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Evaluation of Fertilizer Potential of Sea Weed (*Kappaphycus* and *Gracilaria*) Saps in Potato Crop in North Eastern Hill Region of India

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ABSTRACT

A field experiment was conducted during the summer season at Central Potato Research Station, Shillong, Meghalaya to study the effect of sea weed saps on growth and productivity of potato in the North Eastern hill region of India. The trial was laid out in randomized block design, replicated thrice, with 10 treatments. The number of shoot per plant was found to be non-significant and vary from 2.8 to 3.0. The maximum plant at harvest was recorded under application 7.5 *Kappaphycus* Spray + 100% RDF while lowest under 6.25% + 50% RDF. Maximum small size tuber was found with an application of 10 % *Gracilaria* spray + RDF which was at par with 2.5 % *Kappaphycus* spray + RDF and 7.5 % *Gracilaria* spray + RDF but significantly superior to other treatment. However, the highest medium size tube of potato was noticed under 6.25% *Kappaphycus* spray along with 50% recommended dose of fertilizer. Highest large size tuber was recorded with an application of 5% *Kappaphycus* spray + RDF followed by 2.5% *Kappaphycus* spray along with RDF as well as 7.5 % *Gracilaria* spray + RDF which was at par, but significantly superior to rest of treatment. Application of 2.5% *Kappaphycus* spray + 100% RDF recorded the highest productivity of potato (27.1 t/ha) followedby 100% RDF + *Kappaphycus* spray @ 5.0% (26.6 t/ha) which were at par with each other but significantly superior to the rest of treatments. Based on the economic yield of potato, it may be concluded that the application of 2.5 % *Kappaphycus* spray + 100% RDF was found to be more profitable under rainfed condition of Meghalaya.

Key words : NEH Region, Nutrient, Potato, Seaweed Sap, Tuber Crop

INTRODUCTION

Potato is the one of the most important vegetable crop, primarily cultivated during summer season under rainfed condition of north eastern hill region of India. Fertilizer consumption in potato has been increasing since last few decades due to remunerative prices of potato (Singh *et al.*, 2017). Majority of farmers in the land lock region are not capable to adopt recommended doses of fertilisers for potato cultivation based on soil test value which is not only jeopardising their profitability but also increase the cost of cultivation. Dependence on chemical fertilizers to meet the entire nutrient requirement of potato within a very short period is very high task for sustainable production as the dosage of synthetic fertilizer used per unit area tends to increase every subsequent year to attain same level productivity of potato. Consequently, a large portion of applied nutrient is remaining in the soil as a residual fertility. This condition certainly not only increases cost of cultivation, but also resulted in decline in factor productivity and deterioration of soil health vis-à-vis soil fertility and causes environmental pollution (Kumar *et al.*, 2008). The ever increasing production cost of fertilizers are stressing to search for sustainable and eco-friendly alternative which can maintain high yield yet preserve ecological balance (Singh *et al.*, 2017). Therefore, there is a need of some growth promoting substance at peak growth stage to prompt action for enhancing utilization efficiency of fertilizers. Similarly, seaweeds have been recognized as potential bio-fertilizer (Zhang and Ervin, 2008) and bio-stimulant for improving growth and yield of many crops worldwide as it contains all the trace elements and plant growth regulators such as auxins, gibberellins and cytokinins in varying amount. The information on role of seaweed as a source of nutrients and growth promoting substance has also been established by Datta *et al.* (2003), Saravanan *et al.* (2003) and Shankar *et al.*(2001).Extracts from *Kappaphycu salvarezii* (K sap) contains good amount of Indole Acetic acid (23.4 mg/lit), Gibberelin (27.8 mg/lit) and Kinetin + Zeatin (31.9 mg/lit) and extracts from Gracilariaedulis (G sap) contains significant amount of P (278.5mg/lit), Na (1952 mg/lit), Fe (12.7 mg/lit) and Mn (329 mg/lit) (Rathore *et al.*, 2009; Benjama and Masniyom, 2012).

Foliar applications of nutrients offer a quicker response of supplying nutrients to plants than soil application. Due to bio-degradable properties and quick absorption by foliage of seaweeds sap may become crucial component of sustainable agriculture and holds a strong potential to replace the substantial amount chemical fertilizers without losing the productivity of potato. Hence, keeping these points in view,

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an investigation was undertaken to study the effect of sea weed saps on growth and productivity of potato in the north eastern hill region of India.

MATERIALS AND METHODS

A field experiment was conducted during summer season of 2013-14 at Central Potato Research Station, Shillong, Meghalaya. The geographical co-ordinates of experimental field were 25°54' N latitude and 91°84' E longitude and an altitude of 1740 meters above mean sea level. The soil was sandy loam in the texture with pH 4.3, moderately fertile, being high in organic carbon (1.9%), medium in available nitrogen (305.5 kg/ha), low in available phosphorus (14.5 kg/ha) and high in available potassium (305.0 kg/ha). The maximum temperature varied between 20 and 25°C during crop seasons. Similarly, minimum temperature varied between 8 and 18°C.The trial was laid out in randomized block design, replicated thrice, with 10 treatments.

The medium sized seed tubers of potato cv. KufriJyoti were planted during the first week of March and crop was harvested in the month of July. The gross plot size area of 8.4m^2 (3.5m X 2.4m) while net plot size of 5 m^2 area (2.5mx2.0m)of each plot. The tubers were planted at 20 cm apart in the furrows of 50 cm distance and covered immediately after planting. The recommended dose of fertilizers i.e. 130 kg N, 120 kg P_2O_5 and 60 kg K_2O/ha along with 5 ton of farm yard manure was applied as per treatment. Half dose of N and full dose of P and K in the form of urea, single super phosphate, and muriate of potash, respectively were applied as per treatment as basal dose before planting.

The remaining half dose of N was applied at earthing up. The earthing up was done at 45 days after planting along with weeding to facilitate the development of tubers at the stolen tips. During earthing up the remaining nitrogen dose was side dressed and mixed thoroughly with the soil. The observations on growth attributes *viz.* plant height, no. of shoots per plant were recorded after 70 days of planting at peak growth stage of crop. Other than late blight there was no major incidence of insect pest. For controlling of late blight two spray with 0.2 % mancozeb and one spray of Ridomil MZ (metalaxyl + mancozeb) 0.25 % were sprayed. The crop was harvested manually at maturity in bright sunny days. All the tubers were dried and graded in shade and their weight and number were recorded as grades viz; large size (60g and above), medium size (20-60 g) and small size (less than 20 g). Then tuber yield of different plots were estimated and converted into tonnes/hectare.

The plant samples (tuber and haulm) were collected as per treatment at harvest. Samples were kept in an oven at 60 5C for 48 hours. Before the start of the experiment, composite soil sample for all treatments were collected with the help of soil auger and core sampler. A composite sample from 0-15 cm soil layer was analysed for chemical composition. These samples are processed through standard procedure and pooled analysis of organic carbon and nutrients are taken. However, plot wise soil samples were also collected. At the end of the experiment all plots were sampled separately and all samples were used for chemical analysis for organic carbon, available soil nutrient status for major (N, P, K). All observations for each character were subjected to statistical analysis according to the standard method. The calculated values of the treatments and error variance ratio were compared with Fisher and Yates F table at 5% level of significance. The differences between significant treatments means were tested against CD at 5 per cent probability.

RESULTS AND DISCUSSION

Growth attributes

Growth attributes of potato did not differ significant among different treatments (Table 1). The range of plant emergence was recorded between 81.7 to 90.5 %. Similarly the maximum plant height was found in combination with application of 5.0% Kappaphycus Spray + 100% recommended dose of fertilizers which remains at par to 2.5 % Kappaphycus Spray + 100 % Recommended dose of fertilizer. The number of shoot per plant was also found to be non-significant and vary from 2.8 to 3.0.

The maximum plant (71.7) at harvest was recorded under application 7.5 Kappaphycus Spray + 100% RDF while lowest (64.7) under 6.25% + 50% RDF. Enhancement of plant growth attribute might be due bio stimulatory effect of seaweed extract which provide growth promoter substances such as cytokinins, auxins and vitamines ultimately increasing chlorophyll production by boosting photosysnthesis, thereby stimulating vegetative growth. Similar result was also reported by Gajewski*et al.*(2008) on Chinese cabbage.

Table 1 : Effect of different treatment on growth attributes of potato

Treatments	Emergence (%)	Plant heigh (cm)	Shoot / plant (no.)	Plant at harvest (no.)
(2.5% KS + 100% RDF)	85.7	38.6	3.0	67.3
(5.0% KS + 100% RDF)	89.3	39.6	2.8	68.3
(7.5% KS + 100% RDF)	88.5	36.0	2.9	71.7
(10.0% KS + 100% RDF)	86.9	33.9	2.7	67.3
(2.5% GS + 100% RDF)	81.7	37.9	2.8	70.3
(5.0% GS + 100% RDF)	90.5	37.9	2.9	69.0
(7.5% GS + 100% RDF)	84.5	37.1	3.0	70.3
(10.0% GS + 100% RDF)	87.7	35.8	2.9	65.0
(100% RDF + Water spray)	87.3	35.9	2.8	70.3
(6.25% KS + 50% RDF)	86.5	32.2	2.8	64.7
SEm±	3.3	2.7	0.2	2.4
CD (P=0.05)	NS	NS	NS	NS
CV%	4.6	9	10.3	4.3

Yield attributes

Economic yield of different grade tuber is presented in Table 2which shows that maximum small size tuber was found with application of 10 % Gracilaria spray + RDF which was at par to 2.5 % Kappaphycus spray + RDF and 7.5 % Gracilaria spray + RDF but significantly superior to other treatment. However, the highest medium size tube of potato was noticed under 6.25% Kappaphycus spray along with 50% recommended dose of fertilizer and at par to 2.5 % Kappaphycus spray +RDF, 5.0 % Kappaphycus spray + RDF, 7.5 and 10% Gracilaria spray with RDF but significantly superior to rest of the treatment. Highest large size tuber was recorded with application of 5% Kappaphycus spray + RDF followed by 2.5% Kappaphycus spray along with RDF as well as 7.5 % Gracilaria spray + RDF which was at par but significantly superior to rest of treatment. Data presented with respect to total tuber yield in Table 2 shown that the application of 2.5% Kappaphycus spray + 100% RDF recorded the highest productivity of potato (27.1 t/ha) followed by 100% RDF + Kappaphycus spray @ 5.0% (26.6 t/ha) which were at par to each other but significantly superior to the rest of treatment. Extracts of Kappaphycus contains good amount of Indole Acetic acid, Gibberelin and Kinetin and extracts from Gracilaria edulis (G sap) contains significant amount of P, Na, Fe and Mn. Foliar application of such extract to potato increased the availability mineral nutrients at peak growth stage, consequently, enhancing the yield attributs characters of and finally converting in economic yield. Significant enhancement in yield due to foliar application of seaweed sap extract was also reported by Shah *et al.* (2013) in wheat crop.

Table 2 : Effect of different treatment on grade wise and total economic yield of potato

Treatments	Small size (<20 g)	Medium size (20-60g)	Large size (>60g)	Total tuber yield (t/ha)
(2.5% KS + 100% RDF)	2.8	15.1	9.2	27.1
(5.0% KS + 100% RDF)	2.3	14.3	9.9	26.6
(7.5% KS + 100% RDF)	2.4	10.6	7.8	20.8
(10.0% KS + 100% RDF)	2.1	11.6	7.1	20.8
(2.5% GS + 100% RDF)	2.2	12.6	9.1	23.9
(5.0% GS + 100% RDF)	2.5	12.6	8.4	23.5
(7.5% GS + 100% RDF)	2.9	13.9	9.1	25.9
(10.0% GS + 100% RDF)	3.0	13.1	8.9	25.0
(100% RDF + Water spray)	2.4	11.4	6.2	20.0
(6.25% KS + 50% RDF)	2.5	15.4	7.6	25.4
SEm±	0.2	0.9	0.6	1.7
CD (P=0.05)	0.4	2.0	1.2	3.5
CV%	8.9	8.8	8.2	8.6

Economics of sea weed sap

The economics of sea weed sap spray presented in Table 3 revealed that the maximum net return and B:C ratio (2.08 & 2.03) was recorded with spray of 2.5 % and 5.0 % of *Kappaphycus* sap followed by 7.5% Gracilaria saps. Cost of cultivation in the all treatments is similar in all the treatment because of seaweed sap price was assumed as negligible. Only the major cost incurred for labour charges of spraying of sea weed sap. Total return is function of productivity of potato and prevailing sale price of market. Increases in the net return and benefit cost ratio are directly related to the enhancement of productivity potato.

CONCLUSION

Based on the economic yield of potato, it may be concluded that the application of 2.5 % *Kappaphycus* spray + 100% RDF was found to be more profitable under rainfed condition of Meghalaya.

Table 3 : Economics of sea weed sap spraying on potato cultivation on per hectare basis

Sea weed sap	Sap (litre)	Water (litre)	Cost of Cultivation (Rs/ha)	Total return (Rs/ha)	Net Return (Rs/ha)	B:C Ratio
2.5% *Kappaphycus* sap	25	1000	104438	216753	112315	2.08
5.0% *Kappaphycus* sap	50	1000	104438	212416	107978	2.03
7.5% *Kappaphycus* sap	75	1000	104438	166525	62087	1.59
10.0% *Kappaphycus* sap	100	1000	104438	166632	62194	1.60
2.5% Gracilaria sap	25	1000	104438	191237	86799	1.83
5.0% Gracilaria sap	50	1000	104438	187765	83327	1.80
7.5% Gracilaria sap	75	1000	104438	207463	103025	1.99
10.0% Gracilaria sap	100	1000	104438	199991	95553	1.91
Water spray	-	1000	104438	160157	55719	1.53
6.25% *Kappaphycus* sap	62.5	1000	104438	203356	98918	1.95

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