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Effect of sulphur and zinc application on growth, yield attributes, yield and quality of summer clusterbean [*Cyamopsis tetragonoloba* (L.)] in light textured soil

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Abstract
A field experiment entitled "Effect of sulphur and zinc application on yield and quality of summer clusterbean [*Cyamopsis tetragonoloba* (L.)] in light textured soil" conducted during summer season of 2013 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. This experiment was conducted with three levels of sulphur viz. 0, 20 and 40 kg Sha^{-1} and four levels of zinc viz. 0, 2.5, 5.0 and 7.5 kg Znha^{-1} which comprised of 12 combinations in factorial randomized block design, which was replicated three times and clusterbean variety Gujarat guar 2 was used as a test crop.The soil of the experimental field was loamy sand in texture, alkaline in reaction and soluble salt content under safe limit. It was low in organic carbon, available N, S and Zn, medium in available P_2O_5 and K_2O. Application of 40 kg S/ha with 5.0 kg Zn/ha resulted in significantly higher plant height, number of branches per plant, number of root nodules per plant, fresh weight of root nodules per plant, number of pods per plant, number of seeds per pod, 1000- seeds weight. Application of 40 kg S/ha with 5.0 kg Zn/ha resulted in significantly higher seed yield, stover yield, protein content, protein yield and gum content in seed. Based on the results of the present study, it can be concluded that higher yields can be secured in summer clusterbean crop by application of 40 kg S/ha and 5.0 kg Zn/ha in sulphur and zinc deficient light textured soil of North Gujarat.

Keywords: Sulphur, zinc application, *Cyamopsis tetragonoloba* (L.), textured soil

Introduction
Pulse crops play an important role in Indian agriculture and India is the largest producer and consumer of pulses in the world. Pulses contain a high percentage of quality protein nearly three times as much as cereals. Thus, they are cheaper source to overcome protein malnutrition among human beings. Pulses are the major sources of dietary protein in the vegetarian diet in our country. Besides being a rich source of protein, they maintain soil fertility through biological nitrogen fixation in soil and thus play a vital role in further in sustainable agriculture. In fact, lysine is the most limiting essential amino acid in cereals which is very well supplemented by the protein of pulses. The pulses are known to improve the physical characteristics of soil through tap root system which opens the soil into the deeper strata and their ability to use atmospheric nitrogen through biological nitrogen fixation which is economically sound and environmentally acceptable. In addition, it also provides nutritious fodder and feed for livestock. Pulses are drought resistant and prevent soil erosion due to their deep root and good ground cover, because of these good characters, pulses are called as "Marvel of Nature".

Among the common pulses grown in Gujarat clusterbean popularly known by its vernacular name *GUAR* is an important kharif and summer season grain legume ideally suited for semi-arid and arid regions. In Gujarat clusterbean occupies 1285 ha area with 641 M.T average productions. The crop is grown for various purpose viz. vegetable, green manure and seed. In recent years it has emerged as an industrial crop due to presence of galactomnan (Guar gum) in its endosperm. By-product of guar gum industry from concentrated animal feed of immense value.

In recent years, sulphur deficiency has been aggravated in the soil due to continuous removal by crops and use of high analysis sulphur devoid fertilizers like Urea, Diammonium

phosphate, Murate of potash etc. coupled with intensive cropping with high yielding varieties and reduction in use of organic manure and sulphur containing fungicides and insecticides resulted in sulphur deficiency in soils (Pasricha *et al*. 1972) [11]. Widespread sulphur deficiencies have been reported in soils of India (Tandon 1986) [22] as well as in those of Gujarat (Patel *et al*. 1987) [12] ranging from 15 to 56 per cent with an average of 37 per cent Meisheri and Patel, 1996) [7]. Sulphur deficiency is as high as 81 per cent in light textured soils of North and North West zone of Gujarat (Sadasania, 1992) [15]. They reported that sulphur deficiency tends to affect adversely the growth and which reduces the crop yield to the extent of 10-30 percent. Sulphur is known to play an inevitable and imperative role in a constituent of protein, Vitamins and sulphur containing amino acids i.e. cysteine, cystine and methionin. On the other hand, sulphur deficiency may be responsible for poor flowering, fruiting, cupping of leaves, reddening of stem and petiole and stunted growth. Besides these it is also used as soil amendment and for controlling pathogens.

Zinc is one of such micronutrient, its deficiency in the field crops is the global phenomenon and it has also received maximum attention in our country as compared to other micronutrients due to its significant role in various enzymatic and physiological activity of plant system. It has catalytic function so, required for the transformation of carbohydrates. It is also important for chlorophyll formation, formation of growth hormones and promotion of protein synthesis. The available zinc in Gujarat soil ranges between 0.25 to 2.58 mg kg^{-1} (Dangarwala *et al*., 1983) [4]. As nearly half of the Indian soils are Zn deficient and 24 per cent soil of Gujarat state are Zn deficient and 58 per cent soil of North Gujarat found deficient to medium in available zinc status (Anon., 1994) [1]. Soils of India had multiple nutrient deficiencies, mainly of N, P, K, S and Zn and their use have become essential to obtain optimum crop yield. The results of several experiments suggest that, for achieving the maximum crop yield and fertilizer use efficiency in India, balance fertilization is essential.

Materials and methods

A field experiment was conducted on plot no. B-11 at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. This experiment was conducted with three levels of sulphur viz. 0, 20 and 40 kg Sha^{-1} and four levels of zinc viz. 0, 2.5, 5.0 and 7.5 kg $Znha^{-1}$ which comprised of 12 combinations in factorial randomized block design, which was replicated three times and clusterbean variety Gujarat guar 2 was sown on second week of February. The seeds were sown at rate of 18 kg/ha with inter and intra row spacing of 45 cm and 10 cm, respectively. The seeds were uniformly sown manually 3-4 cm depth in a previously opened furrow as per treatment. A common dose of well decomposed FYM was applied to the experimental field @ 10 t /ha. Furrows were opened manually in each plot by keeping 45 cm spacing in between two rows. A uniform application of nitrogen (20 kg /ha) and phosphorus (40 kg /ha) through urea and DAP, respectively were applied for each plot in soil just before sowing of seed in previously opened furrows. As per treatment, sulphur was applied through gypsum and zinc was applied through zinc chloride at time of sowing of crop. The soil of the experimental field was loamy sand in texture, alkaline in reaction and soluble salt content under safe limit. It was low in organic carbon, available N, S and Zn, medium in available P_2O_5 and K_2O.The data on growth and yield attributes were recorded from randomly selected five plants in each plot and seed yield and stover yield recorded from net plot and converted on hectare basis. The protein content in grain was calculated by multiplying nitrogen content of the seed (per cent) with the factor 6.25 as reported by Gupta *et al.* (1972) and was expressed as percentage. The data were analyzed statistically by adopting the standard procedures described by Panse and Sukhatme (1967).

Results and discussion

Effect of sulphur

An application of sulphur @ 40 kg /ha resulted in significantly higher growth parameter (plant height, no. of branches $plant^{-1}$, no. of root nodules $plant^{-1}$ at flowering and weight of root nodules $plant^{-1}$), yield attribute (maximum number of seeds pod^{-1} and number of pods $plant^{-1}$ and 1000-seeds weigh) to clusterbean. The similar result was also reported by Naagar and Meena (2004) [8], Baviskar *et al.* (2011) [2] and Nawange *et al*. (2011) [10].

The significant response in seed (750.92 kg /ha) and stover (1163.9 kg /ha) yield of clusterbean were obtained under the application of 40 kg S/ha. The higher yields with sulphur application could be ascribed to accelerated nutrient uptake helped the plant to put optimum growth. As these growth and yield attributes as well as nutrients uptake showed significant increase in seed yield, evidently resulted in higher yields with sulphur fertilization. Seed yield of clusterbean is chiefly product of yield attributing characters. These characters were significantly improved due to sulphur application. Stover yield was also found significant resulted due to significant response of plant growth parameters viz. plant height, number of branches per plant (Table 1). Similar results were reported by Shekhavat *et al.* (1996) [20], Bhadoria *et al*. (1997) [3], Shakhela *et al.* (2003) [16], Sharma and Singh (2004) [19], Baviskar *et al.* (2011) [2].

The significantly higher in protein content, protein yield and gum content in seed of clusterbean were recorded due to application of 40 kg S /ha over control and 20 kg S/ha.The beneficial effect of sulphur application might be due to the fact that sulphur is a constituent of amino acids, present in protein further it also participated in several biochemical reaction eventually resulting in increased protein content. These finding are in accordance with those of reported by Bhadoria *et al*. (1997) [3], Kumawat and Khangarot (2002) [5], Shakhela *et al.* (2003) [16], Sharma and Singh (2004), Naagar and Meena (2004) [8], Baviskar *et al*. (2011) [2].

Effect of Zinc

An application of zinc @ 5.0 kg /ha resulted in the significantly higher growth parameter viz. plant height, no. of branches $plant^{-1}$, no. of root nodules $plant^{-1}$ at flowering and weight of root nodules $plant^{-1}$ and yield attributes viz. number of seeds pod^{-1}, number of pods $plant^{-1}$ and 1000-seeds weight. The increase may be expected as zinc plays an important role in the production of indole acetic acid, a growth hormone and tryptophan, a precursor of auxin. Further increase in zinc levels caused deleterious effect. The similar result was also reported by Sharma *et al.* (2004) [19] in Clusterbean.

The significant response in seed (750.92 kg /ha) and stover (1163.9 kg /ha) yield of clusterbean were obtained under application of 5 kg Zn /ha. The higher yields with zinc application could be ascribed to accelerated nutrient uptake helped the plant to put optimum growth. As these growth and

yield attributes as well as nutrients uptake showed significant increase seed yield, evidently resulted in higher yields with zinc fertilization. Stover yield was also found significant resulted due to significant response of plant growth parameters viz. plant height, number of branches per plant. Similar results were reported by Singh and Tiwari (1992) [18] in chickpea, Kushwah (1993) [6] in urdbean, Nagarju and Yadahalli (1996) in cowpea, Sharma *et al.* (2004) [19] in clusterbean.

The significantly higher in protein content, protein yield and gum content of clusterbean were recorded due to application of 5.0 kg Zn /ha. The increase in protein content of clusterbean with zinc application maybe due to the fact that zinc is responsible for activation of number of enzymes associated with protein synthesis as well as with RNA synthesis which direct concern with the protein synthesis. Similar results were also observed by Sunder *et al*. (2003) [21] in clusterbean.

Table 1: Growth and yield attributes as affected by sulphur and zinc application in clusterbean

Treatments	Plant height (cm)	Number of branches per plant	Number of nodules per plant	Fresh weight of nodules per plant (gm)	Number of pods per plant	Seeds per pod
Sulphur						
S_0 :00 kg S/ha	53.86	4.00	7.11	1.56	25.22	4.58
S_1 :20 kg S/ha	60.90	5.30	9.69	2.58	39.72	5.11
S_2 :40 kg S/ha	65.40	6.14	12.31	3.60	49.69	5.66
S.Em±	1.52	0.13	0.22	0.04	0.95	0.14
C.D at 5%	4.45	0.37	0.65	0.12	2.76	0.41
Zinc						
Zn_0:00 kg Zn/ha	52.18	4.63	8.81	2.27	27.75	4.63
Zn_1:2.5kg Zn/ha	59.04	4.96	9.63	2.55	36.42	5.11
Zn_2:5.0kg Zn/ha	65.10	5.52	10.66	2.87	48.24	5.37
Zn_3:7.5kg Zn/ha	64.20	5.48	9.72	2.62	39.44	5.37
S.Em±	1.75	0.15	0.26	0.05	1.29	0.16
C.D at 5%	5.14	0.43	0.75	0.14	3.78	0.48
Interaction						
S× Zn	NS	NS	NS	NS	NS	NS
C.V. %	8.75	8.58	7.93	5.40	10.12	9.56

Table 2: Yield attributes, yield and Protein content as affected by sulphur and zinc application in Clusterbean

Treatments	1000 - seeds weight (gm)	Seed yield (kg/ha)	Stover yield (kg/ha)	Protein content (%)	Protein yield (kg/ha)	Gum content (%)
Sulphur						
S_0 :00 kg S/ha	31.22	518.00	780.5	25.75	133.73	25.92
S_1 :20 kg S/ha	31.48	641.33	981.3	27.15	174.58	27.96
S_2 :40 kg S/ha	32.13	750.92	1163.9	29.08	219.15	29.92
S.Em±	0.07	10.74	13.8	0.30	3.25	0.29
C.D at 5%	0.20	31.51	40.5	0.89	9.55	0.84
Zinc						
Zn_0:00 kg Zn/ha	31.33	537.22	805.8	25.86	140.03	26.26
Zn_1:2.5kg Zn/ha	31.66	637.11	971.0	27.64	176.79	27.82
Zn_2:5.0kg Zn/ha	31.77	721.89	1176.5	28.31	205.79	29.16
Zn_3:7.5kg Zn/ha	31.68	650.78	1006	27.51	180.68	28.50
S.Em±	0.08	12.40	16.0	0.35	3.76	0.33
C.D at 5%	0.23	36.38	46.8	1.03	11.02	0.97
Interaction						
S× Zn	NS	NS	NS	NS	NS	NS
C.V. %	0.74	5.84	4.9	3.85	6.41	3.54

Conclusion

Based on the results of the present study, it can be concluded that higher yields and net return can be secured summer clusterbean crop by application of 40 kg S/ha and 5.0 kg Zn/ha in sulphur and zinc deficient light textured soil of North Gujarat.

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