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Seaweed sap an eco-friendly alternative for higher productivity of rain-fed maize

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Abstract
Field experiment was conducted during kharif season of 2012 and 2013 in maize crop (Var. HQPM-1) at research farm of Birsa Agricultural University, Kanke Ranchi Jharkhand, India. The experiment was laid out in randomized block design with Eighteen treatment combinations, consisting of two seaweed saps (*Kappaphycus alvarezii* and *Gracilaria edulis*), and each of which applied in 5 concentrations (2.5; 5.0; 7.5; 10 and 15%) at 100% RDF and 3 concentrations (7.5;10 and 15%) at 50% RDF and control (two) at each fertilizer level. Seaweed saps were sprayed as per treatments on the foliage of maize thrice at 20 days interval starting from 30 days after sowing (DAS) till 70 DAS. The experimental results revealed that application of 7.5% K sap and 5% G Sap produced 34 and 30% higher grain yield over 100% RDF respectively, as well as 7.5% K sap and 5% G sap at 50% RDF produced as high yield as 100% RDF alone without significant change in available nitrogen in soil with similar net return.

Keywords: seaweed extract, zea mays, yield, nitrogen use efficiency

Introduction
Maize is a heavy feeder crop, and farmers use huge amount of chemical fertilizer for higher productivity. Chemical fertilizer although help in boosting the growth of the plants but depletes the soil health, causes eutrophication on water bodies, as well as fertilizer consists of substances and chemical like methane, carbon-di-oxide, ammonia and nitrogen, emission of these gases contributed in global warming and weather changes. In that situation seaweed extract which is natural marine product, safe and eco-friendly source of nutrient substitution which contains many essential plant nutrients and growth hormones, to enhanced crop productivity without depleting soil health and environment.

Material and Methods
Field experiment was conducted during kharif season of 2012 and 2013 with maize variety HQPM-1 in the research farm of Birsa Agricultural University, Kanke Ranchi Jharkhand, 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, in sandy-loam soil, moderately acidic (pH 5.5) in nature (Jackson, 1973) [4], medium (0.45%) in organic carbon (Walkley and Black’s rapid tritrate method; Jackson, 1973) [4], low (235 kg ha-1) available Nitrogen(Alkaline permanganate method; Subbiah and Asija, 1956) [3], low (11.7 kg ha^{-1}) in available Phosphorus (Brays P1 method; Jackson, 1973) [4] and medium (179.2 kg ha^{-1}) available Potassim (Ammonium Acetate method; Hanway and Heidel, 1952) [2]. Carbohydrate content of maize grain was also analysed. The total rainfall recorded during crop growth period was 856 and 916 mm in first and second year respectively.
Present experiment was laid out in randomized block design and replicated thrice. Eighteen treatment consisted of two seaweed saps *i.e. Kappaphycus alvarezii* and *Gracilaria edulis*, and each of which applied in 5 concentrations (2.5; 5.0; 7.5; 10 and 15%) at 100% RDF and 3 concentrations (7.5;10 and 15%) at 50% RDF and control (two) at each fertilizer level. Seaweed saps were sprayed as per treatments on the foliage of maize thrice at 20 days interval starting from 30 days after sowing (DAS) till 70 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 top dressed in two splits at 35 and 50 DAS. Plant protection chemicals lindane @ 25kg ha^{-1} as basal application, furadan @1.75 kg ha^{-1} at 15DAS and hexacone @ 500ml ha^{-1} at 75DAS were used. Yield attributes, yield and carbohydrate content in grain were recorded. The data were statistically analysed by the method of analysis of variance (ANOVA) as described by Gomez and Gomez 1984 [1].

Results and Discussion

Results reveals that application of 7.5% K and 5% G sap with 100% RDF enhanced grain yield by 34 and 30% respectively over 100% RDF alone (41.9 qha^{-1}) (Table-1). Application of 7.5% K or G sap at 50% RDF produced as high yield (38.4 and 38.8 q ha^{-1} respectively) as 100% RDF alone, without significant change in available nitrogen in soil with similar net return Rs.25247 and 25767 ha^{-1} respectively to 100% RDF alone (Rs.30517 ha^{-1}) (Table-2). Increase in yield indicates the overall improvement in crop growth and plant absorb more nutrients as evident from the enhanced uptake of nutrient in the present study. It may be due to presence of natural chelating compounds in sap that have increased nutrient availability, by a better absorption of the chelated compound at leaf level as reported by Salat 2004 [6]. Whereas nitrogen use efficiency compared to 100% RDF. Suggesting a possible saving on fertilizer requirement by 50% for similar productivity as with 100% RDF under rainfed condition.

Table 1: Yield and quality of maize as affected by seaweed sap application. Seaweed

Treatment	Yield (q ha^{-1})	Protein content (%)	Protein yield (q ha^{-1})	Carbohydrate (%)	Carbohydrate yield (q ha^{-1})
T1 100% RDF + water	41.9	6.43	2.62	49.9	20.57
T2 100% RDF + 2.5% K	45.8	6.55	2.92	52.8	24.01
T3 100% RDF + 5% K	47.6	6.76	3.11	54.3	25.74
T4 100% RDF + 7.5% K	56.2	6.86	3.69	59.9	33.56
T5 100% RDF + 10% K	43.8	6.48	2.77	59.9	26.07
T6 100% RDF + 15% K	42.8	6.45	2.68	61.7	26.28
T7 50% RDF + 7.5% K	38.4	6.48	2.39	53.8	20.28
T8 50% RDF + 10% K	35.3	6.48	2.19	55.9	19.32
T9 50% RDF + 15% K	33.7	6.42	2.08	57.2	18.99
T10 100% RDF + 2.5G	42.4	6.49	2.67	55.1	23.32
T11 100% RDF + 5% G	54.3	6.98	3.67	55.7	30.15
T12 100% RDF + 7.5G	43.1	6.61	2.79	56.7	24.41
T13 100% RDF + 10G	43.8	6.70	2.87	60.2	26.34
T14 100% RDF + 15% G	38.6	6.44	2.40	61.9	23.81
T15 50% RDF + 7.5G	38.8	6.49	2.43	54.5	21.19
T16 50% RDF + 10% G	35.1	6.45	2.18	54.8	19.16
T17 50% RDF + 15% G	34.1	6.45	2.12	56.1	19.18
T18 50% RDF + water	31.0	6.41	1.92	51.4	15.80
SEm (±)	1.8	0.13	0.11	0.8	1.11
CD (P=0.05)	5.8	0.42	0.37	2.7	3.62

Table 2: Soil available nitrogen, nitrogen use efficiency and economics of maize as affected by seaweed sap application

Treatment	Available nitrogen in soil (kg ha^{-1})	Nitrogen use efficiency (kg grain per kg N applied)	Gross return (Rs.ha^{-1})	Net return (Rs.ha^{-1})	B:C ratio
T1 100% RDF + water	244.96	27.95	51863	30517	1.42
T2 100% RDF + 2.5% K	253.02	30.51	58321	34899	1.47
T3 100% RDF + 5% K	254.52	31.72	56877	32134	1.29
T4 100% RDF + 7.5% K	258.50	37.45	69155	42159	1.53
T5 100% RDF + 10% K	252.70	29.22	54146	26732	0.97
T6 100% RDF + 15% K	249.15	28.54	52872	22687	0.74
T7 50% RDF + 7.5% K	232.01	51.23	47553	25247	1.11
T8 50% RDF + 10% K	228.40	47.11	43819	20329	0.85
T9 50% RDF + 15% K	224.00	44.94	41850	15642	0.58
T10 100% RDF + 2.5G	250.24	28.27	52551	29521	1.27
T11 100% RDF + 5% G	259.15	36.19	66650	41247	1.61
T12 100% RDF + 7.5G	252.20	28.74	52708	26735	1.02
T13 100% RDF + 10G	251.47	29.23	54167	26859	0.98
T14 100% RDF + 15% G	237.23	25.76	48566	18663	0.61
T15 50% RDF + 7.5G	231.88	25.89	48098	25767	1.14
T16 50% RDF + 10% G	230.07	46.75	43574	20110	0.84
T17 50% RDF + 15% G	228.99	45.49	42415	16175	0.60
T18 50% RDF + water	226.83	41.27	38549	21344	1.23
SEm (±)	6.27	1.57	2113.2	2113	0.08
CD (P=0.05)	20.44	5.13	6891.6	6892	0.27

Conclusion

Application of 5% G sap along with 100% RDF is a economic and eco-friendly approaches to increase crop productivity without impairing the soil health, as well as spraying of 7.5% K sap along with 50% RDF also substituted to 50% fertilizer requirement of crop.

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