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Effect of Liquid Fertilizers on Nutrient uptake and Soil properties of the Green gram (*Vigna radiata*) crop under Organic farming

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Abstract
Foliar application of different levels of seaweed extract and enriched banana psuedostem sap were studied on different varieties of green gram (*Vigna radiata*) to check the nutrient uptake by the crop and soil properties at certified organic farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during *Rabi* season of the year 2015-16. The treatment L_2 A showed significantly higher uptake of N (30.41 and 37.94 kg ha^{-1}), P (8.29 and 5.45 kg ha^{-1}), K (42.42 and 12.48 kg ha^{-1}), Fe (415.30 and 74.31 g ha^{-1}), Mn (48.96 and 24.57 g ha^{-1}), Zn (118.54 and 41.89 g ha^{-1}) and Cu (16.71 and 8.55 g ha^{-1}) by stover and seed respectively. The minimum value of nutrient uptake by stover and seed recorded in treatment L_6. Among the variety treatment V_1 showed superiority in uptake of N (25.93 and 37.36 kg ha^{-1}), P (6.41 and 5.55 kg ha^{-1}), K (34.27 and 12.58 kg ha^{-1}), Fe (358.92 and 71.08 g ha^{-1}), Mn (39.52 and 22.05 g ha^{-1}), Zn (100.13 and 42.71 g ha^{-1}) and Cu (13.87 and 8.33 g ha^{-1}) by stover and seed respectively as compared to V_2. Highest total uptake of nutrients by crop also observed in the individual treatment V_1 and L_2. The result revealed that non-significant effect on all the soil property tested due to liquid fertilizer except available N, significantly highest value of available N (201.23 kg ha^{-1}) linked with both L_2 and L_5 treatment and its minimum value in L_6.

Keywords: Organic farming, liquid fertilizers, nutrient uptake and soil properties of the crop

Introduction

Seaweeds are the several species of macroscopic multicellular marine algae with no true roots, stems and leaves, and they are one of the important marine living resources with tremendous commercial importance. The use of seaweed as manure is important in the present day world as the seaweed fertilizers are often found to be more successful than the chemical fertilizers (Bokil *et al*., 1972) [3]. Seaweed, has been historically used as a soil amendment material, and may have application for modern agriculture as a low cost source of nutrient-rich biomass (Angus and Dargie, 2002; Cuomo *et al*., 1995) [2, 5]. Liquid fertilizer, obtained from seaweed contains polysaccharide content, which is already broken down, becomes effective at once (Stephenson, 1974) [19]. The Enriched Banana Pseudostem Sap (EBPS) is the value added product prepared from the pseudostem. About 15 to 20 thousand liters of sap can be extracted from one hectare of pseudostem. EBPS contains several major and micro nutrients, plant growth regulators and this mixture is inoculated with different microbes like *Rhizobium*, *Azotobacter etc*., which play an important role in enhancing the crop yield. Seaweeds and Enriched Banana Pseudostem Sap are the organic fertilizer. Organic farming is proving as remedy to cure the ills of modern agriculture. The green gram (*Vigna radiata*) alternatively known as Mung bean, is a plant species in the legume family native to the Indian subcontinent. In India green gram is an important pulse crop after bengal gram and red gram, which is grown and consumed in India and it is the richest source of protein and it supplies part of protein requirement of vegetarian population in India.

Hence the present study was conducted to find out the effect of seaweed and EBPS on nutrient uptake and soil properties of green gram.

Materials and Methods

The present study was conducted at Organic Farm, Navsari Agricultural University, Navsari during *Rabi* season 2015-16. The farm was converted in to organic during 2005, since then organic management practices are adopted to raise the crops. According to the soil taxonomy, the soil of the experiment field is classified under the order of 'Inceptisol', family of Vertic

Ustochrepts belong to Jalalpore series. The soil type was clayey, pH of the soil was 8.01, available N, P_2O_5 and K_2O were 172.48 kg/ha (low), 29.27kg/ha (medium) and 336.33 kg/ha (high), respectively and has sufficient cationic micronutrients content (DTPA extractable Fe, Mn, Zn and Cu). The experiment was laid out in a Factorial Randomized Block Design with 12 treatments replicated 3 times. Crop was fertilized @ 20 kg N ha^{-1} through NADEP compost as basal dose. Three replications were laid out, each of containing 12 plots. The treatments consisting 6 levels of liquid fertilizers *viz*. without any liquid fertilizers (control) (L_1), 2% *Kappaphycus alverezii* seaweed sap (L_2), 4% *Kappaphycus alverezii* seaweed sap (L_3), 6% *Kappaphycus alverezii* seaweed sap (L_4), 1% enriched banana pseudostem sap (EBPS) (L_5) and 2% enriched banana pseudostem sap (EBPS) (L_6) applied on two varieties of green gram *viz.* Co-4 and GBM-1. Three sprays of liquid fertilizer were applied at 27, 45 and 60 DAS. The seed and haulm samples were collected at the time of threshing and were oven dried at 65° C. Dried haulm and seed samples were powdered with the help of stainless steel grinder mixture. After grinding, the haulm and seed samples were analyzed for total N, P, K, S, Fe, Mn, Zn, and Cu content by following standard procedures (Table 1). The dry matter yield (seed and haulm) and individual contents of element in seed and haulm were used for computing uptake. The total uptake was calculated by summation of individual uptake of nutrient by seed and haulm. The uptake was computed using following formula.

Uptake of N, P and K (kg/ha) = (Nutrient content (%) x DMY (kg/ha)) /100

Uptake of Fe, Mn, Zn and Cu (g/ha) = (Nutrient content (mg/kg) x DMY (kg/ha)) / 1000

Soil samples were collected at harvest to determine physico-chemical properties of soil. One representative soil sample from each of the experimental plot was collected using soil auger. Utmost care was taken to keep the soil samples free from contamination of other samples. All samples were labeled properly. The samples were packed in polythene bag with tag details and brought to the laboratory for further analysis.

Table 9: Methods followed for soil and plant sample analysis

Parameters		Methods	References
A. Soil chemical analysis			
1	pH	Potentiometric,	Jackson (1973) [6]
2	EC	Conductometric	Jackson (1973) [6]
3	Organic carbon	Wet oxidation	Jackson (1973) [6]
4	Available N	Alkaline permanganate oxidation	Subbiah and Asija (1956) [20]
5	Available P_2O_5	Spectro photometric (0.5M $NaHCO_3$, pH 8.5, blue color)	Olsen *et al.* (1954) [9]
6	Available K_2O	Flame photometric (Neutral N NH_4OAc)	Jackson (1973) [6]
7	DTPA-extractable Fe, Zn, Mn, Cu	Atomic absorption Spectro photometer method (DTPA)	Lindsay and Norvell (1978) [8]
B. Plant analysis			
1	Total N	Wet digestion (Chromic acid)	Trivedi *et al.* (1999) [21]
2	Total P, K, S, Fe, Mn, Zn, Cu	Wet digestion (di-acid) P:Vanedomolybdo yellow color method K: Flame photometry S: Turbidimetry method Fe, Zn, Mn, Cu: Atomic absorption Spectrophotometer method	Jackson (1973) [6]

Table 2: Effect of different treatments on uptake of macro and micro-nutrient by green gram stover.

Treatment	Uptake (kg ha^{-1})			Uptake (g ha^{-1})			
	N	P	K	Fe	Mn	Zn	Cu
Variety							
V1	25.93	6.41	34.27	358.92	39.52	100.15	13.87
V2	18.37	4.56	24.64	256.29	27.44	70.66	10.04
S.Em. (±)	0.72	0.23	1.28	9.42	1.24	2.94	0.44
CD at 5%	2.10	0.68	3.75	27.62	3.63	8.61	1.28
L.F							
L1	22.01	5.14	28.18	310.39	32.59	84.08	11.69
L2	30.41	8.29	42.42	415.30	48.96	118.54	16.71
L3	24.35	6.11	32.71	341.17	37.62	94.60	12.95
L4	16.56	3.99	22.10	231.52	24.23	64.74	9.06
L5	25.94	6.21	33.52	361.62	39.61	98.55	14.00
L6	13.60	3.20	17.79	185.63	17.89	51.91	7.33
S.Em. (±)	1.24	0.40	2.21	16.31	2.14	5.09	0.76
CD at 5%	3.64	1.18	6.49	47.84	6.28	14.92	2.22
V*L							
S.Em. (±)	1.75	0.57	3.13	23.07	3.03	7.19	1.07
CD at 5%	NS	NS	NS	NS	NS	NS	NS
CV %	13.72	17.94	18.40	12.99	15.67	14.59	15.51

Results and Discussion

Nutrient uptake by stover, seed and crop

The uptake of N, P and K by seed and stover as well as total uptake (Table 20 and 22) were significantly affected due to variety as well as due to various treatments of liquid fertilizer. Among the variety treatment V_1 showed superiority in uptake of N (25.93 and 37.36 kg ha^{-1}), P (6.41 and 5.55 kg ha^{-1}), K (34.27 and 12.58 kg ha^{-1}), Fe (358.92 and 71.08 g ha^{-1}), Mn (39.52 and 22.05 g ha^{-1}), Zn (100.13 and 42.71 g ha^{-1}) and Cu (13.87 and 8.33 g ha^{-1}) by stover and seed respectively as compared to V_2. The high dry matter in the variety V_1 (CO-4) may be traced to the significant difference in nutrient uptake and that reason may be attributed to their genetic variability, varietal difference and environmental adaptability (Samant, 2014). The treatment L_2 A showed significantly higher uptake of N (30.41 and 37.94 kg ha^{-1}), P (8.29 and 5.45 kg ha^{-1}), K (42.42 and 12.48 kg ha^{-1}), Fe (415.30 and 74.31 g ha^{-1}), Mn (48.96 and 24.57 g ha^{-1}), Zn (118.54 and 41.89 g ha^{-1}) and Cu (16.71 and 8.55 g ha^{-1}) by stover and seed respectively. The minimum value of nutrient uptake by stover and seed recorded in treatment L_6. Similar trend was observed in the total uptake by the crop also, individual treatment V_1 and L_2 showed significantly higher nutrient uptake. The result of present study regarding nutrient uptake by straw and seed are in accordance with those obtained by many workers with use of seaweed extract. Seaweed extract are reported effective fertilizer in many crops including vegetables, trees, flowering plants and grain crop (Abetz, 1980) [1]. A marked difference in concentration and uptake of nutrients were also reported earlier by Rathore *et al*. (2009) [13] in soybean and Papenfus *et al*. (2013) [10] in okra. Our results confirm those finding previously reported by Crouch *et al*. (1994) [4] who noted an increased uptake of Mn, K and Cu in lettuce with seaweed concentrate application. Similarly increase in macro and micro-nutrients in wheat in the range of 15.86 to 75.02% and 1.28 to 20.0% respectively was reported by Zodape *et al*., 2009 [13-23]. The enhancement in the uptake of N, P and K and other biochemical constituents has been reported by Pramanick *et al.* (2014) [12], Shehata *et al*. (2011) [16]. Salunkhe *et al*. (2013) [14], Singhal *et al*. (2015) [17] and Zodape *et al*. (2011) [22] with application of seaweed extract in rice, celeriac plant, okra, onion and tomato. Promotive effect of SWS application might be because of increase root proliferation and establishment, there by plants were able to mine more nutrients even from distant places and deeper soil horizons in balanced proportion. Besides SWS regulated plant bio-physiological activities which collectively resulted in maintaining higher photosynthetic activities (Singh and Chandel, 2005) [18]. The preserve of bioactive substances in seaweed extract improves stomata uptake efficiency in the treated plants compared to the non-treated plants.

Table 3: Effect of different treatments on uptake of macro and micro-nutrient by green gram seed.

Treatment	Uptake (kg ha^{-1})			Uptake (g ha^{-1})			
	N	P	K	Fe	Mn	Zn	Cu
Variety							
V1	37.36	5.55	12.58	71.05	22.05	42.71	8.33
V2	21.65	3.34	7.70	42.52	12.81	26.04	4.80
S. Em. (±)	0.79	0.13	0.43	1.60	0.74	0.87	0.22
CD at 5%	2.33	0.39	1.27	4.70	2.16	2.56	0.64
L.F							
L1	27.45	4.15	9.62	50.22	14.11	32.22	5.80
L2	37.94	5.45	12.48	74.31	24.57	41.89	8.55
L3	30.67	4.66	10.60	58.56	17.42	36.18	7.12
L4	25.62	4.01	8.92	46.55	14.44	29.57	5.43
L5	31.85	4.85	11.08	66.84	21.31	37.81	7.38
L6	23.49	3.54	8.13	44.23	12.71	28.58	5.11
S. Em. (±)	1.38	0.23	0.75	2.77	1.28	1.51	0.38
CD at 5%	4.03	0.68	2.19	8.14	3.74	4.43	1.11
V*L							
S. Em. (±)	1.95	0.33	1.06	3.92	1.81	2.14	0.53
CD at 5%	NS	NS	NS	NS	NS	NS	NS
CV %	11.42	12.80	18.08	11.97	17.94	10.76	14.06

Table4: Effect of different treatments on total uptake of macro and micro-nutrient by green gram.

Treatment	Uptake (kg ha^{-1})			Uptake (g ha^{-1})			
	N	P	K	Fe	Mn	Zn	Cu
Variety							
V1	63.29	11.96	46.84	429.96	61.57	142.86	22.20
V2	40.02	7.90	32.34	298.82	40.25	96.70	14.85
S. Em. (±)	1.14	0.31	1.39	9.77	1.76	3.04	0.58
CD at 5%	3.34	0.92	4.08	28.65	5.17	8.91	1.71
L.F							
L1	49.46	9.30	37.81	360.61	46.69	116.30	17.50
L2	68.36	13.73	54.90	489.60	73.53	160.43	25.26
L3	55.02	10.77	43.31	399.73	55.04	130.78	20.07
L4	42.18	8.00	31.02	278.08	38.68	94.31	14.49
L5	57.79	11.06	44.59	428.45	60.92	136.36	21.38
L6	37.09	6.73	25.92	229.86	30.60	80.49	12.44
S. Em. (±)	1.97	0.54	2.41	16.92	3.06	5.26	1.01

CD at 5%	5.79	1.59	7.07	49.63	8.96	15.44	2.96
V*L							
S. Em. (±)	2.79	0.77	3.41	23.93	4.32	7.44	1.43
CD at 5%	NS	NS	NS	NS	NS	NS	NS
CV %	9.36	13.38	14.91	11.37	14.70	10.76	13.35

Table 5: Effect of different treatments on organic carbon content and available major and micro nutrients.

Treatment	OC (%)	Available major nutrients (kg ha^{-1})			Available micro-nutrient (mg kg^{-1})			
		N	P_2O_5	K_2O	Fe	Mn	Zn	Cu
Variety								
V1	1.39	184.68	60.36	438.10	9.43	7.09	0.86	2.06
V2	1.32	185.55	61.02	430.80	9.46	7.07	0.86	2.05
S. Em. (±)	0.03	3.06	0.80	6.46	0.26	0.10	0.02	0.04
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
L.F								
L1	1.28	169.87	56.20	411.98	8.96	6.96	0.78	2.04
L2	1.41	201.23	65.96	460.78	9.60	7.16	0.89	2.09
L3	1.36	185.55	60.24	430.95	9.46	7.06	0.88	2.08
L4	1.38	185.55	61.24	449.93	9.51	7.13	0.87	2.04
L5	1.43	201.23	63.26	441.79	9.59	7.14	0.88	2.10
L6	1.28	167.25	57.22	411.98	9.53	7.02	0.86	2.01
S. Em. (±)	0.05	5.31	1.39	11.19	0.44	0.18	0.03	0.07
CD at 5%	NS	15.56	NS	NS	NS	NS	NS	NS
V*L								
S. Em. (±)	0.07	7.50	1.97	15.82	0.63	0.25	0.04	0.09
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
CV %	8.68	7.02	15.21	16.57	11.47	6.07	7.60	7.80

Soil properties: The result revealed that the O.C content was not affected significantly either by variety or treatments of liquid fertilizer. The trend of O.C content was also not in systematic order with regard to the available N, P_2O_5, K_2O &micro nutrients (Fe, Mn, Zn & Cu) content, except N they were not significantly changed due to treatment effect. The quantity of available N after harvest differed significantly each other due to liquid fertilizer treatment but it was just significant only, hence large variation in N content was not observed. The value of available N, P_2O and K_2O in soil varied from 167.25 to 201.23 kg ha^{-1}, 57.22 to 65.96 kg ha^{-1} and 411.98 to 460.78 kg ha^{-1} respectively in soil after harvest of green gram crop. Higher status of N, P_2O and K_2O in soil was found with treatment receiving 2% seaweed sap (L_2). Similarly micro-nutrient status (Fe, Mn, Zn and Cu) in soil also remained unchanged due to the fertilizer treatments. Almost uniform status of respective nutrient was observed under various treatment of fertilizer. In present investigation, different concentration of seaweed sap and EBPS were applied through foliar spray as treatment, naturally it did not reach to the soil. This might be ascribed to the fact that for non significant difference in post harvest soil properties. The level of N, P and K showed marginal changes but not up to a significant level. Salunkhe *et al.* (2013) [14] did not find significant effect on available nutrient content in soil after harvest of onion crop when banana pseudo stem sap (EBPS) was applied as liquid fertilizer. Non-significant change in nutrient status in the soil after harvest of crop due to use of different concentration of seaweed sap as fertilizer treatments have been also reported by Kalaivanan *et al.* (2012) [7] & Pramanick *et al.* (2013) [11].

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