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DIAGNOSIS AND CORRECTION OF BORON DEFICIENCY

Sunil Kumar[1], Kishore Kumar Das[2] and Dinesh Kumar[3]

[1&3]Department of soil science and agriculture chemistry, [2]Department of Horticulture, S.K. Rajasthan agriculture university Bikaner, Rajasthan -334006

Email of corresponding author - sunilsngwn7@gmail.com

Introduction: Boron is an essential micronutrient and required for optimal growth and development of higher crop plants**.** Its deficiency in crop plants is widely spreading in many countries of the world, especially in calcareous soils of arid to semi-arid regions (Welch *et al.*, 1991). In Indian soils, deficiency of boron is 33 per cent which is wide spread particularly in alluvial soils of India.

Identification of boron deficiency

Boron is very vulnerable to leaching, so its deficiency can temporarily be expected in country India during and after monsoon rains, especially in coarse textured soils. In India, laterite and lateritic soils have been widely reported for the deficiency of B. Boron deficiencies are also more pronounced during drought periods when root activity is restricted. Once B has accumulated in a particular organ, it has restricted mobility in most plant species but not all. Boron is immobile in plants, so its deficiency symptoms develop firstly, and are more severe, on young leaves with marginal, dull yellow chlorosis at the tip of young leaves. Because B plays an important role in the elongation of stems and leaves, stems of B deficient plants are short and stout. If B deficiency is severe, many tillers can die before maturity, or whole plant may die before producing heads. Boron deficiency also manifests itself in poorly developed stamens, blast of pear blossoms, inadequate fruit set, bark necrosis of apple, corking in the fruit, and cracking of fruit. When leaf B levels are in the range of 20 to 25 mg B kg^{-1} (desired is 35 mg B kg^{-1}) on a dry-weight basis, supplemental B is needed. Boron is taken up from the soil only at higher soil temperatures than are other elements. Most values of the critical concentration for B deficiency range from 0.15 to 0.50 mg kg^{-1} soil (HWE – hot water extractable). However, in highly sensitive crops and alkaline clay soils, these values can double. This is because, B sorption increases to a maximum between pH 7.5-9.5. Hence, the critical range of extractable B is generally higher in alkaline soils (Mengel, Kirkby 1987).

Sources, rates, methods and timing of boron application

There are eight different sources of B [borax ($Na_2B_4O_7.10H_2O$ with 11% B), solubor - $Na_2B_8O_{13}.4H_2O$ (20% B), sodium borate ($Na_2B_4O_7.5H_2O$ with 20% B), sodium tetraborate ($Na_2B_4O_2.5H_2O$ with 14% B), boric acid (H_3BO_3 with 17% B), Colemanite ($Ca_2B_6O_{11}.5H_2O$ with 10% B), B frits containing 2-6% B, and boronated superphosphate being used to prevent/correct B deficiency in crops. Borax, solubor, sodium borate and sodium tetraborate have been most commonly used for soil application. Boric acid, colemanite and B frits are considered to be more promising on highly leached sandy soils as well as for long duration field crops including perennial forages and fruit plants owing to their low solubility and slow release of B. Boronated superphosphate has also been tried to correct B deficiency in crops.

Among these B fertilizer sources, borax is the most commonly used B fertilizer to prevent and/or correct B deficiencies in crops. Because of the narrow margin between B sufficiency and toxicity, an excess dose can easily occur and harm plant growth (Rashid 2006). Therefore, extreme care is needed to apply the correct dose of B fertilizer and to distribute it uniformly. Boron application rates generally range from 0.25 to 3.0 kg B ha^{-1}, depending on crop requirement and the method of application. Higher rates are required for broadcast applications than for banded soil applications or foliar sprays. Because B is immobile in plants, B deficiency in crops growing in soils with marginal B levels can occur during peak growing periods (vegetative, flowering, and seed development stages), so a steady supply of B throughout the growing season is essential for optimum growth and seed yield. Foliar fertilization is also an effective way to supply B to plants, especially when root activity is restricted and B deficiency in crop appears under dry soil conditions in the growing season. Experiments regarding the effect of B on yield, mobility and stress tolerance in different crop species revealed that B significantly enhanced yield and it was attributed to the significant increase in the panicle fertility. In extreme cases, crops on low B soils grow well until flowering when floral abortion or seed set failure can result in severe yield losses. Boron deficiency at critical stages of reproductive development has been shown to cause pod abortion with poor seed setting in wheat in Western Australia. Boron application at the onset of reproductive phase was found to be more effective, most likely due to its immobile nature in the plants depending upon the photosynthetic efficiency of the plants. Relatively small amounts of B that are normally required to make significant improvements in B status of annual crops, namely 1–2 kg B ha^{-1}, are in broad accord with such recovery rates. For many crops, absorption of 100–200 g B ha^{-1} of applied B could be expected to be sufficient. Application of 10 kg of boric acid ha^{-1} (1.7 kg B ha^{-1}) or 18 kg of borax ha^{-1} (2.0 kg B ha^{-1}) proved to be effective for 4-5 years in order to cure B deficiency in rice, wheat and cotton soils. It was found that in case of cotton, 0.1% solution of B would be economical if used with insecticides foliar sprays. Value cost ratios (VCR) for B use in these crops have been very good , particularly in the case of cotton, where it ranged from 5:1 to 13:1 by soil application and 20:1 by foliar application of B. It was revealed that application of B significantly boosted rice yield, mainly because of increase in the panicle fertility. Boron may safely be applied to orchard crops at a rate of 0.56 kg B ha-1 as a maintenance dose and at a rate of 1.12 kg B ha^{-1} as a deficiency dose and its residual effect has generally been reported for at least two years. In the case of borax, application rates should not exceed 90 g borax per orchard tree. In India, soil application of B at 20 kg sodium tetraborate to supply 2.8 kg B ha^{-1} as well as two foliar sprays with 0.2% solution of this salt proved equally effective in increasing soybean grain yield and the residual effect of soil applied B on subsequent wheat crop was significantly higher as compared with direct foliar B application. Since B undergoes less leaching in fine-textured soils, single application may produce residual effect. In view of very sharp and narrow difference between optimum and toxic levels of B, more precaution is needed in its repeat application, particularly in medium- to fine-textured soils. Boron deficiency is also invariably corrected by its soil application depending upon soil type. In calcareous soils of Bihar, the rate varying between 1.0 to 2.5 kg B ha^{-1} has been found to be optimum for different crops. (Wong 2003).

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