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ORIGINAL RESEARCH ARTICLE

Assessing the influence of integrated nutrient management on growth and yield of Black gram (*Vigna mungo* L.)

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ABSTRACT

The present study was undertaken to observe the effect of combined application of organic manures and inorganic fertilizers on growth, yield and yield contributing characters of black gram. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The experiment comprises eight treatments viz. Control (no application of manures and fertilizer), Recommended doses of fertilizer (RDF), Cowdung @ 5 t ha^{-1} + 50% of RDF, Poultry manure @ 5 t ha^{-1} + 50% of RDF, Vermicompost @ 5 t ha^{-1} + 50% of RDF, Cowdung @ 5 t ha^{-1} + Poultry manure @ 5 t ha^{-1} + 50% of RDF, Cowdung @ 5 t ha^{-1} + Vermicompost @ 5 t ha^{-1} + 50% of RDF and Poultry manure @ 5 t ha^{-1} + Vermicompost @ 5 t ha^{-1} + 50% of RDF. Combined application of organic manures and inorganic fertilizers exerted significance influence on growth, yield and yield contributing characters of black gram. At growth, the tallest plant (38.74 cm), the highest number of leaves $plant^{-1}$ (15.55), leaf dry weight $plant^{-1}$ (6.99 g) and stem dry weight $plant^{-1}$ (3.01 g) of black gram at 50 days after sowing (DAS) were obtained from poultry manure @ 5 t ha^{-1} and vermicompost @ 5 t ha^{-1} along with 50% of RDF. While, at 50 DAS, the highest number of nodules $plant^{-1}$ (55.22) was recorded from cowdung @ 5 t ha^{-1} along with 50% of RDF and the highest number of SPAD value $plant^{-1}$ (42.03) was found in poultry manure @ 5 t ha^{-1} along with 50% of RDF. Again, at maturity, the highest number of seeds pod^{-1} (5.86), yield $plant^{-1}$ (7.77 g), grain yield m^{-2} (130.70 g) and total dry weight $plant^{-1}$ (17.21 g) were obtained from poultry manure @ 5 t ha^{-1} and vermicompost @ 5 t ha^{-1} along with 50% of RDF. Therefore, it can be concluded that poultry manure @ 5 t ha^{-1} and vermicompost @ 5 t ha^{-1} along with 50% of RDF combination might be a promising practice for black gram cultivation.

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INTRODUCTION

Pulses are important food crop plays a vital role to fulfill daily dietary requirements. Pulses are also known as "the meat of the poor" as they are the most economical source of protein (Hamjah, 2014). Likewise, to improve protein malnutrition, per capita consumption of pulse should be 50 g/day in addition to other sources of protein such as cereals, milk, meat and eggs (Jat *et al*., 2012). Among many pulse crops, black gram (*Vigna mungo* L.) is one of the important pulse crops which belong to the family "Fabaceae". Black gram is highly nutritious as it contains protein (24%), fat (1.4%), carbohydrate (59.6%), calcium (154 mg), phosphorus (385 mg), iron (9.1 mg), beta carotene (38 mg), thiamine (0.4 mg), riboflavin (0.37 mg) and niacin (2

mg) per 100 g seeds (Aggarwal *et al*., 2019). It is also resistant to adverse climatic condition and recovers the soil fertility by fixing atmospheric nitrogen in the soil (Tyagi and Singh, 2019). According to BARC (2016), among total cultivated land 44.63% is suitable, 18.28% is moderately suitable and 10.20% marginally suitable for black gram cultivation in Bangladesh. Although there is a huge possibility but the production is not satisfactory due to several reason such as, non-availability of quality seed, growing under moisture stress conditions, growing under marginal and less fertile soil with low inputs and without pest and disease management, inappropriate post-harvest handling, lack of knowledge and attitude of the farmers (Tyagi and Singh 2019, and Chakrobarty *et al*., 2021). Among many constraints the soil health and fertility can be improved by integrated nutrient management approach. This approach ensures the soil fertility at an optimum level, maximizing crop productivity by using all possible source of nutrient such as organic and as well as inorganic in an integrated manner (Singh *et al*., 2017; Roy *et al*., 2020; Sarker *et al*., 2021; Laila *et al*., 2022).

Chemical fertilizers play an important role to meet the nutritional requirement the plant but their persistent nature poses a greater threat to sustainable agriculture (Tyagi and Singh, 2019). On the other hand, organic manures are not only providing nutrient to the plant but also improves all physical, chemical and biological properties of soil (Paul *et al*., 2021). But use of organic manures or chemical fertilizers alone is not able to increase the productivity of plants. Cowdung, poultry manure, farm yard manure, vermicompost are more likely to be used as an organic amendment to the soil. Cowdung is a good source of nutrient such as nitrogen (N), phosphorus (P) and potassium (K) which also improves soil texture, soil structure, water holding capacity etc. (Hossain *et al*., 2017). Similarly, poultry litter contains all the nutrients essential for plant growth and development, but its efficacy to enhance crop growth depends upon its nutrient availability (Zannat *et al*., 2020). However, vermicompost as soil additives, provide required amounts of nutrient, increase water holding capacity of soil and cation exchange capacity thus reduce the use of mineral fertilizers in cultivation of crop. Vermicompost also contains microsites which are rich in carbon and nitrogen, and it also improves solubility of other nutrients (Parthasakthi *et al*., 2008, Haridha *et al*., 2020). Consequently, use of combined inorganic and organic fertilizer are found to be more effective in improving productivity in several crops (Mainul *et al*., 2014, Bhattacharya *et al*., 2019, Hossain *et al*., 2017, Uddin *et al*., 2022). Subsequently, black gram crop plants will produce more yield when the proper amount of chemical fertilizers is combined with cowdung, poultry manure and or vermicompost. Increased availability of nutrients from both organic and inorganic sources would lead to a translocation of more photosynthesis from source to sink, which ultimately improve the growth, yield and yield-attributing characteristics of black gram. Considering the above facts, the present study was therefore undertaken to evaluate the effects of organic and inorganic sources of nitrogen on the growth and yield of black gram.

MATERIALS AND METHODS

Description of the experimental site

The experiment was conducted at the research field Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during September 2019 to November 2020. The experimental site is located at 25°39′ N latitude and 88°41′ E longitude with an elevation of 37.58 meter above the sea level. Details of the soil characteristics of the experimental site is presented in Table 1 and details of the meteorological data in respect to temperature, rainfall and relative humidity during the growing period of the experimental site are presented in the Table 2.

Table 1. Characteristics of soil of the experimental site.

General characters	**Description**	
AEZ	Old Himalayan Piedmont Plain (AEZ-1)	
General Soil type	Non-Calcareous Brown Floodplain Soil	
Parent material	Piedmont alluvium	
Soil series	Ranishankail	
Drainage	Moderately well drained	
Flood level	Above flood level	
Topography	High land	
Physical characteristics	**Value**	
Bulk density (g cm^{-3})	0.86-1.07	
Particle size (%)		
Sand (2-0.02mm)	60.0	
Silt (0.02-0.002mm)	27.0	
Clay (< 0.002mm)	13.0	
Textural class	Sandy loam	
Chemical characteristics	**Content**	**Interpretation**
pH	5.40-5.50	Moderately acidic
Organic carbon (%)	0.69	Low
Organic matter (%)	1.19	Low
CEC (meq/100g soil)	5.60	Low
Total N (%)	0.07	Very low
Available P (ppm)	16.75	Medium
Exchangeable K (meq/100g soil)	0.17	Medium low

Table 2. Air temperature (°C), relative humidity (%) and rainfall (mm) during crop growing period.

Month	Relative humidity (%)	Temperature		Total rainfall (mm)
		Minimum (°C)	Maximum (°C)	
September	81	9.70	25.0	4.00
October	77	12.50	28.1	00.0
November	78	15.10	28.7	97.0

Experimental treatment and design

The experiment was laid out in a single factor Randomized Complete Block Design (RCBD) with eight treatments and three replications. The total number of unit plots was 24 and the size of unit plot was 2 m × 2 m. Treatments were randomly distributed within the blocks. The treatments were Control (no application of manures and fertilizer), Recommended doses of fertilizer (RDF), Cowdung @ 5 t ha^{-1} + 50% of RDF, Poultry manure @ 5 t ha^{-1} + 50% of RDF, Vermicompost @ 5 t ha^{-1} + 50% of RDF, Cowdung @ 5 t ha^{-1} + Poultry manure @ 5 t ha^{-1} + 50% of RDF, Cowdung @ 5 t ha^{-1} + Vermicompost @ 5 t ha^{-1} + 50% of RDF and Poultry manure @ 5 t ha^{-1} + Vermicompost @ 5 t ha^{-1} + 50% of RDF.

Crop husbandry

The land was ploughed by a tractor drawn disc plough and was leveled by harrowing carefully. After removal of weed and subsequent leveling, the plots were laid out as per as treatment and design of the experiment. The fertilizers were applied as basal dose at final land preparation at the rate of Urea 50 kg ha^{-1}, TSP 85 kg ha^{-1}, Mop 35 kg ha^{-1}, and organic manure were applied as basal dose at final land preparation where cowdung @ 5 t ha^{-1}, vermicompost @ 5 t ha^{-1} and Poultry manure @ 5 ton ha^{-1} respectively. All fertilizers were applied by broadcasting and mixed thoroughly with soil. Seeds of black gram varieties were sown on 4 September, 2019, 20 cm apart, at the rate of 120 kg ha^{-1}. Seeds were sown in that way that it was possible to maintain plant to plant distance of 5cm. Slight irrigation was given for uniform germination after sowing. Intercultural operations such as weeding, thinning, irrigation, drainage and plant protection measures were done as and when necessary.

Data collection

Plant height, root length, number of leaves plant^{-1}, number of primary and secondary branches plant^{-1}, leaf, stem and root dry weight per plant was recorded at 40 and 50 days after sowing (DAS). Three plants sample from each plot were randomly taken and mean was calculated. Again, number of nodules plant^{-1} and SPAD value were recorded from three randomly selected plants at 50 days after sowing. number of pods plant $^{-1}$, number of seeds pod^{-1}, pod length, thousand seed weight, total dry yield plant^{-1}, grain yield per plant^{-1} were recorded at final harvest from three randomly selected plants and the mean was calculated. On contrary, grain yield was recorded per square meter after sun drying from each plot. The grain yields per square meter was recorded on 14% moisture basis.

Statistical analysis

All the collected data were analyzed following the analysis of variance (ANOVA) technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) using a computer operated program package MSTAT (Power, 1985).

RESULTS AND DISCUSSION

Growth characters of black gram as influenced by combined application of organic manures and inorganic fertilizers

Plant height, leaves plant^{-1} at 40 DAS and 50 DAS and root length of black gram at 50 DAS were significantly influenced by combined application of organic manures and inorganic fertilizers (Figure 1A-1C). At 40 DAS, the tallest plant (34.06 cm) was obtained from poultry manure @ 5 t ha^{-1} + 50% of RDF which was at par with RDF, vermicompost @ 5 t ha^{-1} + 50% of RDF, cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} +50% of RDF, cowdung @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF and poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. At 50 DAS, the tallest plant (38.74 cm) was obtained from poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF which was at par with RDF, cowdung @ 5 t ha^{-1} + 50% of RDF, poultry manure @ 5 t ha^{-1} + 50% of RDF, vermicompost @ 5 t ha^{-1} + 50% of RDF, cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF and cowdung @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. In both 40 DAS and 50 DAS the shortest plant was observed at no application of manures and fertilizer (Figure 1A). This might be explained by the availability of enough nutrients throughout the growth phase, which leads to improved plant height of black gram. This result was supported by Mainul *et al*. (2014), Manju *et al.* (2016) and Uddin *et al*. (2022). Again, at 40 DAS, the highest number of leaves plant^{-1} (8.99) was obtained from poultry manure @ 5 t ha^{-1} + 50% of RDF which was at par with RDF, cowdung @ 5 t ha^{-1} + 50% of RDF, vermicompost @ 5 t ha^{-1} + 50% of RDF, cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF, cowdung @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF and poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. While, the lowest number of leaves plant^{-1} (6.89) was obtained from no application of manures and fertilizer. At 50 DAS, the highest number of leaves plant^{-1} (15.55) was obtained from poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF which was statistically similar with cowdung @ 5 t ha^{-1} + 50% of RDF, poultry manure @ 5 t ha^{-1} + 50% of RDF, vermicompost @ 5 t ha^{-1} + 50% of RDF, cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF and cowdung @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. While, the

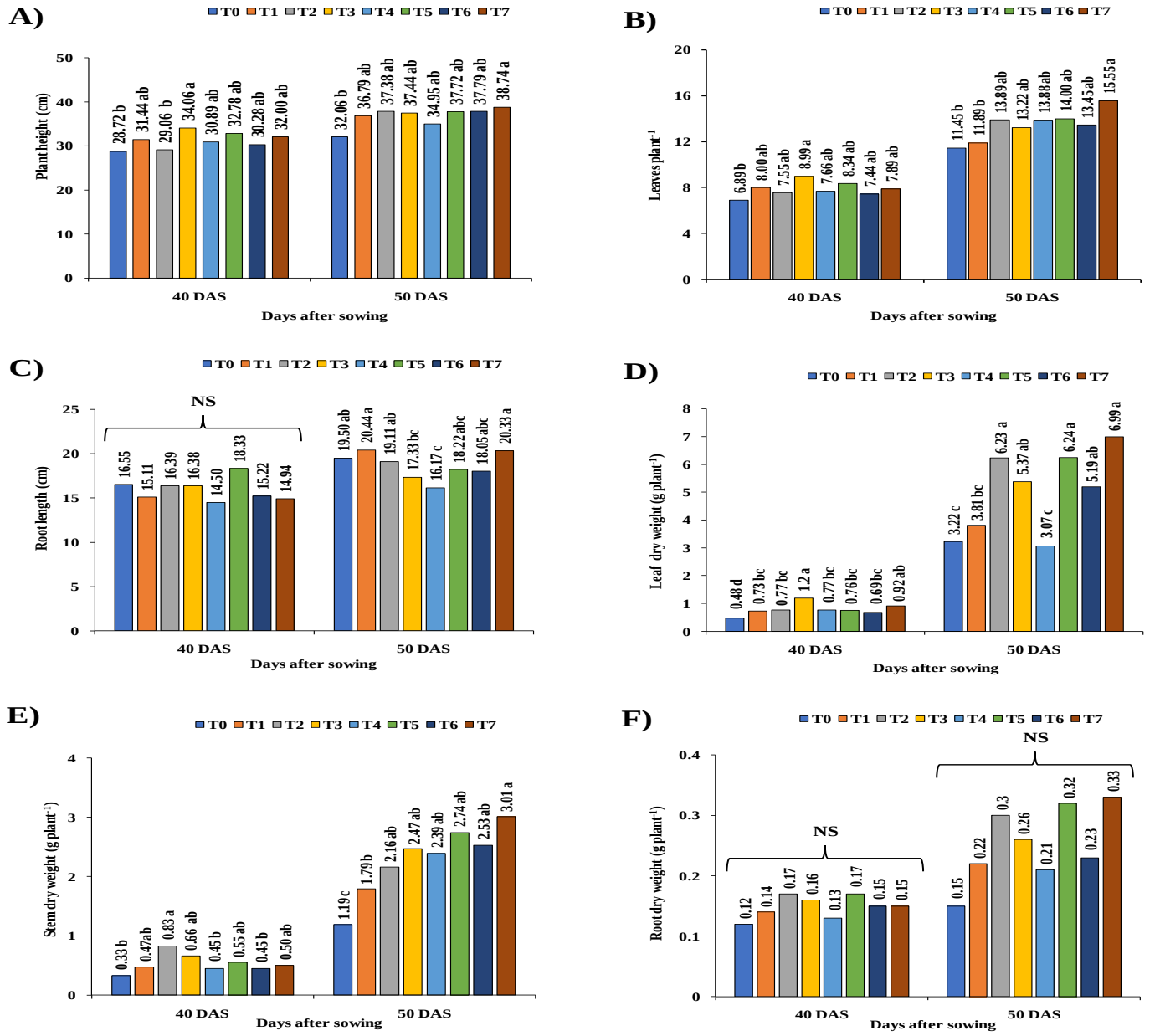

Figure 1. *Plant height, leaves plant^{-1}, root length, leaf, stem and root dry weight of black gram at 40 DAS and 50 DAS as influenced by combined application of organic manures and inorganic fertilizers (1A-1F).*
NS indicates not significant, T_0= Control (no application of manures and fertilizer), T_1= Recommended doses of fertilizer (RDF), T_2= Cowdung (5 t ha^{-1}) + 50% of RDF, T_3= Poultry manure (5 t ha^{-1}) + 50% of RDF, T_4= Vermicompost (5 t ha^{-1}) + 50% of RDF, T_5= Cowdung (5 t ha^{-1}) + Poultry manure (5 t ha^{-1}) + 50% of RDF, T_6= Cowdung (5 t ha^{-1}) + Vermicompost (5 t ha^{-1}) + 50% of RDF, T_7= Poultry manure (5 t ha^{-1}) + Vermicompost (5 t ha^{-1}) + 50% of RDF.

lowest number of leaves plant^{-1} (11.45) was obtained from no application of manures and fertilizer (Figure 1B). Jat *et al.* (2012), Kumar *et al.* (2020), Ruchitha and Mehera, (2022) also found similar result i.e., combined use of organic and inorganic fertilizers is found to be more effective in black gram. Again, numerically, at 40 DAS, the longest root length (18.33 cm) was obtained from cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF and the lowest root length (14.50 cm) was obtained from vermicompost @ 5 t ha^{-1} + 50% of RDF. Similarly, at 50 DAS, the longest root length (20.44 cm) was obtained from RDF which was at par with no manure and no fertilizer and cowdung @ 5 t ha^{-1} + 50% of RDF. While, the lowest root length (16.17 cm) was obtained from vermicompost @ 5 t ha^{-1} + 50% of RDF (Figure 1C). The black gram was exposed to integrated organic and inorganic amendments, which increased the accessibility of major and minor nutrients to the plant. This may have boosted early root growth and cell division, which then increased the absorption of other nutrients from deeper soil layers, increasing plant growth attributes and ultimately plant growth rate (Kumar *et al.*, 2020).

Leaf dry weight plant^{-1} (g) differed significantly with organic and inorganic fertilizer doses (Figure 1D). At 40 days after sowing the highest leaf dry weight plant^{-1} (1.20 g) was found in poultry manure @ 5 t ha^{-1} + 50% of RDF which was statistically similar with poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF and the lowest leaf dry weight plant^{-1} (0.48 g) was recorded at no application of manures and fertilizer. At 50 days after sowing the highest leaf dry weight plant^{-1} (6.99 g)

was found in poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF which was statistically identical to cowdung @ 5 t ha^{-1} + 50% of RDF, cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF, poultry manure @ 5 t ha^{-1} + 50% of RDF and cowdung @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. While, the lowest leaf dry weight plant^{-1} (3.22 g) was found in no application of manures and fertilizer. Stem dry weight plant^{-1} (g) differed significantly with organic and inorganic fertilizer doses (Figure 1E). At 40 days after sowing the highest stem dry weight plant^{-1} (0.83 g) was found in cowdung @ 5 t ha^{-1} + 50% of RDF which was at par with RDF, poultry manure @ 5 t ha^{-1} + 50% of RDF, cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF and poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. While, the lowest stem dry weight plant^{-1} (0.33 g) was recorded at no application of manures and fertilizer. At 50 days after sowing the highest stem dry weight plant^{-1} (3.01 g) was found in poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF which was statistically identical to poultry manure @ 5 t ha^{-1} + 50% of RDF, vermicompost (5 t ha^{-1}) +50% of RDF, cowdung (5 t ha^{-1}) + vermicompost (5 t ha^{-1}) + 50% of RDF and cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF. While, the lowest stem dry weight plant^{-1} (1.19 g) was found in no application of manures and fertilizer. Likewise, Bhattacharya *et al.* (2019) and Zannat *et al.* (2020) also found parallel result in respect of dry weight which confirms the present findings. Root dry weight plant^{-1} (g) differed insignificantly with organic and inorganic fertilizer doses at 40 and 50 DAS (Figure 1F). Numerically, at 40 days after sowing the highest root dry weight plant^{-1} (0.17 g) was obtained from cowdung @ 5 t ha^{-1} + 50% of RDF and cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF. While, the lowest root dry weight plant^{-1} (0.12 g) was recorded from no application of manures and fertilizer. Numerically, at 50 days after sowing the highest root dry weight plant^{-1} (0.33 g) was found in poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF and the lowest root dry weight plant^{-1} (0.15 g) was found in no application of manures and fertilizer. Favorable effect on dry weight is primarily attributable to the fact that balanced and combined use of different plant nutrient sources results in proper absorption, translocation and assimilation of those nutrients. This ultimately increases the dry-matter accumulation and nutrient contents of the plant, demonstrating more uptake of elemental nutrients. Similarly, Anasuyamma *et al.* (2022) observed maximum dry weight at combined use of vermicompost and inorganic NPK.

Number of primary branch plant^{-1} and number of secondary branch plant^{-1} differed insignificantly with organic and inorganic fertilizer doses (Table 3). Numerically, at 40 days after sowing the highest number of primary branch plant^{-1} (2.67) was found in poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. numerically, at 50 days after sowing the highest number of primary branches plnat^{-1} (3.89) was obtained from poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF and cowdung @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. This result was also in line with report of (Tyagi and Singh, 2019) where using of integrated nutrient management increase branches of black gram. Again, at 40 days after sowing the numerically highest number of secondary branch plant^{-1} (0.44) was found in recommended dose of fertilizers and cowdung @ 5 t ha^{-1} + 50% of RDF. Numerically, at 50 days after sowing the highest number of secondary branch plnat^{-1} (2.33) was found in cowdung @ 5 t ha^{-1} + 50% of RDF. Likewise, Mainul *et al.* (2014) found the poultry manure had significant impact on number of branches in mung bean.

Table 3. Number of primary branch plant^{-1}, secondary branch plant^{-1}, nodules plant^{-1} and SPAD value of black gram as influenced by combined application of organic manures and inorganic fertilizer.

Treatments	Primary branch plant^{-1}		Secondary branch plant^{-1}		Nodules plant^{-1}	SPAD value plant^{-1}
	40 DAS	50 DAS	40 DAS	50 DAS	50 DAS	50 DAS
T_0	1.78	2.56	0.00	2.11	25.55 c	36.20 cd
T_1	1.89	2.45	0.44	1.22	28.11 c	35.07 d
T_2	1.78	3.22	0.44	2.33	55.22 a	39.50 ab
T_3	2.22	3.78	0.33	1.00	46.55 ab	42.03 a
T_4	1.89	3.55	0.00	0.33	36.89 bc	35.90 d
T_5	1.89	3.22	0.00	0.89	43.89 ab	36.90 bcd
T_6	2.11	3.89	0.11	0.44	29.22 c	38.86 bc
T_7	2.67	3.89	0.00	1.33	33.33 bc	36.10 cd
Level of significance	NS	NS	NS	NS	**	**
CV(%)	23.49%	18.71%	160.76%	70.22%	13.3%	2.68%

In a column, values followed by similar letter (s) did not differ significantly at ≤ 5% level of probability NS indicates not significant, T_0= Control (no application of manures and fertilizer), T_1= Recommended doses of fertilizer (RDF), T_2= Cowdung (5 t ha^{-1}) + 50% of RDF, T_3= Poultry manure (5 t ha^{-1}) + 50% of RDF, T_4= Vermicompost (5 t ha^{-1}) + 50% of RDF, T_5= Cowdung (5 t ha^{-1}) + Poultry manure (5 t ha^{-1}) + 50% of RDF, T_6= Cowdung (5 t ha^{-1}) + Vermicompost (5 t ha^{-1}) + 50% of RDF, T_7= Poultry manure (5 t ha^{-1}) + Vermicompost (5 t ha^{-1}) + 50% of RDF.

Table 4. Yield and yield contributing characters of black gram as influenced by combined application of organic manures and inorganic fertilizer.

Treatments	Pods plant^{-1}	Seeds pod^{-1}	1000-seed weight (g)	Pod length plant^{-1} (cm)	Yield plant^{-1}		Grain yield m^{-2}		Total dry matter yield plant^{-1}	
					(g)	% change over T_0	(g)	% change over T_0	(g)	% change over T_0
T_0	21.36 d	4.31 b	33.40 f	4.37	3.72 e	-	78.93 g	-	9.65 d	-
T_1	26.63 bc	4.36 b	43.36 bcd	4.41	4.78 de	28.49	84.50 f	7.05	12.90 bc	33.67
T2	25.87 c	5.50 ab	39.70 e	4.42	5.53 bcd	48.65	97.09 d	23.00	12.06 c	24.94
T3	31.80 a	4.83 ab	41.23 de	4.44	6.19 bc	66.39	120.33 b	52.45	14.04 b	45.49
T4	25.73 c	5.32 ab	45.90 a	4.62	5.82 bcd	56.45	92.48 e	17.16	13.25 bc	37.30
T5	25.50 c	4.54 b	43.70 abc	4.64	4.91 cde	31.98	106.82 c	35.33	12.82 bc	32.84
T6	27.87 bc	5.47 ab	42.20 cd	4.49	6.26 b	68.27	100.37 d	27.16	14.65 b	51.81
T7	29.77 ab	5.86 a	45.00 ab	4.41	7.77 a	108.87	130.70 a	65.58	17.21 a	78.34
Level of significance	**	**	**	NS	**	-	**	-	**	-
CV(%)	4.58%	9.08%	1.96%	4.52%	8.22%	-	1.16%	-	4.90%	-

In a column, values followed by similar letter (s) did not differ significantly at ≤ 5% level of probability NS indicates not significant, T_0= Control (no application of manures and fertilizer), T_1= Recommended doses of fertilizer (RDF), T_2= Cowdung (5 t ha^{-1}) + 50% of RDF, T_3= Poultry manure (5 t ha^{-1}) + 50% of RDF, T_4= Vermicompost (5 t ha^{-1}) + 50% of RDF, T_5= Cowdung (5 t ha^{-1}) + Poultry manure (5 t ha^{-1}) + 50% of RDF, T_6= Cowdung (5 t ha^{-1}) + Vermicompost (5 t ha^{-1}) + 50% of RDF, T_7= Poultry manure (5 t ha^{-1}) + Vermicompost (5 t ha^{-1}) + 50% of RDF.

Number of nodules plant^{-1} differed significantly with organic and inorganic fertilizer doses (Table 3). At 50 days after sowing the highest number of nodules plant^{-1} (55.22) was found in cowdung @ 5 t ha^{-1} + 50% of RDF which was at par with poultry manure @ 5 t ha^{-1} + 50% of RDF and cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF and the lowest number of nodules plant^{-1} (25.55) was recorded at no application of manures and fertilizer. Because organic fertilizers serve to lower the danger of nutrient leaching even after the application of inorganic fertilizers in the soil, the combined application of organic and inorganic fertilizers has a good impact on improving nodule. Poultry manure or cowdung are also the best ways to maintain the productivity of crop plants and the health of the soil, particularly when used in conjunction with chemical fertilizers. Similar kind of result also observed by Anasuyamma *et al.*, (2022). SPAD value plant^{-1} differed significantly with organic and inorganic fertilizer doses at 50 DAS (Table 1). At 50 days after sowing the highest number of SPAD value plant^{-1} (42.03) was found in poultry manure @ 5 t ha^{-1} + 50% of RDF which was statistically identical to cowdung @ 5 t ha^{-1} + 50% of RDF and the lowest number of SPAD value plant^{-1} (35.07) was found in RDF. Increased SPAD value might be an outcome of increased nutrient availability and uptake. Bidabadi *et al.* (2016) also found similar results in stevia by using vermicompost leachate.

Yield and yield contributing characters of black gram as influenced by combined application of organic manures and inorganic fertilizer

Yield contributing characters like pods plant^{-1}, seeds pod^{-1}, 1000-seed weight were significantly influenced by combined application of organic manures and inorganic fertilizers except pod length plant^{-1} (Table 4). The highest number of pods plant^{-1} (31.80) was obtained from poultry manure @ 5 t ha^{-1} + 50% of RDF which was at par with poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF and the lowest number of pods plant^{-1} (21.36) was recorded from no application of manures and fertilizer. Again, the highest number of seeds pod^{-1} (5.86) was obtained from poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF which was at par with cowdung @ 5 t ha^{-1} + 50% of RDF, poultry manure @ 5 t ha^{-1} + 50% of RDF, vermicompost @ 5 t ha^{-1} + 50% of RDF and cowdung @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. While, the lowest number of seeds pod^{-1} (4.31) was recorded from no application of manures and fertilizer. Kadam *et al.* (2014), Kumar *et al.* (2020) and Zannat *et al.* (2020) had similar kind of result where integrated use of nutrient results into better pods plant^{-1} and seeds pod^{-1}. Again, numerically, the highest pod length plant^{-1} (4.64 cm) was obtained from cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF and the lowest pod length plant^{-1} (4.37 cm) was recorded from no application of manures and fertilizer. Similarly, the highest 1000-seed weight (45.90 g) was obtained from vermicompost @ 5 t ha^{-1} + 50% of RDF which was at par with cowdung @ 5 t ha^{-1} + poultry manure @ 5 t ha^{-1} + 50% of RDF and poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF. While, the lowest 1000-seed weight (33.40 g) was recorded from no application of manures and fertilizer. Correspondingly, Kumar *et al.* (2020) observed highest 1000-seed weight by using 50% RDF + 50% vermicompost in black gram. The plant may have produced more carbohydrates, nitrogen and photosynthesis as a result of the nutrient absorption. Thus, the favorable effects of organic amendments and RDF resulted in an untimely increase in the pods plant^{-1}, seeds pod^{-1}, 1000-seed

weight of black gram as well as a significant improvement in yield parameters (Bhattacharya *et al.*, 2019).

Yield plant^{-1}, grain yield m^{-2} and total dry weight plant^{-1} of black gram were significantly influenced by combined application of organic manures and inorganic fertilizers (Table 4). The highest yield plant^{-1} (7.77 g) was obtained from poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF and the lowest yield plant^{-1} (3.72 g) was recorded from no application of manures and fertilizer. Again, the highest grain yield m^{-2} (130.70 g) was obtained from poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF and the lowest grain yield m^{-2} (78.93 g) was recorded from no application of manures and fertilizer. The increased yield attributes and yield might be due the increase supply of the major nutrients by translocation of photosynthesis accumulation under the influence of sources of inorganic nutrients. Zannat *et al*. (2020) recorded that amongst the organic sources of nutrients, 25% less than RDF + Vermicompost noted maximum yield and yield attributes over remaining treatments. On the other hand, Ruchitha and Mehera, (2022) reported that poultry manure at 0.6 t ha^{-1} found to be more efficient over other organic amendments. Similarly, the highest total dry weight plant^{-1} (17.21 g) was obtained from poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF and the lowest total dry weight plant^{-1} (9.65 g) was recorded from no application of manures and fertilizer. Again, in case of yield plant^{-1}, grain yield m^{-2} and total dry weight plant^{-1} of black gram, it was observed that the highest % change over control was poultry manure @ 5 t ha^{-1} + vermicompost @ 5 t ha^{-1} + 50% of RDF followed by others. Kumar *et al*. (2020) and Anasuyamma *et al*. (2022) also found similar result which supported the present study.

Conclusion

Present experimental results showed that application of vermicompost and poultry manure with 50% of RDF influenced growth and yield of black gram. At growth, application of poultry manure @ 5 t ha^{-1} and vermicompost @ 5 t ha^{-1} along with 50% of RDF increased plant height, number of leaves plant^{-1}, leaf dry weight plant^{-1} and stem dry weight plant^{-1}. Again, the highest number of seeds pod^{-1}, yield plant^{-1}, grain yield m^{-2} and total dry weight plant^{-1} at maturity was also recorded by vermicompost @ 5 t ha^{-1} and poultry manure @ 5 t ha^{-1} along with 50% of RDF. Therefore, it can be concluded that the application of poultry manure @ 5 t ha^{-1} and vermicompost @ 5 t ha^{-1} along with 50% of RDF may be suggested for the cultivation of black gram. The experimental results can be used to increase crop yield and yield attributes for secure and sustainable farming practices at greater scale.

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