Specific Stem Weight in Alfalfa - A Possible New Approach to Increasing Yields

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Improvement of alfalfa yield and quality are important considerations for both producers and utilizers of alfalfa forage. Over the years, alfalfa improvement has resulted in high yield increases due primarily to breeding for disease and insect resistance and alterations of leaf stem ratio, with emphasis being placed on leaf weight.

Limited research in the area of alfalfa quality has generally been associated with the study of leaf characteristics and attempted improvement in the digestibility of stems. However, when we consider that from 50 to 70% of the alfalfa plant is comprised of stems, the impact of potential improvement in both alfalfa stem quality and total yield may be significant.

It appears worthwhile, therefore, to evaluate the possibility of stem improvement as a means of improvement of both alfalfa yield and quality. In order to observe the variability of specific stem weight within a given population, 110 alfalfa plants were selected from an established field of 'Lew' alfalfa. We were interested in observing what, if any, morphological differences existed among the stems in addition to the variability in stem weight in the variety Lew.

Specific stem weights of the 110 alfalfa plants ranged from 6.0 to 21.0 mg/cm. The wide range of stem weights indicated that there was indeed significant variability among the alfalfa population. Yield and specific stem weight differences of the total population coverage and aselected plants for the three harvests are shown in Table 1. There was an 8 fold yield difference between the highest and lowest producing plants in Harvest 1, 20 fold difference in Harvest 2 and 4 fold difference in Harvest 3. Selection and identification of alfalfa plants with high specific stem weight during the "summer slump" may be an effective means of increasing yields during this normally low productive period.

Table 1. Yield and Specific Stem Weights of Selected 'Lew' Alfalfa Plants

	Harvest 1 7/21		Harvest 2 8/20		Harvest 3 9/23	
	Specific stem weight mg/cm	Yield-Wt plant gm	Specific stem weight mg/cm	Yield-Wt plant gm	Specific stem weight mg/cm	Yield-Wt plant gm
Total Population (av 110 plants)	15.3	8.3	11.9	7.2	7.2	6.6
Clone # 95	21.0	25.06	18.0	20.55	7.3	9.17
Clone # 54	20.0	10.59	13.3	15.59	11.3	15.54
Clone # 93	17.3	14.03	26.0	17.02	9.3	7.98
Clone # 75	13.3	4.67	10.7	1.52	4.7	1.43
Clone # 2	14.7	3.12	4.0	1.18	6.7	2.20

Nitrogen Fixation Efficiency of Alfalfa Under High Temperatures and Saline-Alkali Soils

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Alfalfa, like most legumes, has an advantage over most crops in that it is able to produce its own nitrogen. This occurs as a result of the relationship with Rhizobium meliloti bacteria. The bacteria enter the plant root hair through an infection thread, begin multiplication and form nodules. This symbiotic association is responsible for converting atmospheric nitrogen into a form that is usable by the plant. Under ideal conditions, the amount of nitrogen fixed ranges from 40 to 240 pounds per acre annually with alfalfa. Adding a commercial preparation of Rhizobium bacterial inoculant at planting time ensures the presence of desirable bacteria in the proximity of the developing legume root system. Most of the symbiotically fixed nitrogen is removed with harvest of the forage of the legume, but there is some chance that actively growing alfalfa may excrete nitrogenous compounds into the soil.

Examination of alfalfa plants during the growing season over a number of locations revealed that under Arizona conditions very few alfalfa plants had nodules that were actively fixing nitrogen. Two studies are currently underway to determine the most effective way of overcoming the failure of alfalfa plants to nodulate.

In the first study, 5 alfalfa lines including 'Lew', 'Hayden', heat tolerant, salt tolerant and 'Ranger' are being tested with 4 native rhizobia strains plus a commercial inoculant developed for Arizona. The experiment is still in progress. However, results to date indicate that in fall planted alfalfa, maximum nodulation and nitrogen fixation occurs early in the spring. As the growing season progresses, the nodules become inactive and drop off. At present, the only yield advantage to inoculation may be at the first harvest. We have also observed that both variety of alfalfa and strain of R. melitoti have an effect on nodulation and nitrogen fixation. We hope to be able to identify alfalfa variety and rhizobia strain combinations that will produce consistently high forage yields throughout the season.

A second study, deals with the effects of coating alfalfa seed with 0 to 500,000 bacteria and observing effects on both yield and nodule survival. This study is also under progress and data are not currently available.

We are hopeful in being able to overcome the factors which limit biological nitrogen fixation in alfalfa. By using symbiotically efficient alfalfa varieties and interacting rhizobia strains, alfalfa plants will be able to utilize their inherent capabilities of nitrogen production and thereby increase yields with the minimum of inputs.

Effect of Several Cultural Practices on the Establishment of Alfalfa

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Greenhouse and field experiments were conducted to determine the effect of surface applied phosphoric acid, seeding method, seeding rate, and delayed overseeding with oats (Avena sativa L.) on seedling emergence and yield of alfalfa.

Greenhouse Experiment

The greenhouse experiments were conducted at the University of Arizona and the field experiments at the University of Arizona Mesa Branch Experimental Farm. For the greenhouse experiments 21 seeds were planted in sandy clay loam in each of 192 plastic pots. Seeds in half of the pots were planted at a depth of 1/4 in. while those in the remainder of the pots were planted 1/2 in. deep. Phosphoric acid (12%) was applied to the surface of the soil in half the pots immediately after seed had been planted.

Emergence of seedlings when seeds were 1/4 in. deep was 44% greater than for those at a depth of 1/2 in. The number of emerged seedlings from pots treated with phosphoric acid was significantly greater than from the untreated pots.

Table 1. Average number and weight of alfalfa seedlings harvested 10 days after initiation of the greenhouse experiment, April 20, 1974.

Treatments	Plants (number/ft)	Total plant dry weight (gms/ft)
H_3PO_4 treated	16.6 a*	8.7 a
Control	12.8 b	6.3 b

*Means followed by the same letter are not significantly different at the 0.05 level according to the Student-Newman-Keuls' Multiple Range Test.

Field Experiment

A split-plot design with three replications was used in the field experiment. Two methods of seeding (drill and broadcast followed by cultipacking) and two seeding rates (10 and 20 lb/A) were used in 216 plots. Fertilizer treatment for this experiment included the application of 60 lb/A phosphorous as 12% phosphoric acid in a 5 cm band or as 0-18-0 incorporated into the soil before planting. One-third of each plot in the experiment was over-seeded with Mesa oats two months after planting. Seedlings were counted as they emerged. At the close of the experiment tops and roots were harvested, dried, and weighed.