EFFECT OF OAT COMPANION CROP SEEDING RATE ON ALFALFA ESTABLISHMENT, YIELDS AND WEED CONTROL

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Abstract: An oat companion crop increased forage yield in the seeding year at three of four study sites. Dwarf yellow mosaic virus reduced oat biomass preventing forage gains on the fourth site. When increases in forage yield were observed, they ranged from 1 ton/acre to over 4 tons/acre, with optimum oat seeding rate varying between 8 and 24 lbs/acre. Forage yields were reduced in subsequent cuttings but were not different at the end of the first cutting season. Second cutting season yields did not differ between treatments. An oat companion crop reduced weed biomass during establishment, but also reduced winter weeds in the second year. Alfalfa density at the beginning of the second growing season, was not affected by the addition of an oat companion crop during establishment. Alfalfa seeding rate did not influence forage yields, excepting the second Madera site in 1988. At that site, seasonal forage yields were greater if alfalfa was seeded at 24 or 32 lbs/acre or oats were seeded at 16 to 32 lbs/acre.

Keywords: Companion crop, Oats, Forage yield, Weed Biomass, Forage composition.

INTRODUCTION

Companion crops are often utilized during alfalfa establishment. Companion crops have been shown to increase first cutting forage yield (Depuis, 1983; Janson and Knight, 1973; Kust, 1968; Peters, 1961; Schmid and Behrens, 1972; Wakefield and Pearson, 1964) and decrease weeds (Janson and Knight, 1973; Peters, 1961; Wakefield and Pearson, 1964). However, many of these studies have observed reductions in subsequent alfalfa yields (Depuis, 1983; Peters, 1961; Waddington and Bittman, 1984; Wakefield and Pearson, 1964) and alfalfa stand densities (Schmid and Behrens, 1972; Wakefield and Pearson, 1964).

The majority of these studies have been conducted on nonirrigated land. Peters (1961) working in nonirrigated conditions, concluded that companion crops were not desirable under dry conditions due to competition for water. However, Janson and Knight (1973) observed competition between companion crops and alfalfa to be greatest under irrigated conditions compared to nonirrigated plots. They concluded that irrigated companion crops decreased light available to alfalfa to a greater extent and for a longer duration then did nonirrigated companion crops.

Additionally, most studies utilized a single seeding rate of the companion crop, which have generally been high, ranging from a high of 168 kg/ha (Janson and Knight, 1973) to a low of 54 kg/ha (Peters, 1961). In one study (Smith et al., 1954), an oat companion crop seeding rate was varied from 18 to 108 kg/ha. This study found that increasing oat sowing rates decreased alfalfa stand densities on light soils. This study also found weed density to increase at decreasing oat seeding rates. However, this study was conducted on nonirrigated sites. Studies comparing oat companion crop seeding rates under irrigated conditions have not been done.

The study reported here deals with the influence of fall sown oats at different rates on the establishment of alfalfa stands under irrigated conditions. The specific objectives of this experiment were: (1) to measure and compare first year forage yields of alfalfa established alone or with an oat companion crop at three seeding rates; (2) to compare forage composition of the first cutting when seeding rates of alfalfa and oats are varied; (3) to compare alfalfa stand density during the first two years after establishment for each of the treatments; and (4) to measure and compare alfalfa yield and weed density in the year following establishment for each treatment combination.

MATERIALS AND METHODS

Studies were established in 1986 and 1987 to assess the affects of an oat companion crop at various seeding rates on alfalfa establishment and yield. Study sites were located in 1986 at Lancaster, Madera, and Walnut Grove, and in 1987 at a second Madera location. A split-plot design, replicated four times, was used in which alfalfa seeding

rate was the main plot and oat seeding rates were subplots. Alfalfa seeding rates were 16, 24, and 32 lbs/acre while oat seeding rates were 0, 8, 16, or 32 lbs/acre of 'Curt' oats, a short statured variety with average maturity. Alfalfa variety varied between sites due to differences in environmental conditions. In 1986, oats were seeded using a small-plot small grain drill. In 1987, oats were broadcast and incorporated with a disk, set at 4 inches (2 inch incorporation). Alfalfa was broadcast immediately following oat planting and incorporated with a cultipacker.

Seedings at Lancaster were made on October 9 and 10, 1986. The alfalfa variety utilized was WL 320. Soil at this location is a Hesperia fine sandy loam. This site is approximately 760 meters above sea level, and is relatively cold during winter months compared to other locations in this study. Sprinkler irrigation was used throughout this study. Forage harvest were made on May 5, June 28, and September 10, 1987 and on June 20, July 25, and September 2, 1988. Harvests were missed on July 31, 1987 and May 15 and October 20, 1988.

Planting at Madera was made on November 20, 1986. The alfalfa variety utilized was WL 515. Soil at this location is a Fresno El Peco loam. This site is approximately 75 meters above sea level. Rainfall occurred shortly after planting, eliminating the need for supplemental irrigation during establishment. Flood irrigation was utilized as necessary, during seasonal dry periods. Forage harvests were made on April 23, June 5, July 9, August 7, and September 29, 1987, and April 8, May 17, June 14, July 11, August 26, and September 28, 1988. Harvests were missed on September 1, 1987, and on August 1, 1988.

Planting at Walnut Grove occurred on October 27, 1986. The alfalfa variety utilized was Pioneer 581. This site is approximately 12 meters above sea level. This site was not initially irrigated after planting, and no rainfall occurred for one month after planting. Flood irrigation was utilized after establishment, during seasonal dry periods. Forage harvests were made on April 17, June 1, July 31, and September 4, 1987 and April 8, May 18, June 27, July 22, and August 19, 1988. Harvests were missed on July 1,1987 and October 1, 1988.

Planting at a second site in Madera occurred on November 4, 1987. The alfalfa variety utilized was GT 13R Plus (AgriPro). Soil at this location is a Pozo Loam. This site is approximately 75 meters above sea level. Rainfall occurred shortly after planting, eliminating the need for supplemental irrigation. Flood irrigation was utilized as necessary, during seasonal dry periods. Forage harvests were made on May 5, June 14, July 11, September 2, and October 20, 1988. A harvest was missed on August 5, 1988.

Forage harvest were made using a flail type harvester, cutting a 3 ft by 20 ft section out of the center of each plot and cutting at 2 inches above the ground. Subsamples were removed from each plot for dry matter assessment and feed analysis. At he first harvest after seeding, one meter squared quadrats were also clipped from each plot and separated for composition analysis. Alfalfa and weed stand densities were determined using 0.5 meter squared quadrats in the winter of both years for all sites and plots.

RESULTS AND DISCUSSION

First cutting forage yields were increased by the addition of an oat companion crop at three of the four study sites (Tables 1-4). The oats at the Lancaster site (Table 1) were attacked by dwarf yellow mosaic virus which reduced oat biomass and forage yields at the 8 and 16 lb/a seeding rates. Cuttings made after the initial cutting were generally lower yielding on plots where oats were included, but were not different at the end of the first cutting season (Tables 1-4). Second year forage yields did not differ between treatments.

Oat seeding rate yielding the highest tonage of forage in the first cutting varied between sites. At Lancaster, 32 lbs/a of oats were required before a forage yield increase was observed compared to the no oats control, with or without an herbicide treatment (Table 1). Dwarf yellow mosaic virus reduced oat growth at all seeding rates, thus requiring the higher seeding rates before yields were increased. At the first site in Madera, 8 lbs/a of oats increased forage yields as much as any higher oat rate, increasing forage yields over 2 tons/a compared to the no oat control (Table 2). At

Sacramento, forage yields were increased by 8 lbs/a of oats, but were even greater with 16 lbs/a, compared to the no oat control (Table 3). Seeding oats at 32 lbs/a at the Sacramento location was no more effective than the 16 lbs/a rate. A significant interaction between oat seeding rate and alfalfa seeding rate was observed at the second Madera location (Table 4). When alfalfa was seeded at either 16 or 32 lbs/a, maximum forage yields were obtained at 24 lbs/a or higher of oats. When alfalfa was seeded at 24 lbs/a, no significant increase inforage yields were observed at oat rates above 8 lbs/a. This seems logical with the exception of the 32lbs/a alfalfa seeding rate where lower oat seeding rates would have been expected to yield higher.

Seasonal and two year total forage yields corresponded to the observed trends in forage yields in the first cutting at the Lancaster site (Table 1). Using no oats or 32 lbs/a of oats produced better two year total yields than using either 8 or 16 lbs/a of oats. Herbicide treated plots yielded more alfalfa in the second cutting year compared to plots seeded to 8 or 16 lbs/a of oats, but were no better than the 0 or 32 lbs/a oat seeding rates, and were no better than any treatment in two year total forage yield (Table 1). At the first Madera location, first year total forage yield was greatest at 8 lbs/a of oats or greater, compared to the no oat control (Table 2). In the second cutting year greater yield were obtained on plots were 16 lbs/a of oats were used, compared to 0 or 8 lbs/a of oats. This may reflect greater weed suppression on these plots. Two year total forage yields were equal for all oat seeding rates compared to the no oat plot. At Sacramento, 16 lbs/a of oats were needed to obtain maximum first year and two year total forage yields (Table 3). In the second cutting year, no differences in forage yield were observed between the various treatments at this location, indicating no adverse affects from the oats. At the second Madera location, seeding oats at 24 lbs/a or higher produced the highest yearly forage yield when alfalfa was seeded at 16 lbs/a (Table 4). When alfalfa was seeded at either 24 or 32 lbs/a oat seeding rates of 8 lbs/a increased forage yields compared to the no oat control, with even greater increases occurring if 16 lbs/a or greater were used along with 32 lbs/a of alfalfa (Table 4). This plot will continue to be evaluated next cutting year for continuing trends. It appears from the results obtained in this study that 16 lbs/a of oats is the best seeding rate when using normal alfalfa seeding rates for California. Using higher oat rates can increase forage yield in certain instances in the first cutting, but appears to suppress alfalfa growth in later cuttings, reducing overall forage yield in the first cutting year.

Forage composition in the first cutting was measured and compared for the various treatments (Figures 1-4). In general, forage was very weedy when no oats were used, but was reduced significantly by good oat growth. Alfalfa biomass was also reduced significantly by the addition of oats. This resulted in the first cutting made up of mostly oats.

Alfalfa stand density and weed density was also assessed at the beginning of the second cutting year (data not shown). Alfalfa stands were not affected by the inclusion of oats during establishment. Weeds in the second year, however, were reduced when oats were used during establishment. During establishment, weeds were reduced by the competition from the oats (Figures 1-4). The reduction in weeds during that period also reduced weed seed production and in turn the weed population in the second year. Herbicide treatment at the Lancaster site also had the same affect of reducing weeds in the second year, thus emphasizing the need for weed control during establishment to prevent weed problems later in the life of the stand.

LITERATURE CITED

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Table 1. Forage Yield (tons/acre) for Lancaster - 1987-88

Oat Planting Rate (lbs/a)	Cutting Date 1987 May 5	June 1	July 31	Sept. 10	Total
0	2.54	1.68		1.19	5.41
8	2.24	1.57		.17	4.98
16	2.45	1.48		1.14	5.08
32	2.81	1.42		.2	5.44
0 + Herbicide	2.1	1.8		1.23	5.13
LSD .05	.24	.13		n.s.	.326

Oat Planting Rate (lbs/a)	1988 May 15	June 20	July 25	Sept. 2	Oct. 20	Total	Both Year Total
0		1.79	1.74	1.35		4.88	10.29
8		1.72	1.68	1.29		4.68	9.66
16		1.78	1.64	1.31		4.72	9.8
32		1.79	1.72	1.34		4.84	10.28
0 + Herbicide		1.77	1.77	1.39		4.94	10.06
LSD .05		n.s.	n.s.	.06		.16	.41

Table 2. Forage Yield (tons/acre) for Madera - 1987-88

Oat Planting Rate (lb/a)	Cutting Date 1987 April 23	June 5	July 9	August 7	Sept. 1	Sept. 29	Total
0	1.63	1.38	1.46	1.06		.68	6.2
8	3.92	1.37	1.21	.95		.67	8.11
16	3.88	1.27	1.31	1.00		.7	8.16
32	3.79	1.17	1.34	.95		.69	7.94
LSD .05	.50	14	n.s.	.08		n.s.	.48

Oat Planting Rate (lbs/a)	1988 April 8	May 17	June 14	July 11	Aug. 1	Aug. 26	Sept. 28	Total	Both Year Total
0	1.29	1.52	1.55	1.35		1.28	.96	7.95	14.14
8	1.22	1.45	1.57	.32		1.3	.95	7.81	15.92
16	1.33	1.64	1.61	1.44		1.34	1.03	8.39	16.54
32	1.36	1.54	1.59	1.39		1.28	1.00	8.17	16.11
LSD .05	n.s.	.10	n.s.	n.s.		n.s.	n.s.	.40	.71

Table 3. Forage Yield (tons/acre) for Sacramento - 1987-88

Oat Planting Rate (lb/a)	Cutting Date 1987 April 17	June 1	July 1	July 31	Sept 4	Total
0	1.63	1.38		.76	1.04	4.79
8	2.72	1.08		.75	.95	
16	3.47	1.02		.72	1.03	
32	3.39	.04		.68	.98	
LSD .05	.655	.17		n.s.	n.s.	.723

Oat Planting Rate (lbs/a)	1988 April 8	May 18	June 27	July 22	Aug. 19	Sept. 30	Total	Both Year Total
0	1.43	1.53	1.32	.96	.74		5.98	10.78
8	1.43	1.51	1.33	.93	.71		5.91	11.38
16	1.44	1.5	1.35	.94	.74		5.97	12.23
32	1.42	.6	1.32	.95	.7		5.99	12.07
LSD .05	n.s.	n.s.	n.s.	n.s.	n.s.		n.s.	.78

Table 4. Forage Yield (tone/acre) for Madera 1988 (Site 2)

Planting Rate (lbs/a)		1988						
Alfalfa	oats	May 5	June 14	July 11	Aug. 5	Sept. 2	Oct. 20	Total
16	0	1.14	2.17	1.3		1.01	.59	6.21
	8	2.98	1.72	1.14		1.1	.68	7.62
	16	4.29	1.34	1.0		1.18	.75	8.57
	24	5.36	.63	1.06		1.22	.74	9.0
	32	5.68	.27	1.08		1.16	.67	8.86
24	0	1.3	2.08	1.44		1.22	.82	6.87
	8	4.63	1.52	1.08		1.12	.59	8.93
	16	5.01	1.07	1.1		1.23	.72	9.12
	24	4.53	.8	1.15		1.15	.64	8.27
	32	5.19	.59	1.1		1.1	.69	8.67
32	0	1.26	2.08	1.54		1.17	.94	6.98
	8	3.52	1.43	1.34		1.12	.78	8.19
	16	4.66	1.41	1.14		1.15	.78	9.14
	24	5.74	1.04	1.27		1.28	.9	10.23
	32	5.07	1.0	1.25		1.24	.72	9.29
LSD .05		1.04	.35	n.s.		n.s.	.22	1.13

Fig. 1

Forage Yield and Composition

Lancaster, 1st Cutting, 5-5-87; LSD .05 = .24

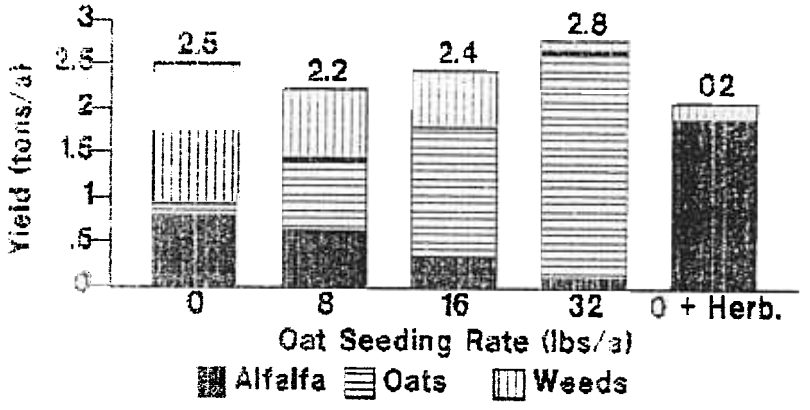


Fig. 2

Forage Yield and Composition

Madera, 1st Cutting, 4-23-87; LSD .05 = .50

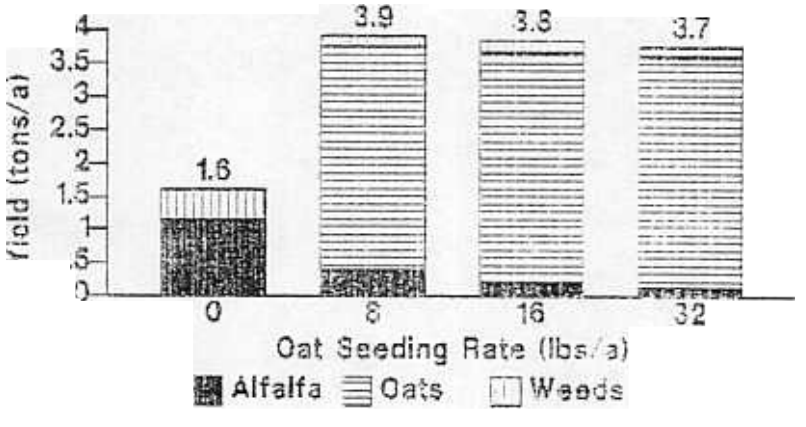


Fig. 3

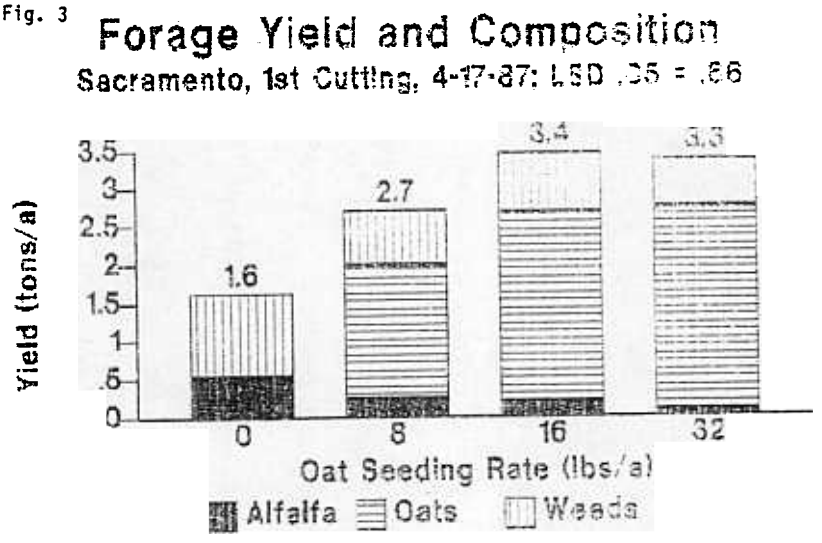
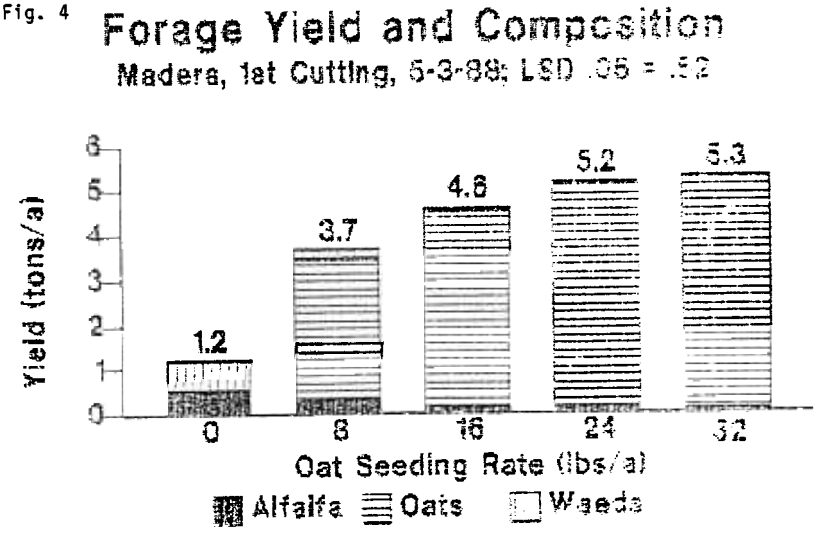

Forage Yield and Composition
Sacramento, 1st Cutting, 4-17-87; LSD .05 = .66
Yield (tons/a)
3.5
3
2.5
2
1.5
1
.5
0
1.6
2.7
3.4
3.3
0
8
16
32
Oat Seeding Rate (lbs/a)
Alfalfa
Oats
Weeds

Fig. 4


Forage Yield and Composition
Madera, 1st Cutting, 5-3-88; LSD .05 = .52
Yield (tons/a)
6
5
4
3
2
1
0
1.2
3.7
4.8
5.2
5.3
0
8
16
24
32
Oat Seeding Rate (lbs/a)
Alfalfa
Oats
Weeds