Boron Effects on Red Clover Seed Production and Quality

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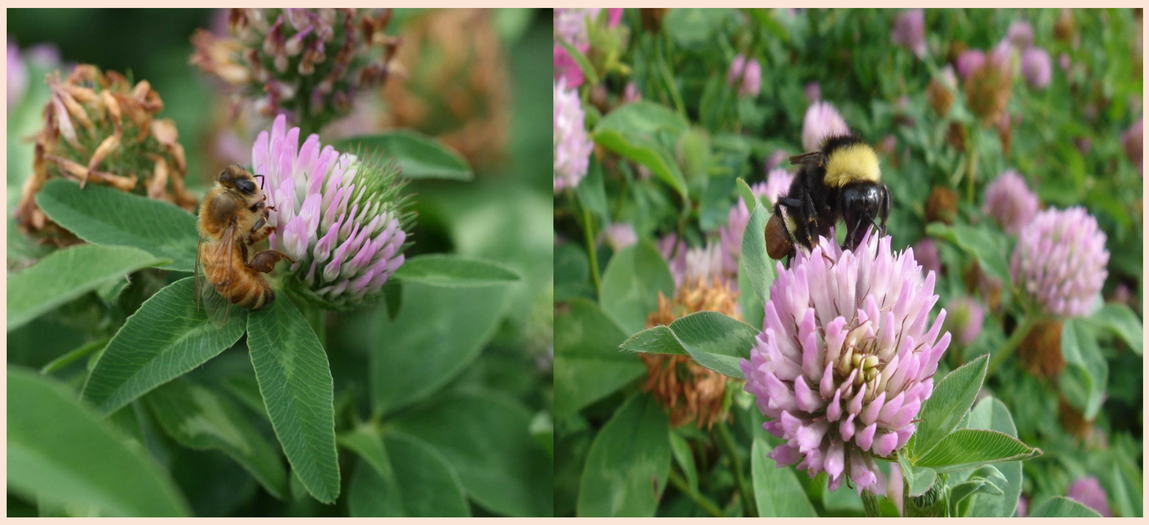
Introduction

Boron (B) is a critical micronutrient for many legume crop species, including alfalfa and clovers grown for seed. Red clover (*Trifolium pratense* L.) is Oregon's most important legume seed crop with yearly production averaging nearly 7,000 ha. Red clover seed yields in western Oregon typically range from 560 to 1,350 kg/ha $^{-1}$. Soils in western Oregon are commonly B deficient, containing less than 1 ppm B. B fertilizer applications are routinely made to 90% or more of the clover seed acres in the region.

Under mild to moderate deficiency, legume growth and development may not be severely affected, but seed yield may be reduced (Mozafar, 1992). When B is deficient, plants produce fewer flowers, and seed yield may be inhibited due to inadequate pollination (Mozafar,1993). Applications of B to clover have been shown to make flowers more attractive to pollinating insects by increasing nectar production and sugar content (Eriksson, 1979). Our objectives were to measure seed yield response to B application at different rates and timings and determine the effect of B on seed germination and vigor.



Methods

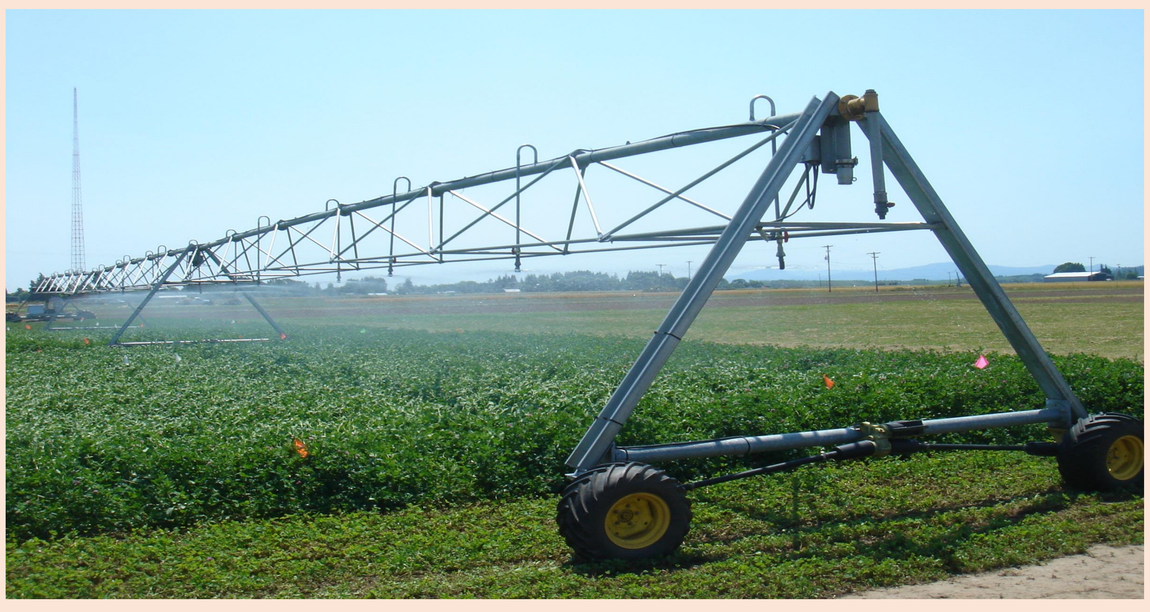
Trials were conducted near Corvallis, Oregon from 2011 to 2013. The experimental design was a randomized complete block with 3 replications. Each plot was 3.3 x 15.2 m. The pre-plant soil test B level was 0.3 to 0.4 ppm across the trial.

Five B treatments were employed in the study:

- Untreated control (no B)
- 1.1 kg B ha^{-1} soil applied at trifoliate stage (Fall)
- 2.2 kg B ha^{-1} soil applied at trifoliate stage (Fall)
- 1.1 kg B ha^{-1} foliar applied at 2 nodes (Summer)
- 2.2 kg B ha^{-1} split among the two timings (Fall + Summer)

Procedures:

- Plots were sampled for total above-ground biomass and B tissue concentration at three growth stages (2 nodes, peak bloom, and one day prior to harvest) after early May silage removal
- Small-plot swather and combine harvest, seed cleaned before seed yield and seed weight determination
- Standard germination, cold test, and accelerated aging tests (AAT) were performed
- ANOVA was conducted and means separated by Fisher's protected LSD values (P = 0.05)



Results

Fertilizer treatments increased plant tissue B concentrations by 66% in 2012 and 33% in 2013 when applied to foliage during summer. No increase in plant tissue B resulted from soil applications in fall (Tables 1 and 2). Increased plant tissue B concentration did not influence seed yield or seed weights at either B rate or application timing. Some transient effects on above-ground biomass were noted early in 2012.

There were no significant difference among treatments in any of the seed quality analyses (Table 3).

Table 1.Effect of rate and timing of B fertilizer treatment on seed yield and other characteristics of first year red clover seed crops in 2012.

Treatment	Yield	Seed Weight	Jun 27 biomass	Jul 24 biomass	Aug 21 biomass	Jun 27 tissue B	Jul 24 tissue B	Aug 21 tissue B
(B kg/ha $^{-1}$)	(kg/ha^{-1})	(mg)	----------(g/m^2)----------			----------(ppm)----------		
Control	892	1.69	478 ab	1647	1302	27.8	22.6 a	23.7 a
Fall 1.1	896	1.68	494 ab	1445	1230	29.0	19.3 a	22.8 a
Fall 2.2	876	1.70	543 b	1474	1865	28.6	22.1 a	22.2 a
Summer 1.1	812	1.75	427 b	1711	1619	27.7	37.4 b	37.0 ab
Split 2.2	893	1.72	555 b	1570	1412	27.4	52.6 c	37.7 b

Table 2. Effect of rate and timing of B fertilizer treatment on seed yield and other characteristics of second year red clover seed crops in 2013.

Treatment	Yield	Seed Weight	Jun 20 biomass	Jul 16 biomass	Aug 6 biomass	Jun 20 tissue B	Jul 16 tissue B	Aug 6 tissue B
(B kg/ha $^{-1}$)	(kg/ha^{-1})	(mg)	----------(g/m^2)----------			----------(ppm)----------		
Control	792	1.72	540	1091	982	25.4	27.7 a	32.3 a
Fall 1.1	740	1.78	642	1101	1050	26.0	24.7 a	25.9 a
Fall 2.2	750	1.76	636	1165	1027	24.1	24.8 a	30.1 a
Summer 1.1	712	1.74	628	1154	1015	24.7	65.3 b	35.2 ab
Split 2.2	766	1.73	537	1024	970	24.4	56.6 b	43.0 b

Table 3. Effect of rate and timing of B fertilizer treatment on seed quality characteristics of second year red clover seed crops in 2013.

	----------Germination test----------			----------Cold test----------			AAT
Treatment	Germ.	Hard seed	Total viable seed	Germ.	Hard seed	Total viable seed	Germ.
(B kg/ha $^{-1}$)	----------(%)----------						
Control	69	26	95	75	20	95	48
Fall 1.1	66	28	94	66	24	90	51
Fall 2.2	70	24	94	74	17	91	54
Summer 1.1	68	27	95	73	20	93	47
Split 2.2	64	29	93	73	18	91	50

Conclusions

The results of this study indicate that red clover seed crops are not adversely affected by B soil test levels in the range of 0.3 to 0.4 ppm as previously thought and that the 1.0 ppm level for taking action to correct a B deficiency may need to be revised in Oregon. These results suggest that present recommendations for B fertilizer applications may not be economically beneficial in increasing red clover seed yield or improving seed quality under Oregon conditions.

References

Eriksson, M. 1979. The effect of boron on nectar production and seed setting of red clover (Trifolium pratense L.). Swed. J. Agric. Res. 9:37.

Mozafar, A. 1993. Role of boron in seed production. In U.C. Gupta (ed.). Boron and its role in crop production. CRC Press, Boca Raton, FL.