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Productivity and Profitability of Summer Blackgram in Response to Integrated Nutrient Management

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ABSTRACT

Background: Pulse crops are commonly known as "rich man's vegetable". Blackgram is the most important pulse crops of Odisha after greengram. Poor productivity of blackgram in Odisha is due to soil related constraints such as organic matter and nutrient availability. Use of unbalanced and inadequate fertilizers accompanied by restricted use organic manures resulted decline in crop yield. Promising results of balanced fertilization was documented in various pulse crop but limited research was under taken in blackgram in East and South Eastern coastal plain zone of Odisha. Therefore, current experiment focused on improving productivity of blackgram with different source of nutrient.

Methods: A field experiment was conducted at Institute of Agricultural Sciences of Siksha "O" Anusandhan (Deemed University), Bhubaneswar, during summer season of 2020 and 2021 to study the Influence of integrated nutrient management on productivity, nutrient uptake and soil fertility of summer blackgram (*Vigna mungo* L.). Blackgram variety 'LBG 787 (Tulsi)' was sown at a spacing of 25 × 10 cm under randomized block design (RBD) with 12 treatment combinations of FYM, inorganic and foliar fertilizer.

Result: Application of 100% RDF + FYM + nutrient priming + 2% DAP spray twice at 30 and 45 DAS led to maximum pods per plant (18.5), pod length (4.5 cm), seeds per pod (7.0), test weight (52.0 g), seed yield (843 kg/ha), stover yield (1214 kg/ha) and harvest index (41.0%). Besides, it also recorded highest gross return (Rs 54,840/ha), net return (Rs 27,050/ha), B:C ratio (2.1), production efficiency (10.83 kg/ha/day), economic efficiency (360.67 Rs/ha/day) and was at par with 75% RDF + FYM + nutrient priming + 2% DAP spray. The later recorded 49.1% higher yield and 152.4% higher net return/ha, respectively than that of 100% RDF alone in East and South Eastern coastal plain zone of Odisha.

Key words: Blackgram, FYM, Foliar spray, Inorganic, Nutrient uptake, Seed yield, Soil fertility.

INTRODUCTION

Blackgram is the 3rd important pulse crop in India, cultivated over an area of 5.44 m ha and with a production of 3.56 mt and productivity of 655 kg/ha (Anonymous, 2018). In Odisha, it is grown in an area of 5.7 lakh ha with a production of 2.59 lakh t and productivity of 456 kg/ha (Anonymous, 2016). The low productivity of blackgram in Odisha has been attributed to the fact that crop is grown in marginal and sub marginal land under rainfed situation with application of low quantities of organic and inorganic sources of plant nutrients, which also resulted in deterioration of soil health and productivity (Kumpawat, 2010). Organic manures provide a good substrate for the growth of microorganisms and maintain a favourable nutritional balance and soil physical properties (Chaudhary *et al.,* 2004). The organic acids produced during decomposition of organic waste can exchange with adsorbed P and increase its availability to plants. For instance, application of FYM increased the activity of acid and alkaline phosphatase, phosphodiesterase, inorganic pyrophosphatase and dehydrogenase enzymes leading to faster hydrolysis of easter-bond P to plant available P (Dinesh *et al.,* 2003). Farm yard manure @ 15 t /ha significantly improved nodulation of black gram and green gram (Nagarajan and Balachandar, 2001). Significant increases in seed and stover yields were also observed at 40 kg $P_2 0_5$ and 20 kg S /ha mainly due to improvement in plant height, branches per plant and pods per plant (Thakur, 1999). To raise production on sustainable basis, there is increased need for integrated use of organic manures, biofertilizers and inorganic sources through optimized combination to increase the productivity and improving the soil health (Sharma and Chauhan, 2011). In view of this, the present study on productivity and profitability of summer blackgram in response to integrated nutrient management was undertaken.

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MATERIALS AND METHODS

The experiment was carried out during summer 2020 and 2021 at the instructional farm of Institute of Agricultural Sciences of Siksha "O" Anusandhan (deemed) university, Bhubaneswar. The experimental farm was situated at 20°25′

N latitude and 85°78′ E longitude with an average altitude of 36 m above the mean sea level under hot and humid region of Odisha. The soil of the experimental site was sandy loam in texture with pH 5.6, EC 0.43 dS/m, organic carbon 0.37% and available N, P and K was 162, 14 and 152 kg/ha, respectively. The experiment was laid out in randomized block design (RBD) with twelve treatments and three replications. The treatments consisted of T_1-100% RDF (20:40:20 and 20, respectively N: P_2O_5 :K_2O and S kg/ ha), T_2- 100%RDF + FYM (5 t/ha), T_3-100%RDF + nutrient priming with Mo and P (Ammonium molybdate 0.1% and 1% solution of SSP) + nutrient spray (2%DAP Spray), T_4-100%RDF + FYM (5 t/ha) + nutrient priming with Mo and P (ammonium molybdate 0.1% and 1%P solution of SSP) + nutrient spray (2%DAP Spray), T_5- 100%RDF + nutrient priming + NPK(19:19:19) (2% Spray), T_6- 100%RDF + FYM + nutrient priming + NPK (19:19:19) (2% Spray), T_7- 75% RDF (20:40:20 and 20, respectively N:P_2O_5:K_2O and S kg/ha), T_8- 75% RDF+FYM (5 t/ha), T_9- 75%R DF+nutrient priming with Mo and P (ammonium molybdate 0.1% and 1%P solution of SSP) + nutrient spray (2% DAP Spray), T_{10}- 75% RDF + FYM (5 t/ha) + nutrient priming with Mo and P(ammonium molybdate 0.1% and 1% P solution of SSP) + nutrient spray (2% DAP Spray), T_{11}- 75% RDF + nutrient priming + NPK (19:19:19) (2% Spray), T_{12}- 75% RDF + FYM + nutrient priming + NPK (19:19:19) (2% Spray). The fertilizers and farm yard manure (FYM) were applied at sowing as per treatments. Foliar spray of diammonium phosphate (DAP) and NPK (19-19-19) was made as per treatment combinations, twice at bud and pod initiation stage. Entire quantity of N, P, K and S were applied at the time of sowing. Seed priming was done by treating the seeds with mixture of 250 mg Mo and 2.5 g DAP (for P) in 250 ml liquid rhizobium carefully, so that seed coat was not injured. The treated seeds were dried under shade for half an hour before sowing.

The blackgram variety 'LBG 787 (Tulsi)' was sown on 15th and 23rd February in 2020 and 2021 at 25 × 10 cm spacing with seed rate of 20 kg /ha. The crop was harvested on 1st May and 18th May in respective year. During the crop season two manual weedings (15 and 30 days after sowing) were done to manage weeds in the experimental crop. Total 4 irrigations were provided to fulfill the crop water requirement. The observations were recorded on growth, yield attributing characters and yield. Production efficiency and economic efficiency was calculated as following formula suggested by Goud and Kale (2010):

$$\text{Production efficiency (kg/ha/day)} = \frac{\text{Grain yield (kg/ha)}}{\text{Total duration taken by the crop (days)}}$$

$$\text{Economic efficiency (Rs/ha/day)} = \frac{\text{Net return (Rs/ha)}}{\text{Total duration taken by the crop (days)}}$$

Table 1: Growth and yield attributes of summer blackgram as influenced by different treatments (Average of 2 years).

Treatments	Plant height (cm) at harvest	No. of branches/plant at 40 DAS	Trifoliate leaves/plant at 40 DAS	Dry matter/ plant (g) at harvest	LAI at 40 DAS	Nodules/ plant at 40 DAS	Chlorophyll content/SPAD value at 40 DAS*
100% RDF	30.0	6.1	12.0	19.3	3.0	12.7	40.2
100% RDF + FYM	33.0	6.6	13.0	23.2	3.6	16.7	42.5
100% RDF + nutrient priming + 2% DAP spray	31.5	6.6	13.0	22.7	3.4	16.3	41.3
100% RDF + FYM + nutrient priming + 2% DAP spray	39.5	7.1	16.0	26.8	4.8	18.7	46.6
100% RDF + nutrient priming + 2% NPK (19-19-19) spray	33.5	6.4	12.0	22.3	3.4	14.8	41.2
100% RDF + FYM + nutrient priming + 2% NPK 19-19-19 spray	34.5	6.9	14.0	24.7	4.0	17.4	44.4
75% RDF	28.5	5.9	9.0	16.7	2.8	11.3	39.2
75% RDF + FYM	29.5	6.5	12.0	22.0	3.5	16.6	42.1
75% RDF + nutrient priming + 2% DAP spray	33.5	6.3	12.0	21.2	3.4	16.1	41.3
75% RDF + FYM + nutrient priming + 2% DAP spray	36.0	7.0	15.0	25.	4.5	18.5	45.3
75% RDF + nutrient priming + 2% NPK (19-19-19) spray	27.0	6.1	10.0	20.3	3.3	14.2	40.3
75% RDF + FYM + nutrient priming + 2% NPK (19-19-19) spray	32.5	6.7	13.0	23.8	3.7	16.9	44.3
SEm±	1.3	0.1	0.5	0.6	0.3	0.1	0.45
CD (P=0.05)	3.8	0.4	1.6	1.9	0.8	0.4	1.32

RDF: Recommended dose of fertilizer, FYM: Farm yard manure, DAP: Diammonium phosphate, DAS: Days after sowing, * Per unit fresh weight of leaf tissue (nmol/mg).

Statistical analyses were done as per standard method prescribed by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth characteristics

Growth attributes (Table 1) were significantly affected by integrated nutrient management (INM). Among the treatments, higher plant height (39.5 cm), number of branches/plant (7.1), leavers/plant (16.0) and leaf area index (4.8) were found with 100% RDF + FYM + nutrient priming + 2% DAP spray. It also recorded 38.9% higher dry matter production (26.8 g/plant) as compared to 100% RDF alone (19.3 g/plant). However, it was on par with 75% RDF + FYM + nutrient priming + 2% DAP spray (25.0 g/plant). Further reduction in RDF by 25% reduced the dry matter production by 15.6%, which was the lowest among the treatments. Further, significantly higher, nodules/ plant (18.7) and SPAD value of chlorophyll (46.6) were recorded at 40 DAS with 100% RDF + FYM + nutrient priming + 2% DAP spray over 100% RDF (3.0, 12.7 and 40.2, respectively). It was on par with 75% RDF + FYM + nutrient priming + 2% DAP spray. Consequently, the dry matter production and its accumulation in different parts of plant was higher with100% RDF + FYM + nutrient priming + 2% DAP spray than that of 100% RDF. Similar results were reported by Yakdri *et al*. (2002) in green gram and Senthil Kumar *et al*. (2008) in blackgram. The increase in these growth parameters might be due to slow release of nutrients from FYM and uniform availability of nutrients along with supplementations through foliar spray during peak demand. Similar finding was reported by Dhakal *et al*. (2016) in green gram.

Yield attributes and yields

The number of pods per plant, number of seeds per pod, pod length and 1000-seed weight were significantly higher with 100% RDF + FYM + nutrient priming + 2% DAP (Table 2). Organics in conjunction with foliar nutrient spray enhanced the number of pods per plant by 60.9, 59.1 and 43.5% in 100% RDF + FYM + nutrient priming + 2% DAP spray, 75% RDF + FYM + nutrient priming + 2% DAP spray and 100% RDF + FYM + nutrient priming + 2% N-P-K spray, respectively as compared to 100% RDF (11.5). The 1000-seed weight also increased to the tune of 29.7, 25.9 and 12.9%, respectively in the above treatments over 100% RDF (40.1 g). These results suggest that role of FYM was more spectacular than foliar spray in improving yield components over the inorganic fertilizer alone. But combined application of both FYM and foliar spray gave a synergistic effect on all the yield attributing characters. This might be due to uniform slow release of all essential elements by FYM throughout growth period of crop and supplementation of nutrients through foliar sprays at peak period of demand.

Higher seed yield (843 kg /ha), stover yield (1214 kg/ha) and harvest index (39.6%) were recorded in 100% RDF + FYM + nutrient priming with P and Mo + foliar spray with 2% DAP and it was at par with 75% RDF + FYM + nutrient

Table 2: Yield attributes and yield of blackgram as influenced by different treatments (Average of 2 years).

Treatments	No. of pods /plant	Pod length (cm)	No. seeds/ pod	Test weight (g)	Yield (kg /ha)						Harvest index (%)		
					Seed			Stover					
					2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
100% RDF	11.5	3.7	6.0	40.1	540	539	540	897	865	881	37.6	38.4	38.0
100% RDF + FYM	16.0	4.2	6.5	44.4	720	670	695	1070	1029	1050	40.2	39.4	39.8
100% RDF + nutrient priming + 2% DAP spray	14.5	4.1	6.4	45.3	700	644	672	1010	960	985	40.9	40.1	40.5
100% RDF + FYM + nutrient priming + 2% DAP spray	18.5	4.5	7.0	52.0	873	812	843	1220	1208	1214	41.7	40.2	41.0
100% RDF + nutrient priming + 2% NPK (19-19-19) spray	12.5	4.0	6.0	41.9	620	600	610	953	915	934	39.4	39.6	39.5
100% RDF+ FYM + nutrient priming + 2% NPK (19-19-19) spray	16.5	4.3	6.6	45.3	760	705	733	1140	1135	1138	40.0	38.3	39.2
75% RDF	11.5	3.5	6.4	41.5	513	507	510	790	751	771	39.4	40.3	39.8
75% RDF + FYM	14.0	4.2	6.3	44.4	707	652	680	1023	983	1003	40.9	39.9	40.4
75% RDF + nutrient priming + 2% DAP spray	13.5	3.9	6.4	43.3	660	623	642	963	931	947	40.7	40.1	40.4
75% RDF + FYM + nutrient priming + 2% DAP spray	18.3	4.3	6.5	50.5	833	776	805	1180	1167	1174	41.4	39.9	40.7
75% RDF + nutrient priming + 2% NPK (19-19-19) spray	12.5	3.7	6.3	42.3	573	564	569	873	875	874	39.6	39.2	39.4
75% RDF + FYM + nutrient priming + 2% NPK (19-19-19) spray	14.5	4.1	6.3	44.5	727	683	705	1103	1131	1117	39.7	37.7	38.7
SEm±	0.6	0.0	0.3	2.5	61.7	12.4	37.3	56.1	34.5	57.0	0.6	-	0.4
CD (P=0.05)	1.9	0.1	1.1	7.5	184.0	37.1	111.0	167.0	102.6	171.0	1.7	NS	1.1

RDF: Recommended dose of fertilizer, FYM: Farm yard manure, DAP: Diammonium phosphate.

priming with P and Mo + foliar spray with 2% DAP and 100% RDF + FYM + nutrient priming + 2% N-P-K spray. Even reduced dose of RDF along with FYM or 2% DAP and NPK spray in different combinations (T_7 to T_{12}) were superior to 100% RDF. Yield loss under 75% RDF could be recovered through application of FYM and foliar nutrients and seed priming. Addition of FYM to RDF increased the crop yield by 28.7% to 33.3%. Reduction in yield of 5.8% due to 25% reduction in RDF (T_7- 75%RDF) could be compensated by addition of FYM (T_8- T_7+FYM) or foliar sprays. NPK (19:19:19) and DAP foliar sprays proved to be effective when applied with either 100 or 75% RDF with an yield increase of 11.5 to 12.9% and 24.4 to 25.8% respectively. Both the foliar sprays increased the yield but DAP 2% was found to be more effective. The same effect of DAP and NPK 19-19-19 has been reported by Kumar *et al*. (2018). The correlation analysis of the grain yield and the chlorophyll content (SPAD) at 40 DAS in the leaves revealed positive correlation (Fig 1, Y = 45.177x - 1310.4 and R^2 = 0.949). The seed yield was expected to increase by 45.18 kg/ha with every unit increase in chlorophyll content.

Beneficial effect of integrated nutrient management was mainly due to positive effect of FYM and supplementation of nutrients through foliar sprays. The slow releasing FYM provided nutrients in required quantities over longer period and the higher demands at the time of pick periods of flowering and fruiting were met through foliar nutrient sprays making the availability of nutrients sufficient for the plant as and when required as reflected in dry matter production. Comparable results were reported by Vasanthi and Subramanian (2004) and Dixit and Elemathi (2007).

Table 3: Economics, production and economic efficiencies of blackgram as influenced by different treatment (Pooled data of 2 years).

Treatments	Cost of cultivation (Rs/ha)	Gross monetary returns (Rs/ha)	Net monetary returns	B:C ratio	Production efficiency (kg /ha/day)	Economic efficiency (Rs /ha/ day)
100% RDF	23,750	34,147	10,397	1.4	7.19	138.63
100% RDF + FYM	27,250	45,220	17,970	1.7	8.93	239.60
100% RDF + nutrient priming + 2% DAP spray	24,290	44,360	20,070	1.8	8.59	267.60
100% RDF + FYM + nutrient priming + 2% DAP spray	27,790	54,840	27,050	2.1	10.83	360.67
100% RDF + nutrient priming + 2% NPK (19-19-19) spray	25,750	39,247	13,497	1.5	8.00	179.96
100% RDF + FYM + nutrient priming + 2% NPK (19-19-19) spray	29,250	47,807	18,557	1.6	9.40	247.43
75% RDF	22,870	32,380	9,510	1.4	6.76	126.80
75% RDF + FYM	25,495	44,327	18,832	1.7	8.69	251.09
75% RDF + nutrient priming + 2% DAP spray	23,410	41,740	18,330	1.8	8.31	244.40
75% RDF + FYM + nutrient priming + 2% DAP spray	26,035	52,280	26,245	2.0	10.35	349.93
75% RDF + nutrient priming + 2% NPK (19-19-19) spray	24,870	36,193	11,323	1.5	7.52	150.97
75% RDF + FYM + nutrient priming + 2% NPK (19-19-19) spray	27,495	45,507	18,012	1.7	9.11	240.16
SEm±		3,753	3,753	0.1	0.20	
CD (P=0.05)		11,078	11,832	0.32	0.60	

RDF: Recommended dose of fertilizer, FYM: Farm yard manure, DAP: Diammonium phosphate.

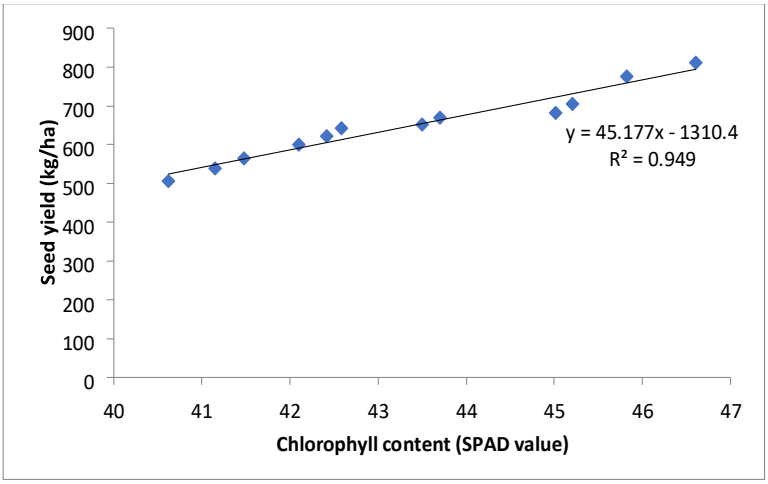


Fig 1: Chlorophyll content in leaves and seed yield correlation.

Economics

Further, higher net returns was obtained with 100% RDF + FYM + nutrient priming + 2% DAP spray (27,050 Rs /ha) with B: C ratio of 2.1, production efficiency (10.83 kg/ha/day) and economic efficiency (360.67 Rs/ha/day) followed by application of 75% RDF + FYM + nutrient priming + 2% DAP spray (26245 Rs/ha and 2.0, respectively) (Table 3). This was attributed to higher seed yield. The lower net returns and B: C ratios were realized with only RDF (100 or 75%). Application of 75% RDF + nutrient priming + 2% DAP spray (without FYM) recorded 43.3% higher net return/ha than that of 100% RDF alone. Addition of FYM along with recommended dose well compensated the additional cost. The results agree with the findings of Chandrasekhar and Bangarusamy (2003) in green gram.

Conflict of interest

All authors declared that there is no conflict of interest.

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