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SEAWEED SAP AS PRODUCTIVITY BOOSTER OF MAIZE

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ABSTRACT

A field experiment conducted in the research farm of Birsa Agricultural University, Ranchi (JH) during *kharif* 2012-13 and 2013-14 with maize variety HQPM-1 in a randomized block design and replicated thrice, with two sources of seaweed sap namely *Kappaphycus alvarezii* and *Gracilaria edulis* at 6 concentrations (0.0, 2.5,5.0, 7.5,10.0 and 15.0%)with 100%RDF (150:60:40 kg N,P_2O_5 andK_2O ha^{-1}) and 4 concentrations (0.0, 7.5, 10.0 and 15%) with 50 % RDF,revealed that application of either 7.5% K sap or 5% G sap along with 100% RDF enhanced the grain yield by 34 and 30% respectively than application of 100% RDF alone (41.92 q ha^{-1}). Application of 7.5% either of K sap or G sap along with 50% RDF produce similar grain yield (38.42 and 38.83 q ha^{-1} respectively) as that with 100% RDF alone and thereby saving 50% fertilizer need of the crop as well as maintained grain quality. Productivity of maize variety "HQPM-1" can be enhanced by more than 30% by the application of either 7.5%K sap or 5% G sap along with 100%RDF and can also save 50% fertilizer need of maize production with 50%RDF.

INTRODUCTION

Maize is an important cereal crop and cheaper source of dietery energy and proteins for economically weaker section of people in the world.The sap from seaweedsare new generation natural organic fertilizers and biostimulants containing nutrients and has the ability to promote faster germination of seeds and enhance yield and resistance ability of many crops (Dwivedi *et al.,* 2014). Seaweed sapcontains abundant natural source of major and minor plant nutrients, amino acids, vitamins, as well as growth promoting substances like gibberellic acid, cytokinins,auxins and quartenary ammonium compoundslike glycine betaine and cholium chloride and have been reported to stimulate the growth and yield of crops (Zodape, 2009; Crouch and Staden, 1993, Mondal *et al.,* 2015, Layek *et al.,* 2015). Liquid seaweed extract when applied to seed , soil or foliar sprayed on crops enhanced seed germination, nutrient uptake, growth (Immanuel and Subramanium, 1999) and yield of crops (Ananthraj and Venkatesalu, 2002). The diluted liquid seaweed extract has also been reported to enhance plant defence against disease and increases salt index (Jayaramanetal, 2011). The presence of adequate amount of natural growth promoting hormones and micronutrients in seaweed sap makes them an excellent fertilizer (Mohanty *et al.,* 2013).Unlike chemical fertilizer, seaweed derived products are biodegradable, non toxic, non polluting and non hazardous to human, animals and birds (Dhargal kar and Pereira, 2005). Liquid seaweed fertilizer is a unique combination of macronutrients, especially K and trace elements, polysaccharides and sugars that are in disssolved form (Mondal *et al.,* 2015).Present investigation was undertaken with the objective to find out the efficacy of seaweed saps (*Kappaphycus alvarezii , Gracilaria edulis)* forenhancingth eproductivityo fmaizeunderrain fedsituation.

MATERIALS AND METHODS

Field experiment was conducted in the research farm of Birsa Agricultural University,Kanke RanchiJharkhand, situated in the hilly region of Chhotanagpur Plateau of Jharkhand, India at 23º17' N Latitude and 85º19' E longitude at an altitude of 625 meter above mean sea level, during *kharif*seasons of 2012 and 2013 with maize variety HQPM-1 in sandy-loam soil, moderately acidic(pH 5.5) in nature (Jackson,1973), medium (0.45%) in organic carbon (Walkley and Black's rapid tritrate method; Jackson, 1973), low (235 kg ha^{-1}) available Nitrogen(Alkaline permanganate method; SubbiahandAsija, 1956), low (11.7 kg ha^{-1}) in available Phosphorus (Brays P1 method; Jackson, 1973) and medium (179.2 $kgha^{-1}$) available Potassim(Ammonium Acetate method; Hanwayand Heidel, 1952).Carbohydrate content of maize grain was also analysed (Dubois *et al.,* 2002). The total rainfall recorded during crop growth period was 856 and 916 mminfirst and second year respectively.

Experiment was laid out in a randomized block design with 18 treatments replicated thrice, with two sources of seaweed sap namely *Kappaphycusalvarezii and Gracilariaedulis*at six concentrations (0.0, 2.5,5.0,7.5,10.0 and 15.0%) with 100%

recommended dose of fertilizers, henceforth called RDF (150:60:40 kg N,P_2O_5 and K_2O ha^{-1}) and four concentration (0.0, 7.5, 10.0 and 15%) with 50% RDF. Seaweed saps were sprayed as per treatments on the foliage of maize thrice at 20 days interval starting from 30 days after sowing (DAS) till70 DAS.Crop was fertilized as per treatment through urea, Di-Ammonium Phosphate (DAP)and Muriate of Potash (MOP). Half dose of nitrogen, full dose of phosphorus and potassium was applied as basal and rest of nitrogen was topdressed in two splits at 35 and 50 DAS. Plant protection chemicals lindane @ 25kg ha^{-1} as basal application, furadan @1.75kgha^{-1} at 15DAS andhexacone @500mlha^{-1} at 75DAS were used.Yield attributes, yield and carbohydratecontent in grain were recorded. The data were statistically analysed by the method of analysis of variance (ANOVA) as described by GomezandGomez (1984).

RESULTS AND DISCUSSION

Effect of seaweed sap on yield and yield attributes of maize :

Maize crop fertilized with 100%RDF and sprayed with 7.5% K sap produced maximum grains per cob (502.5) with bolder seed (29.4 g 100^{-1} seed) which were significantly superior over rest of the combination of sap concentration and fertilizer level except spraying of 5% G sap with 100% RDF. An iincreasing trend of yield attributes were observed with increasing concentration upto 7.5% K sap and 5% G sap with 100% RDF, which thereafter decreased.In case of treatments with reduced fertilizer rates, 50%RDF along with spraying of 7.5% K sap or 7.5% G sap produced similar number of grains per cob (415.6 and 412.9, respectively) and 100 seed weight (26.3 g and 25.9 g, respectively),which was as high as 100% RDF with water spray (410.0 cob^{-1} and 26.5 g, respectively). Dwivedi*etal.*,2014 also observed that the application of K sap upto 15% and G sap upto 5% increased seeds per pod and seeds per plant of black gram.

Maize grain yield followed the trend of yield attributes. Higher grain and stover yield of maize was recorded with application of 100% fertilizer along with 7.5% K sap (56.17 q ha^{-1} and 114.63q ha^{-1}, respectively), which was onpar with application of 5%G sap along with100%RDF (54.29 and 104.16 q ha^{-1}, respectively). Application of either 7.5% K sap or 5% G sap along with 100% RDFenhanced the grain yield of maize by 34 and 30% respectively,than application of 100%RDF with water spray indicating that maize yield can boosted by 30 to 34% by application of seaweed sap. It is interesting to observe that even application of 7.5% of either K sap or G sap along with 50% RDF produced similar grain yield (38.42 and 38.83 q ha^{-1} respectively) as that with 100% RDF with water spray and thereby saving 50% fertilizer need of the crop. Similar finding was also reported by Shah *et al.,* 2012 on wheat, who observed that lower concentration of sap enhanced the yield and at higher concentration (above 7.5% K sap and 5% G sap)it declined. Increase in yield may be due to the presence of different plant growth regulators in sap as well as the minerals element present in the seaweed sap, which increased the rate of photosynthesis and delayed the senescence of the leaves, and ultimately enhanced the supply of photosynthate available for grain filling, thus resulting in bolder grain and consequently higher grain yield (Beckett and Van Staden, 1990; Mondal *et al.,* 2015).

Effect of seaweed sap concentration and fertilizer level on quality of maize

Carbohydrate content in grain was significantly influenced by seaweed sap concentration and fertilizer level. Maximum carbohydrate content in maize grain was recorded in the crop grown with application of 15% K sap along with 100% RDF (63.9%), which was significantly superior over rest of the combinations of K and G sap either with 100 or 50% RDF as well as control (100 or 50% RDF with water spray).

Table 1: Effect of seaweed sap concentration and fertilizer level on yield attributes, yieldand carbohydrate content ofmaize.(Pooled data of 2 years)

Treatments	No of cobs ha^{-1}	No. of grains cob^{-1}	100-seed weight (g)	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Carbohydrate content in grain (%)
T1(100%RDF + water)	53105	410.0	26.5	41.92	90.19	53.93
T2(100%RDF + 2.5% K)	53034	445.7	26.7	45.77	96.11	55.18
T3(100% RDF + 5% K)	52181	457.4	27.0	47.58	99.56	55.72
T4(100% RDF + 7.5%K)	52276	502.5	29.4	56.17	114.63	60.43
T5(100% RDF + 10%K)	51230	445.6	26.7	43.83	94.97	62.37
T6(100% RDF + 15%K)	51319	433.1	26.6	42.80	92.98	63.91
T7(50% RDF + 7.5%K)	49854	415.6	26.3	38.42	86.59	56.93
T8(50% RDF + 10%K)	49797	399.6	25.2	35.34	84.10	59.52
T9(50% RDF + 15% K)	49407	389.3	25.3	33.70	81.85	60.12
T10(100% RDF + 2.5G)	50272	451.3	26.7	42.40	93.36	55.81
T11(100% RDF + 5% G)	51094	507.9	29.6	54.29	104.16	56.55
T12(100% RDF + 7.5G)	49076	466.9	26.8	43.11	96.59	57.72
T13(100% RDF + 10G)	48847	465.2	27.0	43.84	97.65	60.50
T14(100 RDF + 15%G)	49096	449.7	26.3	38.63	89.43	62.37
T15(50% RDF + 7.5G)	49203	412.9	25.9	38.83	88.75	55.17
T16(50% RDF + 10% G)	48845	389.8	25.3	35.06	86.22	55.05
T17(50% RDF + 15% G)	48661	379.8	25.2	34.12	83.64	56.83
T18(50% RDF + water)	48720	362.7	24.3	30.95	77.38	52.95
CD (P = 0.05)	NS	35.9	1.76	5.78	13.47	0.26

Carbohydrate content increased with increasing concentration of K and G sap at both the fertilizer level. Lowest carbohydrate content (53.0%) was recorded with 50% RDF with water spray. Application of 50% fertilizer along with spraying of either K or G sap, irrespective of their concentration produced significantly higher carbohydrate content than application of 100%RDF with water spray (53.93%). Pise and Sabale, 2010 also reported that the carbohydrate content in fenugreek increased gradually with increasing concentration of seaweed liquid fertilizer upto 50% concentration, whichmight be due to the presence of different micro and macro nutrients besides plant growth regulator specially cytokinine.Kannan andTamilselven, (1990) also reported that increase in carbohydrate content may be due to the better absorption of most of the necessary element as well as proliferation of root by application of seaweed sap thus higher uptake of nutrients particularly those needed as constituents in protein synthesis(N, P and S) resulting in higher protein synthesis.Pise andSabale,(2010) also reported that the liquid extract of *Ulva fasciata, Sargassum ilicifolium* and *Gracilaria corticata* influenced the carbohydrates, protein and free amino acids content of *Trigonella foenum*. Our results corroborate with Ananthraj and Venkatasalu, (2002) who reported that carbohydrates and protein content improved in *Dolichosbi florus*seeds treated with10% extract of *Caulerpare cemosa* and *Gracilaria edulis*.

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REFERENCES

Anantharaj, M. and Venkatesalu, V. 2002. Studies on the effect ofseaweed extracts on *Dolichos biflorus*. *Seaweed Res. Utiln*. **24:** 129-137.

Beckett, R. P. and Van staden, J. 1990. The effect of seaweed concentrate on the yield of nutrient stressed wheat. *Botanica Marina*. **33:**147-152.

Crouch, I. J. and Van Staden, J. 1993a. Evidence for the presence of plant growth regulator in commercial seaweed products. *Plant Growth Regulation*. **13:** 21-29.

Dhargalkar, V. K. and Pereira, N. 2005. Seaweed promising plant of the millennium. *Science and Culture*. **71:** 60-66.

Dubois, M., Gilles, K. A., Hamilton, J. K., Robers, P. A. and Smith, F. 1956. *Anal. Chem*. **28(3):** 350-356.

Dwivedi, S. K., Meshram, M. R., Pal, A., Pandey, N. and Ghosh, A. 2014. Impact of natural organic fertilizer (seaweed saps) onproductivity and nutrient status of blackgram (*Phaseolusmungo*L.). *The Bioscan*. **9(4):** 1535-1539.

Gomez, K. A. and Gomez, A. A. 1984. Statistical procedures forAgricultural Research.A Willey - Interscience Publication, *J. Willey and Sons,* New York.

Hanway, J. J. and Hiedel, H. 1952. Soil analysis method as used in Iowa state college soil testing Laboratory. *Iowa Agriculture*. **57:** 1-31.

Jackson, M. L. 1973. Soil Chemical Analysis. *(New Delhi: Prentice Hall of India Pvt. Ltd.).*

Jayaraman, J., Norrie, J. and Punja, Z. K. 2011. Commercial extract from the brown seaweed *Ascophyllumnodosum* reduces fungal diseases in greenhouse cucumber. *J. Applied Phycology*. **23(3):** 353-361.

Immanuel, R. and Subramanian, S. K. 1999. Effect of fresh extract andseaweed liquid fertilizers on some cereals and millets. *Seaweed Res.Utiln*. **21:** 91-94

Kannan, L. and Tamilselvan, C. 1990. Effect of seaweed manures on *Vignaradiata*, L. (green gram). In: perspectives in Phycology. Raja Rao, N. (ed.). *Today and Tomorrows Printers and Publishers, New Delhi.* **5:** 427-430.

Layek, J., Das, A., Ramkrushna, G. I., Trivedi, K., Yesuraj, D., Muruganandham, C., Kubavat, D., Agarwal, P. K. and Ghosh, A. 2015. Seaweed sap: a sustainable way to improve productivity of maize in North-East India*Int J. Env. Stud.* pp.1-11.

Mohanty, D., Adhikary, S. P. and Chattopadhyay, G. N. 2013. Seaweed liquid fertilizer (SLF) and its role in agriculture productivity.*The Ecoscan*.Special issue. Vol. **III:** 147-155.

Mondal, D., Ghosh A., Prasad K., Singh, S., Bhatt, N. Zodape, S.T., Chaudhary, J. P., Chaudhari, J. Chatterjee, P. B., Seth, A. and Ghosh, P. K.2015. Elimination of gibberellin from *Kappaphycusalvarezii* seaweed sap foliar spray enhances corn stover production without compromising the grain yield advantage. *Plant Growth Regulation* **75:** 657-666.

Pise, N. M. and Sabale, A. B. 2010. Effect of seaweed concentrates on the growth and biochemical constituents of *Trigonellafoenum-graecum L. J. Phytology*. **2:** 50-56.

Shah, M. T., Zodape, S. T., Chaudhary, D. R., Eswaran, K. and Chikara , J. 2012. Seaweed saps as an alternative liquid fertilizer for yield and quality improvement of wheat. *Journal of Plant Nutrition* **36:**192-200.

Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for the determination of available N in soils. *Current science*. **25:** 259-260.

Zodape, S. T., Mukherjee, S., Reddy, M. P. and Chaudhary, D. R. 2009.Effect of *Kappaphycusalvarezii* (Doty) Doty ex silva.extract on grain quality, yield and some yield component of wheat (*Triticumaestivum* L.), *Int. J. Plant Prod.* **3:** 97-101.