

Response of molybdenum and foliar application of zinc on growth and yield of cowpea (*Vigna unguiculata* L.)

ABSTRACT

The Experiment was conducted in crop research farm in department of Agronomy during summer season of 2022. The treatments consisted of 3 levels of molybdenum (800, 1000 and 1200g/ha) as soil application and Zinc (5kg/ha, 1% foliar spray and 2.5 kg/ha along with 0.5% foliar spray) applied as soil application and foliar spray and a control. The experiment was layout in a RBD with 10 treatments and Replicated thrice. Application of 1200g molybdenum with zinc 2.5kg along with 0.5% foliar spray recorded highest plant height, Maximum plant dry weight, CGR, RGR and the yield attributes namely more Number of pods per plant, seeds per pod, test weight and seed yield and highest Benefit cost ratio.

Key words: *Economics, molybdenum, yield, zinc.*

INTRODUCTION

Cowpea (*Vigna unguiculata* L.), a member of Leguminaceae family, popularly known as black eye pea or lobia is one of the important pulses grown during summer and rainy season for its long green tender pods, which are used as vegetable and dry seeds as pulse. Its foliage is used as fodder and plants as green manure. It is a major source of poor man's protein, as the protein content in its green leaves is about 3-4%, in immature green pods 4-5% and in mature seeds 23.09-28.75%. The green pods are rich in carbohydrates, minerals, B group vitamins, lysine and tryptophan. Its protein is of high biological value, as it can fortify the carbohydrate rich diet appreciably to improve its nutritive value. However, anti-nutritional factors such as hydrates, oligosaccharides and protease inhibitors have also been reported in its dry seeds. Cowpea is well adapted to drier regions of the tropics and subtropics, where other food legumes do not perform well.

Zinc is an essential mineral nutrient and a cofactor of over 300 enzymes and proteins involved in cell division, nucleic acid metabolism and protein synthesis has speculated that inhibit the activities of a number of antioxidant enzymes, resulting in extensive oxidative damage to membrane lipids, proteins, chlorophyll and nucleic acids. Zinc can affect carbohydrate metabolism at various levels. Further, Zn is required in the biosynthesis of tryptophan, a precursor of the auxin-indole-3-acetic acid. Zn can play important role in improvement in yield and quality of fodder cowpea. According to Indian Institute of Soil Science, Bhopal, India, more than 50% of soil samples were found to be deficient in Zn and in Haryana 60% samples were deficient in Zn. The

deficiency of Zn in soil may lead to poor yield and quality along with Zn uptake of fodder crops. Since, Zn is one of essential nutrients for animals, hence, its proper application may rectify Zn deficiency in animals. Therefore, present study was planned to evaluate the effects of P and Zn application on yield and nutritive value of fodder cowpea (**Rathor et al., 2015**). Zinc deficiency symptoms include, small leaves, shortened internodes giving the plant a stunted appearance. These all leads to poor fodder qualities. According to ICAR-Indian Institute of Soil Science, Bhopal, in India more than 50% soil samples tested were found deficient in zinc; further more in Haryana 60% samples tested were deficient. The deficiency of zinc in soil will lead to poor yield and quality of fodder along with poor zinc uptake. Since, zinc is also a major nutrient in animal nutrition; if we properly apply zinc in soil the deficiency in animal can be rectified. (**Rakesh, K. et al., 2016**).

Molybdenum (Mo) is also an essential trace nutrient due to its pivotal role in more than 60 enzymes that catalyze various redox reactions. Its crucial role in nitrogen fixation through the enzyme nitrogenase and nitrate reductase is well known and thus affects nitrogen transport in plants. On the other hand, the deficiency of Mo in crops leads to the reduced growth of flowers, smaller sizes and less maturity, consequently resulting in a lower grain yield. (**Dhaliwal, S. S. et al., 2022**). Molybdenum is required to the Rhizobium bacteria for proper function of nitrogenase enzyme which involved in nitrogen fixation. Again molybdenum is the cofactor for the enzyme nitrate reductase which involved in nitrogen assimilation. The application of molybdenum in deficient soil encouraged nitrogen fixation and nodule formation (**Chatterjee, R. et al., 2015**).

MATERIALS AND METHODS

The materials and methodology and techniques adopted in the present experiment entitled, Effect of molybdenum and foliar application zinc on growth and yield of cowpea (*Vigna unguiculata* L.) with a brief description regarding site of experiment, soil properties, sampling techniques, climatic conditions during crop growing period, cropping history, calendar operations and statistical analysis are presented in this chapter with following headings.

In order to study the three levels molybdenum of and Foliar application of Zinc on the growth and yield characters of summer cowpea. The experiment was conducted at during *zaid* 2022 Crop Research Farm, Naini Agricultural Institute, SHUATS, Prayagraj. The experimental site of the study is geographically located at 25.28°N latitude, 81.54°E longitude and 98 m altitude above the mean sea level (MSL). The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre- sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture, low in organic carbon (0.36%) and medium in available nitrogen (171.48 kg/ha), phosphorous (15.2 kg/ha) and low in potassium (232.5 kg/ha). The treatments consist of three levels of zinc levels at (800g, 1000g and 1200 g/ha) and application and three levels of molybdenum at (5kg/ha, 1% foliar at 25DAS and 2.5 kg/ha+0.5% foliar spray at 25

DAS) respectively. The experiment was laid out in randomized block design with ten treatments each replicated thrice and control *i.e.*, recommended N, P and K (20:40:20 kg/ha) Kashi Kanchan alone. The plots were prepared with dimension of 3 m × 3 m and seeds of variety were sown with a spacing of 30cm × 10 cm. At 4-5 leaf stage plants were thinned to appropriate density. Weeds were controlled manually at 5-leaf stage, stem elongation and flowering stage to maintain a uniform plant population. Growth characteristics plant height (cm), number of branches per plant, dry weight per plant (g), crop growth rate (g/m²/day) and relative growth rate (g/g/day) were recorded, with following formulas (A & B). Irrigation were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. The crop was completely harvested at physiological maturity stage and their biometric observations such as number of capsules per plant, number of seeds per capsule, 1000 seed weight (g), seed yield (kg/ha), stalk yield (kg/ha) and were recorded. The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by **Gomez (1984)**.

RESULT

Growth parameters

Table.1 pertaining that details of influence of molybdenum and foliar application of zinc on growth and yield of cowpea growth attributes.

Plant height (cm)

At 60 DAS, maximum plant height (88.13cm) was recorded with application of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS which was significantly superior over all other treatments and statistically at par with treatment of T₆: Molybdenum 1000 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS (87.96cm).

Number of branches for plant

At 60 DAS, maximum no. of branches (15.44) was recorded with application of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS which was significantly superior over all other treatments and statistically at par with treatment of T₆: Molybdenum 1000 g/ha + Zn 2.5 kg/ha +0.5% Foliar spray at 25 DAS (15.33)

Number of nodules for plant

At 45 DAS, maximum no. of nodules (17.78) was recorded with application of T₉: Molybdenum 1200 g/ha + Zn- 2.5 kg/ha +0.5% Foliar spray at 25 DAS which was significantly superior over all other treatments and statistically at par with treatment of T₆: Molybdenum 1000 g/ha + Zn - 2.5kg/ha +0.5% Foliar spray at 25 DAS (17.56).

Dry Weight (g/plant)

At 60 DAS, maximum dry weight (23.73 g) was recorded with application of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS which was significantly superior over all other treatments and statistically at par with treatment of T₆: Molybdenum 1000 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS (23.22g) and T₈: Molybdenum 1200 g/ha + 1% Foliar spray at 25 DAS (22.76 g).

Crop growth rate (g/m²/day)

At 30-45 DAS, maximum Crop growth rate ($\text{g/m}^2/\text{day}$) ($18.89 \text{ g/m}^2/\text{day}$) was recorded with application of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha + 0.5% Foliar spray at 25 DAS which was significantly superior over all other treatments and low in T₁₀: control-20:40:20 NPK kg/ha ($13.20 \text{ g/m}^2/\text{day}$).

Relative growth rate (g/g/day)

At 30-45 DAS, relative growth rate (g/g/day) was recorded in T₁ Molybdenum 800g/ha + Zn 5 kg/ha and it found to be non significant.

Yield attributes

Table.2 pertaining that details of influence of molybdenum and foliar application of zinc on cowpea yield attributes.

Number of pods/plants

Treatment with application of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha+0.5% Foliar spray at 25 DAS was recorded maximum number of pods/plant (19.89) which was significantly superior over all other treatments and statistically atpar with treatment Of T₆: Molybdenum 1000 g/ha + Zn - 2.5 kg/ha +0.5% Foliarspray at 25 DAS (19.77)

Number of seeds/pod

Treatment with application of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS was recorded maximum number of seeds/pods (15.55) which was significantly superior over all other treatments and statistically atpar with treatment of T₆: Molybdenum 1000 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS (15.22).

Test weight

Treatment with application of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS was recorded maximum number of test weight (15.14g) which was significantly superior over all other treatments and statistically at par with treatment of T₆: Molybdenum 1000 g/ha + Zn -2.5 kg/ha +0.5% Foliar sprayat 25 DAS (15.01g)

Seed yield (t/ha)

Treatment with application of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS was recorded maximum seed yield (1.56 t/ha) which was significantly superior over all other treatments and statistically at par withtreatment of T₆: Molybdenum 1000 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS (1.51)

Stover yield (t/ha)

Treatment with application of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS was recorded maximum straw yield (2.25 t/ha) which was significantly superior over all other treatments and statistically at par withtreatment of T₆:

Molybdenum 1000 g/ha + Zn – 2.5 kg/ha +0.5% Foliar spray at 25DAS (2.15)

Harvest index (%)

Treatment with application of T₆: Molybdenum 1000 g/ha + Zn – 2.5 kg/ha +0.5% Foliar spray at 25DAS was recorded maximum straw yield (41.15 %) which was significantly superior over all other treatments and statistically at par with treatment of T₉: Molybdenum 1200 g/ha + Zn - 2.5 kg/ha +0.5% Foliar spray at 25 DAS(40.97)

DISCUSSION

Significantly improved the number of branches per plant over 0 and 10 kg ZnSO₄/ha. It is also observed that application of 18 kg/ha zinc caused significantly maximum number of branches (12.33) over the control in cowpea. This might be due to the auxin metabolism and increased photosynthetic rate by zinc nutrition. (**Kumar, R. et al., 2016**).

Molybdenum is an essential trace element and is vital for synthesis and activity of molybdo enzymes such as nitrogen assimilation enzyme-nitrate reductase and the nitrogen fixing enzyme-nitrogenase, the key regulatory component for initiation of nodulation and maintenance of nitrogen fixation in legumes in absence of molybdenum in soil the plant molybdoenzymes can be broken down and severely hamper the nitrogen fixation by soil bacteria (**Chatterjee, R. et al., 2015**).

In growth parameter plant height, branches/plant, number of nodules/plant -The best obtained results were found with effect of zinc or boron might be attributed to the favourable influence of them on plant metabolism and biological process activity and their stimulating effect on photosynthetic pigments and enzyme activity which in turn encourage vegetative growth. (**Karimunnisa, S. et al, 2021**).

Significantly higher dry weight (45.11 g/plant) was recorded in treatment Mo 4g/kg seed. This might be due to higher availability of nutrients, synthesis of more carbohydrates and their translocation to different plant parts resulted in increased vegetative growth including the reproductive structures which in turn increase dry weight of the plant. (**Harshini et al., 2022**).

Significant rise in growth parameters noticed under high fertilizers levels may be attribute uptake of nutrients by the plants favouring better cell division, elongation, amino acid and protein synthesis resulting superior expression of various crop growths attributes, increase in growth parameters and thereby yield attributes and yield under higher levels (**Mahesh et al., 2021**).

Higher number of pods per plant with zinc application could possibly be explained by the fact that zinc application increased the realisation of flower into pods. Zinc application on straw yield of green gram might be due to its direct influence on auxin production which in turn enhanced the elongation processes of plant development (**Masih et al., 2020**)

Then again, zinc application also stimulates the sporogenous tissue production, resulting in increase of pollen grain number per anther. In addition, zinc also facilitates the pollen stigma interaction by improving the stigma receptivity and functioning and also the pollen viability, and together, all these lead to proper germination of pollen grains and normal development as well as increase in yield parameters like number, size and weight of the pods and seeds. (Borah, L. and Saikia, J. 2021.)

The probable reason for increasing yield attributes like number of pods per plant, 1000 seed weight, grain yield, stover yield and harvest index is due to application of 30 kg/ha zinc plays a very important role in the metabolism of the plant process by influencing the activity of growth enzymes as well as it is involved in carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis, and regulation of auxin synthesis and pollen formation. It also converts ammonia to nitrate in crops which contribute to yield. (Karimunnisa, S. *et al.*, 2021)

Seed treated with Mo resulted an increase in seed yield might be due to enhance chlorophyll formation which enhances photosynthesis resulting an increase in plant attributes which ultimately increased the seed yield. (Tahir *et al.*, 2014)

Mo, Fe and Zn led to a significant improvement in the micronutrient concentrations in cowpea grain and stover as compared to control which might have been due to the immediate absorption of available micronutrients by plant leaves. (Dhaliwal 2022)

Seed treated with molybdenum resulted an increase in biological yield which might be due to the increase due to improved germination and balanced growth pattern of plants. Application of molybdenum and P considerably increased growth of plants, dry matter production as well as grain yield of mash bean as compared to control. (Tahir, M. *et al.*, 2014)

CONCLUSION

It is concluded that the treatment combination T9 (Mo-1200 g/ha + Zinc (2.5 kg/ha + 0.5 % foliar spray at 25 DAS)) recorded significantly higher Plant height, number of branches per plant, number of nodules per plant, number of branches per plant, dry weight, crop growth rate ($\text{g/m}^2/\text{day}$), pods per plant, seeds per pod, seed yield, stalk yield, gross return, net return and benefit cost ratio.

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Table.1 Influence of molybdenum and foliar application of zinc on growth of cowpea crop.

Treatment	Plant height (cm)	No of nodules/plant	No of branches/plant	Dry weight /plant(g)	Crop growth rate(g/m²/d ay)	Relative growth rate(g/g/day)
Molybdenum 800 g/ha + Zn ₁ - 5 kg/ha	74.33	13.00	13.00	18.22	13.98	0.046
Molybdenum - 800 g/ha + Zn ₂ -1% Foliar spray at 25 DAS	78.27	14.56	13.11	19.79	15.09	0.041
Molybdenum 800 g/ha + Zn ₃ - 2.5 kg/ha +0.5% Foliar spray at 25 DAS	84.15	15.11	14.33	20.15	15.52	0.045
Molybdenum 1000 g/ha + Zn ₁ - 5 kg/ha	79.31	16.45	14.56	22.08	17.76	0.039
Molybdenum 1000 g/ha + Zn ₃ - 2.5 kg/ha +0.5% Foliar spray at 25 DAS	78.71	16.33	14.78	20.77	15.56	0.038
Molybdenum 1000 g/ha + Zn ₃ - 1% kg/ha +0.5% Foliar spray at 25 DAS	87.96	17.56	15.33	23.22	18.41	0.036
Molybdenum 1200 g/ha + Zn ₁ - 5 kg/ha	83.35	16.44	14.33	21.28	16.93	0.043
Molybdenum 1200 g/ha + Zn ₂ -1% Foliar spray at 25 DAS	82.83	16.45	14.56	22.76	17.74	0.036
Molybdenum 1200 g/ha + Zn ₃ - 2.5 kg/ha +0.5% Foliar spray at 25 DAS	88.13	17.78	15.44	23.73	18.89	0.036
Control (20:40:20 NPK kg/ha)	72.60	13.89	12.44	17.19	13.20	0.045
F Test	S	S	S	S	S	NS
SEm±	0.08	0.42	0.18	0.49	0.58	0.003
CD(0.05)	0.25	1.24	0.53	1.46	1.73	-

Table.2 Influence of molybdenum and foliar application of zinc on yield and yield attributes of cowpea crop.

Treatments	No of pods /plant	No of seeds/pod	Test weight(g)	Seed yield(t/ha)	Stover yield(t/ha)	Harvest index(%)
Molybdenum 800 g/ha + Zn1 - 5 kg/ha	15.66	12.33	11.38	0.73	1.36	34.97
Molybdenum - 800 g/ha + Zn2 -1% Foliar spray at 25 DAS	16.66	12.55	12.00	0.84	1.78	31.98
Molybdenum 800 g/ha + Zn3 - 2.5 kg/ha +0.5% Foliar spray at 25 DAS	17.55	13.00	12.66	0.96	1.59	37.65
Molybdenum 1000 g/ha + Zn1 - 5 kg/ha	18.00	13.55	12.49	1.02	1.99	33.79
Molybdenum 1000 g/ha + Zn3 - 2.5 kg/ha +0.5% Foliar spray at 25 DAS	18.77	14.00	13.30	1.16	1.94	37.52
Molybdenum 1000 g/ha + Zn3 - 1% kg/ha +0.5% Foliar spray at 25 DAS	19.77	15.22	15.01	1.51	2.15	41.15
Molybdenum 1200 g/ha + Zn1 - 5 kg/ha	18.66	13.89	13.39	1.16	1.89	37.89
Molybdenum 1200 g/ha + Zn2 -1% Foliar spray at 25 DAS	19.00	14.11	14.00	1.25	2.00	38.47
Molybdenum 1200 g/ha + Zn3 - 2.5 kg/ha +0.5% Foliar spray at 25 DAS	19.89	15.55	15.14	1.56	2.25	40.97
Control (20:40:20 NPK kg/ha)	15.44	12.00	11.21	0.69	1.20	36.55
F Test	S	S	S	S	S	S
SEm±	0.08	0.20	0.20	0.02	0.03	0.75
CD(P=0.05)	0.25	0.62	0.60	0.06	0.11	2.23

