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Effect of cow based growth enhancers on growth and yield of summer greengram [*Vigna radiata* (L.) Wilczek] under organic farming

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Abstract

A field experiment was conducted during summer season of 2018 at Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Gujarat to study effect of cow based growth enhancers on growth and yield of summer greengram. Almost all the growth attributes of greengram such as plant height, number of branches per plant, leaf area per plant, number of root nodules per plant and dry weight of root nodules per plant showed significant improvement due to application of *jivamrut* @ 500 lit/ha as soil application at 30 and 45 DAS + *panchgavya* @ 3% as foliar application at 20, 35 and 50 DAS. Soil application of *jivamrut* @ 500 lit/ha at 30 and 45 DAS along with *panchgavya* @ 3% as foliar spray at 20, 35 and 50 DAS exhibited its better performance bearing maximum values of number of pods per plant, pod length and seed index. Similarly, it also showed superiority and produced significantly higher seed (1103 kg/ha) and stover yield (2303 kg/ha) as well as realized maximum net returns and BCR of greengram during summer season when grown under organic farming. It also build up maximum population of *rhizobium* and PSB in rhizosphere over control, RDF and sole application of different bioenhancers.

Keywords: Greengram, *jivamrut*, *panchgavya*, *sanjivak*, seed yield, vermiwash

Introduction

Green gram is an excellent source of high quality protein and contains about 25 per cent protein having high digestibility. Vitamin 'C' is synthesized in sprouted seeds of green gram. Being a leguminous crop, it has the capacity to fix atmospheric nitrogen up to 38 kg/ha through symbiosis and improves the fertility and health of soil (Gupta and Prasad, 1982) [4].

Presence of naturally occurring beneficial and effective microorganisms (EMO's) in *panchgavya* predominantly and lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi besides beneficial and proven fertilizers such as *Acetobacter*, *Azospirillum* and Phosphobacterium were detected which have the beneficial effect especially in improving soil quality, growth and yield of crops (Selvaraj *et al.*, 2007) [11]. *Panchgavya*, an organic product is a potential source to play great role for promoting growth and providing immunity to plant system. Bio-chemical properties of *panchgavya* revealed that it possesses almost all the nutrients like N, P, K and micronutrients essential for plant nutrition and growth hormones like IAA and GA required for crop growth (Selvaraj *et al.*, 2007) [11]. *Jivamrut* contains enormous amount of microbial load, which multiply and act as a soil tonic. It is said to enhance microbial activity in soil and ultimately ensuring the availability and uptake of nutrients by the crops (Palekar, 2006) [7].

Vermiwash is coelomic fluid extraction contains several enzymes, plant growth hormones like cytokinins, gibberlines and vitamins along with micro and macro nutrients (Buckerfield *et al.*, 1999) [1]. Nitrogen present in the form of mucus, nitrogenous excretory substances, growth stimulating hormones and enzyme in vermiwash (Tripathi and Bhardwaj, 2004) [14]. Varghese and Prabha (2014) [15] stated that vermiwash is cost effective and used as bio-pesticide and eco-friendly soil conditioner. *Sanjivak* helps to improve soil fertility and enhance crop productivity and quality of product besides pest-repellent. It also contains micronutrients such as Mg, Na, Ca and Zn at variable concentrations and phosphorus (0.007%) and potassium (0.06 3%). Therefore, the use of *Sanjivak* as an organic source of soil amendments may be considered as a cheaper alternative to effective micro-organisms (EM) technology made up of local and natural resources. Use of eco-friendly bioenhancers is another alternate way for

nourishing the crops grown under organic farming besides organic manures and biofertilizers. Hence, present experiment was carried out to find the effect of cow based growth enhancers on growth and yield of summer greengram under organic farming.

Materials and Methods

A field experiment was carried out during summer season 2018 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar on loamy sand soil having low in organic carbon (0.30%) and available nitrogen (143.6 kg/ha), medium in available P₂O₅ (44.1 kg/ha) and potassium (255.0 kg/ha) with soil pH of 7.8. The experiment consisted of twelve treatments *viz.*, T₁: Control (Water spray at 20, 35 & 50 DAS), T₂: *Jivamrut* @ 500 lit/ha as soil application at 30 & 45 DAS, T₃: *Panchgavya* @ 3% as foliar application at 20, 35 & 50 DAS, T₄: *Sanjivak* @ 500 lit/ha as soil application at 20, 35 & 50 DAS, T₅: Vermiwash @ 5% as foliar spray at 20, 35 & 50 DAS, T₆: *Jivamrut* @ 500 lit/ha as soil application at 30 & 45 DAS + *Panchgavya* @ 3% as foliar application at 20, 35 & 50 DAS, T₇: *Jivamrut* @ 500 lit/ha as soil application at 30 & 45 DAS + *Sanjivak* @ 500 lit/ha as soil application at 20, 35 & 50 DAS, T₈: *Jivamrut* @ 500 lit/ha as soil application at 30 & 45 DAS + Vermiwash @ 5% as foliar spray at 20, 35 & 50 DAS, T₉: *Panchgavya* @ 3% as foliar application at 20, 35 & 50 DAS + *Sanjivak* @ 500 lit/ha as soil application at 20, 35 & 50 DAS, T₁₀: *Panchgavya* @ 3% as foliar application at 20, 35 & 50 DAS + Vermiwash @ 5% as foliar spray at 20, 35 & 50 DAS, T₁₁: *Sanjivak* @ 500 lit/ha as soil application at 20, 35 & 50 DAS + Vermiwash @ 5% as foliar spray at 20, 35 & 50 DAS and T₁₂: RDF (20:40:00 kg NPK/ha) were tested in randomized block design with three replications. Greengram variety GM 4 was sown @ 17.5 kg/ha seed rate at an inter-row spacing of 45 cm on 27th February, 2018.

Panchgavya is a special preparation made from five products of deshi cow along with certain other ingredients incubated for specific duration in an open mouth plastic container (Natarajan, 2002). *Jivamrut* is a fermented liquid product prepared by using 10 kg cow dung (fresh) + 10 litre cow urine + 2 kg jaggery + 2 kg pulse flour (cow pea) + 1 kg *sajiv* soil in 200 litre water in a container and stirred well. Allowed the mixture to ferment for 7 days under tree shade. The mixture was stirred twice (morning and evening) every day in a clockwise direction. The container was kept under well ventilated open shed. The mouth of container was tied with thin cotton cloth to enable proper aeration in the container. *Sanjivak* was prepared by mixing 100 kg cow dung, 100 litre cow urine and 500 g jaggery in 300 litre water in a 500 litre capacity drum and allowed to ferment for 10 days.

Common application of well decomposed FYM @ 5.0 t/ha was done in the experimental area and mixed well with the soil. Nitrogen and phosphorus were applied at the rate of 20-40 kg/ha through urea and single super phosphate, respectively in previously opened furrows before sowing of seeds as per treatments. Foliar spray of *panchgavya* @ 3% and vermiwash @ 5% were done at 20, 35 and 50 DAS as per treatments using knapsack sprayer during evening hours. *Jivamrut* (at 30 and 45 DAS) and *sanjivak* (at 20, 35 and 50 DAS) were applied as soil application @ 500 lit/ha in between two rows of the crop using bundle of neem branches during evening hours when soil having optimum moisture content as per the treatments.

Five plants/plot were selected in the net plot area and tagged for recording growth and yield attributes. The crop was manually harvested, threshed and seed and stover yield were recorded. The net return was computed using prevailing market price of inputs, seed and stover of greengram. The soil adhering/adjoining to the root surface was collected and viable microbial bacterial counts of *rhizobium* and phosphate solubilizing bacteria after harvest of crop was determined by Pour plate method (Collins and Patricia, 1976) ^[3].

Results and Discussion

Growth attributes

All growth parameters of greengram *viz.*, plant height, number of branches per plant, leaf area per plant, number of root nodules per plant and weight of dry root nodules per plant were influenced significantly due to use of different bioenhancers (Table 1). An application of *panchgavya* as foliar spray @ 3.0% at 20, 35 and 50 DAS + soil application of *jivamrut* @ 500 lit/ha at 30 and 45 DAS produced significantly tall plants and number of branches per plant than control and application of bioenhancers alone i.e. application of *panchgavya*, *jivamrut*, *sanjivak* and vermiwash individually, but remained on a par with combine application of any two growth enhancers and RDF to greengram. Foliar application of *panchgavya* @ 3.0% at 20, 35 and 50 DAS + soil application of *jivamrut* at 30 and 45 DAS recorded significantly higher leaf area per plant, number of root nodules per plant and dry weight of root nodules per plant over rest of the treatments except application of either *panchgavya* or *jivamrut* in combination with vermiwash @ 5.0% at 20, 35 and 50 days after sowing as foliar spray. The increase in plant height might be due to application of *panchgavya* and *jivamrut* attributed to increase in availability of cytokinin of shoot which in turn play a role in cell elongation process either through cell division and cell elongation. *Panchgavya* might have contained microbial metabolites in appreciable amount that help in maintaining the opening of stomata for longer period both in optimum and adverse conditions during the crop growth which led to increased LAI providing stronger source for sink (Kumar *et al.*, 2011) ^[5]. Panchal *et al.* (2017) ^[8] noted that increase in number of root nodules per plant and dry weight of nodules per plant might be due to better availability of nutrients. Moreover, accumulation of more amounts of nutrients and presence of microbes in the crop rhizosphere stimulate the vegetative growth of plant in terms of more number of branches, leaf area and enhance the root volume and thereby increases number of root nodules per plant ultimately increased dry weight of nodules per plant.

Yield attributes

Yield contributing characters, *viz.*, number of pods per plant, pod length and seed index were significantly improved by application of growth enhancers (Table 2). However, number of seeds per pod being a varietal character showed non-significant effect of treatments.

Application of *panchgavya* as foliar spray @ 3.0% at 20, 35 and 50 DAS alongwith *jivamrut* as soil application @ 500 lit/ha at 30 and 45 DAS gave significantly more pods per plant, pod length and 100 seed weight as compared to control (water spray), an application of 100% RDF through chemical fertilizers and application of only single bio-enhancer. However, it did not differ significantly with combine application of two bio-enhancers to greengram except *sanjivak* + vermiwash. Liquid organic bio-enhancers

particularly *panchgavya* and *jivamrut* contributed to enhancement of number of branches and higher assimilating surface (leaf area) encourages better photosynthesis and

production of more photosynthates which contributed toward the formulation of more pods per plant, length of pod and stouted seed (bold seed).

Table 1: Effect of different treatments on plant height, number of branches per plant, leaf area per plant, number of root nodules per plant and weight of dry root nodules per plant of greengram

Treatments	Plant height at harvest (cm)	Number of branches per plant	Leaf area per plant (cm ²)	Number of root nodules per plant	Weight of dry root nodules per plant (mg)
Control (water spray)	31.8	6.03	384	11.4	3.83
<i>Jivamrut</i> @ 500 lit/ha	34.0	6.14	446	13.3	4.42
<i>Panchgavya</i> @ 3.0%	34.7	6.17	465	13.8	4.76
<i>Sanjivak</i> @ 500 lit/ha	32.7	6.03	388	12.9	4.22
Vermiwash @ 5%	33.6	6.17	455	13.6	4.58
<i>Panchgavya</i> + <i>Jivamrut</i>	42.6	8.07	607	18.2	6.72
<i>Jivamrut</i> + <i>Sanjivak</i>	40.1	7.20	503	14.3	5.48
<i>Jivamrut</i> + Vermiwash	39.8	7.47	525	16.5	5.91
<i>Panchgavya</i> + <i>Sanjivak</i>	40.0	7.20	503	15.8	5.66
<i>Panchgavya</i> + Vermiwash	40.5	7.60	537	16.7	6.12
<i>Sanjivak</i> + Vermiwash	41.6	7.07	470	13.9	5.10
RDF (20:40 kgN-P/ha)	41.2	7.13	496	14.07	5.37
S.Em.±	2.03	0.37	30.21	0.91	0.33
C.D.(P = 0.05)	6.0	1.09	89	2.7	0.99
C.V. (%)	9.35	9.46	10.85	10.90	11.35

IAA and GA present in *panchgavya* could create stimuli in the plant system and simulated the necessary growth and development of crop (Patel *et al.*, 2013) [9]. Shariff *et al.* (2017) [12] noted that cow dung in *panchgavya* act as a medium for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth and resulting in increased pod length.

Yield

Seed and stover yield of greengram significantly influenced by treatments, but non-significant effect of the treatments were found on harvest index (Table 2). An application of *jivamrut* @ 500 lit/ha at 30 and 45 DAS alongwith foliar feeding through *panchgavya* @ 3% at 20, 35 and 50 DAS registered maximum seed yield (1103 kg/ha) and stover yield (2303 kg/ha) followed by foliar application of *Panchgavya* @ 3% at 20, 35 and 50 DAS + Vermiwash @ 5% as foliar spray at 20, 35 & 50 DAS and soil application of *Jivamrut* @ 500 lit/ha at 30 and 45 DAS + Vermiwash @ 5% as foliar spray at 20, 35 & 50 DAS, accounted for 72.34, 57.03 and 56.87% higher seed yield and 84.38, 71.33 and 68.77% higher stover yield over control treatment (Water spray at 20, 35 and 50

DAS), respectively. Higher yield under these treatments ascribed due to improvement in plant height, number of branches per plant, leaf area per plant, number of root nodules per plant, weight of dry root nodules per plant, number of pods per plant, pod length and seed index have significant positive correlation with seed and stover yield. These findings are in line with those reported by Patel *et al.* (2013) [9], Panchal *et al.* (2017) [8] and Shariff *et al.* (2017) [12].

Moreover, in present study the bio-chemical analysis of organic liquid formulations particularly *panchgavya* and *jivamrut* contains naturally occurring beneficial and effective microorganisms (EMO's), lactic acid bacteria and certain fungi besides beneficial and proven fertilizers such as *rhizobium*, *azotobacter*, *azospirillum* and phosphobacterium which might have helped in uptake of nutrients due to increase the supply of easily assimilated major nutrients viz., N and P by symbiotic nitrogen fixation by *rhizobium* and mobilizing unavailable phosphorus into available form by phosphobacterium and at the same time improved soil physical condition that in turn gave higher seed and stover yield. These findings are also corroborated by Patel *et al.* (2013) [9] and Yadav *et al.* (2016) [16].

Table 2: Effect of different treatments on number of pods per plant, pod length, number of seeds per pod, seed index, seed yield, stover yield and harvest index of greengram

Treatments	Number of pods per plant	Pod length (cm)	Number of seeds per pod	Seed index (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
Control (water spray)	15.3	6.5	6.4	3.53	640	1249	34.1
<i>Jivamrut</i> @ 500 lit/ha	15.6	6.9	7.0	3.93	752	1576	32.4
<i>Panchgavya</i> @ 3.0%	17.6	7.4	7.4	4.03	811	1708	32.2
<i>Sanjivak</i> @ 500 lit/ha	15.5	6.9	6.7	3.83	706	1306	35.1
Vermiwash @ 5%	16.8	6.9	7.5	4.00	752	1599	32.1
<i>Panchgavya</i> + <i>Jivamrut</i>	22.1	8.3	8.3	4.93	1103	2303	32.4
<i>Jivamrut</i> + <i>Sanjivak</i>	18.5	7.6	7.7	4.37	905	1843	33.2
<i>Jivamrut</i> + Vermiwash	20.5	8.0	8.3	4.43	1004	2108	32.3
<i>Panchgavya</i> + <i>Sanjivak</i>	19.2	7.9	7.9	4.43	958	1906	33.4
<i>Panchgavya</i> + Vermiwash	21.7	8.0	8.3	4.53	1005	2140	32.0
<i>Sanjivak</i> + Vermiwash	16.6	7.3	7.5	4.10	832	1728	32.7
RDF (20:40 kgN-P/ha)	18.0	7.6	7.5	4.20	895	1745	34.0
S.Em.±	1.06	0.36	0.40	0.22	57.41	122	2.35
C.D. (P = 0.05)	3.1	1.1	NS	0.64	168	357	NS
C.V. (%)	10.22	8.47	9.37	9.13	11.51	11.93	12.34

Microbial study

Microbial population (*Rhizobium* and PSB) were significantly increased by application of growth enhancers (Table 3). Application of *panchgavya* as foliar spray @ 3.0% at 20, 35 and 50 DAS alongwith *jivamrut* as soil application @ 500 lit/ha at 30 and 45 DAS gave significantly higher number of *rhizobium* (27.30×10^5 CFU/g soil) and PSB (29.07×10^5 CFU/g soil) as compared to control (water spray), application of 100% RDF through chemical fertilizers and sole application of bioenhancer followed by combine application of *panchgavya* and vermiwash.

Organic liquid formulations like *panchgavya* and *jivamrut* contains *rhizobium*, *azotobacter*, *azospirillum* and PSB which act as a source of inoculation in the soil besides providing favourable soil condition facilitated the enhancement in the population of *rhizobium* and PSB in these treatments. These findings are in agreement with those reported by Chaudhari (2012) [2]. Moreover, bio-enhancers (*panchgavya* and *jivamrut*) facilitated robust growth of plants and soil health and thereby increased nodulation (Table 1). Increase in nodulation is directly related to increase in microbial count in soil. Similar findings have been reported by Patel *et al.* (2013) [9] and Sutharsan and Mohottige (2017) [13].

Economics

The highest net realization (₹ 24858/ha) was incurred under the treatment of foliar application of *panchgavya* @ 3.0% at 20, 35 and 50 DAS alongwith soil application of *jivamrut* @ 500 lit/ha at 30 and 45 DAS with the BCR value of 1.71 followed by soil application of *jivamrut* @ 500 lit/ha at 30 and 45 DAS along with foliar application of vermiwash @ 5% at 20, 35 and 50 DAS which recorded the net realization of ₹ 22113/ha and BCR value of 1.68 (Table 3). Maximum net returns and BCR was noted under these treatments was mainly on account of higher seed and stover yields and favourable response of greengram to *panchgavya* and *jivamrut*. The results are in confirmity with those reported by Patel (2013) [9] and Panchal *et al.* (2017) [7].

Conclusion

It is concluded that foliar application of 3% *panchgavya* at 20, 35 and 50 DAS + soil application of *jivamrut* @ 500 lit/ha at 30 and 45 DAS or soil application of *jivamrut* @ 500 lit/ha at 30 and 45 DAS + foliar application of 5% vermiwash at 20, 35 and 50 DAS or application of 3% *panchgavya* + vermiwash @ 5% at 20, 35 and 50 DAS may be recommended for obtaining higher seed yield, net returns and improving biological fertility of soil for greengram raised under organic farming during summer season.

Table 3: Effect of different treatments on microbial population and economics of greengram

Treatments	Microbial bacterial count (CFU×10 ⁵ /g soil)		Cost of cultivation (₹/ha)	Net returns (₹/ha)	BCR
	<i>Rhizobium</i>	PSB			
Control (water spray)	17.62	20.46	30408	4090	1.13
<i>Jivamrut</i> @ 500 lit/ha	20.24	23.65	31408	9344	1.29
<i>Panchgavya</i> @ 3.0%	22.90	24.85	33378	10588	1.31
<i>Sanjivak</i> @ 500 lit/ha	19.36	23.08	31083	6829	1.21
Vermiwash @ 5%	20.46	24.21	30783	10015	1.32
<i>Panchgavya</i> + <i>Jivamrut</i>	27.30	29.07	34898	24858	1.71
<i>Jivamrut</i> + <i>Sanjivak</i>	24.12	26.38	32603	16333	1.50
<i>Jivamrut</i> + Vermiwash	25.90	27.66	32303	22113	1.68
<i>Panchgavya</i> + <i>Sanjivak</i>	24.33	26.71	34833	16879	1.48
<i>Panchgavya</i> + Vermiwash	26.66	28.00	34533	19997	1.57
<i>Sanjivak</i> + Vermiwash	23.02	25.36	32238	12818	1.39
RDF (20:40 kg N-P/ha)	20.26	23.56	32048	14792	1.46
S.Em.±	0.82	1.01			
C.D. (P = 0.05)	2.40	2.97			
C.V. (%)	6.27	6.96			

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