Frank Notes

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Boron – A Micronutrient of Macro Importance

Indian agriculture suffers from low yields and low return on investment. Yield of major crops is lower than world average and even lower than some of our neighbouring countries. Out of the major causes of low productivity is deteriorating health of soil. Indian soils suffer from multi-nutrient deficiencies, particularly deficiencies of at least six nutrients namely, nitrogen (N), phosphorus (P), potassium (K), sulphur (S), zinc (Zn) and boron (B) are quite widespread. Balanced supply of all the limiting/ deficient plant nutrients both macro and micronutrients, is pre-requisite for sustenance of soil health and realization of optimum crop yields. Boron is the latest addition in the list of six most deficient nutrients. Among micronutrients, its deficiency ranks second, next only to Zn in limiting crop yields, quality and net returns.

Essentiality of boron as plant nutrient was established by K. Warington in 1923 for its role in primarily maintaining the integrity of cell wall. It is responsible for the cell wall formation and stabilization, lignification and xylem differentiation. It facilitates transport of potassium in guard cells and is involved in stomata opening. Under low boron supply, reduced cell wall stability rapidly diminishes root elongation, leading to significant reduction in root growth. Boron imparts drought tolerance to plants. Poor B supply also reduces the activity of enzymatic systems directly responsible for K uptake. Boron assumes special importance because of its role in fertilization and flowering processes of crops. Under B deficiency, one of the first adverse effects is on flowering and fruiting which ultimately affect the yield and/or quality of the seeds and fruits.

Under inadequate B supply, the plants show some warning signals in the form of characteristic deficiency symptoms. The deficiency symptoms first appear on growing tips and younger leaves. Boron deficiency manifests itself as stunted roots and plants; empty pollen grains and poor pollen vitality (both causing barren ears and hollow fruits); break-down of growing tip tissue with leaves having scorched appearance. So intense, visible and repetitive have been the influences of B on growth and development of some sensitive crops that its deficiency symptoms have become house-hold names. For instance, 'brown heart' of turnip, `crown and heart rot' of sugar beets, 'hollow stem' of cauliflower, 'internal cork' of apple, 'tip burn' of lettuce, `cracked stem' of celery, and `hollow heart' in groundnut kernels are the nutritional disorders associated with B deficiency. Knowledge on B deficiency symptoms can help in diagnosis of its deficiencies. It may be kept in mind that by the time deficiency symptoms appear, damage in terms of yield reductions has already occurred. Adverse effects on yield and quality of crops can occur even in absence of appearance of deficiency symptoms on the foliage because of "hidden hunger". This is very explicit in B nutrition and is often the reason for reduction in crop productivity. It is a must for B that the diagnosis based on visible deficiency symptoms should be corroborated with the results of soil tests and plant tissue analysis.

Boron deficiency is prevalent in more than 80 countries across the globe including India. In a global survey conducted for the Food and Agriculture Organization (FAO), M. Sillanapa reported in 1982 that either Zn or B deficiencies plagued almost all the countries of the world. In India, analysis of more than 200,000 soil samples, collected during 2011-17 with the help of GPS, revealed that zinc deficiency prevailed in 35.6% soils followed by boron deficiency in 23.4% soils. Figures for Zn and B deficient soils rise to 51.6% and 44.7% with inclusion of soil samples in the latent (marginally) deficient category. Thus B deficiencies are closely following those of Zn. The extent of B deficiencies shows inter-state variations, with B-deficient samples ranging from 3% in Rajasthan to 60% in Jharkhand. In states like Jharkhand, Odisha, Karnataka, Jammu & Kashmir, Himachal Pradesh, Manipur, Meghalaya, Mizoram and West Bengal with large area under acid soils, B deficiencies range between 35% and 60%.

India is one of the leading countries in micronutrient research, particularly on zinc and boron. A large number of on-farm and off-farm trials have been conducted during last 30 years to evaluate crop response to B application under varying soil types and crops. The results of these trials have been validated by crop demonstrations at farmers' fields. Information related to suitability of source, rate and

method of B application in crops and cropping systems has been made available under varying agro-ecological conditions. The result of a large scale research trials and field demonstrations in India has established the advantage of B application in terms of increase in yield and quality.

Since, boron is applied in very small doses there is always a problem of uniform application when applied individually. Use of fertilizers fortified with B ensures uniform mixing and spread of its small doses in the soil with no additional expenditure on operation. The procedure of inclusion of new fertilizer products in Fertilizer (Control) Order 1985 has been simplified and a number of B containing products which include straight micronutrient fertilizers, fortified fertilizers, multi-micronutrient mixtures, customized fertilizers and 100% water soluble mixture of fertilizers have been included in FCO during last 10 years.

Government of India is couscious of the fact that the increasing deficiencies of micronutrients, particularly Zn and B, have started adversely impacting the crop response to applied major nutrients N, P and K. In recent years, some policy initiatives have been undertaken to promote the use of micronutrients. The Government encourages the production and availability of B-fortified fertilizers. Under the Nutrient Based Subsidy (NBS) Scheme, additional subsidy of Rs. 300 per tonne is being provided to the manufacturers for fortification of fertilizers with boron. Further, government is also providing an assistance of 50% of the cost limited to Rs. 500 per hectare under National Food Security Mission for the use of micronutrients including boron. In crop and area- specific customized fertilizers (CF), it has been made mandatory for

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manufacturers to add all the deficient micronutrients in soils including B in the CF formulations.

The very low use efficiency of boron (seldom exceeding 5%) continues to be an area of concern and concerted efforts are needed to develop economic sources and efficient management practices. Boron doses need to be calibrated carefully because of very narrow differences in rates associated with its deficiency and toxicity. Since, B is the only micronutrient that affects all the components of horticulture (yield, quality, post-harvest life, disease resistance and use efficiency of other inputs), it must be accorded the highest importance to derive the maximum benefit. By and large, optimum dose of B for soil application varies between 0.5 kg B ha^{-1} for less responsive crops like cereals and 2 kg B ha^{-1} for more responsive crops like fruits, vegetables and oilseeds. Reproductive parts need 2-3 times more B than the vegetative parts. Hence, foliar spray of boron, particularly in horticultural crops, should become part of universal package of practice.

There is a lack of authentic information on actual consumption of B carriers/ fertilizers in the country as the production and sale of micronutrients is largely limited to the unorganized sector. The consumption figures provided by State Governments during *kharif* and *rabi* zonal conferences are also tentative. According to recent FAI estimates, the annual consumption of B fertilizers is about 28,000 tonnes. This is extremely low compared to the estimated requirement of over 160 thousand tonnes. There are large inter-state variations in boron consumption. Four states namely, West Bengal, Karnataka, Maharashtra and Bihar account for over 2/3rd of the total B consumption in the country. At national level, average per hectare boron use is only 139 g which is far below the B removal by crops. The current practice of suboptimal use of B will accelerate the depletion of available B from soil reserves and accelerate the appearance of B deficiencies.

There is a case for reduction of GST rate on micronutrients including Boron from 12% to 5%. The proposed rate of 5% on micronutrients be applicable for thei use in agriculture production. State Governments should develop the mechanism to get authentic and reliable figures for season-wise consumption of micronutrients, particularly Zn and B. The extension machinery of state governments should educate the farmers on benefits of boron application and difference between balanced and toxic doses. Even the extension workers need to be educated about various aspects of boron deficiency and its appropriate application. Regular training programmes should be organized for extension workers and dealers to update their knowledge. The extension literature (charts, booklets, leaflets, etc.,) on boron should be developed and distributed among the field staff and farmers belonging to the B-deficient areas. Finally, improving boron use efficiency should constitute the priority area of future research.■