

## SEASON-LONG YIELD LOSSES FROM WEEDS IN SEEDLING STANDS

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### Introduction.

Winter weeds in fall-seeded alfalfa--who cares? If weeds do get going you can always mow them out in the spring. At worst, you'll lose the first cutting as the alfalfa recovers by the next cutting. Right? The author has heard this sort of logic discussed by growers, PCAs and University personnel on several occasions. There is essentially no accurate information available about the competitive effects of weeds on fall seeded alfalfa, and thus it is not possible to deny or verify the above statements. Work was initiated in fall 1978 to investigate the competitive impacts of weeds during stand establishment in fall-seeded alfalfa. The major parameters of interest were the effect of weeds on alfalfa stands and on yield.

### Materials and Methods.

Two experiments were conducted on the University of California farm at Davis. The soil was a deep fine sandy loam. Alfalfa (cv DeKalb 167) was drill seeded on Oct. 23, 1978, and Oct. 18, 1979. Each plot was 5 drill lines wide spaced 6 inches apart on-center; seed was placed 0.25 to 0.5 inches deep. Individual plot size was 2.5 ft. wide by 17 ft. long. No fertilizer was added. Seeds of a specific weed species (see tables) were scattered over the plot area and lightly raked into the soil surface prior to seeding the alfalfa. The weed seeding rate of about 100 seeds/ft<sup>2</sup> was used, and alfalfa was seeded at either 15 or 30 lb/A. The experiments were established in a randomized split-plot design; weed species were the main plots and alfalfa seeding rates were the subplots. All treatments were replicated 4-fold.

The experiments were sprinkler irrigated for emergence in conjunction with rainfall. The plots received no further irrigation until after the first cutting, as winter rains were adequate to insure good alfalfa and weed growth. All plots were flood irrigated twice between each cutting throughout the growing season; adequate water was supplied to provide vigorous alfalfa growth.

Numbers of alfalfa and weed seedlings were counted about three weeks following the initial irrigation. Alfalfa crowns were counted at the same locations after the first and last cutting each year. Weeds were removed from the hand weeded control plots as soon as practicable after seedling emergence. Weeds between the crop rows were removed by hoeing; those along the drill lines were carefully removed by hand so that alfalfa roots were not disturbed. This entailed cutting each weed seedling off, one at a time, at soil level. Weeding was continued as needed to maintain the plots weed free up to the first cutting. No further weed control was carried out beyond the first cutting.

No pesticides of any type were used prior to the first cutting, except for a 2% zinc phosphide treatment (8.0 lb/A) applied on April 29, 1980 to control a severe meadow mouse (Microtus sp.) population. A paraquat treatment (1.0 lb/A) was applied on Jan. 3, 1980 to control winter weeds between the first and second growing season in the experiment started in the fall of 1978, and 0.5 lb/A of carbofuran was applied on March 6 to control larvae of the Egyptian alfalfa weevil (Hypera brunneipennis Boh.).

Harvest consisted of cutting the entire length of each plot and weighing the quantity of fresh vegetation. A front-mounted sickle-bar mower (Kinco Mfg., KMG-38) was used to cut the plots at about 2 inches above the soil. Three random subsamples were taken from the overall plot sample. These were placed in polyethylene bags and returned to the laboratory for further analysis. Dates of harvest were judged on the basis of the maturity of the alfalfa in the weed free plots. The first cutting was made in early May, and the subsequent harvests were conducted on an approximately monthly schedule. The subplot samples were weighed fresh, separated into alfalfa and weeds components, dried, and reweighed. This permitted calculation of all harvest data on the basis of dry weight and to calculate the yield and percentage of weeds present in the harvested hay. No separa-

tions were made on subsamples if the hay was judged to have less than about 1 to 2% weeds, or less than 1 to 2% alfalfa. Appropriate statistical analyses were performed to determine statistical significance between treatments.

### Results and Discussion.

The alfalfa germinated in 7 to 10 days in both trials, and counts of seedlings showed that excellent emergence had occurred (Tables 1 and 2). Weeds also germinated in the same period and counts showed that adequate but variable populations had developed (Tables 1 and 2). No attempt was made to modify the numbers of weeds present; all weed stands were judged to be within the ranges that can occur in commercial alfalfa fields.

During the winter the weeds grew rapidly and overtopped the slow growing alfalfa, but the degree to which this occurred was species dependent. Mustard (Brassica kaber L.), fiddleneck (Amsinckia intermedia F. & M.), and wild oats (Avena fatua L.) exceeded alfalfa height several-fold. Groundsel (Senecio vulgaris L.), redmaids (Calandrinia ciliata (R. & P.) D.C.) plus miner's lettuce (Montia perfoliata (Donn.) How.), and wild barley (Hordeum murinum L.) were about one or two times taller than the alfalfa in the late winter and were about equal to or shorter than the alfalfa at the first harvest. The annual bluegrass (Poa annua L.) and the chickweed (Stellaria media (L.) Vill.) only slightly exceeded alfalfa growth at any time and had become understory plants by the first harvest. All weeds had flowered and were beginning to collapse by the first harvest; wild oats and wild barley were the most vigorous, and annual bluegrass and chickweed were almost completely dead. The other species were intermediate. Weed yields at the first cuttings (5/9/79 and 5/1/80) reflected the above noted stature of the plants (Tables 3b and 4b). Mustard and wild oats were the largest plants and produced the highest biomass; fiddleneck was also a robust plant and produced a large quantity of vegetation, and wild barley likewise produced a high yield. The yields of these weeds were composed almost entirely of the designated species. The annual bluegrass, groundsel, and redmaids/miner's lettuce produced lower yields than the four preceding species (Tables 3b and 4b), and the samples were contaminated with other weeds that had invaded these plots, such as shepherd's purse (Capsella bursa-pastoris L.), sowthistles (Sonchus spp.), miner's lettuce, and chickweed; the contaminant weeds were estimated not to exceed 20% of the harvest biomass. The degree of invasion by weeds other than the designated species was minimized by hand removal of the undesired species; only partial success was achieved this way. Chickweed produced the lowest biomass (Table 4b) and was the most seriously contaminated with other weeds at harvest; the extent of the contamination was estimated to range from 20% to as much as 50% in one plot. Early competition from November to February thus represented that of chickweed, but by the first harvest the other weed species had also interfered with alfalfa growth. None of the weed species regrew after the first cutting, except the wild barley which regrew moderately and contributed biomass to the second cutting (Table 3b).

First cutting alfalfa yields in the weed free plots were higher in the experiment established in the fall of 1978 (Table 3a) than those of the trial established in the fall of 1979 (Table 4a). This loss of yield was attributed to the damage done by the field mice that invaded the adjacent weedy plots. The mice lived in these weedy plots but foraged, until they were controlled, for the alfalfa in the weed free plots. Visual assessment of mouse damage suggested that a yield of about 1.7 tons/A would have been realized in the weed free plots if the mouse feeding had not occurred. No attempt was made to correct for mouse damage in any of the plots, and the mice probably did affect the first cutting yields in most plots.

The first cutting yields of the alfalfa competing with weeds were almost exact opposites of the weed yields (Table 3a and 4a). As the stature, and yield, of the weed species increased, the yield of alfalfa was accordingly less. On a first cutting yield basis the weeds investigated to date ranked, from most competitive to least competitive, as mustard = fiddleneck = wild oats > wild barley > redmaids/miner's lettuce ≥ groundsel ≥ annual bluegrass > chickweed. Yield loss of the alfalfa ranged from total for more competitive species (mustard, wild oats, fiddleneck) to about 20% to 30% for the least competitive species (chickweed).

The alfalfa yield loss at the first cutting did not reflect a potentially more serious problem caused by some of the weed species. Alfalfa stand counts made after the

first cutting showed that wild oats and fiddleneck had caused substantial to almost complete loss of the alfalfa plants (Table 1 and 2). The difference in degree of alfalfa stand loss recorded for fiddleneck in the two experiments were attributed to two factors. In the experiment started in the fall of 1978, the weeds were sowed so that their outer boundary coincided with the outer alfalfa drill row. This permitted alfalfa plants in the outer drill lines to survive. In the experiment started in October, 1979 the weed seeds were sowed at least 3 inches beyond the outer alfalfa drill line which apparently allowed less possibility for alfalfa survival. As previously noted, the latter experiment experienced a serious invasion of meadow mice; it is possible that the mouse damage accounted for some of the increased alfalfa stand loss recorded in this experiment. No other weed species investigated to date has had any affect on the alfalfa stand (Tables 1 and 3a).

Alfalfa harvests obtained throughout the growing season continued to show that alfalfa yields were influenced by the initial competition (Tables 3a and 4a). The effects remained for the whole of the first season for several species; those that had caused stand loss had the most pronounced long-term effects. Competition from mustard and wild barley, which did not alter the stand, caused alfalfa yield to be depressed throughout the first year. Only by the last cutting was the yield not significantly lower than that of the weed free plots. Weeds which caused less severe initial competition also showed less persistent alfalfa yield reductions during the growing season (Tables 3a and 4 a), but even alfalfa that had suffered only moderate competition from redmaids/miner's lettuce or groundsel required three to four cuttings before yields were not below those of the hand weeded controls.

Weed yields were recorded during the summer growing season, and reflected invasion of summer annual grasses, primarily barnyard grass (*Echinochloa crusgalli* (L.) Beauv.) and yellow foxtail (*Setaria lutescens* L.) (Tables 3b and 4b). These weed yields again correlated closely with the severity of the initial competition; variations in their presence reflected the competitive ability of the alfalfa. Where the alfalfa stand was reduced the summer weeds invaded rapidly and considerable weed growth occurred. When the alfalfa vigor was lowered but the stand was not affected, then the summer weeds invaded less rapidly and comprised less of the harvested yield. There was almost no summer weed invasion in the hand weeded plots that experienced no competition while the stand was becoming established.

A second season of harvesting was continued on the experiment initiated in the fall of 1978. Winter weeds were controlled with a paraquat treatment so that any differences in the yields would reflect the initial competition during stand establishment. There were no differences in the yield of the alfalfa, although the hand weeded controls did show a consistent trend for slightly increased yield (Table 5). The alfalfa stand had declined only slightly from the previous year, and still reflected the differences that were observed after the first cutting in the first season (Table 1).

These two experiments showed several components of the problem of weed competition during stand establishment of fall-seeded alfalfa in the Sacramento valley. These include:

- Losses due to weed competition, if left uncontrolled, can be 100% by the first cutting.
2. Weed species differ greatly in their effects on alfalfa. An overall ranking of the weed species investigated, from greatest to least problem, would be fiddleneck > wild oats > wild barley > groundsel = redmaids/miner's lettuce = annual bluegrass > chickweed. Further experimentation could alter these rankings.
3. Losses due to winter weeds in fall-seeded alfalfa persist for several cuttings, or as long as the first growing season.
4. Some weed species can cause substantial loss of the seedling alfalfa stand.
5. Vigorous alfalfa at the first cutting will substantially reduce invasion of summer weeds.

Acknowledgements

Technical assistance by Debra Ayres and Renzo Lardelli is gratefully acknowledged. Funding for this project was provided by EPA grant # CR-806277-01 without which these experiments could not have been conducted.

TABLE 1. Influence of weeds during stand establishment on number of alfalfa crowns; seeded Oct. 23, 1978.

Competing species	Alfalfa seeding rate lb/A	Alfalfa stand (crowns/ft <sup>2</sup> )				Initial weed stand/ft <sup>2</sup> 11/17/78
		1/17/78	5/10/79	11/1/79	10/23/80	
Hand weeded	15	52	9.1	9.7	9.5	
	30	103	16.0	14.0	12.4	
Wild barley	15	59	10.8	10.2	9.4	49
	30	100	12.0	11.4	10.1	
Redmaids + miner's lettuce	15	58	9.5	9.3	8.7	14
	30	126	15.0	10.8	10.0	
Mustard	15	60	13.0	11.0	10.3	83
	30	80	13.6	13.0	10.6	
Fiddleneck	15	49	5.8	5.1	5.1	41
	30	90	6.8	6.9	6.4	

Counted 1/19/79

TABLE 2. Influence of weeds during stand establishment on number of alfalfa crowns; seeded Oct. 18, 1979.

Competing species	Alfalfa seeding rate lb/A	Alfalfa stand (crowns/ft <sup>2</sup> )			Initial weed stand/ft <sup>2</sup> 11/13/79
		11/8/79	5/19/80	10/3/80	
Hand weeded	15	44.1	21.0	11.9	
	30	75.8	23.1	11.8	
Fiddleneck	15	37.4	0.2	0.9	24
	30	78.8	0.0	0.8	
Groundsel	15	39.3	16.0	9.9	18
	30	77.7	24.6	11.6	
Chickweed	15	41.2	19.5	11.4	42
	30	77.5	23.6	10.8	
Wild oats	15	39.3	4.9	3.0	28
	30	72.6	0.7	1.0	
Annual bluegrass	15	40.9	17.1	10.7	30
	30	76.4	22.9	11.7	

Table 3. Influence of weeds during stand establishment on first year forage yield; seeded Oct 24, 1978.

a. Alfalfa yield

Competing species	Alfalfa seeding rate lb/A	1979 season alfalfa yield, ton/A						Total
		5/9	6/13	7/16	8/15	9/13	10/24	
Hand weeded	15	1.9	2.0	2.6	2.2	1.7	1.6	12.0
	30	2.2	2.4	2.7	2.4	1.7	1.6	13.0
Wild Barley	15	0.1	1.0	1.7	1.6	1.4	1.5	7.3
	30	0.2	1.5	2.3	2.0	1.5	1.5	9.0
Redmaids + miner's lettuce	15	0.7	1.7	2.5	2.0	1.5	1.4	9.8
	30	0.8	1.7	2.6	2.2	1.7	1.6	10.6
Common mustard	15	0.0	0.5	1.5	1.5	1.3	1.4	6.2
	30	0.0	0.7	1.9	1.8	1.4	1.6	7.4
Fiddleneck	15	0.0	0.5	1.5	1.5	1.2	1.3	6.0
	30	0.0	0.7	1.7	1.5	1.4	1.5	6.8

b. Weed yield

Competing species	Alfalfa seeding rate lb/A	1979 season weed yield, ton/A						Total
		5/9	6/13	7/16	8/15	9/13	10/24	
Hand weeded	15	0.0	0.0	0.03	0.04	0.04	0.00	0.11
	30	0.0	0.0	0.00	0.01	0.01	0.00	0.02
Wild Barley	15	5.21	0.58	0.02	0.09	0.07	0.00	5.43
	30	4.08	0.26	0.00	0.02	0.02	0.00	4.38
Redmaids + miner's lettuce	15	1.38	0.00	0.03	0.11	0.03	0.00	1.55
	30	1.51	0.00	0.06	0.05	0.03	0.00	1.65
Common mustard	15	5.74	0.05	0.27	0.23	0.05	0.00	6.34
	30	8.80	0.03	0.22	0.20	0.05	0.01	9.31
Fiddleneck	15	3.28	0.02	0.26	0.22	0.06	0.01	3.85
	30	3.87	0.02	0.23	0.17	0.05	0.00	4.34

Table 4. Influence of weeds during stand establishment on first year forage yield; seeded Oct. 18, 1979.

a. Alfalfa yield

Competing weed species	Alfalfa seeding rate lb/A	1980 season alfalfa yields, ton/A					Total <sup>1</sup>
		5/8	6/17	7/21	8/19	9/23	
Hand weeded	15	1.0	2.3	2.1	1.7	1.2	8.3
	30	1.1	2.4	2.1	1.7	1.1	8.4
Fiddleneck	15	0.0	0.04	0.03	0.23	0.21	0.5
	30	0.0	0.02	0.04	0.04	0.21	0.3
Groundsel	15	0.7	1.4	1.7	1.4	0.9	6.1
	30	0.4	1.6	1.7	1.6	1.0	6.3
Chickweed	15	0.8	2.0	2.0	1.7	1.0	7.5
	30	0.7	2.2	2.0	1.5	1.1	7.5
Wild oats	15	0.0	0.2	0.2	0.6	0.4	1.4
	30	0.0	0.1	0.1	0.3	0.3	0.8
Annual bluegrass	15	0.4	1.9	1.9	1.6	1.1	6.9
	30	0.6	2.1	2.0	1.8	1.0	7.5

b. Weed yield

Competing weed species	Alfalfa seeding rate lb/A	1980 season weed yields, ton/A					Total <sup>1</sup>
		5/8	6/17	7/21	8/19	9/23	
Hand weeded	15	0.00	0.0	0.10	0.05	0.01	0.16
	30	0.00	0.0	0.06	0.06	0.01	0.13
Fiddleneck	15	9.07	0.19	2.08	0.90	0.50	12.74
	30	9.07	0.13	1.71	1.02	0.30	12.23
Groundsel	15	1.29	0.02	0.18	0.28	0.03	1.80
	30	1.29	0.02	0.24	0.15	0.01	1.72
Chickweed	15	0.65	0.00	0.02	0.19	0.01	0.87
	30	0.68	0.00	0.07	0.08	0.02	0.85
Wild oats	15	6.78	0.14	1.53	0.67	0.34	9.46
	30	6.45	0.17	1.65	1.09	0.39	9.75
Annual bluegrass	15	1.27	0.00	0.15	0.05	0.03	.50
	30	1.14	0.00	0.16	0.02	0.01	.33

This is the total for only 5 cuttings.

Table 5. Influence of weeds during stand establishment on second year alfalfa yields; seeded Oct. 24, 1978

Competing species	Alfalfa seeding rate lb/A	1980 season alfalfa yields, ton/A						Total
		5/1	5/29	6/26	<sup>1</sup>	8/26	10/2	
Hand weeded	15	2.0	1.6	1.8	--	1.5	1.3	8.2
	30	1.9	1.6	1.8	--	1.4	1.2	7.9
Wild barley	15	1.9	1.4	1.7	--	1.4	1.2	7.6
	30	1.9	1.5	1.6	--	1.3	1.2	7.5
Redmaids + miner's lettuce	15	1.8	1.5	1.6	--	1.4	1.1	7.4
	30	2.0	1.5	1.7	--	1.3	1.3	7.8
Common mustard	15	1.8	1.5	1.8	--	1.3	1.2	7.6
	30	1.9	1.5	1.8	--	1.4	1.3	7.9
Fiddleneck	15	1.8	1.4	1.6	--	1.5	1.2	7.5
	30	1.9	1.6	1.7	--	1.4	1.2	7.8

<sup>1</sup> Harvest data for this date are not available.