Journal of AgriSearch 4(1):31-35
An Open Access International Peer Reviewed Quarterly

ISSN : 2348-8808 (Print), 2348-8867 (Online)
http://dx.doi.org/10.21921/jas.v4i1.7416

Fertilizer Potential of Sea Weed (Kappaphycus and Gracilaria) Saps in Potato Crop

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ARTICLE INFO

Received on	:	17.01.2017
Accepted on	:	15.02.2017
Published online	:	01.03.2017

ABSTRACT

A field experiment was conducted during winter season of 2012-13 in sandy loam soil at Central Potato Research Station, Patna to study the effects of seaweed saps on growth, yield and nutrient uptake of Potato. The foliar spray was applied at 45, 60 and 75 days after planting at different concentrations (0, 2.5, 5.0, 7.5 and 10 % v/v) of seaweed extracts namely *Kappaphycus* (K Sap) and *Gracilaria* (G Sap). Foliar applications of seaweed sap significantly enhanced large and medium grade as well as total tuber yield. Increment in total tuber yield of potato with application of 7.5% K sap + recommended dose of fertilizer (RDF), 5% G sap + RDF, and 10% G sap + RDF) over control were in tune of 3.95 t ha-1 ,4.88 and 4.07 t ha-1 respectively. Applications of 7.5 % K sap+ RDF and 5% G sap + RDF resulted in increase by 15.8 and 34.9% in large grade tuber yield and 11.5% and 22.5% in medium grade tuber yield, respectively compared to control. Improved nutrient uptake (NPK) was also observed with seaweed extract.

Key words: Seaweed saps, *Kappaphycus*, *Gracilaria*, Potato, Fertilizer, Growth, Yield

INTRODUCTION

Potato (*Solanum tuberosum* Linn.) is one of the most important crops in Bihar after rice, wheat and maize. It is well known fact that potato crop is a heavy feeder of nutrients. However, sole dependence on chemical fertilizers to meet its nutrient demand may pose a great threat to sustainability of its production as the dosage of fertilizer used per unit area tends to increase year after year to obtain same yield. India is the second largest potato producing country in the world after China, with annual production of 37.3 million tonnes from area of 1.83 million hectare. The projected potato production estimates for 2030 is 79 million tonnes from 2.55 million ha (Singh *et al*., 2015). 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). Intercropping of potato with compatible crops during winter season provides an opportunity to increase the potato acreage as well as production (Singh *et al*., 2013). 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. Integrated plant nutrient supply (IPNS) is an important and promising component for sustainable productivity of crops and restores soil fertility (Kharub *et al*., 2003). In this context low input sustainable agriculture and reduced chemical input concepts with focus on green manuring, recycling crop residues, inclusion of legumes in rotation and use of bio-fertilizers or other organic sources of nutrients to substitute a part of nutrient requirement are important, to make potato production an economically viable proposition. Integrated use of organic and inorganic fertilizers in potato based cropping system improves the soil health and productivity of the system (Singh and Lal, 2011). 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).

Among various types of sea weeds, brown sea weeds inhabiting costal region are second most abundant group comprising >200 spp. and has potential to be used in agriculture (Blunden and Gordon, 1986).The Council of Scientific and Industrial Research-Central Salt and Marine Chemical Research Institute (CSMCRI), Bhavnagar, India has introduced sea weeds *Kappaphycus alvarezii* and *Gracilaria edulis* in India and developed cultivation practice for its large scale farming in shallow coastal water. Extracts from *Kappaphycus alvarezii* (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 Gracilaria edulis (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 and Benjama and Masniyom, 2012). Foliar application of mineral nutrients offers a quicker method of supplying nutrients to higher plants than methods involving soil application. Some authors opined possibility of an active uptake through stomata pores instead of cuticular uptake (Eichert *et al*., 1998). Because of its organic and bio-degradable properties seaweeds is important in sustainable agriculture and holds a strong potential to reduce dependence on chemical fertilizers. So, considering these points in view

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present investigation was planned to evaluate potential of seaweed saps as fertilizer for enhancing growth, yield and economics of potato.

MATERIALS AND METHODS

A field experiment was conducted during winter season of 2012-13 at Central Potato Research Station, Patna (Bihar), which is situated at 26.9 0N and 85.10 E at an elevation of 53 m. Experiment was laid out in randomized block design with ten treatments replicated thrice. Treatment consisted of concentration of sea weed sap (%) applied as foliar sprays on potato crop at 45, 60 and 75 days after planting.

T1 = 2.5% *Kappaphycus* sap + Recommended dose of fertilizers (RDF)
T2 = 5.0% *Kappaphycus* sap + RDF
T3 = 7.5% *Kappaphycus* sap + RDF
T4 = 10.0% *Kappaphycus* sap + RDF
T5 = 2.5% *Gracilaria* sap + RDF
T6 = 5.0% *Gracilaria* sap + RDF
T7 = 7.5% *Gracilaria* sap + RDF
T8 = 10.0% *Gracilaria* sap + RDF
T9 = RDF + water spray
T10 = 6.25% *Kappaphycus* sap + 50% RDF

Soil of experimental field was sandy loam in texture with PH 7.1, bulk density 1.46 g/cm3, low in organic carbon (0.43%) and available nitrogen (224.1 kg ha^{-1}), medium in available phosphorous (19.45kg P ha^{-1}) and potassium (260.5kg K^2O ha^{-1}). Field was ploughed to a depth of 20-30 cm by mould board plough followed by one ploughing with harrow and planking. Thereafter, two cross ploughing with cultivator each followed by planking was done to prepare a good seed bed. Potato was planted in rows spaced at 60 cm with seed tuber weighing 45-60 g of cultivar "Kufri Pukhraj" on 8 November 2012 using seed rate of 30-35 q ha-1. Crop was planted in ridge and furrow system and at time of planting seed tuber was covered with 10-15 cm soil to make ridges. Potato crop was fertilized with recommended dose of N, P and K fertilizers viz. 150: 80:100 kg/ha in terms of N, P_2O_5 and K_2O. Full dose of phosphorus and potassium through triple super phosphate and Muriate of potash, respectively, were applied at the time of planting. Half dose of Nitrogen @ 75 kg/ha was applied through urea as basal dose. Herbicide Goal (Oxy-flourfen) @0.5 liter/ha was applied on ridges as pre-emergence (2 DAP) for checking weeds in potato crop. Intercultural operation comprised of one hand weeding and hoeing followed by application of half dose of N @ 75 kg/ha by band placement and earthing up was done 25 DAP. As per the treatment, spray of sea weed sap (*Kappaphycus* sap and *Gracilaria* sap) was done at 45, 60 and 75 DAP. In one hectare 1000 litres of water was used for each spraying. A total of two sprays of Dithane M-45 (Mancozeb 64%) @ 2.5 Kg/ha and one spray of Ridomil (Mancozeb -64% + Matalxyl -8%) @ 2 kg/ha were done during the cropping season. Cop was dehaulmed at 90 DAP on 8 February, 2013 and tubers were lifted from the field 10 days after haulm cutting. Produce of each plot was graded into four grades G1 (<25 g), G2 (25-50 g), G3 (50-75 g) and G4 (>75 g) size tubers, weighed and number counted separately. Soil samples (0-15cm) were collected at beginning of experiment and after crop harvest and were analyzed for organic C, available N, P and K by following standard procedures. The experimental data were subjected to statistical analysis using ANOVA following RBD as described by Gomez and Gomez (1984). Differences were considered significant at 5% level of probability. The cost of cultivation was calculated by taking into account the prevailing market price of inputs and produce. Returns were calculated on yearly basis and (B: C ratio was expressed as net return per rupee spent.

RESULTS AND DISCUSSION

Growth attributes

Plant emergence was uniform in all the treatments. Plant emergence ranged from 96% to 98% (Table 1). There was no significant effect of sea weed sap spray on plant height, number of leaves per plant and stems/plant at 45 and 60 DAP.

Table 1: Effect of Sea Weed Sap on potato emergence and growth parameters

Treatment		45 DAP			60 DAP		
	Germination (%)	Plant height (cm)	Stems/ plant	leaves/ plant	Plant height (cm)	Stems/ plant	leaves/ plant
T_1= 2.5% *Kappaphycus* sap+RDF	96.67	34.40	3.47	52.93	56.4	3.51	79.8
T_2=5.0% *Kappaphycus* sap+RDF	95.33	35.80	3.07	54.20	58.2	3.21	84.6
T_3=7.5% *Kappaphycus* sap+RDF	98.00	35.87	4.00	54.00	59.3	4.11	87.4
T_4=10% *Kappaphycus* sap+RDF	98.33	35.40	3.93	56.67	57.8	4.21	88.3
T_5=2.5% *Gracilaria* sap+RDF	97.33	32.60	3.60	43.60	49.3	3.64	79.8
T_6=5.0% *Gracilaria* sap+RDF	96.00	34.53	4.27	56.73	57.6	4.56	84.4
T_7=7.5% *Gracilaria* sap+RDF	97.33	33.73	3.33	52.27	53.4	3.58	81.4
T_8=10% *Gracilaria* sap+RDF	97.00	34.73	3.60	54.73	60.3	3.94	85.3
T_9=RDF+Water spray	96.00	34.73	3.80	49.00	52.3	3.92	81.4
T_{10}=6.25% K Sap + 50%RDF	96.33	33.27	4.13	56.47	47.5	3.78	72.6
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Tuber yield

Spray of sea weed sap *Kappaphycus* @ 7.5%, *Gracilaria* @ 5% and *Gracilaria* @ 10% had significant effect on grade wise tuber yield and tuber number as well as total tuber yield and tuber number (Table 2).

Spray of *Kappaphycus* @ 7.5% at 45, 60 and 75 DAP increased total tuber yield by 3.95 t ha^{-1} over application of only RDF + spray of water. Similarly spray with *Gracilaria* @ 5% and *Gracilaria* @ 10% improved the total tuber yield by 4.88 and 4.07 t ha^{-1} respectively over application of only RDF + spray of water. The Grade wise tuber yield was also influenced by spray of sea weed saps.

Spray of *Kappaphycus* sap @ 10% and *Gracilaria* @ 5% increased large grade tuber yield by 15.8 and 34.9% over RDF+spray of water. Application of half of RDF + spray with *Kappaphycus* @ 6.5% produced lowest yield of large grade tuber. The yield of medium size tuber increased by 6.43 and 11.47 percent at 5 and 7.5% *Kappaphycus* sap spray respectively, while spray of *Gracilaria* sap @ 2.5 and 10%, increased medium grade tuber yield by 11.61 and 22.47% respectively, over RDF + spray of water. Such increment might be due seaweed extract is a bio stimulant, which provide crop with micro, macro nutrients and significant amounts of cytokinins, auxins and vitamines (Blunden, 1991), ultimately increasing chlorophyll production by boosting photosysnthesis, thereby stimulating vegetative growth. These results agree with those of Blunden and Wildgoose (1977) on potato, Featonby and Van Staden (1983) and Beckett *et al.* (1994) on tepary bean, Arthur *et al.* (2003) on pepper, Zodape *et al.* (2008) on okra, Gajewski *et al.* (2008) on Chinese cabbage and Abdel-Mawgoud *et al.* (2010) on water melon. Significant enhancement in yield due to foliar application of seaweed sap in wheat and tomato was noticed by Shah *et al.* 2013 and Denir *et al.* 2006, respectively.

Among different concentrations of *Kappaphycus* sap tested, all were at par among themselves as well as with RDF+ spray of water. Among different concentrations of *Gracilaria* sap, 5 and 10% were at par among themselves but superior to 2.5 and 7.5% conc. in respect of total tuber yield.

Table 2: Effect of Sea Weed Sap on potato tuber yield

Treatment	Tuber yield (t/ha)			
	Large grade	Medium grade	Small grade	Total tuber
2.5% *Kappaphycu* ssap+RDF	14.74	19.67	1.98	36.39
5.0% *Kappaphycus* sap+RDF	13.60	23.29	1.17	38.07
7.5% *Kappaphycus* sap+RDF	14.77	24.40	1.46	40.63
10% *Kappaphycus* sap+RDF	15.66	21.48	1.19	38.33
2.5% *Gracilaria* sap+RDF	9.29	24.43	1.24	34.96
5.0% *Gracilaria* sap+RDF	18.25	21.70	1.61	41.56
7.5% *Gracilaria* sap+RDF	14.81	21.74	1.24	37.78
10% *Gracilaria* sap+RDF	13.07	26.80	0.88	40.75
RDF+Water spray	13.53	21.89	1.27	36.68
6.25% K Sap + 50%RDF	11.28	19.93	1.22	32.43
CD (P=0.05)	1.92	2.41	NS	3.43

There was no significant variation in small grade tuber number due to different treatments. However, large and medium grade as well as total tuber number followed the trend similar to their yield (Table 3).

Table 3: Effect of Sea Weed Sap on potato tuber number

Treatment	Tuber number (000/ha)			
	Large grade	Medium grade	Small grade	Total tuber
2.5% *Kappaphycus* sap+RDF	143.1	265.5	130.1	538.7
5.0% *Kappaphycus* sap+RDF	94.44	305.2	128.2	527.8
7.5% *Kappaphycus* sap+RDF	114.4	323.9	137.3	575.6
10% *Kappaphycus* sap+RDF	89.87	287.7	136.3	513.9
2.5% *Gracilaria* sap+RDF	96.73	340.2	107.6	544.5
5.0% *Gracilaria* sap+RDF	132.4	299.3	146.1	577.8
7.5% *Gracilaria* sap+RDF	98.04	288.8	150.7	537.5
10% *Gracilaria* sap+RDF	71.24	360.9	141.2	573.3
RDF+Water spray	98.04	289.9	132.4	520.3
6.25% K Sap + 50%RDF	114.40	260.6	119.9	494.9
CD (P=0.05)	12.7	29.6	NS	36.8

Economics

Cost of cultivation was similar in all the treatments, but the gross return and net return differed due to difference in yield. The gross returns as well as net returns and B: C ratio was also maximum with spray of 5 % *Gracilaria* sap. followed by 7.5% *Kappaphycus* and 10% *Gracilaria* saps. The increase in production due to spray of seaweed sap increased the gross and net returns and B:C ratio (Table 4).

Table 4: Economics of Sea Weed Sap spray on potato

Treatment	Cost of cultivation (Rs/ha)	Total return (Rs/ha)	Net return (Rs/ha)	B:C ratio
2.5% *Kappaphycus* sap+RDF	106424	181930	75506	1.71
5.0% *Kappaphycus* sap+RDF	106424	190345	83921	1.79
7.5% *Kappaphycus* sap+RDF	106424	203140	96716	1.91
10% *Kappaphycus* sap+RDF	106424	191625	85201	1.80
2.5% *Gracilaria* sap+RDF	106424	174820	68396	1.64
5.0% *Gracilaria* sap+RDF	106424	207780	101356	1.95
7.5% *Gracilaria* Sap+RDF	106424	188915	82491	1.78
10% *Gracilaria*sap+RDF	106424	203765	97341	1.91
RDF+Water spray	106424	183390	76966	1.72
6.25% K Sap + 50%RDF	104212	162140	57928	1.56

Nutrient uptake

The use of the sea weed sap increased significantly N, P and K uptake by potato compared with control (Table 5). The highest N, P and K uptake was recorded with spray of 5 % *Gracilaria* sap+ RDF followed by 10 % *Gracilaria* sap+ RDF and 7.5% *Kappaphycus* + RDF. All these three treatments were statistically at par. High N, P and K uptake is attributed to higher gross biomass/ potato yield obtained. The lowest uptake was noted in 6.25% *Kappaphycus* Sap + 50% RDF. The N and P uptake was lower than the fertilizer dose applied, however, in case of K; the uptake by potato was higher than K dose applied. These results confirm those previously reported by Crouch *et al.* (1990) who noted increased uptake of Mg, K and Ca in lettuce with seaweed concentrate application. Turan and Köse (2004), Nelson and Van 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 seaweed extract. The presence of marine bioactive substances in seaweed extract improves stomata uptake efficiency in treated plants (Mancuso *et al.*, 2006).

Soil fertility status

It is evident from the Table 5 that there was no significant difference due to different treatments in available soil N, P and K after the harvest of potato crop. There was no appreciable change in available soil N, P and K content as compared to its initial value due to spray of sea weed sap on potato crop.

Table 5: Influence of seaweed sap spray on nutrient uptake by potato and soil fertility after harvest of potato

Treatment	Uptake by potato crop (Kg/ha)			Available soil nutrient after potato harvest (Kg/ha)			
	N	**P**	**K**	**N**	**P**	**K**	**OC (%)**
2.5% Kappaphycu ssap+RDF	111.4	17.8	117.3	229.1	23.0	250.5	0.43
5.0% Kappaphycus sap+RDF	116.4	18.7	123.8	225.5	22.7	247.6	0.42
7.5% Kappaphycus sap+RDF	121.5	19.1	128.5	223.9	22.1	245.8	0.41
10% Kappaphycus sap+RDF	117.2	18.9	124.7	224.2	24.0	251.9	0.41
2.5% Gracilaria sap+RDF	110.7	17.9	119.7	226.5	22.7	249.8	0.43
5.0% Gracilaria sap+RDF	127.3	20.5	141.6	222.4	22.7	245.7	0.43
7.5% Gracilaria sap+RDF	118.1	18.1	122.5	224.6	24.8	248.9	0.42
10% Gracilaria sap+RDF	123.7	19.4	132.2	224.7	22.8	247.9	0.41
RDF+Water spray	112.8	17.9	120.2	226.1	23.2	251.6	0.41
6.25% K Sap + 50%RDF	105.1	16.8	115.0	219.9	22.6	249.6	0.43
Initial soil fertility				224.1	19.4	260.5	0.43
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

CONCLUSION

It can be concluded that supplementation of RDF along with extract of either *Kappaphycus alvarezii* (K sap) at 7.5% concentration or *Gracilaria edulis* (G sap) at 5 /10% concentration could be followed to improve yield of potato. The saps also enhance nutrient uptake by this crop. Presence of microelements and plant growth regulators, especially cytokinins in *Kappaphycus* and *Gracilaria* sap is responsible for increased yield and improved nutrition of potato receiving foliar application of aforesaid two saps. In future, more evaluation of seaweed products will help in more refined interpretation and validating their effect on potato production.

ACKNOWLEDGEMENT

The authors are thankful to the Director, CSMCRI, Bhavnagar (Gujarat) for providing the Seaweed Saps and necessary facilities.

REFERENCES

Abdel-Mawgoud AMR, Tantawy AS, Hafez MM and Hoda AM.2010.Seaweed extract improves growth, yield and quality of different watermelon hybrids. *Research Journal of Agriculture and Biological Sciences* **6** (2): 161-86.

Arthur GD, Stirk WA and Van Staden J.2003.Effect of a seaweed concentrate on the growth and yield of three varieties of Capsicum annuum. *South African Journal of Botany* **69**: 207-11.

Beckett RP, Mathegka AD and Van Staden J.1994.Effect of seaweed concentrates on yield of nutrient stressed tepary bean (*Phaseolus acutifolius Gray*). *Journal of Applied Phycology* **6**: 429-30.

Benjama, O and Masniyom P.2012.Biochemical composition and physico-chemical properties of 2 red seaweeds (*Gracilaria fisheri* and *G tenuistipitaata*) from Pattani Bay in Southern Thailand. *Journal of science and Technology* **34** (2):223-30

Blunden G and Wildgoose PB.1977.Effect of aqueous seaweed extract and kinetin on potato yield. *Journal of Science of Food and Agriculture* **28**: 121-5.

Blunden G. 1991. Agricultural uses of seaweeds and seaweed extracts. In: Guiry MD and Blunden G (eds) Seaweed resources in Europe. Uses and potential. Wiley, Chichester, pp. 65-81.

Blunden G and Gordon SM. 1986.Betaines and their sulphono analogues in marine algae. *Progress in Phycological Research* **4**:39-80.

Crouch IJ, Beckett RP and van Staden J. 1990. Effect of seaweed concentrate on the growth and mineral nutrition of nutrient stressed lettuce. *Journal of Applied Phycology* **2**: 269-72.

Datta A, Das S, Basu M and Basu TK. 2003. Effect of krikelp powder (seaweed extract) and inorganic fertilizer on growth and productivity of pigeon pea under new alluvial zone of West Bengal. *Environment and Ecology* **21**(4): 823-6.

Demir, N Dural B andYaldirim K. 2006. Effect of seaweed suspensions on seed germination of tomato, pepper and aubergine. *Journal of Biological Sciences* **6**(6): 1130-33.

Eichert T, Burkhardt J, Goldbatch HE. 1998 Evidence for the uptake of large anions through stomatal pores. *Botanica Acta*. 111: 461-6.

Featonby SBC and Van Stadena J. 1983. The effect of sea weed concentrate on the growth of tomato plants innematode – infested soil. *Scientia Horticulture* **20**: 137-46.

Gajewski M, Katarzyna G and Bobruk J. 2008.The influence of Goëmar Goteobio stimulator on yield and quality of two Chinese cabbage cultivars. Conf. of biostimulators in modern agriculture "vegetable crops".Warsaw pp. 23-27.

Gomez KA and Gomez AA. 1984. Statistical procedures for agricultural research. John Wiley and Sons, NewYork.

Kharub AS, Chauhan DS, Sharma RK, Chhokar RS and Tripathi SC.2003. Diversification of rice (*Oryza sativa*)–wheat (*Triticum aestivum*) system for improving soil fertility and productivity. *Indian Journal of Agronomy* **48**(3): 149-52.

Kumar A, Tripathi HR, Yadav RA and Yadav DS.2008. Diversification of rice (*Oryza sativa*)–wheat (*Triticum aestivum*) cropping system for sustainable production in eastern Uttar Pradesh. *Indian Journal of Agronomy* **53** (1): 18-21

Mancuso S, Azzarello E, Mugnai S and Briand X. 2006. Marine bioactive substances (IPA extract) improve foliar ion uptake and water tolerance in potted Vitis Vinifera plants. *Advances in Horticultural Science* **20**: 156-61.

Nelson WR and Van Staden J .1984. Effect of seaweed concentrates on wheat culms. *Journal of Plant Physiology* **115**: 433-7.

Rathore S S, Choudhary D R, Boricha G N, Ghosh A B, Bhatt P, Zodape S T and Patolia J S. 2009. Effect of seaweed extract on growth, yield and nutrient uptake of soybean (*Glycin max*) under rainfed conditions. *South African Journal of Botany* **75** (2):351-5.

Saravanan S, Thamburaj S, Veeraragavathatham D and Subbiah A.2003. Effect of seaweed extract and chlomequat on growth and fruit yield of tomato (*Lycopersicon esculentum* Mill). *Indian Journal of Agricultural Research* **37** (2):79-87.

Shah MT, Zodape ST, Chaudhary DR, Eswaran K, Chikara J.2013. Seaweed sap as an alternative liquid fertilizer for yield and quality improvement of wheat. *Journal of Plant Nutrition* **36**: 192-200.

Shankar V, Tripathi PC, Qureshi MAA and Lawande KE 2001. Effect of organic seaweed extracts on growth, yield and quality of onion (*Allium cepa* L) var N-2-4-1. *South Indian Horticulture* **49** (Special): 247-8.

Singh AK, Singh KA, Bharati RC and Chadra N. 2013. Response of intercrops and nutrient management on the performance of tobacco based intercropping system and assessment of system sustainability. *Bangladesh J. Bot*. **42** (2): 343-8.

Singh SK, Lal SS, Dua VK and Singh RK. 2015. Nitrogen Management in Maize + Potato Inter Cropping System under Eastern Indo Gangetic Plains of Bihar. *Journal of AgriSearch 2* (4): 244-50.

Singh SK and Lal S S. 2011. Integrated nutrient management in potato based cropping systems in south Bihar Alluvial Plains. *Potato Journal* **38** (2): 162-9.

Turan K and Kose M.2004. Seaweed extract improve copper uptake of Grapevine (*Vitis vinifera*). *Acta Agriculturae Scandinavica* **54**: 213-20.

Zhang X and Ervin EH.2008. Impact of seaweed extracts based cytokins and zeatinriboside on creeping bent grass heat tolerance. *Crop Science* **48**: 364-70.

Zodape ST, Kawarkhe VJ, Patolia JS and Warade AD 2008. Effect of liquid seaweed fertilizer on yield and quality of okra (*Abelmoschus esculentus* L.). *Journal of Scientific & Industrial Research* **67**: 1115-7.

Citation:

Singh SK, Lal SS, Singh RK and Zodape ST.2017. Fertilizer potential of sea weed (*Kappaphycus* and *Gracilaria*) saps in potato Crop. *Journal of AgriSearch* **4**(1): 31-35