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Effect of zinc, molybdenum and urea on growth and yield of mungbean (*Vigna radiata* L. Wilczek)

KUSUM MALIK, SATISH KUMAR[1] AND K.P. SINGH ARYA[2]

AUTHORS' INFO

Associated Co-author :
[1]Department of Botany, Meerut College, MEERUT (U.P.) INDIA

[2]Raja Mahendra Pratap Post Graduate College, Gurukul-Narsan, HARIDWAR (UTTARAKHAND) INDIA

Author for correspondence:
KUSUM MALIK
Department of Botany, Meerut College, MEERUT (U.P.) INDIA

ABSTRACT : The effect of zinc, molybdenum and urea has been studied on plant height (cm), number of productive branches, number of leaves, leaf area (sq.cm.), fresh weight (g), dry weight (g), number of pods per plant, seed yield per plant and 1000 seeds weight (g) (Test weight) of mungbean [*Vigna radiata* (L.) Wilczek] Var. Pant Mung-4 and Narendra-1. The experiment was conducted at Meerut College, Meerut (U.P.) during the years 2011-2012. Randomised Block Design was followed with 4 replications and 11 treatments. The doses of zinc were 5, 10, 15 and 20 ppm. The concentrations of molybdenum were 1, 2, 3 and 5 ppm and of urea were 1 and 2 per cent along with control. The results were found significant of both varieties of mungbean.

KEY WORDS : Zinc (Zn), Molybdenum (Mo), Mungbean [*Vigna radiata* (L.) Wilczek], Pant Mung-4, Narendra-1, $ZnSO_4$, $H2SO_4$, $FeSO_4$, Chlorophyll, R.B.D.

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Pulses have occupied immense significance in recent years as an important component of Indian economy. Pulses are seeds of leguminous plants and belong to the family Fabaceae. Pulses are rich source of protein and thus form an important part of vegetarian diet supplying the major portion of the protein requirements to human nourishment. About 88 per cent of protein consumed in India are of vegetable origin. Pulses are also rich in Vitamin B. Germinate seeds of pulses contain Vitamin C. Pulses have 2 to 6 per cent fats and can meet the essential fatty acids. Pulse crops are unique in the sense that these possess capacity of fixing atmospheric nitrogen through nitrogen fixing bacteria found in their nodules and thus meet their own nitrogen requirements to a great extent. Pulses are fairly drought tolerant due to their deep root system and many of them are short duration crops. These are also ideal for inter-cropping as well as for multiple cropping system.

The major goal of mungbean (greengram) improvement in India is the development of widely adapted, high yielding, disease and insects resistant varieties responsive to improved cultural practices and possessing tolerance to adverse climatic conditions. Improved nutritional and cooking characteristics are equally important. Limited research has been carried out on simultaneous improvement of grain yield and protein content in mungbean and urdbean (Sandhu *et al.*, 1988).

Since seed is the carrier of production technology, adequate quantity of good quality seed should be made available to the farmers for realising the impact of hybrid technology on agricultural production. The concept of seed quality improves several aspects like germination, vigour, seed health etc. With ultimate purpose of obtaining optimum plant stand for good economic yield.

Zinc application to Zn deficient plants has been found to boost the growth of plant and yield of crops to a great extent. In the deficiency of zinc, plants do not grow probably due to reduction in enzyme activities. Zinc is the part of carbonic anhydrase alcohol dehydrogenase, glutamic dehydrogenase, malic dehydrogenase, reductase and aldoiase etc. Deficiency of zinc, therefore, decreases directly enzyme protein. The zinc is the part of reversal enzymes. It may also be involved in synthesis of protein, part of tryptophan synthetase and regulating formation of tryptophan. Zinc acts in some oxidation reduction systems and its deficiency will lead to excessive oxidation of auxins and reduction of tryptophan, leading to retardation of elongation of stems.

Zinc is the essential mineral element for protein synthesis. In zinc deficient plants, protein synthesis is inhibited and aminoacids and amides are accumulated (Cakmak *et al*., 1989). Zinc deficiency depressed root and shoot growth and chlorophyll concentration. Zinc deficiency appears as interveinal chlorosis first in the older leaves, starting at the tips and margins which varies from rusty brown to yellow. Nene (1966) reported that the deficiency of zinc causes Khaira disease of rice. Tiwari and Dwivedi (1994) reported deficiency of zinc in various districts of Uttar Pradesh and observed DTPA zinc in the range of 0.08 to 9.76 ppm. The Zn deficiency in soil of different states of the country varies from 10 to 95 per cent (Katyal, 1984).

Sharma *et al*. (1996) studied the effect of nitrogen, phosphorus and sulphur on the micronutrient content of blackgram. Agte (1997) studied the effect of natural fermentation of zinc availability (2-28%) and zinc uptake by intestinal segment (1-16%). Vijya and Ponnuswamy (1998) reported that $ZnSO_4$ significantly increased greengram and blackgram seed germination. Chatterjee and Chatterjee (2000) reported that blackgram (*Vigna mungo*) CV. T_9 was given zinc and they studied the effects of Zn on growth, yield and enzyme activity. Masood and Mishra (2000) studied the use of 20-30kg S/ha and some of the micronutrients such as Zn, B, Mo and Fe have improved the productivity of pulse crops.

The essential role is played by trace elements in nutrition and metabolism of plant. Molybdenum, one of the important member of this group is of special significance due to its contribution in activation of several enzyme systems and physiological activities encountered inside the plant body. Molybdenum is a constituent part of the enzyme nitrate reductase concerned with the reduction of nitrate to nitrite in both micro organism and higher plants. It is also known to be specific inhibitor for acid phosphatase. Though, the role of molybdenum in photosynthesis is not known. Reduced levels of photosynthesis have been observed in molybdenum deficient plants that fail to reduce nitrate and fix atmospheric nitrogen. Deficiency of molybdenum has also been shown to decrease the concentration of sugars, particularly reducing sugars, suggesting an involvement of molybdenum in carbohydrate metabolism. It also results in a decrease in the ratio of organic phosphorus/inorganic phosphorus, an effect which could perhaps be explained in the light of the known role of molybdenum as an inhibitor of acid phosphatase.

Plant species vary both in molybdenum requirements and tolerance to excess. Foliar analysis is useful in the diagnosis of molybdenum injury of plant species. Molybdenum is required by plants in only small amount and an excess may cause toxicity to grazing animals. The Mo contents of plants vary considerably according to the species, plant parts, climatic conditions, stage of maturity and soils etc, ranging from less than 0.1 to over 200 ppm in dry matter, but are for the most part within the range 1 to 10 ppm. It is obvious that Mo plays a much more important role in the production of forage crops than other crops because of its essentiality to nitrogen fixing nodule bacteria and also due to its toxic effects on animals.

Salam *et al*. (2005) studied the effect of micronutrients (Zn, Mo, Fe) on fertilization and productivity potential of mungbean and urdbean gave the highest dry matter accumulation, pods per plant, seeds per pod, 100 seed weight, seed yield per plant, pod and seed weight per plant, harvest index and production efficiency.

Singh and Ram (2001) studied the effect of Zn on mungbean biomass, grain yield and quality. Pandey *et al*. (2002) studied enzymic changes in response to Zn nutrition. Pavadai *et al. (*2005) studied the effect of zinc on yield parameters and biochemical contents in blackgram. Mevada *et al*. (2006) of micronutrients (Zn, B, Mo and Fe) on yield of urdbean. Hemalatha *et al.* (2007a&b) studied the effect of Zn and Fe in cereals and pulses. Sritharan *et al.* (2007) studied the effects of foliar spray of chemicals and plant growth regulators on yield of blackgram. Foliar spray of 1 per cent urea had the profound effect in improving the total cholorophyll content, soluble protein content and highest grain yield of 955.20kg/ha in urdbean.

Jongruaysup *et al. (*1997) studied the effect of molybdenum and inorganic nitrogen on Mo redistribution in blackgram. In Mo deficient plants, Mo could be easily remobilized from the roots to the shoot, but was poorly remobilized from the old leaves, whereas in plants given sufficient Mo the element was freely retranslocated from roots, stern and leaves Chaudhary and Das (1997) reported that Mo application significantly increased the canopy, nodule count and yield of blackgram. Kumaran and Subramanian (2002) reported that the treatments as spray 2 per cent DAP + 25ppm ammonium molybdenum + 100 ppm Zn SO_4 + 100 ppm $FeSO_4$ + 0.5 per cent urea resulted in a higher grain yield.

RESEARCH PROCEDURE

The present trials were conducted at Meerut College, Meerut (U.P.) during the years 2011-2012. The seeds of mungbean Var. Pant Mung-4 and Narendra-1 were obtained from G.B. Pant University of Agri. and Tech. Pantnagar (U. Singh Nagar) Uttrakhand. The seeds were sown directly in the plots. R.B.D. was followed with 4 replications and 11 treatments. After 30 days of sowing the crop was sprayed with different concentrations of zinc, molybdenum and urea solutions.

The concentrations of zinc, molybdenum and urea were recorded as zinc 5, 10, 15 and 20 ppm, molybdenum as 1, 2, 3 and 5 ppm, urea 1 and 2 per cent (Table A).

Explanation of symbols for various treatments

Sr. No.	Treatments	Symbols
1.	Control (c)	T_1
2.	Zn 5 ppm	T_2
3.	Zn 10 ppm	T_3
4.	Zn 15 ppm	T_4
5.	Zn 20 ppm	T_5
6.	Mo 1 ppm	T_6
7.	Mo 2 ppm	T_7
8.	Mo 3 ppm	T_8
9.	Mo 5 ppm	T_9
10.	Urea 1%	T_{10}
11.	Urea 2%	T_{11}

The main characters were studied as plant height (cm), number of branches/plant, number of leaves, leaf area (sq.cm.), fresh weight(g), dry weight(g), number of pods/plant, seed yield/plant and 1000 seeds weight (test weight).

The data were collected from 3 plants and then they were averaged for each treatment. The height (cm) was recorded with the help of meter scale and leaf area (sq.cm.) was calculated with the help of planimeter. The data were statistically analysed at I.A.R.I., New Delhi. The results of the findings were interpreted with C.D. at 5 per cent level of significance.

RESEARCH ANALYSIS AND REASONING

The results regarding the effect of zinc, molybdenum and urea on growth and yield characters in mungbean (*Vigna radiata* L.) var. Pant Mung-4 and Narendra-1 are present in Tables 1 and 2.

The plant height (cm) of mungbean (Pant Mung-4 and Narendra-1) was found significant of zinc treatments from T_2 to T_5. As the concentrations of zinc are increased the height is also increased. Plant height in var. Pant Mung-4 was found 46.8 cm in T_5 while it was only 32.1 cm in T_1 (control) in 2012 (Table 1). In var. Narendra-1 it was recorded 38.4 cm in T_5 and 27.1 cm in T_1 (control) in 2012. The data indicate that Pant Mung-4 was found better than Narendra-1 in height gain in plants of mungbean.

As regards the effect of molybdenum on plant height T_8 produced maximum height and minimum was found in T_9 (Mo) in both varieties of mungbean in 2012. The height in T_8 in Pant Mung-4 was 37.3 cm. While in T_9 it was 36.1 cm. in 2012. Similar trend was found in Narendra-1.

Lysenko (1980) reported that foliar nutrition or soil application of fertilizers late in the growing season had a similar effect on growth and both the treatments increased pea yield. Urea gives the best results among the different source *viz.*, urea, ammonium sulphate and ammonium nitrate.

Chakrabarty (1984) studied the effect of foliar spray of urea on growth and yield of pea and reported that foliar spray of urea increased yield, number of pods/plant and 100 seed weight significantly over control and increased seed yield from 6.33 to 13.42 q/ha, number of pods from 24 to 27 and seed weight from 3.32 to 4.00 g.

Jongruaysup *et al.* (1994) analysed Mo deficiency in blackgram (*Vigna mungo*). The relationship of Mo conc. in young leaves and nodules to shoot nitrogen content or seed dry matter in plants treated with 7 levels of Mo supply on a Mo-deficient sandy loam was examined. In severely Mo deficient plants, shoot DM and shoot N contents were deceased. Mo conc. in plant parts increased with increasing Mo supply and were closely related to shoot N content, shoot DM and seed DM.

Kushwaha (1995) reported that *Vigna mungo* was given 0, 30, 60, 90 or 120 kg P_2O_5 and 0, 25 or 50 kg $ZnSO_4$/ha. Seed yield increased with upto 25kg $ZnSO_4$ and with upto 90 kg P_2O_5. The highest seed yield 1691kg/ha was obtained with 25 kg $ZnSO_4$ + 90 kg P_2O_5. Sudarsan and Ramaswami (1995) conducted field trials on sandy clay loam soil, groundnut CV. CO_2, were given foliar applications of $ZnSO_4$ and borax. Zn and Boron increased seed yields compared with the controls. In the following blackgram (*Vigna mungo*) crop grown on the same plots, seed yields were highest (1480 kg/ha) the plots receiving 30 kg $ZnSO_4$/ha.

Khurana *et al.* (1996) reported that zinc application increased the grain and straw yield of rice. Kumar and Singh (1996) reported significant increase in grain and straw yield with increasing level of zinc over control.

The effect of zinc from $T_2 – T_5$ increased the height of mungbean plants because the zinc promotes the growth of plants. T_6 to T_8 molybdenum also increased the height but due to the toxic effect T_9 reduced the height. Molybdenum ions accumulation retards all the growth parameters including height.

Number of productive branches, number of leaves, leaf area (sq.cm.), fresh weight (g), dry weight (g) per plant and number of pods per plant increased in T_5 (Zn) but reduced in T_9 due to toxic effect of molybdenum in

Table 1 : Effect of different concentrations of zinc on growth and yield characters of mungbean (2012)

Pant Mung-4	Height (cm)/plant	No. of tillers/plant	No. of leaves/plant	Leaf area (sq. cm.)/plant	Dry weight (g)/plant	No. of pods/plant	Yield of seed/ plant	1000 seeds weight (g)
T_1(c)	32.1	13	29.3	387	56.3	45.8	62.07	65.3
T_2	37.0	14	30.7	432	61.0	48.7	65.00	65.8
T_3	39.5	15	31.7	508	68.0	54.2	69.30	67.4
T_4	43.9	16	33.3	550	81.3	60.0	74.10	69.7
T_5	46.8	17	34.3	612	94.3	70.5	78.20	72.5
Narendra-1								
T_1	27.1	9	28.0	380	55.1	46.7	60.08	63.4
T_2	30.1	10	28.3	419	56.2	51.2	63.50	64.2
T_3	33.6	11	30.0	467	65.4	57.0	67.26	65.0
T_4	36.2	12	31.3	522	77.7	63.0	70.50	67.2
T_5	38.4	13	32.7	587	89.1	75.0	73.75	70.5

Table 2 : Effect of different concentrations of molybdenum on growth and yield characters of mungbean (2012)

Pant Mung-4	Height (cm)/plant	No. of tillers/plant	No. of leaves/plant	Leaf area (sq. cm.)/ plant	Dry weight (g)/plant	No. of pods/plant	Yield of seed/ plant	1000 seeds weight (g)
T_1(c)	32.1	13	29.3	387	56.3	45.8	62.07	65.3
T_6	33.6	14	30.3	407	56.3	47.6	62.07	65.5
T_7	35.6	14	31.3	455	63.0	53.2	66.80	68.0
T_8	37.3	16	32.3	556	69.6	68.6	88.92	74.5
T_9	36.1	14	31.3	502	65.0	60.0	61.20	71.4
Narendra-1								
T_1	27.1	9	28.0	387	55.1	46.7	60.08	63.4
T_6	28.9	10	28.7	401	53.3	50.4	60.08	63.7
T_7	30.1	10	29.6	448	61.0	56.2	64.80	65.8
T_8	31.7	12	31.3	543	67.6	71.4	85.50	71.5
T_9	30.4	10	29.6	491	63.9	62.3	59.10	69.7

mungbean.

The effect of zinc on seed yield/plant has been shown in Table 1. T_5 treatment of Zn produced 78.20 and 73.75 (g) seed yield in Pant Mung-4 and Narendra-1 in 2012, respectively. The effect of molybdenum on seed yield/ plant has been shown in Table 2. T_8 produced maximum seed yield/plant and minimum by T_9 treatment in both varieties of mungbean. Similar trend was found in 1000 seeds weight in zinc and Mo treatments (Tables 1 and 2) in mungbean var. Pant Mung-4 and Narendra-1. 2 per cent urea spray showed maximum growth and yield parameters in both varieties of mungbean.

Chaudhary and Das (1997) reported that in an experiment in P, S, and Mo application significantly increased the canopy, nodule count, yield of rainfed black gram (*Vigna mungo*), yield of succeeding safflower and reduced splash loss and conserved more soil water. Water stable aggregates, infiltration rate, organic carbon, total N, available P, K, S and Mo in soil increased considerably after the harvest of black gram but decreased after the harvest of succeeding safflower. Pint canopy showed significant positive relationship with nodule count, soil water conservation, water stable aggregates and infiltration rate but showed significant negative relationship with splash loss.

Alam *et al.* (1998) reported the effect of Zinc application with and without copper on yield and composition of rice genotypes Basmati-385 and a mutant DM-25. Rice genotypes responded to Zn application much more in presence of Cu than its application alone. The Zn × Cu interaction significantly increased grain and straw yield and total Zn uptake by both rice genotypes. Higher Zn and Cu uptake by Basmati-385 was attributed to its 7:1: hectare straw yield rather than its differential concentration in grain and straw.

Chatterjee and Chatterjee (2000) reported that Blackgram (*Vigna mungo*) cv. T_9 was given Zn at levels from acute deficiency to excess, and studied the effects on growth, yield and enzyme activity.

Pavadai *et al.* (2005) investigated the effect of Zn at 0, 10, 25, 50, 100, 200 and 500 mg/lit. on the growth (germination, shoot length, root length, branch number and leaf number) and yield parameters (pod number, fresh weight, dry weight, 1000 seed weight and crop yield) of black gram cv. CO_3. Germination percentage decreased with increasing Zn rate starting from 25 mg/litre. Zn at 10 g/lit. showed positive effect on the over all growth and yield of black gram.

Subramanian *et al.* (2005) studied the nutritional and yield responses of blackgram to soil or seed treatment with Zn, B, Mo and S in various combinations. The soil application of the combination of Zn, S and B at 5, 40 and 1.5 kg per ha recorded the highest grain (715 kg/ha) and haulm (904 kg/ha) yields.

Reddy *et al.* (2006) conducted a field experiment to study the influence of foliar fertilizer application of 2 per cent urea on the yield of urd bean with nine treatments. The results revealed that significantly higher plant height, yield attributes, N uptake, seed yield and net returns were observed with 2 per cent urea spray at 30, 40 and 60 days after sowing and was superior to all other treatments.

Sritharan *et al.* (2007) conducted a study to investigate the effects of foliar spray of nutrients and plant growth regulators and yield of black gram. The treatments consisting of foliar spray of DAP 2 per cent, 0.5 per cent $ZnSO_4$, 2 per cent urea foliar spray etc. Among these treatments, foliar spray of 2 per cent urea recorded the highest yield of 955.2 kg/ha followed by foliar spray of 1 per cent KCI along with soil application of humic acid at 20 kg/ha (926.2 kg/ha). The yield enhancement may be due to improvement in growth attributes and yield components *viz.*, relative growth rate, net assimilation rate, crop growth rate, leaf area duration, number of clusters per plant, 100 seed weight and black gram yield per hectare.

Meenu (2010) also conducted experiments at Research Farm of C.C.R. (P.G.) College, Muzaffarnagar. She studied the effect of zinc, molybdenum and urea on the growth and yield of urdbean (*Vigna mungo* L.) Hepper. Two varieties PU-31 and P-30 were taken for the research work. Eleven treatments were considered for study e.g. T_1 (control), T_2 (Zn 2.5 ppm), T_3 (Zn 5 ppm), T_4 (Zn 10 ppm), T_5 (Zn 15 ppm), T_6 (Mo 0.5 ppm), T_7 (Mo 1.0 ppm), T_8 (Mo 1.5 ppm), T_9 (Mo 2.0 ppm), T_{10} (urea 1 %) and T_{11} (urea 2%). Significant effect of zinc T_4 and T_5, molybdenum T_7 and T_8 and of urea 2 per cent were found on morphological and biochemical characters of urdbean (*Vigna mungo* L.). The main characters were plant height, I. of branches per plant, number of leaves, and leaf area (sq.cm.) per plant, NAR, R.G.R. fresh weight (g) and dry weight (g) per plant, number of nodules, fresh and dry weight (g) of nodules/ plant, seed yield (g)/plant and 1000 seed weight (g). Chlorophyll content, nitrogen percentage and protein content showed better performance in comparison to control treatment. T_9 (5ppm molybdenum) showed toxic effect on urdbean plants.

Literature Cited

Agte, V.V., Gokhale, M.K. and Chiplonkar, S.A. (1997). Effect of natural fermentation *on vitro* zinc bioavailability legume mixture. *Internat. J. Food Sci. & Technol.*, **32**(1) : 29-32.

Alam, S.M., Latif, A. and Iqbal, Z. (1998). Differential response of two rice genotypes to zinc and copper application. *Pakistan J. Soil Sci.,* **14**(1-2) : 9-13.

Cakmak, I., Marschner, H. and Bagnerth, F. (1989). Effect of zinc nutritional status on growth, protein metabolism and levels of indole. -3-acetic acid and other phytohormones in bean. *J. Exp. Bot*., **40** : 405-412.

Chakrabarty, R.N. (1984). Effect of foliar application of fertilizers on growth and yield of black-gram (*Vigna mungo*) *Fert. Technol*., **21**(1-4) : 70-73.

Chatterjee, Joba and Chatterjee, C. (2000). Zinc stress changes in the metabolism of blackgram (*Phaseolus mungo*). *Indian. J. Agric. Sci.*, **70**(4) : 250-252.

Chaudhary, H.P. and Das, S.K. (1997). Effect of P, S and Mo application on yield of rainfed blackgram and their residual effect on safflower and soil and water conservation in an eroded soil. *J. Indian Soc. Soil Sci.,* **44**(4) : 741-745.

Dwivedi, Madhu, Upadhaya, R.M. and Dwivedi, G.K. (1992). Effect of inorganic, organic and biofertilizers on yield, protein and aminoacid contents of blackgram and wheat grown in sequence. *Ann. Agric. Res.*, **11**(2) : 191-198.

Hemalatha, S., Patil, Kalpana and Srinivasan, K. (2007a). Influence of heat processing on the bioaccessibility of zinc and iron from cereals and pulses consumed in India. *J. Trace-Elements in Medicine & Biol.*, **21**(1) : 1-7.

Hemalatha, S., Patil, Kalpana and Srinivasan, K. (2007b). Zinc and iron contents and their bioaccessibility in cereals and pulses consumed in India. *Food Chem.*, **102**(4) : 1328-1336.

Jongruaysup, S., Bell, R.W. and Dell, B. (1994). Diagnosis and prognosis of molybdenum deficiency in blackgram (*Vigna mungo* L. Hepper) by plant analysis. *Australian J. Agric. Res.*, **45**(1) : 195-201.

Jongruaysup, S., Dell, B., Bell, R.W., O. Hara, G.W. and Bradley, J.S. (1997). Effect of molybdenum and inorganic nitrogen on molybdenum redistribution in blackgram (*Vigna mungo* L. Hepper) with particular reference to seed fill. *Ann. Bot.*, **79**(1) : 67-74.

Kalyanaraman, S.B. and Sivagurunathan, P. (1994) : Infrared studies on the effect of zinc on blackgram. *J. Plant Nutr.* **17**(5) : 851-857.

Kalyanaraman, S.B. and Sivagurunathan, P. (1994) : Effect of cadmium, copper and zinc on the growth of blackgram. *J. Plant Nutr.*, **16**(10) : 2029-2042.

Katyal, J.C. (1984). Ann. Prog Rep- All India co-ordinated scheme on micronutrients in soils and plants.

Kishor, K., Maurya, B.R. and Ram, P.C. (1994). Effect of iron and molybdenum nutritions on nodulation. symbiotic N_2 fixation and grain yield of urdbean (*Vigna mungo* L. Hepper) *Narendra Deva J. Agric. Res.*, **6**(1) : 189-191.

Khurana, M.P.S., Nayyar, V.K. and Singh, S.P. (1996). Direct and residual effect of applied zinc in cotton and wheat crops. *J. Indian Soc. Soil Sci*., **44** : 174-176.

Kumaran, S. and Subramanian, M. (2002). Effect of plant population and methods of nutrient application on yield and economics of blackgram. *Res. Crops*, **2**(3) : 323-326.

Kumaran, S. and Subramanian, M. (2002). Influence of plant population and methods of nutrient application on yield of blackgram. *Crop Res.*, **22**(3) : 359-361.

Kushwah, B.L. (1995). Response of urdbean to phosphorus and zinc application. *Indian. J. Pulses Res.*, **6**(2) : 152-154.

Lysenko, V.P. (1980). Effect of pea nutrition with different forms of N-fertilization on production and protein synthesis. *Referativenyl Zhurnal.*, **2**(55) : 189.

Masood-Ali and Mishra, J.P. (2000). Nutrient management in pulses and pulse based cropping systems. *Fertil.-News*, **45**(4) : 57-69.

Meenu (2010). Effect of zinc, molybdenum, urea and their interactions on the growth and yield of urdbean (*Vigna mungo* L.) Hepper. Thesis (Botany), Chaudhary Charan Singh University, Meerut, U.P. (INDIA).

Mevada, K.D., Patel, J.J. and Patel, K.P. (2006). Effect of micronutrients on yield of urdbean. *Indian. J. Pulse Res.*, **18**(2) : 214-216.

Nene, Y.N. (1966). Symptoms, causes and control of Khaira disease in paddy. *Indian Phytopath* **19** : 130-131.

Pandey, Nalin, Pathak, G.C., Singh, A.K. and Sharma, C.P. (2002). Enzymic changes in response to zinc nutrition. *J. Plant Physiol.*, **159**(10) : 1151-1153.

Pavadai, P., Dhanavel, D., Seetharaman, N. and Selvaraju, M. (2005). Effect of zinc on germination and yield parameters in black gram (*Vigna mungo* (L.) Hepper var. CO-$_3$). *Plant. Arv.*, **4**(2) : 479-481.

Pavadai, P., Dhanavel, D., Seetharaman, N. and Selvaraju, M. (2005). Efficacy of zinc on germination, seedling growth and biochemical contents of black gram [*Vigna mungo* (L.) Hepper var. CO-3]. *Plant Archieves*, **4**(2) : 475-478.

Reddy, M.M., Padmaja, B., Rao, L.J. and Radhakrishna, K.V. (2006). Effect of foliar spray of urea on nitrogen uptake and yield of urdbean (*Vigna mungo* L.) under rainfed conditions. *Indian. J. Dry land- Agric. Res. & Develop.*, **20**(2) : 151-154.

Rosario, R.R. Del, Lozano, Y. and Noel, M.G. (1980). The chemical and biochemical composition of legume seeds. Mungbean. Philippine *Agriculturist*, **63**(3) : 267-274.

Salam, P.K., Rajput, R.S. , Mishra, P.K., Anita and Srivastava, G.K. (2005). Effect of micronutrients fertilization on productivity potential of urdbean (*Phaseolus mungo* L.) *Ann. Agric. Res.*, **25**(2) : 329-332.

Sharma, S.N., Prasad, R. and Singh, S. (1996). Residual effects of growing mungbean and urdbean on the yield and nitrogen uptake of a succeeding wheat crop. *Fertil. Res.*, **44**(3) : 163-168.

Singh, A.K. and Ram, H. (2001). Effect of phosphorus and zinc fertilization on growth and quality of mungbean (*Vigna radiata* L.) *J. Intracademica*, **5**(3) : 314-317.

Sritharan, N., Anitha, R. and Mallika Vanangamudi (2007). Foliar spray of chemicals and plant growth regulator on growth attributes and yield of blackgram (*Vigna radiata* L.). *Pl. Archieves*, **7**(1) : 353-355.

Tiwari, K.N. and Dwivedi, B.S. (1994). Available zinc status of soils and delineation of the areas of zinc deficiency in Uttar Pradesh. *Fert. News.*, **39**(3) : 31-39.

Vijaya, A. and Ponnuswamy A.S. (1998). Effect of seed fertification with micronutrients on seed quality in black gram and cowpea. *Madras Agric. J.*, **84**(4) : 223-225.

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