NUTRIENT AVAILABILITY FOR ALFALFA SEED PRODUCTION

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INTRODUCTION

Although there is information on the nutrient requirements for forage production, the requirements for alfalfa seed production have largely been ignored. Alfalfa seed production involves considerably less biomass removal than forage production and consequently may involve much different nutrient requirements. Whereas forage production results in substantial nutrient removal with each harvest of biomass, the single harvest of seed removes fewer nutrients and the nutrients in residues are returned to the surface, ultimately providing for nutrient enrichment of the soil surface depending on the life of the stand.

Cultural practices used for seed production may have significant implications for nutrient availability. For example, imposing a moisture stress to induce bloom effectively reduces nutrient availability. Immobile nutrients such as phosphorus (P) or zinc (Zn) are particularly susceptible but any nutrient's availability will be reduced if root activity due to dry conditions is reduced.

Uptake of some nutrients during vegetative growth prior to bloom may be sufficient that seed fill is not limited if those nutrients are easily translocated from older plant tissues to newer tissues. But other nutrients such as Boron (B) and Zinc (Zn) are not translocated within the plant from older vegetative growth to newer tissue such as developing flowers or seed. Supplying B, Zn, and other micronutrients during seed fill is primarily dependent on root uptake from soil during seed filling. Under reduced soil moisture conditions and reduced uptake of B and Zn, a shortage of these nutrients could conceivably limit seed development regardless of their availability during vegetative growth.

Nutrient availability during seed fill may be affected by deeper positioning of nutrients in the soil where soil moisture and root activity persist longer after irrigation has been discontinued. Deeper nutrient placement of immobile or mobile nutrients has not been evaluated for alfalfa seed production. Foliar micronutrient applications also have not been evaluated for their effectiveness in our system. **Therefore, the objective of this study was to compare the effectiveness of B and Zn placement and timing in the alfalfa seed production system.**

METHODS

An established furrow irrigated alfalfa seed trial was conducted on a Greenleaf silt loam at the Parma Research and Extension Center during the 1999 and 2000 seasons. The trial

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involved mobile (B) and nonmobile micronutrients (Zn, Cu, Mn, Fe) either (1) injected 9 inches deep with knives into the furrow bottom on April 14, 1999 (2) broadcast and shallowly incorporated (triple K) the same date or (3) foliar applied at late bud in each season. Only the foliar treatment was re-applied in the 2000 season. Treatments were arranged in a randomized complete block design with five replications. Individual plots were 8 rows wide (22" row spacing) and 50 feet long. The injected and broadcast treatments in 1999 were applied at rates of 5 lb/A of Zn and B and 2 lb/A of Cu, Mn, and Fe. Foliar treatments were applied June 14, 1999 and June 13, 2000 at the late bud stage using the same rates except for B which was applied at only 0.5 lb/A.

Soil samples were collected April 13, 1999 from the 0-12" and 12-24" depths for background residual fertility. Initial soil test values for the 0-12" depth were 7.4 pH, 0.4 mmhos/cm salt, 3.5% lime, 1.06% OM, 17.2 ppm P, 157 ppm K, 0.24 ppm B, 1.3 ppm Zn, 1.0 ppm Cu, 6.2 ppm Mn, and 21 ppm Fe. Of these analyses only soil test B appeared to be limiting according to published critical soil test B levels (0.5 ppm). Above ground plant biomass at late bud was measured June 16, 1999 from 12 ft^2 and B, Zn, Cu, Mn, and Fe contents determined. In the 2000 season, alfalfa buds and the top 6" of the upper stem were collected at late bud and their micronutrient concentrations determined.

The alfalfa was sprayed with defoliant August 16, 1999 and August 28, 2000. Significant wind and hail damage with rain occurrred August 12, fifteen days prior to the 1999 harvest (August 27), with total precipitation for the day measuring 0.3". Appreciable volunteer alfalfa evident in late fall confirmed significant seed loss from this storm. In the 2000 season 0.67" of rain occurred on September 1 followed by 0.12" on September 4. Seed was harvested September 7. The field run seed was further threshed in an enclosed thresher with rubber paddles to separate seed from intact curls. The seed was cleaned on a Clipper and the brown, light, nonviable and heavier, amber colored viable seed separated using an air cylinder.

RESULTS

Whole plant nutrient concentrations and uptake in 1999 were not significantly affected by the soil applications in 1999 (Table 1). Thus, whole plant concentrations do not appear to be effective tools for indicating micronutrient availability at late bud.

Bud tissue B and Fe concentrations in 2000 tended to be lower than in upper stem tissues, possibly reflecting the poor translocation of these nutrients from other plant tissues (Table 1). In contrast, Zn in bud tissue was higher than in the upper stem tissue. But micronutrient concentrations in bud or upper stem tissue were not appreciably affected by the application treatments.

Whole plant biomass for soil applied Zn-Cu-Mn-Fe, especially when injected, was greater than for the control, injected or broadcast B treatments (Table 2). The injected Zn-Cu-Mn-Fe treatment averaged higher in biomass than the broadcast treatment but the variability precluded showing statistical differences. Injected and broadcast B treatments did not differ in biomass from the untreated control.

Table 1. Alfalfa whole plant, bud or upper stem micronutrient content as affected by micronutrient application/placement. Parma, 1999,2000.

Treatments	B	Zn	Cu	Mn	Fe
	Whole plant nutrient concentration - 1999				
	--------------------(ppm)--------------------				
Control	40.7a	22.7a	8.2a	24.3a	220a
Injected	38.7a	21.7a	9.2a	23.0a	263a
Broadcast	45.0a	21.3a	8.1a	30.3a	550a
CV	20	57	49	28	82
	Whole plant nutrient uptake - 1999				
	--------------------(lb/A)--------------------				
Control	.151a	.084a	.031a	.091a	0.834a
Injected	.133a	.108a	.045a	.112a	1.286a
Broadcast	.135a	.088a	.033a	.125a	2.245a
CV	30	74	68	33	80
	Late Bud Tissue Nutrient Concentration - 2000				
	------------------------(ppm)------------------------				
Control	36.0a	49.7a	10.7a	27.3a	86a
Injected	38.0a	51.0a	11.3a	29.0a	82a
Broadcast	36.5a	43.7a	11.0a	28.3a	92b
CV	6	10	6	6	6
	Uppert Stem Nutrient Concentration - 2000				
	------------------------(ppm)------------------------				
Control	42.3a	34.0a	9.8a	25.7b	123a
Injected	43.7a	33.0a	9.2a	26.7b	117a
Broadcast	42.7a	32.7a	9.8a	28.7a	110a
CV	7	12	9	5	15

Seed yield in 1999 averaged only 132 lb/A due to hail injury and was not significantly affected by treatments (Table 2). The 2000 season seed yields averaged 453 lb/A across all treatments, appreciably better than in 1999, but still lower than yields reported by many producers. However, seed yield was affected by treatments in 2000. Seed yield increased with B applied in 2000 regardless of the application method, with yield increasing from 40 to 53%. Among B methods of application, the foliar treatment appeared to be the most effective although methods did not differ statistically.

Seed yield in 2000 increased also with the mix of Zn-Mn-Cu-Fe with yield increasing from 22 to 55%. The broadcast application appeared to be superior to deep injection or foliar appplications. It could not be determined whether the yield increase was due to any particular micronutrient or the mix as a whole. The variability of yields each year from this small plot trial was high in this study and points out the difficulty of conducting small scale research with this crop.

Table 2. Alfalfa biomass at late bud and seed yield as affected by harvest method and micronutrient application/placement. Parma, 1999, 2000.

Treatments	Biomass lb/A 1999	Seed Yield (lb/A) 1999	Seed Yield (lb/A) 2000
Control	3726bc	135a	336b
B			
Injected	3446bc	148a	473a
Broadcast	3036c	120a	470a
Foliar		124a	514a
Zn, Cu, Mn, Fe			
Injected	4900a	125a	448ab
Broadcast	4141ab	154a	521a
Foliar		114a	411ab
CV	18	22	25

Seed Mn, Zn, and Cu were increased by their foliar application in 1999 but not by their soil applications. Seed Mn, Zn, and Cu concentrations in 2000 were also not

Table 3. Alfalfa seed micronutrient concentration as affected by micronutrient application/placement. Parma, 1999, 2000.

Treatments	B	Zn	Cu	Mn	Fe
			1999		
			(ppm)		
Control	12.8a	61.8b	17.3b	18.0b	27.3a
Injected	13.3a	61.3b	18.0ab	17.8b	28.5a
Broadcast	12.5a	58.5b	16.8b	18.0b	24.8a
Foliar	13.0a	66.8b	19.3a	19.5a	24.8a
CV	6	5	8	5	19
			2000		
			(lb/A)		
Control	13.7a	52.7a	17.0a	16.3a	76a
Injected	13.7a	51.7a	16.7a	17.0a	78a
Broadcast	13.3a	52.3a	17.3a	17.7a	71a
Foliar	13.3a	58.3a	18.3a	19.0a	78a
CV	5	14	10	8	6

affected by the 1999 soil applications of these nutrients. Foliar applied Mn, Zn, and Cu in 2000 tended to be higher when foliar applied, similar to 1999, but the differences were not statistically significant. In this study, seed concentrations of micronutrients tended to be a better indicator of micronutrient availability than vegetative tissues. Seed Fe and B were not affected by treatments in any year.

In summary, whole plant alfalfa micronutrient content at late bud in 1999 and bud and upper stem micronutrient concentrations at late bud in 2000 were largely unaffected by the micronutrient applications, regardless of application method. Tissue tests for micronutrients failed to reflect increased micronutrient availability to the plant from the applications despite increases in biomass production at late bud in 1999 from the Zn-Cu-Mn-Fe mix and seed yield increases in 2000 from both B and the mix. The results demonstrate that both B under low soil test conditions, and a Zn, Mn, Cu, Fe mixture, despite moderate soil test levels, can under some conditions appreciably increase seed yield. It is not clear how widely these results may apply to commercial fields in the area. Deep injection provided no advantage over broadcast micronutrient applications.

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