WEED CONTROL FOR NO-TILL
CONTINUOUS WINTER WHEAT
PRODUCTION

By

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INTRODUCTION

In the early stages of agriculture, the necessity of restricting the establishment of unwanted plants gave rise to tillage (33). For many years in Oklahoma, it was common practice to moldboard plow, disc, and then drag the soil with a spike tooth harrow to prepare the land for wheat production (4). However, this type of tillage program created severe problems with soil erosion. Harlan (16) stated that of the approximately 44 million acres in Oklahoma, about half or 22 million acres, have at one time been plowed. By the late 1950's, he found that about 11 million of the acres had been abandoned as cropland. He also found this huge area to be characterized by thin, erodible soils that were quickly ruined by farming operations which left them mostly gullied and washed. In an effort to halt the ruination of croplands by tillage operations that left the soil bare, stubble-mulch tillage was developed between 1945 and 1955 (13) and it became an effective practice for wind and water erosion control in semi-arid and sub-humid areas (43).

Experimentations with substitution of herbicides for tillage began during the 1948-1955 period with contact and phenoxy herbicides, and accelerated after 1962 with the advent of promising new chemicals. At present, minimum tillage (2 to 4 operations plus herbicides) is undergoing extensive field experimentation and early stages of commercial adaptation in the drier parts of the Great Plains because of the energy saving potential and the availability of effective herbicides. The final step to commercialization of no-tillage wheat production, assuming normal progress of ingenuity, has been recently predicted to begin in 1983 (13).

Excluding the demonstrated advantages in moisture storage and soil conservation, the recent, rapid increases in fuel cost and the increasing availability of herbicides may serve to facilitate, if not dictate, a rapid shift away from tillage toward no-tillage wheat production in Oklahoma.

The objectives of the research reported herein were to conduct preliminary investigations of the feasibility of substituting herbicides for summer tillage in the continuous wheat monoculture cropping system common to Oklahoma.

CHAPTER II

LITERATURE REVIEW

Wheat, _Triticum aestivum_, is the most important crop on a world wide basis. The United States ranks second among chief wheat producing countries with over 27 million hectares in the United States seeded to wheat, yielding over 752 million hectoliters in 1975 (23). Oklahoma ranks fourth among the states in total wheat production in the United States and second in production of hard red winter wheat (20). In 1978, over 2.8 million hectares of wheat were planted in Oklahoma and about 2 million hectares harvested (8). In addition, several hundred thousand animal unit months of grazing are provided by wheat during the winter months (19).

Tillage

Hanaway (15) recently stated that tillage is needed to break up plow layers, reduce compaction, and make a good environment for the seed. But with the increasing concern for conservation and the recent developments in planting and pest control technology, the feasibility of producing crops such as wheat without tillage (no-till) has become a possibility that must be investigated, and one that is becoming an important issue in agriculture (30).

Each year in the United States, the horse-power used in tillage practices such as plowing, chiseling, rotary tillage, discing, cultivating, and other phases of soil preparation results in the movement of enough soil to build a super highway that stretches from Los Angeles to New York. This is not only a movement of a tremendous amount of soil, but it requires investments in equipment, labor, and fuel (6).

Weise (40) stated that in 1973 the cost of plowing varied from \$1.21 to \$2.00/ha. The cost of fuel, machinery, labor, and related repairs have increased considerably since 1973. These increases have contributed directly to higher costs of tillage. Nelson and Kletke (26) stated in the 1977-78 Oklahoma Farm and Ranch Custom Rates Report that the costs of moldboard plowing, discing shallow, discing deep, surface chiseling, or tilling with wide sweeps were \$2.36/ha, \$1.17/ha, \$1.49/ha, \$1.42/ha, and \$1.39/ha, respectively. In addition to cost savings, crop production without tillage has the potential for saving substantial amounts of fuel, particularly in times of high seasonal demand for oil products (42). It may also increase crop yields, reduce non-point source pollution, and conserve moisture (30).

Phillips (29) stated that to many people in semi-arid regions, "no-tillage" is often synonymous with "chemical fallow". While a period of fallow does not always procede the planting of a crop, the term "chemical fallow" serves to clarify and emphasize the fact that when tillage is not used during the time a crop is not present in the field, herbicides must be used for weed control. Phillips further stated that several objectives must be met if any fallow and subsequent crop production program is to be successful. These include: a) the preservation of crop residues to reduce wind erosion hazards, b) the control of unwanted vegetation and the creation of conditions favorable for moisture storage during the fallow period, c) the establishment of a satisfactory seedbed for planting the ensuing crop, d) providing acceptable weed control in the crop, and e) assuring the absence of harmful levels of herbicide residues in the soil. It is clear that Phillips' objectives would apply whether they were applied to an extended fallow period or to the typical situation for Oklahoma, where a no-till chemical fallow would extend for only three to four months.

Chemical Weed Control in Wheat Stubble

Past research on chemical weed control in wheat stubble has usually been concentrated in two areas: 1) weed control for fallow in the drier regions of the Great Plains, and 2) weed control for no-till double cropping of soybeans or sorghum after wheat. Very little research has been done for weed control in no-till continuous winter wheat production.

Chemical Fallow

In the late 1940's, Phillips (29) began trying to substitute herbicides for tillage. At that time, the only broad spectrum herbicides available were contact materials such as dinoseb and PCP (chemical names of herbicides are listed in Table I). Using these materials fortified with diesel fuel and with several applications, he was able to control weeds after wheat harvest until seeding time the next year in a wheat-fallow-wheat system. However, the cost and the number of applications needed made the method impractical. He also reported that 2,4-D, dalapon, paraquat, and several triazines were investigated for this purpose, but they did not provide the desired weed control.

In 1956, Baker et al. (7) reported that 2,4-D would successfully

TABLE I

COMMON AND CHEMICAL NAMES OF HERBICIDES

Common Name	Chemical Name
alachlor	2-chloro-2',6'-diethyl-N-(methoxymethyl) acentanilide
atrazine	2-chloro-4-ethylamino-6-isopropylamino-S-triazine
buthidazole	3[5-(1, 1-dimethylethyl)-1,3,4-thiadiazol-2-yl] -4-hydroxy-1-methyl-2-imidazolidinone
cyanazine	2-[[4-chloro-6-(ethylamino)-s-triazin-2-yl] amino]-2-methylpropionitrile [2-chloro-4-(1-cyano-1-methylethylamino)-6-ethylamino-s-triazine]
dalapon	2, 2-dichloropropionic acid
dinoseb	2sec-butyl-4,6-dinitrophenol
glyphosate	N-(phosphonomethyl)glycine
hexazinone	3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4,(1H,3H)-dione
linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
methazole	2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione
metribuzin	4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)-one
MSMA	monsodium methanearsonate
oryzalin	3,5-dinitro-N^4, N^4-dipropysulfanilamide
paraquat	1,1-dimethyl-4,4'-bipyridinium ion
PCP	pentachlorophenol
propachlor	2-chloro-N-isopropylacetanilide
2,4-D	(2,4-dichlorophenoxy)acetic acid

control broadleaves but not grassy species in summer fallow.

Stahlman (35) at Kansas State University reported that cyanazine + atrazine formulated as a 2:1 granular package mixture applied at 3.4 + 1.7 kg/ha to the soft dough stage of physiologically mature wheat, gave adequate control of pigweed (scientific names of plant species are listed in Table II) in a fallow system the first summer after wheat harvest without reducing the yields of the treated wheat. He also found that buthidazole and oryzalin applied to wheat at the prejointing stage adequately controlled pigweed, but oryzalin caused severe lodging of the wheat, and buthidazole caused excessive stem breakage. At North Dakota University, Miller (24) reported that buthidazole applied in October at 1.68 and 2.2 kg/ha gave adequate control of kochia, yellow foxtail, and green foxtail through July, 1978. However, Stahlman reported that spring applications of buthidazole at lower rates (0.28 to 0.84 kg/ha) would give similar results.

Miller (25) studied several combinations of residual herbicides mixed with paraquat for postemergence weed control in chemical fallow. He found that buthidazole, cyanazine, metribuzin, or atrazine, each plus paraquat, gave adequate control of kochia, green foxtail, wild oats, and Russian thistle. All combinations gave better control than paraquat used alone. Wicks (39) found that in Nebraska combinations of metribuzin + atrazine, appeared to have long enough residuals to provide good summer weed control without injuring wheat sown in the fall.

Wiese (41) compared glyphosate with other herbicides for control of vegetation prior to minimum tillage plantings. He found that glyphosate (0.6 to 4.5 kg/ha) gave better control of volunteer wheat,

TABLE II

COMMON AND SCIENTIFIC NAMES OF PLANTS

Common Name	Scientific Name
cheat	Bromus secalinus L.
common lambsquarter	Chenopodium album L.
corn	Zea mays L.
green foxtail	Setaria viridis (L.) Beauv.
hophornbeam copperleaf	Acalypha ostryaefolia Riddell
kochia	Kochia scoparia L. Sharad.
large crabgrass	Digitaria sanguinalis (L.) Scop.
redroot pigweed	Amaranthus retroflexus L.
Russian thistle	Salsola kali L. var. tenvifolia Tausch
rye	Secale cereale L.
small flower bittercress	Cardamine parviflorus L.
sorghum	Sorghum bicolor (L.) Moench.
soybeans	Glycine max (L.) Merr.
wheat	Triticum aestivum L.
wild oat	Avena fatua L.
yellow foxtail	Setaria lutescens (Weigel.) Hubb.

volunteer sorghum, and pigweed than did paraquat (0.3 to 3.4 kg/ha), methazole (2.2 to 6.7 kg/ha), or MSMA (3.4 to 10.0 kg/ha). Paraquat and methazole were more effective on volunteer corn than glyphosate.

Although chemical fallow is currently being practiced in the northern regions of the Great Plains, implementation of this practice has been impaired by the limited number of herbicides labeled for chemical fallow use. For example, in Nebraska atrazine, cyanazine, glyphosate, 2,4-D, and paraquat are the only herbicides labeled for use in a chemical fallow system (12). Currently, there are only three herbicides with labels that would permit use in this manner in Oklahoma. Those three are 2,4-D, glyphosate, and paraquat. It is feasible that herbicides currently labeled for other uses, such as chemical fallow, could be used in Oklahoma in a no-till continuous winter wheat production system. However, research has been needed to determine which herbicides would be suitable for use in Oklahoma.

Double Cropping

Lynn et al. (22) in Indiana found that oryzalin (1.12 to 1.68 kg/ha) broadcast on wheat at the jointing stage of growth caused no adverse effects on the wheat, and it provided adequate summer weed control in no-till soybeans. When applied to fully tillered wheat there were only slight effects.

Addision et al. (1) in Indiana reported that oryzalin may be applied over the top of small grains and provide acceptable weed control in a succeeding no-till planted soybean crop. At herbicidally efficacious rates of 0.8 to 1.12 kg/ha on coarse and medium soils, and 1.68 kg/ha on fine soils, he found that oryzalin caused no adverse effects to wheat or rye when applied at the fully tillered, jointing, or boot stages of growth. Crabgrass and pigweed control was adequate at all rates of oryzalin used.

Kapasta and Strieker (19) reported from Illinois that oryzalin (1.12 to 3.92 kg/ha) and oryzalin + linuron (1.87 + 2.24 kg/ha) applied to wheat in April before weed emergence, controlled green foxtail, common lambsquarter, and large crabgrass in no-till soybeans. They also reported that oryzalin applied alone did not injure the wheat, but when linuron was added, wheat injury occured.

Hicks et al. (17) in Indiana stated that oryzalin + linuron + paraquat (1.68 + 1.12 + 0.28 kg/ha) and oryzalin + metribuzin + paraquat (1.68 + 0.56 + 0.28 kg/ha) would control crabgrass and broadleaves for thirteen weeks after application in no-till soybeans.

French (11) reported from Oklahoma that combinations of glyphosate + oryzalin + linuron (0.8 + 1.1 + 0.8 kg/ha), glyphosate + alachlor + linuron (0.8 + 2.2 + 0.8 kg/ha), and paraquat + alachlor + linuron (0.6 + 2.2 + 0.8 kg/ha) would adequately control copperleaf and pigweed for seven weeks after the treatments were applied. He also found that when weeds were present at wheat harvest, they could be killed with paraquat (0.6 kg/ha) or glyphosate (0.8 kg/ha), providing that the harvesting of the wheat did not remove all or most of the weed foliage.

Allen et al. (2) reported that when no-till grain sorghum was double cropped after wheat in Texas, atrazine would control volunteer wheat and broadleaves.

The practice of double cropping soybeans and sorghum after wheat has become practical in eastern Oklahoma where rainfall is adequate. Currently, the only herbicides labeled for double cropping soybeans after wheat in Oklahoma are oryzalin, metribuzin, alachlor, linuron, glyphosate, and paraquat. Paraquat is the only herbicide labeled in Oklahoma for double cropping sorghum after wheat.

No-Till Continuous Wheat Production

In a no-till continuous wheat production, the soil is never tilled. Weeds are killed by use of herbicides. However, in double cropping soybeans or sorghum after wheat, the soil is typically tilled after harvesting the soybeans or sorghum, before the next crop is planted.

There has been very little research published on no-till continuous wheat. During 1966-69, Davidson and Santelmann (9) found that control of summer annual weeds with residual herbicides was only partially successful. With propachlor at 4.48 kg/ha, only 70% weed control was obtained with a mid-summer rainfall. They found that paraquat at 1.12 kg/ha was relatively ineffective if the weeds were large. Cheat also became a problem in no-till plots because it often emerged after planting. However, it did not occur in clean tillage plots. They also found that the weed species occuring in the chemically treated plots changed over time, as the perennial species became more prominent.

Straw Cover

In reviewing the problems farmers have with wheat straw, Dr. Paul Unger, USDA, Texas A & M, recently stated that everyone has ideas about disposing of wheat straw. Farmers disc it, shred it, plow it, and cuss it. Other people have suggested converting it into fuel (37). However, Dr. Unger suggests leaving it on the soil surface in a no-tillage farming system. His research indicated that a straw mulch virtually eliminated wind erosion, controlled water erosion, increased soil moisture, and consequently improved the yield of subsequent crops (37). In investigations of the amount of straw required to conserve moisture in Bushland, Texas, Unger (37) found that when 30.5 cm of rain fell during the fallow year, only 2.3 cm of moisture were stored in a bare soil. With 0.45 metric T/ha of wheat straw on the soil surface, 2.8 cm of moisture were stored, and with 5.44 metric T/ha of wheat straw on the soil surface, 13.2 cm of moisture were stored in the soil profile.

Tucker (36) stated that for every 35.2 liters of wheat grain produced in Oklahoma, there would be 45.4 to 90.8 kg of straw residue left on the soil surface. With an average wheat crop of 26 hl/ha, there would be from 2.24 to 6.72 metric T/ha of straw left on the soil surface.

Russell (32) found that light applications of straw on the soil surface were almost as effective as the heavier applications of straw for aiding moisture storage. Evaporation the first day was reduced by 55%, with 1.8 metric T/ha of straw compared to bare soil. Increasing the cover to 12.7 T/ha reduced it only 7% more. Leaving more winter wheat residues on the soil surface has increased soil water storage in the Central and Northern Great Plains (14, 33). Increases in soil water storage from chemical fallow have not occured in the Pacific Northwest (27).

Regarding the effect of crop residue on soil erosion, Horner (18) found that on a silty loam with 30% slope, soil loss from land with standing winter wheat stubble was 0.6 metric T/ha for each 2.5 cm of rain and 12.3 metric T/ha per 2.5 cm of rain from land the wheat stubble had been tilled.

French (11) at Oklahoma State University found that the straw may catch part of the herbicide spray applied to stubble and prevent the herbicide from reaching the soil. This effect might necessitate the need for higher herbicide rates or greater water volumes to obtain effective weed control in a minimum tillage or no-tillage system.

Crop residues also effect soil temperature. Unger (37) found that a straw mulch kept the soil warmer in the winter and cooler in the summer. Prihar et al. (31) suggested that a straw mulch could be a good supplement for chemical weed control, and it could promote maize growth by creating a more favorable temperature regime.

Systems that leave residues on the soil surface until they decompose provide a haven for some insects (5). Elimination of residue burial also leaves disease organisms on top of the soil that can be transmitted easily and provide good habitat and cover for rodents, such as field mice. However, Hanway (15) stated that no-tillage would create a good environment in which to provide a healthy crop, by making enough moisture available to the crop to promote vigorous growth without stress. This would help the crop withstand disease and even insect attack.

Seeding Equipment

Seeding equipment designed for seeding small grain in a clean seedbed generally is inadequate for seeding in an untilled seedbed. Under no-till conditions, a drill must be able to cut through the residue without clogging, place the seed at the proper depth, and then cover the seed. The capabilities of several different seeding machines has been investigated by Anderson (3) and Lindwall et al. (21) in Canada.

Anderson (3) compared several machines for seeding spring wheat and found that plant density was low after seeding with a discer (a oneway with a seed attachment), whether direct-seeded (no preseeding tillage), or following preseeding tillage. The seeds were also placed deeper in the soil as compared to seeding with the hose press or double-disc seeders.

Anderson (3) indicated that when volunteer grain, grassy weeds, or both, were present at planting time, seeding with a discer followed by a packer to anchor the crop residue without pulverising the soil was advisable. A suggested alternative was a combination cultivator - rod weeder drill. When volunteer grain and grassy weeds were not a problem, undisturbed fields could be seeded with minimum tillage seeders such as the hoe-press and double-disc planters.

Lindwall (21) compared several commercially available seeders and an experimental triple-disc press drill on a silty loam soil. He found that the double and triple-disc press drills generally failed to penetrate untilled surfaces adequately when the soil bulk density in the upper 5 cm exceeded 1.2 g/cm^3, as was the case in equipment or sprayer tracks, or when the quantity of surface residue exceeded 3,7000 kg/ha. Hoe openers penetrated the soil but failed to clear heavy residues when stubble and straw lengths were excessive (greater than 25 cm). He found that wheat yields on plots seeded with the double and triple-disc drills were superior to those seeded with a side spaced hoe drill.

Research in Texas by Allen et al. (2) indicated that a hoe opener, spaced to avoid interfurrow interference, or a triple-disc opener would cut through surface residue and it provided the least incorporation of plant residue into the soil near the seed.

Fenster (10) found that seeding in heavy mulch residues (up to 2,240 kg/ha) required a drill with at least 60.9 cm of clearance between hoe openers, and at least 45.7 cm of clearance from the tip of the hoe standard and the frame of the machine. Row spacings of 23 to 36 cm were acceptable for drilling in heavy residues and obtaining optimum yields of wheat. Fenster also found that with the specifications mentioned above, rolling coulters were needed for no-till drilling to cut through residues. Rolling coulters of at least 45.7 cm diameter were needed to cut through 5,600 kg/ha of wheat residue. Large rolling coulters require considerable force for penetration of the soil. On medium textured soils with a dry surface, approximately 181.6 kg of weight for each coulter was needed for adequate penetration.

Unger and Weise (38) stated that no-tillage systems are revolutionizing crop production. Through continued research and the innovations of farmers, the revolution should continue to expand. No-tillage crop production, indeed, has the potential for becoming one of the most important advances in agriculture since man first punched holes in the soil with sticks to plant his seed.

CHAPTER III

METHOD AND MATERIALS

Field Studies

Field experiments were conducted at four locations in Oklahoma to evaluate the feasibility of substituting herbicides for summer tillage in a continuous wheat cropping system. The field studies will be referred to hereafter as Field Studies I, II, III, IV, and V, respectively.

All foliar applied herbicide treatments were applied by use of a tractor mounted compressed air plot sprayer with water carrier and total spray volume of 280 l/ha, unless otherwise stated. All granular treatments were applied with a small plot granular applicator that did not require calibration for any factor except plot length.

All experimental data except visual ratings were analyzed statistically. Treatment effects were compared using L.S.D.'s at the 0.05 level of significance.

Visual ratings of crop injury or weed control were based on either a 0-10 scale, with 0 equal to no effect and 10 equal to complete plant kill, or on percent ground cover.

Field Study I

An experiment was established at North Central Research Station, Lahoma, Oklahoma, on a Pond Creek silty loam soil (Pachic Argiustolls) to evaluate herbicide and tillage combinations for control of summer annual weeds during the summer months when wheat is not growing in a continuous wheat production system. (For rainfall data and soil analysis see Appendix Tables XIV and XVIII.)

The experimental design was a randomized complete block, with a split plot arrangement of treatments, replicated four times. The main plot (tillage) treatments were, (a) one pass with a chisel plow with duckfoot chisel points after harvesting the previous wheat crop, followed by herbicide applications on July 7, 1977, (b) herbicide treatments were applied after harvest July 7, 1977, and the plots were tilled on September 1, 1977, with an offset disc, (c) herbicide treatments were applied after harvest (July 7) and no tillage was used. Herbicide treatments were applied on 2.4 by 6.1 m plots with a carrier volume of 374 l/ha.

Visual weed control ratings were taken 14 and 56 days after treatment (DAT) for the July tilled and no-tillage treatments.

The plots were seeded November 15, 1977, to Triumph-64 wheat at 84 kg/ha. The drill used was a John Deere model LZ1010 hoe type drill with a 25.4 cm row spacing converted to a no-till drill by lengthening the frame to accomodate two tool bars so that rolling coulters (50.8 cm diameter) and weights could be added. Specially designed narrow boots were also added for easier penetration of the soil. The rolling coulters were staggered on the two tool bars to permit greater trash clearance (Figure 1).

Visual ratings were taken 288 DAT to evaluate the effect of the herbicides on the fall sown wheat. Wheat yields were taken from a 1.5

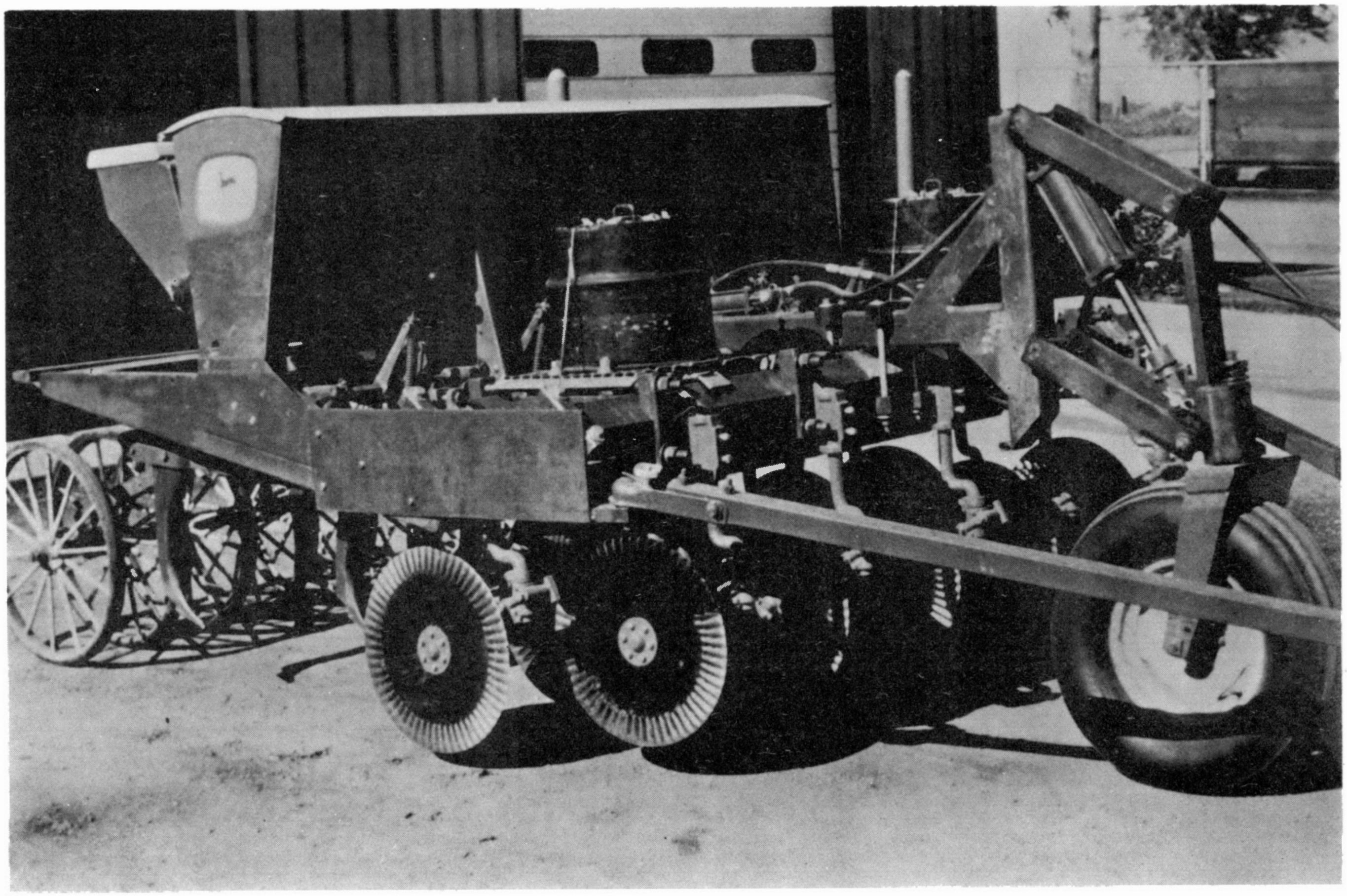

Figure 1. No-Till Drill

by 6.1 m area of each plot on June 28, 1978. Harvest data was obtained by using a self-propelled small plot combine.

Field Study II

Field Study II was conducted at North Central Research Station, Lahoma, Oklahoma, on a Grant fine silty loam soil (Udic Arguistolls) to evaluate herbicides for control of summer annual weeds in untilled wheat stubble. (For rainfall data and soil analysis see Appendix Tables XV and XVIII.) A randomized complete block design was used, replicated three times with a plot size of 4.9 by 9 m. Herbicide treatments were applied April 20, 1978, when the wheat was in the joint stage and June 30, 1978, three days after harvest. When the April 20 treatments were applied, an infestation of cheat was present with a population of approximately 161 plants/m^2. The cheat was in the 1 to 4 tiller growth stage. In addition, seedling pigweed, at a population of approximately 969 plants/m^2 was present. Evaluations of weed control and wheat injury from the treatments applied April 20 were made 28 DAT. Yields were obtained by harvesting a 1.5 by 9 m plot on June, 1978, with a small plot combine.

Based on the results of weed control ratings made two days after harvest, sequential treatments were selected and applied June 30, 1978, as follows: Treatments with three percent or less ground cover of grass species received 2,4-D amine (1.68 kg/ha), other treatments received glyphosate, (1.68 kg/ha). In addition, one treatment consisting of dalapon + 2,4-D + surfactant (4.5 + 1.7 + .5%) was applied postharvest on June 30, 1978. Visual ratings of weed control based on percent ground cover were taken 17 days and 39 days after the June treatments were applied.

On August 21, 1978, the plots were broadcast fertilized with 8.2 kg of nitrogen and 20.9 kg of P_2O_5. On October 2, 1978, the experiment was seeded with Danne wheat at 67 kg/ha with the previously described drill, to determine the residual effects of the herbicide treatments on fall sown wheat. Visual ratings of weed control and wheat injury were taken 181 and 322 days after the April 28, 1978 treatments were applied.

Since some of the plots were heavily infested with cheat in the spring of 1979, the nitrogen content of wheat from all treatments was determined and used as an indication of competition from cheat. The plots were harvested June 14, 1979, with a small plot combine to determine the residual effects of the herbicides on the wheat. Test weight of the harvested grain was determined for each plot as it was harvested.

Field Study III

On April 4, 1978, at Lake Carl Blackwell Research Area, Payne County, Oklahoma, Field Study III was established on a loam soil (Cumulic Haplustoll) to evaluate herbicides applied at the joint growth stage of wheat and to the stubble after harvest, for control of summer annual weeds. A randomized complete block design with four replications was used with each plot measuring 3 by 13.7 m. (For rainfall data and soil analysis see Appendix Tables XVI and XVIII.) On April 4, 1978, 19 herbicide treatments were applied to the jointing wheat. At that time the only weeds present were henbit (107 plants/m^2), small-flowered bittercress (53 plants/m^2) and downy brome (53 plants/m^2).

Visual ratings of winter annual weed control and wheat injury were taken 21 and 50 days after application of the preharvest treatments.

Yield was taken by harvesting each plot on June 27, 1978, with an A model Gleaner combine equipped with a straw spreader.

On June 28, 1978, nine additional herbicide treatments were applied to the stubble. One tillage treatment, which consisted of using an off-set disc once and a tandem disc twice during the summer was included as a check.

By late August, 1978, the plot area had become heavily infested with volunteer wheat. Therefore the plots were divided in half so that each end was a subplot to compare use of a herbicide vs. single tillage operation, prior to seeding, for volunteer wheat control. This procedure was anticipated when the experiment was set up. One half of each plot was treated with 2.2 kg/ha of glyphosate and the remaining half of each plot was tilled once with a subsurface blade. Summer weed control and volunteer wheat control evaluations, based on percent ground cover, were made 108 and 135 days after the preharvest treatments were applied (23 and 50 days after postharvest treatments were applied).

On September 9, 1978, the plot area was planted with 82.88 kg/ha of Tam W 101 hard red winter wheat with the previously described drill. At the time of planting 80.6 kg/ha of 18-46-0 fertilizer was banded with the seed.

A final visual rating was taken 405 days after the application of the preharvest treatments (320 days after postharvest treatments were applied) to determine whether the herbicide treatments had caused noticeable effects on the succeeding crop or annual weeds appearing the spring after treatment. Wheat yields were taken June 27, 1978, by harvesting each plot with a small plot combine.

Field Study IV

A herbicide screening experiment was initiated at the South Central Research Station, Chickasha, Oklahoma, in April, 1979, to evaluate several herbicides for phytotoxicity when applied to wheat in the boot stage and efficacy in controlling summer annual weeds after harvest when no tillage was used.

The experiment was located on a McLain silty clay loam soil (Pachic Arguistolls). A complete randomized block design replicated four times with 3 by 7.6 m plots was used for the experiment. (For rainfall data and soil analysis see Appendix Tables XVII and XVIII.) The Sturdy wheat on which the experiment was established was seeded October 5, 1978. At the time of planting, 44.8 kg/ha of actual nitrogen was banded with the seed. Preharvest herbicide treatments were applied on April 4, 1979, when 90% of the wheat was in the boot stage. Wheat injury was estimated visually 11 and 36 DAT. Yield was taken by harvesting a 1.5 by 7.6 m area of each plot on June 20, 1979. Visual ratings of summer weed control were made 98 and 168 DAT. Based on the results of weed control ratings made 98 DAT, a sequential treatment of glyphosate (2.2 kg/ha) was applied to all the treatments except for where DPX-4189 at 0.1, 0.3 and 0.6 kg/ha was applied preharvest.

Field Study V

Adjacent to Field Study IV, a postharvest screening experiment was initiated to evaluate herbicides applied to the stubble for control of summer annual weeds in a no-tillage system. The wheat was harvested June 18, 1979, with a commercial combine equipped with a straw chopper. Several herbicide treatments were then applied to the stubble on July 5,

1979. At that time tumble pigweed (0 - 0.93 plants/m^2 and 2.5 - 10 cm in height) were present.

Visual ratings of summer weed control were made 28 and 168 DAT. Based on the results of weed control ratings made 28 DAT, a sequential treatment of glyphosate (2.2 kg/ha) was applied to all plots that had weeds present in them except for the disked treatment.

Greenhouse Study

A greenhouse study was initiated February 19, 1979, to evaluate the phytotoxicity of several herbicides to crabgrass, green foxtail, kochia, prairie cupgrass, rough pigweed, and sunflower. The weeds evaluated in this experiment are among the more common weeds found during the summer in a no-till system. Herbicides and rates used were selected from field studies. Herbicide rates were generally lower than field application rates, to stimulate control expected as the residues diminished.

A randomized complete block design with four replications was used. Styrofoam cups with a volume of 200 ml were filled with 170 ml of soil. (For soil analysis see Appendix Table XVIII.) Herbicide treatments were applied, by placing the cups for each treatment in a line and spraying them with a tractor mounted compressed air sprayer with a one nozzle boom. The spray volume was 187 l/ha using water carrier. The appropriate weed seeds were then placed on the soil surface of the designated cups, one species per cup, and mixed into the top 3.8 cm of soil. The cups were subirrigated after planting and then placed on a greenhouse bench. After the initial subirrigation the plots were surface watered with tap water as needed. No supplemental lighting was provided.

Soon after emergence the kochia seedlings in all treatments including the check died, apparently from a seedling disease. The kochia was replanted 11 DAT and a good stand was obtained.

Visual ratings were taken 51 DAT for all plant species except for sunflower. Visual ratings for sunflower control were taken 35 DAT. Harvest data was obtained from each cup by clipping each plant at soil level 51 DAT.

CHAPTER IV

RESULTS AND DISCUSSION

Field Studies

Field Study I

The occurance of a thunderstorm within minutes after the last treatments were applied to Field Study I undoubtedly activated the preemergence herbicides and decreased the activity of the herbicides effective as postemergence materials.

Visual ratings (Table III) 14 DAT in plots tilled in July immediately prior to the herbicide applications indicated that all treatments were adequately controlling prairie cupgrass, rough pigweed, and tumble pigweed. Glyphosate (2.2 kg/ha) was used as the check in this study, and since it was a split plot experiment, it was also applied as a herbicide treatment in the July tillage main plot treatment. However, by 55 DAT, visual ratings (Table III) indicated that only a few treatments were giving adequate control of tumble and rough pigweed, prairie cupgrass, carpetweed, and crabgrass. These treatments were oryzalin + linuron + surfactant, atrazine + oil, and atrazine + ametryn + surfactant. Terbacil also gave good weed control for all species except rough pigweed. A visual rating of volunteer wheat control was also made 55 DAT. None of the treatments provided excellent control, but a few treatments provided sufficient control. These were oryzalin + 2,4-D at both rates,

TABLE III

WEED CONTROL AND INJURY TO FALL SOWN WHEAT FROM HERBICIDE TREATMENTS
APPLIED AFTER JULY TILLAGE
FIELD STUDY I

	Treatment	Rate (kg/ha)	Vis. Rat. 14 DAT(1) 0-10 scale PC	RP	TP	Vis. Rat. 55 DAT % Ground Cover TP	RP	PC	CW	CG	VW	Vis. Rat. 288 DAT % Vol.(2) VW	0-10 sc. WT	% Gr. Cov. SP
1.	Oryzalin + 2,4-D LVE(3)	1.1 + 1.1	9.7	9	9.5	29	38	14	2	1	9.5	38	1	60
2.		2.2 + 1.1	9	8	10	16	23	2	7	3	7	38	2	18
3.	USB 3135 + 2,4-D LVE	.6 + 1.1	9	8	10	13	38	4	5	9	13	40	2	33
4.		1.1 + 1.1	8	9	10	18	17	14	3	9	9	25	2	18
5.	Buthidazole + S.(4)	.6 + ½ %	9.9	9.9	10	13	11	11	1	6	13	78	2	28
6.	Linuron + S.	2.2 + ½ %	9	9	10	12	17	14	4	11	20	38	2	28
7.	Oryzalin + Linuron + S.	2.2 + 1.7 + ½ %	9.9	9.4	10	5	10	5	4	--	14	63	2	10
8.	Atrazine + Oil(5)	2.2 + 9.4 l/ha	9.6	9	10	1	6	5	1	2	7	33	1	23
9.	Procyazine + Oil	2.2 + 9.4 l/ha	9	8	10	15	15	9	1	3	6	43	1	35
10.	Cyanazine + Oil	2.2 + 9.4 l/ha	9	7	10	15	26	9.7	1	8	13	45	1	50
11.	Diuron + S.	2.2 + ½ %	9.9	8	10	16	24	5	1	3	12	30	1	43
12.	Dinitramine + 2,4-D LVE	1.1 + 1.1	9.7	8	10	15	29	4	7	4	12	53	2	50
13.	2,4-D amine + Dalapon	1.1 + 2.2	9	8	10	31	38	8	6	4	8	23	1	85
14.	Ametryn + Atrazine + S.	1.1 + 1.1 + ½%	9.7	9	10	1	5	3	--	4	16	50	1	25
15.	Terbacil	.8	10	7	10	6	28	2	2	1	8	33	6	43
16.	Glyphosate	2.2	9.5	9.7	10	24	43	10	3	4	17	23	1	65
17.	MSMA	4.5	9.9	9	10	24	31	16	1	12	15	33	1	63

(1) DAT = Days after treatment, PC = Prairie cupgrass, RP = Redroot pigweed, TP = Tumble pigweed, CW = Carpetweed, CG = Crabgrass, VW = Volunteer wheat, WT = Wheat, SP = Seedling pigweed

(2) % Vol. = Percent Volunteer wheat in the plots.

(3) Significant quantities of oryzalin settled to the bottom of the tank.

(4) S = Surfactant WK at ½ % v/v.

(5) Oil = Sun 11E nonphytotoxic oil.

USB 3153 + 2,4-D (1.1 + 1.1 kg/ha), atrazine + oil, procyazine + oil, 2,4-D amine + dalapon, and terbacil. Percent volunteer wheat control, wheat injury, and seedling pigweed control were rated April 21, 1978 (288 DAT, Table III), to determine the residual effects of the herbicides on fall sown wheat. No herbicide treatments were controlling volunteer wheat, which was bigger than the sown wheat and found out of the drill rows. Compared to the check (glyphosate treatment), there was little or no wheat injury caused by herbicide treatments, except for the terbacil treatment, which caused considerable injury. Oryzalin + 2,4-D, USB 3153 + 2,4-D (both at the higher rates), and oryzalin + linuron + surfactant were the only treatments that had less than 20% of the plots covered by seedling pigweed. The high population of seedling pigweed was probably a reflection of the late planting date of wheat and stand vigor.

In the plots which received no tillage during the summer, none of the herbicide treatments provided excellent weed control 14 DAT (Table IV). However, the lack of control was anticipated because of the rain (5.1 cm) that began falling fifteen minutes after the last treatment was sprayed. By 55 DAT (Table IV), the only herbicide treatments that appeared effective were USB 3153 + 2,4-D and oryzalin + linuron + surfactant, which were controlling all weed species present except carpetweed. There were more treatments controlling volunteer wheat in the no-tillage main plot than in the July tillage main plot. Oryzalin + 2,4-D at the higher rate, USB 3153 + 2,4-D at both rates, oryzalin + linuron + surfactant, diuron + surfactant, ametryn + atrazine + surfactant, and terbacil were all providing some control of volunteer wheat.

Visual ratings were taken April 21, 1978 (288 DAT), indicated that terbacil persisted long enough to injure the fall sown wheat. Compared

TABLE IV

WEED CONTROL AND INJURY TO FALL SOWN WHEAT WHEN HERBICIDE TREATMENTS WERE APPLIED IN JULY AND NO-TILLAGE WAS USED PRIOR TO PLANTING, FIELD STUDY I

Treatment	Rate (kg/ha)	Vis. Rat. - 14 DAT (1) 0-10 scale			Visual Ratings - 55 DAT (1) % ground cover						Vis. Rat. 288 DAT % Vol.(2)	0-10 sc.	% Gr. Cov.
		PC	RP	TP	TP	RP	PC	CW	CG	VW	VW	WT	SP
1. Oryzalin + 2,4-D LVE (3)	1.1 + 1.1	4	3	3	5	18	34	10	13	11	8	1	48
2.	2.2 + 1.1	7	3	5	1	6	33	24	13	5	25	3	33
3. USB 3153 + 2,4-D LVE	.6 + 1.1	2	0	4	7	9	30	19	9	5	5	2	51
4.	1.1 + 1.1	8	-	3	5	7	6	25	0	7	41	2	13
5. Buthidazole + S.(4)	.6 + ½ %	9	4	8	5	9	18	1	--	23	61	1	23
6. Linuron + S.	2.2 + ½ %	8	3	10	1	10	20	20	8	18	53	2	38
7. Oryzalin + Linuron + S.	2.2 + 1.7 + ½ %	6	1	1	5	5	6	24	--	4	13	2	28
8. Atrazine + Oil (5)	2.2 + 9.4 l/ha	9	-	3	23	19	21	--	4	9	23	1	66
9. Procyazine + Oil	2.2 + 9.4 l/ha	0	-	-	20	16	10	1	4	16	48	0	63
10. Cyanazine + Oil	2.2 + 9.4 l/ha	6	3	-	25	18	21	--	6	11	33	1	60
11. Diuron + S.	2.2 + ½ %	7	-	8	2	28	30	10	8	3	8	3	65
12. Dinitramine + 2,4-D LVE	1.1 + 1.1	6	-	3	8	16	13	31	--	14	33	2	48
13. 2,4-D amine + Dalapon	1.1 + 2.2	2	-	3	9	20	23	28	10	9	35	2	64
14. Ametryn + Atrazine + S.	1.1 + 1.1 + ½ %	6	-	-	5	35	22	3	13	5	30	1	60
15. Turbacil	.8	9.7	-	-	16	58	1	-	1	6	25	5	73
16. Glyphosate	2.2	5	-	-	8	24	25	12	11	13	35	3	58
17. MSMA	4.5	8	-	3	3	32	22	21	8	11	15	1	50

(1) DAT = Days after treatment, PC = Prairie cupgrass, RP = Redroot pigweed, TP = Tumble pigweed, CW = Carpetweed, VW = Volunteer wheat, WT = Wheat, SP = Seedling Pigweed
(2) % Vol. = Percent of Volunteer wheat in the plots.
(3) Significant quantity of surflan settled to the bottom of the tank.
(4) S = Surfactant WK at ½ % v/v.
(5) Oil = Sun 11E nonphytotoxic oil.

to the check (glyphosate), there was little or no injury caused by other herbicide treatments. Oryzalin + 2,4-D, USB 3153 + 2,4-d, both at low rates, and diuron + surfactant were providing sufficient control of volunteer wheat. None of the herbicide treatments persisted long enough to provide control of seedling pigweed.

The third main plot treatment combined herbicide applications in July with a single tillage operation 55 days (September) after treatment. Therefore, the summer weed control rating 55 DAT for the no-tillage treatments would also apply to this main plot treatment.

At 288 DAT (Table V) no volunteer wheat was present in any treatments, indicating that the single September tillage was adequate for volunteer control. The September tillage did noticeably increase injury to the fall sown wheat from buthidazole and terbacil. Apparently buthidazole and terbacil concentrations were still present in the straw or near the surface of the soil.

Regardless of tillage treatment, USB 3153 + 2,4-D (1.1 + 1.1 kg/ha) appeared to be controlling seedling pigweed 288 DAT. Oryzalin + linuron + surfactant (2.2 + 1.7 + ½% v/v) also reduced the number of seedling pigweed present 288 DAT in the July or September tilled plots.

Analysis of yield data indicated that there were no significant differences at the 5% level between herbicide treatments. However, the average yield (Table VI) of September tilled plots was higher than July or no-till plots.

While poor weed control from the no-till plots was expected due to the rainfall immediately after treatment, the poor weed control from the treatments applied to plots tilled in July, immediately before treatment, was a disappointment, obviously the rough condition of the

TABLE V

WEED CONTROL AND INJURY TO FALL SOWN WHEAT WHEN HERBICIDE TREATMENTS WERE APPLIED IN JULY AND ONE TILLAGE OPERATION WAS APPLIED IN SEPTEMBER

FIELD STUDY I

Treatment	Rate (kg/ha)	Vis. Rat. 14 DAT (1) 0-10 scale PC	RP	TP	Vis. Rat. 288 DAT (2) % Vol. VW	0-10 WT	% Gr. Cov. SP
1. Oryzalin + 2,4-D LVE (3)	1.1 + 1.1	2	8	9.5	0	2	53
2.	2.2 + 1.1	5	7	3	0	2	29
3. USB 3153 + 2,4-D LVE	.6 + 1.1	5	3	4	0	2	30
4.	1.1 + 1.1	6	3	5	0	3	16
5. Buthidazole + S. (4)	.6 + ½ %	7	5	8	0	4	35
6. Linuron + S.	2.2 + ½ %	6	3	10	0	2	30
7. Oryzalin + Linuron + S.	2.2 + 1.7 + ½ %	9.4	5	5	0	3	8
8. Atrazine + Oil (5)	2.2 + 9.4 l/ha	6	0	9.3	0	1	35
9. Procyazine + Oil	2.2 + 9.4 l/ha	9	--	--	0	1	38
10. Cyanazine + Oil	2.2 + 9.4 l/ha	5	--	3	0	2	43
11. Diuron + S. (4)	2.2 + ½ %	6	5	10	0	2	43
12. Dinitramine + 2,4-D LVE	1.1 + 1.1	5	3	5	0	3	40
13. 2,4-D amine + Dalapon	1.1 + 2.2	2	--	--	0	2	38
14. Ametryn + Atrazine + S	1.1 + 1.1 + ½ %	5	3	5	0	1	58
15. Terbacil	.8	9	3	3	0	8	53
16. Glyphosate	2.2	7	--	--	0	1	31
17. MSMA	4.5	3	3	--	0	1	43

(1) DAT = days after treatment, PC = Prairie cupgrass, RP = Redroot pigweed, TP = Tumble pigweed, VW = Volunteer wheat, WT = Wheat, SP = Seedling pigweed

(2) % Vol. = Volunteer wheat, in the plot 0-10 visual rating where 0 = no effect, % Gr. Cov. = percent ground cover.

(3) Significant quantities of oryzalin settled to the bottom of the tank in all treatments where it was used.

(4) S = Surfactant WK at ½ % v/v.

(5) Oil = Sun 11E nonphototoxic oil.

TABLE VI

EFFECT OF HERBICIDE TREATMENTS AND TILLAGE PRACTICE ON WHEAT YIELDS FIELD STUDY I

Treatment	Rate	Yield (hl/ha)		
	(kg/ha)	July Till (1)	No Till (1)	Sept. Till (1)
1. Oryzalin + 2,4-D LVE(2)	1.1 + 1.1	8.7	10.5	12.5
2.	2.2 + 1.1	7.5	9.7	12.4
3. USB 3153 + 2,4-D LVE	.6 + 1.1	10.4	10.5	13.1
4.	1.1 + 1.1	9.0	8.3	10.9
5. Buthidazole + S(3)	.6 + ½ %	8.7	8.2	13.1
6. Linuron + S	2.2 + ½ %	14.0	8.2	13.1
7. Oryzalin + Linuron + S	2.2 + 1.7 + ½ %	8.7	10.9	13.1
8. Atrazine + Oil(4)	2.2 + 9.4 l/ha	8.3	9.7	13.0
9. Procyazine + Oil	2.2 + 9.4 l/ha	9.7	8.4	11.4
10. Cyanazine + Oil	2.2 + 9.4 l/ha	9.7	8.1	13.0
11. Diuron + S	2.2 + ½ %	7.4	11.1	11.4
12. Dinitramine + 2,4-D LVE	1.1 + 1.1	6.9	8.6	12.5
13. 2,4-D amine + Dalapon	1.1 + 2.2	7.4	10.7	13.2
14. Ametryn + Atrazine + S	1.1 + 1.1 + ½ %	9.6	9.8	12.2
15. Terbacil	.8	9.3	7.9	9.7
16. Glyphosate	2.2	8.3	8.5	14.5
17. MSMA	4.5	8.7	10.0	14.0
18. Mean(5)		9.0	9.4	12.5

(1) Analysis of variance indicated no significant differences between herbicide treatment means at 5% level, and no treatment by tillage interaction.
(2) Significant quantities of oryzalin settled to the bottom of the spray tank in all treatments where it was used.
(3) S = Surfactant WK at ½ % v/v.
(4) Oil = Sun 11E nonphytotoxic oil.
(5) LSD .05 between tillage practices means = 1.8.

land after one tillage operation had a major effect in reducing the preemergence effectiveness of the treatments.

The overall yield increase due to September tillage could have been due to a number of factors, including release of nutrients tied up in the weeds which remained standing in the July tillage and no-till plots.

Field Study II

It was anticipated that no summer annuals would be present when this experiment was treated on April 20. However, since seedling pigweeds were present, bromoxynil (0.3 kg/ha) was added to all preemergence treatments.

Visual ratings (Table VII) were made 28 days after the treatments were applied to the jointing wheat to evaluate wheat injury, control of seedling pigweed and possible control of the cheat, which was tillered when the treatments were applied. Buthidazole (WP and G), alachlor + tebutryn, and metribuzin did have an effect on the cheat, but these treatments also caused wheat injury in the form of stunting and stand reduction. All treatments except for alachlor (G) + bromoxynil, buthidazole (G), and metribuzin provided fair to adequate control to the pigweed. Alachlor + terbutryn, buthidazole and metribuzin, reduced wheat yields significantly. Alachlor (G and EC) + bromoxynil, and oryzalin + bromoxynil were the only treatment which did not reduce wheat yields. The low test weights of the harvested grain were due to the high population of cheat.

A visual rating (Table VIII) of weed control immediately after harvest indicated that buthidazole (WP) and oryzalin + bromoxynil were the only treatments with good broadleaf control. Treatments with oryzalin, diuron or metribuzin were controlling the grasses to

TABLE VII

EFFECT OF HERBICIDE TREATMENTS APPLIED TO WHEAT IN THE JOINT STAGE ON WEED CONTROL AND YIELD OF TREATED WHEAT, FIELD STUDY II, 1978

Treatment	Rate (kg/ha)	Visual Rating 28 DAT (1) WH	CH	SP (2)	Harvest Data Yield (kg/ha)	Test Wt. (kg/hl)
1. Oryzalin + Bromoxynil	2.2 + 0.3	0	0	7	9.9	55.4
2. Oryzalin + Diuron	2.2 + 1.8	1	0	6	6.7	48.2
3. Diuron	1.8	1	0	7	4.2	---- (3)
4. Metribuzin	.6	2	3	4	3.7	----
5. Alachlor + Diuron	2.2 + 1.8	1	0	6	5.6	47.7
6. Alachlor + Bromoxynil	3.4 + 0.3	0	0	8	9.3	53.5
7. Alachlor (G) + Bromoxynil	3.4 + 0.3	0	0	0	10.0	54.9
8. Alachlor + Tebutryn	2.2 + 2.5	8	6	9	1.6	----
9. Tebutryn	2.5	3	0	7	5.1	41.9
10. Buthidazole (WP)	.6	3	4	9	.96	----
11. Buthidazole (G)	.6	2	3	2	.80	----
12. Check	---	0	0	0	10.8	56.6
13. Check	---	0	0	0	10.8	54.5
$LSD_{.05}$ =					1.0	3.9

(1) Number of days after treatment.
(2) WH = Wheat, CH = Cheat, SP = Seedling Pigweed
(3) A dash indicates that there was not enough grain to determine test weight.

TABLE VIII

EFFECT OF JOINT STAGE AND POSTHARVEST HERBICIDE TREATMENTS ON SUMMER WEED CONTROL AND FALL SOWN NO-TILL WHEAT, FIELD STUDY II

	Preharvest Treatments (4-20-78)	Rate (kg/ha)	Vis. Rat. (1) 6-28-78 (% Gr. Cv.)		Postharvest Treatments 6-30-78	Rate (kg/ha)	Visual Rating 7-17-78 (0-10 scale)				Visual Rating 8-8-78 (% Ground Cover)						
			BR	GR			TP	RP	K	PG(3)	K	PC	RP	SP	TP	VW	N
1.	Oryzalin + Bromoxynil	2.2 + 0.3	9	1	2,4-D	1.68	9	--	10	10	0	0	--	0	--	0	¼
2.	Oryzalin + Diuron	2.2 + 1.8	23	1	"	"	10	--	9	10	0	0	--	0	0	0	0
3.	Diuron	1.8	33	3	"	"	8	10	10	--	-	¼	0	3	0	0	0
4.	Metribuzin	.6	83	3	"	"	2	10	9.3	7	¼	24	0	0	19	0	-
5.	Alachlor + Diuron	2.2 + 1.8	20	1	"	"	9	9.3	10	10	¼	7	0	12	0	0	0
6.	Alachlor + Bromoxynil	3.4 + 0.3	27	40	Glyphosate	"	10	10	9.6	6	¼	27	0	15	0	0	0
7.	Alachlor (G) + "	3.4 + 0.3	37	9	"	"	10	10	4	7	¼	4	0	30	¼	¼	-
8.	Alachlor + Tebutryn	2.2 + 2.5	20	10	"	"	10	10	10	10	0	0	0	3	¼	½	-
9.	Tebutryn	2.5	37	15	"	"	10	10	7	7	4	1	0	0	¼	¼	2
10.	Buthidazole (WP)	0.6	11	6	"	"	10	10	9.6	--	0	¼	0	¼	¼	1	0
11.	Buthidazole (G)	0.6	23	15	"	"	9.6	10	--	1	10	1	7	8	0	½	10
12.	Untreated	---	37	32	Dalapon + 2,4-D + S(2)	4.5 + 1.1	6	10	10	4	0	26	0	10	¼	0	¼
13.	Untreated	---	37	8	Glyphosate	1.68	10	9.9	8		3	12	¼	20	0	0	¼

TABLE VIII (Continued)

	Preharvest Treatments (4-20-78)	Rate (kg/ha)	Postharvest Treatments 6-30-78	Rate (kg/ha)	Wheat Forage Nitrogen 5-3-79 %	Visual Rating 5-29-79 (4) WH	CH	Yield (hl/ha)	Dockage %
1.	Oryzalin + Bromoxynil	2.2 + 0.3	2,4-D	1.68	2.45	90	10	21.4	4
2.	Oryzalin + Diuron	2.2 + 1.8	"	"	2.47	95	5	20.4	3
3.	Diuron	1.8	"	"	2.70	73	27	12.7	14
4.	Metribuzin	0.6	"	"	2.54	50	50	9.3	27
5.	Alachlor + Diuron	2.2 + 1.8	"	"	2.27	57	43	9.6	20
6.	Alachlor + Bromoxynil	3.4 + 0.3	Glyphosate	"	1.44	5	95	1.2	72
7.	Alachlor (G) + "	3.4 + 0.3	"	"	1.58	4	96	1.4	72
8.	Alachlor + Terbutryn	2.2 + 2.5	"	"	1.99	22	78	5.0	36
9.	Terbutryn	2.5	"	"	1.98	15	85	2.8	53
10.	Buthidazole (WP)	0.6	"	"	2.72	75	25	15.1	15
11.	Buthidazole (G)	0.6	"	"	2.54	73	27	15.1	15
12.	Untreated	---	Dalapon + 2,4-D + S(2)	4.5 + 1.1	1.65	10	90	2.3	73
13.	Untreated	---	Glyphosate	1.68	1.66	8	92	1.5	75
	$LSD_{.05}$ =				0.74			3.7	15

(1) Vis. Rat. = Visual Rating
(2) S = Surfactant WK at ½% v/v.
(3) BR = Broadleaves, GR = grasses, RP = redroot pigweed, SP = seedling pigweed, K = kochia, PC = prairie cupgrass VW = volunteer wheat, N = nutsedge.
(4) Rated on Percent Ground Cover.

the extent that these treatments contained 3% or less ground cover of the grass species after harvest.

Since it appeared that grass species would not be a major problem where the ground cover of grass was less than 3%, 2,4-D was applied to control the broadleaves in the five treatments with good grass control. Where additional grass and broadleaf control was needed, glyphosate was applied.

Visual ratings taken 17 days after the postharvest treatments were applied revealed (Table VIII) that 2,4-D gave good to excellent control of broadleaves, except where metribuzin was applied to preharvest (Table VIII). Metribuzin had thinned the wheat stand to the point that the tumble pigweed grew faster, and the 2,4-D therefore did not control it as well.

Glyphosate gave excellent control of redroot and tumble pigweed, but only fair control of kochia in two treatments with 37% broadleaf ground cover at the time of treatment. Glyphosate gave poor to excellent control of prairie cupgrass. Dalapon + 2,4-D + surfactant gave excellent broadleaf control, but resulted only in fair control of prairie cupgrass.

The plots were visually rated again on August 8, 1978, at which time the percent ground cover of weeds present was determined. Alachlor + bromoxynil with glyphosate sequential was not controlling prairie cupgrass and seedling pigweed, alachlor (G) + bromoxynil with glyphosate sequential and alachlor + diuron with 2,4-D sequential were not controlling seedling pigweed. Prairie cupgrass and tumble pigweed were inadequately controlled in the metribuzin with 2,4-D sequential treatment. Dalapon + 2,4-D + surfactant gave good control of all species except prairie cupgrass and a flush of seedling pigweed emerging in August when the plots were rated. The postharvest glyphosate and 2,4-D treatments were not as effective as anticipated.

Generally, there was excellent correltation between forage nitrogen content in May, 1979 and dockage at harvest, which was due to cheat. This confirmed the obvious competition for nitrogen between the wheat and cheat in several of the treatments. It is important to note however, that all of the treatments except oryzalin + bromoxynil decreased the yield of the previous crop to which they were applied, and the cheat control from treatments other than oryzalin occured prior to harvest of that treated crop. In contrast, the dockage data from the treated crop confirms that the two treatments containing oryzalin had cheat present when the treated crop was harvested. Therefore, the oryzalin treatments must have controlled the cheat preemergence the fall after the treatments were applied. Diuron, buthidazole and oryzalin were the only treatments that increased wheat yield and decreased dockage.

Field Study III

Visual rating of wheat injury and weed control 21 days after application of treatments to wheat in the jointing growth stage indicated that none of the herbicides adequately controlled all of the winter annuals present when the treatments were applied (Table IX). Treatments containing diuron, linuron or buthidazole were producing slight injury symptoms on the wheat. Terbutryn was causing both stunting and stand reduction. Wheat treated with metribuzin at 1.1 kg/ha and linuron at 1.7 kg/ha was noticeably chlorotic.

Cheat was not controlled by any of the herbicide treatments. Metri-

TABLE IX

EFFECT OF HERBICIDE APPLICATIONS TO WHEAT IN THE JOINT STAGE ON WINTER ANNUAL WEED CONTROL AND WHEAT PRODUCTION, FIELD STUDY III

	Treatment	Rate (kg/ha)	Visual Ratings 21 DAT (1)(2) WT	CT	DB	HT	SH	BC	50 DAT(1) WT	Harvest Data-1979 Yield (ha/kg)	Harvest Data-1979 Yield (kg/hl)
1.	Diuron	1.3	1	1	0	9.5	--	6	1	28.1	70.3
2.		1.8	1	0	0	10	--	9	1	14.4	71.2
3.	Alachlor (EC)	2.3	0	0	0	0	0	0	0	34.7	70.7
4.	"	3.4	0	0	0	0	0	0	0	36.9	72.0
5.	" (15G)	3.4	0	0	0	0	0	0	0	36.5	70.3
6.	Metribuzin	.6	1	0	6	10	0	9	1	26.9	70.9
7.		1.1	5	1	10	10	5	10	2	16.2	68.8
8.	Bifenox	1.1	0	0	0	1	0	1	0	35.8	71.7
9.		2.3	0	0	0	1	0	1	0	34.6	71.2
10.	Tebutryn	1.8	4	0	6	10	--	4	1	20.0	71.1
11.		2.5	5	1	8	10	10	10	2	13.7	69.9
12.	Linuron	1.1	1	0	0	7	0	1	0	28.8	70.7
13.		1.7	2	1	3	9	0	9	1	25.7	70.9
14.	Oryzalin	1.1	0	0	0	0	0	0	1	27.0	70.7
15.		2.2	0	0	0	0	0	0	0	30.8	71.2
16.	Buthidazole (50WP)	.6	3	1	8	9.8	3	8	2	8.2	69.5
17.	Oryzalin + Diuron	2.2 + 1.7	1	0	3	10	10	10	2	17.7	70.9
18.	Alachlor + Diuron	2.3 + 1.7	3	1	0	10	0	10	2	18.8	70.9
19.	Alachlor + Bifenox	2.3 + 1.1	0	0	0	1	0	2	0	36.7	71.9
20.	Check	---	0	0	0	0	0	0	0	32.1	71.7
	$LSD_{.05}$									4.9	1.7

(1) DAT = Days after treatment

(2) WT = Wheat, CT = Cheat, SH = Shepherdspurse, HT = henbit, DB = downy brome, BC = small flowered bittercress.

buzin, terbutryn, and buthidazole were much more effective on downy brome than cheat. Terbutryn at 2.5 kg/ha and oryzalin + diuron provided excellent control of shepardspurse. Henbit was controlled by diuron, metribuzin, terbutryn and buthidazole, and the higher rate of linuron.

A visual evaluation of wheat injury 50 DAT indicated that the wheat had recovered from the earlier foliar injury. However, when the wheat was harvested approximately one month later, it was apparent that several treatments had reduced the grain yield. The difference between the apparent low injury 50 DAT and reduced yields may be attributed to the occurance of 11.4 cm of rainfall in eight days during the later part of May which may have leached the herbicides far enough into the root zone to increase wheat injury. Terbutryn at both rates, buthidazole, oryzalin + diuron, alachlor + diuron, metribuzin, linuron, and the higher rate of diuron significantly decreased yield compared to the untreated check. No herbicide treatments significantly increased yield.

Weed pressure after harvest was not heavy at this location as indicated by the July 21 rating (Table X). Moisture after harvest was more than adequate for weed growth. The lack of weeds could have been due to the exceptionally rank growth of the wheat, which resulted in abundant straw mulch. Another rating taken August 17, 1978, indicated that all treatments were heavily infested with volunteer wheat. This could also be attributed to the rank crop growth, which caused severe lodging before harvest. Only oryzalin + diuron and atrazine gave good volunteer wheat control. By the time of this August rating, carpetweed and red sprangletop had increased considerably in the plots treated with metribuzin, terbutryn, linuron, or alachlor (EC and G) at 3.4 kg/ha. All postharvest treatments except glyphosate adequately

TABLE X

SUMMER WEED CONTROL, DOWNY BROME CONTROL AND EFFECTS ON FALL SOWN WHEAT AFTER PREHARVEST AND POSTHARVEST TREATMENTS
FIELD STUDY III

			Weed Control (% Ground Cover)										Vis. Rates (5-14-79)				Harvest Data - 1979	
			7-21-78					8-17-78					Glyphosate		Sweep(1)			
	Rate	Treatment											W	DB	W	DB	Yield	Test Wt.
Treatment	(kg/ha)	Stage	RST	CW	VW	MT	PC(1)	VW	DVW	WH	RST	CW(1)	0-10	%GrCv	0-10	%GrCv	(hl/ha)	(kg/hl)
1. Diuron	1.3	Joint	0	½	2	0	0	40	3	0	½	0	1	5	1	2	25.5	69.3
2.	1.8	"	0	¼	1	0	0	36	4	0	¼	0	0	4	0	1	31.0 D	70.4
3. Alachlor (EC)	2.3	"	¼	2	7	0	0	48	3	½	½	4	2	8	1	7	26.1	69.2
4.	3.4	"	0	2	6	¼	½	48	2	¼	1	11	2	8	2	3	25.9	68.8
5. Alachlor (15G)	3.4	"	¼	1	13	0	¼	56	½	0	4	6	2	2	2	3	24.8	69.5
6. Metribuzin	.6	"	½	2	1	0	¼	39	2	0	3	10	1	0	1	1	30.3	69.5
7.	1.1	"	1	2	1	0	¼	41	4	0	6	4	0	0	0	3	32.7 D	69.3
8. Bifenox	1.1	"	0	½	10	0	¼	59	1	0	½	5	2	3	1	4	25.9 D	69.5
9.	2.3	"	¼	½	9	¼	0	49	2	0	2	2	2	13	2	8	22.6	69.5
10. Terbutryn	1.8	"	½	4	1	0	1	34	3	4	6	5	0	¼	0	0	31.4 D	70.5
11.	2.5	"	½	1	1	0	½	34	4	¼	6	3	1	¼	1	0	32.0 D	70.1
12. Linuron	1.1	"	0	3	6	0	¼	48	2	0	2	8	1	10	1	3	28.4	69.3
13.	1.7	"	0	3	3	0	¼	48	3	0	2	8	1	1	1	2	31.1 D	71.0
14. Oryzalin	1.1	"	0	0	5	0	0	46	1	0	0	0	1	2	2	6	27.8	69.3
15.	2.2	"	0	0	4	0	0	23	3	0	¼	0	1	8	1	6	28.0	69.0
16. Buthidazole (50WP)	.6	"	¼	0	½	0	0	38	3	0	1	0	1	0	0	3	33.1 D	69.3
17. Oryzalin + Diuron	2.2 + 1.7	"	0	0	0	0	0	8	7	0	0	0	0	0	1	¼	30.7 D	67.4
18. Alachlor + Diuron	2.3 + 1.7	"	0	0	1	0	0	29	4	0	1	0	0	1	1	½	27.1 D	69.7
19. Alachlor + Bifenox	2.3 + 1.1	"	¼	3	11	0	¼	53	1	0	2	7	1	3	1	6	26.2	70.5

TABLE X (Continued)

Treatment	Rate (kg/ha)	Treatment Stage	Weed Control (% Ground Cover) 7-21-78 RST	CW	VW	HW	PC[(1)]	8-17-78 VW	DVW	WH	RST	CW[(1)]	Vis. Rates (5-14-79) Glyphosate W 0-10	Glyphosate DB %GrCv	Sweep[(1)] W 0-10	Sweep DB %GrCv	Harvest Data - 1979 Yield (hl/ha)	Test Wt. (kg/hl)
20. Glyphosate (Check for 78 harvest)	2.3	Post. Harv.	0	1	12	14	½	57	2	¼	1	3	2	3	0	7	26.4	69.2
21. Oryazlin + Metribuzin	1.1 + .4	"	¼	0	4	0	0	37	½	0	0	0	2	9	2	7	24.5	69.2
22. Oryzalin + Linuron	1.1 + .8	"	0	0	13	0	0	41	1	0	¼	0	1	4	1	4	25.2	68.7
23. Alachlor + Metribuzin	2.3 + .4	"	0	0	10	0	0	48	2	0	14	0	0	16	1	9	23.8	68.4
24. Alachlor + Linuron	2.3 + .8	"	0	0	7	0	0	53	½	0	0	0	1	7	2	13	23.4	70.8
25. Alachlor + Terbutryn	2.3 + 2.3	"	0	0	15	0	0	54	2	0	0	0	0	9	1	7	20.1	70.1
26. Terbutryn	2.3	"	0	0	8	0	0	58	2	0	0	0	1	18	1	13	25.2	69.3
27. Atrazine (80WP)	2.3	"	0	0	7	0	0	11	8	0	¼	0	0	1	1	1	26.1	69.1
28. 2,4-D + Dalapon	1.1 + 2.3	"	0	14	15	0	0	54	1	0	¼	½	1	12	1	10	23.4	69.3
29. Glyphosate[(3)]	2.3	"	½	½	12	0	¼	46	2	0	6	4	1	28	2	7	23.4	68.1
30. Tillage	---	"	0	0	3	0	0	31	0	0	0	1	1	3	1	4	27.7	69.3
Mean														5.9		4.7		
LSD 0.05 =																	4.1	1.5

(1) RST=Red sprangletop, CW=carpetweed, VW=volunteer wheat, DVW=dead volunteer wheat, HW=horseweed, PC=prairie cupgrass, WH=water hemp, W=wheat, DB=downy brome

(2) D=treatments that decreased yields in 1978

(3) The tillage treatment was disced with an offset disc 6-29-79 and with tandem disc 8-17-78.

controlled carpetweed and red sprangletop.

A rating was not taken after the plots were divided in half to compare glyphosate with sweep tillage as a preplanting cleanup treatment because both treatments adequately controlled all vegetation in the plots.

Visual evaluations on May 14, 1979 (Table X), indicated there was more downy brome where glyphosate had been used as a preplant cleanup treatment than where the sweep was used. The appearance of less downy brome where the sweep was used may have been due to a better stand of wheat.

Statistical analysis of 1979 yield data showed that, averaged over all preharvest and postharvest treatments, the tillage treatment applied in August increased yields 2.7 hl/ha over the glyphosate treatments. Since there was no interaction between the joint or postharvest treatments and the glyphosate vs. sweep tillage treatments applied in August, 1978, the 1979 harvest data is reported averaged over the glyphosate vs. sweep tillage treatments.

The 1979 yield data indicated that some of the herbicide treatments resulted in equal or higher yields than the summer tillage treatment. Some of the increased wheat yields in 1979 may have been due to the fact that some of the herbicide treatments reduced the wheat stand in 1978, leaving more nutrients for the 1979 wheat crop. Treatments which reduced wheat yields in 1978, but not in the crop sown the fall after treatment were: diuron (1.8 kg/ha), metribuzin (1.1 kg/ha), terbutryn (1.8 and 2.5 kg/ha), linuron (1.7 kg/ha), buthidazole (0.56 kg/ha), oryzalin + diuron (2.2 + 1.7 kg/ha), alachlor + diuron (2.2 + 1.7 kg/ha).

Of the treatments applied postharvest, oryzalin + metribuzin, oryzalin + linuron, alachlor + metribuzin, terbutryn, and atrazine did not reduce the yield of the fall sown wheat, compared to the summer tillage check.

Field Study IV

Visual ratings were taken 11 and 36 days after application of the treatments to wheat in the boot stage (Table XI). At 11 DAT, MC-10108 and MC-10982 at both rates, were causing slight stunting and stand reduction of the wheat. By 36 DAT, the wheat in these treatments appeared to be growing out of the stunting, but was becoming chlorotic. Cyanazine at both rates was also injuring the wheat 36 DAT, causing stunting, stand reduction, chlorosis, and lodging. Atrazine (2.2 kg/ha) and terbutryn (1.1 and 1.8 kg/ha) also caused wheat lodging.

Yields were significantly reduced by atrazine (G), both rates of bladex (G), terbutryn, and the high rates of MC-10108 and MC-10982. Alachlor (3.4 kg/ha) was the only treatment that significantly increased yield compared to the untreated check.

Visual observations were taken August 2, 1979 and October 11, 1979, for summer weed control. A visual rating was not taken after the glyphosate treatments were applied. The only treatments that provided excellent weed control August 2 were DPX-4189 at all rates tested (Table XI). The October 11 visual rating revealed that cyanazine at 3.4 kg/ha was the only treatment with less than 20% ground cover of volunteer wheat.

TABLE XI

EFFECT ON WHEAT AND SUMMER WEED CONTROL OBTAINED FROM SEVERAL HERBICIDE TREATMENTS TO WHEAT STUBBLE, FIELD STUDY IV, 1979

Treat. No.	Treatments	Rate (kg/ha)	Wheat Vis. Ratings (0-10 scale)		Cl.[1]	Lodg.[1]	Yield	Test Wt.	Postharvest Control (% Gr. Cov.)				
									8-2-79[2]				10-11-79
			11 DAT	36 DAT	%	%	(hl/ha)	(kg/ha)	TP	VW	K	CW	VW
1.	DPX-4189	.1	0	0	11	0	31.1	73.8	0	0	0	1	53
2.		.3	0	0	3	0	34.4	75.7	0	0	0	0	43
3.		.6	0	0	1	0	35.3	75.7	0	0	0	0	40
4.	Cyanazine (G)	1.7	0	4	61	40	11.0	69.7	8	0	0	2	34
5.		3.4	0	9	96	96	2.6	----	7	2	0	0	15
6.	MC 10108	.3	1	1	49	0	26.3	73.0	13	1	1	1	38
7.		.6	2	1	63	0	18.0	66.7	4	1	1	1	46
8.	MC 10982	.3	2	1	44	0	27.5	69.8	5	1	1	2	44
9.		.6	2	1	54	0	21.9	67.6	11	1	1	1	43
10.	Trifluralin (G)	.6	0	0	0	0	35.2	75.5	5	1	1	2	38
11.		1.1	0	0	1	0	32.0	74.7	8	0	5	3	40
12.	DCPA (G)	4.5	0	0	1	0	35.4	75.6	14	1	0	1	38
13.		6.7	0	0	2	0	33.9	75.2	12	2	1	1	35
14.		8.9	0	0	4	0	31.0	74.3	7	0	0	3	34
15.	Alachlor	2.2	0	0	3	0	31.8	75.2	5	0	2	1	35
16.		3.4	0	0	1	0	35.3	74.0	7	0	1	1	34
17.	Perfluidone (G)	1.7	0	0	0	0	31.0	74.3	4	1	1	1	38
18.		3.4	0	0	8	0	27.6	73.6	5	2	0	0	35
19.	Terbutryn	1.1	0	0	1	1	24.1	73.8	13	2	2	1	48
20.		1.8	0	1	1	48	15.4	70.4	8	0	1	2	54
21.	Alachlor (EC)	2.2	0	0	10	0	35.5	73.7	4	0	1	1	38
22.		3.4	0	0	15	0	39.7	74.6	11	0	0	1	44
23.	Diuron (Sprayable C)	1.8	0	0	0	0	28.7	75.5	6	1	2	1	30
24.	Atrazine (90 G)	2.2	0	0	5	3	21.4	73.2	9	1	1	4	29
25.	Chloramben	3.4	0	0	1	0	31.5	75.1	3	1	2	2	41
26.	Check	---	0	0	13	0	31.8	73.0	8	5	1	1	45
	$LSD_{.05}$ =						5.8	3.1					

(1) % Chlorosis and % Lodging determined 36 days after treatment (DAT).
(2) TP = Tumble pigweed, VW = Volunteer wheat, K = Kochia, CW = Carpetweed.

Field Study V

At the time the experiment was initiated, seedling pigweed was present. Therefore, glyphosate (0.8 kg/ha) was added to all treatments for postemergence control.

Visual observations for summer weed control were taken August 2, 1979 and October 11, 1979. Treatments which were providing excellent summer weed control on August 2 (Table XII) were: Glyphosate + oryzalin + linuron, glyphosate + oryzalin + metribuzin, glyphosate + alachlor + linuron. The tillage treatment had more volunteer wheat than the check, which was undistrubed after harvest. A visual rating was not taken after the glyphosate treatments were applied. By October 11, 1979, volunteer wheat had become thick. Treatments where oryzalin was applied were the only treatments controlling the volunteer wheat. The tillage treatment again had more volunteer wheat than the check, which was undisturbed.

Greenhouse Evaluation

Results of the greenhouse screening of three herbicides for their ability to control weed species common in wheat after harvest revealed that crabgrass was controlled by all herbicides and rates used (Table XIII). Green foxtail was not completely controlled by any of the herbicide treatments, but plant counts and fresh weights were significantly decreased by all the treatments compared to the check. Metribuzin provided excellent control of kochia. Diuron and oryzalin at all rates used significantly decreased kochia but did not provide 100% control, as did metribuzin. Oryzalin at 0.6, 1.1, and 1.4 kg/ha were

TABLE XII

WEED AND VOLUNTEER WHEAT CONTROL OBTAINED BY APPLICATION OF SELECTED HERBICIDES TO WHEAT STUBBLE, FIELD STUDY V, 1979

Treatment Number	Treatments	Rate (kg/ha)	Weed Control 8-2-79 TP	VW	CW (1)	% Grd. Cv. 10-11-79 VW
1.	Glyphosate + Oryzalin + Linuron	0.8 + 1.1 + 0.8	0	0	0	11
2.	Glyphosate + Oryzalin + Cyanazine	0.8 + 1.1 + 1.0	1	0	0	8
3.	Glyphosate + Oryzalin + Metribuzin	0.8 + 1.1 + 0.4	0	0	0	9
4.	Glyphosate + Alachlor + Metribuzin	0.8 + 2.2 + 0.4	0	0	0	43
5.	Glyphosate + Alachlor + Cyanazine	0.8 + 2.2 + 1.0	2	0	0	41
6.	Glyphosate + Alachlor + Linuron	0.8 + 2.2 + 0.8	0	0	0	38
7.	Glyphosate	0.8	3	1	1	35
8.	Disked after Harvest	---	3	16	2	73
9.	Check	---	4	1	1	30

(1) TP = Tumble Pigweed, VW = Volunteer Wheat, CW = Carpetweed

TABLE XIII

GREENHOUSE CONTROL OF SIX COMMON WEEDS IN WHEAT STUBBLE WITH METRIBUZIN, DIURON, AND ORYZALIN

Treatment	Rate (kg/ha)	Crabgrass			Green Foxtail			Kochia			Prairie Cupgrass			Redroot Pigweed			Annual Sunflower		
		VR(1)	PC(2)	FW(3)	VR	PC	FW	VR	PC	FW	VR	PC	FW	VR	PC	FW	VR	PC	FW
Metribuzin	.3	10	0	0	8	2	61	10	0	0	9	1	178	9.5	0.3	0	10	0	0
	.4	10	0	0	9	3	13	10	0	0	9.5	1	2	10	0	0	10	0	0
	.6	10	0	0	9.9	0.3	0.3	10	0	0	9.8	0.3	225	10	0	0	10	0	0
	.7	10	0	0	9.3	1	3	10	0	0	9.8	0.3	200	10	0	0	10	0	0
Diuron	.6	10	0	0	7	2	248	9	1	325	5	1	656	9	0.3	41	9	1	333
	.8	10	0	0	8	2	46	9	1	305	9.7	1	3	10	0	0	9	2	693
	1.1	10	0	0	8	1	650	9	1	180	8	2	26	10	0	0	8	0	0
	1.4	10	0	0	9.9	1	1	10	1	190	9.7	1	2	10	0	0	9	0	0
Oryzalin	.6	10	0	0	9.7	1	7	6	17	470	10	0	0	9.8	0.3	0	1	4	3,244
	.8	10	0	0	9.7	1	276	6	12	355	9.5	1	263	9.4	0.3	13	2	3	2,470
	1.1	10	0	0	9.5	1	2	8	8	40	10	1	0	10	0	0	0	3	2,336
	1.4	10	0	0	9.7	0.3	175	8	5	51	10	0	0	10	0	0	2	3	2,687
Check	---	0	5	345	0	17	1,088	0	30	2,024	0	12	2,700	0	3	273	0	4	2,239
$LSD_{0.05}$ =			1	17		2	622		11	419		2	508		1	73		2	1,058

(1) VR = Visual Rating
(2) PC = Plant Count
(3) FW = Fresh Weight in miligrams

the only treatments that provided 100% control of prairie cupgrass. The low rates of both metribuzin and diuron, and oryzalin at 0.6 and 0.8 kg/ha were the only treatments that did not provide excellent control of rough pigweed. Metribuzin at all rates used, and diuron at 1.1 and 1.4 kg/ha provided 100% control of sunflower. Diuron at 0.6 and 0.8 kg/ha significantly decreased fresh weight of sunflower compared to the check. Fresh weights of sunflower in the oryzalin treatments were all higher than the fresh weight of the check.

CHAPTER V

SUMMARY AND CONCLUSIONS

Field experiments were conducted to investigate the use of herbicides to control summer annual weeds in no-till continuous winter wheat production.

Of the several herbicides evaluated for weed control and wheat tolerence, buthidazole, oryzalin + metribuzin, and oryzalin + cyanazine all gave good control of summer annual weeds. DPX-4189 was the only herbicide that gave excellent control of summer annual weeds. Oryzalin (2.2 kg/ha) gave preemergence cheat control in wheat sown the fall after the treatments were applied.

Several preharvest herbicide applications did not significantly reduce wheat yield and test weight. Several herbicides applied preharvest or postharvest had no visible effect on fall sown wheat. Glyphosate, oryzalin, tank-mixed combinations of oryzalin, or one tillage prior to planting the next wheat crop gave good control of volunteer wheat. At one location, a single tillage treatment applied to control volunteer wheat resulted in higher overall average wheat yield than use of glyphosate for volunteer wheat control.

In a greenhouse experiment, crabgrass was controlled by metribuzin diuron and oryzalin. None of the herbicides adequately controlled green foxtail. Metribuzin gave excellent control of kochia. Oryzalin at 0.6, 1.1 and 1.4 kg/ha gave 100% control of prairie cupgrass. Rough pigweed control was generally excellent except for treatments of metribuzin (0.6 kg/ha), diuron (0.6 kg/ha) and oryzalin (0.6 and 0.8 kg/ha). Metribuzin at all rates and diuron at 1.1 and 1.4 kg/ha gave 100% control of sunflower.

No-till continuous winter wheat production was demonstrated, using various herbicides applied preharvest or following harvest for summer annual weed control. Control of volunteer wheat may require a sequential treatment with a postemergence herbicide or a single tillage operation. However, further research of herbicides and rates used needs to be done. In addition, the investigation of the use of one or two tillage operations supplemented by herbicides as a means to reduce wheat production costs.

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APPENDIXES

TABLE XIV

RAINFALL DATA - NORTH CENTRAL RESEARCH STATION, LAHOMA OKLAHOMA (JULY 1, 1977 - JUNE 22, 1978)

Date	Centimeters	Date	Centimeters
July 8	5.1	Sept. 13	.2
July 22	.4	Sept. 14	.3
July 26	.1	Sept. 15	.1
July 27	.2	Sept. 16	.7
July 29	.1	Sept. 17	.1
July 31	1.9	Sept. 21	.1
Aug. 2	1.0	Oct. 10	.1
Aug. 10	.1	Oct. 25	.4
Aug. 11	1.9	Oct. 30	.1
Aug. 12	1.4	Oct. 31	.3
Aug. 13	2.0	Nov. 2	.2
Aug. 14	2.1	Nov. 6	.1
Aug. 17	1.4	Nov. 8	1.4
Aug. 18	.2	Nov. 9	1.6
Aug. 19	.1	Nov. 29	.1
Aug. 20	.6	Dec. 1	.3
Aug. 23	1.8	Dec. 5	.4
Aug. 24	.1	Jan. 1	.1
Aug. 25	2.9	Jan. 16	.7
Aug. 28	.8	Jan. 17	.3
Aug. 31	.1	Jan. 19	.2
Sept. 6	1.4	Jan. 24	.1
Sept. 11	.5	Jan. 25	.1

TABLE XIV (Continued)

Date	Centimeters	Date	Centimeters
Feb. 1	.1	May 3	2.8
Feb. 2	.1	May 4	.7
Feb. 7	.1	May 6	.1
Feb. 8	.1	May 7	.1
Feb. 9	.3	May 18	.2
Feb. 13	3.2	May 20	.9
Feb. 15	.1	May 21	.6
Feb. 20	.2	May 26	1.4
Mar. 3	.7	May 27	3.4
Mar. 13	.3	May 28	5.0
Mar. 15	.4	June 2	.1
Mar. 16	.6	June 3	.1
Mar. 23	.1	June 5	2.5
Mar. 24	.1	June 6	.2
April 3	.1	June 8	.2
April 4	1.8	June 19	1.3
April 10	1.3	June 21	3.3
April 15	.3	June 22	.3
May 1	1.4		

TABLE XV

RAINFALL DATA - NORTH CENTRAL RESEARCH STATION, LAHOMA, OKLAHOMA (APRIL 20, 1978 - JUNE 24, 1979)

Date	Centimeters	Date	Centimeters
April 20	.9	Aug. 11	.1
April 21	.6	Aug. 26	.2
April 26	1.4	Aug. 28	1.2
April 27	3.4	Sept. 9	.1
April 28	4.9	Sept. 16	.3
June 2	.1	Sept. 18	.4
June 3	.1	Sept. 20	1.8
June 5	2.5	Sept. 21	2.6
June 6	.2	Sept. 25	.1
June 8	.2	Sept. 26	3.1
June 19	1.3	Nov. 6	1.7
June 22	3.3	Nov. 12	.7
June 23	.3	Nov. 15	1.5
July 2	.1	Nov. 16	.3
July 5	.1	Nov. 17	.3
July 6	.8	Nov. 22	.3
July 15	1.2	Nov. 24	.4
July 22	.7	Nov. 25	.7
July 23	1.3	Dec. 31	.4
Aug. 3	.3	Jan. 6	.1
Aug. 4	1.3	Jan. 12	1.4
Aug. 5	.1	Jan. 19	.1
Aug. 10	.1	Jan. 30	.1

TABLE XV (Continued)

Date	Centimeters	Date	Centimeters
Feb. 7	.1	May 3	3.9
Feb. 21	.7	May 4	2.4
Feb. 28	.6	May 6	.1
Mar. 2	2.8	May 10	.8
Mar. 18	5.1	May 11	.1
Mar. 22	3.6	May 18	1.1
Mar. 23	.4	May 21	1.3
April 1	1.0	May 26	.3
April 4	1.3	June 1	.1
April 11	2.9	June 6	.6
April 18	.3	June 7	.3
April 22	.4	June 8	.5
April 29	.5	June 10	3.1
May 2	2.5	June 24	3.7

TABLE XVI

RAINFALL DATA - LAKE CARL BLACKWELL RESEARCH AREA, PAYNE CO., OKLAHOMA (APRIL 1, 1978 - JUNE 29, 1979)

Date	Centimeters	Date	Centimeters
April 2	.1	June 22	2.3
April 4	1.7	July 14	1.1
April 6	.6	July 15	1.0
April 15	.3	July 23	1.5
April 28	.1	July 27	.1
April 29	.6	Aug. 3	.7
May 1	1.3	Aug. 4	.7
May 3	2.0	Aug. 11	.7
May 4	.7	Aug. 19	.5
May 6	.2	Sept. 21	2.4
May 7	.6	Oct. 9	3.2
May 18	.5	Oct. 23	.6
May 20	2.8	Nov. 6	1.7
May 21	1.0	Nov. 13	.2
May 22	.1	Nov. 14	.6
May 26	.3	Nov. 15	.1
May 27	2.5	Nov. 16	3.5
May 28	4.7	Nov. 17	1.5
June 5	2.3	Nov. 18	.3
June 7	.6	Nov. 20	.1
June 18	.5	Nov. 22	.5
June 19	2.6	Nov. 26	1.0
June 20	.8	Dec. 31	.9

TABLE XVI (Continued)

Date	Centimeters	Date	Centimeters
Jan. 6	.2	April 19	.4
Jan. 11	.1	April 21	.7
Jan. 12	.1	April 27	.1
Jan. 14	.5	April 29	.8
Jan. 19	3.0	May 2	.3
Jan. 27	.3	May 3	6.5
Jan. 28	.4	May 4	3.7
Feb. 6	1.5	May 5	.6
Feb. 7	8.1	May 11	.3
Mar. 3	1.6	May 19	.2
Mar. 17	.6	May 21	1.2
Mar. 18	1.8	May 22	1.5
Mar. 19	1.9	May 26	.2
Mar. 22	3.0	June 6	.1
Mar. 23	.2	June 7	.8
April 1	.4	June 9	6.0
April 3	.6	June 10	2.4
April 4	.7	June 22	.8
April 10	.1	June 23	.1
April 11	4.0	June 24	.6
April 18	.3	June 29	.2

TABLE XVII

RAINFALL DATA - SOUTH CENTRAL RESEARCH STATION, CHICKASHA, OKLAHOMA (APRIL 3, 1979 - SEPT. 21, 1979)

Date	Centimeters	Date	Centimeters
April 3	2.5	June 10	1.1
April 17	.3	June 25	.8
April 18	.4	June 26	.3
April 19	.3	July 6	3.6
April 20	.9	July 7	2.8
April 21	2.7	July 17	.1
April 23	.1	July 18	.3
May 2	1.2	July 19	.5
May 3	1.6	July 31	.5
May 4	4.0	Aug. 16	.7
May 10	.6	Aug. 20	1.1
May 11	.3	Aug. 21	.5
May 19	.4	Aug. 22	1.8
May 21	3.0	Aug. 23	.5
May 22	.2	Aug. 27	.3
May 23	.1	Aug. 28	.4
May 27	.3	Sept. 1	2.2
May 28	.2	Sept. 2	2.2
May 31	3.8	Sept. 7	.3
June 6	3.7	Sept. 20	.2
June 7	2.3	Sept. 21	.1
June 9	7.8		

TABLE XVIII

SOIL ANALYSIS

Field Study	Texture	% O.M.	pH	N* (kg/ha)	P* (kg/ha)	K* (kg/ha)	Sand	Silt	Clay
I	loam	1.4	5.3	52	168	1364	35	47	19
II	loam	0.8	5.2	82	76	677	38	37	26
III	loam	2.6	5.7	8	41	272	40	36	24
IV, V	loam	0.8	6.0	10	49	390	37	42	21
Greenhouse	loam	1.4	5.3	80	104	1039	28	46	26

* Soil samples were collected at the time the experiments were initiated.

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