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Influences of different organic sources and seaweed extract on quality, nutrient content, uptake, soil fertility status and soil microbial population after harvest of summer greengram (*Vigna radiata* L.)

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Abstract

A field experiment was carried out at Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, during summer season of 2020 to study the influences of different organic sources and seaweed extract on quality, nutrient content, uptake, soil fertility status and soil microbial population after harvest of summer greengram (*Vigna radiata* L.). Significantly highest protein yield (208.31 kg/ha) was found with seaweed extract @ 10%. Significantly the highest uptake of N (71.69 kg/ha), P (4.97 kg/ha) and K (31.46 kg/ha) by the greengram were obtained with seaweed extract @ 10%. Significantly higher K uptake (32.61 kg/ha) was recorded with combined application of FYM and seaweed extract (O₁B₂). Significantly the highest available P₂O₅ content (43.56 kg/ha) in soil was recorded with the application of vermicompost @ 2 t/ha; while, different sources of organic manures were found to be non-significant with respect to the available N and K₂O. Significantly highest post-harvest microbial status of *Rhizobium* and PSB (102.56 and 134.50 CFU × 10⁵/g soil) were recorded with the application of vermicompost @ 2 t/ha. From the bioenhancers, significantly the highest post-harvest status of, PSB (172.25 CFU × 10⁵/g soil) with *panchagavya* @ 3% and *Rhizobium* (127.25 CFU × 10⁵/g soil) was found with seaweed extract @ 10%.

Keywords: Organic manures, bioenhancers, greengram, quality, content, uptake

Introduction

Green gram is the third most important pulse crop of India covering an area of 4.2 million ha with a total production of 2.0 million tonne and an average productivity of 461 kg/ha. The coverage of area and its production is maximum in Rajasthan (17.21 lakh ha and 7.47 lakh tonne) (Anon., 2017-18) [1]. Mungbean contains about 24 per cent protein, this is being about two third of the protein content of soybean, twice of wheat and thrice of rice. The protein is comparatively rich in lysine, an amino acid that is deficient in cereal grains. So, a diet combining mungbean and cereal grains form a balanced amino acid diet. Every 100 g mungbean seeds contain 132 mg calcium, 6.74 mg iron, 189 mg magnesium, 367 mg phosphorus and 1246 mg potassium and 4.8 mg ascorbic acid, 0.621 mg thiamine, 0.233 mg riboflavin, 2.251 mg niacin, 1.910 mg pantothenic acid and 114 IU vitamin A (Haytowitz and Matthews, 1986) [4].

In plant nutrition, organic manures and bioenhancers play important role, as they act directly for increasing the crop yields either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. It supplies macronutrients and micronutrients (Fe, S, Mo and Zn etc.) in available form to the plants through biological means and improves physical-chemical properties of soil as well as stimulate of soil flora and fauna etc. Manures like vermicompost is also commonly used organic manure which is rich in both macro and micronutrients, besides having plant growth promoting substances, humus forming microbes and nitrogen fixers (Bano *et al.*, 1987) [2]. Castor Cake is simple manure, which acts progressively that encourages soil microbial activity. It has insecticidal properties and naturally pest repellent. It can be used in organic farming and fits for any type of soil, with its high content of organic matter (Gupta *et al.*, 2004) [3]. Banana pseudostem sap is rich in nutrients and having growth promoting substances, its judicious utilization in crop production enhances crop yield with very less input costs. It is intended to minimize use of chemical fertilizers (Salunkhe *et al.*, 2013) [8].

Panchagavya, has the potential to play the role of promoting growth and providing resistance in the plant system. *Panchagavya* consists of five products *viz.*, cow dung, urine, milk, curd and *ghee* and is used in widely for agricultural and horticultural crops. Descriptions of this holy combination could be traced to Vedas, the divine scripts of Indian wisdom. Seaweeds or marine macro-algae are important renewable plant resources occurring in the seas, brackish waters and lagoons across the globe. Application of liquid extract from these organisms as foliar spray and/or seed treatment showed positive results on enhancement of vegetative growth and yield of several crops. In addition they increase the biochemical constituents of plants and possess environmental stress mitigating potential. Amendment of seaweed liquid fertilizer (SLF) to soils improves the soil health by enhancing the micronutrient quantity and quality and microbial activity. The seaweed resources of the Indian coast and the methods so far followed for preparation of SLF and their mode of application to crops is presented (Mohanty *et al.*, 2013)^[6].

Material and Methods

The experiment was laid out at Agronomy Instructional Farm, C. P. College of Agriculture, SDAU, Sardarkrushinagar. Geographically, Sardarkrushinagar comes under North

Gujarat Agro-climatic Zone-IV and Agro-ecological situation (AES-II). The soil of the experimental field was loamy sand in texture, with low in organic carbon (0.30%) and available nitrogen (162.72 kg/ha), medium in available P₂O₅ (47.82 kg/ha) and available K₂O (258.6 kg/ha) with soil pH of 7.5. The experiment was laid out in a Split Plot Design (SPD) with four replications. As main plot factors three organic manures *viz.*, Farm yard manure @ 5 t/ha (O₁), Vermicompost @ 2 t/ha (O₂) and Castor cake @ 0.75 t/ha (O₃) were incorporated in soil before sowing and as sub-plot factors four sprays of bioenhancers *viz.*, Panchagavya @ 3% (B₁), Seaweed extract @ 10% (B₂), Banana pseudostem sap @ 1% (B₃) and Control (Water spray) (B₄) were sprayed as foliar spray at 20, 40 & 60 DAS. The greengram variety GM 4 was sown on 4th March 2020 at 45 cm row to row spacing by using recommended seed rate of 20 kg/ha. All other agronomic practices were adopted as per need of the crop.

Results and Discussion

Effect on quality parameters

Protein content (%): Data presented in Table 1 revealed that different treatments *viz.*, organic manures, bioenhancers and their combinations did not exert significant effect on protein content in seed of summer greengram.

Table 1: Effect of organic manures and bioenhancers on protein content and protein yield of summer greengram

Treatment	Protein content (%)	Protein yield (kg/ha)
Organic manures (O)		
O ₁ : Farm yard manure @ 5 t/ha	23.80	202.54
O ₂ : Vermicompost @ 2 t/ha	23.26	195.39
O ₃ : Castor cake @ 0.75 t/ha	23.84	192.30
S.Em.±	0.19	5.48
C.D. (P=0.05)	NS	NS
C.V.%	3.19	11.14
Bioenhancers foliar spray (B)		
B ₁ : Panchagavya @ 3%	23.43	193.67
B ₂ : Seaweed extract @ 10%	23.87	208.31
B ₃ : Banana pseudostem sap @ 1%	23.51	202.64
B ₄ : Control (water spray)	23.72	182.35
S.Em.±	0.21	4.48
C.D. (P=0.05)	NS	13.01
Interaction (O × B)		
S.Em.±	0.36	7.77
C.D. (P=0.05)	NS	NS
C.V.%	3.06	7.89

Protein yield (kg/ha)

Manurial incorporation and combination of manures-bioenhancers were failed to affect protein yield (Table 1). Among the different bioenhancers, significantly higher protein yield (208.31 kg/ha) was observed with foliar spray of seaweed extract @ 10% at 20, 40 and 60 DAS (B₂) indicating 14.2 per cent increase over control (B₄) (water spray) and also it was at par with banana pseudostem sap @ 1% at 20, 40 and 60 DAS (B₃) (202.64 kg/ha). These results are in line with Zodape *et al.* (2010)^[11]; Singhal *et al.* (2016)^[9] and Kocira *et al.* (2017)^[5].

Effect on nutrients content and uptake

Nutrient content in seed: The data presented in Table 2 revealed that nitrogen, phosphorus and potassium content in seeds were not significantly influenced by different organic manures, bioenhancers and interaction. Even though maximum nitrogen (3.82%), phosphorus (0.26%) and potassium content (0.83%) in seed was found with castor cake @ 0.75 t/ha (O₃) incorporated treatment. Meanwhile maximum nitrogen (3.82%), phosphorus (0.26%) and potassium content (0.84%) in seed noticed with foliar spray of seaweed extract @ 10% at 20, 40 and 60 DAS (B₂).

Table 2: Effect of organic manures and bioenhancers on N, P and K content in seed of summer greengram

Treatment	Seed content (%)			Stover content (%)		
	N	P	K	N	P	K
Organic manures (O)						
O ₁ : Farm yard manure @ 5 t/ha	3.81	0.26	0.82	1.75	0.12	1.18
O ₂ : Vermicompost @ 2 t/ha	3.71	0.25	0.75	1.95	0.13	1.15
O ₃ : Castor cake @ 0.75 t/ha	3.82	0.26	0.83	1.89	0.13	1.18
S.Em.±	0.03	0.002	0.03	0.07	0.01	0.01
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
C.V.%	3.33	3.11	16.85	15.18	17.65	3.36
Bioenhancers foliar spray (B)						
B ₁ : Panchagavya @ 3%	3.75	0.26	0.81	1.97	0.13	1.16
B ₂ : Seaweed extract @ 10%	3.82	0.26	0.84	1.90	0.13	1.18
B ₃ : Banana pseudostem sap @ 1%	3.75	0.26	0.79	1.92	0.13	1.16
B ₄ : Control (water spray)	3.79	0.26	0.76	1.67	0.12	1.17
S.Em.±	0.03	0.002	0.04	0.08	0.004	0.01
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Interaction (O × B)						
S.Em.±	0.06	0.004	0.07	0.14	0.01	0.02
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
C.V.%	3.14	3.10	16.43	14.63	12.02	3.04

Nutrient content in stover

The mean data on nutrient content viz., N, P and K in stover was statistically analyzed and found that nitrogen, phosphorus and potassium content in stover not differed significantly due to different organic manures, bioenhancers and their interaction (Table 2).

Nutrient uptake

The data presented in Table 3 revealed that nitrogen, phosphorus and potassium uptake by crop was not significantly influenced by different organic manures. Even though numerically maximum nitrogen uptake (68.45 kg/ha) by crop was recorded in the plots which received vermicompost @ 2 t/ha (O₂) incorporation. Numerically higher phosphorus (4.62 kg/ha) and potassium uptake (29.69 kg/ha) by crop was recorded in the plots which received farm yard manure @ 5 t/ha (O₁) incorporation.

Nitrogen, phosphorus and potassium uptake by crop was significantly influenced by different bioenhancers. Significantly higher nitrogen (71.69 kg/ha), phosphorus (4.97

kg/ha) and potassium uptake (31.46 kg/ha) by crop was recorded in foliar spray of seaweed extract @ 10% at 20, 40 and 60 DAS (B₂). This is due to the increased supply of plant nutrients with sources of seaweed extract sprays application in plant available form might have increased the accumulation of dry matter concomitantly by affecting the ramification of roots favorably. The interaction effect of organic manures and bioenhancers was not significant in altering the nitrogen and phosphorus uptake by greengram but, interaction effect of organic manures and bioenhancers was significant in altering the potassium uptake (Table 4). Significantly higher potassium uptake (32.61 kg/ha) was observed with treatment combination O₁B₂ (farm yard manure with seaweed extract), which was at par with O₁B₁ (farm yard manure with *panchagavya*), O₂B₁ (vermicompost with *panchagavya*), O₂B₂ (vermicompost with seaweed extract), O₃B₂ (castor cake with seaweed extract), O₁B₃ (farm yard manure with banana pseudostem sap), O₂B₃ (vermicompost with banana pseudostem sap) and O₃B₄ (castor cake with no bioenhancer spray).

Table 3: Effect of organic manures and bioenhancers on nutrient uptake and available nutrients status after harvest of summer greengram

Treatment	Nutrients uptake (kg/ha)			Available nutrients status (kg/ha)		
	N	P	K	N	P ₂ O ₅	K ₂ O
Organic manures (O)						
O ₁ : Farm yard manure @ 5 t/ha	65.92	4.62	29.69	197.99	43.41	241.65
O ₂ : Vermicompost @ 2 t/ha	68.45	4.59	28.23	195.91	43.56	248.49
O ₃ : Castor cake @ 0.75 t/ha	64.55	4.26	27.47	195.96	39.33	241.48
S.Em.±	1.80	0.12	1.01	5.04	0.87	5.19
C.D. (P=0.05)	NS	NS	NS	NS	3.00	NS
C.V. %	10.84	10.93	14.16	10.25	8.23	8.51
Bioenhancers foliar spray (B)						
B ₁ : Panchagavya @ 3%	68.64	4.53	28.63	198.08	41.02	245.82
B ₂ : Seaweed extract @ 10%	71.69	4.97	31.46	200.82	42.30	247.20
B ₃ : Banana pseudostem sap @ 1%	68.03	4.61	28.36	195.88	42.11	245.77
B ₄ : Control (water spray)	56.88	3.84	25.40	191.70	42.96	236.70
S.Em.±	2.06	0.12	1.00	3.06	0.96	5.42
C.D. (P=0.05)	5.99	0.35	2.89	NS	NS	NS
Interaction (O × B)						
S.Em.±	3.57	0.21	1.73	5.31	1.66	9.39
C.D. (P=0.05)	NS	NS	5.01	NS	NS	NS
C.V. %	10.78	9.40	12.14	5.40	7.91	7.70

Table 4: Effect of O × B on potassium uptake by summer greengram

Potassium uptake (kg/ha)				
O/B	B ₁	B ₂	B ₃	B ₄
O ₁	30.32	32.61	31.90	23.93
O ₂	28.25	30.39	29.89	24.38
O ₃	27.31	31.38	23.31	27.89
S.Em.±	1.73			
C.D. (P=0.05)	5.01			
C.V. %	12.14			

Effect on soil nutrients status after harvest of crop**Available N, P₂O₅ and K₂O**

Different organic manures, bioenhancers and interaction effect had no significant influence on the post harvest soil nutrient status for available nitrogen and potassium (Table 3). However, effect of organic manures incorporation found significant for available phosphorus in soil after harvest of greengram.

1. Available nitrogen

Despite of non significant result, maximum available nitrogen (197.99 kg/ha) was recorded with farm yard manure @ 5 t/ha (O₁) as soil incorporation followed by vermicompost @ 2 t/ha (O₂) and castor cake @ 0.75 t/ha (O₃). Even with non significant result, foliar spray of seaweed extract @ 10% at 20, 40 and 60 DAS (B₂) was noticed maximum available nitrogen content (200.82 kg/ha) in soil after harvest of green gram.

2. Available P₂O₅

The treatment vermicompost @ 2.0 t/ha (O₂) recorded significantly higher available P₂O₅ content (43.56 kg/ha) in soil after harvest; being at par with farm yard manure @ 5 t/ha (O₁) but, superior over castor cake @ 0.75 t/ha (O₃). This is attributed to release of organic acids during microbial decomposition of organic matter which might encompass in the solubility of native phosphates thus increasing availability of phosphorus pool in the soil. In addition, the organic anions compete with phosphate ions for the binding sites on the soil particles. Further the root system of the legumes has capacity to solubilise soil phosphorus through extraction of amino acid which encourages the growth and multiplication of soil microbes which finally leads to mineralization of unavailable

P to available P in soil. These findings are in accordance with those reported by Tharmaraj *et al.* (2011)^[10] and Rao *et al.* (2013)^[7]. Available P₂O₅ was not affected significantly due to various bioenhancers and interaction effect in soil after harvest of greengram.

3. Available K₂O

Despite of non-significant results, maximum available K₂O (248.49 kg/ha) was recorded with vermicompost @ 2.0 t/ha (O₂) as soil incorporation followed by farm yard manure @ 5.0 t/ha (O₁) and castor cake @ 0.75 t/ha (O₃). Even with non-significant result, foliar spray of seaweed extract @ 10% at 20, 40 and 60 DAS (B₂) was noticed maximum available K₂O content (247.20 kg/ha) in soil. Lower available K₂O (236.70 kg/ha) was recorded with control (water spray).

(d) Effect on soil microbial population

The microbial population *viz.*, *Rhizobium* and PSB was found significant by different organic manures (Table 5 & Fig. 1). Significantly the highest population of *Rhizobium* and PSB (102.56 and 134.50 CFU × 10⁵/g soil, respectively) were observed in the soil where vermicompost @ 2 t/ha was incorporated. Among bioenhancers tried, significantly the highest population of *Rhizobium* (127.25 CFU × 10⁵/g soil) were observed with seaweed extract @ 10% spray and significantly the highest PSB (172.25 CFU × 10⁵/g soil) population was observed with *panchagavya* @ 3% spray. Significantly the lowest count of *Rhizobium* and PSB (63.67 and 71.58 CFU × 10⁵/g soil, respectively) were recorded with water spray. This might be due to presence of beneficial microbes in the seaweed extract and *panchagavya* along with nutrients and food material required by them, thus higher microbial colonies. The results were in line with the findings of Mohanty *et al.* (2013)^[6].

The interaction effect of organic manures and bioenhancers was significant for *Rhizobium* and PSB count (Table 5). Significantly higher *Rhizobium* (139.75 CFU × 10⁵/g soil) being produced with O₁B₂ (farm yard manure with seaweed extract) and lowest *Rhizobium* (48.00 CFU × 10⁵/g soil) count was recorded with O₃B₄ (castor cake and no bioenhancers spray) (Table 6). Significantly highest PSB (178.50 CFU × 10⁵/g soil) being observed with O₃B₁ (castor cake with *panchagavya*) and lowest PSB (65.75 CFU × 10⁵/g soil) count was recorded with O₁B₄ (farm yard manure and no bioenhancers spray) (Table 7).

Table 5: Effect of organic manures and bioenhancers on population of *Rhizobium* and PSB in soil after harvest of summer greengram

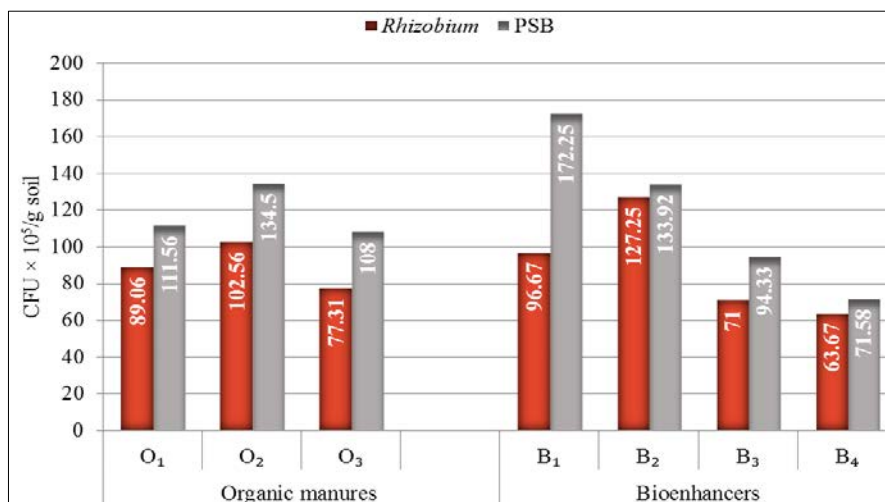
Treatment	Microbial population (CFU × 10 ⁵ /g soil)	
	<i>Rhizobium</i>	PSB
Organic manures (O)		
O ₁ : Farm yard manure @ 5 t/ha	89.06	111.56
O ₂ : Vermicompost @ 2 t/ha	102.56	134.50
O ₃ : Castor cake @ 0.75 t/ha	77.31	108.00
S.Em.±	1.79	3.12
C.D. (P=0.05)	6.18	10.79
C.V.%	7.97	10.57
Bioenhancers foliar spray (B)		
B ₁ : <i>Panchagavya</i> @ 3%	96.67	172.25
B ₂ : Seaweed extract @ 10%	127.25	133.92
B ₃ : Banana pseudostem sap @ 1%	71.00	94.33
B ₄ : Control (water spray)	63.67	71.58
S.Em.±	2.04	2.83
C.D. (P=0.05)	5.92	8.22
Interaction (O × B)		
S.Em.±	3.54	4.90
C.D. (P=0.05)	10.26	14.23
C.V.%	7.89	8.31

Table 6: Effect of O × B on population of *Rhizobium* in soil after harvest of summer greengram

<i>Rhizobium</i> (CFU × 10 ⁵ /g soil)				
O/B	B ₁	B ₂	B ₃	B ₄
O ₁	94.00	139.75	74.50	48.00
O ₂	130.75	132.00	89.00	58.50
O ₃	65.25	110.00	49.50	84.50
S.Em.±	3.54			
C.D. (P=0.05)	10.26			
C.V. %	7.89			

Table 7: Effect of O × B on population of PSB in soil after harvest of summer greengram

PSB (CFU × 10 ⁵ /g soil)				
O/B	B ₁	B ₂	B ₃	B ₄
O ₁	168.00	115.25	97.25	65.75
O ₂	170.25	167.50	117.25	83.00
O ₃	178.50	119.00	68.50	66.00
S.Em.±	4.90			
C.D. (P=0.05)	14.23			
C.V. %	8.31			

**Fig 1:** Effect of organic manures and bioenhancers on population of *rhizobium* and PSB in soil after harvest of summer greengram

Conclusion

It is concluded results that for obtaining higher quality and maintaining soil health under organic farming, summer greengram should be fertilized either with farm yard manure @ 5.0 t/ha, vermicompost @ 2.0 t/ha or castor cake @ 0.75 t/ha and three foliar sprays of either *panchagavya* @ 3%, seaweed extract @ 10% or banana pseudostem sap @ 1% at 20, 40 and 60 days after sowing under North Gujarat Agro-climatic condition.

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