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Influence of Seaweed Saps on Nutrient Uptake and Yield and of Maize (Zea mays L.)

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Abstract: *A field experiment was conducted during Kharif, 2012-13 to study the effect seaweed saps on Nutrient uptake and yield of maize in red sandy loam soils of Telangana state. The foliar spray was applied thrice at different concentration of 5, 10, 15% (v/v) of seaweed extracts namely Kappaphycus and Gracilaria. The grain yield of maize (DHM 117) was significantly higher with application of 10% Gracilaria sap spraying thrice + RDF (9306 kg/ha) application than compared to the maize crop applied with 7.5% Kappaphycus sap + 50% recommended dose of fertilizer which recorded significantly lowest grain yield (7271 kg/ha). The percent increase in grain yield of maize with application of 10% Gracilaria sap thrice was 22.9% than compared to 7.5 Kappaphycus sap +50% recommended dose of fertilizers application. While, it is 8.5% higher than compared to water sprayed with recommended dose of fertilizers applied crop. The higher nutrient uptake by maize stalk and grain was observed with 10% Gracilaria sap + RDF treatment.*

Keywords: *Seaweed saps, Kappaphycus, Gracilaria, Recommended dose of fertilizer, Maize, Nutrient uptake.*

INTRODUCTION

The worldwide concern about the environmental pollution caused by imbalanced and misuse of fertilizers have led farmers towards the use of organic fertilizers or low input sustainable agriculture (Bhatia, 2002). With increasing demand, availability of organic fertilizers from one or two sourses is not adequate. To meet the increasing demand many viable options as possible have to be explored (Chhaya 1997) and one such option is use of sea weed as a fertilizer (Zodape 2001). In recent years, the use of natural sea weed products as substitute to the conventional chemical fertilizers assumed importance (Lingapur *et. al.* 2002). Application of sea weed preparations as fertilizer has many beneficial effects on plants (Norrie and Hiltz, 1999). Many claims have been made for seaweed extracts including increased nutrient uptake and changes in plant tissue composition, increased resistance to fungal disease, reduces incidence of insect attack higher yields deeper root development and improve ability to withstand adverse environmental conditions (Ferreira and Lourens, 2002).

This study evaluates foliar application of Kappaphycus and Gracilaria sea weed sap in enhancing nutrient uptake and yield of maize crop

MATERIALS AND METHODS

An experiment was conducted during Kharif 2012-13 at Agricultural Research Station, Karimnagar situated at 79°15′ East longitude and 18°30′ North latitude with an elevation of 259.15m above mean level. The experimental site was red sandy loam soils having neutral pH (6.64), medium in organic carbon (0.65%) and high available nitrogen (613.88 kg/ha), high in available phosphorus (62.84 kg/ha) and high in available potassium (436 kg/ha). It is covered under Northern Telangana agro climatic zone of Telangana state which falls under semi arid climate with dry hot summer and cold winters. The actual rainfall

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received during Kharif 2012-13 from June to October 2012 was 721.2 mm in 51 rainy days. The maximum temperature ranged from 31.9 to 35.7°C, while, the minimum temperature ranged from 23.2 to 26.4°C during the crop season. The experiment was laid out in randomized block design with three replications and ten treatments. The treatments included foliar application of two sea weed extracts of Kappaphycus (K sap) and Gracilaria (G sap) in different concentrations as

T1 : 2.5% Kappaphycus sap + RDF;

T2 : 5% Kappaphycus sap + RDF;

T3 : 10% Kappaphycus sap + RDF;

T4 : 15% Kappaphycus sap + RDF;

T5 : 2.5% Gracilaria sap + RDF;

T6 : 5% Gracilaria sap + RDF;

T7 : 10% Gracilaria sap + RDF;

T8 : 15% Gracilaria sap + RDF;

T9 : RDF + Water spray;

T10 : 7.5% Kappaphycus sap + 50% RDF.

The Maize crop (DHM 117) was sown on 26-06-2012 with the plot size of 6 rows of 4 m width with crop spacing at 75 × 20 cm. The recommend dose of fertilizer (RDF) for maize was 200:60:50 Kg NPK/ha was applied, with entire phosphorus as basal, recommended dose of nitrogen in four equal splits *i.e.*, basal, 23, 42 and 55 DAS and recommended dose of potassium as basal (50%) and at flowering (50%). Three sprays of Kappaphycus and gracilaria sea weed extracts were applied at per-tasseling stage to flowering stage at 43, 57 and 66 DAS. The spray fluid was mixed with adjuvant sandovit @1 ml/ litre water. The total spray volume of 500 litres/ha was applied in each application. The fertilizer topdressing and spraying of sea weed extracts were not coincided. The other management practices were adopted as per recommended package of practices. The crop was harvested on 19-10-2012.

Data were taken through random sampling at 60 DAS to measure dry matter accumulation, leaf no/plant and leaf area of flag leaf by measuring the length × width method there by LAI was computed as the ratio of the leaf area to the area of ground cover. The chlorophyll index was measured by chlorophyll meter. Data on yield attributes were taken randomly before harvesting. Plot yields were recorded on plot basis. At harvesting, stalk samples were collected from each treatment, oven dried at 70° C to constant weight and treatment wise maize seed was air dried and ground to pass through a 0.5 mm sieve for chemical analysis.

RESULTS AND DISCUSSION

Effect of Sea Weed Sap on Nutrient Uptake of Maize Stalk and Grain

The nutrient uptake (nitrogen, phosphorus and potassium) by maize stalk and grain was presented indicated that the nitrogen uptake in maize stalk with 15% G sap application + RDF recorded higher (258 kg/ha) followed by N uptake with 10% G sap + RDF (256.6 kg/ha) and 10% / 15% K sap + RDF application (252.8 kg/ha). The lowest uptake of N was observed in 7.5% K sap + 50% RDF (199.3 kg/ha). The RDF + water spay (248.5 kg/ha) was found to be equivalent to 5% K sap + RDF (248.4 kg/ha) or 5% G sap + RDF (249.8 kg/ha).

The phosphorus uptake resulted higher in maize stalk with 10% G sap + RDF treatment (37.4 kg/ha) followed by 10% K sap + RDF (36.0 g/ha). The lowest uptake of P was noticed with 7.5% K sap + 50% RDF (23.2 kg/ha).

While, the potassium uptake was also found to be higher with application of 15% G sap + RDF (201.3 kg/ha) followed by 10% G sap + RDF (198.6 kg/ha) and 15% K sap + RDF (192.1 kg/ha). The lowest uptake of K was with 7.5% K sap + 50% RDF (117.9 kg/ha). (Table 1).

The Nutrient uptake by maize grain was also found to follow the similar trend. The highest nutrient uptake by maize grain was observed with 10% G sap + RDF treatment (66.1 – 34.6 – 18.4 kg of NPK /ha). The increased uptake was possibly due to higher yield in this treatment. The lowest nutrient uptake by maize grain was recorded with 7.5% K sap + 50% RDF (43.7 – 18.8 – 12.4 kg of NPK /ha) (Table 3). These results confirm those findings previously reported by Crouch *et. al.* (1990) who noted an increased uptake of magnesium (Mg), K and Calsium (Ca) in lettuce with sea weed extract application. Turan and Kose (2004), Nelson and Van

Table 1
Effect of sea weed sap on uptake of nitrogen, phosphorus and potassium on maize (DHM 117) crop.

	Nutrient up take by maize (kg/ha)					
	Nutrient uptake by maize stalk (kg/ha)			*Nutrient uptake by maize grain (kg/ha)*		
Treatments	*Nitrogen*	*Phosphorus*	*Potassium*	*Nitrogen*	*Phosphorus*	*Potassium*
T1 : 2.5% K sap + RDF	220.4	27.1	138.7	54.7	23.0	14.2
T2 : 5% K sap + RDF	248.4	32.9	164.7	58.0	23.2	16.3
T3 : 10% K sap + RDF	252.8	36.0	175.9	57.6	28.0	16.3
T4 : 15% K sap + RDF	252.8	34.3	192.1	54.5	28.5	15.8
T5 : 2.5% G sap + RDF	237.8	32.3	146.4	54.5	26.2	13.0
T6 : 5% G sap + RDF	249.8	34.4	179.2	63.1	28.5	15.6
T7 : 10% G sap + RDF	256.6	37.4	198.6	66.1	34.6	18.4
T8 : 15% G sap + RDF	258.0	35.5	201.3	60.5	34.1	17.4
T9 :RDF + Water spray	248.5	30.7	176.6	48.4	26.8	15.0
T10 : 7.5% K sap + 50% RDF	199.3	23.2	117.9	43.7	18.8	12.4

Staden (1984) and Mancuso *et. al.* (2006) also observed increased uptake of N, P, K and Mg in grapevines and cucumber with the application of sea weed extract. The prescence of marine bioactive substances in sea weed extract improves stomata uptake efficiency in treated plants than compared to non treated ones (Mancuso *et. al.*, 2006, Biswajit *et. al.*, 2013).

Effect of Sea Weed Sap on Soil Health

The soil available nitrogen status did not differ significantly with different treatments after harvest of maize. The soil available nitrogen after harvest of maize was found to decline in all the treatments than compared to the initial status. Comparison among different treatments indicated higher soil available nitrogen after harvest of maize with 5%G sap + RDF (298 kg/ha) followed by treatments of 2.5% G sap + RDF (294.4 kg/ha) and 10% K sap + RDF (290 kg/ha). The treatment of 7.5% K sap + 50% RDF recorded lowest soil available nitrogen (221 kg/ha) after harvest. The higher removal of N than the initial soil level possibily may be due to higher removable by crop and in adequate substitution through fertilization and mineralization.

The soil available Phosphorus did not differ significantly in different treatments after harvest of maize. However the soil available phosphorus exhibited higher removal after harvest of maize in 10% G sap + RDF (52.3 kg/ha) followed by 15% G sap + RDF (53.1 kg/ha) and 10% K sap + RDF (56.5 kg/ha) (Table 2).

The soil available potassium differed significantly with different treatments. It was found to be significantly higher in maize after harvest in treatment of 5% G sap + RDF and also found to be on par with treatment of 15% G sap + RDF (503.3 kg/ha), 2.5% G sap + RDF (495.3 kg/ha), water spray + RDF (487.3 kg/ha), 5% K sap + RDF (484 kg/ha), 10% K sap + RDF (483.3 kg/ha) and 15% K sap + RDF (480 kg/ha). Significantly higher K removal was observed with 10% G sap + RDF (428.7 kg/ha) and 2.5%K sap + RDF (426 kg/ha). Significantly lowest soil available potassium was recorded with 7.5% K sap + 50% RDF (386.3 kg/ha) (Table 2).

The soil organic carbon status also differed significantly in different treatments. Significantly higher O.C was recorded after harvest in treatment of 5% G sap + RDF (0.76%) and was found to be on par with 10% K sap + RDF (0.75%), water spray + RDF (0.73%) and 15% G sap + RDF (0.70%). Significantly the soil organic carbon was found to deplete after harvest of maize in treatment of 5% K sap + RDF (0.42%) application. (Table 2) and was found to be on par 10% Gsap + RDF (0.46%), 7.5% Ksap+50% RDF (0.46%), 2.5% K sap + RDF(0.50%) and 2.5%G sap +RDF(0.52%).

Table 2
Effect of sea weed sap on Soil fertility after final harvest of maize (DHM 117) crop.

	Nutrient status after harvest of maize (kg/ha)			
Treatments	*Available nitrogen (kg/ha)*	*Available phosphorus (kg/ha)*	*Available Potassium (kg/ha)*	*Organic carbon (%)*
T1 : 2.5% K sap + RDF	258	56.7	426.0	0.50
T2 : 5% K sap + RDF	275	54.2	484.0	0.42
T3 : 10% K sap + RDF	290	53.5	410.3	0.75
T4 : 15% K sap + RDF	262	53.7	399.3	0.60
T5 : 2.5% G sap + RDF	294	56.2	495.3	0.52
T6 : 5% G sap + RDF	298	55.5	586.3	0.76
T7 : 10% G sap + RDF	284	52.3	428.7	0.46
T8 : 15% G sap + RDF	282	53.1	503.3	0.70
T9 :RDF + Water spray	269	54.6	487.3	0.73
T10 : 7.5% K sap + 50% RDF	221	53.6	386.3	0.46
Initial Soil Status	613.88	62.84	436.0	0.65
C.D (0.05)	NS	NS	111.6	0.104
S.Em+	22.5	3.8	37.3	0.04
C.V(%)	14.3	10.5	14	11.7

Effect of Sea Weed Sap on Yield of Maize

The Maize Cob and Grain yield differed significantly among different concentrations of sea weed sap sprayings and water spray (Table 3).

Cob yield

The cob yield recorded significantly higher in maize crop applied with 10% G sap (11444 kg/ha) and was found to be on par with application of 15% Gracilaria sap (11205 kg/ha), 10% Kappaphycus sap (11183 kg/ha). 15% Kappaphycus sap (10994 kg/ha). 5% Gracilaria sap (10780 kg/ha), 5% Kappaphycus sap (10652 kg/ha) and water spray treatment (10608 kg/ha). While the cob yield in maize crop applied with 7.5% Kappaphycus sap + 50% RDF recorded significantly lowest than compared to all the other treatments under test (Biswajit *et. al.*, 2013). The cob yield with 10% Gracilaria sap application thrice on maize crop resulted in 19.7% higher cob yield than compared to 7.5% Kappaphycus sap + 50% RDF. While, the percentage increase in cob yield was 7.3% over the crop with water spray (Table 3).

Grain yield

The data on grain yield indicated that maize crop applied with 10% Gracilaria sap spraying thrice resulted in significantly higher grain yield (9306 kg/ha) and was found to be on par with application of 10% Kappaphycus sap (9058 kg/ha); 15% Gracilaria sap (9047 kg/ha); 15% Kappaphycus sap (8817 kg/ha), 5% Gracilaria sap (8598 kg/ha) and crop with water spray (8515 kg/ha). The maize crop applied with 7.5% Kappaphycus sap + 50% recommended dose of fertilizer recorded significantly lowest grain yield (7271 kg/ha) and was on par with maize crop sprayed with 2.5% Kappaphycus sap (7892 kg/ha). The percent increase in grain yield of maize with application of 10% Gracilaria sap thrice was 22.9% than compared to 7.5 Kappaphycus sap +50% recommended dose of fertilizers application. While, it is 8.5% higher over water sprayed crop.

Significantly higher cob and grain yield with application of 5/10/15% Gracilaria sap or 10/15%

Table 3
Effect of sea weed sap on Cob and Grain yield of maize (DHM 117) crop.

Treatments	*Cob yield (kg/ha)*	*Grain yield (kg/ha)*
T2 : 5% K sap + RDF	10652	8351
T3 : 10% K sap + RDF	11183	9058
T4 : 15% K sap + RDF	10994	8817
T5 : 2.5% G sap + RDF	10122	8094
T6 : 5% G sap + RDF	10780	8598
T7 : 10% G sap + RDF	11444	9306
T8 : 15% G sap + RDF	11205	9047
T9 :RDF + Water spray	10608	8515
T10 : 7.5% K sap + 50% RDF	9193	7271
C.D (0.05)	844	843
S.Em+	282	282
C.V(%)	4.6	5.7

Kappaphycus sap and water spray may be attributed to higher nutrient uptake by the maize stalk and grain which contributed to the higher yield in these treatments as is evident from the nutrient uptake studies. Zodape et al, 2008 also reported the promotive effects of sea weed extract due to mining of nutrients besides plant bio physiological activities. Another reason for higher yields in these treatments may also be attributed to the initial soil fertility status which was found to be medium in organic carbon and available NPK was found to be higher in status which must have inturn contributed to higher yields in these treatments including water spray treatment. Further sea weed extracts stimulate various aspects of growth and development resulting in overall good health of the plants. The effect of sea weed extracts on root development and mineral absorption, shoot growth and photosynthesis and ultimately crop yield was significant as the extract is the rich source of several primary nutrients like K,P, secondary nutrients like Ca, Mg, trace elements like Zn, Cu, Fe, Mn (Biswajit *et. al.*, 2013) .

CONCLUSION

In red sandy loam soils with higher NPK status and medium in organic carbon, the cob and grain yield of maize (DHM 117) was significantly higher with application of 10% Gracilaria sap spraying thrice + RDF (9306 kg/ha) application and was found to be on par with application of 10% Kappaphycus sap (9058 kg/ha); 15% Gracilaria sap (9047 kg/ha); 15% Kappaphycus sap (8817 kg/ha), 5% Gracilaria sap (8598 kg/ha) and crop with water spray (8515 kg/ha). The maize crop applied with 7.5% Kappaphycus sap + 50% recommended dose of fertilizer recorded significantly lowest grain yield (7271 kg/ha) and was on par with maize crop sprayed with 2.5% Kappaphycus sap (7892 kg/ha). The percent increase in grain yield of maize with application of 10% Gracilaria sap thrice was 22.9% than compared to 7.5 Kappaphycus sap +50% recommended dose of fertilizers application. While, it is 8.5% higher than compared to water sprayed with recommended dose of fertilizers applied crop.

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