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Research Article

Effect of Applied Potassium and Manganese on Yield and Uptake of Nutrients by Clusterbean (*Cyanosis teragonoloba*)

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ABSTRACT

The influence of potassium and magnesium on growth, yield and uptake of nutrients in clusterbean crop *Cv. Bundelkhand 1* was assessed from a pot experiment on a sandy loam soil in *Kharif* season of 2007-08. The levels of potassium and Mn significantly affected the green foliage, dry matter yield and nutrient content, uptake of NPK and Mn by clusterbean at both the cuttings. The treatment which received 60 kg of K_2O ha^{-1} and 10 kg of $MnCl_2$ ha^{-1} recorded the highest green foliage, dry matter yield, nutrient content, uptake of NPK and Mn over control. The results clearly indicated that appropriate level of major and micro nutrient combination could affect morpho-physiological, biochemical attributes, yield and yield components in clusterbean.

Key words: Clusterbean, potassium, manganese, yield and uptake

Introduction

Clusterbean is a main *Kharif* legume crop, recently classified in arid legume group and is grown for vegetable, green fodder, green manure and for grain. This drought hardy crop grows well in rainfed conditions of Rajasthan especially in arid parts of the State and also thrives well in the rainfed regions. Its deep penetrating root system enables the plant to utilize available moisture more efficiently and thus offers better scope for it's rainfed cropping. The crop survives best even under moderate salinity and alkalinity. In India, it is grown on an area of 23.30 lakh hectares with the production of 6.2 lakh tones and the productivity is 322.7 kg seeds per hectare (FAO, 2009). It has high calorific and nutritive value and its seed contains 28-32% of gum. The powder made after refining the gum obtained from the plant makes an important raw material for many industries. India has been a dominant player in respect of guar and guar gum in the world market as the major producer of guar seeds in the world.

Several measures have been taken to increase the yield potential of pulses, but they are primarily concerned with the use of NPK, pesticides and management practices coupled with genetic improvement of crop plants. But, very little attention has been given to test the combination of integrated nutrient supply system, which limits crop productivity. Sharma (2003) reported that crop yields during initial phase of transition from conventional to organic agriculture generally decline in many cases. For maximizing

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the productivity, the eventual plant nutrients must be supplied in balanced form. The importance of potassium in plant nutrition is well recognized although unlike nitrogen and phosphorus, it does not enter into the composition of any product. The potassium activates more than 60 enzymes and enzymatically catalyzes the system involved in photosynthesis, metabolism and translocation of carbohydrates and proteins, membrane permeability, stomatal regulation and water utilization. Other benefits ascribed to K include resistance of plants against pests, disease and stresses caused by drought, frost, salinity, sodicity and in assuring improved crop quality characteristics. In recent years, the application of micronutrients is gaining more importance in improving yield potential besides also quality of produce in several crops. Micronutrients though required in minute quantity, their role is the deciding factor on yield and quality of many crops. Manganese, one of the essential micronutrients though involved in respiratory process such as oxidation of carbohydrates to carbondioxide and water, also participates in the metabolism of nitrogen. It activates the enzymes, directly involved in the synthesis of chlorophyll. The present investigation therefore, was undertaken to find out the effect of both potassium and manganese on yield and nutrient uptake in clusterbean.

Material and Methods

A green house experiment was conducted at Main Agricultural Research Station, R.B.S. College, Bichpuri, Agra affiliated to Dr. B.R. Ambedakar University, Agra during *Kharif* season of 2007-2008. The soils taken for the experimental study was sandy loam in texture having EC 0.17 dSm^{-1}, pH 7.8, available nitrogen 215.0 kg^{-1}, available potassium 15.0 kg^{-1} and available potassium 132.8 kg^{-1}. Clusterbean cultivar *'Bundelkand 1'* was subjected to four levels of potassium (0, 20, 40, 60 kg ha^{-1}) and four levels of manganese (0, 2.5, 5.0, and 10 mg kg^{-1}) in a pot experiment in randomized block design with three replications. Whole amount of manganese and potassium was applied as manganese chloride and of potash at the time of sowing, whereas the recommended doses of nitrogen and phosphorus were supplied through urea and single super phosphate, respectively. At appropriate moisture level, the soil in each pot was pulverized and fertilizer amount were added as per the treatment. Then each pot was seeded with 10 healthy seeds of clusterbean and plants were thinned to 5 after 20 days of sowing. Equal amount of water was applied to every pot at the time of irrigation. At the time of harvest at each cutting, the green foliage was recorded. After drying in oven at 105°C for 4 hours, the dry matter yield was recorded. Harvested plant samples were analyzed for NPK and Mn content by adopting standard procedures as suggested by Jackson (1973). The uptake of nitrogen by clusterbean crop was calculated by multiplying N content (%) values with corresponding yield data. The same procedure was adopted for estimation of phosphorus, potassium and manganese uptake by plants.

Results and Discussion

Yield studies: The positive response of clusterbean to increased potassium and magnesium fertilization evidenced by way of enhanced green foliage, dry matter and increased seed yield. The data presented in Table 1 indicates that the green foliage and dry matter per plant increased significantly with increasing rates of application of potassium and manganese. The treatment which received 60 kg of K_2O ha^{-1} and 10 mg kg^{-1} of $MnCl_2$ recorded the highest statistically significant green foliage and dry matter yield. Singh *et al*. (2003) also similarly showed that increasing rates of nitrogen, potassium, sulphur and potassium application had a positive and significant effect on growth and yield of safflower. The percent increase in green foliage yield of clusterbean with K_1 (20 kg ha^{-1}), K_2 (40 kg ha^{-1}), K_3 (60 kg ha^{-1}) levels of potassium over control were 0.75, 1.94 and 3.35 percent, respectively. Further, it is clear from the Table 1 that the green foliage yield of clusterbean also increased significantly with increasing the levels of manganese. On the other hand, the percent increase in green foliage yield of clusterbean with Mn_1 (2.5 mg kg^{-1}), Mn_2 (5.0 mg kg^{-1}) and Mn_3

Table 1. Effect of potassium and manganese on green foliage and dry matter (g pot^{-1}) yield of clusterbean

Treatment	Yield (g pot^{-1})	
	Green foliage	Dry matter
Potassium Levels		
K_0	39.15	5.25
K_1	39.45	5.38
K_2	39.93	5.50
K_3	40.54	5.65
S. Em±	0.13	0.05
C.D. at 5%	0.40	0.15
Manganese Levels		
Mn_0	39.66	5.27
Mn_1	40.04	5.37
Mn_2	40.87	5.51
Mn_3	43.14	5.57
S. Em±	0.12	0.06
C.D. at 5%	0.37	0.18

Table 2. Effect of potassium and manganese on NPK and Mn content (%) of clusterbean

Treatment	Nutrient content (%)			
	N	P	K	Mn
Potassium Levels				
K_0	2.25	0.28	3.15	18.00
K_1	2.32	0.31	3.18	18.30
K_2	2.38	0.33	3.23	18.74
K_3	2.24	0.36	3.26	19.17
S.Em±	0.04	0.01	0.01	0.18
C.D. at 5%	0.12	0.02	0.02	0.56
Manganese Levels				
Mn_0	2.33	0.28	3.18	16.77
Mn_1	2.35	0.32	3.22	17.35
Mn_2	2.38	0.34	3.24	18.38
Mn_3	2.40	0.37	3.28	19.17
S.Em±	0.05	0.01	0.006	0.20
C.D. at 5%	NS	0.02	0.01	0.57

(10.0 mg kg^{-1}) over control were 0.98, 2.97 and 3.64% respectively. Gangwar and Singh (1992) also observed the similar reporting on growth and yield of oat arising from fertilization in adequate doses.

The percent increase in dry matter yield of clusterbean with respect to K_1 (20 kg ha^{-1}), K_2 (40 kg ha^{-1}), K_3 (60 kg ha^{-1}) and with Mn_1 (2.5 mg kg^{-1}), Mn_2 (5.0 mg kg^{-1}) and Mn_3 (10.0 mg kg^{-1}) levels of Mn over control were 2.23, 4.65, 7.36, 1.67, 4.08 and 5.57, respectively. Singh and Singh (2002) reported the significant effect of sulphur and potassium on yield and quality of maize. Singh and Pathak (2002) also observed the effect of potassium and magnesium on yield, their uptake and quality characteristics in wheat. Tomar *et al*. (2001) showed that response of chickpea to potassium in a calcareous soil was significant.

Chemical composition of clusterbean: The data regarding the chemical composition of clusterbean with respect to application of potassium and manganese levels is presented in Table 2. Enhanced levels of K_1 (20 kg ha^{-1}), K_2 (40 kg ha^{-1}) and K_3 (60 kg ha^{-1}) increased significantly the metabolism nitrogen content of clusterbean as compared to control. The maximum significant nitrogen content was noted with highest level of potassium over the control. Similar, results were also observed by Tomar *et al.* (2001) and Mishra (2003). A critical examination of data given in Table 2 indicated that the increased manganese levels did not significantly affect nitrogen content of clusterbean. However, the nitrogen content of clusterbean increased with increasing levels of manganese as compared to each preceeding lower levels of manganese. The maximum nitrogen content of clusterbean was noted with highest level of Mn_3 (10 mg kg^{-1}). Similar, results were reported by Singh (1996).

It is apparent from Table 2 that levels of potassium significantly affected the phosphorus content in comparison to the control in general. The maximum phosphorus content was observed with K_3 (60 kg ha^{-1}) level of potassium application. Similar, results were observed by Tomar *et al*. (2001) and Mishra (2003). As regards the levels of manganese application, the phosphorus content of clusterbean crop increased significantly with increasing levels of manganese in comparison to the control. The maximum and significant phosphorus content was observed at highest level of manganese (10 mg kg^{-1}) over control. Similar, results were reported by majority of workers such as Dahiya *et al.* (1990).

The data given in Table 2 reveals that the potassium content of clusterbean increased significantly with increasing levels of potassium tried in the present investigation. The maximum significant potassium content was noted at highest level of potassium (K_3) over control than any lower level of potassium. Similar, findings were reported by Tiwari (2001) and Singh and Singh (2002). Likewise, each higher level of manganese significantly results higher potassium content in clusterbean in comparison to preceeding lower levels of manganese. The maximum potassium content was noted at highest level of manganese (10 mg kg^{-1}) application. These results are in also accordance with the findings of Singh and Singh (1998).

An evaluation of data given in Table 2 reveals that the manganese content of clusterbean increased significantly with increasing levels of potassium as compared to the control except K_1 (20 kg ha^{-1}) level of potassium. It is quite clear that the maximum significant content of NPK clusterbean was recorded at highest level of potassium (60 kg ha^{-1}). Similarly, manganese content in clusterbean significantly enhanced with increasing levels of applied manganese as compared to the control. It is also evident that each higher level of applied manganese resulted in significantly higher manganese content of clusterbean.The maximum enhancement in manganese content was noted at highest (60 kg ha^{-1}) level of manganese. Similar, findings were also reported by Gupta *et al.* (1995) and Sharma and Singh (1999).

Uptake studies: The data regarding the NPK and manganese uptake in clusterbean with respect to potassium and manganese levels is presented in Table 3. It was observed that comparatively more enhancement in nitrogen uptake by clusterbean was found with highest level of potassium K_3 (60 kg ha^{-1}). These results are in accordance with those of Pandey *et al.* (2001) and Singh and Singh (2002). The maximum significant enhancement in nitrogen uptake by clusterbean crop was recorded at highest level of manganese (10 mg kg^{-1}) application as compared to the control. Similar results were observed by Singh and Singh (1995), Sharma and Singh (1999). The maximum

Table 3. Effect of K and Mn on NPK and Mn ppm uptake (kg ha^{-1}) by clusterbean

Treatment	Nutrient uptake (kg ha^{-1})			
	N	P	K	Mn
Potassium Levels				
K_0	52.92	6.59	74.09	18.9
K_1	55.84	7.48	76.98	19.7
K_2	58.69	8.17	79.74	20.6
K_3	61.93	9.19	82.50	21.6
S.Em±	0.310	0.250	2.10	1.90
C.D. at 5%	0.914	0.740	5.94	3.66
Manganese Levels				
Mn_0	55.01	6.61	75.05	17.7
Mn_1	56.02	7.71	77.83	18.6
Mn_2	58.53	8.40	79.48	20.2
Mn_3	60.14	8.94	80.89	21.4
S. Em±	0.310	0.008	2.25	1.90
C.D. at 5%	0.900	0.002	5.87	3.66

significant enhancement in phosphorus uptake was recorded with K_3 (60 kg ha^{-1}) level of potassium as compared to the control. Similar, results were observed by Pandey *et al*. (2001), Verma and Nandram (2003). The maximum utilization of phosphorus by clusterbean crop was recorded at Mn_3 (10 mg kg^{-1}) level of applied manganese. Similar, observations were also recorded by Dahiya *et al*. (1990). Comparatively more significant potassium utilization was recorded with highest level of potassium (60 kg ha^{-1}) over the control. Our findings are in agreement with those of Pandey *et al.* (2001) and Verma and Nandram (2003). The more beneficial effect on potassium uptake by the clusterbean crop was noted with highest level of manganese (10 mg kg^{-1}). The maximum level of manganese uptake by clusterbean crop was found with highest level of potassium (60 kg ha^{-1}). The maximum and significant enhancement of manganese uptake was recorded with highest level of manganese (10 mg kg^{-1}). Similar, findings were reported by Singh and Singh (1995) and Singh (1996).

Conclusions

The following conclusions can be drawn from the aforesaid findings:

1. The soil application of 60 kg ha^{-1} potassium as muriate of potash, 20 kg ha^{-1} manganese as manganese chloride is recommended for obtaining higher production of clusterbean crop.
2. Application of potassium improved the content and uptake of nitrogen, phosphorus, potassium and manganese by clusterbean. Similarly, the content and uptake of these nutrients increased with higher level of manganese.

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