Establishing Red Clover Seed Stands in the Autumn With Cereal Cover Crops

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ABSTRACT

In Oregon, USA, red clover (*Trifolium pratense* L.) seed crops are usually established in September or early October. Because of the initial slow growth of red clover, the potential for soil erosion during autumn and winter months is high. There is an interest in establishing red clover with cereal cover crops to provide ground cover during the autumn and winter until clover can produce sufficient vegetation to cover the soil surface. This study was conducted to investigate the response of red clover seed production when established with wheat (*Triticum aestivum* L.) or oat (*Avena sativa* L.) cover crops. Cover crops were inter-seeded with red clover in late summer and subsequently killed by herbicides during the following winter. In the two experiments conducted, red clover seed yields during the first and the second year after establishment were not reduced by the cover crops. Red clover hay yields during the first cutting in each year were also unaffected by the cover crops. These results suggest that red clover may be autumn-seeded with wheat or oats as a cover crop without deleterious effects on seed production. Some evidence also suggested that oat is less competitive with red clover than wheat.

Additional index words: **oat, wheat, *Trifolium* spp.**

INTRODUCTION

Red clover is one of the most important legumes in the world (Smith, Taylor and Bowley, 1985), with seed production in the U.S. concentrated in two regions, the Midwest and the Northwest. In the Midwest, seed production is normally secondary to forage production; the first crop is generally used for forage and the subsequent crop harvested for seed (Rincker and Rampton, 1985). In the Northwest, stands are row-seeded and managed for seed production. Environmental conditions in this region that allow seeds to mature in the absence of rain-induced losses generally result in greater seed yields than the Midwest (Rincker and Rampton, 1985). Red clover is the most important legume crop grown for seed production in Oregon. During 1993, more than 5,000 tons of red clover seed were produced on about 8,500 ha in Oregon, with a production value of nearly $9 million (Miles, 1994). In western Oregon, the red clover seed crop is normally autumn (fall)-planted on well-drained soils. The seed bed is prepared conventionally and red clover is sown in rows during late summer and irrigated to improve establishment. Red clover seedlings establish slowly during the cool autumn and winter months. Rapid growth occurs in spring when temperatures increase. Weeds are usually controlled by herbicides throughout autumn and spring. Because of inadequate soil cover during autumn, winter, and early-spring when almost all of the precipitation occurs in western Oregon, the potential for soil erosion on the first-year clover fields is high. Consequently, farmers are looking for alternative methods for establishing red clover to reduce soil erosion.

The use of wheat and oats as cover (nurse) crops when establishing forage legumes has long been a standard practice in the U.S. (Peters, 1961; Curran, Kephart and Twidwell, 1993; Sulc, Albrecht and Casler, 1993) and Canada (Waddington and Bittman, 1984; Moyer, 1985; Fairey and Lefkovitch, 1991). Originally, the purpose for including cover crops was to reduce weed competition (Peters, 1961). With the emergence of herbicides in the 1940s and the capability to selectively control weeds in legume seed beds, the use of cover crops became less popular (Peters, 1961; Lee, 1985). More recently, the interest in conservation practices such as reductions in pesticide use and soil erosion have stimulated interest in using cover crops for establishing forage legumes (Simmons *et al.*, 1992; Curran *et al.*, 1993; Sulc, *et al.*, 1993).

When the combination of rainfall intensity and slope increases erosion potential, growing cover crops is the best available means of controlling erosion (Sojka, Langdale and Karlen, 1984; Zhu *et al.*, 1989). To protect the soil from erosion, legume forages are established with a small grain cover crop, which at the appropriate stage is killed by selective herbicides (Curran, Kephart and Twidwell, 1990; Curran *et al.*, 1993). The cover crop residue reduces soil erosion even after competition is minimized (Curran *et al.*, 1993). Use of oats as a cover crop for establishment of an alfalfa (*Medicago sativa* L.) forage crop was estimated to reduce soil erosion by tenfold (Curran *et al.*, 1993). A recent farmer survey indicated that soil protection is a more important reason than weed control and producing additional herbage when using cover crops to establish forage legumes (Simmons, *et al.*, 1992).

Research on cover crops used for legume establishment has focused primarily on their effects on forage yield. Results indicate that in general, competition from cover crops reduces vegetative growth and, consequently, forage yield (Peters, 1961; Waddington and Bittman, 1984; Moyer, 1985; Sheafer, Barnes and Marten, 1988; Curran *et al.*, 1990). There is limited information on possible effects of cover crops on legume seed production. Polish rapeseed (*Brassica campestris* L.) as a cover crop significantly reduced forage yield of spring-seeded alfalfa during the first production year (Waddington and Bittman, 1984), whereas no consistent seed yield differences were observed for sowing with and without the cover

1 *Department of Crop and Soil Science , Oregon State Univ., Corvallis, OR 97331-3002. Contribution from Oregon Agric. Exp. Stn., (Tech. Paper No. 10663.)*

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crop (Waddington and Malik, 1987). Using oats as a cover crop for spring establishment of red clover had little effect on the seed production in the following year, but barley (*Hordeum vulgare* L.) and canola (*Brassica campestris* L.) cover crops reduced red clover seed yield (Fairey and Lefkovitch, 1991).

The objective of this experiment was to determine the effects of including wheat or oat as cover crops on seed production of autumn-planted red clover. The small grains were considered cover crops to reduce soil erosion during autumn and winter months. Effects of small grain cover crops on clover hay yield in the first cutting was also measured.

MATERIALS AND METHODS

Two field experiments were conducted at the Hyslop Crop Science Field Laboratory near Corvallis, Oregon, during the summers of 1985 and 1986. The soil type was Woodburn silt-loam (fine-silty, mixed, mesic Aquultic Argixerolls). For both experiments, a conventional seedbed was prepared in late-August, with 225 kg ha^{-1} of 15-15-15 fertilizer incorporated. In the first experiment, 8 kg ha^{-1} of red clover cv. Kenland was seeded on September 5, 1985 in 0.35 m rows oriented north-south. On the same day, 45 kg ha^{-1} of either winter wheat (cv. Malcolm) or spring oats (cv. Cayuse) were seeded in east-west rows spaced 0.30 m apart. Control plots with no cereal cover crops were also included. Plots were 3.6 x 15 m and were arranged in a randomized complete block design with three replications. About 10 cm of water was applied with sprinklers on the first and the third week after seeding to improve stand establishment. Weed control was initiated with a broadcast application of 1.7 kg a.i. of dinoseb (2-1(1-methylpropyl)-4,6- dinitrophenol) ha^{-1} in October (Whitson *et al.*, 1985). On January 31, 1986, 2.2 kg a.i. of pronamide (3,5-dichloro(*N*-1,1- dimethyl-2-propynyl)benzamide) ha^{-1} was applied to remove the cover crops and other annual grasses. A soil test for plant nutrients was not conducted, but under the soil conditions of western Oregon, red clover seed crops generally respond positively to P, S, and B applications (Gardner *et al.*, 1972). Therefore, on March 25, 1986, 180 kg ha^{-1} of 0-25-0-10 (S) fertilizer was applied, and on June 25, Solubor® was applied at 2.8 kg ha^{-1} (about 0.5 kg B ha^{-1}).

On June 1, 1986, plant height was measured on four random spots along the length of each plot. On that day, plants were counted on 0.3 m of two rows in each plot and then hand harvested and air-dried for dry weight measurements. The foliage for all plots was then removed with a flail chopper to simulate a hay cutting. Five cm of irrigation was applied by sprinklers on June 13, to encourage regrowth. Honey bees (*Apis mellifera* L.) at about 5 hives ha^{-1} (Morrison, Foeppel and Rincker, 1984) were provided for pollination on July 3. On August 28, final plant height measurements were taken as above and 0.3-m sections of four rows were hand-harvested to determine seed yield components. All plots were subsequently harvested with a small plot harvester to determine seed yield.

All plots received two applications of 0.34 kg a.i. ha^{-1} MCPA (dimethyl 2,3,5,6,- tetrachloro-1,4- benzenedicarboxylate) on October 1 and 22, 1986 for the control of broadleaf weeds (Whitson *et al.*, 1985). On December 3, 1986 a tank mix of 4.7 L ha^{-1} paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) and 2.3 kg a.i. ha^{-1} diuron (N'-(3,4-dichlorophenyl)-N,N- dimethylurea) was applied. On February 6, 1987, 2.3 kg a.i. ha^{-1} pronamide was also applied to control annual grasses. On February 23, 1987, 180 kg ha^{-1} 0-25-0-3 (S) fertilizer was applied on all plots. Only the hay yield and the seed yield were measured in this year.

A second experiment was seeded on September 9, 1986. All procedures were the same as for the first experiment except that irrigation water was not applied after seeding. Further, dinoseb was no longer registered for use on red clover. Consequently, on October 22, 1986, 2,4-DB (4(2,4-dichlorophenoxy)butanoic acid) ester was applied at 1.1 kg a.i. ha^{-1} for weed control. On December 30, 1986, 2.2 kg a.i.

Table 1. Mean monthly temperatures and monthly total precipitation for Corvallis, Oregon, USA during the research period.

	1985			1986			1987			1988		
	Mean. temp.		Total	Mean temp.		Total	Mean temp.		Total	Mean temp.		Total
Month	Max.	Min.	Precip	Max.	Min.	Precip	Max.	Min.	Precip	Max.	Min.	Precip
	°C		mm	°C		mm	°C		mm	°C		mm
Jan.				10	2	166	8	1	209	7	1	180
Feb.				10	3	251	11	3	114	11	2	43
March				16	5	77	13	4	94	14	3	99
April				15	4	47	19	5	40	16	6	84
May				19	7	64	21	8	36	18	7	98
June				25	11	8	25	10	7	22	9	46
July				25	10	29	25	12	57	28	11	2
Aug.	27	10	12	31	11	0	29	11	4	28	10	0
Sept.	22	8	20	22	9	90	26	8	1	26	8	19
Oct.	18	5	99	19	7	71	23	5	7			
Nov.	7	0	119	12	4	219	12	5	99			
Dec.	5	–4	94	8	0	89	7	1	290			

Table 2. Effects of companion crops on red clover agronomic and seed yield performance in Experiment 1.

Companion crop	Plant height (cm)	Plant count (no m^{-2})	Hay yield (kg ha^{-1})	Plant height (cm)	Plant count (no m^{-2})	Total dry weight (kg ha^{-1})	Seed yield (kg ha^{-1})	Seed weight (g 1000^{-1})	Seed heads (no m^{-2})	Heads/ plant (no)	Seeds/ head (no)
Measured June 1, 1986 (Forage harvest)				**Measured Aug. 28, 1986 (Seed harvest)**							
Wheat	48	123	2912	43	164	2738	311	1.58	414	2.5	51
Oat	46	119	3808	47	133	2891	413	1.57	405	3.0	66
None	64	129	4256	45	189	2612	393	1.56	380	2.0	69
LSD P < 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Measured May 19, 1987 (Forage harvest)				**Measured Aug. 20, 1987 (Seed harvest)**							
Wheat			7078			1733	62	1.74			
Oat			7019			2119	74	1.78			
None			6190			2113	76	1.75			
LSD P < 0.05			NS			NS	NS	NS			

Table 3. Effects of companion crops on red clover agronomic and seed yield performance in Experiment 2.

Companion crop	Plant count (no m^{-2})	Hay yield (kg ha^{-1})	Total weight (t ha^{-1})	Seed yield (kg ha^{-1})	Seed weight (g 1000^{-1})
	Measured May 19, 1987			Measured Sept. 7, 1987	
Wheat	136	1568	1090	9	1.51
Oat	129	1170	1060	13	1.48
None	133	1945	1234	4	1.44
LSD P < 0.05	NS	NS	NS	NS	NS
	Measured June 14, 1988			Measured Sept. 13, 1988	
Wheat		3599	2930	97	1.52
Oat		4192	2875	97	1.51
None		3614	3012	107	1.54
LSD P < 0.06		NS	NS	NS	NS

of pronamide ha^{-1} was also applied to remove the cover crops and other annual grasses. All other management practices and measurements in both production years were the same as in Experiment 1.

RESULTS

The cereal crops germinated rapidly in both experiments and the red clover seedlings were very slow to emerge and establish. Observations indicated that most red clover seedlings had not developed the first true leaf until one month after seeding. In general, by late October of the seeding year, oats were 15 to 20 cm tall with upright vigorous growth, whereas the wheat was more prostrate in growth habit and was 7 to 10 cm tall. In the first experiment, broadleaf weeds were completely removed by the dinoseb herbicide. The cold weather during November and December of 1985 (Table 1) killed most of the oats and created a layer of senescing leaf tissue blanketing the red clover by mid-December. There were almost no surviving oat plants by late January. The wheat was unaffected by the cold weather and had grown to a height of about 25 cm by mid-January, 1986, before it was killed by pronamide application in late January.

No significant differences were observed in plant height, plant counts, or hay yield during the first year of experiment 1 (Table 2). At harvest, there were no significant differences in plant height, seed yield, or yield components in response to the cover crops (Table 2).

Hay yields were considerably higher in the second year than in the first year, although the previous cover crops did not affect the hay yield (Table 2). In contrast, seed yields were lower during the second year (Table 2). Nevertheless, use of cover crops for establishment had no effect on seed

yield during the second production year.

In the second experiment, hay and seed yields were very low during the first production year (Table 3). The lack of irrigation after seeding along with unseasonably warm weather during the autumn and early winter (Table 1) favored the rapid growth of weed species. Also, weed control was less effective in this experiment than in the first experiment because dinoseb was no longer registered for use on red clover seedlings. Further, a dry spring and summer also reduced red clover growth. The cover crops did not affect red clover stand density, hay yield, total dry matter at seed harvest, or seed yield of the first production year in this experiment (Table 3). Measurements during the second production year also indicated that the cover crops had no significant effects on red clover hay yield or seed production (Table 3).

DISCUSSION

Seed yields from the second-year harvest of experiment 1 and both years from experiment 2 were well below the 330 kg ha^{-1} average seed yield in Oregon between 1980 and 1988 (Ext. Econ. Info. Office, Oregon State University). Although data were not collected, field observations indicated that the stands were very poor in experiment 2. Lack of irrigation after seeding provided the advantage for growing weeds, and chemical weed control was less effective in this experiment because dinoseb was no longer registered for use on seedling red clover. Consequently, the stand of the second experiment was severely infested with broadleaf weeds. Environments (location and year) have a substantial effect on the growth of legumes established with cover crops (Brink and Marten, 1986; Sulc, 1993), and many environmental and management practices affect red clover seed yield (Clifford, 1980). The extremely dry and warm weather during the August of 1986, 1987, and 1988 (Table 1) probably affected stand establishment and limited seed set and seed fill. Nevertheless, useful conclusions were made from the findings of this research.

Results indicated that including wheat or oats as cover crops for autumn establishment of red clover did not affect the hay yield or clover seed production. The non-winter-hardy oat cover crop appeared to compete less with the red clover than the wheat cover crop. Fairey and Lefkovitch (1991) also found that oats had little or no effect on seed production of spring-established alfalfa, alsike clover (*Trifolium hybridum* L.), and red clover, whereas barley and canola had deleterious effects. Another advantage for using oats as a cover crop in Oregon is that in some years oats would not survive the winter and a pure clover stand could be obtained in the spring without using herbicides.

Beside potential benefits for reducing soil erosion, cover crops may protect young clover seedlings in the winter. In western Oregon, autumn planting in some years may not provide clover seedlings enough time to adequately develop before the onset of cold weather. Consequently, some seedlings do not survive the winter cold, specially on east facing slopes where the cold wind prevails. Using cover crops to protect clover seedlings from frost damage merits further investigations in locations subject to severe winter damage. Because of the potential benefits, we recommend autumn-establishment of red clover seed crops in Oregon with cover crops. However it is noteworthy that white clover seed yield was considerably higher when direct-drilled into barley stubble in the autumn than when it was sown with a cover crop (McCartin, 1985). Further research is needed to investigate effects of direct-drill autumn establishment of red clover into cereal or grass seed stubble on seed production of red clover.

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