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Effect of Molybdenum and Sulphur on Yield and Economics of Summer Black gram (*Vigna mungo* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at the Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.), during the month of *Zaid* 2022. To study treatments consisting of three levels of Molybdenum *viz.* Mo 1 kg, 1.5 kg and 2 kg/ha and three levels of Sulphur *viz*. 10, 20 and 30 kg/ha. The soil on the experimental plot was sandy loam in texture, had a pH of 7.1, contained 0.28 per cent organic carbon, and had 225 kg of nitrogen, 19.50 kg of phosphorus, and 92 kg of potassium available per hectare. There were 10 treatments, each reproduced three times, and they were organised using a random block design. The outcomes showed that treatment 9 (Molybdenum 2 kg/ha + Sulphur 30 kg/ha) significantly increased the number of pods/plant (27.6), the number of seeds/pod (9.53), seed yield (1.25 t/ha), Stover yield (2.87), harvest index (30.3%), gross returns (87500.00), net returns (47281.52)and B:C ratio (1.18) in comparison to alternative treatments.

Keywords: Molybdenum; sulphur; yield; economics; production.

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1. INTRODUCTION

Black gram is the most widely consumed and produced food in India. Black gram output makes up around 10% of India's total pulse production. It generates between 1.5 and 1.9 MT of urad yearly from an area of about 3.5 m ha, with an average yield of 500 kg/ ha**.** The nation's production of black gram, which ranged between 12 and 14 lakh tonnes in the 2000s, stayed consistent for more than a decade. However, production unexpectedly increased in 2010–11 to 17.5 lakh tonnes, mostly due to increased production from Madhya Pradesh, Rajasthan, and Tamil Nadu. The most recent projections show UP and Maharashtra hold the top two spots, each providing over 32%. Madhya Pradesh and Andhra Pradesh each account for 14% of the nation's total production (Aman Parashar et al. 2020) [1-3]. In recent years, pulses have assumed enormous significance as a crucial facet of the Indian economy. Pulses are leguminous plant seeds and are in the Fabaceae family. Pulses are a significant component of the vegetarian diet since they provide a high source of protein, meeting most of the body's needs. In India, 88% of all protein intake comes from plants. Additionally, pulses are a good source of vitamin B. Vitamin C is present in the germinated seeds of pulses. Pulses can provide the required fatty acids because they contain 2 to 6% fat. Pulse crops are special in that they have the ability to fix atmospheric nitrogen using nitrogen-fixing bacteria located in their nodules, greatly satisfying their own nitrogen needs in the process. Pulses are reasonable. Deep roots and the fact that many of them are short-lived crops make them drought resilient. These are also excellent for numerous cropping systems and intercropping (Malik et al. 2015) [4-6]. Molybdenum is one of the most recognized nutrient elements considered to be essential for the growth of plants. For developing nations like India, legumes are a good and relatively less expensive source of proteins, carbs, and minerals. It is essential for the growth of plants also playing important role in the structural interring of the cell wall and cell membrane and synthesis of protein as well as nitrogen fixation. Legume plays an additional role in symbiotic nitrogen fixation [7-9]. The nitrogen-fixing enzyme, nitrogenase is a compound of molybdenum. Without adequate quantities of this element, nitrogen fixation can't occur. Molybdenum has been perceived as an important micronutrient as its paucity leads to poor seed yield in pulses. It is a structural component of nitrogenase and nitrate reductase enzymes which brings about oxidation-reduction reactions in plant cells [10-12].

Sulphur is another important essential plant nutrient. After nitrogen, phosphorus, and potassium, sulphur ranks as the fourth main element due to its role in plant metabolism and yield responses. Sulphur is a vital component of several physiological processes, including the production of chlorophyll and amino acids cysteine and methionine, which contain sulphur [13,14]. Additionally, it produces coenzyme A, synthesises some vitamins (such as biotin and thiamine), and regulates the metabolism of protein, fat, and carbs. In legumes, sulphur also encourages nodulation. Sulphur can be quite beneficial in this regard for increasing the yield of pulses like black gram. Due to the use of high analytical Sulphur free fertilisers like urea and diammonium phosphate (DAP) in high-yielding varieties and intensive cropping, widespread S insufficiency has been seen on wider regions and is especially obvious in light textured soils deficient in organic matter [15-17].

2. MATERIALS AND METHODS

The experiment was carried out in 2022 during the summer season. The experiment was set up using a Randomized Block Design with three replications and ten treatment combinations, with the different treatments being distributed at random within each replication. The soil in the experimental field was a sandy loam with a slightly alkaline reaction (pH 7.1), a low level of organic carbon (0.28%), accessible N (225 kg/ha), P (19.50 kg/ha), and a larger level of K (92.00 kg/ha). The treatment combinations are:

T_1 – Molybdenum 1kg/ha + Sulphur 10kg/ha,
T_2 – Molybdenum 1kg/ha+ Sulphur 20kg/ha,
T_3- Molybdenum 1kg/ha+ Sulphur 30kg/ha,
T_4 – Molybdenum 1.5kg/ha+ Sulphur 10kg/ha,
T_5 – Molybdenum 1.5kg/ha+ Sulphur 20kg/ha,
T_6 – Molybdenum 1.5kg/ha+ Sulphur 30kg/ha,
T_7 – Molybdenum 2kg/ha+ Sulphur 10kg/ha,
T_8- Molybdenum 2kg/ha+ Sulphur 20kg/ha,
T_9 – Molybdenum 2kg/ha+ Sulphur 30kg/ha,
T_{10}- Control 25:50:25(NPK kg/ha).

The observations were recorded on different yield parameters at harvest viz number of pods/ plant, number of seeds/pod, seed yield, stover yield and harvest index.

3. RESULTS AND DISCUSSION

3.1 Yield

Treatment with Molybdenum 2kg/ha+ Sulphur 30kg/ha recorded significantly the highest Number of pods /plant (27.6). However, treatment Molybdenum 1.5kg/ha+ Sulphur 30kg/ha (27.00) was statistically at par with the treatment Molybdenum 2kg/ha+ Sulphur 30kg/ha. Treatment with Molybdenum 2kg/ha+ Sulphur 30kg/ha recorded significantly the highest Number of seeds/pod (9.53). However, treatment Molybdenum 1.5kg/ha+ Sulphur 30kg/ha (9.27) was statistically at par with the treatment Molybdenum 2kg/ha+ Sulphur 30kg/ha. The highest test weight (31.20) was recorded in Treatment 7 with an application of Molybdenum 2kg/ha+ Sulphur 10kg/ha, though there was no significant difference among the treatments. Treatment with Molybdenum 2kg/ha+ Sulphur 30kg/ha recorded the highest seed yield (1.25 t/ha). However, treatment with Molybdenum 1kg/ha+ Sulphur 30kg/ha (1.12), Molybdenum 1.5kg/ha+ Sulphur 30kg/ha (1.22) and Molybdenum 2kg/ha+ Sulphur 20kg/ha (1.06) were statistically at par with the treatment Molybdenum 2kg/ha+ Sulphur 30kg/ha. Treatment with Molybdenum 2kg/ha+ Sulphur 30kg/ha recorded the highest stover yield (2.87 t/ha). However, treatment with Molybdenum 1kg/ha+ Sulphur 30kg/ha (2.69), Molybdenum 1.5kg/ha+ Sulphur 30kg/ha (2.77) and Molybdenum 2kg/ha+ Sulphur 20kg/ha (2.63) were statistically at par with the treatment Molybdenum 2kg/ha+ Sulphur 30 kg/ha. Treatment with Molybdenum 2kg/ha+ Sulphur 30 kg/ha recorded the highest biological yield (4.12 t/ha). However, treatment with Molybdenum 1kg/ha+ Sulphur 30kg/ha (3.18), Molybdenum1.5 kg/ha+ Sulphur 30kg/ha (3.99) and Molybdenum 2kg/ha+ Sulphur 20kg/ha (3.69) was statistically at par with the treatment Molybdenum 2kg/ha+ Sulphur 30kg/ha. Treatment with Molybdenum 2kg/ha+ Sulphur 30kg/ha recorded the highest harvest index (30.3%). However, treatment with Molybdenum 1kg/ha+ Sulphur 20kg/ha (27.83%), Molybdenum 1kg/ha+ Sulphur 30kg/ha (28.49%), Molybdenum 1.5kg/ha+ Sulphur 20kg/ha (28.19%), Molybdenum 1.5kg/ha+ Sulphur 30kg/ha (30.34%) and Molybdenum 2kg/ha+ Sulphur 20kg/ha (28.22%) were statistically at par with the treatment Molybdenum 2kg/ha+ Sulphur 30kg/ha.

3.2 Economics

The highest cost of cultivation was seen in the treatment Molybdenum 2kg/ha+ Sulphur 30kg/ha (INR 40218.48) and the lowest was seen in the control (INR 30568.48). Gross returns varied due to Molybdenum and different levels of Sulphur on the Yield and Yield Components of a Black gram. The highest Gross returns were seen in the treatment Molybdenum 2kg/ha+ Sulphur 30kg/ha (INR 87500.00) and the lowest Gross returns were seen in the treatment control (INR 55300.00)

Table 1. Effect of molybdenum and sulphur on yield attributes of black gram

Treatments	No. of pods/ Plant	No. of Seeds/ Pod	Test Weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
Molybdenum 1kg/ha+ Sulphur 10kg/ha	20.40	7.20	28.00	0.83	2.40	25.50
Molybdenum 1kg/ha+ Sulphur 20kg/ha	21.40	8.00	27.40	0.99	2.56	27.83
Molybdenum 1kg/ha+ Sulphur 30kg/ha	25.60	9.00	26.60	1.12	2.69	28.49
Molybdenum 1.5kg/ha+ Sulphur 10kg/ha	21.00	7.40	29.80	0.87	2.44	26.24
Molybdenum 1.5kg/ha+ Sulphur 20kg/ha	22.20	8.20	29.20	1.03	2.60	28.19
Molybdenum 1.5kg/ha+ Sulphur 30kg/ha	27.00	9.27	29.80	1.22	2.77	30.34
Molybdenum 2kg/ha+ Sulphur 10kg/ha	21.20	7.80	31.20	0.93	2.50	26.98
Molybdenum 2kg/ha+ Sulphur 20kg/ha	24.20	8.60	30.60	1.06	2.63	28.22
Molybdenum 2kg/ha+ Sulphur 30kg/ha	27.60	9.53	29.00	1.25	2.87	30.14
Control 25:50:25 (NPK kg/ha)	20.00	7.00	28.87	0.79	2.36	24.57
SEm(±)	0.28	0.11	0.95	0.07	0.08	1.02
CD at 5%	0.84	0.33	--	0.22	0.25	3.03

Table 2. Effect of molybdenum and sulphur on economics of black gram

Treatments	Total cost of cultivation (INR/ha)	Gross Returns (INR/ha)	Net Returns (INR/ha)	B:C Ratio
Molybdenum 1kg/ha+ Sulphur 10kg/ha	34118.48	58100.00	23981.52	0.70
Molybdenum 1kg/ha+ Sulphur 20kg/ha	36668.48	69300.00	32631.52	0.89
Molybdenum 1kg/ha+ Sulphur 30kg/ha	39218.48	78400.00	39181.52	1.00
Molybdenum 1.5kg/ha+ Sulphur 10kg/ha	34618.48	60900.00	26281.52	0.76
Molybdenum 1.5kg/ha+ Sulphur 20kg/ha	37168.48	72100.00	34931.52	0.94
Molybdenum 1.5kg/ha+ Sulphur 30kg/ha	39718.48	85400.00	45681.52	1.15
Molybdenum 2kg/ha+ Sulphur 10kg/ha	35118.48	65100.00	29981.52	0.85
Molybdenum 2kg/ha+ Sulphur 20kg/ha	37668.48	74200.00	36531.52	0.97
Molybdenum 2kg/ha+ Sulphur 30kg/ha	40218.48	87500.00	47281.52	1.18
Control 25:50: 25(NPK kg/ha)	30568.48	55300.00	24731.52	0.81

Net Returns varied due to Molybdenum and different levels of Sulphur on Yield and Yield Components of a Black gram. The highest Net returns were seen in the treatment Molybdenum 2kg/ha+ Sulphur 30kg/ha (INR 47281.52) and the lowest Gross returns were seen in the treatment control (INR 24731.52) Highest B: C Ratio was recorded with the treatment Molybdenum 2kg/ha+ Sulphur 30kg/ha (1.18) and lowest B: C Ratio was seen in the treatment control (0.81).

4. CONCLUSION

From the results, it can be concluded that better production and economic returns in Black gram were recorded with the application of Molybdenum 2 kg/ha and Sulphur 30 kg/ha in treatment 9.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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