CONTROL OF VOLUNTEER SUNFLOWER WITH HERBICIDES

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Summary

Twelve herbicides at various rates and stages of sunflower growth were sprayed on sunflower alone and sunflower growing in grain-drill sown plots of oat, canarygrass, flax, and pea. Sunflower did not have tolerant stages of growth to effective herbicides sprayed at several postemergence stages. Pea and oat were most competitive and flax least competitive with sunflower. 2,4-D((2,4-dichlorophenoxy)acetic acid), MCPA (((4-chloro-o-tolyl)oxy)acetic acid), 2,4-DB (4-(2,3-dichlorophenoxy)butryic acid), MCPB (4-((4-chloro-o-tolyl)oxy)butyric acid), and bentazon (3-isoprophyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2,2-dioxide) gave selective control of sunflower in all four crops. Metribuzin (4-amino-6-tert-butyl-e-(methylthio)-as-triazin-4(4H)one) and dinoseb (2-secbutyl-4,6-dinitrophenol) gave selective control only in pea, whereas bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) gave selective control in all crops but pea. Dicamba (3,6-dichloro-o-anisic acid) gave selective control in oat and canarygrass. Twelve herbicides were sprayed on sunflower growing in cultivated rows of grain sorghum, soybean, pinto bean, navy bean, or kidney bean. Atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) plus oil, cyanazine (2((4-chloro-6-(ethylamino)-s-triazin-2-71)amino) -2-methylpropionitrile), dicamba, bentazon, and 2,3-D sprayed postemergence controlled sunflower in grain sorghum, but no preemergence herbicide gave good control. Bentazon postemergence gave good control in soybean and field bean. Mertibuzin preemergence gave excellent selective control in soybean but injured pinto bean. Volunteer sunflower in these nine crops can be killed with selective herbicides.

Introduction

Sunflower (Helianthus annuus L.) for birdfeed, human food, and oilseed is harvested with a combine and many seeds fall to the ground. Some seeds survive the winter, and volunteer sunflower growing in other crops is a common occurrence. Thus sunflower is both a crop and a weed. As a weed, it competes strongly with any field crop. Damage from volunteer sunflower is not confined to reduced yield of the infested crop. Crop rotation cannot be highly effective in disease and insect control unless volunteer sunflower is killed at an early stage of growth.

The objective of this research was to evaluate herbicides for control of sunflower in nine crops representing three botanical families.

Materials and Methods

Trials were conducted on Waukegan slit loam soil of pH 6.3 and medium (4%) organic matter at Rosemount, Minnesota. Early-sown crops of oat (Avena sativa L. 'Lodi'), canarygrass (Phalaris canariensis L. 'Alden'), flax (Linum usitatissimum L. 'Linott'), and pea (Pisum sativum L. 'Century') were sown with a grain drill in rows 15 cm apart on April 14, 1973 and April 20, 1974. Late-planted crops of grain sorghum (Sorghum bicolor(L.) Moench. 'Minn. 1'), soybean (Glycine max (L.) Merr. 'Clay'), pinto bean (Phaseolus vulgaris L. 'UI-114'), navy bean (P. vulgaris L. 'Seafarer'), and kidney bean (P. vulgaris L. 'Charlevoix') were planted in rows 76 cm apart on May 22, 1973 and May 20, 1974.

The drill strips of early-sown crops were 3.7 m wide, and sunflower and flax were sown in alternate rows 30 cm apart across the drill strips. Spray-plot size consisted of a single sunflower row between flax border rows across the 3.7 m wide strips of the four crops plus an unseeded strip making spray plots 0.6 by 18.5 m. Spray volume was 374 L/ha. The flax border rows served as guides for spraying the sunflower row with a single nozzle, back-pack experimental plot sprayer. The design was split-split plot with crops as main plots, sunflower growth stages as subplots, and herbicides and rates as sub subplots and was replicated twice. Sunflower growth stages when 2,4-D, MCPA, 2,4-DB, dicamba, bromoxynil, and dalapon were applied included cotyledon, 2 to 3-leaf, 4 to 5-leaf, 6 to 7-leaf, and 12-leaf stages in 1973 and 4 to 5-leaf and 8-leaf stages in 1974. MCPB, bentazon, and dinoseb were applied at four to five-leaf and eight-leaf stages. Growth stages for crops when most herbicides were applied ranged from three leaf to jointing for oat and canarygrass, 2cm to bud for flax, and four node to bud for pea. Metribuzin and pyrazon (5-amino-4-chloro-2-phenyl-3(2H)-pyridazinone) were applied at preemergence to cotyledon and four to five-leaf sunflower growth stages. Other herbicides and rates used in the early-sown crops were 2,3-D at 0.14, 0.28, or 0.56 kg/ha; MCPA at 0.14, 0.28, or 0.56 kg/ha; 2,4-DB at 0.28 or 0.56 kg/ha; MCPB at 0.56 kg/ha; dicamba at 0.14 kg/ha; bromoxynil at 0.28 kg/ha; dalapon at 0.84 kg/ha; bentazon at 1.12 kg/ha; dinoseb at 1.68 (24°C) or 2.52 (17°C) kg/ha; metribuzin at .56 kg/ha; pyrazon at 4.48 kg/ha; and difenzoquat (1,2-dimethyl-3,5-diphenyl-1H-pyrazolium) at 2.24 kg/ha. Dimethylamine salts of 2,4-D, MCPA, 2,4-DB, and dicamba and the sodium salt of MCPB were the formulations used.

Prior to planting the late-planted crops, a mixture of sunflower cultivars was sown with a grain drill at a rate of 700,000 seeds/ha followed by deep disking twice in cross-wise directions and spike-tooth harrowing for seedbed preparation. Designs were randomized blocks replicated twice for each crop, and spray-plot size was a single row 0.8 by 18.5 cm. Plots were cultivated for weed control between the rows. Herbicides and rates used on the late-planted crops included metribuzin at 0.42 kg/ha applied preplant and incorporated with a hand rototiller 3 cm deep for soybean and applied preemergence at 0.56 or 0.84 kg/ha on soybean and pinto bean. Other preemergence treatments were atrazine or cyanazine at 2.24 kg/ha or terbutryn (2-(tert-butylamine)-4-(ethylamino)-6-(methylthio)-s-triazine) at 2.69 kg/ha on grain sorghum and pyrazon at 4.48 kg/ha on pinto bean. Post emergence treatments on grain sorghum included atrazine at 1.68 plus crude sunflower oil at 2.12 kg/ha or cyanazine at 2.24 kg/ha at the two-leaf stage, dicamba at 0.14 kg/ha or bentazon at 0.84 or 1.12 kg/ha at the three-leaf stage, and 2,4-D at 0.14, 0.28, or 0.56 kg/ha at four to eight-leaf stages. Postemergence treatments on all four legume crops included

bentazon at 0.84 or 1.12 kg/ha at the one-trifoliolate-leaf stage and at the two-trifoliolate-leaf stage on pinto bean. Other postemergence treatments on soybean were chloroxuron (3-(p-(p-chlorophenoxy)phenyl)-1,1-dimethylurea) at 1.68 kg/ha plus surfactant (50% trimethylnonanol-ethyleneoxide complex, 5% isopropanol, and 45% water) at 0.5% v/v at the one-trifoliolate-leaf stage and 2,4-DB at 0.11 kg/ha at the three trifoliolate-leaf stage.

Sunflower control and crop injury ratings were made at various times. At crop maturity, counts were made of sunflower heads per 3.7 m length of sunflower row in each of the early-sown crop plots and per 18.5 m length of crop row in the late-planted crops. Data from the early-sown crop trials were analyzed as split-split plots and from the late-planted trials as randomized blocks within each crop. LSD values at the 0.05 level are reported as commonly recognized measures of variability even though F ratios were significant at the 0.01 level.

Results and Discussion

Oat, canarygrass, flax, and pea

Good stands of these crops sown early offer considerable competition to sunflower even though the number of sunflower heads in the unsprayed plots was reduced only by pea (Table 1). Plant and head size of sunflower in the other crops was much less than in sunflower grown alone. Average estimated control by oat, canarygrass, flax, and pea without herbicide was 63%, 48%, 30% and 70%, respectively. The control in columns 3 and 4 of Table 1 shows control by the herbicides without help from crop competition.

Several herbicides -- 2,4-D, MCPA, 2,4-DB, MCPB, and bentazon -- controlled sunflower at rates that were not injurious to any of the crops. MCPA and 2,4-D rates of 0.56 kg/ha are not in the table because they were higher than needed to control sunflower. Bromoxynil gave the most rapid kill of sunflower and was injurious only to pea whereas dinoseb was harmless to pea but injured the other crops. Dicamba gave excellent sunflower control but injured pea and flax severely and the other crops slightly. Metribuzin gave good sunflower control and only slight injury to pea at the emerging to 2.5 cm stage for sunflower and pea but killed other crops. Difenzoquat killed sunflower, but the rate was too high for the crops. Dalapon and pyrazon did not kill sunflower.

Sunflower growth stage and control

Growth stage at time of spraying significantly (0.05 level) affected sunflower control and number of heads at harvest in 1973 but not in 1974. However, herbicide treatment mean squares were significantly greater than stage or stage X treatment mean squares which justifies the use of treatment averages in Table 1. Sunflower was killed by sprays of 2,4-D, MCPA, 2,4-DB, dicamba, or bromoxynil from cotyledon through the 12-leaf stage and by sprays of MCPB, bentazon, or DNBP from 4 through 8-leaf stages. Growth stage differences in response to herbicides were caused by inadequate spray coverage due to late germination or canopy protection rather than by sunflower resistance.

Although spraying in the four to five-leaf stage gave better control than at later stages, average data are shown in Table 1 because control was satisfactory in this 4 to 12-leaf range, and this range includes the recommended crop growth stages for most of the herbicides. Except for metribuzin, spraying prior to four-leaf stage was undesirable because of late germinating of sunflower seed. However, plants from late germinating seed suffered serious competition especially from oat and pea and many did not head. Nevertheless, control from spraying prior to the four-leaf stage was not satisfactory if sunflower disease prevention by crop rotation is a consideration.

Grain, sorghum, soybean, pinto bean, navy bean and kidney bean

These late-planted crops were grown in rows 76 cm apart, and they did not retard sunflower growth as did the early-sown crops in rows of 15 cm apart. Consequently, partial control after spraying did not give satisfactory control at maturity (Table 2).

The best treatments in grain sorghum were atrazine plus oil and cyanazine at the cotyledon to two-leaf stage. Of the preemergence treatments, atrazine gave only partial control, cyanazine injured sorghum, and terbutryn did not kill sunflower. Dicamba, 2,4-D at 0.28 kg/ha, and bentazon at 1.12 kg/ha were effective postemergence treatments. Bentazon at 0.84 kg/ha and 2,4-D at 0.14 kg/ha gave only partial control.

In the legume crops, metribuzin preemergence at 0.84 kg/ha gave excellent control in soybean but severely injured pinto bean. Pyrazon did not kill sunflower. Bentazon gave excellent control at 1.12 kg/ha in all legumes but was unsatisfactory at 0.84 kg/ha. 2,4-DB and chloroxuron gave partial control, but the latter injured soybean.

Good control of sunflower without crop injury was accomplished by at least one herbicide in each of these nine crops of varied growth habit and culture. Consequently, the volunteer sunflower problem need not be a major deterrent to continued expansion of the sunflower crop into new areas.

TABLE 1. Early Control of Sunflower Grown Alone and Control at Crop Maturity in Sunflower Alone, Oat, Canarygrass, flax, and pea at Rosemount, Minnesota in 1973-74.

Herbicide	Rate (kg/ha)	Control 9 days after spraying (%)	Sunflower Heads Per Plot at Maturity				
			Sunflower	Oat	Canarygrass	Flax	Pea
None		0	23	21	22	22	6
		Sprays applied to sunflower between 4 and 12-leaf stages					
2,4-D	0.14	85	1	0 a	0 a	1 a	1 b
2,4-D	-.28	91	1	0 a	1 a	0 a	1 d
MCPA	0.14	87	2	0	2	1	1 a
MCPA	0.28	90	1	0	1	1 a	0 b
2,4-DB	0.28	100	1	0	0	0 a	0 b
2,4-DB	0.56	90	0	0 a	0	0 b	0 b
MCPB	0.56	100	3	0	0 a	1 a	0 a
Dicamba	0.14	97	0	0 b	1 b	0 c	0 d
Bromoxynil	0.28	100	0	0 a	0	0 b	0 d
Dalapon	0.84	0	20	3	11	17	1
Bentazon	1.12	100	1	0	1	1 a	0
Dinoseb[e]	1.68	100	1	0 c	0 c	2 d	0 a
Dinoseb[e]	2.52	100	2	0 d	0 d	3 d	0 a
Metribuzin[e]	0.56	100	0	0 d	0 d	0 d	0 c
Pyrazon[e]	4.48	80	21	1	1	16 a	1 c
Difenzoquat[e]	2.24	100	1	1 d	0 d	0 d	0 d
Metribuzin	0.56	95	1	0 d	1 d	1 d	0 a
Pyrazon[e]	4.48	0	24	17	18	22 c	10
LSD (0.05 Level)		9	1	1	1	1	1

a Slight crop response but complete recovery.
b Crop injured but recovered with little effect on yield.
c Crop injured with probable decrease in yield.
d Crop injury severe.
e 1974 data.

TABLE 2. Early Control of Sunflower and Control at Crop Maturity in Grain Sorghum, Soybean, Pinto Bean, Navy Bean, and Kidney Bean at Rosemount, Minnesota in 1973-74.

Crop and Herbicide	Rate (kg/ha)	Sunflower Stage	Control 14 days After Spraying (%)	Sunflower heads per plot at Maturity
Grain Sorghum				
None			0	101
Atrazine	2.24	preemergence	68	20
Cyanazine	2.24	preemergence	75	18 c
Terbutryn	2.69	preemergence	50	82 a
Atrazine + Oil	1.68+2.12	cotyledon to 2-leaf	100	1 a
Cyanazine	2.24	cotyledon to 2-leaf	100	1 b
Dicamba	0.14	4-leaf	88	1
Bentazon[e]	0.84	4-leaf	96	70
Bentazon[f]	1.12	4-leaf	100	0
2,4-D[e]	0.14	8-leaf	95	27
2,4-D[f]	0.28	12 to 14-leaf	100	0
2,4-D[f]	0.56	12 to 14-leaf	100	0
LSD (0.05 level)			9	31
Soybean				
None			0	100
Metribuzin[f]	0.42	preplant	25	45 c
Metribuzin[f]	0.56	preemergence	5	75
Metribuzin[e]	0.84	preemergence	80	0 b
Bentazon[e]	0.84	4 to 6-leaf	35	85
Bentazon[f]	1.12	4-leaf	100	6 b
Chloroxuron + surf.	1.68	4 to 6-leaf	85	32 c
2,4-DB	0.11	12 to 14-leaf	65	54
LSD (0.05 level)			15	25
Pinto Bean				
None			0	107
Metribuzin[e]	0.84	preemergence	85	25 d
Pyrazon[e]	4.48	preemergence	0	100
Bentazon[e]	0.84	4 to 6-leaf	50	55
Bentazon[e]	0.84	8-leaf	75	80
Bentazon[f]	1.12	4-leaf	100	19 a
LSD (0.05 level)			5	4
Navy and kidney bean average				
None			0	101
Bentazon[e]	0.84	4 to 6-leaf	50	100
Bentazon[f]	1.12	4-leaf	100	7 a
LSD (0.05 level)			5	4

a - Slight crop response but complete recovery. b- Crop injured but recovered with little effect on yield. C - Crop injured with probable decrease in yield. d - Crop injury severe. e - 1974. f - 1973.