Original Research Article

Performance ofdifferent graded dose of fertilizer on growth, yield and quality of Black gramvarieties (*Vigna mungo* L.)

Abstract

A study was conducted during the *kharif* season of 2022 at the Research plot, Department of Agronomy, AKS University, Madhya Pradesh to investigate the impact of graded doses of fertilizers*viz*., Control (F_0), NPK @ 18:18:18 kg ha^{-1} (F_1), NPK @ 19:19:19 kg ha^{-1}(F_2), and NPK @ 20:20:20kgha^{-1}(F_3) and three varieties*i.e*.,IPU-2-43 (V_1), PU-31 (V_2), Indira-1 (V_3) on black gram.The experimental design employed was a Randomized Complete Block Design, with the 12 treatment combinations replicated three times.Results revealed that treatment F_3(NPK @ 20:20:20kgha^{-1}) significantly enhanced plant height (40.73 cm), number of branches per plant (4.49), number of leaves per plant (27.09) and number of root nodules (30.89). This grade also resulted in maximum yield attributes such as the number of pods per plant (22.00), grains per pod (4.89), test weight (36.98 g), grain (9.31 q/ha) and stover yield (18.10 q/ha). Additionally, the highest protein content (21.71 %) in black gram grain was observed with the application of F_3(NPK @ 20:20:20kgha^{-1}).Regarding varieties, Indira-1 displayed superior growth parameters and yield-contributing characters compared to IPU-2-43 and PU-31. Notably, Indira-1 exhibited higher protein content in seeds.The results suggest that the application of NPK @ 20:20:20 kgha^{-1} and cultivation of the Indira-1 variety hold promise for enhancing black gram productivity.

Keywords: Black gram, fertilizer grade, urd, varieties

1. Introduction

Black gram (*Vigna mungo* L.) plays a crucial role in preserving and enhancing soil fertility by harnessing atmospheric nitrogen through root nodules containing Rhizobium bacteria. With a composition of 60% carbohydrates, 24% proteins, and 1.3% fats, it stands out for its phosphorus richness, surpassing other pulses by 5-10 times [1]. The suboptimal productivity of black gram can be attributed to factors such as inadequate fertility management and the cultivation of outdated traditional varieties, both contributing

significantly to diminished yields. In 2018-19, pulse cultivation covered 29.03 million hectares, yielding 23.40 million tonnes at a rate of 806 kg/ha [2]. In Madhya Pradesh, black gram is cultivated across 1788.80 thousand ha, producing 1744.35 thousand MT with a productivity of 975 kg/ha.

Among various cultivation practices, fertility management emerges as a crucial agronomic aspect for elevating crop yield and sustaining soil fertility. Nitrogen fertilizer, essential for enhancing soil fertility and crop productivity, boosts grain yield and biomass. This vital nutrient plays a pivotal role in the growth, development, and protein content of pulses [3]. The scarcity of phosphorus poses a significant challenge in realizing the maximum yield potential [4]. Phosphorus influences root growth, nodulation, energy storage, and transport. It is a crucial component of nucleic acids and several enzymes which are crucial for energy conversion in carbohydrate metabolism and plant respiration.[5] while working on green gram revealed that the application of 100% RDF augmented the growth characteristics *viz*., plant height, number of branches plant^{-1}, number of nodules plant^{-1} and dry matter accumulation. [6] also highlighted that seed yield (945 kg ha^{-1}) and stover yield (1900 kg ha^{-1}) were higher when the recommended level of fertilizers was incorporated in the soil.

Modern varieties of black gram generally exhibit higher grain yields, with yield components significantly influenced by fertilizer levels. However, farmers often cultivate black gram without optimal fertilizer doses, hesitating to adopt higher amounts. Utilizing new varieties with the appropriate fertilizer dosage has the potential to increase yields. Variations in yield-related parameters persist among varieties from different parental origins, with these characteristics being genetically controlled. Despite the availability of various black gram varieties, information regarding their suitability for cultivation in diverse altitudinal ranges is lacking.[7] briefed that yield and yield attributes were significantly influenced by different cultivars of black gram. The variety PU-31 proved to be better as it registered maximum plant height, dry weight, number of pods per plant, number of seeds per pod, test weight, seed yield, haulm yield and harvest index.

The cultivation aspects of black gram, especially in the Vindhya region, have been relatively underexplored. There exists a potential to significantly influence productivity per unit area through the judicious application of fertilizers and the selection of suitable varieties. Consequently, the present study was undertaken to assess the performance of graded doses of fertilizers and varieties on growth, yield and quality of black gram.

2. Materials and Methods

2.1. Location

During the *kharif* season of 2022, an experiment was conducted at the Research plot, Department of Agronomy, AKS University, Satna M.P. which is located in the north-eastern part of Madhya Pradesh the latitude of $23^0$58' to $25^0$12' N and longitude of $80^0$21' to $81^0$23' east in Rewa division of M.P.

2.2. Physicochemical properties of experimental soil

The soil of the experimental sitewas clay loam in texture andhad a pH (7.30) and an electrical conductivity of 0.18dS m^{-1}. The soil had a low organic carbon content (0.45 %) and contained only 178.2 kg ha^{-1} of available nitrogen, 14.4 kg ha^{-1} of available phosphorus and 196.0 kg ha^{-1} of available potassium.

2.3 Experimental design

The experimental design employed was a Randomized Complete Block Design, with the 12 treatment combinations repeated three times.The treatment combinations applied in the experiment were drawn from four graded doses of fertilizers *i.e.*, Control (F_0), NPK @ 18:18:18 kg ha^{-1}(F_1), NPK @ 19:19:19 kg ha^{-1}(F_2), and NPK @ 20:20:20 kg ha^{-1}(F_3) and three varieties *viz.*, IPU-2-43 (V_1), PU-31 (V_2), Indira-1 (V_3).Seeds @ 20 kg ha^{-1} were used for sowing. The sowing was done on furrows with a spacing of 30 × 10 cm.The fertilizer application was done as per the treatments.The grossplot size was 15 $m^2$and the gross experimental area was 801 m^2.The sowing took place on July 21, 2022. Thinning was performed at 20 DAS when plants attained a height of 10 cm.

2.4 Parameter observation

Five plants were randomly chosen from each net plot and specifically identified for biometric observations throughout various growth stages. These plants were individually harvested to facilitate comprehensive post-harvest studiessuch as the number of pods per plant, number of seeds per pod, test weight (g), grain yield (q ha^{-1}), stover yield (q ha^{-1}) and harvest index (%). A random sample was taken from the grain yield of each plot and brought to the laboratory for estimation of protein content in the seeds.

2.5 Data analysis

The analytical approach employed involved the use of analysis of variance to assess the significance of the experimental outcomes. In instances where the F-test yielded significance at a 5% level, the critical difference (C.D.) for treatment means was calculated.

3 Results and Discussion

3.1 Effect of different fertilizer grades

A perusal of the data in Table 1 and Fig. 1 manifests thatapplication of F_3(NPK @ 20: 20: 20 kg ha^{-1}) recorded significantly higher values for plant height (40.73 cm), number of branches per plant (4.49), number of leaves per plant (27.09) and root nodules per plant (30.89) followed by F_2 (NPK @ 19: 19: 19kgha^{-1}). While values for these parameters were lowest in Control (F_0).This increase in plant growth of black gram might be due to better availability of nutrients throughout the crop growth stages, where the chemical fertilizer supplied the NPK at the initial growth stages of the crop and later stages of nutrients. The number of branches and trifoliate leaves per plant is an important indicator of the total source available to the plant for photosynthesis production. This could be attributed to an augmented provision of multi-nutrients, complemented by exceptionally favourable conditions concerning the physicochemical and biological attributes of the soil. These results also corroborate the findings of Sekhar *et al*. (2020) [8] and Sahu *et al*. (2022) [9].

The application of F_3(NPK @ 20: 20: 20 kg ha^{-1}) resulted insignificant maximum yield attributing parameters *viz*., number of pods per plant (22.00), number of grains per pod (4.89), test weight (36.98 g), grain yield (9.31 q/ha), stover yield (18.10 q/ha) and harvest index (33.55 %) followed by F_2(NPK @ 19: 19: 19 kg ha^{-1}). While values for these parameters were lowest in Control (F_0). The superior yield attributes and overall productivity observed in this treatment can be attributed to heightened growth parameters resulting from an enhanced supply of essential plant nutrients. Nitrogen facilitates vegetative growth, phosphorus enhances both root development and flowering, and potassium supports various physiological processes. When these essential nutrients are supplied in sufficient quantities, they lead to enhanced growth and improved yield attributes. The adequate availability of these nutrients likely plays a role in the increased accumulation of carbohydrates and their efficient translocation from source to sink, particularly reproductive organs. As a result of this mechanism, there is a substantial increase in various yield-attributing parameters. These results pertain in close agreement with numerous researcherslikeVakeswaran*et al*. (2016) [10], Singh *et al*. (2018) [11] and Sahu *et al*. (2021) [12].

Fertilizer grade had a significant impact on protein content in black gram grain. The maximum protein content (21.71 %) in black gram grain was recorded under the application F_3(NPK @ 20: 20: 20 kg ha^{-1}) while the least protein content was in control (F_0). Nitrogen is particularly crucial in protein synthesis. Plants absorb nitrogen from the soil in the form of nitrates or ammonium ions. Within the plant, nitrogen is incorporated into amino acids, the fundamental building blocks of proteins. These amino acids then combine in specific sequences to form diverse proteins, which are indispensable for the plant's structure, function, and various biochemical processes. While nitrogen is the primary element associated with protein formation, phosphorus and potassium also play an essential role in supporting these processes. Phosphorus is a crucial component of ATP and ATP is a co-factor in many biochemical reactions, including those associated with protein synthesis. It provides the energy needed for the formation of peptide bonds during protein synthesis [13]. Potassium plays a role in the activation of enzymes involved in protein synthesis. Therefore, a balanced supply of NPK is essential to ensure optimal protein formation.Comparable findings were documented by Thiyageshwari *et al.* (2018) [14].

3.2 Effect of varieties

Black gram varieties differed significantly with respect to growth parameters like plant height, number of leaves, number of branches and root nodules, almost at all the growth stages. Variety Indra-1 recorded significantly higher plant height (38.61 cm) and branches per plant (4.48), number of leaves per plant (24.72) as well as higher root nodules (31.22) as compared to variety IPU- 2-43and PU- 31. This might be due to the fast growth habit of variety Indra-1 which increased plant height, dry matter accumulation branching and nodules.

The results regarding yield contributing characters *viz*., number of pods per plant (20.23), number of seeds per pod (4.77), test weight (37.13 g), grain yield (9.71 q/ha), stover yield (18.59 q/ha) and harvest index (33.83 %) showed that variety Indra-1 was superior as compared to IPU- 2-43 and PU- 3 which might be because of synthesis of more photosynthates due to increased source capacity and efficient translocation of photosynthates to the sink (seed).The variety Indra-1 outperformed others,indicating that this variety has better adaptability to theprevailingenvironment in this region. Dash and Rautary (2017) [15],Mondal and Sengupta (2019) [16] and Pareek*et al.* (2022) [17] also observed differences in yield attributing characters under different varieties of black gram.

It was further observed that variety Indra-1 showed significantly higher protein content (21.85 %) in seed over others. The results of the present investigation regarding the differential behaviour of black gram varieties with respect to protein content are in close conformity with the findings of other workers like Patidar and Singh (2018) [18], Adhithya*et al*. (2022) [19] and Pareek*et al*. (2022) [17].

4 Conclusion

Based on the experimentation, it may be concluded that among graded doses of fertilizers, the application of NPK @ 20:20:20 kg $ha^{-1}$was found to be most effective in obtaining better yield attributes and yield (9.31 q ha^{-1} and 18.10 q ha^{-1} of grain and stover yield, respectively) of black gram. Similarly, among three varieties tested under the investigation, 'Indira-1'gave the highest yield (9.71 q ha^{-1} and 18.59 q ha^{-1} of grain and stover yield, respectively), therefore, application of NPK @ 20:20:20 kg $ha^{-1}$and variety 'Indira-1' should be opted for better outcomes.

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Table 1. Effect of graded doses of fertilizers and varieties on growth, yield and quality of Black gram.

Treatments	Plant height (cm)	Number of branches per plant	Number of leaves per plant	Number of root nodules	Number of pods per plant	Number of seeds per pod	Test weight (g)	Grain yield (q/ha)	Stover yield (q/ha)	Harvest index (%)	Protein content (%)
Graded dose of fertilizers											
F_0	20.32	2.56	12.73	29.16	7.60	1.40	32.11	4.57	11.06	29.05	19.15
F_1	37.77	4.11	25.27	29.89	20.42	4.29	35.35	7.73	15.67	32.95	20.75
F_2	39.77	4.27	26.29	30.78	21.29	4.71	36.32	8.53	17.27	32.59	20.94
F_3	40.73	4.49	27.09	30.89	22.00	4.89	36.98	9.31	18.10	33.55	21.71
S.Em ±	**0.36**	**0.09**	**0.22**	**0.25**	**0.22**	**0.10**	**0.18**	**0.19**	**0.29**	**0.72**	**0.25**
C.D. (*p*=0.05)	**1.05**	**0.27**	**0.66**	**0.72**	**0.65**	**0.28**	**0.54**	**0.55**	**0.85**	**2.11**	**0.74**
Varieties											
V_1	33.78	3.92	22.67	29.85	17.23	3.60	34.99	7.39	15.08	32.64	20.49
V_2	31.55	3.17	21.15	29.47	16.02	3.10	33.44	5.51	12.89	29.65	19.56
V_3	38.61	4.48	24.72	31.22	20.23	4.77	37.13	9.71	18.59	33.83	21.85
S.Em ±	**0.31**	**0.08**	**0.19**	**0.21**	**0.19**	**0.08**	**0.16**	**0.16**	**0.25**	**0.62**	**0.22**
C.D. (*p*=0.05)	**0.91**	**0.23**	**0.57**	**0.63**	**0.56**	**0.25**	**0.46**	**0.48**	**0.73**	**1.83**	**0.64**

Fig. 1 Effect of graded doses of fertilizers and varieties on growth attributesofBlack gram.

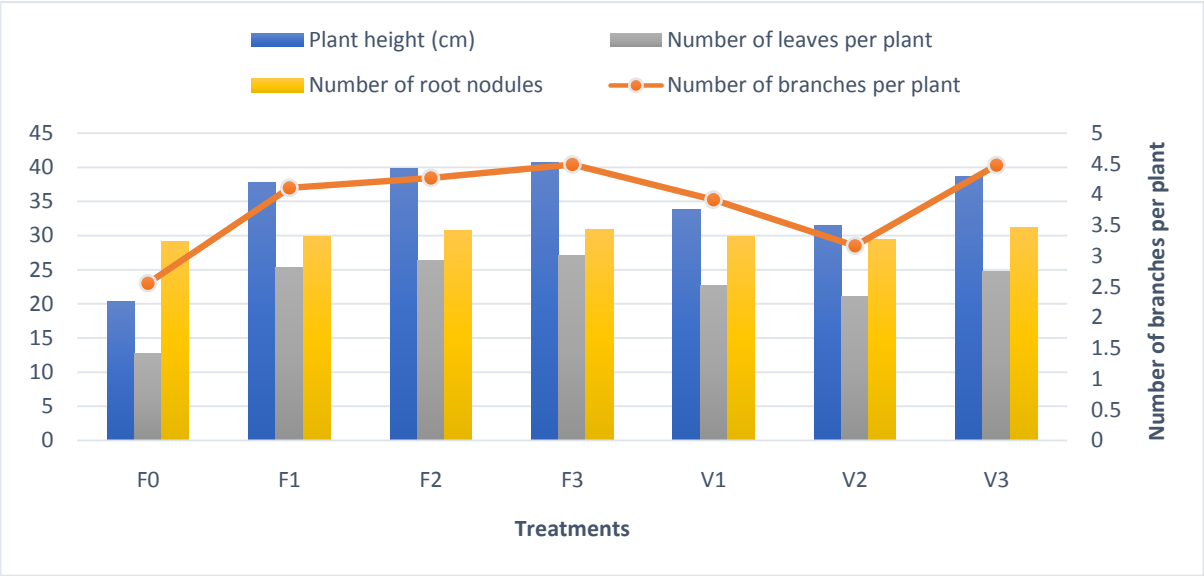

Fig. 2 Effect of graded doses of fertilizers and varieties on yield attributes and yield ofBlack gram.