Title
Relative efficiency of boron sources in improving cauliflower (Brassica Oleracea L.) yield and its uptake in Indian soils

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Introduction

Among micronutrients, boron (B) is indispensable for the normal growth and development of plants. Boron gains a special importance in flowering and fertilization process, boosting yield and quality of crop produce, though boron is relatively immobile within plant system. The contention developed in minds of planners since the inception of the Green Revolution, that all soils in India are adequate in B so crops do not need B fertilization for long time, has done more harm than bring benefits to agriculture (Kanwar and Randhawa 1974). Modern agriculture over the years has resulted in greater depletion of B in soil so its deficiencies have emerged as a serious obstacle in sustaining higher production of food as well as horticultural crops in all parts of the country (Singh 2001). Cauliflower (*Brassica oleracea* L.) is one of the important vegetable crops widely grown in all soils of India. Its successful cultivation requires application of high amount of NPK besides other package of practices. Most often yields remain low due to inadequate supply of micronutrients particularly of boron. Studies were therefore undertaken to optimize the rate of B fertilization and evaluate efficiency of various sources for correcting this deficiency more economically in different agro-ecological zones of India.

Materials and methods

Data on boron status in soils has been processed to delineate boron deficiency in India. Further, to correct B deficiency, eight field studies were conducted to evaluate the relative efficiency of B sources and optimizing rates of B application needed for cauliflower crop grown in soils of different agro-ecological zones (AEZ) of India. Granular borax penta hydrate has been commercially made available for correcting B deficiencies in agricultural crops. It can be applied either directly or through blending with NP or NPK fertilizers due to its granular size of -5.0+1.4 mm. Two sources of boron are borax penta hydrate granular (hereafter called as Granubor II, 14.6% B) and borax deca hydrate crystalline (called as borax, 10.6% B). Basal application of B was made to soil prior to planting of cauliflower seedlings. Treatments comprising borax at the rate of 75, 100 and 125% and Granubor IIat 75, 100 and 125% of the recommended rate 1.00 kg B ha^{-1} were imposed along with one B control (NPK alone). Boron was applied on equivalent B nutrient basis. All standard agronomic and cultural practices were adopted for the growing crop. The study covers major soil types like hill and mountainous (Alfisols) of the Himalayas, red sandy loam and lateritic soils (Alfisols) of central and eastern India, and alluvial soils of Gujarat (*Ustochrepts*) and calcareous (*Calciorthent*) soils representing various agro-ecological zones of India.

Results and discussion

Survey studies revealed that deficiency of boron ranges from 2-84% in certain soils and agroecological zones. Its deficiency is widespread in acidic (Alfisol) soils of Kokan, Kerala, Orissa, Chattishgarh, Jharkhand, West Bengal, Assam and north eastern states as well as in calcareous (Calciorthents) soils of Gujarat, Bihar, eastern Uttar Pradesh and central parts India. Crops in 46% acid soils suffered with lack of proper boron nutrition as compared to 33% in country as a whole.

Application of B significantly increased the biomass yield as well as economic benefits of cauliflower in different soils, crops and zones (Table 1). Response of crops to 0.75 kg B ha^{-1} gave significantly low yield. Increasing rates of boron added 100 to 125% of the recommended dose gave significantly higher yields in different soils. Addition of 1.25kg B ha^{-1} did not show any deleterious effect. Both the sources like Granubor II and borax significantly increased the

yield over the control. However, Granubor II out-performed the crystalline borax in most of the soils in correcting B deficiency in cauliflower. The Granubor II gave a higher benefit cost ratio (Table 1).

Thus preferential use of Granubor II at the rate of 1.25 kg B ha^{-1} was found to be beneficial to correct B deficiency in cauliflower over borax in different soils of India. Application of boron increased the total uptake of boron at all locations. Boron application increased the status of available boron in soils and thus left a residual effect to subsequent crops. Efficiency of both the sources was at par in increasing boron concentration in plant parts and total boron uptake.

Table 1: Effect of boron application through borax and Granubor (GB II) sources on fresh head yield and benefit: cost ratio in different soils of India

Location	State	Soil type	No. of Trial	NPK-B yield, kg ha^{-1}	Response, kg ha^{-1}		Net Profit, Rs. ha^{-1}		Benefit- Cost ratio	
					GB-II	Borax	GB-II	Borax	GB-II	Borax
Hyderabad	A.P.	Haplustalf	1	20200	7533	6133	22228	17899	59.91	35.8
Coimbatore	T.N.	Haplustalf	1	20840	2867	4527	8230	13081	22.18	26.16
Anand	Gujarat	Ustochrept	1	21700	3067	2100	8829	5800	23.8	11.6
Pusa	Bihar	Calciorthent	1	19300	2433	2867	6928	8101	18.67	16.2
Kullu	H.P.	Haplustalf	3	13713	3281	2246	9471	6240	25.53	12.36
Ranchi	Jhark-hand	Haplustalf	1	14400	4200	3400	12600	10200	32.96	19.4
Overall			8	17197	3743	3096	10904	8850	29.3	17.5

Cost of Cauliflower= Rs. 3.00/kg , B 1.0 kg/ha rate by Granubor-II cost= Rs.371/- & borax= Rs. 500/

Summary and conclusions

Results showed that as much as 46% soil samples from hilly, red and lateritic soils, coarse textured, leached acidic soils and 12% samples representing non-acidic soils showed boron deficiency with a mean of 33%. Cauliflower significantly responded to boron application in all regions and soil types. Application of 0.75 kg B ha^{-1} gave significantly lower fresh cauliflower yield compared to 1.0-1.25 kg B ha^{-1}. Application of 1.25 kg B ha^{-1} gave higher yield in Haplustalfs (Hilly and red lateritic) soils and 1.0 kg B ha^{-1}in Ustochrept (alluvial) soil of Gujarat. Efficiency of granubor was somewhat more or at par to borax deca hydrate crystal.

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