Dr. Nalewaja inspects a field of sunflowers infested with wild mustard.

WEEDS IN SUNFLOWERS

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Introduction

Weed competition in crops is a major economic loss to farmers. The seriousness of a weed infestation is not visually spectacular, unfortunately; and further, weed competition generally does not cause a complete loss in crop production. Therefore, many agriculturalists directly or indirectly fail to realize the importance of this silent yet continuous invasion of weeds. Small but consistent crop yield reductions overlooked year after year result in a staggering total economic loss perhaps much more serious than one large loss of a season's production as little incentive exists to prevent further small yield losses.

Sunflowers (**Helianthus annuus** L.) have been considered good competitors with weeds (1). How-

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ever, many sunflower fields in North Dakota have well-established weed infestations and the sunflowers appear stressed. Several studies were conducted to determine the yield losses from weed competition in sunflowers.

Experimental Methods

The weed competition in sunflowers from a natural weed infestation was studied as part of an experiment to evaluate herbicides for weed control in sunflowers from 1966 to 1968 at Fargo. The experimental plots were made weed free by hoeing and hand pulling, simulated cultivation by hoeing weeds between the rows except for six inches over the row, and weedy with no weed removal. The weed treatment plots were 8 by 30 feet, and the sunflower varieties were seeded in 38-inch rows at right angles to direction of the plots. The sunflower varieties seeded were Advent, T56002, Smena, Arrowhead, Commander, Armavirec, Mennonite, Mingren, and Peredovik in 1966 and Peredovik and Mennonite in 1967 and 1968. Yield data are presented as an average over varieties except for data from 1968. The experiments contained four replications.

Competition from wild mustard (**Brassica Kaber** (D.C.) L. C. Wheeler) or yellow foxtail (**Setaria lutescens** (Weigel) Hubb.) at various densities in the sunflower row and from duration of a natural weed infestation in sunflowers was studied from 1967 to 1969 on the Dalrymple Experimental Plot at Casselton, North Dakota. Peredovik sunflowers were seeded in 40-inch rows across weed treatment plots 12 by 30 ft. The experiment contained six replications. Weed densities and time of weed removal data will be given in results and discussion.

Evaluation of herbicides for weed control in sunflowers has been conducted since 1965 at either Fargo or Casselton. The experimental procedures were similar each year. Preplant treatments were tandem disk incorporated in 1966 and 1967 or rototiller soil incorporated after 1967. Preemergence herbicides were surface applied. All treatments were applied with a small plot sprayer to plots 8 by 30 feet at 17 gallons per acre and 35 pounds per square inch. Weed control was evaluated visually during late June.

Results and Discussion

Weeds caused substantial yield losses in sunflowers. The sunflower seed yield data for weed free, weedy, and weeds in the row (stimulated cultivation) from 1966 to 1968 are presented in Table 1. The average sunflower seed yield loss from weed competition without cultivation was 840 lb/A and with cultivation was 192 lb/A. A seed yield loss of 192 lb/A occurred in the cultivated sunflowers even though a hoe, as used to simulate cultivation, would cause very little sunflower root pruning compared to normal cultivation. The simulated cultivation gave better and closer to the row weed control than is obtained generally with cultivation. Further, the weed infestations were light, consisting mainly of yellow foxtail with occasional plants of redroot pigweed (**Amaranthus retroflexus** L.), field pennycress (**Thlaspi arvense** L.), and common purslane (**Portulaca oleracea** L.).

Table 1. Sunflower seed yields in pounds per acre as influenced by various weed infestations.

Weed infestation[1]	Year 1966	1967	1968	Average
Weed free	1439	1482	1817	1579
Cultivated	1401	1192	1569	1387
Weedy	512	477	1227	739

[1]Cultivation was hoeing all weeds except from a 6-inch band over the row and weedy was no weed removal.

In 1968, bushel weight in lb/bu, seed weight in g/100 seed, iodine index value of the oil, and oil content of the harvested sunflower seeds were determined and the values are presented in Table 2. Sunflower seed yields from weed-free plots generally were higher in bushel weight, g/100 seeds, percent oil, and iodine value of the oil than from weedy plots.

Table 2. Influence of various weed infestations upon sunflower seed characteristics, 1968.

Weed infestation	Bushel wt, lb/bu	g/100 seeds	% oils	Iodine value
Weed free	28.3	6.46	51.3	138
Cultivated	27.5	6.24	49.3	137
Weedy	27.9	6.05	50.6	137

Experiments with various densities of wild mustard and yellow foxtail revealed that on a per-plant basis wild mustard was a more severe competitor with sunflowers than yellow foxtail. Wild mustard at relatively low densities caused severe sunflower seed yield reductions. The three-year average seed yield loss from 1, 2, 4, 8, and 16 wild mustard plants per foot of sunflower row was 104, 287, 314, 334, and 407 lb/A, respectively (Table 3). These plots were maintained free of other weeds. The sunflower seed yield loss varied with the years; and the seed yield loss in 1969 from 16 wild mus-

tard plants per foot was 815 lb/A. Wild mustard seed will germinate and emerge more rapidly at cool temperatures than will seed of sunflowers; thus, cool temperatures following sunflower seeding will increase the competitive advantage of wild mustard.

Table 3. Influence of various wild mustard and yellow foxtail infestations on sunflower seed yield, Casselton.

Wild mustard plants/ft of row	Sunflower seed yield lb/A[1]	% reduction	Yellow foxtail plants/ft of row	Sunflower seed yield lb/A[1]	% reduction
0	1331a		0	1532a	
1	1227ab	8	6	1454ab	6
2	1144b	15	12	1412b	8
4	1017c	24	18	1354b	12
8	997c	26	24	1358b	12
16	924c	31	30	1353b	12

[1]Values are an average of data from 1967-69 and six replications each year. Values followed by the same letters are not significantly different at the 0.05% level, or would only occur once in 20 times due to chance.

Yellow foxtail was less competitive than wild mustard on a plant-to-plant basis, but foxtail infestations usually are higher than wild mustard infestations in commercial sunflower fields. Thirty foxtail plants per foot of sunflower row reduced the sunflower seed yield 179 lb/A, averaged over three years (Table 3). Thus, foxtail competition, even though less intensive than wild mustard, is a serious hindrance to maximum sunflower yields when the yearly presence and high density of foxtail in eastern North Dakota is considered. Only 18 foxtail plants per foot of row, a light infestation, caused the maximum yield loss in sunflowers. Thus, even with a light infestation of foxtail, weed control is necessary for maximum sunflower yields.

The importance of wild mustard competition in sunflowers must be recognized, as wild mustard is a keen competitor and grows abundantly in North Dakota. The high density and persistence of wild mustard is evident visually from either unsprayed fields or sprayer skips in fields throughout the state. Further, the importance of wild mustard competition becomes more obvious when one realizes that the currently registered herbicides for sunflowers are either ineffective or inconsistent for wild mustard control.

The studies described with wild mustard and foxtail competition in sunflowers were with isolated weed species; but in normal field conditions, weed infestations consist of a high density of mixed species which would probably give even greater competition. A mixed infestation of wild mustard with its tap root and foxtail with the fibrous roots would compete severely with sunflowers for nutrients over a wide area of the soil profile.

Competition from a natural weed infestation in the row with sunflower began shortly after emergence as determined from experiments where the weeds were removed at various dates after emergence. The sunflower seed yield, averaged over the three years, was reduced 343 lb/A by weeds in competition with sunflowers for four weeks after emergence (Table 4). The sunflowers were maintained weed free after the various removals. Weeds allowed to compete with sunflowers for four weeks caused the major portion of the yield losses for the season. Weed competition for more than four weeks tended to cause further sunflower seed yield decreases, but these yield decreases were not significant when averaged for the three years.

The yield reduction, from competition for 10 weeks, was 471 lb/A which represented season-long competition from a weed infestation in the row. The weeds between the rows were controlled with conventional cultivation. Thus, the 471 lb/A yield reduction probably is representative of the loss which occurs with commercial production where weeds in the row are not controlled. Therefore, maximum sunflower seed yields can occur only if weeds are controlled shortly after emergence. Early season weed control may be obtained either with preemergence herbicides which control weeds at germination or shortly thereafter, or by harrowing of fields prior to sunflower emergence to control the weeds which emerge early.

Sunflower plots kept weed free after emergence for various periods and then allowed to become reinfested in the row only all had similar yields (Table 4). Thus with the first weed infestation removed, either further weed emergence did not occur or the sunflowers, once given the compet-

Table 4. Influence of various periods of weed control early and late in the season upon sunflower seed yield, Casselton, North Dakota, 1967-69.

Weeks after[1] emergence of weeding	Sunflower seed yield, lb/A	Weeks maintained[2] weed free after emergence	Sunflower seed yield, lb/A
0	1361a[3]	2	1309a
2	1254a	4	1277a
4	1018b	6	1236a
6	973b	8	1264a
8	910b	10	1278a
10	890b	12	1310a

[1]After the first weeding, plots were maintained weed free.
[2]Plots weed free at emergence and weeding was discontinued after various periods.
[3]Values followed by the same letter are not significantly different at the .05% level according to Duncan's multiple range test.

itive advantage, were not greatly influenced by late emerging weeds. During all three years, weed reinfestation was light after the first growth of weeds was removed.

The sunflower seed yield losses from weed competition generally were greater in 1969 than in either 1967 or 1968. In the plots with the natural weed infestation, the higher densities of weeds in 1969 than in the other years could explain the high sunflower seed yield losses from season-long weed competition. However, in plots where weed densities were established, competition also was greater in 1969 than in the other years. Apparently, environmental conditions were more favorable for weed competition in 1969 than in 1967 or 1968. Sunflower seeding occurred during the last week in May each year. The average maximum temperature for the first 10 days of June was 77.2, 78.7, and 67.6 F for 1967, 1968, and 1969, respectively. The colder temperatures in 1969 compared to the other two years probably explain the greater weed competition in 1969. The cool temperatures curtailed sunflower growth, but the growth of many weed species apparently was not affected.

The percent control data of various weeds with the presently registered herbicides in trail from 1965 through 1971 are presented in Table 5. Foxtail was present in the experiments every year. The foxtail control was good with all three herbicides. However, **a,a,a**-trifluoro-2,6-dinitro-**N,N**-dipropyl-**p**-toluidine (trifluralin)[1] was more consistent with slightly better foxtail control than 3-amino-2,5-dichlorobenzoic acid (chloramben)[1] or S-ethyl dipropylthiocarbamate (EPTC)[1].

Wild mustard was present in the plots only during three of the years (Table 5). Chloramben gave the best wild mustard control, followed by EPTC and trifluralin. Generally, wild mustard control with chloramben was good when environmental conditions were favorable for chloramben activity; i.e., rain within several days after application. Wild mustard is susceptible only marginally to chloramben but quite resistant to EPTC and trifluralin. Thus, the main deficiency in the presently registered herbicides for weed control in sunflowers is in wild mustard control. This is a primary concern to growers since wild mustard is a severe competitor with sunflowers.

Redroot pigweed and common lambsquarters (**Chenopodium album** L.) were present in the experiments only during two years and at light levels of infestation. Consequently, the results were quite variable. The three herbicides generally gave similar good control of redroot pigweed and common lambsquarters. The average weed control with EPTC was lower than for the other two herbicides because of poor redroot pigweed control in 1968.

[1]The trade names for trifluralin, chloramben, and EPTC are Treflan, Amiben and Eptam, respectively.

Summary

Research was conducted on the competition of wild mustard, foxtail (green and yellow), and natural weed infestations with sunflowers. Wild mustard was a severe competitor with sunflowers with four plants per foot of row causing a 314 lb/A sunflower seed yield reduction, averaged over three years. Foxtail was less competitive, causing an average loss of 178 lb/A with 18 plants per foot of row. The average sunflower seed yield loss from a natural weed infestation was 192 lb/A where cultivation was simulated by hoeing and 471 lb/A with conventional cultivation. Most of the competition from weeds occurred within four weeks after emergence. Presently registered herbicides gave good foxtail, redroot pigweed, and common lambsquarters control but poor wild mustard control. Chloramben was better for wild mustard control than EPTC or trifluralin.

REFERENCE

1. Robbins, W. W., A. S. Crafts, and R. N. Raynor. 1942. **Weed Control.** McGraw-Hill Book Co., New York. 543 pp.

Table 5. Per cent control of various weeds in sunflowers with presently registered herbicides in experimental plots from 1965 to 1971.

Herbicide	Rate lb/A	Foxtail		Wild mustard		Redroot pigweed and common lambsquarters	
		No. of trt. years[1]	Av. control	No. of trt. years	Av. control	No. of trt. years	Av. control
Chloramben, preemergence	2 to 3	10	76	3	57	5	93
EPTC - preplant soil incorporated	3	7	78	3	34	4	70
Trifluralin preplant soil incorporated	½ to 1	8	88	3	3	4	93

[1]Represents the number of times a weed was present in the experiments over the years for a given treatment, e.g., if a herbicide was in an experiment at two rates in a year, two values would have been obtained each on average of four replications.