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TRUSTED CROP NUTRITION EXPERTISE℠

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Boron – How to Extend Nutrient Availability

The Challenge with Boron Management

Although boron (B) is considered the most deficient micronutrient in the world after zinc, dynamics of B use in plants and soils have continued to perplex farmers, agronomists and researchers for decades. In short, B is a micronutrient that's needed in relatively small quantities; in fact, the narrow range between deficiency and toxicity in most plant species means the highly concentrated nature of common B sources can easily lead to undesirable distribution across a field. Furthermore, the soil-mobile nutrient B is commonly applied in a form that's immediately soluble and susceptible to loss at the time of application, which means ensuring season-long availability can be difficult. For these combined reasons, tempered overall yield responses to B have been observed. Keeping this challenge in mind, this document raises awareness of factors affecting yield response to B, and introduces new technologies available for B management.

What Do We Know About Boron?

Agronomically speaking, the ideal B management program should consider factors such as crop, soil type, environment and B fertilizer source. Any source that contains B in the form of sodium borate is considered highly soluble with commercially available products in both dry and liquid forms. On the contrary, nutrient sources that contain B in the calcium borate form generally exhibit intermediate- to slow-release properties (Mortvedt and Woodruff, 1993). These release characteristics influence mobility in the soil, which is unrelated to nutrient mobility in the plant. Boron is considered immobile in plant tissue except for crops that transport sugars in the polyol form (e.g., tree fruit crops), and this fact should be considered when selecting the most appropriate B source (Brown and Shelp, 1997).

Some growers prefer to deliver a portion or all of their B needs using foliar applications due to the convenience of a 'free pass' when combined with a crop protection or irrigation application, and the fact that this approach typically leads to the quickest response from a tissue-test standpoint. Others prefer dry B applications due to one or more of the following reasons: 1) Growers can usually supply higher application rates; 2) dry sources are generally more economical on a cost per unit of B; 3) root uptake ensures the plant can partition B to the plant tissues that need it most; and 4) dry sources can lead to more consistent yield responses.

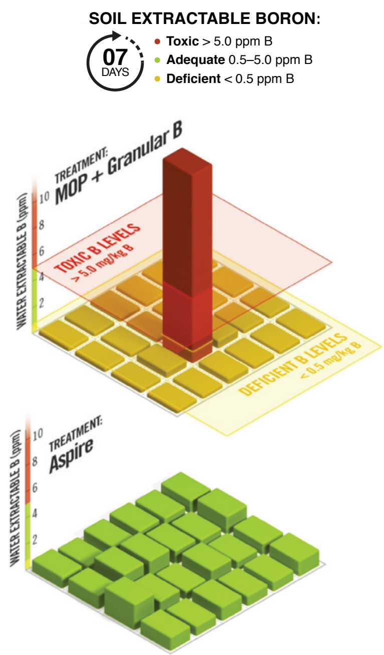

Fig. 1. Water-extractable B measured in the soil after seven days, comparing a MOP + B blend to MOP co-granulated with B (marketed as "Aspire®") with the same amount of total potassium and boron. Yellow, green and red indicate deficient, adequate and toxic levels, respectively. Adapted from da Silva, et al. (2018).

New fertilizer technologies have improved boron management by providing improved nutrient distribution, season-long B availability and a more flexible application window.

What New Tools Exist That Provide Uniform B Distribution?

To quantify limitations associated with conventional, dry B nutrient sources, da Silva, et al. (2018) evaluated how different fertilizers influence B distribution and thus availability to plant roots. This study compared a conventional muriate of potash (MOP) + granular B blend to a treatment with the same amount of total B (though co-granulated with MOP) and found that co-granulated fertilizers more uniformly provide "adequate" B across the entire soil landscape (Figure 1). In other words, management of micronutrient sources is less likely an application-rate issue, but instead a function of limited nutrient distribution.

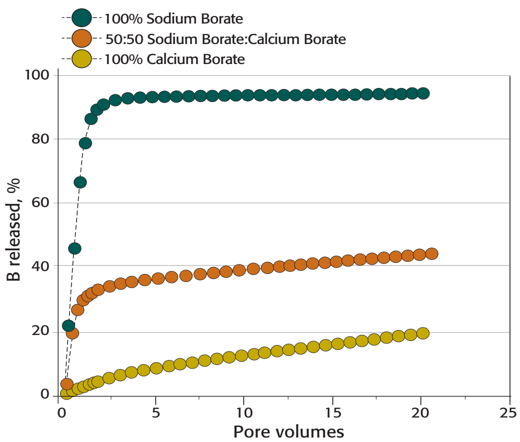

Fig. 2. Cumulative B released through a sandy Entisol (Mt Compass soil type) in a column study as influenced by B source and amount of simulated precipitation. To promote nutrient release, "pore volumes" of distilled water were added to a test tube to simulate precipitation. Higher values indicate greater nutrient release, while color differences correspond to differences in B source. Note: All B sources were co-granulated with MOP. Adapted from da Silva, et al. (2018).

When Do Plants Need B Most?

In addition to nutrient distribution, adequate plant availability is also influenced by solubility properties of different B sources. Season-long availability is critical in grain crops like corn (Bender, et al., 2013) and soybean (Bender, et al., 2015), which require B for plant development during critical vegetative and reproductive growth phases. While sodium borate–based fertilizers are immediately plant-available at the time of application, their highly soluble nature can make them subject to loss by leaching, and this B may not be available for late-season plant demands (Figure 2). On the contrary, more slowly soluble

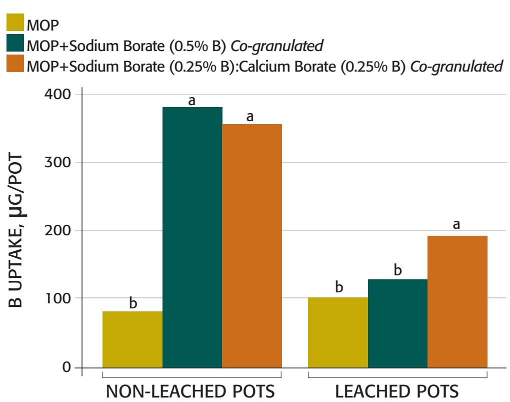

Fig. 3. Effect of B source on B uptake for canola grown with or without leaching prior to planting. All treatments with B received the same amount of total B; only the source differed. Lowercase letters on top of each bar in the chart above show statistical differences at the 0.05 level. Adapted from da Silva, et al. (2018).

B sources (e.g., those with calcium borate) may provide adequate B for late-season plant requirements, but there is a risk of B not being available quickly enough for early-season plant needs. According to da Silva, et al. (2018), the increased nutrient uptake associated with two forms of B (Figure 3) may be the most effective solution to ensure season-long plant-available B and to provide the most flexible application window. A new fertilizer technology, marketed as "Aspire®," uniformly distributes these same two forms of B for optimal plant growth and yield.

Conclusions

Due to complex soil chemistry and plant physiology, B can be a difficult nutrient to manage. However, any fertilizer technology or application method that can ensure adequate availability to each and every plant will lead to improved agronomic effectiveness and plant response to B. In short, new fertilizer technologies have improved boron management by providing improved nutrient distribution, season-long B availability and a more flexible application window.

Further Readings

Bender, et al. 2013. Modern corn hybrids' nutrient uptake patterns. *Better Crops with Plant Food.* 97:7–10.

Bender, et al. 2015. Modern soybean varieties' nutrient uptake patterns. *Better Crops with Plant Food.* 99:7–10.

Brown and Shelp. 1997. Boron mobility in plants. *Plant and Soil.* 193:85–101.

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