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Effect of Phosphorous and Molybdenum on Yield and Economic of Black gram (*Vigna mungo* L.)

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Abstract
A field experiment was conducted during Zaid 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil texture of the experimental site was sandy loam, with a pH of 7.1, low organic carbon (0.36 percent), available N (171.48 kg/ha), available P (15.2 kg/ha), and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments consist of three phosphorus levels *viz.*, 30kg/ha, 40kg/ha and 50kg/ha and molybdenum *viz*. 0.5 kg/ha, 1.0 kg/ha and 1.5kg/ha. The results showed that application of Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha was recorded significantly higher plant height (45.65 cm), Plant dry weight (6.68 g/plant). However, Crop growth rate (5.11 g/m^2/day) was recorded highest in treatment Phosphorous 50 kg/ha + Molybdenum 0.5 kg/ha. However, treatment with Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha recorded significantly highest No. of pods/plant (16.22), Length of the pod (6.74 cm), No. of Seeds/pod (6.87), Test weight (37.81 g), Seed yield (1378.27 kg/ha), Harvest index (37.01 %) as compared to other treatments.

Keywords: Black gram, Economic, Molybdenum, Phosphorus, yield

Introduction

One of the most important pulse crops is black gramme (*Vigna mungo*). The food legumes, particularly the grain or pulses are important food stuff in all tropical and subtropical countries. It is grown throughout India. Black gramme is a grain legume that is grown commercially and belongs to the family "*leguminosae*" and genus "*vigna*" and from the standpoint of global food and nutritional security, it is extremely important. It is also known as urd bean, udad dal, urad dal or urad. It also serves as a cover crop, and its thick root system prevents erosion. By symbiotically fixing atmospheric nitrogen in root nodules, the crop also enhances soil fertility.

Black gram is grown well in moisture retentive light soil, but loamy and clay loam are suitable for the cultivation of Black gram. Loam to clay loam with neutral PH are best suited for Black gram cultivation. It is susceptible to waterlogged conditions of the soil. It is well-known for its nutritional value, which includes high levels of protein (22-24%), carbs (56.6-59.6%), fat (1.2-1.4%), minerals (3.2%), phosphorus (385 mg/100g), and calcium and iron. It differs from other pulses in that it has a mucilaginous pasty texture, which adds body to the mass caused by the long polymeric chains of carbohydrates in the polysaccharide chain. Tamil Nadu leads first in productivity with an average yield of 775 kg/ha. It had 24.7 percent protein, 0.6 percent fat, 0.9 percent fibre, and 3.7 percent ash, as well as adequate calcium, phosphorus, and essential vitamins. It is referred to as "poor man's "meat" due to the lower cost of protein (Aslam *et al.*, 2010) [1].

Phosphorus is second most critical plant nutrient, but for pulses, it assumes primary importance, owing to its important role in root proliferation and there by atmospheric nitrogen fixation or phosphorous play a vital role in crop production in pulses (Kachave *et al.*, 2018) [4]. Phosphorus application has a significant impact on pulse yield and nutritional quality.

Molybdenum is regarded as a critical micronutrient because its lack causes low seed yield in pulses. It is a structural component of nitrogenase and nitrate reductase enzymes which brings about oxidation- reduction reaction in plant cells (Yadav *et al.*, 2017) [11]. Micronutrients contribute to increased legume output through their impact on the plant, the symbiotic nitrogen fixation process, and the efficient use of main and secondary nutrients.

Materials and Methods

The present examination was carried out during *Zaid* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28ºN latitude, 81.54ºE longitude and 98 m altitude above the mean sea level. Super goldy variety used for sowing yellow mustard. The experiment laid out in Randomized Block Design which consisting of nine treatments with T_1: Phosphorous 30 kg/ha + Molybdenum 0.5 kg/ha, T_2: Phosphorous 30 kg/ha + Molybdenum 1.0 kg/ha, T_3: Phosphorous 30 kg/ha + Molybdenum 1.5 kg/ha, T_4: Phosphorous 40 kg/ha + Molybdenum 0.5 kg/ha, T_5: Phosphorous 40 kg/ha + Molybdenum 1.0 kg/ha, T_6: Phosphorous 40 kg/ha + Molybdenum 1.5 kg/ha, T_7: Phosphorous 50 kg/ha + Molybdenum 0.5 kg/ha, T_8: Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha,T_9: Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha were replicated thrice.

The experimental location had a consistent topography and sandy loam texture, had a virtually neutral soil response (PH 7.1), was low in organic carbon (0.38 percent), had medium available N (225 kg ha-1), greater available P (19.50 kg ha-1), and medium available K. (213.7 kg ha-1). Urea, DAP, and MOP were used as nutrient sources to meet the requirements for nitrogen, phosphorous, and potassium. Fertilizers were applied as a basal application at the time of seeding. Several plant growth data were recorded at numerous intervals from germination to harvest, as well as several yield parameters after harvest. These parameters include growth parameters, plant height, and plant dry weight. The yield data, such as pods per plant, seeds per pod, pod length (cm), test weight (1000 seeds), and seed yield (kg/ha), were recorded and statistically evaluated using analysis of variance (ANOVA) as applied to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984) [3].

Results and Discussion

Yield attributes and Yield

Number of Pods/Plant

Significantly Maximum Pods/plant (16.22) was recorded with the treatment of application of Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha over all the treatments. However, the treatments Phosphorous 40 kg/ha + Molybdenum 1.0 kg/ha (15.72) and Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha (16.15) which were found to be statistically at par with Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha.

The increased number of pods per plant may be due to improved early vegetative growth in terms of higher leaf area, dry matter buildup, and a robust root system, which resulted in more branches, resulting in a considerable rise in the number of pod producing branches. Similar findings were observed by Singh *et al.* (2020) [1] and Chatterjee and Bandyopadhyay (2017) [2].

Length of the Pod (cm)

Significantly highest length of the Pod (6.74 cm) was recorded with the treatment of application of Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha over all the treatments. However, the treatment Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha (6.68 cm) which was found to be statistically at par with Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha.

Number of Seeds/Pod

Significantly highest Seeds/Pod (6.87) was recorded with the treatment of application of Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha over all the treatments. However, the treatments Phosphorous 40 kg/ha + Molybdenum 1.5 kg/ha (6.65) and Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha (6.77) which were found to be statistically at par with Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha.

Test weight (g)

Significantly highest Test weight (37.81 g) was recorded with the treatment application of Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha over all the treatments. However, the treatment with (37.35 g) in Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha which was found to be statistically at par with Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha.

Number of pods per plant, seed production per plant, and test weight were all strongly influenced by plant yield attributing factors. This could be attributed to increase the availability of phosphorus and molybdenum with each successive level of micronutrient and its positive effect on growth attributes and subsequently on yield components. Combined application of P and Mo helped in translocation of photosynthesis to pods and seeds. The results were found to be in accordance with Kishore *et al.* (2020) [6] and Kathyayani *et al*. (2021) [5].

Seed yield (kg/ha)

Significantly highest Seed yield (1378.27 kg/ha) was recorded with the treatment application of Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha over all the treatments. However, the treatments with (1310.46 kg/ha) in Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha which were found to be statistically at par with Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha.

The source and sink connection is responsible for the increase in seed production caused by phosphorus application. It appears that greater translocation of photosynthetic from source to sink might have increased seed yield (Patil *et al*. 2007) [9]. Phosphorus increases yield due to its well-developed root system, increased N fixation and its availability to the plants and favourable environments in the rhizosphere. Paes *et al* (2010) [8].

Grain and stover yield of Black gram was significantly influenced with increasing levels of molybdenum. This is perhaps due to the combined application of P and Mo, which enhanced the survival and multiplication of microorganisms, improved nitrogen fixation, transport of sugars and better up take and assimilation of available nutrients by the plants during the entire growth period. Similar results have been reported by the findings of Sahare *et al*. (2019).

Harvest Index (%)

Significantly highest Harvest index (37.01 %) was recorded with the treatment application of Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha over all the treatments. However, the treatments with (36.29 %) in Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha which were found to be statistically at par with Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha.

Highest harvest index was observed due to improved cell activities, enhanced cell multiplication and enlargement and luxuriant growth and yield attributes of the crops probably due to more absorption and utilization of available nutrients leading to overall improvement of crop growth reflected to source-sink relationship, which in turn enhanced the yield attributes that ultimately more yield which was reported by Kokani *et al*. (2015) [7].

Economics

Gross returns, Net returns and Benefit cost ratio were significantly influenced due to different treatments.

Higher Gross returns have been recorded with the Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha (Rs. 66507.6/ha) over rest of the treatments followed by Phosphorous 40 kg/ha + Molybdenum 1.5 kg/ha (Rs.61572/ha) whereas minimum gross return was recorded with Phosphorous 30 kg/ha + Molybdenum 0.5 kg/ha (Rs. 47368.2/ha).

Higher Net returns have been recorded with the treatment Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha (Rs. 47349/ha) over rest of the treatments followed by Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha (Rs. 44760.4/ha) whereas minimum Net returns was recorded with Phosphorous 30 kg/ha + Molybdenum 0.5 kg/ha (Rs. 27246/ha).

Higher Benefit cost ratio have been recorded with the treatment Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha (2.08) over rest of the treatments followed by Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha (2.05) whereas lower Benefit cost ratio was recorded with Phosphorous 30 kg/ha + Molybdenum 0.5 kg/ha (1.32).

Table 1: Effect of Phosphorous and Molybdenum on Yield attributes and Yield of Black gram

Treatments	No. of Pods/Plant	Length of the Pod (cm)	No. of Seeds/Pod	Test Weight (g)	Seed Yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
1. Phosphorous 30 kg/ha + Molybdenum 0.5 kg/ha	13.15	5.57	5.64	32.60	799.21	1864.0	30.00
2. Phosphorous 30 kg/ha + Molybdenum 1.0 kg/ha	13.72	5.76	5.67	33.34	825.47	1924.4	30.01
3. Phosphorous 30 kg/ha + Molybdenum 1.5 kg/ha	14.74	5.86	5.92	33.89	965.53	1994.9	32.61
4. Phosphorous 40 kg/ha + Molybdenum 0.5 kg/ha	15.42	5.97	6.08	34.37	982.68	2058.6	32.35
5. Phosphorous 40 kg/ha + Molybdenum 1.0 kg/ha	15.72	6.36	6.56	35.81	1180.46	2154.4	35.39
6. Phosphorous 40 kg/ha + Molybdenum 1.5 kg/ha	14.93	6.46	6.65	36.45	1154.07	2276.3	33.64
7. Phosphorous 50 kg/ha + Molybdenum 0.5 kg/ha	15.34	6.19	6.38	35.10	1095.53	2112.5	34.14
8. Phosphorous 50 kg/ha + Molybdenum 1.0 kg/ha	16.15	6.68	6.77	37.35	1310.46	2300.5	36.29
9. Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha	16.22	6.74	6.87	37.81	1378.27	2345.6	37.01
F test	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S. EM (±)	0.19	0.06	0.07	0.41	24.34	35.68	0.54
CD (P = 0.05)	0.056	0.17	0.22	1.22	86.47	106.96	1.30

Table 2: Effect of Phosphorous and Molybdenum on Economics of Black gram

Treatment	Cost of cultivation	Gross returns	Net returns	B:C Ratio
1. Phosphorus 30 kg/ha + Molybdenum 0.5 kg/ha	20122.2	47368.2	27246	1.32
2. Phosphorus 30 kg/ha + Molybdenum 1.0 kg/ha	20622.2	50860.8	30238.6	1.46
3. Phosphorus 30 kg/ha + Molybdenum 1.5 kg/ha	21122.2	53791.8	32669.6	1.54
4. Phosphorus 40 kg/ha + Molybdenum 0.5 kg/ha	20684.7	55515.6	34830.9	1.68
5. Phosphorus 40 kg/ha + Molybdenum 1.0 kg/ha	21184.7	59884.2	38699.5	1.82
6. Phosphorus 40 kg/ha + Molybdenum 1.5 kg/ha	21684.7	61572	39887.3	1.83
7. Phosphorus 50 kg/ha + Molybdenum 0.5 kg/ha	21247.2	58314	37066.8	1.74
8. Phosphorus 50 kg/ha + Molybdenum 1.0 kg/ha	21747.2	58413.5	44760.4	2.05
9. Phosphorus 50 kg/ha + Molybdenum 1.5 kg/ha	22747.2	66507.6	47349	2.08

Conclusion

It is concluded that application of treatment Phosphorous 50 kg/ha + Molybdenum 1.5 kg/ha was recorded significantly higher Seed yield (1378.27 kg/ha), higher gross returns (66507.6 INR/ha), net returns (47349 INR/ha), and benefit cost ratio (2.08). Since, the findings based on the research done in one season.

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