SIGNIFICANCE OF SEEDLING DISEASES IN STAND ESTABLISHMENT

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Establishing a good stand is the first requirement for ensuring a productive field of forage alfalfa. It is the responsibility of the agronomist and plant pathologist to determine the conditions and diseases that affect this crop stage. We recognize that the first phase in the life of an alfalfa crop has disease problems that are distinct from successive stages. Moreover, certain stresses may result from seedling diseases that affect growth of the mature crop.

Seed quality and disease are special factors of concern in stand establishment. Yet stands may also be affected drastically by weather and soil conditions and probably to some extent by the method of seeding. Thus, a complex set of factors influences stand establishment.

The economic significance of seedling diseases is unclear: Plant pathologists in the United States have disagreed about their importance mainly on the basis of early experiments with fungicide seed treatments. Some found that treatment improved stands while others found no effect (1, 5). Subsequent research has shown that there is a good deal of natural variation in the soil populations of alfalfa seedling pathogens and in the effect of soil and environmental conditions on their ability to cause disease (3). It can be expected that large disease losses will occur in some fields but not in others.

Disease and other types of seedling losses of alfalfa are usually guarded against in the US by overseeding. Compensating for losses by this expedient is effective but disguises the impact of disease and may not be cost effective. It is not easy to tell what disease stresses are placed on the seedling stage with this control measure. Furthermore, seed costs are significant: A better picture of how seeding rates influence forage yields is badly needed.

Causes of Stand Losses

I found that reductions in emergence of alfalfa in various surveys ranged between 35 and 70% in the Central Valley. My studies with two cultivars (Lahonton and Moapa 69) showed that emergence failures were only partly due to disease. For example, with the seed lots of the two cultivars used in this study, I found that 10 to 15% of the seeds failed to germinate either because of nonviability or hard seed coats. When planted in pasteurized soil or greenhouse potting mix, a further 10 to 15% of the seeds failed to emerge. Thus, with both cultivars, I found a total of 20 to 30% reduction in emergence without any assistance from soil-borne seed or seedling pathogens.

Results of my studies showed that disease adds to these losses. However, I also found considerable variation in the degree of disease in greenhouse tests with different soils collected from the Central Valley. Soil treatment with heat, a fumigant (metham sodium) or fungicides increased emergence greatly in some soils but not in others (Table 1). The degree of disease losses was influenced by soiltemperatures. With a soil from Davis, I found that disease accounted for a 15 to 20% emergence reduction at moderate soil temperatures (63-82 F) but a 30 to 40% reduction at a lower daily temperature cycle (46 to 63 F) in the greenhouse (Table 2). When losses from disease and the other causes were added up, emergence reductions of 35 to 70% were found. Emergence in a late September planting in soil used in these greenhouse tests in plots at Davis ranged between about 50 and 65% (Table 2). Soil temperatures during the emergence period ranged from 73 to 90 F, thus, these results agreed closely with losses at similar temperatures with the same soils in the greenhouse experiments.

One of the most interesting results I encountered in this work was the consistent difference in susceptibility of the two cultivars, Lahonton and Moapa 69, to pre-emergence damping-off (Table 2). I also noted differences in susceptibility between dormant cultivars (Ranger and Pioneer 545) to pre-emergence damping-off. We have little information on differences in the susceptibility of different cultivars to seedling diseases. The knowledge that differences in susceptibility exist should encourage

TABLE 1. Influence of fungicides on emergence of alfalfa in soils from different field sites.

Treatment	Lindemann	WSFS	Davis-1	Davis-2
	Sites (Emergence, % of control)			
Untreated	49.3	50.1	60.3	86.9
Pentachloronitrobenzene	68.6	62.6	-	88.3
Ethazole	52.3	102.2	100.0	100.0
Thiabendazole	48.3	46.0	69.0	89.1
Autoclaved	-	-	-	105.6
LSD .05	14.4	19.6	25.0	23.8

TABLE 2. Emergence of seedlings of Lahonton and Moapa 69 at various soil temperatures in the greenhouse and the field (Davis, CA).

Soil temperatures (F) (min)	(max)	Percent Emergence Lahonton	Moapa 69
		(greenhouse)	
46	63	42.2	54.4
59	65	53.0	67.0
66	70	53.0	67.7
75	81	57.4	65.9
77	82	53.7	76.7
LSD (5%)		12.0	
		(field)	
73	90	52.8	65.9
LSD (5%)		11.4	

further work in this area, particularly on selection of germplasm for resistance.

Forked Root Disease

Pre-emergence damping-off by soil-borne fungi such as species of *Fusarium*, *Pythium*, and *Rhizoctonia* appears to be the most significant seedling disease of alfalfa in regard to stand establishment (2, 3, 4). However, seedling growth may be altered by infection by certain of these pathogens (3). Multiple tap roots are stimulated on seedlings after infection by the pathogen *Pythium ultimum* (Fig. 1). Seedlings with forked roots are usually stunted and may not grow as rapidly as single tap rooted plants. At the field plots at Davis, the proportion of multiple tap rooted plants was 10% in Moapa stands and nearly 25% in Lahonton stands in the second growing season. Growth of the forked rooted plants was slower than single rooted plants during the first two growing seasons (Fig. 2). Because of the possibilities for compensation by single tap rooted plants, the overall effect of the forked root condition on forage yield is uncertain. Nevertheless, this condition should be carefully evaluated, especially with cultivars (e.g. Lahonton) that show strong tendencies toward root-forking.

Seeding rates and yields

As mentioned above, increased seeding rates can be used to compensate for seedling losses. What is gained from increasing seeding rates as far as forage yields are concerned? In a field trial at West Side Field Station (Five Points, CA) where different seeding rates (10, 15, 20, and 25 lbs/acre) were tested, I found that forage yields differed only at the first harvest (Table 3). In subsequent harvests taken periodically over a 4 year period there were no significant differences between yields in plots seeded at different rates.

TABLE 3. Relationship between seeding rates and forage yield

Seeding Rate	Harvest Dates[a/] (tons/acre)							
(lbs/acre)	Jun 79	Sep 79	Jun 80	Sep 80	Jul 81	May 82	Jun 82	Sep 82
10	0.62	1.08	2.44	1.30	1.64	1.54	1.38	0.93
15	0.75	1.07	2.22	1.18	1.63	1.55	1.26	0.86
20	0.83	1.14	2.21	1.34	1.63	1.39	1.38	1.06
25	0.91	1.10	2.31	1.28	1.64	1.43	1.32	0.92
Corr. coef.	.597	.129	-.173	.117	.002	-.362	-.034	.181
Sig. level(%)	5	ns	ns	ns	ns	ns	ns	ns

[a/] Cultivar was Moapa 69; Corr. coef. = correlation coefficient; Sig. level = significance level in percent determined with 14 degrees of freedom.

Emergence in these plots was about 35%. Yet, even at the seeding rate of 10 lbs/acre, the yields were equal to those plots seeded at 25 lbs/acre within the first season. These studies raise serious questions about our seeding procedures. Careful investigations on seeding rates are needed in other parts of California. They should be designed to include studies of pests affecting emergence and development of both the immature and mature crops.

Conclusions

Failure of alfalfa seedling emergence accounts for significant stand losses and may reach 70% or higher under some conditions. Disease may or may not contribute extensively to these losses. Current methods of compensating for losses employs overseeding. However, results from limited experimentation suggest that the degree of overseeding practiced in California may not lead to increased forage yields beyond the early life of the crop. Other means of disease control should be evaluated as more economical and effective means of ensuring healthy alfalfa stands. Special attention should be given to an integrated pest management strategy where knowledge of disease factors (e.g. proneness of field to seedling diseases), cultivar resistance, and chemical and biological protective control measures are part of the arsenal to combat seedling diseases of alfalfa.

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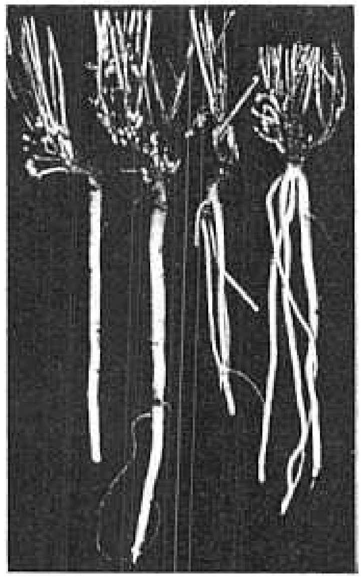

FIGURE 1

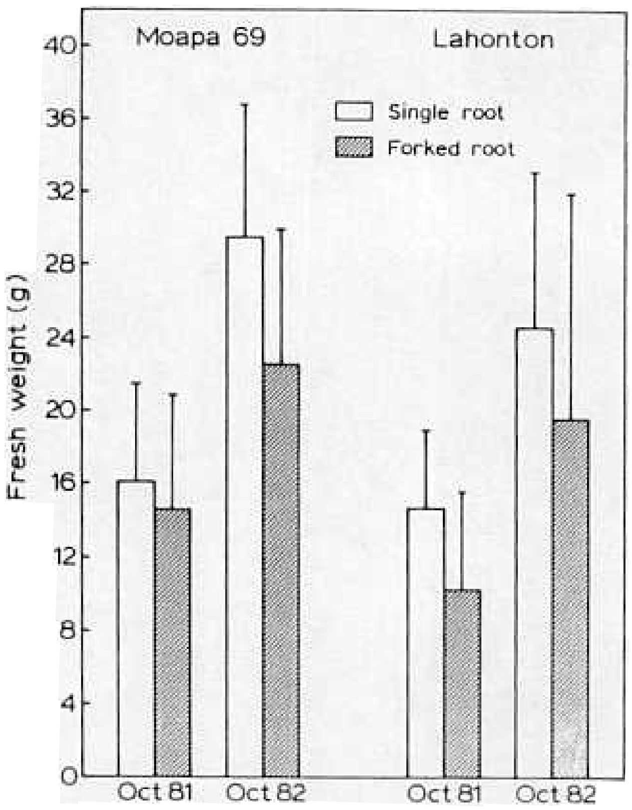

FIGURE 2

Figure 1. Field-grown 10-month old alfalfa plants (cultivar Moapa 69) showing single tap rooted plants (left) and "forked root" plants (right).

Figure 2. Fresh weights (shoots and tap roots) of two cultivars of alfalfa with single or forked tap roots harvested one (6 Oct. 81) and two (11 Oct. 82) years after seeding (23 Sept. 80) at Davis, CA. Vertical bars = confidence limits, $\underline{P}$ = 0.05.