Boron the Mighty Micronutrient!

Dr. Tarlok Singh Sahota CCA

Boron is one of the 17 essential nutrients (considering cobalt as an essential nutrient as well). Continuous/aggressive cropping with high yielding varieties, without additions of micronutrients, including boron, is leading to increased micronutrient deficiencies in crop plants. Boron deficiency is fairly wide spread in North America. Response to boron application has been reported from at least 43 states in USA and throughout Canada. Even though it is (i) required in small amounts in the plants tissue (30 ppm in canola at flowering as well as top 15 cm of alfalfa at 10 % bloom and only 5 ppm in cereals whole plants before filling) and (ii) removed in small amounts by crop plants from soils (100 gram/ha by alfalfa and barley grains, 700 gram/ha by corn grains, 60 grams/ha wheat grains, 70 grams/ha peas-vines and pods and potatoes), its deficiency in soils and crops can cause serious physiological damage, retard plant growth and bring in substantial reduction in crop yields even when other nutrients are applied in sufficient quantities and the deficiency symptoms of boron are not clearly seen on crop plants. For example, in legumes, boron deficiency, without any visible symptoms, can reduce the legumes seed yield by 40-50%.

Deficiency Symptoms of Boron: The symptoms of boron deficiency vary with crops. In soybean or peanut, boron deficiency often induces an internal empty space known as "hollow heart". Legumes sown in boron deficient soil have a poor rate of germination. More seed must be sown, and seedlings are stunted. Alfalfa grown in boron deficient soils, exhibits reduced root and shoot growth and yellow, red or purple discoloration on the upper leaves. In apples, boron deficiency causes internal corking, while shoot tips form a rosette shape. Papayas with boron deficiency have lumpy fruit. Crooked stem in celery and 'Black Heart' (heart rot) in sugarbeets are signs of boron deficiency. In canola, symptoms of boron deficiency can be confused with that of sulphur. In boron deficient tissues, cambial cells cease to divide. Boron deficiency is known to inhibit protein synthesis. *In general, a common consequence of boron deficiency in all crops is an interruption in flowering and fruiting, so that yields are poor and the fruit or grain is deformed or discoloured.*

Functions of boron in plants: Boron plays an important role in sugar transport, cell wall synthesis, lignification, cell wall structure, respiration, metabolism (of carbohydrate, RNA, IAA and phenol), membranes, root growth, pollination (pollen tube growth and elongation, pollen production and viability and germination of pollen grains), plant maturity and disease resistance. In fact, boron is the only nutrient that plays the most important role in crop pollination. Boron also influences the colonization of Mycorrhiza at the root surface and thereby influences P (as also K) uptake. It also regulates K/Ca ratio in plants. Research in USA has shown that boron is important in nitrogen fixation and nodulation in legumes. Boron plays an important role in plant diseases control. It synthesizes lignin as a pathogen barrier and restricts fungal hyphae from movement through the cell walls. Boron application is reported to decrease rust in wheat and control postharvest gray mold in grapes (caused by *Botrytis cinerea*) by strongly inhibiting spore germination, germ tube elongation, and spread of mycelia. Deficiency of boron could result in pollen sterility and thus increase ergot risk in cereals. In Finland and also in Canada, boron deficiency has been reported to increase ergot severity. Barren corn stalks and unfilled tops in corn cobs could be a strong pointer to boron deficiency! It may be worth mentioning that U.S. corn growing champion David Hula had included boron in his fertilizer mix for obtaining record breaking yield of grain corn (454 bushels per acre) in 2013.

Boron in Soils: In soils, boron is present in four forms: (i) as soluble boric acid or H_3BO_3 in the soil solution that is directly plant-available, (ii) mineral boron, released in the soil on weathering of minerals, (iii) adsorbed by the clay minerals and iron hydroxides; released to the soil solution upon desorption, and (iv) in organic matter; released to the soil solution upon microbial decomposition of the organic matter. However, the largest amount of boron in the soils is found in the organic matter; decomposition of which will be slow in cold weather/regions such as ours. Solubility of boron (as also root activity in surface soils) is restricted under dry weather conditions which can lead to temporary deficiency of boron in crops even when boron is present in sufficient amounts in the soils. A good rain will fix such a situation. For example, an alfalfa crop with shorter internodes, as a result of boron deficiency due to dry weather, will outgrow that stage after a good rain; the new internodes will be of normal length though the older shorter internodes will remain short. In the acidic soils, boron is more water-soluble and is therefore liable to leaching below the root-zone. This season, boron content in whatever soil test reports I have seen from Thunder Bay so far ranged between 0.1-0.4 ppm which is extremely low (acidic soils and good amount of rainfall last year; both conducive to leaching!). Liming of the acidic soils to improve soil pH could restrict boron availability. Maximum availability of boron is at a soil pH of 6.0-6.5. The most common soil test for boron is the hot-water-soluble test, which is more difficult to conduct than most other micronutrient soil tests, but most crops' response to boron has been correlated with it. Though not accredited in Ontario, I found it quite useful for making recommendations on application of boron to field crops. For adequate supply of boron to crops, soils should have at least 1.2 ppm boron. Boron deficiency is most common in coarse textured (sandy) soils that are low in (i) organic matter and (ii) boron containing minerals.

Correcting boron deficiency: Deficiency of boron could be corrected by its soil or foliar application. Generally speaking, micronutrients uptake is rapid during early growth and there is a gradual dilution as the plant matures. Therefore, it is advisable to apply boron at seeding @ 2.5 kg boron/ha in soils highly deficient in boron (<0.4 ppm) and @ 1 kg boron/ha in soils deficient/ or marginal in boron (0.4-1.2 ppm). Higher amounts could also be applied to crops that show high response to boron application (alfalfa, apple, cotton, peanut, sugarbeet, sweet potato, tomato, cauliflower and celery) and lower amounts could be applied to crops that are low (cereals, soybean, potato, grain sorghum, pasture grasses and blueberries) or medium (carrots, corn, clover, lettuce, radish and citrus) in response to boron application. Because of relatively low amounts of recommended boron, and a narrow range between deficiency and toxicity of boron, it is advisable to blend boron with other fertilizers that are applied at seeding to ensure its uniform application/and optimum nutrition. Borax (15 % boron) and Solubor (20 % boron) are good fertilizer sources of boron. Boron deficiencies at later stages of crop growth (e.g. flowering) could be corrected by spray application of boron @ 1 kg/ha. Toxicity of boron is often dreaded. However, there should be no cause for alarm as long as the amount of boron in soils does not exceed 5 ppm and the amount of applied boron is no greater than 2.5 kg/ha.

Published in Ontario Farmer (November 18, 2014): 48 (37), Page A33 and in Northwest Link June 2014, Pages 7-9!