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Effect of soil amendments and organic foliar sprays on crop growth, seed yield and quality of green gram (*Vigna radiata* L.)

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Abstract: A field experiment was conducted on clay textured soil at Bio-organic farm, Main Agricultural Research Station, UAS Dharwad during *kharif* season of 2013 to study the effect of soil amendments and organic foliar sprays on crop growth, seed yield and quality of green gram (*Vigna radiata* L.). The treatment consisting soil application of organic manures and liquid organic foliar sprays at flower initiation and 15 days after flowering (DAF).The soil amendments and organic foliar spray significantly influenced the crop growth, seed yield and seed quality parameters of green gram. Among the treatment combinations the application of FYM (33.33%) + vermicompost (33.33 %) + glyricidia leaf manure (33.33%) equivalent to 100% RDF and foliar spray of 3% panchagavya at flower initiation and 15 DAF has recorded significantly higher plant height (66.33cm), number of branches (6.20), number of trifoliate leaves (6.87) and dry matter accumulation (11.15 g/plant) at harvest and it is also recorded more number of pods per plant (21.27), pod length (10.25 cm), number of seeds per pod (12.10), seed yield per plant (12.89 g/plant) and seed yield per hectare (1263kg/ha). The higher seed quality parameters such as 100 seed weight (5.86 g), seed germination percentage (95.67%), shoot length(16.53cm) root length (18.25 cm), seedling vigour index (3308) and protein content (23.79%) as compared to other treatment combinations and control.

Key words: Farm yard manure, Glyricidia, Panchagavya, Vermicompost

Introduction

Green gram (*Vigna radiata* L. Wilczek) is one of the most ancient and extensively grown leguminous crops in India. It is a short duration crop and rich in protein and vitamin B. In India it occupies an area of 3.44 million ha with a production of 1.88 million tones with the average yield 526 kg per ha. Whereas, in Karnataka it occupies an area of about 2.86 lakh ha with a production of about 0.67 lakh tones with average productivity of 237 kg per ha (Anon., 2012).

The continuous use of chemical fertilizers leads to reduction in the crop yield and resulted in imbalance of nutrients in the soil, which has adverse effects on soil health. Use of soil organic manures alone or in combination with liquid organic manures will help to improve physico-chemical properties of the soils and efficient utilization of applied organic manures for improving seed yield and seed quality. Organic manures provide a good substrate for the growth of microorganisms and maintain a favorable nutritional balance and soil physical properties. The main drawback in organic seed production is the non-availability of organic seeds for its further multiplication. In view of this the present investigation was carried out to know the effect of soil organic manures and organic foliar sprays on crop growth, seed yield and quality of green gram.

Material and methods

A field experiment was conducted during *kharif* 2013 at Bio-Organic farm, Main Agricultural Research Station, UAS, Dharwad, Karnataka, India. The soil of the experimental site was clayey in texture with bulk density of 1.27 g /cc, pH of 7.70, organic carbon of 0.55%. The soil is low in available N (211.40 kg/ha) and P_2O_5 (27.34 kg/ha) and medium in available K_2O (346.19 kg/ha).

The experiment was laid out in RCBD with three replications. There were 12 treatments combinations consisting of soil amendments are of four organic manures and three organic foliar sprays. The green gram (Cv.DGGV-1) was sown with a spacing of 30 cm x 10 cm. The recommended dose of phosphorus for green gram was supplemented with different combinations of soil organic manures with equal proportions based on their P content. The required quantity of organic manures *viz.,* Farm yard manure, vermicompost, glyricidia green leaf manure and neem cake were applied uniformly as per the treatment combinations and incorporated into the soil three weeks before sowing. The recommended dose of fertilizers (RDF- 25 kg N + 50 kg P_2O_5 + 0 kg K_2O ha^{-1}) was applied to the plots as per the treatment details in the form of urea, diammonium phosphate and muriate of potash. All the fertilizers were applied in a single dose at the time of sowing in furrows opened at 5 cm away and 5 cm deep in the soil as basal dose. The organic foliar sprays of 3% panchagavya, 10% vermiwash and water spray (absolute control) were sprayed at two times, one at initiation of flowering and another at fifteen days after flowering according to the treatment combinations.

Results and discussion

Application of Phosphorus equivalent to 100 per cent recommended dose through FYM (33.33 %) + vermicompost (33.33 %) + glyricidia green leaf manure (33.33 %) (S_4) with equal proportion recorded significantly higher plant height (63.40 cm), number of branches (5.82), number of trifoliate leaves (6.38) and dry matter accumulation (10.80 g/plant) at harvest as compared to control S_1 (RDF+ FYM 5t/ha) (Table 1). The increased plant growth parameters might be due to the improvement in soil physical condition for the plant growth

Table 1. Effect of soil amendments and organic foliar sprays on crop growth and seed yield and seed quality parameters in green gram (Cv. DGGV-1)

Treatments	Plant height (cm)	Number of branches per plant	Number of trifoliate leaves per plant	Dry matter accumulation (g/plant) at harvest	Number of pods per plant	Pod length (cm) number of seeds per pod	No. of seeds per pod	Seed yield per plant (g)	Seed yield per ha (kg/ha)
S_1	59.53	5.29	5.73	10.30	16.91	8.14	9.83	9.39	952
S_2	60.50	5.37	5.93	10.47	17.40	8.90	10.37	10.19	1029
S_3	61.84	5.62	6.09	10.55	17.64	9.04	10.47	10.69	1057
S_4	63.40	5.82	6.38	10.80	18.99	9.38	11.20	11.55	1145
S.Em ±	0.36	0.09	0.10	0.02	0.17	0.06	0.12	0.13	6.87
C.D. at 5%	1.06	0.26	0.29	0.06	0.51	0.017	0.36	0.37	20.15
Foliar spray (F)									
F_1	63.29	5.86	6.37	10.87	18.85	9.49	11.15	11.44	1135
F_2	62.38	5.62	6.10	10.75	18.06	9.20	10.65	10.48	1029
F_3	58.29	5.10	5.63	9.97	16.03	7.92	9.60	9.09	919
S.Em ±	0.31	0.08	0.09	0.02	0.15	0.05	0.11	0.11	5.95
C.D. at 5%	0.91	0.23	0.25	0.05	0.44	0.15	0.31	0.32	17.45
Interactions (SxF)									
$S_1 \times F_1$	61.40	5.73	6.00	10.56	17.54	8.70	10.20	10.13	1014
$S_1 \times F_2$	61.11	5.33	5.80	10.49	17.40	8.50	10.10	9.62	1012
$S_1 \times F_3$	56.10	4.81	5.40	9.85	17.80	7.23	9.20	8.42	831
$S_2 \times F_1$	62.30	5.70	6.20	10.83	18.13	9.50	11.40	10.80	1094
$S_2 \times F_2$	61.94	5.40	6.00	10.68	17.87	9.20	10.40	10.61	1064
$S_2 \times F_3$	57.30	5.00	5.60	9.89	16.20	8.00	9.60	9.15	928
$S_3 \times F_1$	63.13	5.84	6.40	10.93	18.47	9.50	11.20	11.94	1169
$S_3 \times F_2$	62.60	5.80	6.20	10.77	18.13	9.40	10.40	10.96	1074
$S_3 \times F_3$	59.80	5.27	5.67	9.96	16.33	8.23	9.80	9.18	929
$S_4 \times F_1$	66.33	6.20	6.87	11.15	21.27	10.25	12.10	12.89	1263
$S_4 \times F_2$	63.90	5.93	6.41	11.06	18.83	9.70	11.70	12.14	1185
$S_4 \times F_3$	59.97	5.33	5.87	10.17	16.87	8.20	9.80	9.62	986
S.Em ±	0.62	0.16	0.17	0.03	0.30	0.10	0.21	0.22	11.90
C.D. at 5%	1.86	0.47	0.53	0.10	0.88	0.30	0.62	0.65	34.90

Note:
NS = Non- significant
Soil amendments (S)
S_1 : RDF (25:50:00 kg N: P_2O_5: K_2O/ha) + FYM 5 t ha^{-1} (Control/ RPP).
S_2 : FYM (50%) @12.5 t ha^{-1}) + Vermicompost (50%) @2.5 t ha^{-1}
S_3 : FYM (33.33%) @8.33 t ha^{-1} + Vermicompost (33.33%) @ 1.66 t ha^{-1} + Neem cake (33.33%) @ 1.66 t ha^{-1}
S_4 : FYM (33.33%) @ 8.33 t ha^{-1} + Vermicompost (33.33%)@1.66 t ha^{-1} + Glyricidia green manure (33.33%) @ 4.62 t ha^{-1}
Organic foliar spray (F)
F_1 : 3 % Panchagavya
F_2 : 10% Vermiwash
F_3 : Water spray (Control)

along with increased availability of N, P and K especially in the treatment combination of FYM (33.33%) + VC (33.33%) + GLM (33.33%). The addition of organic manures had significant positive effects on the soil physical and biological properties besides enhancing plant growth parameters (Tharmaraj *et al.,* 2011).

The organic foliar sprays at flower initiation and 15 days after flowering had a significant influence on crop growth parameters of green gram (Table 1). The 3% panchagavya spray (F_1) recorded significantly highest plant height (63.29 cm), number of branches (5.86), number of trifoliate leaves (6.37), dry matter accumulation (10.87 g /plant) at harvest as compared to absolute control water spray. However, it was on par with 10% vermiwash spray. The foliar spray of panchagavya @ 3% enhanced the growth rate of plant since it contains the favorable micro and macronutrients and growth hormones. This might be due to beneficial effect of panchagavya as an efficient plant growth stimulant that enhances the biological efficiency of crops. It is used to activate biological reactions in the soil and also protect the plants from disease incidence (Nileema and Sreenivasa, 2011).

Interaction effects of organic soil amendments and liquid organic foliar sprays had shown significant influence on crop growth parameters of green gram. The combined soil application of 100 per cent RDP with FYM (33.33%) + VC (33.33%) + GLM (33.33%) and foliar spray of 3% panchagavya at flower initiation and 15 days after flowering (S_4F_1) recorded significantly highest plant height (66.33 cm), number of branches (6.20), number of

Table 2. Effect of soil amendments and organic foliar sprays on seed quality parameters in green gram (Cv.DGGV-1)

Treatment	100 seed weight (g)	Germination percentage	Root length (cm)	Shoot length (cm)	Seedling vigour index	Protein content (%)
Soil amendments (S)						
S_1	4.92	92.22 (73.70)*	16.83	14.47	2890	21.97
S_2	5.07	93.21 (75.04)	17.11	14.74	2957	22.29
S_3	5.00	92.55 (74.28)	16.94	14.65	2932	22.08
S_4	5.42	93.78 (75.69)	17.36	15.17	3035	22.64
S.Em ±	0.06	0.48	0.06	0.08	34	0.15
C.D. at 5%	0.18	1.41	0.17	0.23	101	0.43
Foliar spray (F)						
F_1	5.29	94.91 (77.00)	17.78	15.74	3174	23.11
F_2	5.11	93.16 (73.95)	17.13	14.45	2910	22.18
F_3	4.89	91.75 (72.15)	16.28	16.28	2776	21.45
S.Em ±	0.05	0.42	0.05	0.07	38	0.13
C.D. at 5%	0.16	1.22	0.15	0.20	116	0.39
Interactions (S×F)						
$S_1 \times F_1$	5.02	94.91 (77.00)	17.42	15.33	3089	22.63
$S_1 \times F_2$	5.01	93.16 (74.89)	17.10	14.30	2902	22.17
$S_1 \times F_3$	4.73	90.00(71.54)	15.97	13.77	2678	21.11
$S_2 \times F_1$	5.21	95.00 (77.09)	17.90	15.57	3170	23.22
$S_2 \times F_2$	5.04	93.67(75.46)	17.17	14.40	2918	22.30
$S_2 \times F_3$	4.95	91.00 (72.58)	16.27	14.27	2783	21.37
$S_3 \times F_1$	5.07	94.67 (76.67)	17.57	15.52	3129	22.82
$S_3 \times F_2$	5.03	92.67 (74.31)	16.90	14.33	2844	21.86
$S_3 \times F_3$	4.91	90.33 (71.86)	16.37	14.10	2825	21.56
$S_4 \times F_1$	5.86	95.67 (78.03)	18.25	16.53	3308	23.79
$S_4 \times F_2$	5.37	94.00 (75.82)	17.33	14.78	2976	22.38
$S_4 \times F_3$	4.98	91.67 (73.22)	16.50	14.20	2821	21.76
S.Em ±	0.06	0.84	0.10	0.13	61	0.27
C.D. at 1%	0.18	2.49	0.31	0.39	184	NS

Note: *Figures in parantheses are transformed values

NS = Non- significant

Soil amendments (S)

S_1 : RDF (25:50:00 kg N: P_2O_5: K_2O/ha) + FYM 5 t ha^{-1} (Control/ RPP).

S_2: FYM (50%) @12.5 t ha^{-1}) + Vermicompost (50%) @2.5 t ha^{-1}

S_3: FYM (33.33%) @8.33 t ha^{-1} + Vermicompost (33.33%) @ 1.66 t ha^{-1} + Neem cake (33.33%) @ 1.66 t ha^{-1}

S_4: FYM (33.33%) @ 8.33 t ha^{-1} + Vermicompost (33.33%)@1.66 t ha^{-1} + Glyricidia green manure (33.33%) @ 4.62 t ha^{-1}

Organic foliar spray (F)

F_1:3% Panchagavya

F_2:10% Vermiwash

F_3:Water spray (Control)

trifoliate leaves (6.87), total dry matter accumulation (11.15 g/ plant) as compared to control S_1F_3 (RDF + FYM 5 t/ha + water spray).The higher plant growth characters might be due to the presence of growth enzymes present in panchagavya which favored rapid cell division and multiplication. The similar results was also obtained by application of enriched compost (33.33%) + vermicompost (33.33%) + glyricidia leaf manure (33.33%) equivalent to 100% RDN and foliar spray of 3% panchagavya at flower initiation and 15 DAF as reported by Patil *et al.* (2012) in chickpea. The increased plant biometrical parameters might be due to the better availability of nutrients from the application of soil amendments and organic foliar sprays and effective conversion of nutrients from these organic sources such as Fe, Mg and Zn available at the site of photosynthesis. The presence of coconut water in panchagavya contains kinetin along with other enzymes might have increased the chlorophyll content of the leaves. Hence, this might have lead to higher leaf area production and capture of more solar radiation resulting in higher photosynthesis and consequent improvement in all growth attributes. These results are in agreement with the findings of Somasundaram (2003) in green gram. Similarly De Britto and Girija (2006) observed the cow dung in panchagavya acts as a medium for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth in blackgram and green gram. Kumaravelu and Kadambian (2009) noticed that the panchagavya helps in promoting the metabolic activities of the plant and resultant seeds in green gram. When organics are applied, nutrients will be released slowly and also the nutrient losses will be minimized due to increased absorption of nutrients as a result of increased cat ion exchange capacity with increased organic matter content. Thus plant nutrients will be available for a long period in adequate quantity thereby plant can absorb the required nutrients as per its demand resulting in better growth, development and yield components.

Addition of organic matter improves soil structure, porosity, water holding capacity and decreases bulk density and chemical properties such as soil organic carbon and available nutrients will also be improved. All these have beneficial effect on soil health, crop growth and yield on sustainable basis (Somasundaram, 2003)

Among the organic soil amendments, application of phosphorus through FYM + Vermicompost + Glyricidia green leaf manure in equal proportion resulted in significantly higher seed yield and seed yield attributing characters. The application of FYM (33.33%)+ vermicompost (33.33%)+ glyricidia green leaf manure (33.33%) in equal proportion to RDF produced significantly more number of pods/plant (18.99), pod length (9.38 cm), number of seeds per pod (11.20), seed yield per plant (11.55 g/plant) and seed yield per hectare (1145 kg/ha) over control RDF+FYM @ 5 t ha^{-1} and all the other organic soil amendments (Table 1). The Increased seed yield and yield attributing characters of green gram by application of soil amendments might be due to higher availability of nutrients to plants, besides increased water holding capacity and other physical properties which might have caused increased rate of infiltration and this might be also due to formation of more root nodules, vigorous root development, better nitrogen fixation and better development of plant growth leading to higher photosynthetic activity and translocation of photosynthates to the sink which in turn resulted in better development of yield attributes and finally higher seed yield. Similar results were also reported by Yadav and Vijayakumari (2003) recorded the application of vermicompost with neem cake were found to be effective in improving seed quality parameters in chilli, The results of the present investigations are in confirmity with findings of Patil *et al.* (2012) in chickpea, Ravusaheb (2008) in sesame and Shwetha (2008) in soybean.

Foliar spraying of 3 % panchagavya at flower initiation and 15 days after flowering has recorded significantly more number of pods/plant (18.85), pod length (9.49 cm), number of seeds per pod (11.15), seed yield per plant (11.44 g/plant) and seed yield per hectare (1135 kg/ha) followed by 10% vermiwash as compared to absolute control water spray. This might be due to fact that cow dung in panchagavya act as a medium for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth (De Britto and Girija, 2006). These findings are in agreement with Patil *et al.,* 2012 in chickpea, Ravusaheb (2008) also obtained significantly highest total dry matter production and growth, yield and yield attributing parameters due to two sprays of panchagavya at 30 DAS and flowering stage over no spray of panchagavya in sesame. Similar results are noticed with findings of Shwetha (2008) in soybean.

Among the interactions of soil amendments and organic foliar sprays, spraying of 3% panchagavya in combination with FYM (33.33%) + Vermicompost (33.33%) + Glyricidia green leaf manure (33.33%) has recorded significantly higher number of pods/plant (21.27), pod length (10.25 cm), number of seeds per pod (12.10), seed yield per plant (12.89 g/plant) and seed yield per hectare (1263 kg/ha) over control S_1F_3 (RDF + FYM 5 t ha^{-1} + water spray). The seed yield of green gram is the product of various yield attributing characters like number of pods, pod length, number of seeds per pod and test weight and these are differed significantly due to application of soil amendments, organic foliar spray and their combined applications. This might be due to availability and optimum supply of nutrients to plants favorably influenced the flowering and seed formation which ultimately increased the pods/plant, seeds/pod and test weight. Higher yield attributing characters in aforesaid treatments is a consequence of increased rate of photosynthesis coupled with efficient translocation of photosynthetes from source (leaf and stem) to sink (pods) and this may be attributed to significant improvement in the sink size (number of pods) which could be due to increased number of branches per plant, which might have resulted in the development of more number of reproductive parts and there by increased the sink size to obtain higher seed yield. These findings are in agreement with findings of Patil *et al.,* 2012 in chickpea, Ravusaheb (2008) in sesame and Shwetha (2008) in soybean.

Application of soil amendments, organic foliar sprays and their interactions not only influenced the crop growth and seed yield of green gram but it also helped in enhancing the seed quality parameters(Table.2). The application of soil amendments of FYM (33.33%) + Vermicompost (33.33%) + Glyricidia green leaf manure (33.33%) recorded highest 100 seed weight (5.42 g), seed germination percentage (93.78%), root length (17.36 cm), shoot length (15.17 cm), seedling vigour index (3,035) and protein content (22.64%) and this might be due to better nutrient status in the soil and better assimilation of nutrients by plants was reflected upon their reproductive health and quality of seed. The increase in the seed quality with application of soil amendments may also be due to better nutrient availability and its uptake by mother plant. This might have lead to accumulation of higher quantities of seed components like calcium carbonate and increased lipid metabolism which helps in increasing the protein content in seed. These results are in conformity with findings of Patil (2008) in capsicum.

Organic foliar spray of 3% panchagavya recorded significantly higher 100 seed weight (5.86 g), germination percentage (94.91%), root length (17.78 cm), shoot length (15.74 cm), seedling vigour index (3,179) and protein content (23.11%). This may be attributed to the action of growth promoters such as kinetin , GA and beneficial microbes present in panchagavya. Ramaswamy and Vijaykumar (2009) reported that Panchagavya significantly increased the growth and yield and resultant seed quality parameters due to supply of all micro and macronutrients present in the panchagavya and also by the growth enzymes present in panchagavya favoured rapid cell division and multiplication in senna, Similar observation were also recorded by Kumaravelu and Kadambian (2009) in green gram, Saritha *et al.* (2013) in cluster bean. The organic foliar spray of 3% panchagavya recorded significant difference in protein content percentage (23.11%). This might be due to enzymatic activity of nitrate reductase and glutamate synthase results in higher protein content percentage. These results are also in

conformity with the findings of Vijayakumari *et al.* (2012) in soybean.

The interactions of soil amendments and organic foliar spray were found to be significant with respect to seed quality parameters such as germination percentage, shoot length, root length and seedling vigour index (Table 2). Among the interactions S_4F_1 (FYM (33.33%) + Vermicompost (33.33%) + Glyricidia green leaf manure (33.33%) coupled with 3% panchagavya were found to be significant with respect to 100 seed weight (5.86 g), seed germination percentage (95.67%), shoot length (16.53 cm), root length (18.25 cm) and seedling vigour index (3,308). This may be due to action of growth promoters such as kinetin , GA and beneficial microbes present in panchagavya and also due to enhanced carbohydrate synthesis and effective translocation of these photosynthates in source to sink relationship. These results are in conformity with the findings of Saritha *et al.* (2013) in cluster bean.

Soil application of Phosphorus equivalent to 100 per cent recommended dose with FYM (33.33%) + vermicompost (33.33%) + glyricidia leaf manure (33.33%) coupled with foliar spray of 3% panchagavya at flower initiation and 15 days after flowering increased the crop growth, seed yield and better quality parameters of green gram. Soil amendments will helps in accomplishing the nutrient demand of green gram through various organic nutrient sources and reduce the dependence to chemical fertilizers.

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