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Effect of different organic and inorganic sources of nutrients on growth, yield, residual nutrient status and physiology of black gram

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Abstract

A field experiment was conducted during *kharif* 2018 at Research Farm, Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar to assess the effect of different sources of nutrients on growth, yield, residual nitrogen status and physiology of black gram. The treatment combinations include T_1: Control, T_2: 100% RDF, T_3: 100% N through FYM, T_4: 100% N through vermicompost, T_5: 50% RDF + 50% N through FYM, T_6: 50% RDF + 50% N through vermicompost, T_7: 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake, T_8: 75% RDF + *Rhizobium* + PSB, T_9: 50% RDF + *Rhizobium* + PSB, T_{10}: 50% FYM + *Rhizobium* + PSB, T_{11}: *Jeevamrit* @ 75 l ha^{-1} + *Beejamrit* (seed treatment) + *Ghanjeevamrit* @ 250 kg ha^{-1}. The experiment was laid down in randomized block design with three replications. Results of the study revealed that growth characters, no. of pods $plant^{-1}$ (32.25), biological yield (3903 kg ha^{-1}), seed yield (1050 kg ha^{-1}) and stover yield (2853 kg ha^{-1}) was obtained significantly highest under 100% RDF which remained at par with 75% RDF + *Rhizobium* + PSB. Application of 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake recorded significantly higher residual nitrogen in soil after the harvest of crop. Highest chlorophyll content was recorded under T_2 which remained at par with T_8 and T_9. However, there was no significant affect on canopy temperature with different sources of nutrients. Treatment T_2 (100% RDF) realized highest net returns (Rs. 32779 ha^{-1}) and B:C (2.15) closely followed by T_8.

Keywords: Black gram, *Beejamrit*, *Jeevamrit*, *Ghanjeevamrit*, PSB, *Rhizobium*, FYM

Introduction

India is the largest producer and consumer of pulses in the world occupying an area of 29.44 million hectares, with production of 23.13 million tones and productivity of 786 kg ha^{-1} (Anonymous, 2017) [1]. Though, the average yield of pulses is very low as compared to cereals owing to many reasons. Pulses are the cheapest source of good quality dietary protein for the human being. They are having very high fiber content which helps to decrease blood cholesterol levels and control blood sugar levels. Besides this, the positive impact of pulses on soil health is also very well known, in particular their ability to fix nitrogen naturally, which fertilizes the soil for crops (Mir *et al.*, 2013) [11].

Black gram (*Vigna mungo* L.; Fabaceace), is one of the highly priced and nutritious pulse grown in tropical countries especially in India. It is rich in protein (25%), phosphoric acid, dietary fiber and carbohydrates. It also contain high levels of potassium (983 mg/100g), calcium (138 mg/100g), iron (7.57 mg/100g), niacin (1.447 mg/100g), thiamine (0.273 mg/100g), riboflavin (0.254 mg/100g) and vitamins like A, B_1, B_3 and C (Girish *et al.*, 2012) [7]. It is used in preparation of many south Indian dishes like dosa, idli etc. Besides being cooked as dal for consumption with roti and rice, it is also used in making papad (Batra *et al.*, 1974) [4]. It is grown for forage and hay purpose. Its crop residues serve as an important feed for livestock. It can be used as cover crop and green manure.

Despite having superior nutritional value and wider adaptability to environmental conditions including marginal and low nutrient status soils, the cultivation of black gram by farmers is very less owing to its less production in the country. It is cultivated in India over an area of 4.47 million hectares with production of 2.83 million tones and productivity of 632 kg ha^{-1} (Anonymous, 2017) [1].

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The low yield of black gram is due to various reasons such as non-availability of quality seeds of improved varieties, cultivation on marginal and less fertile soils with low inputs and without pest and disease management, cultivation under moisture stress conditions etc. Further, imbalanced use of chemical fertilizers as well as reduction in use of organic manures resulted in low crop productivity and deterioration in soil health (Chaudhari *et al*., 2016) [6].

However, now a days, this crop is gaining importance due to its hardiness nature and comparatively more resistant against insect, pests and diseases. Integrating chemical fertilizers with organic fertilizers has been found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production (Nambiar and Aborol, 1992) [12]. Combined application of composts along with traditional organic liquid manures like *Beejamrit*, *Jeevamrit*, *panchgavya, sasyamrut* and vermiwash etc. can release the nutrients in a more synchronized manner as per the need of the crop (Kanwar *et al*., 2006) [10]. Farm yard manure is known to play an important role in improving the fertility and productivity of soils through its positive effects on soil physical, chemical and biological properties and balanced plant nutrition in traditional agriculture (Amruta *et al.*, 2017) [2]. Biofertilizers are known to play an important role in increasing availability of nitrogen and phosphorus besides improving biological fixation of atmospheric nitrogen and enhance phosphorus availability to crop (Bhat *et al.*, 2013) [5]. Therefore, use of efficient strains of *Rhizobium* may help augment nitrogen fixation and boost production of crops. Thus, to derive maximum benefits from the black gram in terms of nutrition and economy, it is felt there is great scope to increase productivity of black gram with adoption of integrated use of different organic and inorganic nutrients. Hence, keeping in view the above facts, the present study was planned with the objective to study **"**Effect of different organic and inorganic sources of nutrients on growth, yield, residual nutrient status and physiology of black gram".

Materials and Methods

The field experiment was conducted during *kharif* season of the year 2018 at Research Farm, Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana). The location is situated at 29º 10´N latitude and 75º 46´E longitudes at an elevation of 215.2 meter above mean sea level. The climate of this region is typical semi-arid with dry desiccating winds during summer and severe cold during winter. Total rainfall during the crop season was recorded 241.7 mm. The soil of the experimental field was sandy loam in texture having organic carbon (0.34%), available nitrogen (127 kg/ha), available phosphorus (15.8 kg/ha) and available potassium (270 kg/ha). The experiment was laid down in randomized block design with three replications. The treatment combinations were, T_1: Control, T_2: 100% Recommended Dose of Fertilizers (RDF), T_3: 100% N through FYM, T_4: 100% N through vermicompost, T_5: 50% RDF + 50% N through FYM, T_6: 50% RDF + 50% N through vermicompost, T_7: 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake, T_8: 75% RDF + *Rhizobium* + PSB, T_9: 50% RDF + *Rhizobium* + Phosphate solubilizing bacteria (PSB), T_{10}: 50% FYM + *Rhizobium* + PSB, T_{11}: *Jeevamrit* @ 75 l/ha + *Beejamrit* (seed treatment) + *Ghanjeevamrit* @250 kg/ha.

For preparation of *Jeevamrit* and *Ghanjeevamrit*, mix cowdung, cow urine, jaggery, chickpea flour, soil and water in required quantities as per requirement and keep in a drum, stir with stick daily twice and leave it to decompose for 2-3 days. For *Beejamrit*, mix cow dung, urine, calcium hydroxide, soil and water in required quantity, stir and leave for 24 hours. A pre-sowing irrigation was given to ensure uniform germination. Farmyard manure, vermicompost and neem cake were incorporated 5 days before sowing in respective plots as per treatment specifications. Recommended dose of fertilizers (N: 20 kg/ha, P_2O_5: 40 kg/ha) were applied through urea and single super phosphate as per treatments as basal dose at the time of sowing. Seeds were treated with *Rhizobium*, PSB and *Jeevamrit* as per treatment specifications and dried in shade.

The black gram variety UH-1 was sown with hand plough on 19 June 2018 at an inter- row spacing of 30 cm using seed rate of 20 kg/ha. Two hand weeding were done at 25 and 45 days after sowing. One irrigation was applied at 30 days after sowing. To reduce the infestation of white fly, two sprays of insecticide Azadirachtin 0.03% were done, first at 35 days after sowing and spray was repeated 20 days after the first spray. The chlorophyll content and canopy temperature (°C) at 50% flowering were estimated by SPAD- 502 plus chlorophyll meter and LT-300 Infrared thermometer, respectively. Total number of pods of randomly selected five plants were counted and mean value for number of pods/plant was recorded.

After the manual harvesting of the crop, bundles were made plot wise and whole plant samples after sun drying were weighted to obtain biological yield and expressed in kg ha^{-1}. The material was manually threshed, winnowed and the clean seeds obtained from individual plot were weighted to obtain seed yield. The stover yield was obtained by subtracting seed yield from biological yield. Composite soil samples were collected before layout of the experiment to determine the initial soil status. The soil samples were also collected from each treatment after harvest of crop to assess the change in nutrient status. The soil samples collected from 0-15 cm depth were dried under shade, powdered and passed through 2 mm sieve and were used for analysis. For economic studies, price prevailing in the market were used. For the statistical analysis of data, computer programme OPSTAT was used.

Results and Discussion

Growth parameters

Plant height increased successively with advancement in the age of the crop irrespective of treatments. The rate of increase was more pronounced during 30 to 45 DAS as compared to 45 DAS to maturity. Treatments failed to produce significant difference in plant height at 30 DAS. However, at 45 DAS and maturity, application of 100% RDF recorded highest plant height and remained at par with 75% RDF + *Rhizobium* + PSB.

At 30 DAS, 45 DAS and at maturity, all the treatment combinations produced significantly higher dry matter per plant over control. The maximum dry matter (1.95, 11.12, 20.17 g/plant at 30 DAS, 45 DAS and at harvest, respectively) was recorded in T_2 (Table 1) and T_8 and both remained statistically at par with each other. This might be due to initial boost of nitrogen through 100% RDF that have stimulated cell division which resulted in better growth characters throughout the plant growth. Similar results have been reported by Pargi *et al*. (2018) [13] in cowpea with 100% RDF. Among organics, best results were obtained under T_7 (1/3 N through FYM + 1/3 N though vermicompost + 1/3 N through neem cake) (Table 1).

Yield attributes and yield

The data in Table 2. revealed that among different treatments, significantly higher number of pods/plant (32.25) and number of seeds/pod (7.8) were obtained under application of 100% RDF as compared to all other treatments except T_8 (75% RDF + *Rhizobium* + PSB) to which it was at par. Yield attributes in T_7 (1/3 N through N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake), T_4 (100% N through vermicompost) and T_3 (100% N through FYM) did not differ significantly. The increased yield attributes under these treatments might be due to availability of adequate major nutrients that helped in better harnessing of solar energy that resulted in better development of photosynthetic organs and good branching resulting in more pods per plant. These results are in conformity with result of Sharma *et al*. (2015) [17] and Joshi *et al*. (2018) [8].

The maximum biological yield (3903 kg ha^{-1}), seed yield (1050 kg ha^{-1}) and stover yield (2853 kg ha^{-1}) was recorded in 100% RDF (T_2) which was significantly superior over rest of the treatments except T_8 (75% RDF + *Rhizobium* + PSB) which yielded 3775 kg ha^{-1} biological yield, 1008 kg ha^{-1} seed yield and 2767 kg ha^{-1} stover yield (Table 2). The minimum yield (biological, seed and stover) was recorded under control (T_1) which was significantly inferior to the rest of treatments. Results are in accordance with the findings of Patel *et al*. (2016) [14].

Residual nutrient status

Results presented in Table 3. showed that application of 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake significantly increased the available nitrogen (131 kg ha^{-1}) in the soil at the harvest of black gram as compared to control (125 kg ha^{-1}). Application of 100% N through FYM and vermicompost recorded 130.2 and 130.8 kg ha^{-1} available nitrogen, respectively, which were at par with each other. This may be due to slow mineralization of nitrogen from organic sources which results in more nitrogen buildup in soil. The present findings are in line with those reported by Rajkhowa *et al*. (2003) [16].

Treatment T_8 (75% RDF + *Rhizobium* + PSB) recorded significantly higher available phosphorus (17 kg ha^{-1}) over all other treatments and remained at par with T_9 (50% RDF + *Rhizobium* + PSB) and T_{10} (50% FYM + *Rhizobium* + PSB). This might be due to higher availability and mobilization of phosphorus due to inoculation of seeds with PSB which solubilize unavailable form of phosphorus in soil. Data reveals that no significant difference was observed with sources of nutrients on available potassium in soil.

Physiological parameters

Data pertaining to SPAD chlorophyll content was recorded at 50% flowering (Table 4). The maximum chlorophyll content was obtained in 100% RDF (45.50) which was significantly superior than rest of the treatments and remained statistically at par with 75% RDF + *Rhizobium* + PSB and 50% RDF + *Rhizobium* + PSB. Canopy temperature remained non-affected with different treatments. Though, lowest canopy temperature (30.3 ºC) was recorded under treatment T_2 (100% RDF) and highest (34.8 ºC) under T_1 (control). Similar results were obtained by Pingoliya *et al*. (2015) [15] and Babli *et al*. (2017) [3].

Economics

Treatment T_2 fetched maximum gross returns (Rs. 61082 ha^{-1}), net returns (Rs. 32779 ha^{-1}) and B:C (2.15) which was closely followed by T_8 (75% RDF + *Rhizobium* + PSB). Whereas lowest gross returns (Rs. 36061 ha^{-1}), net returns (Rs. 9768 ha^{-1}) and B:C (1.37) was obtained under control (T_1) (Table 5). Results of our experiment are in accordance with Kadam *et al*. (2014) [9].

Table 1: Effect of different sources of nutrients on growth parameters of black gram

	Treatments	Plant height (cm)			Dry matter accumulation (g/plant)		
		30 DAS	45 DAS	At maturity	30 DAS	45 DAS	At maturity
T_1	Control	13.01	26.20	39.60	1.11	6.52	11.83
T_2	100% RDF	15.02	38.01	53.10	1.95	11.12	20.17
T_3	100% N through FYM	13.63	31.50	45.20	1.48	8.70	15.79
T_4	100% N through vermicompost	13.54	31.90	45.80	1.51	8.84	16.03
T_5	50% RDF + 50% N through FYM	14.25	34.20	49.10	1.68	9.83	17.84
T_6	50% RDF + 50% N through vermicompost	14.15	34.70	49.60	1.70	9.95	18.04
T_7	1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake	13.90	32.30	46.90	1.52	9.07	16.45
T_8	75% RDF + *Rhizobium* + PSB	14.78	37.26	52.50	1.90	10.77	19.45
T_9	50% RDF + *Rhizobium* + PSB	13.42	35.40	50.20	1.73	10.06	18.23
T_{10}	50% FYM + *Rhizobium* + PSB	13.35	29.90	44.30	1.38	8.10	14.70
T_{11}	*Jeevamrit* @75 l/ha + *Beejamrit* (seed treatment) + *Ghanjeevamrit* @250 kg/ha	13.22	28.10	42.00	1.27	7.34	13.34
	SEm±	0.68	0.56	0.68	0.05	0.24	0.41
	CD at 5%	NS	1.62	1.99	0.14	0.70	1.21

Table 2: Effect of different sources of nutrients on yield attributes and yield of black gram

	Treatments	Number of pods per plant	Number of seeds per pod	Yield (kg/ha)		
				Biological	Seed	Stover
T_1	Control	18.91	5.0	2573	616	1957
T_2	100% RDF	32.25	7.8	3903	1050	2853
T_3	100% N through FYM	25.24	5.8	3223	822	2401
T_4	100% N through vermicompost	25.63	6.1	3300	835	2465
T_5	50% RDF + 50% N through FYM	28.52	6.6	3600	929	2671
T_6	50% RDF + 50% N through vermicompost	28.85	6.7	3598	939	2659
T_7	1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake	26.30	6.4	3344	856	2488
T_8	75% RDF + *Rhizobium* + PSB	31.22	7.4	3775	1008	2767

T_9	50% RDF + *Rhizobium* + PSB	29.13	6.9	3613	944	2669
T_{10}	50% FYM + *Rhizobium* + PSB	23.59	5.6	3060	765	2295
T_{11}	*Jeevamrit* @75 l/ha + *Beejamrit* (seed treatment) + *Ghanjeevamrit* @250 kg/ha	20.99	5.4	2809	694	2115
	SEm±	0.67	0.13	55.1	21.4	37.9
	CD at 5%	1.96	0.37	160.2	62.3	110.4

Table 3: Effect of different sources of nutrients on residual nutrient status of soil

Treatments		Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha	Available Potassium (kg/ha)
T_1	Control	125.0	14.17	266.0
T_2	100% RDF	127.5	16.00	268.5
T_3	100% N through FYM	130.2	16.47	272.6
T_4	100% N through vermicompost	130.8	16.53	273.0
T_5	50% RDF + 50% N through FYM	128.5	16.20	271.0
T_6	50% RDF + 50% N through vermicompost	129.0	16.37	271.8
T_7	1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake	131.0	16.50	273.5
T_8	75% RDF + *Rhizobium* + PSB	129.2	17.00	267.5
T_9	50% RDF + *Rhizobium* + PSB	129.1	16.90	267.0
T_{10}	50% FYM + *Rhizobium* + PSB	129.8	16.80	272.0
T_{11}	*Jeevamrit* @75 l/ha + *Beejamrit* (seed treatment) + *Ghanjeevamrit* @250 kg/ha	128.2	16.10	270.8
	SEm±	0.86	0.14	2.61
	CD at 5%	2.50	0.41	NS

Table 4: Effect of different sources of nutrients on physiology of black gram

Treatments		SPAD Chlorophyll content	Canopy temperature (°C)
		At 50% flowering	At 50% flowering
T_1	Control	34.20	34.8
T_2	100% RDF	45.50	30.3
T_3	100% N through FYM	39.70	31.1
T_4	100% N through vermicompost	40.30	31.7
T_5	50% RDF + 50% N through FYM	42.70	31.4
T_6	50% RDF + 50% N through vermicompost	43.20	31.1
T_7	1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake	41.10	31.2
T_8	75% RDF + *Rhizobium* + PSB	45.10	32.2
T_9	50% RDF + *Rhizobium* + PSB	44.80	30.9
T_{10}	50% FYM + *Rhizobium* + PSB	38.20	30.6
T_{11}	*Jeevamrit* @75 l/ha + *Beejamrit* (seed treatment) + *Ghanjeevamrit* @250 kg/ha	37.40	33.7
	SEm±	0.44	1.58
	CD at 5%	1.29	NS

Table 5: Effect of different sources of nutrients on economics of black gram

Treatments		Cost of cultivation (Rs/ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C
T_1	Control	26293	36061	9768	1.37
T_2	100% RDF	28303	61082	32779	2.15
T_3	100% N through FYM	29493	47953	18460	1.62
T_4	100% N through vermicompost	31629	48732	17103	1.54
T_5	50% RDF + 50% N through FYM	28898	54161	25263	1.87
T_6	50% RDF + 50% N through vermicompost	29966	54756	24790	1.82
T_7	1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake	31822	49926	18104	1.56
T_8	75% RDF + *Rhizobium* + PSB	27841	58662	30821	2.10
T_9	50% RDF + *Rhizobium* + PSB	27348	54999	27651	2.01
T_{10}	50% FYM + *Rhizobium* + PSB	27943	44316	16373	1.58
T_{11}	*Jeevamrit* @75 l/ha + *Beejamrit* (seed treatment) + *Ghanjeevamrit* @250 kg/ha	27853	40556	12703	1.45

Conclusion

It may be concluded from the study that maximum value of growth parameters, yield attributes and yield were obtained under application of 100% RDF which remained at par with 75% RDF + *Rhizobium* + PSB. Residual nitrogen status of soil was improved with application of organic nutrient sources like FYM, Vermicompost, *Jeevamrit*, *Beejamrit* and *Ghanjeevamrit* and among them treatment with, 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake has shown higher available nutrient status in the soil.

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