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Effect of Integrated Nutrient Management on Yield Attributes and Yield of Black Gram Cv. Pu-31

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ABSTRACT

Background: The main pulses grown in India are chickpea, arhar, lentil, black gram, mung bean, moth bean, horse gram, pea, khesari, cowpea, *etc*. Black gram is fourth major pulse crop in India, that contributes 13 and 10 per cent of total area and production respectively. This is annual plant that attains 30-100 cm height and its stem is covered with brown hairs and much branched from the base. The pods are long and cylindrical being 5-6 cm length and 4-10 seed in pods. The seeds are generally black, very dark brown.

Methods: The field experiment was conducted in *kharif*-2019 at research farm of Tirhut College of Agriculture Dholi, to study the effect of integrated nutrient management on growth, yield parameters and the yield of black gram cv-PU-31, by the use different sources of nutrient in a integrated manner such as three level of fertilizer *i.e.* F_1-75, F_2-100 and F_3-125% RDF and two levels of organic manure *i.e.* M_1-control and M_2-FYM @ 5 t ha^{-1} and three levels of biofertilizer *i.e.,* B_1-rhizobium, B_2-nutrient mobilizer, B_3-rhizobium+ nutrient mobilizer. The treatments were allocated in randomized block design (factorial) and replicated thrice.

Result: The results revealed that F_3 produced taller plants, more dry matter, crop growth rate (CGR) yield attributes resulting higher yield of grain and straw (10.78, 22.61 q ha^{-1} respectively) which was statistically at par with plant height, dry matter, crop growth rate, yield attributes and yield of grain, straw and highest harvest index (10.73, 22.20 q ha^{-1} and 32.58% respectively) to F_2. Among addition of organic manure significantly maximum plant height, dry matter and crop growth rate and yield attributes resulting maximum yield of grain, straw and harvest index (11.2, 22.79 q ha^{-1} and 33.31% respectively) was found in M_2 over M_1. In biofertilizer treatments, B_3 recorded higher plant height, dry matter and crop growth rate, yield attributes resulting in significantly higher yield of grain, straw and harvest index (10.26, 21.90 q ha^{-1} and 31.92% respectively) over B_1 and B_2.

Key words: Blackgram, Growth, Integrated nutrient management, Nutrient mobilizer, Yield.

INTRODUCTION

The middle east is considered to be a picture of early home of human civilization where evidence of pulses came in the fertile crescent 11000 year ago. “Pulse” is a derivative of the Latin words puls or pultis, which means “thick soup”. Pulse crop are an important member of the legume family, with over 1800 different species. The rapid increase in the world population is a challenge for agricultural experts to supply food for survival as well as to conserve natural resources. To avoid this challenge, we need to conserve natural resources so that natural resources maintain their productivity. India records the first place in pulses area and production in the world but due to the large population of India, the availability of per capita pulses is not being fulfilled which is 51.3 g day^{-1} (Directorate of Economics and Statistics). To meet this deficiency, it is very important for India to increase pulses production. Pulses are given second importance after cereals. The pulses crop are rich in protein, fiber, vitamins and minerals such as magnesium, iron, zinc and low in fat, making them a great addition to any diet that play very important role in the diet of humans specially in Indian people who are not able to supply their body protein being mostly vegetarian. Therefore, pulses are an important tool to eliminate hunger and nutritional deficiency as pulse crops contain many times more protein than cereal crops. Pulse crops also play a vital role in health of soil due to association with rhizobium bacteria and fixing atmospheric nitrogen in the soil and enhancing soil fertility. The main pulse crops grown in India include chickpea, arhar, lentil, urd bean, mung bean, moth bean, horse gram, pea, khesari, cowpea, *etc*. black gram belongs to the leguminoseae family and subfamily Papilionaceae and India is the origin place of black gram which is highly valued pulse crop that cultivated since ancient time (Vavilov,1951). Black gram is known by different names in their regional languages in different regions of India like Urd and Urdi in Hindi, Marathi, Gujarati, Maskalai in Bengali, Ulathamparuppu in Tamil, Manipappu in Telugu, Udri in Kannada and Uzhummu in

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Malayalam *etc*. Black gram is sown several cropping system as sequential, mixed, catch and sole crop. Black gram is a perfect integration of all the nutrients as it includes protein (24%), carbohydrate (60%), fat (1.3%), minerals, vitamins and it is 5-10 times richer than other pulses in phosphoric acid (P_2O_5) Gangaiah *et al.* (2008).

MATERIALS AND METHODS

The field trial was conducted during the *kharif*-2019 on the research farm of TCA Dholi at the Dr. Rajendra Prasad Central Agricultural University, Pusa campus in Samastipur (Bihar). The experiment has eighteen treatment combinations, comprising three nutrient management practices *i.e.,* fertilizer (75%, 100% and 125% RDF), organic manure (control and FYM@ 5 t ha^{-1}) and biofertilizer (rhizobium, nutrient mobilizer and rhizobium + nutrient mobilizer). The experiment was laid out in factorial randomized block design with three replications. The variety of Black gram "pant urd-31" was sown in last week of July with a spacing of 30 cm × 10 cm and seed rate of 20 kg ha^{-1}. The soil of the experimental plot was calcareous in nature having pH of 8.15 and EC at 0.37 dSm^{-1}. The soil was moderately fertile being medium in Organic carbon (0.43), available nitrogen (175.6 kg ha^{-1}), phosphorus (18.4 kg ha^{-1}) and potassium (124.17 kg ha^{-1}). The recommended doses of fertilizer (RDF) of black gram was 20:45:20 kg NPK ha^{-1} respectively. The amount of manure and fertilizer are calculated according to the treatment details and applied sowing time. Fertilizer was applied in lines 7-10 cm away from the main lines of the seed in the form of urea (46%), SSP (16% P_2O_5) and muriate of potash (60% K_2O) and organic manure through farm yard manure were applied at sowing time as per treatment details and Biofertilizer (*viz.*, Rhizobium, Nutrient Mobilizer and Rhizobium + Nutrient Mobilizer) was applied as seed treatment. The monsoon usually begins in the third or fourth week of June and last until September. During the period, a total of 719.4 mm of rainfall was received. The average maximum and minimum temperatures were 31.50°C and 25.27°C. The average maximum and minimum relative humidity was recorded 97.38% and 82.24%, respectively. For observation of crop, five selected plants were tagged for further identification and were monitored for growth and yield parameters. The results were analyzed as per statistically standardized principle of ANOVA technique described by Gomez and Gomez (1984) at 5% level of significance.

RESULTS AND DISCUSSION

The results show that balancing use of nutrition in black gram with various sources (*i.e.* fertilizer, manure and Biofertilizer) effectively improves the yield (Fig 1 and Table 3) of black gram with various yield attributes (Table 2) and growth parameters (Table 1).

Effect of fertilizer

The significant difference was not observed at 20 DAS in the growth of crop of the black gram. With application of fertilizer, significantly higher plant height (48.54 cm), number of branches $plant^{-1}$(4.49), dry weight $plant^{-1}$ (9.71 g), crop growth rate (13.57 g day^{-1} m^2) were observed in F_3-125% RDF at 60 DAS respectively. But statistically at par plant height (46.42 cm), number of branches $plant^{-1}$(3.75), dry weight $plant^{-1}$ (8.81 g), crop growth rate (12.65 g day^1 m^2) were found in F_2-100% RDF. The higher growth indices were due to the better nutrients availability at the critical stage which facilitates better nutrient transfer and accumulation of dry matter. These findings are in line with Mere *et al.* (2013). Application of fertilizer F_3-125% RDF gave significantly higher yield attributes such as pod $plant^{-1}$ (34.99), grain pod^{-1} (5.53), length of pod (4.39 cm), test weight (40.22g) over 100% RDF while at par pod $plant^{-1}$ (33.35), grain pod^{-1} (5.35) and length of pod (4.11 cm). Higher yield parameters may be due to higher levels of inorganic fertilizers increasing efficiency of photosynthesis and activity of enzymes responsible for energy transformation. Kumar *et al.* (2014) also found similar results in there experimentation. Grain yield is main and more important than total biological retention which has resulted in different combination of many physiological processes depending on the environment in which it was grown. Final value of yield of many plant species comes from the source-sink ratio and the various components of the sink such as the pods

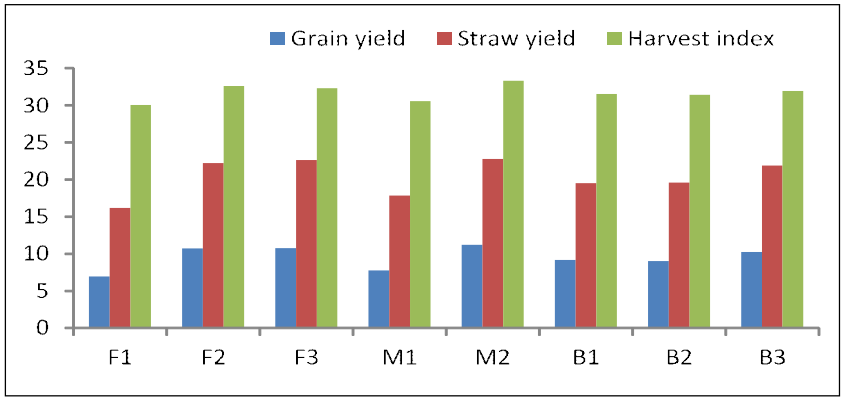

Fig 1: Grain yield, straw yield and harvest index of black gram as influenced by integrated nutrient management.

plant^{-1}, seeds pod^{-1} and test weight. Source component can be the assimilation reserve of leaves before flowering. The accumulate and translocate of photosynthates' depends on the efficient photosynthetic structure and source-sinking condition growth and development in early stages of crop production as the final yield depends on all components of the source and sink operating in different phenophase of growth during the plant life cycle. The increasing availability of important nutrients to plants leads to increased early root growth and cell proliferation, leading to greater absorption of other nutrients from deeper layers of soil and ultimately increased growth parameters, straw yield, grain yield biological yield and harvest index. (Dhaka *et al.* 2016). In the present study black gram grain and straw yield significantly influenced with treatments due to different inorganic fertilizer. Grain and straw yield (10.78 and 22.61 q ha^{-1} respectively) were significantly higher using 125% RDF and was on par with grain yield (10.73 q ha^{-1}) and straw yield (22.20 q ha^{-1}) with 100% RDF. This may be due to the higher yield attributes occurred and supported to produce higher yield under this treatment. Similar result found Mere *et al*. (2013) in soyabean and Kumar *et al.* (2014) in rice.

Effect of organic manure

Integrated nutrient management ensures high productivity of crop, minimize fertilizer costs, improves the physical properties of soil with efficiency of added nutrients as well as ensuring good soil health and an environmental friendly approach. Although Organic manures play a crucial role in the long term depletion of nutrients through the plants while inorganic pose a greater threat to sustainability therefore turn to enhanced use of organic manure which is necessary to sustain the yields or quality of produce of crop. The use of the organic manure alone does not result in spectacular increase in yield. Therefore, the aforementioned conclusion facilitated the cultivation of black gram using organic and inorganic fertilizers with integration. The current general recommendation on fertilizers does not ensure the efficient and economical use of nutrients (Singh, 2018). The significant effect was not observed at 20 DAS in the growth of crop of the black gram with application of manure but at 60 DAS significantly maximum plant height (47.51 cm), number of branches (4.11), dry matter (9.39 g plant^{-1}) and CGR (13.21 g day^{-1}m^{2}) in M_2- FYM @ 5 tons ha^{-1} treatment were registered as compared to M_1- control (no application of FYM). Increase growth at different phase of crop may be supply of nutrients from FYM and that manure provides nutrition to plants for longer duration compared to without FYM application. The combined and balanced nutrition of primary, secondary and trace elements from source of organic manure with improvement of the physiological efficiency therefore efficient absorption, translocation and assimilate of nutrients results increasing plant dry matter accumulation and nutrient content. The positive effects of FYM on growth may be the supplementary supply of plant nutrients and enhanced fertility status of the soil (Datt *et al.,* 2003). The organic manure significantly increased the number of pod plant^{-1} (33.99), grain pod^{-1} (5.50), length of pod (4.39) and test weight (40.19 g) with M_2- FYM @ 5 tons ha^{-1} treatment over M_1- control. Higher yield attributes can be proposed when application of manure because the beneficial effect of manure ensure a better nutrients balance when using useful source of nutrition during crop production organic manure contributes the growth of the rhizosphere microorganism and results in better plant productivity. As a result significantly maximum grains yield (11.2 q ha^{-1}) and straw yield (22.79 q ha^{-1}) was recorded under FYM @ 5 tons ha^{-1}. The amount of inorganic fertilizer can be reduced up to 75% by using organic manure without significant affecting of

Table 1: Effect of fertilizers, organic manures and biofertilizers on growth parameters of black gram cv PU-31.

Treatment	Plant height		Number of branches		Dry matter		Crop growth rate	
	20 DAS	60 DAS	20 DAS	60 DAS	20 DAS	60 DAS	20 DAS	60 DAS
A. Fertilizer dose								
F_1 (75% RDF)	10.27	42.9	1.07	3.52	1.4	8.17	2.35	11.38
F_2 (100% RDF)	10.83	46.42	1.11	3.75	1.4	8.81	2.35	12.65
F_3 (125% RDF)	11.16	48.54	1.16	4.49	1.56	9.71	2.60	13.57
SE(m)±	0.24	0.98	0.02	0.16	0.05	0.18	0.09	0.32
CD.(P=0.05)	NS	2.82	NS	0.43	NS	0.52	NS	0.93
B. Farm yard manure (t ha^{-1})								
M_1 (Control)	10.65	44.4	1.10	3.74	1.46	8.40	2.43	11.65
M_2 (FYM @ 5 t ha^{-1})	10.85	47.51	1.12	4.11	1.47	9.39	2.44	13.21
SE(m)±	0.2	0.8	0.02	0.12	0.04	0.15	0.07	0.26
CD.(P=0.05)	NS	2.30	NS	0.35	NS	0.43	NS	0.76
C. Biofertilizer								
B_1 (Rhizobium)	10.6	44.53	1.12	3.73	1.44	8.60	2.41	11.92
B_2 (Nutrient mobilizer)	10.81	44.37	1.08	3.77	1.44	8.60	2.38	11.89
B_3 (Rhizobium + B_2)	10.85	48.96	1.13	4.26	1.51	9.59	2.52	13.48
SE(m)±	0.24	0.98	0.02	0.16	0.05	0.18	0.09	0.32
CD (P=0.05)	NS	2.82	NS	0.43	NS	0.52	NS	0.93

seed yield (Kumar *et al*. 2016). The yield of crop is in fact the cumulative results of vegetative growth and yield attributes and these are increased by the better supply of nutrients with the FYM treatment which attributed to better nutrient availability, vegetative growth, nutrient transformation and dry matter accumulation during the reproductive phase ultimately in turn improved yield parameters thus increased final grain and straw yield (Sharma *et al.* 2003 and Singh *et al.* 2009).

Effect of biofertilizer

Use of biofertilizers in crop production is cost effective and cheap source of nutrients supply. Most useful and effective for leguminous crop. Legume crops are able to fix atmospheric N through rhizobium bacteria present in the nodules of their roots through the process of symbiosis. The effectiveness of symbiosis depends on the rhizobium strain, the host plant and is influenced by a number of soil and environmental factors (Vincent, 1970). The significantly higher growth parameters was found with B_3- Rhizobium + nutrient mobilizer due to occurrence of rhizobium bacteria a nitrogen fixer microbe and another nutrient solubilizers which solubilised the unavailable nutrient into available form of nutrients. Hence B_3 recorded significantly higher crop growth attributes of black gram crop and also attributed to optimum uptake of N and P. Inoculation of seed with biofertilizer found no significant effect on growth parameters at 20 DAS, while at 60 DAS significantly higher plant height (48.96 cm), number of branches (4.26), dry matter

Table 2: Effect of fertilizers, organic manures and biofertilizers on yield attributes of black gram cv PU-31.

Treatment	Pods plant^{-1}	Pod length (cm)	Grains pod^{-1}	Test weight (gm)
A. Fertilizer dose				
F_1 (75% RDF)	30.56	3.86	4.79	40.11
F_2 (100% RDF)	33.35	4.12	5.35	40.16
F_3 (125% RDF)	34.99	4.39	5.53	40.22
SE(m)±	0.70	0.10	0.13	0.10
CD.(P=0.05)	2.01	0.28	0.39	NS
B. Farm yard manure (t ha^{-1})				
M_1 (Control)	31.95	3.86	4.95	40.15
M_2 (FYM @ 5 t ha^{-1})	33.99	4.39	5.50	40.19
SE(m)±	0.57	0.08	0.11	0.085
CD.(P=0.05)	1.64	0.23	0.32	NS
C. Biofertilizer				
B_1 (Rhizobium)	31.67	3.94	5.08	40.16
B_2 (Nutrient mobilizer)	31.64	3.95	5.07	40.11
B_3 (Rhizobium + B_2)	35.61	4.48	5.53	40.22
SE(m)±	0.7	0.10	0.13	0.10
CD.(P=0.05)	2.01	0.28	0.39	NS

Table 3: Effect of fertilizers, organic manures and biofertilizers on straw yield, grain yield and harvest index of black gram cv PU-31.

Treatment	Grain yield	Straw yield	Harvest index
A. Fertilizer dose			
F_1 (75% RDF)	6.94	16.16	30.04
F_2 (100% RDF)	10.73	22.20	32.58
F_3 (125% RDF)	10.78	22.61	32.28
SE(m)±	0.29	0.46	0.74
CD.(P=0.05)	0.85	1.34	2.14
B. Farm yard manure (t ha^{-1})			
M_1 (Control)	7.77	17.85	30.57
M_2 (FYM @ 5 t ha^{-1})	11.2	22.79	33.31
SE(m)±	0.24	0.38	0.60
CD.(P=0.05)	0.69	1.09	1.74
C. Biofertilizer			
B_1 (Rhizobium)	9.17	19.5	31.50
B_2 (Nutrient mobilizer)	9.03	19.57	31.41
B_3 (Rhizobium + B_2)	10.26	21.90	31.92
SE(m)±	0.29	0.46	0.74
CD.(P=0.05)	0.85	1.34	2.14

(9.59 g plant^{-1}) and CGR (13.48 g day^{-1}m^{2}) were recorded with B_3- Rhizobium + nutrient mobilizer inoculation treatment and minimum growth attributes was recorded in B_2- nutrient mobilizer treatment and B_1- rhizobium treatment. Nitrogen and phosphate are essential component of all living matters including amino acid, protein, nucleotides and chlorophyll. Combined inoculation of rhizobium + nutrient mobilizer showed higher growth parameters due to synergistic effect. These findings are similar with previous reports of (Gupta *et al.* 2003). Application of rhizobium + nutrient mobilizer inoculation significantly increased the yield indices such as pod plant^{-1} (35.61), grain pod^{-1} (5.53), length of pod (4.48) and test weight (40.22) over only inoculate rhizobium or nutrient mobilizer alone. A similar response was also found for plant biomass and grain yield. Simultaneously higher grain yield (10.26 q ha^{-1}) and straw yield (21.90 q ha^{-1}) was obtained by B_3- Rhizobium + nutrient mobilizer treatment which was superior over other biofertilizer treatment. Increased nitrogen fixation and production of secondary metabolites by bacteria support plants for efficient energy conversion and more dry matter accumulation; these results were also approved by (Thakur *et al.* 1999 and Negi *et al.* 2007) Interactions: The interaction effect between fertilizer, manure and Biofertilizer was observed non significant at 20 and 60 DAS.

CONCLUSION

Under this experimentation it was concluded that application of NPK @125% RDF (25:56:25 kg ha^{-1}) + FYM @ 5 tons ha^{-1} + Rhizobium + nutrient mobilizer treatment gave maximum growth and yield parameters and yield, but statistically at par growth and yield parameters and yield found in F_2- 100 % RDF (20:45:20 kg ha^{-1})+ FYM@ 5 tons ha^{-1} + Rhizobium + nutrient mobilizer which was found effective for cultivation of black gram with maximum yield for sustainable and economically effective. That as a result of the combined action of organic and inorganic sources of nutrient the improvement in the physical efficiency of various macro and micro nutrients produces high quality and quantity of crops under scrutiny.

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