



Effect of seaweed saps on growth, yield, nutrient uptake and economic improvement of maize (sweet corn)

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Abstract: A field experiment was conducted during the rabi season of 2012-13 at Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) to study the effects of seaweed saps on growth, yield, nutrient uptake and economic of maize (sweet corn) in *Matasi* soil of Chhattisgarh. The foliar spray of two different species (namely *Kappaphycus* and *Gracilaria*) was applied thrice at different interval of crop with different concentrations (0, 2.5, 5.0, 7.5, 10.0 and 15% v/v) of seaweed extracts. Foliar applications of seaweed extract significantly enhanced the growth, yield, nutrient uptake and B:C ratio parameters. The green cob yield (189.97 q ha^{-1}) and fodder yield (345.19 q ha^{-1}) were recorded highest under treatment (T_8) 15% G Sap + recommended dose of fertilizer (RDF) which was significant similar with treatment 15% K Sap + RDF (185.24 q ha^{-1}) in case of green cob yield. The highest N, P and K uptake by green cob and fodder were observed under 15% G Sap + RDF (T_8). Treatment 15% G Sap + RDF (T_8), recorded maximum gross return (Rs. $2,07,230 \text{ ha}^{-1}$), net return (Rs. $1,38,756 \text{ ha}^{-1}$) and B:C ratio (2.0), which was followed by treatment 15% K Sap + RDF (T_4) with net return (Rs. $1,33,199 \text{ ha}^{-1}$) and B:C ratio (1.95). Treatment 15% G Sap + RDF (T_8) gave Rs. $45,996 \text{ ha}^{-1}$ more as compared to Water spray + RDF (T_9).

Keywords: Gracilaria, Kappaphycus, Maize cob yield, Nutrient uptake, Seaweed saps

INTRODUCTION

Sea weeds are marine algae, saltwater dwelling, and simple organisms that fall into the rather outdated general category of "plants". Most of them are the red (6000 species), brown (2000 species) or green (1200 species). A wide range of beneficial effects have been reported from the use of liquid seaweed extracts (Blunden, 1991), including increased crop yields, resistance of plants to frost, increased uptake of inorganic constituents from the soil, more resistance to stress conditions and reduction in storage losses of fruit. Sea weeds have proved effective in enhancing yield, pest and frost resistance in vegetables, fruits, flowers, cereals and pulses. Seaweed extracts had beneficial effect on seed germination and plant growth (Thirumal *et al.*, 2003).

Maize (*Zea mays* L.) is a miracle crop emerging as the third most important cereal crop next to rice and wheat. It is grown for food, feed and as a source for numerous industrial products. Its array of diversity of uses and large hidden potential for exploitation led the renowned Nobel laureate, Norman E Borlaug to say that "last two decades saw the revolution in rice and wheat; the next few decades will become the maize era". India is the seventh largest producer of maize in an area of 8.11 million hectares with a production of 18.9 million tones and 2335 kg ha^{-1} productivity (CMIE, 2010).

Sweet corn is one type of maize and contains 13 to 15% sugar in immature grains. Sweet corn is consumed at the soft dough stage with succulent grains, emerges as an alternative dish of urbanites namely, vegetable, roasted ears, soups, corn syrup and sweeteners etc. It also found a special niche in the preparation of native beer. Sweet corn can be harvested within 80 to 90 days after sowing. They are harvested earlier by 35 to 45 days compared to normal grain corn. Presently, greater emphasis is given to the cultivation of sweet corn due to increasing demand. There is an increasing tendency to produce sweet corn at commercial level to augment the income of the farming community dwelling in the outskirts of big cities and metropolis. Since there is limited scope to increase the area under sweet corn cultivation because of competition from other cereals and cash crops, the only alternative is through enhancement of productivity by various management factors (Bhatt, 2012). Therefore, to evaluate foliar application of different sea weeds sap to enhance growth, yield and nutrient uptake of Sweet corn with this objective trial was conducted towards the balancing nutrients requirement for the optimum productivity of maize (Sweet corn) crop.

MATERIALS AND METHODS

Experimental field and soil information: Field experiments were carried out during *Rabi* season of 2012-13 at Research cum Instructional Farm of Indira Gan-

dhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh). The experimental site, Raipur comes under the seventh agro climatic region of India i.e. Eastern plateau and hills which is termed as sub humid with hot summer and cold winter. Weekly average meteorological data during the span of experimentation, recorded at meteorological observatory, Indira Gandhi Krishi Vishwavidyalaya, Raipur, for the year 2012-13. The total rainfall of 14.00 mm was received during rabi season 2012-13. The maximum temperature ranged in crop seasons was 25.6 0C to 30.7 0C during rabi season 2012-13. The minimum temperatures during the same season was 8.3 0C to 18.1 0C. The Sun shine hours ranged from 3.3 to 9.9 hour day⁻¹. The other weather parameters were normal during the season. The experiment comprised of ten treatments, the details of treatments are T1: 2.5% K Sap + RDF, T2: 5.0% K Sap + RDF, T3: 10% K Sap + RDF, T4: 15% K Sap + RDF, T5: 2.5% G Sap + RDF, T6: 5.0% G Sap + RDF, T7: 10% G Sap + RDF, T8: 15% G Sap + RDF, T9: Water Spray + RDF and T10: 7.5 % K SAP+50% RDF. Three sprays of *Kappaphycus* and *Gracilaria* extract were applied at different growth stages after 30, 50 and 70 day after sowing (DAS). The soil of experiment field was 'Inceptisols' (sandy loam) which is locally known as 'Matasi'. The soil of the site is sandy loam with pH 7.0, EC 0.29 dSm⁻¹, organic carbon 0.60%, Available N 269.69 kg ha⁻¹, P 14.42 kg ha⁻¹ and K 489.44 kg ha⁻¹. Spraying of sea weed sap was done in the field as per the treatment. First spraying was done at 30 DAS on February 15, 2012, second at 50 DAS on March 07, 2013 and third spray was done at 70 DAS on March 27, 2013 through knapsack sprayer. 500 liter ha water was used at 30 DAS and 600 liter at 50 and 70 DAS. The treatments were distributed in a randomized block design with three replications. The recommended dose of fertilizer N:P₂O₅:K₂O was 120:60:40 kg ha⁻¹, respectively and N applied in the form of urea, P₂O₅ (Phosphorus) in the form of SSP and K₂O (Potassium) in the form of muriate of potash (MOP). Entire phosphorus and potash were applied as basal. Nitrogen fertilizer was applied in three split's as per schedule that is, 50% N as basal and remaining in two equally split doses.

Observation taken: Growth attributing characters plant height (cm), number of leaves; stem girth and yield attributing characters were recorded as per the standard method. The plant height (cm), number of leaves and stem girth of maize was recorded at harvest. Five plants were used for recording observation. Mean value was then computed by dividing the summation with five. The post harvest observations like cob length, cob girth and cob weight were recorded from five tagged plants in each plot. After recorded data the average was worked out to get plants⁻¹. The number of row cob⁻¹ and number of grain row⁻¹ were counted randomly selected five cobs from each plot. The mean value was calculated. The grain number per cob was

worked out by using the formula, Grain number per cob = No. of row X No. of grain row⁻¹.

Plant analysis: Plant samples were drawn from the randomly tagged plants of different rows of the treated plots and analyzed. Nitrogen content in sweet corn plant at harvest was estimated. Phosphorus and potassium content were determined in the extracts after digesting the plant material with tri acid mixture of 9: 4: 1 (HNO₃: H₂SO₄: HClO₄). The analysis was done by micro Kjeldahl, Vanadomolybdophosphoric yellow colour and flame photometric methods for nitrogen, phosphorus and potassium, respectively. The uptake of N, P and K by sweet corn crop was computed on the basis of dry matter accumulation and expressed as kg ha⁻¹.

Statistical analysis: The experiment was laid out in randomized block design (RBD). The data obtained from various characters under study were analyzed by the method of analysis of variance as described by Gomez and Gomez (1984). The level of significance used in "F" test was given at 5 percent. Critical difference (CD) values are given in the table at 5 percent level of significance, wherever the 'F' test was significant at 5 percent level.

Preparation and chemical composition of liquid seaweed extract: The seaweed extract used in this study was obtained from *Kappaphycus sp.* and *Gracilaria sp.* The algae were handpicked from the coastal area of Rameswaram, T. N., India during September, 2011. It was washed with seawater to remove unwanted impurities and transported to the field station at Mandapam, Rameswaram. Here, samples were thoroughly washed using tap water. After that, fresh seaweed samples were homogenized by grinder with stainless steel blades at ambient temperature, filtered and stored (Eswaran et al., 2005). The liquid filtrate was taken as 100% concentration of the seaweed extract and further diluted as per the treatments. The nitrogen (N) content of seaweed extract (100% concentrate) was determined by taking 20 ml of filtrate which was oxidized and decomposed by concentrate sulphuric acid (10 ml) with digestion mixture (K₂SO₄ : CuSO₄ = 5:1) heated at 400° C temperature for 2½ hours as described in the semi-micro Kjeldahl method (AOAC, 1995), and other nutrient elements were analyzed by inductively coupled plasma-optical emission spectroscopy (ICP-OES), after wet digestion of filtrate (20 ml) with HNO₃-HClO₄ (10:4) di-acid mixture (20 ml) and heated at 100°C for 1 hour and then raise the temperature to about 150°C (Richards, 1954)

RESULTS AND DISCUSSION

Growth characters of maize (sweet corn): From the observations recorded at harvest (Table 3), it is revealed that the maximum plant height (210.67 cm) was recorded with application of 15% G Sap + RDF (T8) which was found at par with treatments T3, T4 and T7. The observation recorded for number of leaves plant⁻¹

Table 1. Chemical composition of *Kappaphycus* sap.

Nutrient	Amount present	Nutrient	Amount present
Moisture	94.38 g/100 ml	Iron	8.58 mg/100 ml
Protein	0.085 g/100 ml	Manganese	0.22 mg/100 ml
Fat	0.0024 g/100 ml	Nickel	0.35 mg/100 ml
Crude fibre	0.01 g/100 ml	Copper	0.077 mg/100 ml
Carbohydrate	1.800 g/100 ml	Zinc	0.474 mg/100 ml
Energy	7.54 Kcal/100 ml	Chromium	3.50 mg/100 ml
Sodium	18.10 mg/100 ml	Lead	0.51 mg/100ml
Potassium	358.35 mg/100 ml	Thiamine	0.023 mg/100 ml
Magnesium	116.79 mg/100 ml	Riboflavin	0.010 mg/100 ml
Phosphorous	2.96 mg/100 ml	B-Carotene	0.0 mg/100 ml
Calcium	32.49 mg/100 ml	Iodine	160 mg/100 ml
Indole acetic acid	23.36 mg/L	Kinetin + Zeatin	31.91 mg/L
Gibberelin GA	27.87 mg/L		

Data courtesy: National Institute of Nutrition, Hyderabad, India (except growth hormone data generated by CSMCRI using quantitative MS-MS and LC-MS techniques)

Table 2. Chemical composition of *Gracilaria* sap.

Nutrient	Amount present	Nutrient	Amount present
Ash	38.91 g/100 g	Calcium	295.50 mg/100 g
Crude protein	9.58 g/100 g	Copper	0.20 mg/100 g
Crude fibre	10.40 g/100 g	Zinc	1.00 mg/100 g
Crude lipid	2.00 g/100 g	Iron	67.35 mg/100 g
Saturated fatty acid	48.92% of total fatty acids	Manganese	4.16 mg/100 g
Total amino acids	889.78 mg/g of protein	Nickel	0.92 mg/100 g
Moisture	88.88%	Cobalt	0.24 mg/100g
Vitamin C	28.50 mg/100 g	Sulphate	106.20 mg/100 g
Carbohydrate	45.92%	Chlorine	1170.00 mg/100g
Potassium	8633.00 mg/100 g	Lead	1.11 mg/100 g
Magnesium	549.50 mg/100 g	Cadmium	0.14 mg/100 g
Phosphorus	278.50 mg/100 g	Sodium	158.50 mg/100 g

Source: (Benjama and Masniyom, 2012). *Gracilaria* extract also contains variable amount of phytohormones like Auxin, Cytokinin, Abscisic acid etc. (Yokoya *et al.*, 2010)

indicated that maximum numbers of leaves (12.40) was recorded under treatment 15% K Sap + RDF (T4) which was found at par with treatments T2, T3, T5, T6, T7 and T8. Data recorded for stem girth showed significant influence and spray of 15% G Sap + RDF (T8) produced the highest stem girth which was significantly similar in treatments T3, T4, T7 and T9. The lowest plant height, number of leaves and stems girth were recorded under treatment 7.5 % K SAP+50% RDF (T10). The foliar spray of seaweed sap during important growth stages of sweet corn crop, increased their metabolism activity and act as growth stimulant for healthy plant

development. The increased growth and yield attributes may be due to the presence of some growth promoting substances such as IAA and IBA, gibberellins, cytokinins, micronutrients, vitamins and amino acids (Challen and Hemingway, 1966).

Yields attributes and yield of maize (sweet corn):

The different sprays of seaweed sap were significantly influenced for yield attributes and yield except the observation recorded for cob length and cob girth (Table 4). The highest green cob weight with husk (374.08 g cob⁻¹), number of grains row cob⁻¹ (17.47), number of grains row⁻¹ (39.87) and ultimately the high-

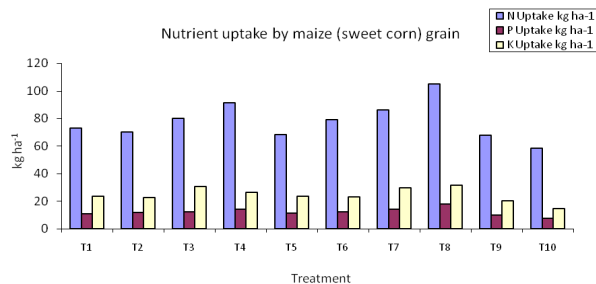
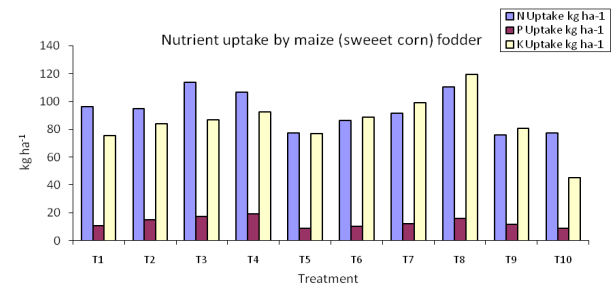
**Fig. 1:** Nutrient uptake (N, P, K) by maize grain as influenced by seaweed saps.**Fig. 2:** Nutrient uptake (N, P, K) by maize fodder as influenced by seaweed saps.

Table 3. Growth characters of maize (Sweet corn) as influenced by seaweed saps.

Treatment	Plant height (cm)	No. of leaves plant ⁻¹	Stem girth (cm)
T ₁ : 2.5% K Sap + RDF	201.20	11.47	8.01
T ₂ : 5% K Sap + RDF	204.80	12.07	8.23
T ₃ : 10% K Sap + RDF	207.27	12.33	8.41
T ₄ : 15% K Sap + RDF	209.53	12.40	8.53
T ₅ : 2.5% G Sap + RDF	201.47	11.67	8.05
T ₆ : 5% G Sap + RDF	204.60	11.80	8.25
T ₇ : 10% G Sap + RDF	207.00	12.20	8.46
T ₈ : 15% G Sap + RDF	210.67	12.33	8.67
T ₉ : Water Spray + RDF	198.13	11.13	8.37
T ₁₀ : 7.5 % K SAP+50% RDF	193.67	11.07	7.87
SEm±	1.50	0.25	0.10
CD (P=0.05)	4.47	0.75	0.30

Table 4. Yield attributes and yield of maize (sweet corn) as influenced by seaweed saps.

Treatment	Cob length with husk (cm)	Cob girth with husk (cm)	Green cob weight (g cob ⁻¹)	No of grain row cob ⁻¹	No. of gain row ⁻¹	Total no. of grain cob ⁻¹	Green cob yield (q ha ⁻¹)	Fodder yield (q ha ⁻¹)
T1: 2.5% K Sap + RDF	25.33	20.43	339.67	16.47	38.00	626.60	140.27	305.33
T2: 5% K Sap + RDF	27.09	20.87	350.00	16.60	38.87	646.60	145.61	314.08
T3: 10% K Sap + RDF	26.17	20.51	357.33	16.87	38.93	654.93	167.66	325.01
T4: 15% K Sap + RDF	26.72	20.82	369.75	17.20	39.47	678.60	185.24	328.65
T5: 2.5% G Sap + RDF	25.35	20.05	333.01	16.40	38.20	626.27	141.68	305.84
T6: 5% G Sap + RDF	26.47	20.57	349.49	16.87	38.87	655.40	152.92	312.82
T7: 10% G Sap + RDF	26.59	20.67	359.85	17.13	39.27	672.20	167.97	326.40
T8: 15% G Sap + RDF	26.98	20.78	374.08	17.47	39.87	695.80	189.97	345.19
T9: Water Spray + RDF	26.27	19.79	340.30	16.40	38.20	627.00	138.29	305.87
T10: 7.5 % K SAP+50% RDF	25.77	19.72	332.83	15.80	37.20	588.67	111.09	286.13
SEm±	0.45	0.28	8.36	0.24	0.47	12.04	4.30	4.16
CD (P=0.05)	NS	NS	24.86	0.73	1.41	35.78	12.79	12.38

Table 5. Nutrient uptake by of maize (sweet corn) as influenced by seaweed saps.

Treatment	Dry grain yield (q ha ⁻¹)	Dry fodder yield (q ha ⁻¹)	Total nutrient uptake		
			N uptake (kg ha ⁻¹)	P uptake (kg ha ⁻¹)	K uptake (kg ha ⁻¹)
T1: 2.5% K Sap + RDF	22.54	61.87	169.36	21.65	98.75
T2: 5% K Sap + RDF	22.02	68.56	165.07	26.76	106.33
T3: 10% K Sap + RDF	25.52	74.92	193.63	29.38	117.21
T4: 15% K Sap + RDF	27.47	82.52	197.72	33.57	118.46
T5: 2.5% G Sap + RDF	22.07	57.43	145.63	20.40	100.31
T6: 5% G Sap + RDF	23.52	64.61	165.05	22.58	111.54
T7: 10% G Sap + RDF	26.36	73.10	177.66	26.41	128.99
T8: 15% G Sap + RDF	30.00	86.77	215.27	33.95	150.59
T9: Water Spray + RDF	20.20	65.32	143.46	21.53	101.25
T10: 7.5 % K SAP+50% RDF	15.48	43.8	135.49	16.67	60.15
SEm±	1.56	2.4	6.88	1.12	3.88
CD (P=0.05)	4.64	7.14	20.47	3.35	11.55

Table 6. Cost of cultivation, gross return, net return and B:C ratio of maize (sweet corn) as influenced by seaweed saps.

Treatment	Cob yield (q ha ⁻¹)	Fodder yield (q ha ⁻¹)	Economic Return from Cob (Rs ha ⁻¹)	Economic Return from Fodder (Rs ha ⁻¹)	Cost of Cultivation (Rs ha ⁻¹)	Gross return (Rs ha ⁻¹)	Net return (Rs ha ⁻¹)	B:C ratio
T1: 2.5% K Sap + RDF	140.27	305.33	140270	15267	62099	155537	93438	1.50
T2: 5% K Sap + RDF	145.61	314.08	145610	15704	63374	161314	97940	1.55
T3: 10% K Sap + RDF	167.66	325.01	167660	16251	65924	183911	117987	1.79
T4: 15% K Sap + RDF	185.24	328.65	185240	16433	68474	201673	133199	1.95
T5: 2.5% G Sap + RDF	141.68	305.84	141680	15292	62099	156972	94873	1.53
T6: 5% G Sap + RDF	152.92	312.82	152920	15641	63374	168561	105187	1.66
T7: 10% G Sap + RDF	167.97	326.4	167970	16320	65924	184290	118366	1.80
T8: 15% G Sap + RDF	189.97	345.19	189970	17260	68474	207230	138756	2.03
T9: Water Spray + RDF	138.29	305.87	138290	15294	60824	153584	92760	1.53
T10: 7.5 % K SAP+50% RDF	111.09	286.13	111090	14307	61590	125397	63807	1.04

est number of grain cob⁻¹ (695.80) were observed under treatment 15% G Sap + RDF (T₈). However, treatment T₂, T₃, T₄, T₆ and T₇ were found at par in case of green cob weight and number of grains row⁻¹. In case of number of grains row cob⁻¹ treatments T₃, T₄, T₆ and T₇ were found at par and in case of total number of grains cob⁻¹ treatment T₄ and T₇ found at par with treatment 15% G Sap + RDF (T₈). Above all yield characters were observed lowest under treatment 7.5% K SAP+50% RDF (T₁₀) due to minimum response of nutrient applied in the field under this treatment. Green cob yield (189.97 q ha⁻¹) and fodder yield (345.19 q ha⁻¹) were recorded highest under treatment 15% G Sap + RDF (T₈) which was significantly similar with treatment 15% K Sap + RDF (T₄) in case of green cob yield. The lowest green cob yield and fodder yield was recorded under treatment 7.5% K SAP+50% RDF (T₁₀). Growth hormones like cytokinin and gibberellins have been detected in the extract of *Kappaphycus alvarezii* and *Gracilaria spp.* which might be responsible for beneficial effects in the present study. Significant increase in seed yield of black gram (Venkataraman and Mohan, 1997) and marketable bean by 24% has been reported with the foliar application of seaweed extract (Temple and Bomke, 1989). Growth hormones like cytokinin and gibberellins along with other trace element have been detected in the extract of *Kappaphycus spp.* and *Gracilaria spp.* which might be responsible for beneficial effects in the present study. Foliar application of aqueous extract of gives positive result on the growth and yield of pea and black gram (Ramamoorthy *et al.*, 2006a, 2006b, Ramamoorthy and Sujatha, 2007). Seaweed extracts not only increase the vegetative growth of the plant but it also triggers the early flowering, fruiting in crops and ultimately on grain yield. Zodape *et al.* (2011) also reported that foliar application of liquid extract of *Kappaphycus spp.* increase the yield tomato. Application

of seaweed extract enhanced the early growth and yield attribute properties in legume plants and 12-25% higher yield than that of control (Sethi and Adhikary, 2008).

Nutrient uptake by maize (sweet corn): Grain yield was recorded at harvest of the maize crop on dry basis till the natural senescence of crop, the grain yield (30 q ha⁻¹) and fodder yield (86.77 q ha⁻¹) were recorded highest under treatment 15% G Sap + RDF (T₈) which was found at par with treatment T₃, T₄ and T₇ in case grain yield and treatment T₄ found at par in case of fodder yield with same treatment. The lowest grain yield (15.48 q ha⁻¹) and fodder yield (43.80 q ha⁻¹) were recorded under treatment 7.5 % K SAP+50% RDF (T₁₀). The nutrient uptake was analyzed for grain (Fig. 1) and fodder (Fig. 2) after harvest of crop was done, the maximum N, P and K uptake in grain was observed under treatment 15% G Sap + RDF (T₈) which was found at par with treatment T₄ in case of N uptake in grain and treatments T₃ and T₇ were found at par in case of K uptake of grain. The lowest uptake of N, P and K in grain was recorded under treatment 7.5 % K SAP+50% RDF (T₁₀). The data recorded for nutrient uptake in fodder, the maximum N uptake was recorded under treatment 10% K Sap + RDF (T₃) which was found at par with treatments T₄ and T₈. The maximum P uptake in fodder was recorded under treatment 15% K Sap + RDF (T₄) and maximum K uptake was observed under treatment 15% G Sap + RDF (T₈). The lowest P and K uptake in fodder was recorded under treatment 7.5 % K SAP+50% RDF (T₁₀) and the lowest N uptake was recorded under treatment Water Spray + RDF (T₉). The total nutrient uptake by maize (Table 5), the maximum total N, P and K uptake were observed under 15% G sap + RDF (T₈) which was found at par with only treatment 10% K sap + RDF (T₄) for total N and P uptake. These results are closely similar with findings of Pramanick *et al.* (2013) who

noted that the foliar application of seaweed sap improved the nutrient uptake capacity of crop. Presence of marine bioactive substance in seaweed sap improves stomata uptake efficiency in treated plants compared to non treated ones (Mancuso *et al.*, 2006). The findings of Rathore *et al.* (2009) also confirmed that the foliar application of 15% (v/v) aqueous extracts prepared from fresh *Kappaphycus alvarezii* resulted in 57% increase of *Glycine max* yield compare to the control and intensified nutrient uptake by soybean crop.

Economics of maize (sweet corn): It is revealed from the data present in table 6, that the cost of cultivation of maize (sweet corn) varied from Rs. 60,824 to 68,474 ha⁻¹ owing to the use of different doses of seaweed sap and fertilizers. The data recorded for yield showed that the maximum cob yield (189.97 q ha⁻¹) was observed under treatment 15% G Sap + RDF (T8), hence, as compared with other treatment it gave maximum gross return (Rs. 2,07,230 ha⁻¹), net return (Rs. 1,38,756 ha⁻¹) and B:C ratio (2.0), which was followed by treatment 15% K Sap + RDF (T4) with net return (Rs. 1,33,199 ha⁻¹) and B:C ratio (1.17). Treatment 15% G Sap + RDF (T8) gave Rs. 45,996 ha⁻¹ more as compared to Water spray + RDF (T9). Application of seaweed extract enhanced the early growth and yield attribute properties in legume plants and yield return of 12-25% more than that of control (Sethi and Adhikary, 2008).

Conclusion

It was concluded that the seaweed extracts are effective in increasing the growth parameters, yield attributes of maize and its application gave the maximum return. The saps also enhance nutrient uptake by maize cob and fodder. Presence of some macro and micro-elements and plant growth regulators, especially cytokinins, IAA, GA in *Kappaphycus* and *Gracilaria* extracts is responsible for the increased yield and improved nutrition of sweet corn receiving foliar application of the aforesaid two saps.

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