CHEMICAL WILD OAT (*AVENA FATUA*) CONTROL IN HARD RED WINTER WHEAT (*TRITICUM AESTIVUM*)

By

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CHAPTER I

INTRODUCTION

Wild oats (Avena fatua L.) are a major weed problem throughout the world and are more recently becoming a serious problem in many crop systems in central and western United States; however, cereal crops are the most severely affected at the present time. In recent years, it has also become of economic importance in southern Oklahoma and northern Texas. Adaptation of farming practices to reduce labor and power requirements has enhanced the problem. This species is spreading into areas previously uninfested as well as intensifying where little or no economic problem existed. The weed not only reduces the yields and quality of grain crops but also costs the farmer in extra tillage expenses and handling costs. Control of wild oats with cultural practices has shown only limited success; therefore, chemical control appears to be the only alternative (47).

Wild oats may be easily distinguished from cultivated oats (Avena sativa L.) by the presence of an oval scar, sometimes referred to as the "suckermouth," surrounded by a dense pubescence at the base of the grain; the presence of a long, heavy, twisted awn on all florets of the spikelet; and the open or spreading type panicle (15). Two species have been identified in Oklahoma. A. fatua infests an estimated 250,000 acres at economic levels in the south-central part of the state. Cotton County is the most seriously affected, although other counties are being infested annually. This research was conducted only on the fatua species. A. sterilis has been identified in the north-central part of the state and is estimated to infest 40,000 acres. Wild oat infestations are predicted to spread to every wheat producing county in Oklahoma because the weed cannot be effectively controlled with cultural practices and the seeds can persist in the soil for several years.

Efforts to chemically control wild oats in winter wheat (Triticum aestivum L.) have presented special problems. The herbicide must give good initial control and persist long into the growing season to control late germinating plants. Postemergence applications may be required at two or more growth stages to achieve season-long control. Grazing wheat during the winter months has also presented a problem. At the present time, all of the herbicides labeled for wild oat control have a full season grazing restriction.

Ideally, it would be desirable to have a herbicide which would provide full-season wild oat control with one application, without extensive crop damage. The specific objectives of this research were (a) to evaluate the ability of several herbicides, applied at various growth stages, to control wild oats and (b) to evaluate the influence of these applications on hard red winter wheat.

CHAPTER II

LITERATURE REVIEW

Several species and subspecies of the genus *Avena* which can survive in nature are referred to as wild oats. The *Avena* species which are generally considered weeds in cultivated crops are *A. fatua*, *A. sterilis* ssp. *ludoviciana*, *A. sterilis* ssp. *macrocarpa*, *A. barbata*, and hybrids of the various species and subspecies (34). The major survival mechanisms of wild oats are dormancy, which precludes exhaustion of the seed supply in any one year, and longevity, which permits the seed to live for long periods under conditions which are unfavorable for germination (42).

Wild Oat Survival

Research by Miller and Nalewaja (26) indicated that a high percent of seed viability was lost soon after seed burial; however, approximately 15 percent of the seed remained viable after 4 years. Viability was lost more rapidly when nitrogen fertilizer was included. Viability was retained longer when seeds were buried deep. Three consecutive years of fallow treatments reduced seed populations by 98 percent while continuous wild oats without cropping increased the seed in the soil by 654 percent. Three years of continuous rye (*Secale cereale* L.), or winter wheat and no herbicides resulted in a reduction of wild oat seed in the soil; however, barley (*Hordeum vulgare* L.), spring wheat

(*Triticum aestivum* L. 'Waldron') and flax (*Linum usitatissimum*) resulted in an increase of wild oat seeds (44). Miller and Nalewaja (22) also found that of the total of wild oat seed initially present in spring tilled and no-tilled plots, only 22 and 26 percent, respectively, produced wild oat seedlings after two seasons. Twice as many seedlings emerged in the first season as in the second season of the study and over 70 percent of the wild oat seedlings which emerged came from the 3 to 9 cm soil depth. The number of viable seed increased as burial depth increased. Research conducted by Quail and Carter (40) has given support to these findings. They indicated that relatively few of the seeds placed on the surface of the soil germinated. As the depth at which the seeds were buried increased below 8 cm, the percentage of seedlings that emerged decreased sharply. In fact, 90 percent of these seedlings came from seeds buried in the top 8 cm of soil. Thurston (44) reported that 80 to 90 percent of the wild oats that germinated did so the first year, fewer germinated in each successive year. Of the wild oats sown, only 20 percent produced seedlings. The longevity of buried seed ranged from 2 to 6 years and appeared to depend on the local environmental conditions and cultural practices.

Quail and Carter (40) reported the optimum temperature for germination of *A. fatua* was 15 C and *A. ludoviciana* was 5 C lower. When harvested, all seeds were dormant, but 5 months later a substantial percentage of all the seeds germinated between 5 and 20 C. Above 20 C, the germination percentage dropped sharply and was zero at 30 C.

Wild Oat - Crop Competition

Competition between wild oats and cereal crops has been studied extensively. Thurston (45) indicated that A. fatua was controlled by a dense crop of fall-sown cereal. The crop genus was unimportant provided it grew well on the site. Even in a light infestation of barley, wild oats grew less vigorously than on fallowed plots. Reduction in wild oat height, dry weight, number of seeds produced per plant, and increased seed dormancy were caused by shading (41). Short wild oat selections were affected to a lesser degree by shading than were tall selections. Bell et al. (3) noted that wild oat competition increased the losses in spring wheat yields by 22 and 39 percent at wild oat densities of 70 and 160 seedlings per m^2, respectively. Similar wild oat densities reduced barley yields 7 and 30 percent, respectively. Flax yields were reduced 60 percent when wild oats were present at 80 plants per m^2 (5).

Maximum wheat yields were obtained by removing wild oats at the earliest possible opportunity (18). However, yield increases can still be obtained by controlling wild oats at a later stage of crop growth. Haizel and Harper (12) determined that removal of wild oat infestations from barley had little or no effect on barley yields if wild oats were allowed to compete for 3 weeks. Wild oat density had no effect on barley yields. Wild oats which survived, compensated for reduced stand and became more competitive. Bell et al. (4) found that competition from wild oats until the 4 to 5-leaf stage in flax reduced flax seed yields 15 percent while competition until maturity reduced yields by 75 percent.

Chemical Control

Miller et al. (33) suggested that wild oat response to herbicides may vary with biotypes. Four varieties of Avena fatua L. ssp. fatua were classified into 230 wild oat lines on the basis of seed characteristics. Their response ranged from 41 to 97 percent control with difenzoquat (chemical names of all herbicides are in Table I) and 31 to 100 percent control with flufenprop-methyl.

TABLE I

COMMON AND CHEMICAL NAMES OF HERBICIDES

Common Name	Chemical Name
alachlor	2-chloro-2',6'diethyl-N-(methoxymethyl) acetanilide
barban	4-chloro-2-butynyl m-chlorocarbanilate
bromoxynil	3,5-dibromo-4-hydroxybenzonitrile
diallate	S-(2,3-dichloroallyl)diisopropylthio-carbamate
diclofop (HOE 23408)	2-[4-(2,4-dichlorophenoxy)phenoxy]propanoic acid
difenzoquat (AC-84777)	1,2-dimethyl-3,5-diphenyl-1-H-pyrazolium
flufenprop-methyl (SD 29761)	methyl-2-[benzoyl(3-chloro-4-fluoro-phenyl)amino]propanoate
HOE 29160	not released
MCPA	[(4-chloro-o-tolyl)oxy]acetic acid
MSMA	monosodium methanearsonate
oryzalin	3,5-dinitro-N^4,N^4-dipropylsulfanilamide
triallate	S-(2,3,3-trichloroallyl)diisopropylthio-carbamate
2,4-D	(2,4-dichlorophenoxy)acetic acid

Parker (39) investigated the importance of depth of incorporation of diallate and triallate. He observed that triallate is only one-half as effective as diallate against A. fatua when both were incorporated to a depth of 5 cm, but when incorporated only in the first cm, the difference between the two compounds is negligible. He also noted that triallate has greater selectivity in barley and wheat when incorporated shallow after sowing than prior to sowing. Dexter et al. (9) reported, however, that triallate applied at 0.84 kg/ha gave significantly better wild oat control with a 7.6 cm incorporation than with a 2 cm incorporation. The frequent lack of soil moisture in the top 2 cm of soil in the field may explain the reduced weed control from shallow incorporation.

Beestman and Deming (2) found that significant triallate volatilization occurred continuously from moist soils under constant air exposure but did not volatilize more rapidly than herbicides which do not respond to incorporation. They suggested that lower triallate mobility in moist soils coupled with the strong dependence of triallate bioactivity and deactivation by dry surface soils was primarily the reason for the response of triallate to incorporation rather than volatility.

The importance of vapor action on wild oat seedlings below the soil surface was demonstrated by Miller and Nalewaja (25). They noted that growth inhibition from vapors of soil applied liquid and granular triallate increased as soil moisture content and soil temperature increased. Further, vapors from the liquid formulation inhibited seedlings growth more than vapors from the granular formulation.

Norris and Lardelli (36) found that triallate applied preemergence and incorporated with a spike-tooth harrow over five wheat varieties gave excellent wild oat control. However, the wheat varieties differed in their sensitivity to triallate. Billet and Ashford (6) determined that triallate incorporated preemergence halted the growth of wild oat seedlings at the time of coleoptile emergence from the soil surface.

Postemergence applied triallate granules significantly reduced wild oat growth; however, granules applied preemergence on the soil surface caused a greater reduction in wild oat leaf growth (6). Miller and Nalewaja (24) also indicated that granular triallate was more effective than the emulsifiable concentrate for postemergence wild oat control. Fair seasonal control was obtained with the granular formulation at rates of 2.24 kg/ha or greater. However, some wheat injury was noted with the 2.80 and 3.36 kg/ha rates. Stage of growth at the time of applications did not appear to affect control in the field, although in the laboratory plants became more resistant with increased maturity. Moisture after application was essential for control. Control decreased as temperature increased with both formulations (24).

Neidermyer and Nalewaja (35) found that growth of wheat and wild oat seedlings was reduced by barban at 0.3 µg and 0.6 µg applied to the first node. Barban application to the base and midpoint of the first leaf blade required a lower dose to reduce wild oat growth than wheat growth. Increased tillering occurred from barban injury to the main culm in wheat.

Friesen (10) investigated the effects of dosage, growth stage, spray volume, spray pattern, and fertility of the soil on the selective control of wild oats with barban. Generally, reduction in numbers of wild oat plants was greatest when barban was applied at 0.28 and 0.43 kg/ha in a low volume of spray (56 l/ha) and the wild oats were in the 1½ to 2-leaf stage. Treatments applied in the 3-leaf stage reduced growth and tillering but fewer plants were killed. Increasing the spray volume to 887 l/ha greatly reduced the effectiveness of barban at both stages.

The addition of aqueous nitrogen at rates as low as 46.75 l/ha increased wild oat control with barban (30, 32). The greatest increase in wild oat control with barban-aqueous nitrogen combinations was obtained on soils low in nitrogen. Aqueous nitrogen applications several days prior to barban were more effective than when the two were applied together.

Research by Miller et al. (27) indicated that wheat and wild oat susceptibility to barban increased as post-treatment temperatures decreased. Maximum barban susceptibility for wild oats in wheat occurred with a constant 18 C or alternating 18 C day and 10 C night post-treatment temperature. Furthermore, a night temperature lower than the day temperature increased wild oat control but did not correspondingly increase wheat injury compared to the constant temperature treatment.

Therkilsen and Behrens (43) determined that simulated rainfall within 8 hours of foliar treatments caused substantial reductions in wild oat control with difenzoquat and diclofop. However, rainfall reduced wild oat control to a lesser degree when barban was used.

The survival of autumn-germinated wild oats in a mild winter caused a serious infestation in winter wheat whereas spring-germinated plants are much more suppressed by a vigorous crop growth (13).

Therefore, it appears that barban applications should be timed in relation to these wild oats. Spring applications of barban were beneficial when due to either late sowing or unfavorable growing conditions. The competitive power of winter wheat is not high enough to suppress wild oats which are still in the barban sensitive development stage. Applications of barban in the spring can sometimes control wild oats which are well past the 2½-leaf stage.

Miller et al. (19) stated that wheat injury from barban decreased as application was delayed 4 to 16 days after emergence. These results indicated that wheat tolerance to barban increased with time after emergence.

Diclofop (HOE 23408) will control wild oats and green foxtail (Setaria viridis L.) when applied preplant, preemergence, or postemergence; however, rates required for control preplant and preemergence was 2 to 4 times higher than for postemergence applications (23, 8). Wheat showed excellent tolerances to diclofop at rates up to 1.12 kg/ha. Some injury was observed at 1.68 kg/ha applied late postemergence. Friesen (11) noted that diclofop applied at rates of 0.84 to 1.68 kg/ha gave 80 percent control of wild oats in wheat and barley when applied at the 2 to 5-leaf stage of wild oats. Wild oat injury following soil application was markedly less than with foliar applications. Indications were that diclofop was more phytotoxic to the emerging weeds via shoot than via root contact.

Field studies conducted by Mason et al. (16) indicated that diclofop gave better wild oat control in winter wheat than did four other wild oat herbicides evaluated. Although excellent control was noted at both the 1 to 2-leaf and 4 to 6-leaf growth stages, wheat yields were higher when diclofop was applied at the earlier wild oat growth stage. Todd and Stobbe (46) observed that barley, wild oats, and green foxtail were from 2 to 1,090 percent more sensitive to diclofop applied at the 2-leaf stage than was wheat. Selectivity decreased with increasing maturity of plant material. However, Mayland (17) found that wild oats were moderately sensitive to diclofop applied at the 1 to 3-leaf stage of growth.

O'Sullivan et al. (38) found that a reduced rate of diclofop in combinations with different adjuvants provided as effective wild oat control as recommended field rates without adjuvants. They also observed that ester formulations of herbicides used for broadleaf weed control caused less antagonism of diclofop activity than did the amine formulations. Miller and Nalewaja (21) had reported earlier that weed control with diclofop was reduced when MCPA, 2,4-D, or bromoxynil plus MCPA was added as a mixture.

Blank and Behrens (7) determined that wild oat control was significantly reduced with difenzoquat when Surfel was the added surfactant, while wheat injury was significantly increased using Triton X-100 as the added surfactant. The addition of 2,4-D or MCPA did not reduce wild oat control. Hunter (14) observed injury to five spring wheat varieties treated with difenzoquat at 0.70 and 0.84 kg/ha. Yellowing of the leaves occurred 4 to 5 days after treatment and plants did not elongate as rapidly as untreated plants. Some varieties were shorter and heading was delayed 2 to 17 days.

Bartee et al. (1) applied MSMA at 2.24 and 3.36 kg/ha to hard red spring wheat at the 2 and 3-leaf stage of growth. He observed 78 percent control of wild oats with treatments applied at the later growth stage. The wheat was not injured except for some yellowing of the foliage; however, normal leaf color returned within three weeks. Miller et al. (29) concluded that MSMA at comparable rates gave better wild oat control at the 4-leaf stage than when applied at the 2 to 3½-leaf stage.

Combinations of MSMA with barban applied at the 2 and 4-leaf stages of wild oat growth gave better control than either applied alone (28). MSMA combinations with difenzoquat appear to be antagonistic as wild oat control was reduced with the combination.

Miller et al. (20) found that flufenprop-methyl (SD 29761) gave good to excellent wild oat control in wheat at 0.56 kg/ha at the 4-leaf stage of wild oat growth; however, some barley injury was observed. In other studies, flufenprop-methyl gave greater wild oat control at the 5-leaf than the 2 or 3½-leaf stage of growth (31). Two to three times more chemical was necessary for early postemergence than late postemergence wild oat control. Hard red spring and durum wheat cultivars exhibited excellent tolerance to flufenprop-methyl. Olson and Nalewaja (37) reported that wild oat control was greater than 80 percent up to six weeks after wild oat emergence (anthesis stage), but decreased when application was delayed further. Wheat was most susceptible to flufenprop-methyl during anthesis. The injury was expressed as reduced plant height, grain yield, and kernels per spike. Grain yield reductions were the result of reduced kernels per spike.

CHAPTER III

METHODS AND MATERIALS

Field experiments were conducted at several locations in Oklahoma to evaluate herbicides for wild oat control and hard red winter wheat susceptibility.

An experimental-plot compressed air tractor sprayer was utilized to apply all treatments. Aqueous solutions were applied through a boom with nozzle tips being spaced on 51 cm centers. Nozzle tips were selected to give a predetermined carrier volume and pressure and were directed at a 90^{o} angle to the soil surface except where otherwise noted. Granules were applied with a pull-type "easy flow" Gandy applicator, 106.7 cm wide and pulled behind the experimental-plot tractor sprayer at 4.8 km/hr to insure uniform application.

A randomized complete block design with four replications was used for all experiments unless otherwise noted. Wild oat control and crop injury ratings were taken periodically throughout the growing season.

A 0 to 10 rating scale was used where 0 indicated no weed control or crop injury and 10 indicated complete weed control or crop destruction. For presentation in this manuscript these numbers were converted to percent weed control or crop injury.

A preliminary wild oat control experiment was initiated in the fall of 1974 at Devol, Oklahoma to evaluate several herbicides which have shown promise for wild oat control. Winter wheat was not planted in the plot area in order that weed control could be more effectively evaluated. The soil type at this location was a Foard silt loam on a 0 to 1 percent slope. This soil was characterized as having adequate drainage for most crops and a high moisture holding capacity. Single postemergence applications were made at three wild oat growth stages, 2 to 3-leaf, 6 to 7-leaf, and 6 to 8-tillers. Treatments at the 2 to 3-leaf and 6 to 7-leaf stages were applied in the fall while the 6 to 8-tiller treatment was applied in the spring of the following year, November, December and March, respectively. Plots were 1 by 4.6 m in size in a natural infestation of 405 plants per m^2. All herbicides were applied in a water carrier volume of 93.5 l/ha. Wild oat yields were obtained by randomly harvesting foliage samples from two 30.5 sq cm areas in each plot. These were weighed and reported as g/m^2 of fresh foliage.

One experiment was established at the Agronomy Research Station near Perkins in a weed-free area to determine the susceptibility of Triumph 64 wheat to several herbicides. Plots were 1.5 by 4.6 m in size. Wheat was planted at a rate of 67 kg/ha with a "hoe" type drill. Row spacing was 25.4 cm apart. Treatments were applied postemergence at the 1-leaf, 3-leaf, 6-leaf (2 tillers), and 5 to 6-tillers stages of growth in a water carrier volume of 93.5 l/ha. A self-propelled experimental-plot combine with 1.5 m header was used to harvest each plot. Yields were taken and recorded in the field.

In the fall of 1975 two field experiments were established near Randlett, Oklahoma to further evaluate herbicides for wild oat control. These experiments were conducted in an area with a natural wild oat infestation and stubble mulched as a common cultural practice. The soil type at both locations was a Foard silt loam on a 0 to 1 percent slope. A weed-free seed bed was prepared prior to planting wheat. Preplant treatments of triallate were incorporated with a rotary-hoe to ensure that the herbicide would remain in the top 2.5 cm of soil. This implement was run twice over the experimental area to ensure uniform incorporation. The emulsifiable concentrate formulation was utilized for preplant incorporated treatments and the granular formulation applied as postemergence treatments. Preplant treatments were applied in a water carrier volume of 280.5 l/ha and incorporated within 1 hr after application. Both experiments were harvested with an experimental-plot combine and test weights taken.

Wheat var. 'Tam 101' was planted at one experiment (Kinder Farm) with a disc-type drill with a 25.4 cm spacing at a seeding rate of 78.4 kg/ha. Before planting 112 kg/ha of nitrogen as anhydrous ammonia and 72.8 kg/ha of 18-46-0 was applied. Plot size was 3.1 by 6.1 m. Postemergence treatments were applied at wild oat growth stages of 2 to 3-leaf (October), 2 to 4-tiller (November), and 6 to 8-tiller stages (March). This coincided with the 3 to 4-leaf, 3 to 4-tiller, and early jointing stages for wheat growth, respectively. Surfactants were applied with the barban and difenzoquat treatments. All treatments at the first postemergence stage were applied in a water carrier volume of 46.8 l/ha and the other two stages at 93.5 l/ha. The boom was set at a 45^{o} angle to the soil surface and sprayed at a pressure 3.2 kg/cm^2. X-77 surfactant was used with barban and Tritron X-100 with difenzoquat, both at a concentration of 0.5% by volume. Sequential treatments consisted of a preplant incorporated treatment (October) followed by one or two postemergence applications or multiple postemergence applications made at different growth stages. The applications included one, two, or, in some cases, three different chemicals. Yields in this experiment were obtained by combining a 1.5 by 6.1 m strip from the center of each plot, screening out the wild oats, weighing the remaining sample and reporting wheat yield as kg/ha. Yields are an average of three replications.

In the second experiment (Baber Farm) wheat var. 'Sturdy' was planted at a rate of 61.6 kg/ha with a 'disc type' drill. Seeds were sown at a depth of 5.1 cm and spaced in 25.4 cm rows. Preplant incorporated treatments were again applied in the fall and postemergence applications in the fall and early spring. Topical treatments were applied at the 1 to 2-leaf, 1 to 3-tiller, and 6-tiller stages of wild oat growth. The wheat was in the 2 to 3-leaf, 2 to 3-tiller, and 6 to 8-tiller stage, respectively. Wild oat populations were 450 plants/m^2. Boom angle and pressure was the same as previously described. Wheat yields were obtained by multiplying the harvested 1.5 by 6.1 m sample by a visual estimate of the percent wheat in each plot. Yields are an average of three replications.

Another field experiment on the Kinder Farm was initiated in the fall of 1976 near the location of the 1975 experiment. The clay loam soil had a wild oat population of 492 plants/m^2. Soil characteristics were an organic matter content of 0.95 percent and a pH of 7.4. Fertility practices consisted of 112 kg/ha of nitrogen applied as anhydrous ammonia before planting and 18-46-0 at a rate of 78.4 kg/ha at planting. Plots were 3.1 by 9.1 m in size and winter wheat var. 'Tam 101' was planted in the experiment with a disc type drill in 25.4 cm rows.

Several of the treatments from 1975 were repeated and research was expanded to include several herbicides not previously evaluated. Triallate was applied as a preemergence incorporated treatment to determine whether wild oat control could be improved or crop safety could be increased. Preplant incorporated and preemergence incorporated treatments (October) were tilled with a rotary hoe at a depth of 2.5 centimeters. Preplant plots were tilled twice and preemergence plots tilled once. A water carrier volume of 280.5 l/ha was used for both methods of application. Sequential applications were also expanded in an attempt to get full season control of wild oats. These treatments were applied at either two or three postemergence stages or as one or two postemergence applications following a preplant incorporated treatment. Postemergence treatments were applied at the 2 to 3-leaf (November) and 4 to 7-leaf (December) stages of wild oat growth in the fall and 5 to 20-tiller (March) stage in the spring. These stages coincided with the 2½-leaf, 5 to 7-leaf and fully tillered stages of wheat growth, respectively. All postemergence treatments, except barban, were applied at 187 l/ha. Several of the barban and difenzoquat treatments were applied in a tank-mix with liquid fertilizer. A liquid nitrogen solution of 28-0-0 at a rate of 46.75 l/ha was applied with barban and difenzoquat was applied with a nitrogen formulation of 7-0-0 at a rate of 187 l/ha. The surfactant used with the difenzoquat treatments was Tritron X-100 at 0.5% by volume. All barban treatments were applied in a water carrier volume of 46.8 l/ha and at a pressure of 3.2 kg/cm^2. The spray boom was tilted at a 45^{o} angle to the soil surface. For all other treatments the boom was directed at a 90^{o} angle to the soil surface. Yields were obtained by harvesting a 1.52 by

9.14 m strip from the center of each plot with a self-propelled plot combine. Yields were averaged over the four replications and converted to kg/ha. Test weights and percent moisture were also sampled from each plot.

CHAPTER IV

RESULTS AND DISCUSSION

Several herbicides were evaluated for wild oat phytotoxicity in a noncrop environment at a location near Devol, Oklahoma (Table II). It was assumed that without crop competition visual ratings could be easily taken and herbicide performance more accurately determined. Best results were obtained with diclofop and flufenprop-methyl. Diclofop gave excellent wild oat control when applied in the fall at the 2 to 3-leaf and 6 to 7-leaf stages of growth and at the higher rate of 1.68 kg/ha applied in the spring at 6 to 8 tillers. Wild oat yields following diclofop applications were the lowest in the experiment when compared to other herbicides applied at the same growth stages. Flufenprop-methyl also exhibited excellent postemergence activity when applied in fall, especially at the 6 to 7-leaf stage. Applications made to wild oats in the 2 to 3-leaf stage were not as effective. Visual ratings indicated that tank mixtures of flufenprop-methyl plus barban gave 10 to 30% less control than flufenprop-methyl applied alone.

Of the other herbicides used in this experiment, barban and difenzoquat gave no better than 40 to 50% wild oat control regardless of rate or stage of growth applied. All treatments in the study yielded significantly less wild oat foliage than the check. A possible reason for the poor control with barban was that treatments were made with a

TABLE II

RELATIONSHIP OF WILD OAT SUSCEPTIBILITY TO HERBICIDES APPLIED POSTEMERGENCE AT THREE GROWTH STAGES (DEVOL, OKLAHOMA, 1974)

		Wild Oat Stage of Growth at Treatment Time										
	Rate	2 to 3-Leaf Stage				Wild Oat Fresh Herbage Weights	6 to 7-Leaf Stage			Wild Oat Fresh Herbage Weights	6 to 8-Tiller Stage	Wild Oat Fresh Herbage Weights
Treatment	(kg/ha)	21*	55*	130*	155*		34*	109*	144*		35*	
		%				(g/sq m)	%			(g/sq m)	(%)	(g/sq m)
Barban	0.28	20	40	30	40	242.0††	10	20	10	224.7††	0	348.1
	0.43	20	50	50	50	227.9††	10	30	10	254.3††	0	361.8
Diclofop	1.12	50	90	80	90	63.4††	20	90	100	28.0††	40	191.7††
	1.68	80	90	80	90	42.0††	30	90	100	23.9††	80	89.7††
Difenzoquat	0.84	40	40	30	10	248.5††	10	0	0	336.6†	20	279.8††
	1.12	40	50	30	30	180.2††	10	0	0	305.3†	20	257.6††
	2.24	60	60	40	40	155.5††	20	40	30	179.4††	40	250.2††
Flufenprop-methyl	0.28	10	20	60	70	130.0††	10	70	60	114.4††	—	215.2††
	0.56	10	30	60	70	122.6††	10	80	90	47.7††	—	183.5††
Barban + flufenprop-methyl	0.28 + 0.28	10	30	50	50	180.2††	10	60	40	157.2††	—	177.8††
	0.28 + 0.56	10	30	60	80	138.3††	10	80	60	88.1††	—	453.4
MSMA	3.36	—	—	—	—	—	—	—	—	—	30	215.2††
	4.48	—	—	—	—	—	—	—	—	—	40	183.5††
	6.72	—	—	—	—	—	—	—	—	—	60	177.8††
Check	—	0	0	0	0	453.4	0	0	0	453.4	0	453.4
LSD (.05)						112.8				112.8		112.8
LSD (.01)						149.5				149.5		149.5

*Days following treatment.

C.V. = 19.9%

†Yield means are significantly different than the check at the 5% level.

††Yield means are significantly different than the check at the 1% level.

water carrier volume of 94 l/ha. Research (10) has shown that lower spray volumes greatly increase wild oat susceptibility to barban. Above average rainfall in the fall resulted in very actively growing plants for the first two treatments (Table III). Rainfall during the winter and spring was below the seasonal monthly averages.

TABLE III

DISTRIBUTION AND AVERAGE RAINFALL AND TEMPERATURES FOR 1974-75 CROPPING SEASON AT DEVOL, OKLAHOMA

Month	Rainfall (cm) Day*		Rainfall (cm) 1974-75	Average Monthly Temperature (^{o}C) 1974-75
September			20.8	19
October			11.7	18
November			2.8	10
December	11	.62	3.0	6
January	2	1.10	5.6	6
	31	.91		
February			7.4	5
March	26	.40	4.7	10
April	8	.93	4.5	16
	28	.40		
Total			60.5	

*Daily rainfall is given for a period immediately following herbicide treatment.

Another experiment was initiated in the fall of 1974 at the Agronomy Research Station at Perkins to examine the influence of these herbicides on winter wheat yields (Table IV). Only slight crop injury (chlorosis) was noted with treatments of difenzoquat; however, this did not persist over 30 days. Yield comparisons indicated that none of the herbicide treatments significantly reduced wheat yields regardless of the stage of wheat growth at the time of herbicide application. Climatic conditions during the study are given in Table V.

Experiments in 1975 were expanded to include preplant incorporated and sequential treatments. Treatments were also evaluated for the first time in a cropping environment at two locations near Randlett, Oklahoma. Evaluation of data from the first experiment (Kinder Farm) indicated that several herbicides showed good potential for controlling wild oats with a single application (Table VI). Crop injury ratings and wheat yields from these treatments are given in Table VII. Triallate applied preplant incorporated at 3.36 kg/ha gave excellent early season control, but control was not persistent enough to last the entire growing season. These higher rates of triallate were sufficient to cause stand reductions to the wheat. However, an increase in tillering of the wheat was noted and yields were not as low as was first expected. Postemergence applications of diclofop, difenzoquat, and MSMA at either the 2 to 3-leaf (October) or 2 to 4-tiller (November) gave excellent wild oat control and no visual crop injury. Barban applications resulted in the poorest control ratings (0 to 30%) when applied in the fall. Comparison of wheat yields with barban treatments indicated that although visual control was almost the same for the first two treatment stages, although not significant, yields were

TABLE IV

INFLUENCE OF SEVERAL WILD OAT HERBICIDES APPLIED AT FOUR GROWTH STAGES ON TRIUMPH 64 WHEAT YIELDS

Treatment	Rate (kg/ha)	Wheat Treatment Stage			
		1-Leaf	3-Leaf	6-Leaf	5 to 6-Tiller
		kg/ha			
Barban	0.28	1633	1552	1425	1236
	0.43	1411	1243	1364	1324
Diclofop	1.12	1700	1243	1505	1478
	1.68	1734	1451	1317	1418
Difenzoquat	0.84	1841	1344	1491	1418
	1.12	1888	1431	1384	1210
	2.24	1606	1317	1452	1243
Flufenprop-methyl	0.28	1593	1277	1371	1404
	0.56	1693	1364	1391	1331
Barban + flufenprop-methyl	0.28 + 0.28	1882	1317	——	——
	0.28 + 0.56	1740	1196	——	——
MSMA	3.36	——	——	1485	1418
	4.48	——	——	1566	1149
	6.72	——	——	1404	1290
Check	————	1452	1452	1452	1452
LSD (.05)		476(NS)	476(NS)	476(NS)	476(NS)
LSD (.01)		617(NS)	617(NS)	617(NS)	617(NS)

C.V. = 20.4%

TABLE V

DISTRIBUTION AND AVERAGE RAINFALL AND TEMPERATURES FOR THE WHEAT SUSCEPTIBILITY STUDY AT PERKINS, OKLAHOMA

Month	Rainfall (cm) Day*		Rainfall (cm) 1974-75	Average Monthly Temperature (^oC) 1974-75
November			15.3	11
December	28	0.1	5.5	6
January	2	0.7	6.9	7
	3	0.8		
February	16	1.1	4.2	5
	18	0.1		
	22	1.4		
March			8.2	9
April	7	1.1	4.3	17
	8	2.0		
	13	0.4		
	27	0.8		
Total			44.4	

*Daily rainfall is given for a period immediately following herbicide treatment.

TABLE VI

EFFECTS OF A SINGLE HERBICIDE APPLICATION ON
WILD OAT CONTROL (KINDER FARM, 1975)

Treatment	Rate (kg/ha)	Wild Oat Stage	Visual Wild Oat Control 53*	95*	150*	215*
			%			
Triallate	3.36	PPI	80	90	80	50
			35*	77*	132*	197*
			%			
Barban + surf.**	0.14	2 to 3-leaf	0	10	0	20
	0.28	"	30	30	30	30
Diclofop	1.12	"	40	70	80	90
	1.68	"	50	80	100	100
			12*	54*	96*	174*
			%			
Barban + surf.**	0.14	2 to 4-tiller	10	10	0	0
	0.28	"	20	20	0	0
Difenzoquat	0.84	"	20	60	80	90
	1.12	"	30	60	70	80
	2.24	"	40	70	100	100
Diclofop	1.12	"	40	80	100	100
	1.68	"	40	90	100	100
MSMA	3.36	"	20	70	80	100
	4.48	"	30	70	100	100
	6.72	"	50	90	100	100
						50*
			%			
Difenzoquat + surf.**	0.84	6 to 8-tiller	—	—	—	30
	1.12	"	—	—	—	40
	2.24	"	—	—	—	50
Diclofop	1.12	"	—	—	—	30
	1.68	"	—	—	—	30
MSMA	3.36	"	—	—	—	10
	4.48	"	—	—	—	20
	6.72	"	—	—	—	20
Barban + MCPA	0.14 + 0.56	"	—	—	—	0
Check (weedy)	———	———	0	0	0	0

*Days following treatment.

**Surfactant applied at 0.5% by volume.

TABLE VII

EFFECTS OF A SINGLE HERBICIDE APPLICATION ON WINTER WHEAT (KINDER FARM, 1975)

Treatment	Rate (kg/ha)	Wheat Stage	Visual Crop Injury 53*	150*	215*	Yield (kg/ha)
				%		
Triallate	3.36	PPI	70	30	20	2070
			35*	132*	197*	
				%		
Barban + surf.**	0.14	3 to 4-leaf	0	0	0	2204†
	0.28	"	0	0	0	2231†
Diclofop	1.12	"	0	0	0	2728††
	1.68	"	0	0	0	2809††
			12*	54*	174*	
				%		
Barban + surf.**	0.14	3 to 4-tiller	0	0	0	2090
	0.28	"	0	0	0	2177†
Difenzoquat	0.84	"	10	10	0	2601††
	1.12	"	30	20	0	2513††
	2.24	"	40	20	0	2681††
Diclofop	1.12	"	10	10	0	2190†
	1.68	"	10	20	0	2507††
MSMA	3.36	"	10	10	0	2439††
	4.48	"	10	10	0	2527††
	6.72	"	20	20	0	2560††
					50*	
				%		
Difenzoquat + surf.**	0.84	early jointing	—	—	0	1767
	1.12	"	—	—	0	1854
	2.24	"	—	—	10	1935
Diclofop	1.12	"	—	—	0	1915
	1.68	"	—	—	0	1915
MSMA	3.36	"	—	—	30	679††
	4.48	"	—	—	40	491††
	6.72	"	—	—	40	356††
Barban + MCPA	0.14 + 0.56	"	—	—	0	1808
Check (weedy)	———	———	0	0	0	1788
LSD (.05)						376
LSD (.01)						503

*Days following treatment.

**Surfactant applied at 0.5% by volume.

C.V. = 14.9%

†Yield means are significantly different than the check at the 5% level.

††Yield means are significantly different than the check at the 1% level.

slightly higher when the wild oats were controlled earlier in the season. Postemergence applications of barban in the spring (March) at the 6 to 8-tiller stage of wild oat growth were unsuccessful. Both foliar and soil activity was noted with the diclofop treatments. Wild oats that germinated following treatments of diclofop had deformed root systems and soon died.

MSMA applied to wild oats in the 2 to 4-tiller stage and wheat in the 3 to 4-tiller stage resulted in complete wild oat control, minor wheat injury, and significantly higher yields than the untreated weedy check. However, MSMA applications made to wild oats in the 6 to 8-tiller stage and wheat in the early jointing stage resulted in only 10 to 20 percent wild oat control, 30 to 40 percent visual wheat injury, and the lowest wheat yields.

Triallate applied preplant incorporated followed by sequential postemergence herbicide treatments were evaluated in two experiments near Randlett. The second herbicide was applied to control wild oats that had escaped the triallate treatment in an attempt to obtain season long control. Generally, these treatments were no better than the single, early, postemergence treatments applied alone. However, triallate applied at 1.68 kg/ha as a preplant incorporated treatment and followed by a postemergence treatment of triallate at the same rate was more effective than one application of triallate at 3.36 kg/ha applied preplant incorporated (Table VIII). Visual wheat injury, noted as stand reductions, was observed with triallate treatments; however, all treatment yields were significantly higher than the weedy check (Table IX). Postemergence treatment with triallate and diclofop resulted in the highest wheat yields.

TABLE VIII

INFLUENCE OF A PREPLANT INCORPORATED TREATMENT FOLLOWED BY A POSTEMERGENCE TREATMENT ON WILD OAT CONTROL (KINDER FARM, 1975)

Treatment	Rate (kg/ha)	Wild Oat Stages	Visual Wild Oat Control 53*	95*	150*	215*
			%			
Triallate	3.36	PPI	80	90	80	50
			35*	77*	132*	197*
			%			
Triallate, barban + surf.**	1.68, 0.28	PPI, 2 to 3-leaf	70	70	80	40
	3.36, 0.28	"	80	100	90	40
			12*	54*	96*	174*
			%			
Triallate, triallate (10G)	1.68, 1.68	PPI, 2 to 4-tiller	80	80	90	70
	3.36, 3.36	"	80	100	100	80
						50*
			%			
Triallate, triallate (10G)	1.68, 1.68	PPI, 6 to 8-tiller	—	—	—	40
	3.36, 3.36	"	—	—	—	40
Triallate, diclofop	1.68, 1.12	"	—	—	—	70
Triallate, difenzoquat + surf.**	1.68, 1.12	"	—	—	—	10
Check (weedy)	———	———	0	0	0	0

*Days following postemergence treatment.

**Surfactant applied at 0.5% by volume.

TABLE IX

WHEAT SUSCEPTIBILITY TO PREPLANT INCORPORATED TREATMENTS FOLLOWED BY POSTEMERGENCE TREATMENTS (KINDER FARM, 1975)

Treatment	Rate (kg/ha)	Wheat Stages	Visual Crop Injury 53*	150*	215*	Yield (kg/ha)
			%			
Triallate	3.36	PPI	70	30	20	2070
			35*	132*	197*	
			%			
Triallate, barban + surf.**	1.68, 0.28	PPI, 2 to 3-leaf	40	20	20	2224†
	3.36, 0.28	"	60	40	30	2150†
			12*	54*	174*	
			%			
Triallate, triallate (10G)	1.68, 1.68	PPI, 2 to 4-tiller	40	30	20	2500††
	3.36, 3.36	"	70	60	30	2231†
Triallate, diclofop	1.68, 1.12	"	40	40	10	2580††
					50*	
			%			
Triallate, triallate (10G)	1.68, 1.68	PPI, 6 to 8-tiller	—	—	20	2439††
	3.36, 3.36	"	—	—	40	2076
Triallate, diclofop	1.68, 1.12	"	—	—	10	2412††
Triallate, difenzoquat + surf.**	1.68, 1.12	"	—	—	20	2197†
Check (weedy)	———	———	0	0	0	1788
LSD (.05)						361
LSD (.01)						495

*Days following postemergence treatment.

**Surfactant applied at 0.5% by volume.

C.V. = 9.6%

†Yield means are significantly different than the check at the 5% level.

††Yield means are significantly different than the check at the 1% level.

Additional evaluations of sequential herbicide treatments were made in 1975 near Randlett (Baber Farm) with preplant incorporated treatments followed by a single postemergence application or multiple postemergence applications (Table X). Excellent wild oat control was observed when triallate was applied preplant incorporated and followed by a postemergence application of barban, triallate (10G), diclofop, or difenzoquat. The stage of wild oat growth at the time of the post-emergence treatment made little difference. Only slight (20%) wild oat control was noted when barban was applied at the 1 to 2-leaf stage followed by barban or difenzoquat applied at the 1 to 3-tiller and 6-tiller stages of wild oat growth. Wheat yields from these treatments were significantly higher than the check (Table XI).

Herbicides were applied also as a single application to winter wheat infested with wild oats. Triallate applied preplant (October) incorporated gave excellent early season control but was only fair control (60%) 215 days after treatment (Table XII). Diclofop, difenzo-quat, and MSMA exhibited excellent phytotoxicity to wild oats when applied at the 1 to 2-leaf (October) and 1 to 3-tiller (November) stages of growth. Treatments delayed until spring (6-tiller) were relatively ineffective and only slight stunting of the wild oats was noted. Wheat injury noted was slight stand reduction (20%) caused by triallate applied preplant incorporated (Table XIII). Chlorosis was noted when difenzoquat and MSMA were applied at the 2 to 3-tiller and 6 to 8-tiller stages of wheat growth.

It is apparent from these data that wild oats are highly competi-tive with winter wheat. Many of the herbicide treatments resulted in wheat yields much higher than the weedy check. Herbicide treatments

TABLE X

WILD OAT CONTROL WITH SEQUENTIAL HERBICIDE APPLICATIONS (BABER FARM, 1975)

Treatment	Rate (kg/ha)	Wild Oat Stages	Visual Control Ratings 53*	95*	150*	215*
			%			
Triallate	3.36	PPI	80	100	90	60
			35*	77*	132*	197*
			%			
Triallate, barban + surf.**	1.68, 0.14	PPI, 1 to 2-leaf	90	90	100	80
	3.36, 0.14	"	90	100	90	80
			12*	54*	96*	174*
			%			
Triallate, triallate (10G)	1.68, 1.68	PPI, 1 to 3-tiller	80	90	90	80
	3.36, 3.36	"	90	90	90	80
Triallate, diclofop	1.68, 1.12	"	90	90	100	100
Barban + surf.**, barban + surf.**	0.14, 0.14	1 to 2-leaf, 1 to 3-tiller	10	30	0	0
						50*
			%			
Triallate, triallate (10G)	1.68, 1.68	PPI, 6 tiller	—	—	—	90
	3.36, 3.36	"	—	—	—	90
Triallate, diclofop	1.68, 1.12	"	—	—	—	90
Triallate, difenzoquat + surf.**	1.68, 1.12	"	—	—	—	90
	3.36, 1.12	"	—	—	—	90
Barban + surf.**, barban + surf.**	0.14, 0.14	1 to 2-leaf, 6 tiller	—	—	—	0
Barban + surf.**, difenzoquat + surf.**	0.14, 1.12	"	—	—	—	20
Check (weedy)	————	————	0	0	0	0

*Days following treatment.

**Surfactant applied at 0.5% by volume.

TABLE XI

WINTER WHEAT SUSCEPTIBILITY TO SEQUENTIAL HERBICIDE APPLICATIONS (BABER FARM, 1975)

Treatment	Rate (kg/ha)	Wheat Stages	Visual Crop Injury 53*	95*	150*	215*	Yield (kg/ha)
				%			
Triallate	3.36	PPI	40	30	30	20	1270††
			35*	77*	132*	197*	
				%			
Triallate, barban + surf.**	1.68, 0.14	PPI, 1 to 2-leaf	10	10	10	0	1613††
	3.36, 0.14	"	40	30	30	20	1398††
			12*	54*	96*	174*	
				%			
Triallate, triallate (10G)	1.68, 1.68	PPI, 1 to 3-tiller	10	10	10	0	1546††
	3.36, 3.36	"	30	30	30	20	1478††
Triallate, diclofop	1.68, 1.12	"	10	10	10	0	1727††
Barban + surf.**, barban + surf.**	0.14, 0.14	"	0	0	0	0	181
						50*	
				%			
Triallate, triallate (10G)	1.68, 1.68	PPI, 6 tiller	—	—	—	10	1236††
	3.36, 3.36	"	—	—	—	20	1304††
Triallate, diclofop	1.68, 1.12	"	—	—	—	10	1398††
Triallate, difenzoquat + surf.**	1.68, 1.12	"	—	—	—	10	1330††
	3.36, 1.12	"	—	—	—	30	1384††
Barban + surf.**, barban + surf.**	0.14, 0.14	1 to 2-leaf, 6 tiller	—	—	—	0	208
Barban + surf.**, difenzoquat + surf.**	0.14, 1.12	"	—	—	—	20	1122††
Check (weedy)	———	———	0	0	0	0	491
LSD (.05)							359
LSD (.01)							484

*Days following treatment.

**Surfactant applied at 0.5% by volume.

C.V. = 12.1%

†Yield means are significantly different than the check at the 5% level.

††Yield means are significantly different than the check at the 1% level.

TABLE XII

WILD OAT CONTROL WITH A SINGLE HERBICIDE APPLICATION (BABER FARM, 1975)

Treatment	Rate (kg/ha)	Wild Oat Stage	Visual Control Rating 53*	95*	150*	215*
			%			
Triallate	3.36	PPI	80	100	90	60
			35*	77*	132*	197*
			%			
Barban + surf.**	0.14	1 to 2-leaf	20	10	0	0
	0.28	"	10	10	0	0
Diclofop	1.12	"	40	50	50	50
	1.68	"	60	60	70	80
			12*	54*	96*	174*
			%			
Barban + surf.**	0.14	1 to 3-tiller	10	0	0	0
	0.28	"	0	10	10	0
Diclofop	1.12	"	40	80	100	100
	1.68	"	40	90	100	100
Difenzoquat + surf.**	0.84	"	30	70	60	70
	1.12	"	30	70	60	80
	2.24	"	40	80	90	100
MSMA	3.36	"	20	60	80	80
	4.48	"	30	80	80	80
	6.72	"	50	90	100	100
						50*
			%			
Difenzoquat + surf.**	0.84	6 tillers	—	—	—	10
	1.12	"	—	—	—	10
	2.24	"	—	—	—	20
Diclofop	1.12	"	—	—	—	10
	1.68	"	—	—	—	20
MSMA	3.36	"	—	—	—	0
	4.48	"	—	—	—	20
	6.72	"	—	—	—	30
Barban + MCPA	0.14 + 0.56	"	—	—	—	0
Check (weedy)	—	—	0	0	0	0

*Days following treatment.

**Surfactant applied at 0.5% by volume.

TABLE XIII

WINTER WHEAT SUSCEPTIBILITY TO INDIVIDUAL HERBICIDES APPLIED AT VARIOUS GROWTH STAGES (BABER FARM, 1975)

Treatment	Rate (kg/ha)	Wheat Stage	Visual Crop Injury				Yield (kg/ha)
			53*	95*	150*	215*	
			%				
Triallate	3.36	PPI	40	30	30	20	1270††
			35*	77*	132*	197*	
			%				
Barban + surf.**	0.14	2 to 3-leaf	0	0	0	0	114
	0.28	"	0	0	0	0	228
Diclofop	1.12	"	0	0	0	0	914†
	1.68	"	0	0	0	0	1546††
			12*	54*	96*	174*	
			%				
Barban + surf.**	0.14	2 to 3-tiller	0	0	0	0	81
	0.28	"	0	0	0	0	208
Difenzoquat + surf.**	0.84	"	0	1	0	0	1109††
	1.12	"	0	1	0	0	1868††
	2.24	"	10	20	0	0	1593††
Diclofop	1.12	"	0	0	0	0	1774††
	1.68	"	10	0	0	0	1801††
MSMA	3.36	"	0	10	10	10	1317††
	4.48	"	0	30	10	10	1189††
	6.72	"	10	30	10	10	1075††
						50*	
			%				
Difenzoquat + surf.**	0.84	6 to 8-tiller	—	—	—	0	1156††
	1.12	"	—	—	—	30	403
	2.24	"	—	—	—	40	632†
Diclofop	1.12	"	—	—	—	0	632†
	1.68	"	—	—	—	0	1008†
MSMA	3.36	6 to 8-tiller	—	—	—	0	208
	4.48	"	—	—	—	20	309
	6.72	"	—	—	—	30	128
Barban + MCPA	0.14 + 0.56	"	—	—	—	0	491
Check (weedy)	————	————	0	0	0	0	491
LSD (.05)							386
LSD (.01)							530

*Days following treatment.

**Surfactant applied at 0.5% by volume.

C.V. = 14.6%

†Yield means are significantly different than the check at the 5% level.

††Yield means are significantly different than the check at the 1% level.

showing very little wild oat control or wheat injury resulted in the lowest wheat yields. Increasing the herbicide rates frequently resulted in increased wheat yields. Herbicides applied to wild oats at the 1 to 3-tiller stage of growth and wheat in the 2 to 3-tiller stage of growth generally resulted in the best wild oat control and highest wheat yields.

Rainfall and temperature information is given in Table XIV. Precipitation and temperatures were extremely low during 1975-76 cropping season although soil moisture at each treatment stage was good.

In the fall of 1976 another experiment was initiated on the Kinder Farm to further determine the effect of herbicides for wild oat control in winter wheat. Treatments were applied preplant incorporated, preemergence incorporated, and postemergence at three growth stages of wild oats. Wheat susceptibility to these herbicides was also evaluated. Triallate applied preplant incorporated gave 70 to 80% wild oat control 122 days after treatment but control ratings decreased to 30 to 60% when rated 74 days later (Table XV). The same treatments applied preemergence incorporated gave 10 to 30% better control. Crop injury to winter wheat from the granular formulation was also less with only slight (10 to 20%) stand reduction, even at the highest rate of 3.36 kg/ha (Table XVI).

The effect of single postemergence herbicide applications on wild oat control is shown in Table XVII. Diclofop gave excellent wild oat control regardless of the stage of application. Of the other herbicides evaluated, difenzoquat and barban gave 70 to 100% and MSMA gave 60% control when rated five weeks after treatment. HOE 29160, a herbicide not previously investigated, exhibited excellent postemergence

TABLE XIV

DISTRIBUTION AND AVERAGE RAINFALL AND TEMPERATURES
FOR WILD OAT STUDIES AT RANDLETT, OKLAHOMA
(1975-76)

Month	Rainfall (cm)			Average Monthly Temperature (^{o}C)
	Day*		Total	1975-76
September			8.3	21
October	15	2.0	2.5	18
November	2	2.1	4.2	11
	3	0.5		
	20	1.6		
December			5.7	6
January			0	5
February			.7	11
March	29	0.4	5.4	12
April	15	0.8	10.3	17
	16	3.1		
	20	1.0		
	24	3.7		
Total			37.1	

*Daily rainfall is given for a period immediately following herbicide treatment.

TABLE XV

INFLUENCE OF PREPLANT OR PREEMERGENCE INCORPORATED HERBICIDES ON WILD OAT CONTROL (KINDER FARM, 1976)

Treatment	Rate (kg/ha)	Treatment Stage	Visual Control Ratings		
			122*	164*	196*
			%		
Triallate	1.12	PPI	70	60	30
	1.40	"	70	60	40
	1.68	"	80	60	40
	3.36	"	70	70	60
Triallate (10G)	1.12	"	70	80	30
	1.40	"	70	90	50
	1.68	"	70	90	50
	3.36	"	80	90	60
Triallate	1.40	PRE I	50	90	40
	1.68	"	80	90	50
	3.36	"	90	90	60
Triallate (10G)	1.40	"	50	80	50
	1.68	"	60	80	50
	3.36	"	70	80	60
Check (weedy)	——	——	0	0	0

*Days following treatment.

TABLE XVI

WINTER WHEAT SUSCEPTIBILITY TO PREPLANT OR PREEMERGENCE INCORPORATED HERBICIDES APPLIED FOR WILD OAT CONTROL (KINDER FARM, 1976)

Treatment	Rate (kg/ha)	Treatment Stage	Visual Crop Injury 122*	164*	196*	Yield (kg/ha)
			%			
Triallate	1.12	PPI	30	30	20	1788†
	1.40	"	30	20	20	2124††
	1.68	"	40	30	30	1727†
	3.36	"	60	50	40	1431
Triallate (10G)	1.12	"	10	20	0	2197††
	1.40	"	0	10	0	2251††
	1.68	"	0	10	0	2332††
	3.36	"	30	30	20	2164††
Triallate	1.40	PRE I	0	10	10	2399††
	1.68	"	0	10	10	2567††
	3.36	"	20	20	20	2567††
Triallate (10G)	1.40	"	0	0	0	2392††
	1.68	"	0	0	0	2392††
	3.36	"	0	10	10	2560††
Check (weedy)	——	——	0	0	0	1297
LSD (.05)						372
LSD (.01)						498

*Days following treatment.
C.V. = 12.0%
†Yield means are significantly different than the check at the 5% level.
††Yield means are significantly different than the check at the 1% level.

TABLE XVII

WILD OAT CONTROL WITH SINGLE POSTEMERGENCE HERBICIDE APPLICATIONS MADE AT THREE WILD OAT GROWTH STAGES (KINDER FARM, 1976)

Treatment	Rate (kg/ha)	Wild Oat Stage	Visual Control Rating 87*	129*	161*
				%	
Barban	0.07	2 to 3-leaf	60	70	70
	0.10	"	80	80	90
	0.14	"	80	80	100
Barban in N-solution	0.07	"	80	70	80
	0.10	"	70	80	90
Diclofop	0.84	"	90	90	90
	1.68	"	100	100	100
MSMA	5.04	"	20	50	40
	6.72	"	30	60	70
			65*	107*	139*
				%	
Difenzoquat + surf.**	0.84	4 to 7-leaf	30	80	70
	1.12	"	60	80	80
	2.24	"	80	90	100
Diclofop	0.56	"	40	40	50
	1.12	"	60	80	90
	2.24	"	70	90	100
HOE 29160	1.12	"	70	90	90
MSMA	3.36	"	30	70	60
	4.48	"	40	80	60
				27*	59*
				%	
Difenzoquat + surf.**	0.48	10 to 20-tiller	—	30	30
	1.12	"	—	60	40
	2.24	"	—	70	40
Difenzoquat + 2,4-D + surf.**	0.84 + 1.12	"	—	50	40
	1.12 + 1.12	"	—	60	40
Difenzoquat in N-solution	0.84	"	—	40	20
	1.12	"	—	60	30
Diclofop	0.56	"	—	20	40
	1.12	"	—	50	60
	1.68	"	—	60	90
HOE 29160	1.12	"	—	40	40
MSMA	3.36	"	—	30	20
	4.48	"	—	30	30
N-solution	46.75 (l/ha)	"	—	0	0
Check	—	—	0	0	0

*Days following treatment.

**Surfactant applied at 0.5% by volume.

activity (90%) when applied at the 4 to 7-leaf stage of wild oat growth. In this experiment, the addition of liquid nitrogen as the carrier for barban treatments did not increase barban activity. Difenzoquat phytotoxicity to wild oats was not affected by 2,4-D when applied as a tank mix. Evaluation of wheat yields and injury ratings from the single postemergence treatments indicated that the highest yields were obtained when herbicide applications were made in the fall (Table XVIII). Chlorosis and stunting were noted when herbicides were applied to fully tillered wheat. Treatments applied in the fall resulted in significantly higher wheat yields than treatments applied in the spring or late winter.

Several herbicides were applied postemergence following a preplant incorporated treatment of triallate for wild oat control (Table XIX). Postemergence herbicide treatments of diclofop, difenzoquat, and barban gave 80 to 100% control throughout the cropping season when applied at either the 2 to 3-leaf or 4 to 7-leaf growth stage of wild oats that had escaped the triallate treatment. Triallate granules, alachlor, and oxyzalin were not as effective when applied at the same stages. When postemergence treatments were delayed until the spring (10 to 20-tiller stage) control was 50% less effective. All treatments resulted in crop injury which ranged from 20 to 60% (Table XX). The injury was caused primarily by the triallate treatments and was primarily wheat stand reduction. All treatment wheat yields were significantly higher than the check except when the postemergence herbicide was triallate (10G) applied at the 2 to 3-leaf or oxyzalin at the 5 to 7-leaf stage of growth.

The effect of multiple herbicide applications of the same

TABLE XVIII

WINTER WHEAT SUSCEPTIBILITY TO HERBICIDES APPLIED AS A SINGLE POSTEMERGENCE APPLICATION FOR WILD OAT CONTROL (KINDER FARM, 1976)

Treatment	Rate (kg/ha)	Wild Oat Stage	Visual Crop Injury 87*	Visual Crop Injury 129*	Visual Crop Injury 161*	Yield (kg/ha)
				%		
Barban	0.07	2 to 3-leaf	0	0	0	2554††
	0.10	"	0	0	0	2708††
	0.14	"	0	0	0	2876††
Barban in N-solution	0.07	"	0	0	0	2513††
	0.10	"	0	0	0	2849††
Diclofop	0.84	"	0	0	0	2466††
	1.68	"	0	0	0	2802††
MSMA	5.04	"	0	0	0	2124††
	6.72	"	0	0	0	2103††
			65*	107*	139*	
				%		
Difenzoquat + surf.**	0.84	5 to 7-leaf	0	0	0	2197††
	1.12	"	0	0	0	2412††
	2.24	"	0	0	0	2473††
Diclofop	0.56	"	0	0	0	2164††
	1.12	"	0	0	0	2540††
	2.24	"	0	0	0	2742††
HOE 29160	1.12	"	0	0	0	2587††
MSMA	3.36	"	0	0	0	1989††
	4.48	"	0	1	0	2298††
				27*	59*	
				%		
Difenzoquat + surf.**	0.84	fully-tillered	—	30	10	1640
	1.12	"	—	30	20	1680
	2.24	"	—	30	20	1754†
Difenzoquat + 2,4-D + surf.**	0.84 + 1.12	"	—	30	20	1660
	1.12 + 1.12	"	—	30	20	1485
Difenzoquat in N-solution	0.84	"	—	20	10	1277
	1.12	"	—	30	20	1398
Diclofop	0.56	"	—	10	0	1519
	1.12	"	—	20	10	1855†
	1.68	"	—	20	10	1827†
HOE 29160	1.12	"	—	20	0	1727†
MSMA	3.36	"	—	30	20	1518
	4.48	"	—	30	30	1344
N-solution	46.75 (l/ha)	"	—	0	0	1552
Check	———	———	0	0	0	1297
LSD (.05)						413
LSD (.01)						564

*Days following treatment.

**Surfactant applied at 0.5% by volume.

C.V. = 13.7%

†Yield means are significantly different than the check at the 5% level.

††Yield means are significantly different than the check at the 1% level.

TABLE XIX

WILD OAT CONTROL WITH TRIALLATE APPLIED PREPLANT INCORPORATED AT 1.68 KG/HA AND FOLLOWED BY POST-EMERGENCE TREATMENTS MADE AT THREE WILD OAT GROWTH STAGES (KINDER FARM, 1976)

Postemergence Treatment	Rate (kg/ha)	Wild Oat Stage	Visual Control Rating		
			87*	129*	161*
				%	
Triallate (10G)	1.40	2 to 3-leaf	60	70	60
Barban	0.07	"	80	90	80
	0.10	"	90	90	90
Diclofop	1.68	"	90	90	100
Alachlor	3.36	"	70	70	40
			65*	107*	139*
				%	
Triallate (10G)	1.40	4 to 7-leaf	70	70	40
	1.68	"	70	80	50
Oryzalin	0.28	"	70	60	20
	0.84	"	70	70	40
Diclofop	1.12	"	80	90	100
Difenzoquat + surf.**	0.84	"	80	90	80
	1.12	"	80	90	100
Barban in N-solution	0.28	"	80	90	100
	0.43	"	80	90	100
				27*	59*
				%	
Diclofop	1.12	10 to 20-tiller	—	80	70
Difenzoquat + surf.**	0.84	"	—	80	50
	1.12	"	—	80	50
Barban in N-solution	0.28	"	—	80	40
Triallate PPI alone	1.68	————	80	60	40
Check (weedy)	——	————	0	0	0

*Days following postemergence treatment.

TABLE XX

WINTER WHEAT SUSCEPTIBILITY TO TRIALLATE APPLIED PRE-PLANT INCORPORATED AT 1.68 KG/HA AND FOLLOWED BY POSTEMERGENCE TREATMENTS MADE AT THREE GROWTH STAGES (KINDER FARM, 1976)

Postemergence Treatment	Rate (kg/ha)	Wild Oat Stage	Visual Crop Injury 87*	129*	161*	Yield (kg/ha)
				%		
Triallate (10G)	1.40	2 to 3-leaf	50	40	30	1586
Barban	0.07	"	30	20	20	2433++
	0.10	"	40	30	20	2984++
Diclofop	1.68	"	30	30	20	2359++
Alachlor	3.36	"	30	40	20	2453++
			65*	107*	139*	
				%		
Triallate (10G)	1.40	5 to 7-leaf	20	30	20	1935+
	1.68	"	30	40	20	2218++
Oryzalin	0.28	"	30	20	20	1660
	0.84	"	40	30	30	1754
Diclofop	1.12	"	20	30	20	2507++
Difenzoquat + surf.**	0.84	"	20	30	20	2876++
	1.12	"	30	40	30	2533++
Barban in N-solution	0.28	"	30	40	20	2318++
	0.43	"	50	60	30	2533++
				27*	59*	
				%		
Diclofop	1.12	fully-tillered	—	30	30	2298++
Difenzoquat + surf.**	0.84	"	—	50	30	2406++
	1.12	"	—	50	30	2171++
Barban in N-solution	0.28	"	—	40	40	2204++
Triallate PPI alone	1.68	—	40	30	30	1727
Check (weedy)	—	—	0	0	0	1297
LSD (.05)						467
LSD (.01)						626

*Days following postemergence treatment.

C.V. = 14.6%

+Yield means are significantly different than the check at the 5% level.

++Yield means are significantly different than the check at the 1% level.

herbicide on wild oat control was also investigated (Table XXI). Two applications of either diclofop or barban applied as sequential treatments gave excellent wild oat control (80 to 100%). Control with the same herbicides was 20 to 40% less than one application was made in the fall and the other application delayed until the spring. Generally, yields from multiple postemergence treatments were higher when two applications were made in the fall while the wild oats were small, although all of these treatments yielded significantly higher than the check (Table XXII).

Rainfall and temperature data for the 1976-77 season are given in Table XXIII. Generally, rainfall and temperatures were above average in the early fall and below average during the winter and spring months.

TABLE XXI

WILD OAT CONTROL WITH MULTIPLE POSTEMERGENCE
HERBICIDE APPLICATIONS
(KINDER FARM, 1976)

Treatment	Rates (kg/ha)	Wild Oat Stages	Visual Control Rating 65*	107*	139*
			— % —		
Barban	0.07, 0.28	2 to 3-leaf, 4 to 7-leaf	80	100	100
	0.10, 0.42	" "	80	100	100
	0.14, 0.56	" "	90	100	100
Diclofop	0.84, 0.56	" "	90	100	100
	1.26, 0.84	" "	90	100	100
MSMA	3.36, 2.24	" "	40	70	60
				27*	59*
				— % —	
Barban	0.07, 0.42	2 to 3-leaf, 10 to 20-tiller	—	70	60
	0.07, 0.28, 0.42	2 to 3-leaf, 4 to 7-leaf, 10 to 20-tiller	—	100	100
Diclofop	0.56, 1.12	4 to 7-leaf, 10 to 20-tiller	—	80	80
	0.84, 1.12	" "	—	90	100
Check (weedy)	—	—	0	0	0

*Days following final treatment.

TABLE XXII

WINTER WHEAT VAR. 'TAM 101' SUSCEPTIBILITY TO MULTIPLE POSTEMERGENCE HERBICIDE APPLICATIONS (KINDER FARM, 1976)

Treatment	Rates (kg/ha)	Treatment Stages	Yield (kg/ha)
Barban	0.07, 0.28	2 to 3-leaf, 4 to 7-leaf	2789††
	0.10, 0.42	" "	2473††
	0.14, 0.56	" "	2849††
Diclofop	0.84, 0.56	" "	2661††
	1.26, 0.84	" "	2849††
MSMA	3.36, 2.24	" "	2359††
Barban	0.07, 0.42	2 to 3-leaf, 10 to 20-tiller	2352††
	0.07, 0.28, 0.42	2 to 3-leaf, 4 to 7-leaf, 10 to 20-tiller	2903††
Diclofop	0.56, 1.12	2 to 3-leaf, 10 to 20-tiller	2285††
	0.84, 1.12	" "	2688††
Check (weedy)	———	———	1297
LSD (.05)			367
LSD (.01)			494

C.V. = 10.3%

†Yield means are significantly different than the check at the 5% level.

††Yield means are significantly different than the check at the 1% level.

TABLE XXIII

DISTRIBUTION AND AVERAGE RAINFALL AND TEMPERATURES FOR THE WILD OAT CONTROL STUDY AT RANDLETT, OKLAHOMA (1976-77)

Month	Rainfall (cm)			Average Monthly Temperature (^{o}C)
	Day*		Total	1976-77
September			13.1	22
October	19	0.9	9.5	14
	27	1.6		
	29	1.7		
	30	1.9		
November	11	0.3	0.3	7
December	6	0.8	0.8	3
January			2.9	0
February			3.3	10
March	11	0.8	3.0	13
	27	2.2		
Total			32.9	

*Daily rainfall is given for a period immediately following herbicide treatments.

CHAPTER V

SUMMARY

Field studies were conducted for three years to evaluate several herbicides for wild oat control and determine their effect on hard red winter wheat. In general, higher wheat yields were achieved when the wild oats were controlled early in the cropping season. Spring applications were not as effective in controlling wild oats as fall treatments.

Postemergence treatments of diclofop in the fall consistently gave excellent wild oat control and high wheat yields when applied as a single application. Both postemergence and preemergence activity on wild oats were observed from postemergence applications of diclofop. Wild oats that emerged well after these treatments had malformed roots and did not survive. Difenzoquat and MSMA applied to wild oats in the 4 to 8-leaf stage of growth were effective 2 of the 3 years evaluated. These herbicides caused some crop injury (chlorosis) if application was delayed until the wheat started jointing.

Wild oat control was inconsistent from year to year with postemergence applications of barban. It is essential that this herbicide be applied early (1 to 2-leaf wild oats) in a low carrier volume (47 l/ha) and pressure of 3.2 kg/cm^2. Flufenprop-methyl and HOE 29160 were evaluated only one year, but both herbicides gave excellent wild oat control when applied postemergence at the 4 to 7-leaf stage of wild oat growth.

Triallate (EC) applied preplant incorporated gave good early season wild oat control (70 to 80%), but control was no higher than 30 to 60% later in the season. The granular formulation of triallate exhibited slightly better wild oat control and crop safety than did the emulsifiable concentrate when applied in the same manner. Crop injury noted from the triallate treatments was slight stand reduction. The wheat rapidly compensated for the injury with increased tillering and yields were always significantly higher than the weedy check.

Triallate applied preplant incorporated followed by a postemergence applied herbicide was generally no better than the postemergence herbicide applied alone in the fall. However, sequential postemergence herbicide applications gave excellent wild oat control if the first treatment was made early in the fall.

This research also indicates that wild oats are highly competitive with winter wheat. Three weeks of wild oat competition between herbicide applications was sufficient to cause slight yield reductions. Substantially reduced wheat yields were recorded when wild oats were not effectively controlled or when moderate wheat injury resulted from herbicide treatments.

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