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SEEDING TECHNIQUES FOR ALFALFA TO IMPROVE SUBIRRIGATED MEADOWS*

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Improving quality and quantity of forage harvested from poor condition, subirrigated hay meadows in the Nebraska Sand Hills is critical to the winter forage reserve of livestock producers. Alfalfa (*Medicago sativa* L.) is the most commonly used legume for meadow improvement. Broadcast seeding (11.2 kg/ha) was compared to sod seeding (11.2 kg/ha) as a method to introduce alfalfa into an alkaline subirrigated meadow (Fluvaquentic Haplustolls). Before seeding, the study area received 78.5 kg/ha phosphorous. Paraquat (0.29 kg/ha) was applied to one-half of the area to suppress plant competition and provide qualitative information on treatment consistency across a range of sod competition. Lo-till sod seeding was accomplished with a power tillage seeder. Seedling density was determined in spring the following year. Broadcast alfalfa had a greater seedling density than sod-seeded alfalfa (38.4 and 19.1 plants/m^2, respectively, p=.09). Apparently, paraquat had no effect on seedling establishment and tended to reduce total yield. Yields the year of seeding, using a two harvest scheme, were greater for broadcast compared to sod-seeded alfalfa (p=.02). However, there was no significant difference between yields of broadcast alfalfa and control.

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INTRODUCTION

Subirrigated meadows are a critical forage component in much of the Nebraska Sand Hills. They are very productive and are the major source of winter feed for ranching operations. Winter hay supply often restricts the size of the livestock enterprise. Practices that enhance hay production in subirrigated meadows may directly influence profitability. Alfalfa (*Medicago sativa* L.) introduced into these meadows may provide an alternative to nitrogen fertilization, which can improve forage yield. In addition, alfalfa may improve forage quality which will reduce winter supplementation costs. Alfalfa requires good drainage and can tolerate some alkaline conditions, but it is not well adapted to highly alkaline soils (Hanson and Barnes, 1973).

Brouse and Burzlaff (1968) recommended seeding alfalfa in subirrigated meadows only where the March water table was lower than 0.61 m. They recommended drilling seed; however, broadcast seeding has been a common economical management practice when incorporated with fertilizer application. The development of sod-seeding techniques provides an alternative seeding method (Waller et al., 1981). Herbicides used to suppress existing vegetation have improved the establishment of seeded legumes when employed in combination with sod-seeding techniques (Evans, 1977; Fribourg et al., 1978; Taylor et al., 1969; Waller et al., 1981). This trial was initiated to compare broadcast seeding with sod seeding for establishing alfalfa in subirrigated native hay meadows. The effect of paraquat (1, 1′-Dimethyl-4,4′-bipyridinium dichloride) on seedling establishment was examined. With any technique that disturbs or suppresses existing sod, there is the potential to reduce dry matter (DM) production. Thus, another objective was to determine whether alfalfa could be successfully introduced without decreasing hay yield in the year of seeding.

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STUDY AREA AND PROCEDURES

The experiment was conducted at the Milldale Ranch in central Nebraska (Logan County). Mean annual precipitation in this area is 536 mm with 447 mm falling during the growing season (March–September). Precipitation during the growing season of the seeding year was about normal (445 mm) (Anonymous, 1980). The meadow selected was a typical, depleted saline subirrigated range site. Soil was classified as an Ord fine sandy loam, alkali (coarse-loamy, mixed, mesic, Fluvaquentic Haplustolls) (Plantz and Sherfey, 1974). Soil pH on the site ranged from 7.8 to 9.3 ($\bar{x} = 8.3$). Sodium (Na) content as high as 1,220 ppm was recorded. Although small amounts of big bluestem (*Andropogon gerardii* Vitman) and switchgrass (*Panicum virgatum* L.) were present, productivity of the area was low due to the dominance of inland saltgrass (*Distichlis spicata* (L.) Greene), Kentucky bluegrass (*Poa pratensis* L.), and foxtail barley (*Hordeum jubatum* L.). Four treatments, each with and without paraquat, were evaluated using a randomized block design with four blocks. All plots (4.9 m x 21.3 m) received one application of phosphorus (78.5 kg/ha). Treatments were: control, nitrogen fertilizer (78.5 kg/ha, single spring application), broadcast alfalfa (11.2 kg/ha, 'Titan' variety), and sod-seeded alfalfa (11.2 kg/ha). Equal amounts of alfalfa seed were applied with a hand-operated seeder or a John Deere 1550 Powr-till seeder that had a 20.3 cm row spacing. Seeding was done 4 May 1979. Paraquat (0.28 kg/ha) was applied to one-half of the study area the day before seeding simply to broaden the scope of inference regarding treatments. It provided information on the consistency of treatment response over a range of sod competition.

Strips (0.8 m x 6.1 m) were cut in each plot with a flail-type forage plot harvester on two dates, 25-27 June and 13 August, the year of seeding. Cutting height for the June harvest was 13 cm to avoid damaging seedlings. The August harvest cutting height was typical of hay management (5-7 cm). Following both sampling dates the entire area was hayed to the respective height in order to reduce shading of the seedlings from the existing canopy and to equalize mowing effects on non-seeded treatments. Fresh material from the forage harvester was weighed and subsamples were oven dried (68° C). Ground samples were analyzed for crude protein (Anonymous, 1975) and *in vitro* dry matter disappearance (IVDMD) (Tilley and Terry, 1963).

Seedling establishment was evaluated in the spring (1980) following the year of seeding. Number of living plants was counted in randomly located quadrats (0.3 m x 0.3 m) within the broadcast alfalfa, 10 in each plot. Similar procedures were employed for the sod-seeded treatments with the exception that belt transects (1 cm x 1 m) were randomly located along seeded rows. Treatment comparisons were accomplished using a Fisher's protected LSD (Steel and Torrie, 1980). Comparisons among paraquat treatments cannot be made because the paraquat application was not replicated. However, treatment x paraquat interactions can be evaluated.

RESULTS AND DISCUSSION

Establishment

Broadcasting alfalfa seed resulted in a higher density of plants ($p = .09$) than sod seeding alfalfa (Table I). However, individual plants appeared to be more vigorous on the sod-seeded treatment which may reflect the effect of depth of planting. There was a trend for reduced establishment where paraquet was used (Table II). Davies and Davies (1981) reported similar findings indicating decreased germination as the interval between spraying and seeding was reduced.

Yield

In June, grass canopy dry matter yields were higher from broadcast than sod-seeded alfalfa plots ($p = .02$) (Table I). Because this harvest was designed to cut above the alfalfa seedlings, differences in production were due to the mechanical disturbance associated with sod seeding. Yield of control plots exceeded broadcast-seeded alfalfa plots ($p = .09$) while the fertilized plots yielded more than any other treatment ($p < .01$).

TABLE I. Influence of treatment on seedling establishment, dry matter (DM) yield harvested on two different dates, and forage quality (crude protein and IVDMD) parameters determined for the August harvest. Treatments were control, nitrogen fertilization, broadcast seeding alfalfa, and sod-seeding alfalfa.

Variable	Control	Fertilized	Broadcast Alfalfa	Sod-seeded Alfalfa
	TREATMENTS			
Establishment (seedlings/m^2)			38.4 a	19.1 b
DM yield (kg/ha)				
June	1,480 a*	2,460 b	1,240 c	910 d
August	1,950 bc	1,740 c	2,440 a	2,040 b
Total	3,430 bc	4,200 a	3,680 b	2,950 c
Crude protein (%)	11.2 ab	11.8 a	10.5 b	10.0 b
IVDMD (%)	52.2 a	53.0 a	53.1 a	53.6 a

*Values within a row followed by the same letter are not different ($p \leq .10$) as determined by a Fisher's protected LSD.

TABLE II. Dry matter (DM) yields harvested in June and August and crude protein and IVDMD determined from August harvest. Treatments were control, nitrogen fertilization, broadcast seeding alfalfa, and sod-seeding alfalfa. All treatments were applied with (+) or without (–) paraquat. S.E. = Standard error.

	Control		Fertilized		Broadcast Alfalfa		Sod-seeded Alfalfa		S.E.
	+	–	+	–	+	–	+	–	
Seedling establishment (plants/m^2)					18.2	19.9	36.6	40.1	9.6
DM yield (kg/ha)									
June	1,060	1,900	1,600	3,320	940	1,540	650	1,170	130
August	1,650	2,240	1,530	1,950	2,020	2,870	1,740	2,340	210
Total	2,710	4,140	3,310	5,270	2,960	4,410	2,390	3,510	280
Forage quality (August)									
Crude protein (%)	11.6	10.8	11.8	11.7	10.8	10.2	10.6	9.5	0.7
IVDMD (%)	53.8	50.6	54.8	51.2	54.6	51.6	55.0	52.2	1.6

In August, plots that were seeded with alfalfa produced more dry matter than fertilized plots ($p < .01$) (Table I). The conspicuous yield reduction on fertilized plots apparently indicated that the rapid, vigorous early growth of vegetation resulted in insufficient carbohydrate reserves for substantial regrowth following the June harvest. Additionally, nitrogen may have become a limiting factor. Yield of control plots was similar to fertilized plots and sod-seeded alfalfa plots. Broadcast alfalfa had the highest yield ($p \leqslant .07$).

Dry matter yields of both harvests were summed for total yield (Table I). Broadcasting alfalfa resulted in a higher yield averaged over paraquat ($p = .02$) than sod-seeding alfalfa. Total yield for broadcast alfalfa was similar to control, while fertilized plots produced the highest yield ($p < .08$). Data indicated that alfalfa could be successfully established by broadcasting in a subirrigated meadow without a loss in yield in the seeding year.

Paraquat tended to reduce June, August, and total yields (Table II). The most dramatic observation occurred on fertilized plots in June where yield reductions due to paraquat exceeded 50%. Yield reductions in June were expected to enhance seedling establishment; however, this did not occur. There was no treatment x paraquat interaction, indicating treatment response remained similar across variable canopy development.

Forage Quality

Forage quality data (crude protein and IVDMD) from the second harvest were considered (Tables I and II). This harvest date was assumed to be more representative of native hay management in the Sand Hills. No difference due to treatment was detected in crude protein or IVDMD values. However, paraquat did have a tendency to increase IVDMD apparently due to the delayed maturity of vegetation. Similar parameters of forage quality across treatments were encouraged by an unusually wet July (55% higher, 10.1 cm) and the canopy removal in June. Normally a single harvest in August with nearer normal precipitation would be expected to result in lower IVDMD and protein on native meadows.

Alsike clover (*Trifolium hybridum* L.) established on the same site appeared to be adapted to the more alkaline areas within the meadow. The differential adaptations of alfalfa and alsike clover to alkalinity should be considered when developing the seeding mixture. The inherent variability of subirrigated meadow sites in the Sand Hills would warrant the addition of alsike clover proportional to the area with alkalinity problems. A March water table within 0.61 m of the surface would indicate a site on which alfalfa would be poorly adapted (Brouse and Burzlaff, 1968).

SUMMARY

Broadcasting alfalfa seed to improve a subirrigated meadow provided better seedling establishment than sod seeding in this study. Total dry matter yield was highest on plots fertilized with nitrogen; however, yields for broadcast seeding and control were similar and sod seeding, although lower, was similar to control. Apparently, paraquat had little effect on seedling establishment while tending to reduce yields and

increase IVDMD. The absence of a treatment x paraquat interaction indicated that treatment response would be similar across different levels of canopy development.

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