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Effect of integrated nutrient management on growth, yield attributes and yield in blackgram (*Vigna mungo* L.)

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Abstract

A field experiment was conducted on Effect of integrated nutrient management on growth and yield of blackgram (*Vigna mungo* L.) during *Kharif* 2021 at Krishi Vigyan Kendra, Ambikapur. The experiment was laid out in randomized block design replicated thrice with seven nutrient management treatments *viz.* T_1-100% RDF (20:40:20 kg N:P:K ha^{-1}), T_2-100% RDF + Rhizobium + PSB, T_3-75% RDF +Vermicompost @ 1 tonne ha^{-1}, T_4 -75% RDF +Vermicompost @ 1 tonne ha^{-1}+ Rhizobium + PSB, T_5-50% RDF + Vermicompost @ 2 tonnes ha^{-1}, T_6 - 50% RDF + Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB, T_7- Vermicompost @ 2 tonnes ha$_{-1}$ + Rhizobium + PSB. Studies revealed that the growth characters *viz.* plant height, branches plant^{-1}, dry matter accumulation, crop growth rate, yield attributes *viz.* pods plant^{-1}, seeds pod^{-1} and test weight, grain yield and stover yields were influenced significantly by different nutrient management practices. The maximum values of these parameters were recorded under the treatment T_2- 100% RDF + Rhizobium + PSB which was at par with T_4-75% RDF +Vermicompost @ 1 tonne ha^{-1}+ Rhizobium + PSB. However, the application of 100% RDF (20:40:20 kg N:P:K ha^{-1}) also recorded next superior except above two treatments.

Keywords: Integrated nutrient management, vermicompost, seed yield, rhizobium and PSB

Introduction

Blackgram (*Vigna mungo* L.), commonly known as "urd bean", is one of the most popular pulse crop among pulses and grown throughout the country. According to Vavilov (1951) it is originated from India and spread throughout the world, belong to the leguminaceae family. Blackgram is a perfect combination of all nutrients as it contains about 24-26 percent protein, 1.2 per cent fat and 56.6 per cent carbohydrates on dry weight basis and rich source of calcium and iron. Blackgram plays a crucial role to maintaining and improving the soil fertility through its ability to fix atmospheric nitrogen in the soil through root nodules which possesses Rhizobium bacteria. In addition to this, blackgram is a excellent source of forage and it gives a profuse vegetative growth consequently covers the ground to prevent the soil erosion. It is also good for silage making as well as green manuring. Being drought tolerant and warm weather crop, blackgram is well adopted in drier regions, where other legumes do not perform well due to insufficient rainfall. It is also a shade tolerant crop therefore well-suited for intercropping with other crops like maize, millet, sorghum, sugarcane and cotton. The major growing countries are Africa, Myanmar and Thailand. In India, blackgram is grown on 29 lakh ha area with total production of 15.9 lakh tonnes and productivity of 532 kg ha^{-1} (Anonymous, 2015) [2]. In India, larger area of cultivated blackgram is in the states of Madhya Pradesh, Maharashtra, Uttar Pradesh, Rajasthan, Karnataka and Bihar with a production of 18.80 lakh tonnes and productivity of 451.61 kg ha^{-1}. In Chhattisgarh, it occupied approximately 1.44 lakh ha area with 320 kg ha^{-1} productivity (Anonymous, 2018) [3].

It is cultivated mostly on marginal lands in mono/mixed cropping system without any fertilizers under rainfed condition in India as well as in Chhattisgarh and this is the principle constraint that highly responsible for low productivity of the blackgram crop as well as other pulses. In some cases it is notices that farmers grow blackgram without application of fertilizer or use less than recommended dose fertilizers. This improper supply of nutrient negatively affects the yield of blackgram (*Vigna mungo* L.), soil health, and population of microbes and also farmer's outcome. However, application of excessive fertilizer caused declining in nutrient-use efficiency this lead to uneconomical fertilizer consumption and leave adverse effects on atmosphere (Aulakh and Adhya 2005) [4] and groundwater quality (Aulakh *et al.*,

2009) [6] causing health hazards and climate change. On other hand, nutrient mining has occurred in many soils due to lack of affordable fertilizer sources and where fewer or no organic residues are returned to the soils.

Considering all constraints related to pulses especially blackgram can be avoid by numerous ways but integrated nutrient management the easiest, quick and affordable way. Adoption of INM leads to maintain the soil fertility to an optimum level for higher crop production to obtain the maximum profit in unit area (Aulakh and Grant 2008; Sangeeta *et al*., 2014) [5] and is a positive initiation to address the both concerns of nutrient *viz.* excess application and nutrient depletion. INM is the only viable option for those, especially marginal farmers who unable to afford nutrients supply through costly chemical fertilizers (Aulakh *et al*., 2009) [6]. Therefore, INM proved easier way to increase the productivity of crops using inorganic fertilizers along with biofertilizers. Thus, integrated approach of nutrient supply by chemical fertilizers along with biofertilizers is gaining importance as this system not only reduces the use of excessive use of inorganic fertilizers, but also sustaining the crop productivity by improving soil health as well as proved eco-friendly approach for environment and human health. Integration of inorganic fertilizers and biofertilizers resulted in better growth, yield and nutrient uptakes in black gram (Kumpawat, 2010) [14], green gram (Mandal and Pramanick, 2014) [15] and rice (Kumar *et al*., 2014) [11] as compared to sole application of inorganic fertilizers.

Materials and Methods

The experiment was conducted at Krishi Vigyan Kendra, Ajirma, Ambikapur, Chhattisgarh during the *Kharif* season of 2021. Geographically, experimental site is situated at 23˚10' N latitude and 83˚15' E longitudes with an elevation of 623 m above mean sea level. The average annual rainfall of this region is 1254 mm. Larger portion of total rainfall was received during the south west monsoon with little amount of rainfall was received during Oct. to May. The experiment was laid out in randomized block design and replicated thrice consisted of seven treatments *viz.* T_1- 100% RDF (20:40:20 kg N:P:K ha^{-1}), T_2- 100% RDF + Rhizobium + PSB, T_3- 75% RDF + Vermicompost @ 1 tonne ha^{-1}, T_4- 75% RDF + Vermicompost @ 1 tonne ha^{-1} + Rhizobium + PSB, T_5- 50% RDF + Vermicompost @ 2 tonnes ha^{-1}, T_6- 50% RDF + Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB and T_7- Vermicompost @ 2 tonnes ha-1 + Rhizobium + PSB. The blackgram variety "Indira Urd Pratham" was sown on 6th Aug 2021, manually by adopting line sowing method at 30 cm row to row spacing and harvested on 26 Oct 2021. Vermicompost was applied before sowing as per the treatments requirement. Full dose of recommended fertilizer (20: 40: 20; N: P_2O_5: K_2O kg ha^{-1}) was applied as basal dose through N:P:K (12:32:16). Almost dose of recommended nitrogen was applied through N:P:K fertilizer but remains dose was applied through urea. Rhizobium and PSB culture were used seed inoculation.

Results and Discussion

Growth parameters

It is evident from the data that integration of inorganic fertilizer with organic (Vermicompost) and biofertilizers (Rhizobium and PSB) significantly influenced the different growth parameters *viz.* plant height, no. of branches plant^{-1}, dry matter accumulation and crop growth rate of blackgram. Among all nutrient management practices, the highest plant height (52.05 cm), no. of branches plant^{-1} (6.74), dry matter accumulation (10.73 g plant^{-1}) and crop growth rate (0.128 g plant^{-1} day^{-1}) were recorded under 100% RDF + Rhizobium + PSB which was almost at par with 75% RDF + Vermicompost @ 1 tonne ha^{-1} + Rhizobium + PSB. Besides, the application of 100% RDF (20:40:20 kg N:P:K ha^{-1}) also recorded superior over rest of treatments except above two treatments (T_2 and T_4). Conversely, the application of Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB recorded lowest value of plant height (41.19 cm), no. of branches plant^{-1} (4.10), dry matter accumulation (6.72 g plant^{-1}) and crop growth rate (0.071 g plant^{-1} day^{-1})among all nutrient management practices. There are numerous factors that responsible for higher growth parameters under 100% RDF + Rhizobium + PSB but possibly this might be due to application of 100% RDF which provide rapid availability of nutrient to the plants as well as application of bio-fertilizer *viz.* Rhizobium and PSB also helped to sustain availability of inorganic and organic nutrient for longer time resulted plants absorbed nutrient in sufficient amount from the soil and grow well and attained higher growth parameters. Similar results were also reported by Divyavani *et al.,* 2020 [7]: Beniwal and Tomar 2019.

Yield attributes

A perusal data regarding yield attributes *viz*. no. of pod plant^{-1}, no. of seeds pod^{-1} and test weight are presented in the Table 2 and graphically depicted through the Fig 2. clearly shows that all yield attributes were significantly deviated by various nutrient management practices except test weight. Thus the significantly highest no. of pods plant^{-1} (29.01) and no. of seeds pod^{-1} (7.07) were recorded under the application of 100% RDF + Rhizobium + PSB which was being comparable with 75% RDF + Vermicompost @ 1 tonne ha^{-1} + Rhizobium + PSB. On contrary, the lowest no. of pods plant^{-1} (22.51) and no. of seeds pod^{-1}(5.05) were recorded under Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB. Data regarding test weight was found non-significant with respect to all nutrient management practices. Although the highest test weight (42.36 g) was recorded under the application of Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB which was closely followed by 50% RDF + Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB (42.13 g). Whereas the lowest test weight (40.30 g) was recorded under 100% RDF (20:40:20 kg N:P:K ha^{-1}). No. of pods plant^{-1} and no. of seeds pod^{-1} depends on the no. of flowering buds plant^{-1}, no. of branches plant^{-1} and no. of flowers and its retention and proper fertilization. All these parameters highly attained by plant only in single condition when plant uptake more nutrient from the soil which facilitate to initiate more flowering buds, higher no. of flower plant^{-1} and proper fertilization, which ultimately leads to better retention yield attributes. Another side, the reason behind the higher test weight under Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB possibly may be due to inferior yield attributes consequently plant assimilates more photosynthates in only rare sink (seeds) thus seed become larger in size and this phenomena directly affect the test weight. Similar results were also confirmed by Tyagi and Singh 2019 [20]; Khan *et al*., 2017 [10].

Seed yield (q ha^{-1})

Data regarding seed yield presented in the Table 2 and graphically depicted through the Fig 3. Various integrated nutrient management practices exerted significant variation in yield. It is clearly evident from the data that the significantly highest seed yield (10.50 q ha^{-1}) was obtained under 100% RDF + Rhizobium + PSB which was statistically at par with 75% RDF +Vermicompost @ 1 tonne ha^{-1}+ Rhizobium + PSB (9.62 q ha^{-1}). Whereas, significantly lowest seed yield (6.11 q ha^{-1}) was obtained under Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB. Increases in seed yield possibly may be due to increases in fertility level, increasing fertility level was achieved by balance application of nutrient which leads to encourage the growth of crop and optimum utilization of soil moisture and other resources resulted better development of the yield attributes like more no. of pods plant^{-1}, effective no. of pods plant^{-1}, more no. of seeds pod^{-1}, larger seeds. Moreover the improvement in yield attributes and consequent to higher yield might possibly be due to the enhanced synthesis of photosynthates and their transport to the sink through efficient physiological activities in plants. In addition to this, higher seed yield may be due to greater synthesis of photosynthates and efficient partitioning of dry matter into the economic portion (seed). This finding also confirmed by Kumar *et al.*, 2016 [12] and Shekhawat *et al*., 2021.

Stover yield (q ha^{-1})

Data to stover yield presented in the Table 2 and graphically depicted through the Fig 3. Stover yield is a total of dry matter production of crop excluding seed yield during its life span. Application of different fertilizer doses along with manures and bio-fertilizer significantly affected the stover yield, maximum (24.47 q ha^{-1}) being obtained under the treatment 100% RDF + Rhizobium + PSB which was comparable with 75% RDF + Vermicompost @ 1 Tonne ha^{-1}+ Rhizobium + PSB (22.51 q ha^{-1}). Whereas, significantly lowest stover yield (17.36 q ha^{-1}) was obtained with the application of Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB. The increase in stover yield is due to increase in plant height and dry matter production at higher nutrient levels. The presence of adequate amount of major nutrients in the soil might have enabled the plant to fix nitrogen from the atmosphere in nodules which encourage the plants growth and its development, which is the possibly accountable for increased stover yield. In addition to this, increase in straw yield might have attributed to the higher photosynthetic activity in urd bean plant leading to a better supply of carbohydrates resulted in more number of branches and dry matter. All the parameters related to growth and yield attributing characters directly and indirectly contribute to encourage stover yield. Similar finding also reported by Shekhawat *et al*., 2021.

Harvest index (%): Harvest index is a correlated, computed parameters and measure of physiological productivity potential of crop. It indicates the ability of a plant to convert the dry matter into economic yield (seed). Being computed parameters it is also varied according to seed yield and stover yield. The significantly higher harvest index (30.02%) was recorded under 100% RDF + Rhizobium + PSB which was closely at par with 75% RDF +Vermicompost @ 1 tonne ha^{-1}+ Rhizobium + PSB (29.94%). Whereas, the application 100% RDF (20:40:20 kg N:P:K ha^{-1}) (29.73%) and 75% RDF +Vermicompost @ 1 tonne ha^{-1} (29.13%) were closely related to 100% RDF + Rhizobium + PSB with little difference and both were recorded comparable with each other. Application of 100% RDF + Rhizobium + PSB improve the overall fertility status of the soil resulted crop grow well and having vigorous plant growth might have produced more photosynthates as well efficient partitioning of accumulated photosynthates eventually enhanced yield attributes which ultimately increased the seed yield and once yield attributes increases consequently harvest index increases. This finding also supported by Kumar *et al.*, 2016 [12].

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

Treatment	Plant height(cm)	No. of branches plant^{-1}	Dry matter accumulation (g plant^{-1})	Crop growth rate (g plant^{-1} day^{-1})
T_1 -100% RDF (20:40:20 kg N:P:K ha^{-1})	46.77	5.57	9.45	0.108
T_2 -100% RDF + Rhizobium + PSB	52.05	6.74	10.73	0.128
T_3 -75% RDF +Vermicompost @ 1 tonne ha^{-1}	44.92	5.07	8.01	0.102
T_4 -75% RDF +Vermicompost @ 1 tonne ha^{-1} + Rhizobium + PSB	49.24	6.12	10.33	0.118
T_5 - 50% RDF + Vermicompost @ 2 tonnes ha^{-1}	42.03	4.80	7.25	0.073
T_6 - 50% RDF + Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB	43.75	5.02	7.56	0.082
T_7 - Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB	41.19	4.10	6.72	0.071
S.Em±	1.24	0.25	0.60	0.017
CD(p=0.05)	3.82	0.78	1.85	0.037

Table 2: Effect of integrated nutrient management on yield attributes, yields and harvest index.

Treatment	No. of pod plant^{-1}	No. of seeds pod^{-1}	Test weight (g)	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
T_1 -100% RDF (20:40:20 kg N:P:K ha^{-1})	26.05	6.23	40.30	8.90	21.03	29.73
T_2 -100% RDF + Rhizobium + PSB	29.01	7.07	41.67	10.50	24.47	30.02
T_3 -75% RDF +Vermicompost @ 1 tonne ha^{-1}	25.89	6.04	41.07	8.07	19.63	29.13
T_4 -75% RDF +Vermicompost @ 1 tonne ha^{-1}+ Rhizobium + PSB	26.44	6.68	41.83	9.62	22.51	29.94
T_5 - 50% RDF + Vermicompost @ 2 tonnes ha^{-1}	24.01	5.73	41.50	6.69	18.46	26.60
T_6 - 50% RDF +Vermicompost @ 2 tonnes ha^{-1}+ Rhizobium + PSB	25.01	5.94	42.13	7.47	19.06	28.15
T_7 - Vermicompost @ 2 tonnes ha^{-1} + Rhizobium + PSB	22.51	5.05	42.36	6.11	17.63	25.73
S.Em±	1.00	0.34	0.55	0.55	1.32	0.27
CD(p=0.05)	2.8	1.05	NS	1.68	4.07	0.83

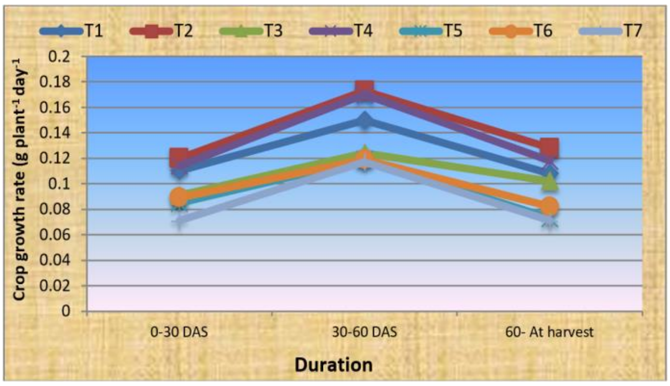

Fig 1: Crop growth rate as influenced by different integrated nutrient management practices.

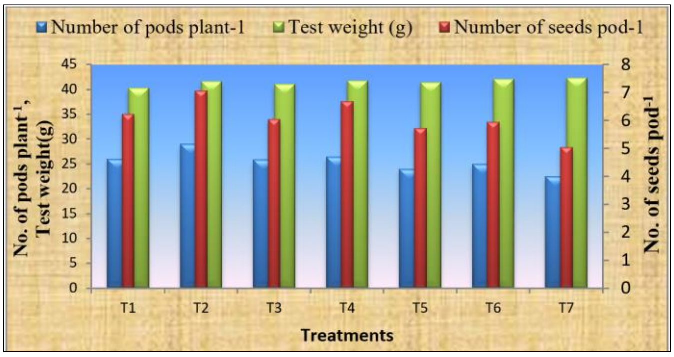

Fig 2: No. of pods plant^{-1}, No. of seeds pods^{-1} and Test weight (g) of blackgram as influenced by different integrated nutrient management practices.

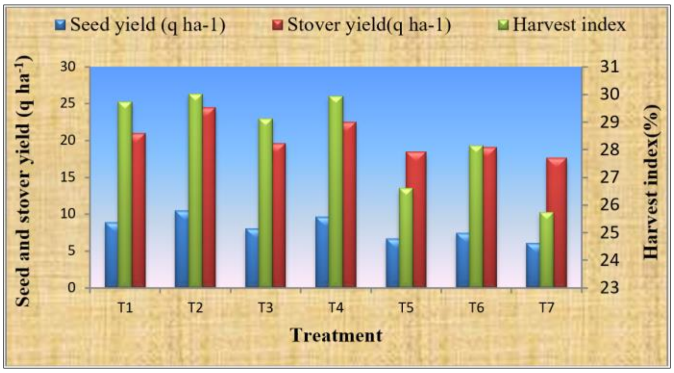

Fig 3: Seed, stover yields (q ha^{-1}) and harvest index (%) of blackgram as influenced by different integrated nutrient management practices.

Conclusion

Based on the results narrated above, it may be concluded that the application 100% RDF + Rhizobium + PSB which was on par with 75% RDF +Vermicompost @ 1 tonne ha^{-1}+ Rhizobium + PSB both are an suitable and advisable nutrient management practices for better growth parameters as well excellent yield attributes and for getting higher seed yield.

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