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Effect of integrated nutrient management on yield, uptake and economics of black gram (*Vigna mungo*) under *terai* Region of West Bengal

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ABSTRACT

A field experiment was conducted for two consecutive years to study the effect of integrated nutrient management on yield, nutrient uptake and economics of black gram (Vigna mungo L. Hepper.). Results of the experiment revealed that average pod picking^{-1}, pod length, number of seeds pod^{-1}, and test weight was found to be highest under T_{11} (50% RDF + FYM @ 2.5 t ha^{-1} + VC @1.25 t ha^{-1} + NC @ 1.25 t ha^{-1} + PM @ 1.25 t ha^{-1}) followed by T_{10} (T_1+VC @ 1.5 t ha^{-1}+ PM @ 1.5 t ha^{-1}) and T_8 (T_1+ Poultry manure @ 2.5 t ha^{-1}). Based on pooled data treatment T_{11} recorded highest seed yield of 851.92 kg ha^{-1} which was statistically at par with T_{10} (841.46 kg ha^{-1}), however T_1 (100 % RDF+ Borax @ 10.0 Kg ha^{-1}) resulted highest B:C ratio (4.61), due to lower treatment cost.

Key words: Economics, nutrient uptake, seed yield

Pulses are included in cropping systems to improve soil health and fertility status. Role of pulses in organic agriculture is of great significance as it helps organic farms self sufficient in nitrogen through fixation of atmospheric nitrogen. The productivity of pulses mainly depends on proper nutrient management practices. Low organic matter content in entisols coupled with low and imbalanced application of macro and micro nutrients to the crop limits the full potential of yield and is the main yield barrier for crops (Ghosh *et al.*, 2003). Use of chemical fertilizer in pulse production is very low, pulses are generally grown in soils with low fertility status or with application of low quantities of organic and inorganic sources of plant nutrients, which has resulted in deterioration of soil health and productivity (Kumpawat, 2010). Integrating chemical fertilizers with organic manures was quite promising, not only in maintaining higher productivity but also in providing greater stability in crop production (Nambiar and Abrol, 1992). Limited availability of farm yard manure is however an important constraint in its use as a source of nutrient. Poultry manure is now available in abundance due to development of poultry industry. Vermicompost is gaining popularity and can be produced at farmer's level. Neemcake are also known to serve as a source of organic manures. Black gram (*Vigna mungo* L. Hepper.) is one of the important pulse crops in India. It is a protein rich staple food. It contains about 25 percent protein, which is almost three times that of cereals. It supplies protein requirement of vegetarian population. The information on the effect of all these organics in conjunction with inorganic fertilizer is limiting (Shanwad *et al.*, 2010). It is very much essential to develop a strong workable and compatible package of nutrient management through organic resources for black gram based on scientific facts, local conditions and economic viability (Kannaiyan, 2000). A similar finding was recorded by Kumpawat (2010). Keeping the above points in mind the present investigation has been undertaken.

MATERIALS AND METHODS

The experiment was carried out at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during 2010 and 2011. The farm is situated at 26° 19' 86" N latitude and 89° 23' 53" E longitude and at an altitude of 43 meters above mean sea level. The soil was sandy to sandy loam in texture with pH 5.85, 0.52% organic carbon and 217.65, 22.82 and 174.68 kg ha^{-1} of available nitrogen, phosphorus and potassium respectively. The experiment was laid out in Randomized Block Design with 12 treatments and replicated thrice. Cost of cultivation involved in production of black gram is about Rs. 4593/-. Treatments comprised of T_1-100% RDF (N: P:K=15:30:30 kg ha^{-1}) + Borax @ 10.0 Kg ha^{-1}, T_2- Vermicompost (VC) @ 5.0 t ha^{-1}, T_3- Poultry manure (PM) @ 5.0 t ha^{-1}, T_4-Neemcake (NC) @ 5.0 t ha^{-1}, T_5- FYM @ 5 t ha^{-1}, T_6- T_1+ (VC) @ 2.5 t ha^{-1}, T_7- T_1+ FYM @ 5.0 t ha^{-1}, T_8- T_1+ (PM) @ 2.5 t ha^{-1}, T_9- T_1+ NC @ 2.5 t ha^{-1}, T_{10}- T_1+VC @ 1.5 t ha^{-1}+ PM @ 1.5 t ha^{-1}, T_{11}- 50% RDF + FYM @ 2.5 t ha^{-1} + VC @1.25 t ha^{-1} + NC @ 1.25 t ha^{-1} + PM @ 1.25 t ha^{-1} and T_{12}- Control (with out any fertilizer). Treatments comprising of sole organics are from T_2 to T_5, whereas combination of organics and inorganics comprises from T_6 to T_{11}. There is no substitution of FYM in combination treatment T_7 receiving 5 t ha^{-1} as it is bulky in nature with low percentage of N, P_2O_5 and K than that of other organic concentrates. All the organic sources of manures were applied 30 days before sowing. The N-P-K content of FYM, vermicompost, poultry manure and neem cake were 0.74 – 0.42 – 0.58, 2.44 – 0.75- 1.50, 4.93-1.03-1.32 and 2.27-0.76-1.26 %, respectively. Black gram (Pant U-30) was sown in line, with the recommended spacing of 45 cm line to line and 10 cm plant to plant

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(Singh *et al.*, 1983). The crop was sown and first picking starts on 14th March and 13th May and 12th March and 10th May in 2010 and 2011, respectively. The unit plot size was 6m × 4m. Irrigation was given as and when required. Data were recorded on agronomic parameters including number of pods plant^{-1}, number of seeds pod^{-1}, pod length, 100 pod weight, 1000 seed weight and seed yield (kg ha^{-1}). All together 4 picking was done at 10 days interval starting from 60 days after sowing. The data were analyzed statistically for comparing the treatment means.

RESULTS AND DISCUSSION

Yield attributes and seed yield

The data for different yield attributes *viz.*, average pods picking $^{-1}$ pod length, number of seeds pod^{-1} and 1000 seed weight are presented in table-1 and 2. It was indicated from these data that higher values of average pods per picking (24.15 and 22.75), pod length (9.88 and 10.08 cm), number of seeds pod^{-1} (11.82 and 12.04), and 1000 seed weight (53.9 and 52.3 gm) were statistically maximum under T_{11} (50% RDF + FYM @ 2.5t ha^{-1} + VC @1.25t ha^{-1} + NC @ 1.25t ha^{-1} + PM @ 1.25t ha^{-1}) followed by (not statistically but in most of the cases T_{10} was at per) T_{10} (T_1+VC @ 1.5t ha^{-1}+ PM @ 1.5t ha^{-1}), T_8 (T_1+ poultry manure @ 2.5t ha^{-1}) and T_9 (T_1+ neem cake @ 2.5t ha^{-1}) in both the years of investigation. Treatment with 50% recommended dose with FYM @ 2.5t ha^{-1}, vermicompost @1.25t ha^{-1}, neem cake @ 1.25t ha^{-1} and poultry manure @ 1.25t ha^{-1} (T_{11}) resulted increase in yield contributing factors which ultimately helped in producing the highest seed yield (851.92 kg ha^{-1}).

Table 1: Effect of organic sources of nutrients on yield attributes of summer gram

Treatments	Average pods picking^{-1}			Pod length (cm)			Number of seeds pod^{-1}		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	16.90	19.79	18.35	7.21	7.21	7.21	8.76	9.71	9.24
T_2	17.88	20.13	19.01	7.48	7.88	7.68	9.43	10.26	9.85
T_3	18.36	20.40	19.38	7.64	7.88	7.76	9.65	10.26	9.96
T_4	19.51	20.79	20.15	7.81	8.04	7.93	9.98	10.65	10.32
T_5	17.61	20.00	18.81	7.31	7.71	7.51	9.04	10.15	9.6
T_6	20.36	21.08	20.72	8.38	8.41	8.4	10.43	10.76	10.6
T_7	20.13	20.90	20.52	7.98	8.14	8.06	10.21	10.65	10.43
T_8	21.60	21.71	21.66	9.08	8.71	8.9	11.1	11.32	11.21
T_9	20.64	21.49	21.07	8.54	8.54	8.54	10.43	10.76	10.6
T_{10}	22.85	21.88	22.37	9.38	9.24	9.31	11.6	11.32	11.46
T_{11}	24.15	22.75	23.45	9.88	10.08	9.98	11.82	12.04	11.93
T_{12}	12.62	11.98	12.30	6.58	6.21	6.4	6.48	6.66	6.57
SEm(±)	**1.44**	**0.82**	**0.20**	**0.04**	**0.37**	**0.25**	**0.34**	**0.33**	**0.06**
LSD(0.05)	**2.98**	**1.70**	**0.62**	**0.12**	**0.77**	**0.50**	**0.72**	**0.68**	**0.17**
Treatment x Year									
SEm(±)		**0.69**			**0.13**			**0.19**	
LSD(0.05)		**2.16**			**0.40**			**0.60**	

Among the treatments with combined application of organic and inorganic treated plot T_{11} (50% RDF + FYM @ 2.5 t ha^{-1} + VC @1.25 t ha^{-1} + NC @ 1.25 t ha^{-1} + PM @ 1.25 t ha^{-1}) gave 16.05, 15.07, 13.39 and 12.58 % of yield advantage in comparison with sole organics T_5 (FYM @ 5 t ha^{-1}), T_2 (vermicompost @ 5.0 t ha^{-1}), T_3 (poultry manure @ 5.0 t ha^{-1}) and T_4 (neem cake @ 5.0 t ha^{-1}) based on pooled data. T_{11} (50% RDF + FYM @ 2.5 t ha^{-1} + VC @1.25 t ha^{-1} + NC @ 1.25 t ha^{-1} + PM @ 1.25 t ha^{-1}) produced 20.94 % more seed yield than 100 % chemically treated plot with borax @ 10.0 Kg ha^{-1} (T_1). Control plot recorded significantly lowest seed yield in both the years of investigation. Increase in yield attributes and seed yield were also found owing to increase in supply of nutrients in more synchronize way at the treatments receiving 50% recommended dose with FYM @ 2.5 t ha^{-1}, vermicompost @1.25 t ha^{-1}, neem cake @ 1.25 t ha^{-1} and poultry manure @ 1.25 t ha^{-1}. Combined use of organic and inorganic resulted in better growth associated with increased availability of nutrients might have resulted in better development of yield attributes under these treatments. Roopadevi *et al.* (2001), Agbede *et al.* (2008) and Raundal *et al.* (1999) also found similar result.

Table 2: Effect of organic sources of nutrients on yield attributes and seed yield of summer gram

Treatments	1000 seed weight (g)			Seed yield (kg ha^{-1})		
	2010	2011	Pooled	2010	2011	Pooled
T_1	41.05	43.84	42.45	696.70	712.13	704.42
T_2	43.00	44.48	43.74	719.61	761.09	740.36
T_3	43.90	45.12	44.51	731.50	771.15	751.33
T_4	44.31	45.54	44.92	732.49	780.92	756.71
T_5	41.75	44.34	43.05	715.32	752.90	734.11
T_6	47.10	48.52	47.81	759.91	804.39	782.16
T_7	45.25	46.18	45.72	751.13	789.61	770.38
T_8	49.50	50.34	49.92	805.79	826.23	816.01
T_9	48.70	49.35	49.03	781.99	812.11	797.05
T_{10}	53.65	50.88	52.27	848.23	834.69	841.46
T_{11}	53.90	52.3	53.10	859.18	844.66	851.92
T_{12}	38.25	39.26	38.76	351.79	332.36	342.08
SEm(±)	**1.08**	**2.36**	**0.23**	**40.94**	**19.02**	**3.59**
LSD(0.05)	**2.23**	**4.89**	**0.70**	**84.91**	**39.43**	**11.19**
			Treatment x Year			
SEm(±)		**0.78**			**12.46**	
LSD(0.05)		**2.44**			**38.79**	

Nutrient uptake

Pooled data (Table 3) revealed that application of 50% Recommended dose with the combination of FYM @ 2.5 t ha^{-1}, Vermicompost @1.25 t ha^{-1}, neem cake @ 1.25 t ha^{-1} and Poultry manure @ 1.25 t ha^{-1} brought about significant improvement in N, P and K uptake by black gram to the extent of 22.76, 25.86 and 29.29 % respectively over 100 % recommended dose of fertilizer with Borax @ 10.0 Kg ha^{-1} (T_1). Similar findings were also scrutinized by Hussain *et al.*, (2011), Sailaja and Ushakumari (2002) and Agbede *et al.* (2008). Organic manures increased the absorption power of the soil for cations and anions, particularly nitrogen and

Table 3: Effect of organic sources of nutrients on N, P and K uptake by summer gram

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	33.66	31.54	32.6	8.95	8.98	8.97	11.21	11.04	11.13
T_2	35.06	34.34	34.7	9.63	9.58	9.61	11.74	12.04	11.89
T_3	35.48	35.03	35.26	9.79	9.73	9.76	11.92	12.28	12.1
T_4	36.15	35.47	35.81	10.04	9.86	9.95	12.01	12.42	12.22
T_5	34.42	33.03	33.73	9.36	9.51	9.44	11.44	11.49	11.47
T_6	37.21	36.7	36.96	10.67	10.42	10.55	12.7	13.37	13.04
T_7	36.66	36.05	36.36	10.15	9.87	10.01	12.48	12.89	12.69
T_8	38.33	37.68	38.01	10.76	10.62	10.69	13.06	14.05	13.56
T_9	37.63	37.08	37.36	10.54	10.43	10.49	12.95	13.46	13.21
T_{10}	39.73	38.8	39.27	11.04	10.78	10.91	13.34	14.5	13.92
T_{11}	40.34	39.7	40.02	11.33	11.25	11.29	13.54	15.23	14.39
T_{12}	25.54	25.09	25.32	6.18	5.98	6.08	8.08	7.96	0.08
SEm(±)	**0.77**	**0.68**	**0.07**	**0.22**	**0.39**	**0.02**	**0.72**	**0.56**	**0.24**
LSD(0.05)	**1.60**	**1.40**	**0.22**	**0.45**	**0.82**	**0.06**	**1.49**	**1.17**	**0.89**
				Treatment x Year					
SEm(±)		**0.24**			**0.06**			**0.27**	
LSD(0.05)		**0.76**			**0.19**			**0.84**	

Table 4: Effect of organic sources of nutrients on economics of summer gram production

Treatments	General cost of Cultivation (₹ha^{-1})	Cost of treatment (₹ha^{-1})	Total cost (₹ha^{-1})	Gross return (₹ha^{-1})	Net return (₹ha^{-1})	Benefit: Cost ratio
T_1	4593	4054.70	8647.70	49071.40	40423.70	4.67
T_2	4593	17500.00	22093.00	51569.70	29476.70	1.33
T_3	4593	30000.00	34593.00	52706.50	18113.50	0.52
T_4	4593	50000.00	54593.00	52332.70	-2260.30	-0.04
T_5	4593	5000.00	9593.00	51135.70	41542.70	4.33
T_6	4593	12804.70	17397.70	55510.70	38113.00	2.19
T_7	4593	7138.05	11731.05	53656.40	41925.35	3.57
T_8	4593	19054.70	23647.70	56828.80	33181.10	1.40
T_9	4593	29054.70	33647.70	54475.40	20827.70	0.62
T_{10}	4593	9304.70	13897.70	58597.70	44700.00	3.22
T_{11}	4593	26444.00	31037.00	59325.00	28288.00	0.91
T_{12}	4593	0.00	4593.00	23884.00	19291.00	4.20

* Farm Yard Manure: ₹ 925 t^{-1}, Poultry Manure: ₹ 6 kg^{-1}, Black gram : ₹ 70 Kg^{-1}, Vermicompost: ₹ 3.5 kg^{-1}, Borax (Powdered):₹ 300 kg^{-1}, Neemcake: ₹ 10 Kg^{-1} **Mean prices are for the period of 2010 and 2011

phosphate. These ions are released gradually during entire growing period of the crop which might have increased concentration and uptake of major nutrients with the use of organics. Treatment receiving 50% Recommended dose with the combination of FYM @ 2.5 t ha^{-1},vermicompost @1.25 t ha^{-1}, neem cake @ 1.25 t ha^{-1} and poultry manure @ 1.25 t ha^{-1} recoded highest value of nitrogen (40.34 and 39.7 kg ha^{-1}), phosphorus (11.33 and 11.25 kg ha^{-1}) and potassium uptake (13.54 and 15.23 kg ha^{-1}) in both the years of investigation followed by treatment receiving T_1+VC @ 1.5 t ha^{-1}+ PM @ 1.5 t ha^{-1}, T_1+ poultry manure @ 2.5 t ha^{-1} and T_1+ neem cake @ 2.5 t ha^{-1}.

Economics

Treatment receiving 100 % recommended dose of fertilizer (N: P: K=15:30:30 kg ha^{-1}) + Borax @ 10.0 kg ha^{-1} resulted the highest benefit: cost ratio of 4.61, which was followed by T_5 (FYM @ 5 t ha^{-1}) T_{12} (control) and T_7 (T_1+ FYM @ 5.0 t ha^{-1}). The highest gross return to the tune of ₹ 59325.00 was recorded under T_{11}(50% RDF + FYM @ 2.5 t ha^{-1} + VC @1.25 t ha^{-1} + NC @ 1.25 t ha^{-1} + PM @ 1.25 t ha^{-1}) followed by T_{10} (₹ 58597.70), T_8 (₹ 56828.80) and T_9 (₹ 55510.70), whereas lowest Gross return was recorded under control plot (T_{12}). Lowest B: C ratio of -0.04 was recorded under T_4 which give the lowest net return; the reason is due to higher unit cost of neem cake (₹ 10 kg^{-1}) which was not compensated by the additional yield of black gram.

Among the treatments good performance in terms of yield and yield attributes was obtained from T_{11} but performed poor in case of benefic cost ratio due to lower net return. From the economic point of view T_1 fetched higher gross return and profit per rupee investment.

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