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Effect of Organic and Liquid Manures on Productivity and Profitability of Blackgram

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ABSTRACT

Background: Blackgram being important crop among pulse is gaining popularity and thus requiring suitable crop production practices especially under organic farming. In this context, this study was proposed with the objective to investigate the optimal nutrient management practices in organic blackgram by utilizing various organic nutrient sources.

Methods: Field experiments were conducted at two different locations in spilt plot design. The treatments consisted of 4 levels of organic manure *viz*., Farm Yard Manure (FYM) @ 12.5 t ha^{-1}, Vermicompost (VC) @ 2.5 t ha^{-1}, Enriched FYM (EFYM) @ 750 kg ha^{-1} and Enriched VC (EVC) @ 1 t ha^{-1} as main plot treatments and five levels of foliar spray of liquid manure *viz*., two foliar sprays of Panchagavya @ 3% and Fermented egg extract (FEE), Fermented fish extract (FFE), Farmers effective microorganisms (FEM), Jeevamruth each @ 5%.

Result: Results revealed that application of EFYM and VC, produced higher yield parameters and grain yield, respectively under main plot organic manure addition at site-I and II. Among the sub plots liquid manure treatments Panchagavya spray has produced higher grain yield along with the yield parameters at both the sites. Among the organic manures higher economic returns were obtained with the application of EFYM at both the sites while among the liquid manures better returns were obtained with the application of Panchagavya at site-I and Panchagavya or FEM spray at site-II.

Key words: Blackgram, Foliar spray, Organic nutrient management, Profitability, Yield.

INTRODUCTION

Blackgram is one of the important pulse crops grown throughout India. It is rich source of 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 seed. In India, black gram is grown on 4.14 million hectares with total production of 2.23 m tones and productivity of 538 kg ha^{-1}. In Tamil Nadu, it occupies an area of 4.02 m ha with the productivity of 559 kg ha^{-1} (Anonymous, 2022).

To reduce the impact of adverse effect of inorganic fertilizer use on soil and environmental health, a shift to adopt sustainable agricultural practices is necessary, which also saves the farmers from the high cost of fertilizers consumption and input energy. Biofertilizers and organic fertilisers made from farm residues and waste are examples of such sustainable techniques (Khurana and Kumar, 2022).

Current land use does not exactly meet the food demand for the growing population under organic farming alone which, is also the main criticism facing by organic farming (Connor and Minguez, 2012). Therefore the major goal lying ahead is to increase yields under organic farming (Roos *et al*., 2018). Food availability can be increased under organic agriculture by integration of inputs rather than the individual approach as it makes strenuous to meet food demand due to lesser amount of nutrient present per unit of organic manures as compared to the inorganic fertilizers. The productivity of the crop enhanced when nutrient supply was continuous in form of foliar spray followed by manure incorporation (Thiagarajan and Somasundaram, 2019). In blackgram, studies under sole organic conditions are scanty. Hence this study was proposed to find the optimal nutrient management practices in organic blackgram by utilizing various organic nutrient sources.

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MATERIALS AND METHODS

The experiments were carried out in Agricultural Research Station, Bhavanisagar, Erode, Tamil Nadu (Experimental site-I) during January and July, 2022 and wetlands farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore (Experimental site-II) during February and June, 2022. The Experimental site-I is located at latitude 11°N and longitude of 76°E and the Experimental site-II is located at 11°N and 77°E with an altitude of 426.7 m above MSL.

The experiment was conducted in spilt plot design with three replications. The treatments comprised of four levels of organic manure *viz*., Farm Yard Manure (FYM) @ 12.5 t ha^{-1}, Vermicompost (VC) @ 2.5 t ha^{-1}, Enriched FYM (EFYM) @ 750 kg ha^{-1} and Enriched VC (EVC) @ 1 t ha^{-1} as main plot treatment and five levels of liquid manure *viz*., two foliar sprays of Panchagavya @ 3% and Fermented egg extract (FEE), Fermented fish extract (FFE), Farmers effective microbes (FEM), Jeevamruth each @ 5%. Foliar sprays of liquid manure were done at first flowering (At least 30% flower initiation in plots) and 10 days after 1st spray. Blackgram was sown at a spacing of 30 cm × 10 cm.

In Experimental site-I the soil was low in nitrogen, high in phosphorous and potassium and low in organic carbon content. The pH was 7.04 and 6.74 during trial-I and II, respectively. At site-II the soil was low in nitrogen, medium in phosphorous, high in potassium and organic carbon content. The pH was 8.58 and 8.40 during trial-I and II, respectively. Yield attributing characters were recorded as per the standard methods at physiological maturity stage. The seed and stover yield was recorded from net plot area of each treatment. The data obtained from various characters under study were analyzed by the method of analysis of variance as described by Panse and Sukhatame, (1967).

Table 1: Effect of organic and liquid manure on yield attributes and yield of organic blackgram at Experimental site-I.

Treatments	No. of clusters plant^{-1}		No. of pods plant^{-1}		Pod length (cm)		No. of seeds pod^{-1}		Grain yield (kg ha^{-1})		Stover yield (kg ha^{-1})	
Organic	Experiment											
manure	I	II	I	II	I	II	I	II	I	II	I	II
FYM @ 12.5 t ha^{-1}	8.7	12.6	12.1	17.4	4.21	4.31	6.3	6.4	556	616	1959	2096
VC @ 2.5 t ha^{-1}	10.9	15.7	16.6	22.6	4.57	4.65	6.7	6.7	693	731	2362	2437
EFYM @ 750 kg ha^{-1}	11.8	17.0	18.0	24.4	4.66	4.73	6.8	6.9	760	799	2485	2569
EVC @1 t ha^{-1}	9.5	13.7	13.6	19.0	4.33	4.44	6.4	6.4	610	649	2095	2192
CD (5%)	0.67	1.08	1.20	1.57	0.18	0.24	0.15	0.15	39.9	31.5	218.5	186.4
Liquid manure												
Panchagavya @ 3%	11.4	16.4	17.5	23.8	4.65	4.76	6.8	6.8	744	778	2422	2513
FEE @ 5%	9.2	13.3	13.1	18.3	4.27	4.35	6.3	6.4	591	632	2053	2152
FFE @ 5%	10.8	15.6	16.0	22.2	4.58	4.67	6.6	6.7	680	737	2306	2398
FEM @ 5%	10.2	14.7	15.1	20.9	4.39	4.48	6.5	6.6	645	692	2246	2341
Jeevamruth @ 5%	9.5	13.7	13.6	19.0	4.31	4.40	6.4	6.4	613	656	2100	2213
CD (5%)	0.46	0.74	0.93	1.22	0.10	0.09	0.14	0.14	28.3	23.7	67.6	75.9
M_1S_1	9.5	13.9	14.2	19.4	4.40	4.53	6.7	6.7	639	677	2200	2271
M_1S_2	8.0	11.4	11.0	16.0	4.10	4.16	6.0	6.3	515	572	1855	1960
M_1S_3	8.5	12.6	12.0	17.8	4.22	4.35	6.3	6.3	547	626	1961	2100
M_1S_4	9.1	13.1	11.8	17.0	4.20	4.30	6.3	6.3	544	611	1907	2081
M_1S_5	8.3	12.0	11.5	16.6	4.12	4.23	6.3	6.3	537	595	1872	2065
M_2S_1	12.5	18.1	19.2	26.0	4.86	4.92	7.0	7.0	777	818	2546	2624
M_2S_2	9.2	13.3	13.4	18.4	4.31	4.42	6.3	6.3	593	630	2084	2171
M_2S_3	12.3	17.7	19.0	25.7	4.84	4.91	7.0	7.0	755	796	2527	2600
M_2S_4	10.7	15.5	17.2	23.4	4.45	4.54	6.7	6.7	702	741	2470	2540
M_2S_5	9.8	14.1	14.2	19.4	4.39	4.45	6.3	6.3	635	673	2185	2250
M_3S_1	13.2	18.9	22.1	29.7	4.93	5.03	7.0	7.0	893	910	2705	2831
M_3S_2	10.5	15.2	15.0	20.5	4.42	4.49	6.7	6.7	679	717	2275	2362
M_3S_3	12.9	18.4	19.4	26.2	4.89	4.93	7.0	7.0	795	856	2600	2672
M_3S_4	11.7	16.8	18.0	24.4	4.60	4.69	6.7	7.0	731	771	2501	2561
M_3S_5	10.7	15.5	15.5	21.1	4.44	4.53	6.7	6.7	701	740	2344	2420
M_4S_1	10.2	14.8	14.5	20.1	4.42	4.57	6.7	6.7	668	706	2237	2325
M_4S_2	9.2	13.2	13.0	18.2	4.26	4.35	6.3	6.3	576	609	1997	2115
M_4S_3	9.5	13.7	13.8	19.2	4.36	4.48	6.3	6.3	624	669	2135	2220
M_4S_4	9.3	13.5	13.5	18.8	4.32	4.40	6.3	6.3	603	645	2105	2183
M_4S_5	9.2	13.3	13.3	18.6	4.29	4.37	6.3	6.3	579	615	2001	2115
Organic × Liquid manure	1.06	1.71	2.04	2.68	0.25	0.28	0.30	0.28	64.2	52.7	249.0	229.7
Liquid × Organic manure	0.93	1.48	1.86	2.44	0.21	0.17	0.29	0.27	56.7	47.4	135.3	151.8

The economics was calculated treatments wise where net returns were calculated as a difference between the cost of cultivation from the gross income. The benefit cost ratio (BCR) was calculated by the formula:

$$BCR = \frac{\text{Gross return (` ha}^{-1})}{\text{Cost of cultivation (` ha}^{-1})}$$

RESULTS AND DISCUSSION

Yield attributing characters and yield

Significant results were observed for grain yield, stover yield, number of clusters plant^{-1} and pods plant^{-1}, pod length and number of seeds pod^{-1} among the various parameters with the application of organic and liquid manures (Table 1 and 2).

At Site-I, among manures the application of EFYM (11.8 and 17.0) showed significantly increased clusters plant^{-1} whereas, in site-II VC (10.6 and 15.8) gave higher clusters number during trial-I and II, respectively. Spraying of Panchagavya recorded significantly higher number of clusters plant^{-1} for site-I (11.4 and 16.4) and at site-II (10.4 and 15.4) during trial-I and II, respectively. The number of pods plant^{-1} at site-I showed significantly higher number along with the application of EFYM (18.0 and 24.4) and at site-II with the application of VC (15.6 and 21.6) during trial-I and II, respectively. Panchagavya spray at site-I (17.5 and

Table 2: Effect of organic and liquid manure on yield attributes and yield of organic blackgram at Experimental site-II.

Treatments	No. of clusters plant^{-1}		No. of pods plant^{-1}		Pod length (cm)		No. of seeds pod^{-1}		Grain yield (kg ha^{-1})		Stover yield (kg ha^{-1})	
Organic	Experiment											
manure	I	II	I	II	I	II	I	II	I	II	I	II
FYM @ 12.5 t ha^{-1}	7.8	11.9	10.4	16.3	3.97	4.05	5.5	5.9	527	569	1910	2019
VC @ 2.5 t ha^{-1}	10.6	15.8	15.6	21.6	4.35	4.58	6.5	6.7	715	760	2221	2460
EFYM @ 750 kg ha^{-1}	9.5	14.8	14.0	20.0	4.28	4.48	6.1	6.4	648	696	2163	2343
EVC @1 t ha^{-1}	8.4	13.1	11.9	17.7	4.14	4.34	5.9	6.2	567	611	2046	2096
CD (5%)	0.63	0.75	0.69	0.74	0.14	0.09	0.28	0.24	37.9	41.2	108.8	144.7
Liquid manure												
Panchagavya @ 3%	10.4	15.4	15.3	21.3	4.32	4.56	6.3	6.5	699	742	2199	2394
FEE @ 5%	8.1	12.7	11.4	17.3	4.07	4.20	5.7	6.0	551	596	1980	2085
FFE @ 5%	9.1	14.0	12.6	18.5	4.17	4.35	6.1	6.4	603	649	2093	2235
FEM @ 5%	9.7	14.5	13.9	19.8	4.26	4.46	6.2	6.5	644	690	2127	2300
Jeevamruth @ 5%	8.3	13.0	11.8	17.7	4.11	4.26	5.8	6.2	574	618	2027	2134
CD (5%)	0.54	0.52	0.63	0.66	0.04	0.08	0.14	0.14	27.2	29.3	47.3	71.2
M_1S_1	8.7	14.0	13.0	19.0	4.20	4.42	6.0	6.3	621	652	2120	2201
M_1S_2	7.3	11.0	9.1	15.0	3.80	3.74	5.0	5.7	468	520	1812	1950
M_1S_3	7.7	11.5	10.3	16.1	3.95	4.03	5.7	6.0	513	554	1859	1984
M_1S_4	7.8	11.8	10.5	16.3	4.00	4.19	5.7	6.0	535	577	1920	2001
M_1S_5	7.5	11.2	9.3	15.4	3.92	3.89	5.3	5.7	500	540	1837	1962
M_2S_1	12.1	17.0	19.0	25.2	4.47	4.75	6.7	7.0	829	873	2280	2625
M_2S_2	9.0	14.6	13.6	19.5	4.27	4.48	6.3	6.3	638	682	2150	2300
M_2S_3	11.1	15.8	14.2	20.2	4.30	4.53	6.3	6.7	684	732	2240	2445
M_2S_4	11.7	16.8	17.3	23.4	4.46	4.67	6.7	7.0	768	812	2265	2585
M_2S_5	9.3	15.0	14.0	19.9	4.26	4.48	6.3	6.7	655	700	2172	2345
M_3S_1	11.3	16.2	16.0	22.1	4.40	4.62	6.3	6.3	724	775	2250	2540
M_3S_2	8.0	12.8	11.8	17.7	4.16	4.36	5.7	6.0	553	595	2002	2080
M_3S_3	9.5	15.4	14.0	20.0	4.27	4.48	6.4	6.7	658	707	2222	2421
M_3S_4	10.5	16.0	15.8	21.8	4.40	4.59	6.3	6.6	709	762	2242	2489
M_3S_5	8.3	13.8	12.5	18.4	4.16	4.37	6.0	6.3	595	640	2101	2185
M_4S_1	9.5	14.3	13.1	19.0	4.23	4.44	6.0	6.3	624	668	2145	2210
M_4S_2	7.9	12.5	11.1	16.9	4.05	4.20	5.7	6.0	544	588	1957	2010
M_4S_3	8.1	13.1	12.0	17.9	4.17	4.36	6.0	6.3	557	601	2050	2091
M_4S_4	8.7	13.5	12.0	17.9	4.16	4.39	6.0	6.3	564	609	2080	2125
M_4S_5	8.0	12.1	11.3	17.1	4.10	4.31	5.7	6.0	547	591	2000	2045
Organic × Liquid manure	1.14	1.19	1.31	1.39	0.16	0.17	0.38	0.35	61.5	66.4	137.3	192.0
Liquid × Organic manure	1.07	1.03	1.25	1.32	0.08	0.17	0.29	0.28	54.4	58.6	94.7	142.5

23.8) and at site-II (15.3 and 21.3) recorded significantly greater number of pods during trial-I and II, respectively. The length of the pod at site-I was higher with the application of EFYM (4.66 and 4.73 cm) and at site-II the application of VC (4.35 and 4.58 cm) recorded higher length during trial-I and II respectively. Panchagavya spray showed higher pod length in both site-I (4.65 and 4.76 cm) and site-II (4.32 and 4.56 cm) during trial-I and II, respectively. Number of seeds pod^{-1} at site-I was higher the application of EFYM (6.8 and 6.9) and at site-II application of VC (6.5 and 6.7) during trial-I and II respectively. Panchagavya spray showed higher seeds number in both site-I (6.8 and 6.8) and site-II (6.3 and 6.5) during trial-I and trial-II, respectively. Application of EFYM (2485 and 2569 kg ha^{-1}) at site-I and VC (2221 and 2460 kg ha^{-1}) at site-II recorded greater stover yield during trial-I and II, respectively. Among the foliar sprays, Panchagavya recorded higher stover yields for site-I (2422 and 2513 kg ha^{-1}) and site-II (2199 and 2394 ha^{-1}) during trial-I and II, respectively. The interaction effect for the higher yield attributes showed results of similar trend as that of the main and sub plot.

The manures application attributed for better vegetative growth and development in blackgram, as a result of balanced nutrition and better soil fertility status which together with the influence of foliar sprays might have created a better environment for the development of yield parameters in blackgram. Similar results have been reported by Meena *et al*. (2021) and Sangeetha *et al*. (2013). The enhanced yield parameters in the study might be attributed to spraying Panchagavya twice, which has various nutrients in balanced amount, along with the beneficial microorganisms, growth promoters and ability to boost flowering. These results are in line with Kumawat *et al*. (2009) and Leo Daniel Amalraj *et al*. (2013). The foliar spray

Table 3: Effect of organic and liquid manure on test weight and harvest index of organic blackgram.

Treatments	Test weight (g)				Harvest index			
Organic manure	Site-I		Site-II		Site-I		Site-II	
	Experiment							
	I	II	I	II	I	II	I	II
FYM @ 12.5 t ha^{-1}	4.37	4.51	3.89	4.13	0.19	0.20	0.19	0.19
VC @ 2.5 t ha^{-1}	4.72	4.77	4.29	4.40	0.19	0.20	0.21	0.20
EFYM @ 750 kg ha^{-1}	4.80	4.84	4.21	4.31	0.20	0.20	0.20	0.20
EVC @1 t ha^{-1}	4.56	4.66	4.09	4.20	0.19	0.19	0.19	0.19
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS
Liquid manure								
Panchagavya @ 3%	4.77	4.83	4.27	4.39	0.20	0.20	0.20	0.20
FEE @ 5%	4.45	4.60	3.98	4.16	0.19	0.19	0.19	0.19
FFE@ 5%	4.68	4.74	4.08	4.26	0.20	0.20	0.19	0.20
FEM @ 5%	4.62	4.69	4.21	4.30	0.19	0.20	0.20	0.20
Jeevamruth @ 5%	4.55	4.63	4.04	4.19	0.19	0.20	0.19	0.19
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS
Organic × Liquid manure	NS	NS	NS	NS	NS	NS	NS	NS
Liquid × Organic manure	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Effect of organic and liquid manure on net returns and benefit cost ratio of organic blackgram.

Treatments	Net return (` ha^{-1})				BCR			
Organic manure	Site-I		Site-II		Site-I		Site-II	
	Experiment							
	I	II	I	II	I	II	I	II
FYM @ 12.5 t ha^{-1}	-8649	-466	-5990	-126	0.9	1.0	0.9	1.0
VC @ 2.5 t ha^{-1}	-3555	2107	5241	11578	1.0	1.0	1.1	1.1
EFYM @ 750 kg ha^{-1}	31377	37063	24124	30768	1.5	1.6	1.5	1.6
EVC @1 t ha^{-1}	3031	8715	4053	10247	1.1	1.1	1.1	1.2
Liquid manure								
Panchagavya @ 3%	16971	21985	17743	23742	1.3	1.4	1.3	1.4
FEE @ 5%	-10192	-4221	-8838	-2489	0.9	1.0	0.9	1.0
FFE @ 5%	9836	17597	6721	13107	1.2	1.3	1.1	1.2
FEM @ 5%	6202	12845	12217	18656	1.1	1.2	1.2	1.3
Jeevamruth @ 5%	4938	11068	6441	12568	1.1	1.2	1.1	1.2

of Panchagavya has improved the growth, physiological, yield attributes and yield especially when the foliar spray was given during the flowering stage (Jha *et al*., 2015; Sutar *et al*., 2019 and Ajaykumar *et al*., 2022).

Application of EFYM (760 and 799 kg ha^{-1}) and Panchagavya spray (744 and 778 kg ha^{-1}) showed significantly higher grain yield during both trial-I and II respectively in Experimental site-I. The Experimental site- II recorded significant grain yield with the application of vermicompost (715 and 760 kg ha^{-1}) and Panchagavya spray (699 and 742 kg ha^{-1}) during both the trial-I and II. Significantly higher yield among the main plots was recorded by EFYM followed by VC and EVC in site-I where FYM recorded the lowest yield. Application of VC was followed by EFYM and EVC showed higher yield where FYM recorded lowest in site-II. Panchagavya was followed by FFE in site-I and FEM in site-II respectively, showed superior yield where, FEE and Jeevamruth recorded the lowest yield being statistically at par for both the sites.

With the application of enriched FYM, the nutrient availability might have improved as a result of beneficial effects of biofertlizers and rock phosphate in site-I. Improvement in the soil properties, plant growth and root parameters might have led to yield enhancement which might be a result of better soil biological condition brought on by vermicompost application in site-II. These results were in accordance with Suresh, (2005) and Parthasarathi *et al*. (2008). The yield increase with Panchagavya foliar spray might have been due to the contribution from enhanced absorption of the nutrients and influence of plant growth regulators. This result is in line with Choudhary *et al*. (2017). In the study, the initial supply of nutrition by manures incorporation followed by foliar spray of the liquid manures twice ensured the balanced nutrient supply throughout the growth period.

The test weight and harvest index showed non significant difference in both the locations during trial-I and II (Table 3).

Economics

The economics was given as net returns (` ha$^{-1}$) and Benefit cost ratio. The economics showed higher net returns with the application of EFYM at site-I (31377and 37063 ` ha^{-1}) and at site-II (24124 and 30768 ` ha$^{-1}$) during trial-I and II, respectively. Among the foliar sprays the net returns were greater with the Panchagavya spray at site-I (16971 and 21985 ` ha^{-1}) and at site-II (17743 and 23742 ` ha^{-1}) during trial-I and II, respectively. The BCR was maximum with the incorporation of EFYM at site-I (1.5 and 1.6) and at site-II (1.5 and 1.6) during trial-I and II, respectively. Higher BCR was obtained by spraying Panchagavya at site-I (1.3 and 1.4) and at site-II (1.3 and 1.4), during trial-I and II, respectively. Reduced quantity of manure applied along with higher yields might have led to the increased returns. These results are in line with Masu *et al*. (2019) and Somasundaram *et al*. (2020) (Table 4).

CONCLUSION

On the basis of experimental results, it was concluded that economically beneficial returns for organic blackgram were obtained at Experimental site-I, with the incorporation of Enriched FYM @ 750 kg ha^{-1} followed by Panchagavya @ 3% as foliar spray twice and for Experimental site-II it was with the incorporation of Enriched FYM @ 750 kg ha^{-1} followed by Panchagavya @ 3% or Farmers Effective Microorganisms (FEM) @ 5% twice as foliar spray.

Conflict of interest: None.

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