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Response of different levels of NPK and molybdenum growth and yield attributes of black gram (*Vigna mungo* L.) Var. Shekhar-2

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Abstract
The field experiment was carried out at Research field of Department of Soil Science, Allahabad school of Agriculture, During *summer* season of 2016-17. The experiment was laid out in 3×3 factorial randomized block design with 9 treatments in three replications. It was observed that the best yield attributes characters in treatment T_{8}-@ (25:40:40 kg NPK ha^{-1} + 100 g Molybdenum ha^{-1}) in respect to different days intervals i.e. 25, 50 and 75 days after sowing (DAS). Plant height was 11.30, 31.13 and 44.10 cm found to be significant at 75 DAS but non-significant at 25, 50 and 75 DAS. Number of leaves $plant^{-1}$ were 9.30, 20.60 and 31.10 found to be non-significant at 50 and 75 DAS but significant at 75 DAS. Leaves length $plant^{-1}$ was 7.50 and 8.83 found to be significant at 75 but non-significant at 50and 75 DAS. Highest number of pod $plant^{-1}$, Number of pod seeds $^{-1}$, number of nodules $plant^{-1,}$ fresh weight $plant^{-1}$ (g), dry weight $plant^{-1}$ (g), test weight (g), seed yield (t ha^{-1}), was found in T_{8}- @(25:40:40 kg NPK ha^{-1} + 100 g Molybdenum ha^{-1}) which was 31.90, 10.67, 32.90, 21.23, 12.00, 47.03 and 7.20 was found to be significant. Highest B: C ratio (1:1.93) was recorded in T_{8}-@ (25:40:40 kg NPK ha^{-1} + 100g Molybdenum ha^{-1}). However, since these findings are based on one year experiment and therefore, further research may be conducted to substantiate it under Allahabad agro climatic conditions.

Keywords: NPK, molybdenum, growth, yield, black gram

Introduction
Black gram (*Vigna mungo*) is one of the important pulse crops grown throughout India. Proper fertilization is essential to improve the productivity of black gram. It can meet its nitrogen requirements by symbiotic fixation of atmospheric nitrogen. The nutrients which need attention are phosphorus and sulphur. Black gram is very much responsive to sulphur application. Both phosphorus and sulphur can improve the quality and quantity of the crop. Hence, the present investigation was undertaken to find out the response of black gram to different levels of phosphorus, sulphur and PSB application.

Pulses are the important source of dietary protein with a protein content nearly twice as high as that of in cereals. The food value of pulse grains is high and contain 18-28 percent protein and 1-5 percent fat and considered rich in calcium as compared to cereals and contain about 100-120 mg of calcium per 100 g seeds. They are also rich in iron, thiamine, riboflavin and niacin. Each plant of pulse crop is virtually a nature's mini nitrogen fertilizers that enable to meet its own requirements and benefit the succeeding crop. Pulses are also excellent feed and fodder for livestock. Besides their dietary value and nitrogen fixing ability, pulses also play an important role in sustaining intensive agriculture by improving physical, chemical and biological properties of soil and are considered excellent crops for diversification of cereals based cropping systems. High amounts of iron and aluminum in acid soils favour formation of complexes with boron and results in its higher deficiency in acid soil (Singh, 2006) [28]. This highlights the urgency of applying B fertilizers in such soils to check further deterioration of agricultural production. Molybdenum, being a constituent of nitrate reductase and nitrogenase enzymes, is associated with ammonia reduction and nitrogen fixation and its deficiency adversely affects growth and yield of Mungbean.

In Rabi and Kharif season the area under pulse crop at present is around 23 million hectare with the production around 15 million tones and productivity about 650 kg ha^{-1} (The Hindu survey, 2012). mungbean crop fix atmospheric nitrogen 58-109 kg ha^{-1}, in symbiotic association with Rhizobium bacteria. Mungbean crop has also been reported to smother weed flora appreciably 20-45 percent when intercropped with tall cereals or pigeonpea and consequently, minimize the cost incurred on weed control. Improvement in seed yield of mungbean through use of boron which is one of the most import trace elements is essential for normal life cycle of the plants. Boron influenced the absorption of N, P, K and its deficiency changed the equilibrium of optimum of those three macronutrients. Boron plays a key role in sugar translocation, nitrogen fixation, protein synthesis, sucrose synthesis, cell wall composition, membrane stability and K^+ transporter. In crop quality and yield, the role of boron in pollen germination and pollen tube growth is more important. molybdenum is important for good foliage growth of higher plants. It involved in the process in nitrogen fixation, nitrate reduction and nitrogen metabolism.

Materials and Methods

The experiment was conducted during *summer* season of 2016-17 at Crop research farm Department of Soil Science and Agricultural Allahabad School of Agriculture SHUATS Allahabad. The experimental site is located in the sub - tropical region with 25^0 27^1 N latitude 81^0 51^1 E longitudes and 98 meter the sea level *altitudes.* The experiment was laid out in a 3×3 RBD factorial design with three levels of NPK and Molybdenum with nine treatments, each consisting of three replicates. The total number of plots was 27. Black gram (*Vigna mungo* L.) were sown in *summer* season plots of size 2 x 2 m with row spacing 40 cm and plant to plant distance 15 cm. The Soil of experimental area falls in order of inceptisol. The soil of the experimental field is alluvial in nature, both the mechanical and chemical analysis of soil was done before the starting the experiment to ascertain the initial fertility of the soil. The soil samples were randomly collected from 0-15 cm depths at randomly prior to tillage operations. The samples were mixed depth *viz.* and its weight was reducing by air drying, conning, quartering and passing it through 2mm sieve. To obtain composite soil sample in respective to different depth *viz.* the soil was stored for mechanical chemical analyzed. The treatment consisted of nine combination of inorganic source of fertilizers T_0-@(0:0:0 kg NPK ha^{-1} + 0 g Molybdenum ha^{-1}), T_1-@ (0:0:0 kg NPK ha^{-1} + 50 g Molybdenum ha^{-1}), T_2-@(0:0:0 kg NPK ha^{-1} + 100 g Molybdenum ha^{-1}), T_3-@(12.5:20:20 kg NPK ha^{-1} + 0 kg Molybdenum ha^{-1}), T_4-@ (12.5:20:20 kg NPK ha^{-1} + 50 g Molybdenum ha^{-1}), T_5-@(12.5:20:20 kg NPK ha^{-1} + 100 g Molybdenum ha^{-1}), T_6-@ (25:40:40 kg NPK ha^{-1} + 0 g Molybdenum ha^{-1}), T_7-@(25:40:40 kg NPK ha^{-1} + 50 g Molybdenum ha^{-1}), T_8-@(25:40:40 kg NPK ha^{-1} + 100 kg Molybdenum ha^{-1}). The source of NPK and Molybdenum Urea, SSP, MOP and Sodium molybdate respectively.

Physical and chemical analysis of soil samples (pre-sowing)

Table 1: Physical analysis of soil

Particulars	Method Employed	Results
Sand (%)	Bouyoucous Hydrometer	62.71
Silt (%)	Bouyoucous method (Bouyoucous, 1927) [33]	23.10
Clay (%)	-	14.19
Textural Class	Core method	Sandy loam
Bulk Density (g/cm³)	Core method (Muthuaval, 1992) [32]	1.23
Particle Density (g/cm³)	Graduated measuring cylinder (Muthuaval, 1992) [32]	2.27
Pore Space (%)	Graduated measuring cylinder (Muthuaval, 1965)	48.53
Water Holding Capacity (%)	Graduated measuring cylinder (Muthuaval, 1992) [32]	53.53

Table 2: Chemical analysis of soil

Particulars	Method Employed	Results
pH (1:2)	Digital pH meter (Jackson, 1958)	7.57
EC (dSm-1)	EC meter (Digital Conductivity Meter) (Wilcox, 1950)	0.17
Organic Carbon (%)	Walkley and Black's method, 1947	0.48
Available Nitrogen (kg ha-1)	Alkaline potassium permanganate method (Subbiah and Asija, 1956)	215.23
Available Phosphorus (kg ha-1)	Colorimetric method (Olsen *et al*., 1954)	20.33
Available Potassium (kg ha-1)	Flame photometric method (Toth and Prince, 1949)	127.65
Available Sulphur (kg ha-1)	Colorimetric method (C.H Williams, 1955)	11.25

Results and Discussion

Table 3: Shows the interaction effect of different levels of NPK and Molybdenum the important growth parameters of Black gram

Treatment	Plant height (cm)			Number of leaves plant^{-1}			Leaves length plant^{-1}		No. of pod plant^{-1}	
	25 DAS	50 DAS	75 DAS	25 DAS	50 DAS	75 DAS	50 DAS	75 DAS	50 DAS	75 DAS
T_0	8.43	28.17	35.90	6.97	17.70	22.90	5.13	6.70	16.33	25.43
T_1	8.90	28.57	36.90	7.07	18.00	23.53	5.53	7.03	17.73	26.33
T_2	9.00	28.87	37.77	7.17	18.17	24.80	5.73	7.37	18.07	27.17
T_3	9.67	29.57	38.60	7.60	18.43	25.97	5.83	7.47	19.73	27.83
T_4	9.80	29.67	39.27	8.20	18.87	26.47	6.53	7.87	21.73	28.53
T_5	10.17	29.97	40.60	8.47	19.07	27.00	6.57	7.90	21.97	29.53
T_6	10.83	30.60	41.74	8.63	19.40	29.07	6.60	8.30	22.40	30.27
T_7	10.97	30.73	42.70	8.80	20.43	30.33	7.07	8.57	24.73	31.03
T_8	11.30	31.13	44.10	9.30	20.60	31.10	7.50	8.83	26.30	31.90
F-test	NS	NS	NS	S	NS	NS	NS	NS	NS	NS
S.Ed. (±)	0.507	0.607	0.331	0.387	0.410	0.509	0.373	0.062	0.741	0.282
C.D. (at 5%)	1.075	1.287	0.702	0.820	0.869	1.080	0.790	0.132	1.570	0.599

Table 4: Shows the interaction effect of different levels of NPK and Molybdenum the important plant yield attributes parameters of Black gram

Treatment	No. of length pod Seeds $^{-1}$	No. of seeds pod $^{-1}$	No. of nodules plant^{-1} (g)	Fresh weight (g)	Dry weight(g)	Test weight (g/1000 seeds)	Total grain yield (t ha^{-1})	B:C Ratio
T_0	5.77	6.03	13.27	12.70	8.70	39.37	3.84	1:1.17
T_1	6.60	6.70	15.63	14.07	9.40	40.10	4.23	1:1.28
T_2	6.90	7.40	18.80	14.97	10.07	41.43	5.00	1:1.50
T_3	7.37	7.73	19.33	15.50	10.43	42.40	5.80	1:1.66
T_4	7.53	8.33	20.47	16.87	10.77	42.93	5.60	1:1.60
T_5	7.63	8.90	21.13	17.60	11.23	43.77	5.80	1:1.64
T_6	7.90	9.40	22.50	18.47	11.37	45.10	5.83	1:1.58
T_7	8.10	9.50	23.70	19.63	11.53	45.97	6.37	1:1.71
T_8	8.30	10.67	23.90	21.23	12.00	47.03	7.20	1:1.93
F-test	S	S	S	S	S	NS	S	
S.Ed. (±)	0.162	0.141	0.751	0.356	0.125	13.927	0.252	
C.D. (at 5%)	0.334	0.300	1.592	0.755	0.266	29.526	0.535	

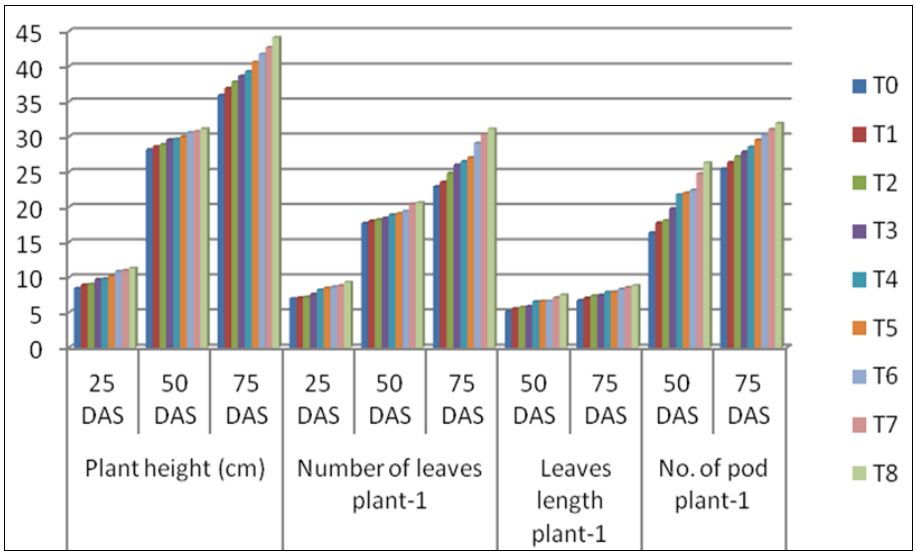

Fig 1: Shows the interaction effect of different levels of NPK and Molybdenum the important growth parameters of Black gram.

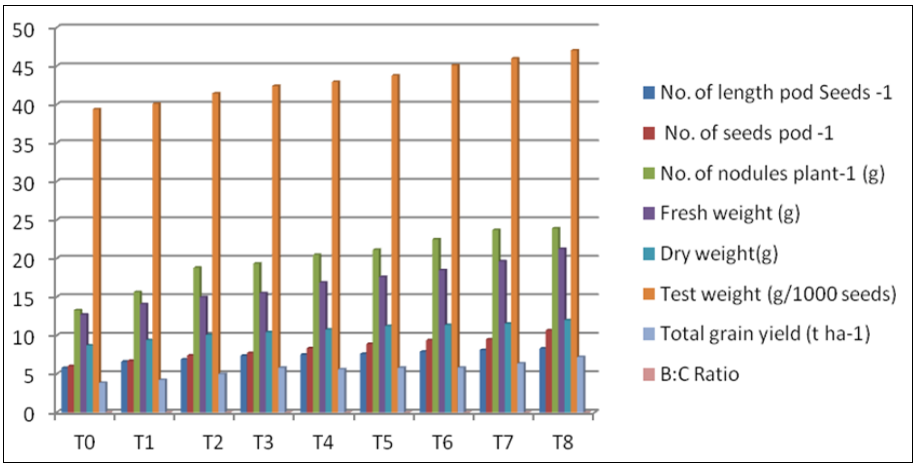

Fig 2: Shows the interaction effect of different levels of NPK and Molybdenum the important plant yield attributes parameters of Black gram.

Growth parameters

Plant height (cm)

Increase in plant height due to increasing of NPK and Molybdenum may be due to adequate nutrients which are turns help in vigorous vegetative growth of plants and subsequently increase the plant height through cell elongation cell division photosynthesis and turbidity of plant cell. The maximum height recorded as 11.30, 31.13 and 44.10 respectively at 25, 50 and 75 DAS in treatment T_8 Similar results have also been recorded by Tripathi *et al.* (2011) [31].

Number of leaves plant^{-1}

The effect of different levels of NPK and Molybdenum on number of leaves plant^{-1} was found significant at 25, and 75 DAS, whereas found non-significant at 50 DAS. The maximum number of leaves plant^{-1} was recorded as 9.30, 20.60 and 31.10 respectively at 25, 50 and 75 DAS in treatment T_8 Similar results have also been recorded by Tripathi *et al.* (2011) [31].

Leaves length plant^{-1}

The effect of different levels of NPK and Molybdenum on leaves length plant^{-1} was found to be significant at 90 DAS.

Where as found non-significant at 50 and 75 DAS. The maximum of leaves length plant^{-1} was recorded as 7.50 and 8.83 respectively at 50 and75 in treatment T_8 Similar results have also been recorded by Tripathi *et al.* (2011) [31].

Higher yield response in comparison of NPK and Molybdenum alone was recorded with balanced application of NPK and Molybdenum. The maximum number of pod plant^{-1} was recorded as 31.90 in treatment T_8 and minimum number of pod plant^{-1} was recorded as 25.43 in treatment T_0 and were found to be significant. The maximum fresh weight of plant recorded as 21.23 in treatment T_8 and minimum fresh weight of plant was recorded as 12.70 in treatment T_0 were found to be significant, The maximum dry weight of plant was recorded as 12.00 in treatment T_8 and minimum dry weight of plant was recorded as 8.70 in treatment T_0 and were found to be significant. The maximum test weight of seeds 47.03 g. was recorded in T_8 and minimum test weight of seeds was 39.37 g recorded in T_0 and were found to be significant. The maximum seed yield 7.20 t ha^{-1} was recorded in T_8 and minimum seed yield 3.84 t ha^{-1} was recorded in T_0 and were found to be significant.

Conclusion

It is concluded that the best yield attributes characters in treatment T_8 in respect to different days intervals i.e. 25, 50 and 75 days after sowing (DAS). Plant height was 11.30, 31.13 and 44.10cm found to be significant at 90 DAS but non-significant at 25, 50 and 75 DAS, number of leaves plant^{-1} were 9.30, 20.60 and 31.10 found to be significant at 25 and 75 DAS but non-significant at 50, and 75 DAS, leaves length plant^{-1} was 7.50 and 8.83 found to be at 90 DAS significant and at 50 and 75 DAS non-significant. Highest number of pod plant^{-1} was 31.90 found to be non-significant. Highest fresh weight (g), dry weight (g), test weight (g) and seed yield (t) which was 21.23, 12.00, 47.03, 7.20 found to be significant. T_8 which was found to be significant. Highest B:C ratio (1:1.93) was recorded in (T_8).

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