Furrow-Irrigated Alfalfa Dry Matter Yield is Not Affected by Different Seeding Rates in the Southern High Plains, USA

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ABSTRACT

Alfalfa (*Medicago sativa* L.) hay producers often wonder if increasing seeding rates above the currently recommended rate of 20 lb/ac will increase alfalfa dry matter (DM) yield. The objective of this study was to determine the effect of different seeding rates (SR) on DM yield of alfalfa under furrow irrigation. Two experiments were conducted from 2001 to 2008. The first experiment was sown in 2001. Two alfalfa SR (15 and 30 lb/ac) were assessed for two years. The second experiment was sown in 2005, with four SR (10, 20, 30, and 40 lb/ac). For both experiments, there were minimum statistical differences in total DM yield. We conclude that there is no effect on DM yield by using a seeding rate greater than 20 lb/ac because alfalfa can adjust DM yield over a wide range of plant populations. Although an alfalfa stand can be established at seeding rates below 20 lb/ac, seedbed preparation, environmental factors, pests, weeds, and planting management increase the risk of poor establishment.

INTRODUCTION

Good alfalfa stand establishment is the base for successful production throughout the life of the stand. Many factors must be considered during planting, and seeding rate (SR) is among the most important because initial plant population can affect production. Usually, farmers increase the SR above the recommended rate of 20 lb/ac just to be sure that they plant enough seed to have a good stand. However, it has been demonstrated that increasing SR does not necessarily improve stand establishment or increase dry matter (DM) yield. Increasing SR increases plant density, but decreases shoots per plant and shoot weight (Kephart et al., 1992; Lloveras et al., 2008). Previous studies have shown that DM yield was greater the first year with higher SR, with no differences the second and third years (Hansen and Krueger, 1973). However, other studies have shown no differences in DM yield by increasing SR (Lloveras et al., 2008; Mueller et al., 2008). In fact, it was observed that as SR increased, plant mortality also increased during the first 24 months (Kephart et al., 1992; Hall et al., 2004). In addition, under drought conditions, greater SR resulted in lower shoot weight and potentially lower DM yield (Kephart et al., 1992). In the Southern High Plains, USA, typical alfalfa SR ranges from 15 to 40 lb/ac, and information about adequate SR is limited. Therefore, the objective of this study was to determine the effect of SR on alfalfa DM yield under furrow-irrigated conditions.

FIELD DESCRIPTIONS

This research was conducted from 2001 to 2008 at the New Mexico State University Agricultural Science Center at Tucumcari (35°12’0.5” N, 103°41’12.0” W; elevation 4,091 ft; Canez fine sandy loam [fine-loamy, mixed, thermic Ustollic Haplargid]). Experiment 1 was established on August 30, 2001. ‘Dona Ana’ alfalfa was sown at two SR (15 and 30 lb/ac) using a disk drill fitted with a seed-metering cone. Experimental design was a randomized complete block with three replicates. Each plot was two furrow beds of 6 ft x 15 ft. The experiment was fertilized with 22-104-44 lb N-P_2O_5-K_2O/ac on March 12, 2002 and April 3, 2003. In 2002, the study was irrigated once to field capacity prior to each of two harvests. In 2003, the experiment was not irrigated and was harvested just one time, after which the study was terminated due to lack of available water for irrigation. Alfalfa was harvested using a self-propelled forage plot harvester equipped with a sickle-knife and electronic scale, leaving a stubbing height of three inches. A subsample of harvested material was collected from each plot and oven dried at 158°F for 48 h for DM determination. The DM percentage was used to calculate DM yield (ton/ac).

Experiment 2 was planted on September 22, 2005. Alfalfa cultivar ‘RSC 751’ was sown at four SR (10, 20, 30, and 40 lb/ac) in a randomized complete block

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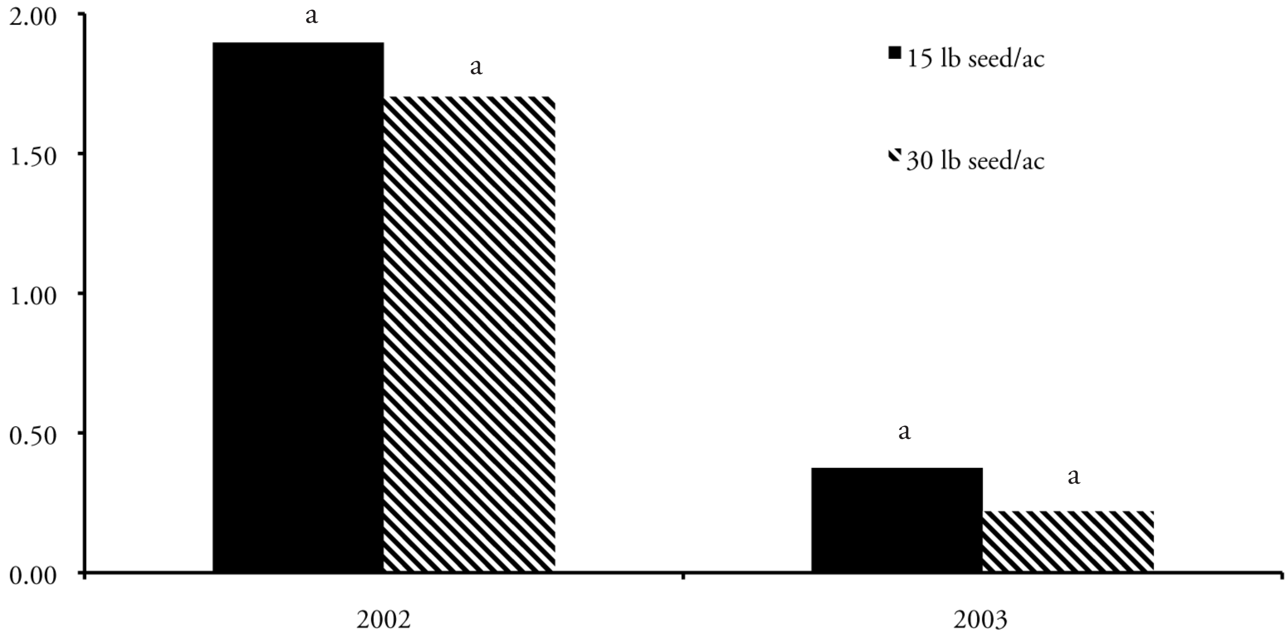

Figure 1. **Accumulated dry matter yield (ton/ac) per year of two alfalfa seeding rates sown in 2001 (Experiment 1). Columns within a year with the same letter do not differ (P > 0.05).**

Table 1. Total DM Yield (ton/ac) Per Year and at Different Alfalfa Seeding Rates in Experiment 2

Year	DMY
2006	2.10[b]
2007	4.03[a]
2008	4.06[a]
LSD (P < 0.05)	0.49
Seeding Rate (lb/ac)	
10	3.68[a]
20	3.46[a]
30	3.44[a]
40	3.01[b]
LSD (P < 0.05)	0.41

[a-b]Means followed by the same letter do not differ (P < 0.05).

design with four replicates per treatment. Plot size, fertilization, and management were similar to Experiment 1. Furrow irrigations to field capacity were applied once prior to each harvest. The experiment was harvested five times in 2006 and 2008 because irrigation water was not available until mid-May, and six times in 2007, using the same harvester as in Experiment 1.

Dry matter yield was statistically analyzed as split-plot design with year and SR as fixed effects and block as a random effect using the Mixed Procedure of SAS (SAS Institute, 2007). If a significant difference was found among treatments, Fisher's protected LSD at $\propto$=0.05 was used to separate means (Littell et al., 2002).

RESULTS AND DISCUSSION

Experiment 1

There was no statistical difference between the two SR in 2002 and 2003 (Figure 1). Although the accumulated DM yield of three harvests in 2002 was also not significant, there was a slight increase in DM yield with an SR of 15 lb/ac compared to 30 lb/ac. A similar trend was also observed in the harvest taken in 2003 (Figure 1), in which yield was numerically higher for 15 than for 30 lb/ac.

Experiment 2

The year by SR interaction was not significant, and single effects are shown in Table 1. Dry matter yield among years was on average 1.9 ton/ac greater in 2007 and 2008 than in 2006 (P < 0.05). The timing of water availability had an impact on annual DM yield. Even though annual precipitation was lower in 2007 than

Table 2. Monthly Precipitation (inches) from 2001 to 2008 and Long-Term Mean (1905–2005) at Tucumcari, NM

	Year								
Month	2001	2002	2003	2004	2005	2006	2007	2008	Mean
January	0.67	0.54	0.07	0.07	1.33	0.09	0.68	0.02	0.38
February	0.95	0.16	0.64	0.59	1.10	0.00	0.18	0.03	0.49
March	2.65	0.32	1.25	0.94	1.16	0.18	3.03	0.21	0.74
April	0.10	0.53	0.69	3.73	2.33	0.72	0.82	0.78	1.18
May	2.82	0.65	1.88	0.29	2.35	1.14	0.81	2.50	2.00
June	1.76	0.67	3.99	1.87	0.14	1.72	2.81	2.04	2.01
July	0.67	4.38	0.53	2.27	2.98	3.22	0.81	5.64	2.63
August	2.83	0.72	4.26	2.75	4.46	5.10	1.25	3.61	2.85
September	0.19	4.00	0.30	3.98	4.28	1.60	0.47	0.58	1.61
October	0.15	1.20	0.96	2.78	0.56	1.08	0.73	2.91	1.29
November	1.57	1.49	0.91	2.27	0.00	0.14	0.24	0.09	0.70
December	0.24	0.73	0.22	0.39	0.00	1.51	1.13	0.22	0.58
Annual	14.60	15.39	15.70	21.93	20.69	16.50	12.96	18.63	16.46

2006 (Table 2), there was more rain in the first six months of 2007 than 2006, which increased DM yield in the first cuttings of 2007. Among SR, there was no difference in DM yield from 10 to 30 lb/ac, but DM yield was lower at an SR of 40 lb/ac (Table 1).

Alfalfa seeding rate studies have usually reported that increasing SR mainly affected plant density, shoots per plant, shoot weight, and root-crown weight. Increasing SR increased plant density, but also increased plant mortality the first 24 months (Kephart et al., 1992; Hall et al., 2004; Lloveras et al., 2008). In contrast, increasing SR decreased shoots per plant, shoot weight, and root-crown weight (Kephart et al., 1992; Hall et al., 2004; Lloveras et al., 2008; Hansen and Krueger, 1973). Similar to our finding, in most other studies, DM yield was minimally affected by the SR (Kephart et al., 1992; Hall et al., 2004; Lloveras et al., 2008; Hansen and Krueger, 1973). This shows the enormous plasticity of alfalfa plants to modify their structure depending on plant competition. Even though we did not measure plant density, shoot weight, and plant mortality in this study, we expect that the effect of SR on these parameters had trends similar to those reported in the literature (Lloveras et al., 2008).

In addition, alfalfa crude protein concentration is an important plant component when marketing price is based on the nutritive value of alfalfa hay. Hansen and Krueger (1973) and Lloveras et al. (2008) did not find any effect of SR on crude protein concentration. In our case, we expect that crude protein was also not affected by SR.

Our results support that an SR of 10 lb/ac is sufficient for good stand establishment and DM yield. This SR is half of the conventional SR that farmers have been using in Southern High Plains, which potentially represents a significant monetary savings. However, it is necessary to properly manage factors like seedbed conditions, seed depth, planting date, and weed control in order to have a good stand establishment with low SR. Increasing SR to 20 or 30 lb/ac may be justified when some of these factors are not correctly addressed.

CONCLUSION

Our findings support that increasing SR beyond the recommended rate (20 lb/ac) does not necessarily increase DM yield. In addition, we found that it is possible to decrease SR to 10 lb/ac without significantly affecting DM yield. However, seedbed preparation, pest and weed control, and planting method are critical when using low SR. Therefore, SR beyond 30 lb/ac does not necessarily increase DM yield, and SR below 20 lb/ac is feasible, but only with excellent management.

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