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Improvement on Growth, Yield, Economics and Soil Fertility Status of Blackgram (*Vigna mungo* L.) Under Integrated Nutrient Management

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ABSTRACT

An On-farm Trial (OFT) was conducted during *rabi* season of 2016–17 at farmers' field in Ragudiapada village of Angul district in Odisha, India using randomized block design with ten replications to study the improvement on growth, yield, economics and soil fertility status of blackgram under integrated nutrient management. The results indicated that 75% STBFR+FYM @ 2.0 t ha^{-1} incubated with PSB @ 5 kg ha^{-1}+seed inoculation of *Rhizobium culture* @ 20 g kg^{-1} of seed+sodium molybdate @ 0.3 g kg^{-1} of seed recorded significantly higher plant height(43.52 cm),branches plant^{-1} (4.85), nodules plant^{-1} (22.75), pods plant^{-1} (21.2), seeds pod^{-1} (6.19), grain yield (6.45 q ha^{-1}) and harvest index (37.2%). The same treatment fetched higher gross return of ₹ 32787 ha^{-1} with a benefit– cost ratio of 1.67 and additional net return of ₹ 4861 ha^{-1} as compared STBF. With regards to soil fertility after crop harvest, the same treatment resulted in the highest soil available nitrogen (220.8 kg ha^{-1}), phosphorus (12.07 kg ha^{-1}) and potassium (193.05 kg ha^{-1}) which was 14.3, 11.8,9.7% higher over the initial soil status, respectively. Thus, 75% STBFR+FYM @ 2.0 t ha^{-1}incubated with PSB @ 5 kg ha^{-1}+seed inoculation of *Rhizobium culture* @ 20g kg^{-1} of seed+sodium molybdate @ 0.3 g kg^{-1} of seed is the proven technology which is effective for higher crop growth, yield, profitability and soil fertility status of blackgram under mid central table land zone of Odisha.

KEYWORDS: Blackgram, available nutrients, molybdenum, nodulation, profitability, *rhizobium*, yield

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1. INTRODUCTION

Blackgram is one of the most important legume crop and being drought tolerant and warm weather crop, it is well adopted to the drier regions of the tropics. It is grown throughout the country during both in summer and rainy seasons and contributes about 13% of total area in pulses and 10% of their total production in our country (Shashidhar et al., 2020). In India, it occupies an area of 3.06 million hectares with a production of 1.70 million tones and an average productivity of 555 kg ha^{-1} (Anonymous, 2021). It has ability to fix about 22.1 kg of atmospheric nitrogen $hectare^{-1}$ through its root nodules. In Odisha, it occupies an area of 1.97 lakh hectare having a productivity level of 468 kg ha^{-1} (Anonymous, 2022). Integrated Nutrient management supply all the macro and micro nutrients which are required by crop for balanced nutrition (Patil et al., 2010). Lower productivity of blackgram is due to use of sub-optimal rate of fertilizer, poor management and cultivation in marginal and sub-marginal lands. Moreover, the use of chemical fertilizers resulted in deterioration of soil fertility (Masu et al., 2019, Thiyagarajan et al., 2003). The existing blanket recommendation for crops does not ensure efficient and economic use of fertilizers, as it does not take into account of the fertility variations resulting in imbalanced use of fertilizer nutrients (Singh, 2018). The nutrient management and legume based cropping system also tremendously benefit the sustenance of soil health (Meena, 2013, Sreedevi et al., 2018). The alternate source of nutrients other than the conventional inorganic sources in an integrated manner, is highly needed for sustained pulses productivity (Chaudhary et al., 2019, Singh et al., 2011). There is immense scope for improving the production potential of blackgram by use of organic manures, inorganic manures and biofertilizers(Verma et al., 2017). Integrating mineral fertilisers with organic manures offer an environmentally safe, economically sound, socially reasonable, and ecologically sustainable production system (Midya et al., 2021, Sahu et al., 2017). Integration of Integrated nutrient management system involving organics like FYM, biofertilisers and chemical fertilizers is a better way to achieve higher seed yield and yield attributes and to improvephysico–chemical and biological properties of the soil (Chhaya and Jain, 2014). Application of different organic–cum–inorganic sources of nutrients is effective for higher yield, better economy and improved soil fertility status. (Nagar et al., 2016, Samant et al., 2021). Among the various methods of fertilizer recommendations, the soil test based fertilizer recommendations is also appropriate practices to improve yield as well as soil nutrient status (Gayathri et al., 2009, Salam et al., 2004.). Thus, there is a scope for improving the production potential of this crop by use of inorganic and bio–fertilizers. Application of *Rhizobium* with seed priming significantly increased nodulation (Basumatary et al., 2018, Kumar et al., 2010). Molybdenum plays a pivotal role in nitrogen fixation resulting increase in flower numbers, pod formation (Meena et al., 2020, Awomi et al., 2012). Organic manures provide a good substrate for the growth of micro–organisms and maintain a favourable nutrient supply environment and improve soil physical properties (Kumpawat, 2010). Among the various methods of fertilizer recommendations, the soil test-based fertilizer recommendations is also appropriate practices to improve yield as well as soil nutrient status (Gayathri et al., 2009). Keeping in view such problems an attempt was made with an objective to study the improvement on growth, yield, economics and soil fertility status of blackgram under integrated nutrient management in mid central table land zone of Odisha.

2. MATERIALS AND METHODS

The study was carried out as On-farm Trial (OFT) at farmers' field during *rabi* (December, 2016 –March, 2017) season at *Ragudiapada* village in Angul district under mid-central table land zone of Odisha. The experimental site lies in $84^0$23'E longitude and $20^0$25'N latitude and average elevation of 94 m above sea level. The soil was sandy loam, acidic in nature (pH–5.5), low in organic carbon(0.49%) and available nitrogen (193.2 kg ha^{-1}), phosphorus (10.8 kg ha^{-1}) and medium in potash (176.0 kg ha^{-1}) content. Three treatments namely; Farmers' practice ($N:P_2O_5:K_2O$ 05:25:00 kg ha^{-1}), Soil test based recommended fertilizer dose (STDFR), ($N:P_2O_5:K_2O$ 25:50:40 kg ha^{-1}) and 75% STBFR+FYM @ 2.0 t ha^{-1} incubated with PSB @ 5 kg ha^{-1}+seed inoculation of *Rhizobium culture* @ 20 g kg^{-1} of seed+sodium molybdate @ 0.3 g kg^{-1} of seed (INM), were replicated 10 times in randomized block design.

Blackgram (variety: PU 35) was cultivated with recommended package of practices. The crop was sown during 3rd week of December and harvested during 1st week of March. Ten different farmers' each having 0.15 hectare of land cultivated the crop. Observations on different growth and yield parameters were taken and economic analysis was done by calculating cost of cultivation, gross return, net return, B:C ratio and profitability. Available soil nutrients content were determined following the standard procedures (Jackson, 1973). Final crop yield (seed and stover) were recorded and harvest index was calculated by using the Following formula (Gardner et al., 1985).

Harvest index (%)=(Economic yield)/(Biological yield)×100

The soil fertility status was analyzed by standard methods. The data were statistically analyzed applying the techniques of analysis of variance and the significance of

different sources of variations were tested by error mean square of Fisher Snedecor's 'F' test at probability level 0.05 (Cochran and Cox, 1977).

3. RESULTS AND DISCUSSION

3.1. Growth parameters and yield attributes

Results (Table 1) indicated that the growth parameters and yield attributes of blackgram significantly affected by different treatments. Application of 75% STBFR+FYM @2.0 t ha^{-1}incubated with PSB @ 5 kg ha^{-1}+seed inoculation of *Rhizobium culture* @ 20g kg^{-1} of seed+sodium molybdate @ 0.3 g kg^{-1} of seed (INM) recorded significantly higher plant height (43.52 cm), branches plant^{-1} (4.85), nodules plant^{-1} (22.75), which might be responsible for higher yield attributes *i.e.*, pods plant^{-1} (21.20) and seeds pod^{-1} (6.19) followed by soil test based recommended fertilizer dose, STDF, (N:P_2O_5:K_2O 25:50:40 kg ha^{-1}). The overall improvement in the growth of blackgram with the addition of FYM, *Rhizobium culture and* sodium molybdatecould be ascribed to their pivotal role in several physiological and biochemical processes, viz., root development, photosynthesis, energy transfer reaction and symbiotic biological N fixation process. This corroborates the findings of Singh et al. (2014) and Meena et al. (2020). The farmers practice recorded the lowest growth parameters and yield attributes. The increase in various parameters owing to increased availability of nutrients over the long periods, which have positive effect on growth of the plants (Meena et al., 2013 and Singh and Singh, 2014).

3.2. Yield

Analysis of data (Table 2) revealed that significantly the maximum pod yield was recorded with 75% STBFR+FYM @ 2.0 t ha^{-1} incubated with PSB @ 5 kg ha^{-1}+seed inoculation of *Rhizobium culture* @ 20 g kg^{-1} of seed+sodium molybdate @ 0.3 g kg^{-1} of seed (6.45 q ha^{-1}) which had 2.17 and 1.12 q ha^{-1} higher yield advantage over STBRF (5.33 q ha^{-1}) and Farmers practice (4.28 q ha^{-1}) respectively. Among the treatments, INM produced higher stover yield (10.87 q ha^{-1}) and harvest index (37.24%) which might be due to application of nutrients in the integrated form led to efficient photosynthetic structural system. Combined use of inorganic, organic and biofertilizers resulted in better growth associated with increased availability of nutrients might have resulted in better development of growth and yield attributing parameters, which ultimately resulted in higher yields. The results are in agreement with the findings of Meena et al. (2021), Vaiyapuri et al. (2010), Chhaya and Jain (2014) and Sreedevi et al. (2018).

Table 1: Effect of integrated nutrient management on growth and yield parameters of blackgram

Treatments	Plant height (cm)	No. of branches Plant^{-1}	No. of nodules Plant^{-1}	No. of pods Plant^{-1}	No. of seeds Pod^{-1}
Farmers practice (N:P_2O_5:K_2O 05:25:00 kg ha^{-1})	38.76	4.26	14.68	18.20	5.46
Soil test based recommended fertilizer dose (STDFR),(N:P_2O_5:K_2O 25:50:40 kg ha^{-1})	41.37	4.63	20.84	19.70	5.59
75% STBFR+FYM @2.0 t ha-1incubated with PSB @ 5 kg ha^{-1}+seed inoculation of Rhizobium culture @ 20 g kg^{-1} of seed+sodium molybdate @ 0.3 g kg^{-1} of seed	43.52	4.85	22.75	21.20	6.19
SEm±	0.71	0.08	0.36	0.64	0.10
CD (p= 0.05)	2.12	0.23	1.08	1.91	0.30

3.3. Soil fertility

With regards to soil fertility (Table 2) after crop harvest, the INM resulted in the highest soil available nitrogen (220.8 kg ha^{-1}), phosphorus (12.07 kg ha^{-1}) and potassium (193.05 kg ha^{-1}) which was 14.3, 11.8, 9.7% higher over the initial soil status, respectively (Chaudhary et al., 2019). INM improved the soil fertility status as compared to STBF and farmers practice.

This result may be attributed due to the application of FYM; in addition to being a store house of almost all the nutrients, required for plant growth, improved the soil environment by way of improving the physico–chemical properties of soil. The availability of most of the plant nutrients increased owing to reduction in pH, and improvement in the cation exchange capacity of the soil. Application of FYM and inorganic fertilizers in conjunction with *Rhizobium* had favourable impact on available N, P and K content in soil aftercrop harvest. The improvement of soil nutrients status with the addition of FYM might be due to the chelating action of organic compounds released during decomposition of manures and prevention of these cations from fixation, precipitation, oxidation and leaching. The grain yield significantly responded to organic nutrients owing to variation in nutrient composition, decomposition of organic residues and nutrient release pattern.These findings are in

Table 2: Effect of integrated nutrient management on yield and soil fertility status of blackgram

Treatments	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)	Available nutrient status (kg ha^{-1})		
				N	P	K
Farmers practice (N:P_2O_5:K_2O 05:25:00 kg ha^{-1})	4.28	7.49	36.38	195.2	11.30	177.0
Soil test based recommended fertilizer dose (STDFR),(N:P_2O_5:K_2O 25:50:40 kg ha^{-1})	5.33	9.14	36.85	205.5	11.68	187.4
75% STBFR+FYM @ 2.0 t ha^{-1} incubated with PSB @ 5 kg ha^{-1}+seed inoculation of Rhizobium culture @ 20 g kg^{-1} of seed+sodium molybdate @ 0.3 g kg^{-1} of seed	6.45	10.87	37.24	220.8	12.07	193.05
SEm±	9.80	0.173	1.05	6.5	0.19	3.2
CD (p= 0.05)	29.1	0.51	3.1	19.3	0.59	9.5

agreements with those of Singh et al. (2011), Sahu et al. (2017), Nagar et al. (2016) and Tyagi and Singh (2019).

3.4. Economics

An analysis on economics (Table 3) revealed that INM recorded higher gross return of ₹ 32787 ha^{-1} with a benefit–cost ratio of 1.67 and additional net return of ₹ 4861 ha^{-1} as compared STBF which gave the net return (₹ 8331 ha^{-1}) and benefit–cost ratio(1.44). INM recorded additional cost, gross return and net return ₹ 2333, ₹ 11009 and ₹ 8677, respectively over farmers practice.

The same treatment also recorded the maximum profitability (₹ 36.14 ha^{-1} day^{-1}) followed by STBF. This could be attributed to higher seed and straw yield coupled with lower cost of production resulted in higher net return and BCR value. These observations were supported by the findings of Singh et al. (2011), Kumawat et al. (2015) and Chaudhary et al. (2016).

Table 3: Effect of integrated nutrient management on economics ofblackgram

Treatments	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	Benefit cost ratio	Profitability (ha^{-1} day^{-1})
Farmers practice (N:P_2O_5:K_2O 05:25:00 kg ha^{-1})	17262	21778	4515	1.26	12.37
Soil test based recommended fertilizer dose (STDFR),(N:P_2O_5:K_2O 25:50:40 kg ha^{-1})	18800	27131	8331	1.44	22.83
75% STBFR+FYM @2.0 t ha^{-1} incubated with PSB @ 5 kg ha^{-1}+seed inoculation of Rhizobium culture @ 20 g kg^{-1} of seed+sodium molybdate @ 0.3 g kg^{-1} of seed	19595	32787	13192	1.67	36.14
SEm±	324	522	595	0.039	1.631
CD (p= 0.05)	964	1552	1769	0.11	4.85

*Sale price of blackgram seed, ₹ 5000 q^{-1} and stover, ₹ 50 q^{-1} for the year 2016–17; 1US$=INR 65.86)

4. CONCLUSION

75% STBFR+FYM @2.0 t ha^{-1} incubated with PSB @ 5 kg ha^{-1}+seed inoculation of *Rhizobium culture* @ 20 g kg^{-1} of seed+sodium molybdate @ 0.3 g kg^{-1} of seed helped for higher crop growth, yield, profitability and soil fertility status of blackgram under mid central table land zone of Odisha.

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