ALFALFA TISSUE AND SEED YIELD RESPONSE TO APPLIED BORON

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ABSTRACT

Alfalfa seed production can be limited by low boron (B) and information on tissue tests used for indicating B needs is lacking. Alfalfa seed trials were conducted in 2007 and 2008 in a silt loam to compare B concentrations in reproductive tissues (buds and flowers) with more traditional upper stems for reflecting available B. Factorial combinations of mid April knifed-in B (main plots) at three rates and four subplot foliar B timing treatments (non-treatment or 0.4 lb B/A at bud, flowering, and both bud and flowering) were evaluated in a split plot arrangement with four replications. Upper stem, bud or flower tissue B at pre-bud, bud and flowering were determined. Seed yield increased in 2007 with 0.46 lb B/A knifed deeply into furrow bottoms but was not significantly affected by foliar B. Foliar B at flowering increased seed yield in 2008 with no previous B applied but was excessive and decreased yield if applied in conjunction with previous soil or bud stage applied B. Seed germination and B concentrations were unaffected by B treatments. Alfalfa tissue B concentrations did not reflect soil applied B rates. Foliar applied B increased alfalfa tissue B concentrations only when sampled within a few days of the application. Reproductive tissue B concentrations provided no advantage over upper stem tissues for indicating B shortages for seed production. Tissue testing for B does not provide a reliable means to predict seed yield response to applied B.

INTRODUCTION

Boron (B) is known to be important for alfalfa seed production as adequate B is essential for cell division of meristematic tissue and growth of the tissue from the transport of sugars. It is particularly critical for reproductive growth as it helps regulate hormones affecting flower initiation and fruit growth. Boron affects flower production and retention, pollen tube growth and germination, and seed development.

Boron is poorly translocated within the plant; movement from older vegetative tissue to meristimatic tissue (developing flowers, pods, and seed). Early season B applications for vegetative growth (forage) may not be as effective for seed yield as applications closer to seed set. For flowering occurring over an extended period of 3 to 5 weeks, even late bud applications may not be optimum.

The optimum timing and means for providing B are not established for southern Idaho alfalfa seed production. Previous research at Parma has shown alfalfa seed yield to be responsive to either B applied alone or with other micronutrients in single applications at late bud or early bloom. There is less information on the need for multiple applications, or the risk of excessive B reducing seed production. Recent reports suggest seed germination may also be improved with foliar B (Dordas, 2006). In our previous studies, higher seed yields with applied B were due primarily to more harvestable seeds, suggesting either more flowering or better flower and pod survival.

Unfortunately, soil and tissue tests developed for forage yield are not very useful for predicting needs during seed development (Dordas, 2006). Tissues historically used for forage alfalfa include whole plants, mid stems and upper stems. Since B can be particularly important for flowering, seed set and fruiting, we wondered if reproductive tissue, buds and flowers, might be more indicative of plant B status for seed production.

OBJECTIVES

Our objective was to conduct a study that would allow us to investigate B method and timing while also enabling the comparison of bud and flower reproductive alfalfa tissues to upper stem tissues for indicating B adequacy for seed production.

METHODS

Field trials were conducted in 2007 and 2008 on a silt loam where alfalfa was already established for seed production. The alfalfa was cultivated in rows spaced 21" apart and furrow irrigated once each season using corrugates spaced 42" apart and centered between every other row. Treatments were factorial combinations of early spring soil injected B (main plots) and four foliar B treatments (none, bud, flower, or bud and flower stage applied B at 0.4 lb Solubor B/A) which were subplots of the split plot design. In main plots B as Solubor was injected in corrugate centers to a depth of 6-8 inches on April 20 (2007) or Aril 21 (2008) at rates of 0, 0.23 and 0.46 lb B/A in 2007 and 0, 0.44 and 0.88 lb/A in 2008. The injected soil B main plots were irrigated once within a few days to activate soil applied herbicide and the irrigation also likely moved B deeper into the soil. Foliar treatments were applied at early bud on June 4, 2007 and June 9, 2008 and at full flower on June 12, 2007 and June 28, 2008. Individual plot size consisted of six rows wide and 80' long.

Alfalfa upper stems were sampled at pre-bud (June 4, 2007 and June 6, 2008) prior to foliar B and upper stems, buds and flowers were sampled at bud (June 12, 2007 and June 25, 2008) and full flowering (June 27, 2007, and July 7, 2008). Tissue samples were not rinsed before oven drying. Tissues were ground and total B determined by the UI Analytical Services Lab.

Other than the B treatments, the alfalfa in the trials was managed (weeds, insects, water, defoliation) as the rest of the field by the grower. Production was measured after defoliation using a small plot combine from the four middle rows of each plot. Seed was screened initially using a seed clipper, and final seed weight was recorded after cleaning with rice rollers. The two hundred seed weight and germination of the cleaned seed were also measured.

RESULTS AND DISCUSSION

Soil test B (hot water extractable) in April measured 0.47 ppm in 2007 and 0.48 ppm in 2008 in the first foot. Seed production was average in 2007 but excellent in 2008. Soil applied B increased seed yield in 2007 ($P>F=0.011$) but not in 2008. However, there was a significant soil x foliar treatment interaction (Figure 1) in 2008 ($P>F=0.05$). Without foliar B, seed yield increased 15% (2008) with the highest soil applied B rate, similar to 2007. In contrast the highest seed yields with foliar B applied at flowering occurred with the lowest soil applied B rate. Flowering stage foliar B increased yield in previously untreated soil only in 2008. The data suggest that a combination of both soil and foliar applied B were excessive for seed production in 2008. A yield decline from combined B applications was not evident in 2007 possibly because soil applied B rates in 2007 were roughly half those in 2008. The lack of a consistent seed yield response to foliar B in 2007 is puzzling and the results contrast with our previous

experience and a recent published account (Dordas, 2006). The data do not provide a clear indication of the consistently most effective timing for foliar B to be applied.

The results suggest that hot water extractable B at 0.47 and .48 ppm in the first foot are not adequate for maximum seed production. However, since water is typically withheld during the bud stage to induce greater bloom, the first foot of soil is likely dry in most southern Idaho alfalfa seed fields during late bud and bloom. Consequently, root activity is likely greater at deeper soil depths during bloom and extractable B from soils in the first foot may not be as useful as B in deeper soil samples.

Alfalfa seed germination averaged 97% and was unaffected by B treatments, unlike the Dordas report (2006). The cleaning procedure was not indicated in the Dordas report (2006). The seed evaluated for germination in our study was seed cleaned by a commercial seed processor and was likely more thoroughly cleaned and the lightest seed discarded. This may also account for the lack of difference in seed weight in our study due to applied B. Seed B concentrations in 2007 were also unaffected by B treatments, consistent with our previous experience.

Pre or early bud upper stem B concentrations actually decreased in 2007 and 2008 with the highest soil applied B rate (Figure 2). Furthermore, both upper stem and bud tissue B at full bud or upper stem and flower tissue at flowering also failed to reflect increased available B from April soil applied B. Stem tissues at the bud stage had higher B concentrations than bud tissues. Surprisingly, tissue B was only affected by bud stage foliar applied B in 2007 when samples were collected 8 days after the application, consistent with a previous report (Dordas, 2006). In contrast, bud stage tissue B on June 25 in 2008 did not reflect the June 6 foliar applied B. By flowering, tissue B concentrations both years did not differ with early June foliar applied B.

The inability of tissue B to reflect earlier soil or foliar applications is due to B washed from the plant by subsequent showers, or plant dilution from additional vegetative growth. Vegetative growth was not measured in these trials. Precipitation in 2007 totaled 0.83 inches (0.05 and 0.78) between the first foliar B and the subsequent tissue sampling. Precipitation measured only 0.05 inches in 2008 between the first foliar B and the subsequent tissue sampling. The results suggest that tissue B will not provide reliable estimates of B availability from soil applied B and only reflect foliar B applications if sampling occurs relatively soon after the application.

LITERATURE CITED:

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Boron in soils and plant nutrition. A practical guide to boron fertilization. 2002. US Borax Inc.

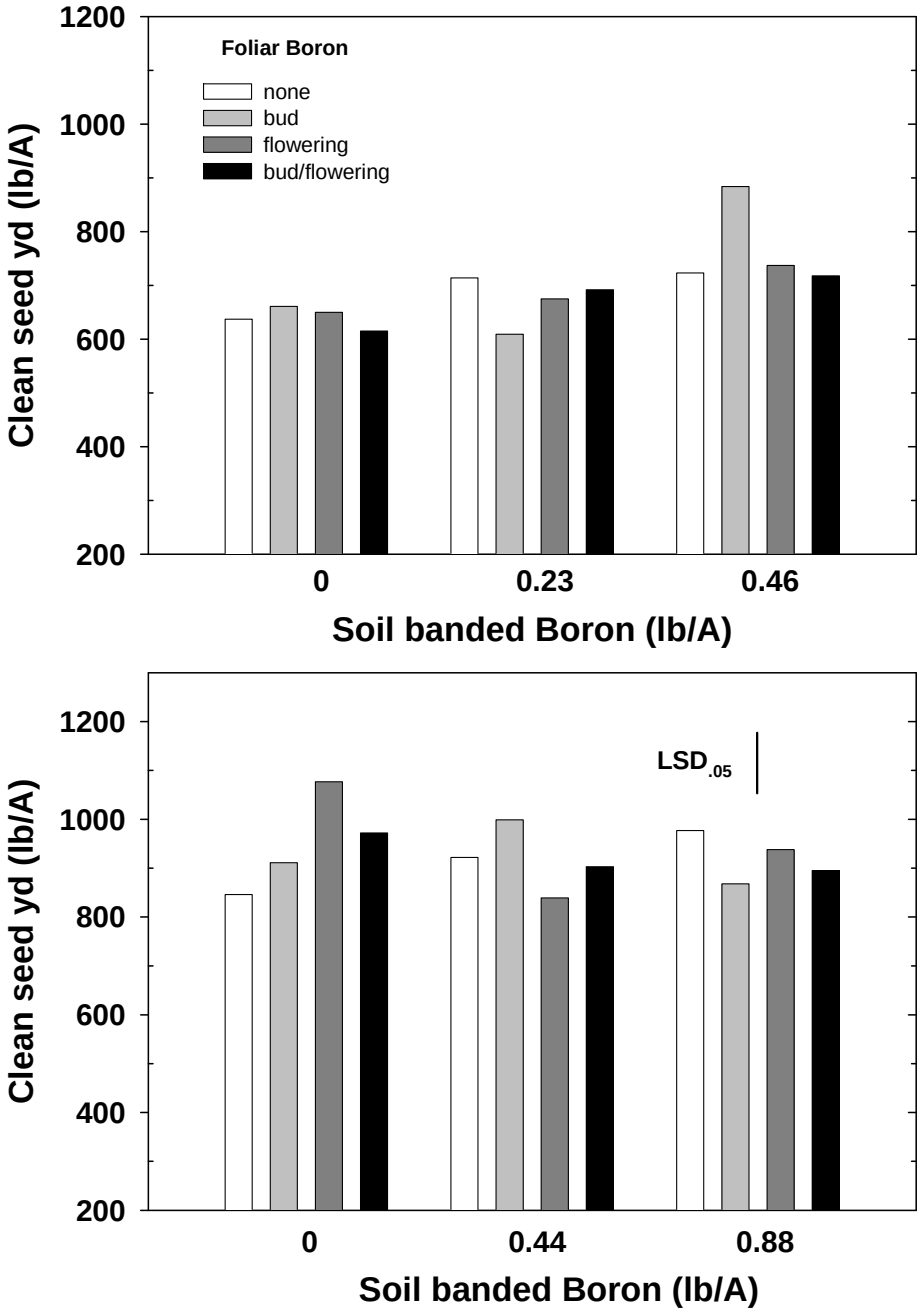

Figure 1. Seed yield as affected by soil injected and foliar B in 2007 and 2008. The legend for 2007 also applies to 2008. The $LSD_{.05}$ for 2008 is for interaction mean comparisons.

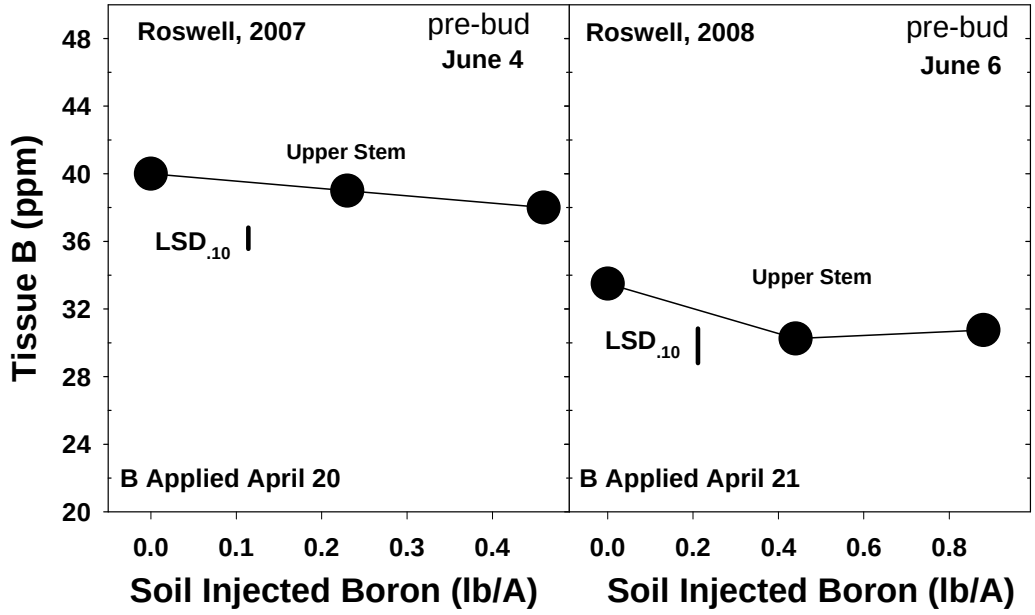

Figure 2. Alfalfa upper stem tissue B concentrations at the pre-bud stage in June of 2007 and 2008 as affected by soil injected B in April.

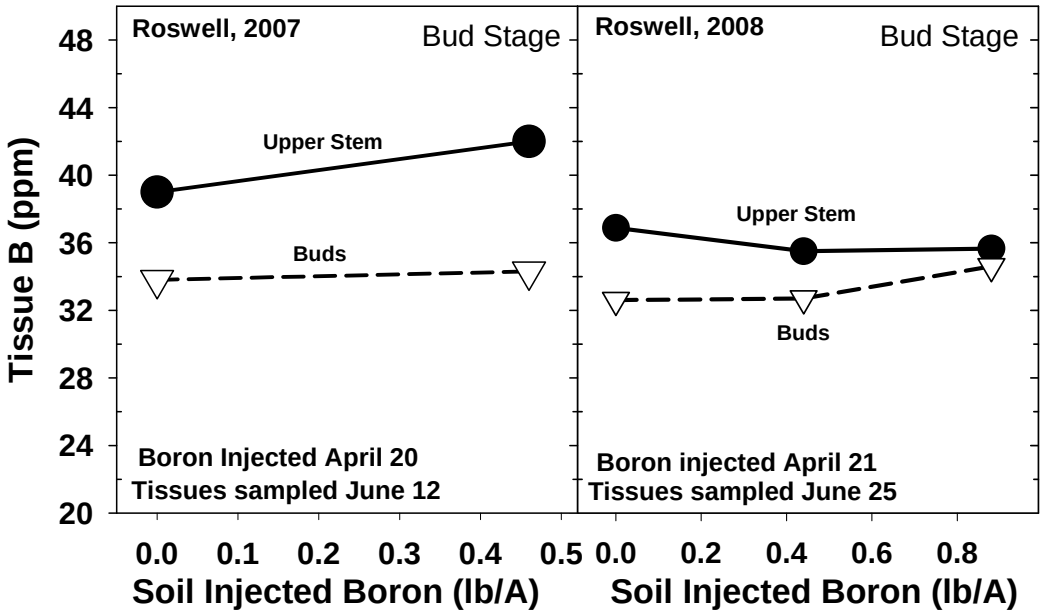

Figure 3. Alfalfa upper stem and bud tissue B concentrations at the bud stage in June of 2007 and 2008 as affected by soil injected B in April.

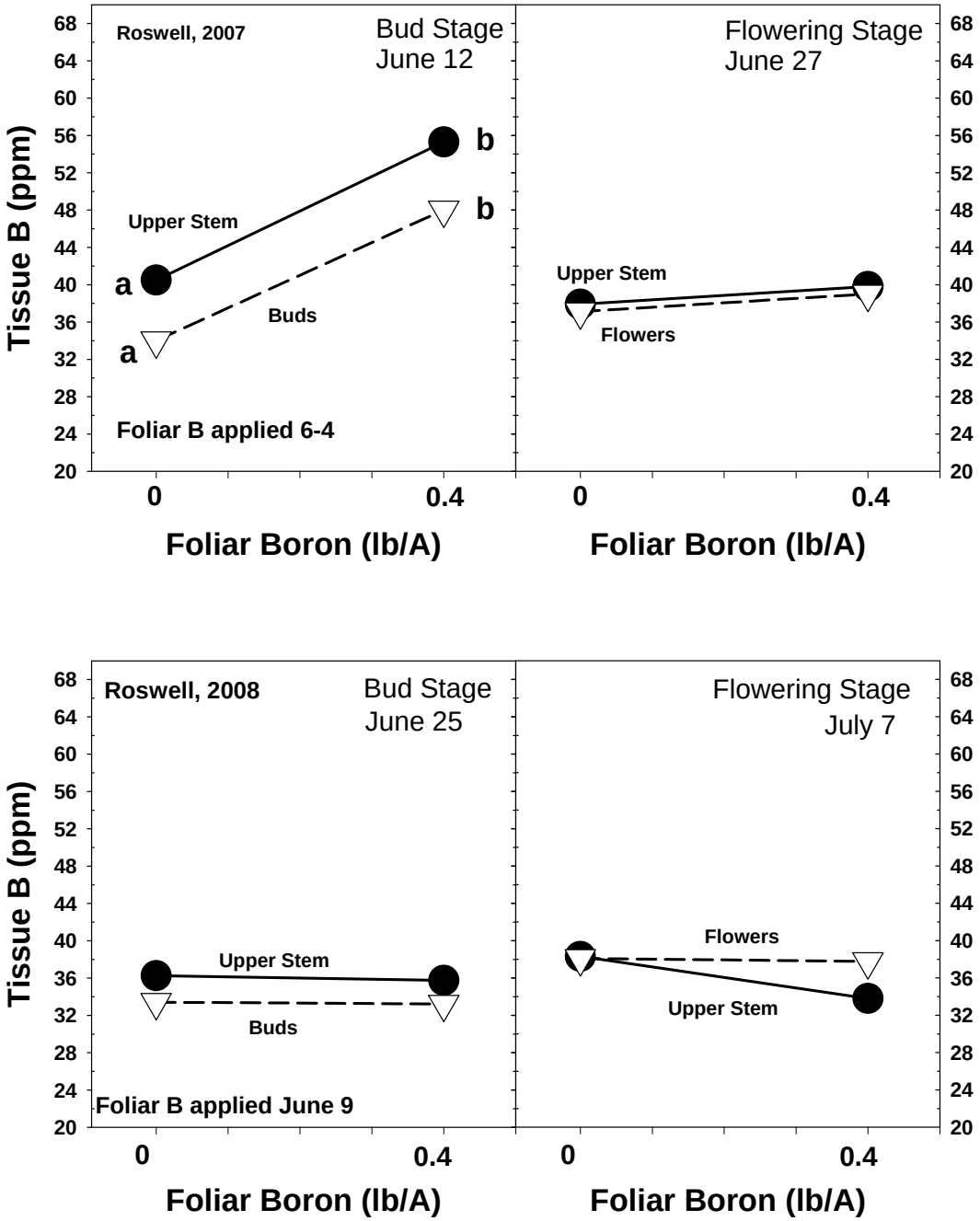

Figure 4. Alfalfa upper stem and reproductive tissue (buds or flowers) B concentrations as affected in 2007 and 2008 by foliar applied B at the early bud stage. Values are averaged across soil injected B treatments.

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