crop was sown in February and harvested in May.
Both K and G saps were effective in increasing grain yield of maize over control. K Sap Outperformed G sap at all the concentrations as the yields were found to be statistically superior. Highest grain yield was observed at 10% K sap (72.0 q/ha) which means an increase of 35.3% over control. In case of G Sap highest grain yield was observed at 15% concentration (67.3 q/ha) i.e. an increase of 26.5% over control. The mixture of 7.5% K sap and 7.5 % G sap (T9) was statistically superior as compared to spray of 10% G sap alone. Application of 10% K sap was best with respect to enhancement in crop yield. Uptake of N, P & S were more in grain as compared to straw of maize, while uptake of K, Ca Mg, Cu, Fe &Mn followed the reverse trend in grain & straw. In both cases uptake, due to application of saps was significantly superior over control and increased progressively with increasing concentration of saps from 2.5 to 15%. Highest total uptake of N, P, K, Ca, S, Cu, Mn and B was observed at 10% K-Sap level while for Mg, Zn & Fe highest uptake was observed at 15% K-Sap. In general, total uptake of nutrient was more with K-Sap as compared to G-Sap at almost all the concentration levels of the sap. However, nutrient concentration in grain and straw was found more at 15% K sap. Hence, if better yield is desired 10 % K sap would be best but for quality produce 15 % K sap could be used.

Keywords: sea weed, liquid fertilizer, kappaphycus, gracilaria, nutrients, uptake

Introduction
India is an agricultural country. Nearly 70% of the population thrives in rural area engaged in agriculture making the back bone of our economy. The fast-growing population is mounting tremendous pressure on food production in the country. Our current food production is 250 MT and it must be doubled by 2040 to feed the ever-increasing population. This task of feeding the ever-increasing population becoming more and more difficult with shrinking land resources and emerging challenges of soil organic matter depletion, imbalance fertilizer use, declining nutrient use efficiency, negative soil nutrient balance, emerging multi-nutrient deficiencies particularly of secondary and micronutrients etc. Indiscriminate and imbalance use of chemical fertilizers have resulted in poor soil health and the sustainability of the production system is at stake. Emergence of multi micronutrient deficiency in soils has not only significantly contributed to lower crop production but has also resulted in nutritional problems in humans and animals. The use of inorganic micronutrient fertilizers in soils with use efficiency as low as 2-5% has resulted in poor soil health owing to its accumulation and interactions with other plant nutrients besides, causing economic losses to the farmer. It has been established well beyond doubt that foliar spray of micronutrients is always better as compared to soil application, however the use is restricted owing to poor availability and high costs. Under these circumstances sea weed liquid fertilizers can be a boon to farming community. Shah *et al.* (2013) [11] reported that foliar applications of K. Alvarezzii and G. Edulis sap at 7.5% and 5.0 % concentrations significantly increased the yield of wheat grain by 19.74% and 13.16%, respectively, in comparison to control.

Dilavarnaik *et.al* (2017) [3] found seaweed sap application at 15% concentration of either K or G sap significantly increase the germination, SVI, fresh and dry weight, whereas at higher concentration reduction in these parameter were noticed. Seed soaking in seaweed saps at 15% G sap followed by three sprays of 10% G sap spray at 20, 40 and 70 days after sowing significantly increased the grain and straw yield of hybrid maize.

Use of sea weeds is not new to mankind. The earliest record of use of seaweeds dates to 2700 BC in compilation on “Chinese herbs” by Emperor Shen Nung. After human food consumption, the next most valuable commercial use of sea weed is as raw material for extraction of phycocolloids, which are used in several industries. But until now the contribution of sea weeds in agriculture as source of organic fertilizer is very limited. However, a great potential exists owing to the large quantities of nutrients present in it. In agriculture, sea weeds can be used as soil conditioners, fertilizers and green manures due to the presence of high amount of potassium salts; micronutrients and growth promoting hormones and regulators. Besides, this sea weed extract can also be used as liquid fertilizers (SLF) for foliar spray on plants as the nutrients would be readily available to plants through natural opening such as lenticels, hydathodes and stomata. Seaweed extract, as a foliar sprays, have been used in horticulture for several decades (Blunden, 1991) [a1], and being organic and biodegradable, it is important in sustainable agriculture (Cassan *et al.,* 1992 [2]). The seaweed concentrates are effective biostimulant in many crops including vegetables, trees, flowering plants and grain crops (Stirk *et al.*, 2004) [12]. Chemical analysis of sea weeds and their extracts have revealed the presence of a wide variety of plant growth regulators such as auxins and cytokinins in varying amounts (Jameson, 1993) [6] Zhang and Ervin, 2004, 2008) [13, 14]. But unfortunately, the commercial cultivation of sea weed in India is negligible. However, India produces a total of 3203 MT/yr of sea weed as against a total world production of 2165675 MT/yr. Most of the production is from cottage industries. Sea weed liquid fertilizers have a great potential in the coming years because of its beneficial role in crop and soil. If the benefits of sea weed liquid fertilizers are established beyond doubt, it would give a boost to the commercialization of sea weed cultivation, which in turn would make the saps availability easier promoting better crops and soils and ultimately it would be a win-win situation for sea weed cultivators, agriculture farmers and humanity as a whole.

The present investigation was carried out to evaluate the performance of two seaweed liquid fertilizers extracted from ‘Kappaphycus” and “Gracilaria” on Autumn Maize. In Bihar, maize crop is cultivated in about 7.06 lakh hectares with an annual production of 24.8 lakh tons and a productivity of 3.5 t/ha (Directorate of Economics & Statistics 2014-15), which is above the national average of 2.5 t/ha. In Bihar, Begusarai district is major maize producing district followed by Samastipur, Bhagalpur and Khagaria. In Bihar, maize is cultivated in all crop seasons viz. Kharif, Rabi and autumn. Autumn maize has the largest cropped area (42-43%) of total cropped area), while Rabi maize has the highest contribution in total maize production (40 – 41%). Hence, the experiment was carried out on Autumn Maize because of yield gaps and largest cropped area so that the benefits of Sea Weed Liquid Fertilizers, if any be disseminated among larger maize growing farming community.

Material and Methods

The experiment was carried out at Crop Research Centre of Rajendra Agricultural University, Pusa, Samastipur, Bihar.

The soil at experimental site was alkaline in reaction with medium availability of N, P, and K. The soil was deficient in available Zn and B. The organic carbon status was also on the lower side. The chemical properties of the soil have been summarized in Table 1.

The maize cultivar 900 M gold was used. The crop was sown in February and harvested in May.

The spraying of saps was done at knee high, tasselling and sulking stage.

Results

Plant Height

All the treatments varied significantly with control for both the years. There was progressive increase in plant height with the application of “K Sap”. It increased from 174.7 cm to 179.6 cm with the increase in spray concentration from 2.5 % to 15% (table 2). However, in case of “G Sap” maximum plant height of 182.6 cm was observed at 5% G sap. From the study, it seems that “G Sap” was more effective in increasing plant height at lower concentration but at higher concentration the height decreased. Over the years there was no significant changes in plant height.

Table 1: The general initial soil properties of the experimental site.

SL. No.	Particulars	Value
1.	pH	8.49
2.	EC (dS/m)	0.37
3.	Organic Carbon (%)	0.43
4.	Available N (Kg/ha)	213.0
5.	Available P_2O_5 (Kg/ha)	17.5
6.	Available K_2O (Kg/ha)	135.0
7.	Available Ca + Mg (meq./l)	10.3
8.	Available S (ppm)	13.5
9.	Available Zn (ppm)	0.69
10.	Available Cu (ppm)	0.74
11.	Available Fe (ppm)	15.3
12.	Available Mn (ppm)	4.8
13.	Available B (ppm)	0.42
14.	Free $CaCO_3$ (%)	33.4
15.	CEC c mol. (p^+)/Kg	8.8
16.	Textural Class	Silty Loam

The experiment was designed in RBD with 10 treatments as detailed below:

Plant Girth

Pooled mean value for plant girth varied from 13.4 mm in control to 16.2 mm at 10 % K sap (T3). Both the saps were found superior over control in increasing plant girth at all concentrations. K Sap performed relatively better than G Sap for all the concentration treatment. In case of “K Sap” plant girth increased significantly up to 10% concentration and thereafter decreased. The best concentration was found to be 10% K Sap which recorded an increase of 20.9% over control. No significant variation in plant girth was observed over the years (table 2).

Cob Length

Cob length significantly improved with the application of both K and G sap. The magnitude of increase was more pronounced in case of K sap at all the concentrations as compared to G sap. In case of K sap T3 (10% K sap) was most effective in improving cob length (18.3 cm) which recorded an increase of 22.8 % over control i.e. T 10 (table 2).

Table 2: Treatment Details

T1	**RDF + 3 Spray of K Sap (2.5 %)**
T2	RDF + 3 Spray of K Sap (5.0 %)
T3	RDF + 3 Spray of K Sap (10.0 %)
T4	RDF + 3 Spray of K Sap (15.0 %)
T5	RDF + 3 Spray of G Sap (2.5 %)
T6	RDF + 3 Spray of G Sap (5.0 %)
T7	RDF + 3 Spray of G Sap (10.0 %)
T8	RDF + 3 Spray of G Sap (15.0 %)
T9	RDF + 3 Spray of K + G Sap (7.5 % each)
T10	RDF + Water Spray (Control)
RDF (Recommended Dose of Fertilizer for Maize Crop) N: P: K: 120:75: 50 and Zn @ 5 Kg/ha	

Cob Diameter

Cob diameter increased significantly with the application of either K sap or G sap over control i.e. water spray. The cob diameter progressively increased with increase in sap concentration for both saps. The highest cob diameter of 10.0 cm was recorded at 15% spray of K sap while the same was 9.3 cm at 15% spray of G sap (table 3). Treatment T9 i.e spray of both 7.5% K and 7.5 % G sap produced cob diameter of 9.6 cm which was statistically superior over spray of 15 % G sap i.e. treatment T8.

Table 3: Maize plant parameters as influenced by application of SLF (pooled)

Treatments	**Parameters**														
	Plant Height (Cm)			**Plant Girth (mm)**			**Cob Length (cm)**			**Cob Diameter (cm)**			**100 grain weight (g)**		
	2012	**2013**	**Mean**	**2012**	**2013**	**Mean**	**2012**	**2013**	**Mean**	**2012**	**2013**	**Mean**	**2012**	**2013**	**Mean**
T1 RDF + (2.5 % K)	174.8	174.6	174.7	14.2	14.2	14.2	15.8	15.9	15.9	8.9	9.0	8.9	38.0	38.3	38.2
T2 RDF + (5.0 % K)	175.8	175.6	175.7	15.3	15.3	15.3	17.0	17.2	17.1	9.6	9.7	9.6	38.2	38.5	38.4
T3 RDF + (10.0 % K)	176.5	174.5	175.5	16.3	16.1	16.2	18.2	18.4	18.3	9.8	9.9	9.8	38.7	39.1	38.9
T4 RDF + (15.0 % K)	182.4	176.7	179.6	15.9	15.4	15.7	17.8	18.0	17.9	10.0	10.1	10.0	38.8	39.1	39.0
T5 RDF + (2.5 % G)	182.1	181.9	182.0	13.7	13.7	13.7	15.3	15.4	15.4	8.6	8.7	8.6	37.4	37.7	37.6
T6 RDF + (5.0 % G)	182.7	182.5	182.6	13.9	13.9	13.9	15.5	15.6	15.6	8.7	8.8	8.7	37.7	38.0	37.9
T7 RDF + (10.0 % G)	178.3	178.1	178.2	14.4	14.4	14.4	16.0	16.1	16.1	9.0	9.1	9.0	37.9	38.2	38.1
T8 RDF + (15.0 % G)	178.4	178.2	178.3	14.7	14.7	14.7	16.4	16.5	16.5	9.3	9.4	9.3	37.8	38.1	38.0
T9 RDF + (7.5 % K + 7.5 % G)	170.8	175.7	173.3	15.4	15.8	15.6	17.1	17.3	17.2	9.6	9.7	9.6	38.0	38.4	38.2
T10 RDF + (Control, Only water)	164.7	166.3	165.5	13.3	13.4	13.4	14.8	14.9	14.9	8.4	8.5	8.4	34.2	34.3	34.3
CD (p = 0.05) Y = Year, T = Treatment	Y = ns	T = 8.1	Y x T = 11.6	Y = ns	T = 0.5	Y x T = 0.7	Y = ns	T = 0.5	Y x T = 0.7	Y = ns	T = 0.3	Y x T = 0.4	Y = ns	T = 1.2	Y x T = 1.6

100 Grain Weight

Weight of 100 grain varied significantly over control. However, all the other treatments were statistically at par. K sap was more effective in enhancing grain weight as compared to G sap for both the years. No significant changes were observed over the years.

Grain Yield

Both K and G saps were effective in increasing grain yield of maize over control. K Sap Outperformed G sap at all the concentrations as the yields were found to be statistically superior. Highest grain yield was observed at 10% K sap (72.0 q/ha) which means an increase of 35.3% over control (table 4). In case of G Sap highest grain yield was observed at 15% concentration (67.3 q/ha) i.e. an increase of 26.5% over control. The mixture of 7.5% K sap and 7.5 % G sap (T9) was statistically superior as compared to spray of 10% G sap alone. The beneficial effect on yield of wheat crop has been reported by Zodape *et. al.* 2009 [15]; on sesame crop by Gandhiappan and Perumal, 2001 [5]; on maize crop by Jeamin *et. al.* 1991 [7]; on wheat crop by Nelson and Van Staden 1984a [8].

Table 4: Maize grain and Stover yield as influenced by application of SLF (pooled)

Treatments	**Parameters**					
	Grain Yield (q/ha)			**Stover Yield (q/ha)**		
	2012	2013	Mean	2012	2013	Mean
T1 RDF + (2.5 % K)	62.2	60.4	61.3	76.5	75.1	75.8
T2 RDF + (5.0 % K)	67.8	66.0	66.9	83.1	81.8	82.5
T3 RDF + (10.0 % K)	72.9	71.0	72.0	89.3	87.8	88.6
T4 RDF + (15.0 % K)	71.0	69.0	70.0	87.0	85.7	86.4
T5 RDF + (2.5 % G)	58.3	56.5	57.4	72.1	71.1	71.6
T6 RDF + (5.0 % G)	61.1	59.6	60.3	75.2	74.2	74.7
T7 RDF + (10.0 % G)	66.6	64.8	65.7	81.6	80.3	81.0
T8 RDF + (15.0 % G)	68.4	66.2	67.3	84.1	82.7	83.4
T9 RDF + (7.5 % K + 7.5 % G)	71.5	69.7	70.6	87.2	85.9	86.6
T10 RDF + (Control, Only water)	53.9	52.5	53.2	66.3	65.2	65.8

CD (p = 0.05) Y = Year, T = Treatment	Y = ns	T = 4.5	Y x T = 6.4	Y = ns	T = 5.4	Y x T = 7.7

Stover Yield

Application of both K sap and G sap increased the stubble yield significantly over control. With increasing concentration stubble yield increased up to 10% K sap and thereafter decreased at 15% K concentration however statistically they were at par. In case of G sap the stubble, yield increased progressively up to 15% concentration. The best treatment was 10% K sap (T3) which recorded a yield advantage of 34.6% over control. No significant changes in either grain or Stover yield was observed over the years.

Table 5: Major nutrient uptake by maize grain as i

Treatments	Parameters														
	N (Kg/ha)			P (Kg/ha)			K (Kg/ha)			Zn (g/ha)			Fe (g/ha)		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
T1 RDF + (2.5 % K)	85.3	99.2	92.2	19.3	20.6	19.9	21.8	20.6	21.2	156.8	160.3	158.5	477.0	513.3	495.2
T2 RDF + (5.0 % K)	94.3	110.3	102.3	21.7	23.8	22.8	27.8	26.4	27.1	181.8	186.3	184.1	838.9	905.2	872.1
T3 RDF + (10.0 % K)	102.1	119.4	110.8	24.8	27.0	25.9	31.4	29.8	30.6	205.7	210.9	208.3	1098.6	1185.4	1142.0
T4 RDF + (15.0 % K)	100.2	116.7	108.5	24.9	26.9	25.9	30.6	29.0	29.8	206.7	211.4	209.1	1139.8	1227.5	1183.6
T5 RDF + (2.5 % G)	79.9	92.8	86.3	17.5	18.7	18.1	21.0	19.9	20.4	98.0	99.9	99.0	465.1	499.7	482.4
T6 RDF + (5.0 % G)	84.4	99.0	91.7	19.0	20.3	19.6	23.2	22.1	22.7	118.6	121.7	120.2	643.6	695.4	669.5
T7 RDF + (10.0 % G)	92.7	108.3	100.5	21.3	23.4	22.3	25.3	24.1	24.7	168.0	171.9	169.9	1042.9	1124.1	1083.5
T8 RDF + (15.0 % G)	96.0	111.3	103.7	22.6	24.5	23.6	27.4	25.8	26.6	183.4	186.8	185.1	1229.9	1319.5	1274.7
T9 RDF + (7.5 % K + 7.5 % G)	100.9	117.9	109.4	23.6	25.8	24.7	29.3	27.9	28.6	191.0	196.0	193.5	933.3	1008.4	970.9
T10 RDF + (Control, Only water)	73.4	85.6	79.5	15.1	16.3	15.7	17.3	16.4	16.8	86.8	89.0	87.9	405.3	437.5	421.4
CD (p = 0.05) Y = Year, T = Treatment	Y = 4.5	T = 10.0	Y x T = 14.1	Y = 1.0	T = 2.3	Y x T = 3.3	Y = ns	T = 3.0	Y x T = 4.2	Y = ns	T = 17.1	Y x T = 24.2	Y = 46.2	T = 103.2	Y x T = 146.0

Nutrient Uptake

Uptake of N and P were more in grain as compared to straw of maize, while uptake of K, Cu and Fe followed the reverse trend in grain & straw (table 6). In both cases uptake, due to application of saps was significantly superior over control and increased progressively with increasing concentration of saps from 2.5 to 15%. As a biostimulant, sea weed sap may contain chelating compounds (i.e., mannitol in sea weeds) that can increase nutrient availability, a better absorption of chelated compounds at leaf level has been suggested (Slat, 2004). In addition, concentrates can increase root size, thus increasing the volume of soil sampled by a plant (Nelson and van Staden, 1984b) [9]. Highest total uptake of N, Pand K was observed at 10% K-Sap level while for Zn& Fe highest uptake was observed at 15% K-Sap. In general, total uptake of nutrient was more with K-Sap as compared to G-Sap at almost all the concentration levels of the sap.

Soil nutrient status

Different treatments did not influence the available nutrient status significantly (table 6).

Table 6: Nutrient content in post-harvest soil as influenced by application of SLF (pooled)

Treatments	Parameters														
	N (Kg/ha)			P (Kg/ha)			K (Kg/ha)			Zn (g/ha)			Fe (g/ha)		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
T1 RDF + (2.5 % K)	215.0	221.3	218.1	19.5	19.5	19.49	126.0	125.9	125.9	0.61	0.63	0.62	15.0	15.2	15.1
T2 RDF + (5.0 % K)	218.0	222.1	220.1	19.3	19.7	19.48	125.0	127.4	126.2	0.60	0.62	0.61	14.8	15.2	15.0
T3 RDF + (10.0 % K)	221.0	226.3	223.6	20.4	20.9	20.64	131.0	134.1	132.6	0.59	0.61	0.60	14.4	14.5	14.5
T4 RDF + (15.0 % K)	223.0	229.3	226.1	20.0	20.6	20.28	127.0	130.6	128.8	0.59	0.61	0.60	14.3	14.4	14.4
T5 RDF + (2.5 % G)	214.0	218.7	216.3	19.6	20.0	19.81	125.0	127.7	126.4	0.60	0.62	0.61	14.9	16.4	15.6
T6 RDF + (5.0 % G)	215.0	219.1	217.0	20.7	21.1	20.90	123.0	125.3	124.2	0.61	0.63	0.62	14.9	15.0	15.0
T7 RDF + (10.0 % G)	217.0	218.9	218.0	20.0	20.2	20.09	127.0	128.1	127.6	0.59	0.61	0.60	14.8	14.9	14.9
T8 RDF + (15.0 % G)	218.0	224.3	221.2	18.8	19.3	19.07	120.0	123.5	121.7	0.58	0.60	0.59	14.9	15.3	15.1
T9 RDF + (7.5 % K + 7.5 % G)	208.0	214.0	211.0	17.0	17.5	17.25	120.0	123.5	121.7	0.58	0.60	0.59	14.7	15.1	14.9
T10 RDF + (Control, Only water)	212.0	218.1	215.1	19.0	19.5	19.27	121.0	120.9	120.9	0.61	0.63	0.62	15.2	15.4	15.3
CD (p = 0.05) Y = Year, T = Treatment	Y = ns	T = ns	Y x T = 24.8	Y = ns	T = 1.6	Y x T = 2.2	Y = ns	T = ns	Y x T = 16.1	Y = ns	T = 0.02	Y x T = 0.03	Y = ns	T = ns	Y x T = 1.7

Conclusion

Among the two saps K sap was found to be superior to G sap in enhancing the yield of Maize crop. Application of 10% K sap was best with respect to enhancement in maize crop yield. However, nutrient concentration in grain and straw was found more at 15% K sap. Hence, if better yield is desired 10 % K sap would be best but for quality produce 15 % K sap could be used. Foliar application of saps did not produce any significant change in soil properties, however, slight increase in organic carbon, nitrogen and phosphorous was found.

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References

1. Blunden G. Agricultural uses of seaweeds and seaweed extract In: Seaweed Resources in Europe: Uses and Potential, eds. ZM. D. Guiry and G. Blunden. 1991, 66-81. Chichester, UK: John Wiley and Sons.
2. Cassan L, Jeannin I, Lamaze T, morot Gavdry JF. The effect of the Ascophyllum nodosum extract Goemar GA 14 on growth of spinach. Botanica Marina. 1992; 35: 437-439.
3. Dilavarnaik S, Basavaraja PK, Yogendra ND, Ghos A. Influence of seaweed saps on germination, growth and yield of hybrid Maize under Cauvery command of Karnataka, India. International Journal of Current microbiology and applied Science. 2017; 6:1047-1056.
4. Directorate of Economics and Statistics, Govt. of Bihar, 2014. http://krishi.bih.nic.in/Statistics/Area,%20Production,%20and%20Yield%20of%20Maize%20during%202014-15.pdf.
5. Gandhiappan K, Perumal P. Growth promoting effect of seaweed liquid fertilizer (Enteromorpha intestinalis) on the sesame crop plant. Seaweed Resource Util. 2001; 23:23-25.
6. Jameson PE. Plant hormones in the algae. Progress in Phycological Research. 1993; 9:240-279.
7. Jeamin L, Lescure JC, Morot-Gaudry JF. The effects of aqueous seaweed sprays on the growth of maize. Bot. Mar. 1991; 34:469-473.
8. Nelson WR, Van Staden J. The effect of seaweed concentrate on wheat culms. J Plant Physiology. 1984a; 115:433-437.
9. Nelson WR, Van Staden J. Effect of seaweed concentrate on growth of wheat. South African Journal of Science. 1984b; 82:199-200.
10. Salat A. Les biostimulants-PHM [Biostimulants-PHM]. Revue Horticole. 2004; 454:22-24.
11. Shah MT, Zodape ST, Choudhary DR, Eswaran K, Chikara J. Seaweedsap as an alternative liquid fertilizer for yield and quality improvement of Wheat. Journal of Plant Nutrition. 2013; 36:2192-200.
12. Stirk WA, Arthur GD, Lourens AF, Novok O, Strnad MJ. van Staden Changes in cytokininand auxin concentrations in seaweeds concentrates when stores at an elevated temperatures. Journal of Applied Phycology. 2004; 16:31-39.
13. Zhang X, Ervin EH. Cytokinin – containing seaweed and humic acid extracts associated with creeping bentgrass leaf cytikinins and drought resistance. Crop Science. 2004; 44:1-10.
14. Zhang X, Ervin EH. Impact of seaweed extract –based cytokinin and zeatin riboside on – creeping bentgrass heat tolerance. Crop Science. 2004; 48:364-370.
15. Zodape ST, Mukherjee S, Reddy MP, Chaudhary DR. Effect of Kappaphycusaharezii (Doty) Doty ex. Silva. Extract on grain quality, yield and some yieldcomponents of wheat (*Triticum aestivum* L.). Int. J Plant. Prod. 2009; 3:97-101.