EFFECT OF SEEDING METHOD ON BROMUS SPP. CONTROL
WITH PREPLANT APPLICATIONS OF ATRAZINE AND
CYANAZINE IN NO-TILL WHEAT

By

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CHAPTER I

INTRODUCTION

In 1985 wheat (*Triticum aestivum* L.) was produced in 42 states of the union (33). Oklahoma ranks third in the production of hard red winter wheat, with over 3,000,000 ha planted each year, and fourth in overall wheat production among the states (15,31,33). In recent years, Oklahoma wheat producers have experienced increasing problems associated with several winter annual grass species (34). Peeper (34) reported in 1976 that an estimated \$44 X 10^6 per year in losses could be attributed to five winter annual *Bromus* spp. which included cheat (*Bromus secalinus* L.), hairy chess (*Bromus commutatus* Schrad.), downy brome (*Bromus tectorum* L.), japanese chess (*Bromus japonicus* Thunb.), and rescuegrass (*Bromus catharticus* Vahl.). These losses are attributed to yield reductions caused by competition, dockage, additional seed cleaning costs, and harvest delays due to maturity differences between wheat and *Bromus* spp. (21). Greer et al. (21) reported in 1980 that growers do not usually distinguish between these different *Bromus* spp. and refer to them collectively as cheat. But, the major species infesting approximately 1,200,000 ha of wheat in Oklahoma is cheat. However, rescuegrass, downy brome, japanese chess, and hairy chess may be found to some degree in the same fields. Greer et al. (21) further reported that in addition to yield losses sustained from competition of these *Bromus* spp., maturity differences between cheat and wheat result in dockage at the elevator. Dockage at local elevators from heavily infested fields can average 10 to 15% and may be as high as 35%. The amount of dockage will vary from year to year depending upon how much cheat matures and shatters before the wheat is harvested. When the cheat does mature and shatter before the wheat is harvested, dockage is low and producers may not realize the extent of the problem.

Peeper (34) reported that the increasing severity of Bromus spp. may be partially attributed to the use of stubble mulch or minimum tillage practices and the early planting of wheat for pasture. Rydrych (40) reported in 1968 that in the Pacific northwest, cultural practices adopted to improve soil and water conservation, particularly the practice of stubble mulching, had increased downy brome infestations by allowing downy brome to produce seed and become established. Tillage practices for cheat control can reduce populations but, complete control may not be possible (36). Reductions of Bromus spp. infestations have been noted when a moldboard plow has been used to bury seed to a depth from which emergence is not possible (36). Greer et al. (22) reported that deep plowing can be effective for cheat control by inhibiting seedling emergence if the soil is completely turned over to a depth of 15 to 21 cm. Runyan (37) reported that moldboard plowing gave good control of Bromus spp., whereas tillage systems using stubble mulch and minimum tillage type tools did not control Bromus spp., except when used in the late fall after these weeds germinated.

The use of herbicides for control of Bromus spp. infestations in winter wheat has been complicated by the relative high cost of labeled herbicides, differences in wheat variety responses to some herbicides, and often the lack of adequate selectivity. Currently only 2 herbicides, metribuzin and triallate (common and chemical names of pesticides used herein are listed in Table I) are labeled for Bromus spp. control in Oklahoma wheat fields. A third herbicide, cyanazine, is labeled for Bromus spp. suppression (4). However, these herbicides have several edaphic, varietal, and/or grazing restrictions that limit their use. Except for cyanazine they are also relatively expensive. Thus, the lack of inexpensive herbicides for Bromus spp. control with adequate selectivity under a wide range of conditions has slowed adoption of reduced and no-tillage wheat production in Oklahoma. Atrazine and cyanazine, which breaks down quicker than atrazine, are relatively inexpensive herbicides that can effectively control Bromus spp., but wheat has little physiological tolerance to either (49).

Therefore, this research was designed to determine whether preplant broadcast applications of atrazine or cyanazine, could be used to control Bromus spp. in no-till wheat, in conjunction with drill openers designed to move the herbicide from the drill row for crop safety.

TABLE I

COMMON AND CHEMICAL NAMES OF PESTICIDES

Common	Chemical
atrazine	6-chloro-N-ethyl-N'-(1-methyethyl)-1,3,5-triazin-2,4-diamine
diallate	S-(2,3-dichloro-2-propenyl)bis(1-methylethyl) carbamothioate
diuron	N'-(3,4-dichlorophenyl)-N-N-dimethylurea
cyanazine	2-[[4-chloro-6-(ethylamino)-1,3,5-triazin-2-yl] amino]-2-methylpropanenitrile
ethyl-metribuzin[1]	4-amino-6-(1,1-dimethylethyl)-3-(ethylthio)-1,2,4-triazin-5(4H)-one
glyphosate	N-(phosphonomethyl)glycine
glyphosate + 2,4-D[2]	0.108 kg acid equivalent/liter of glyphosate as the isopropylamine salt + 0.192 kg acid equivalent/liter of 2,4-D as the isopropylamine salt
malathion	0,0-dimethyl phosphorodithioate of diethyl mercaptosuccinate
maneb	Manganese ethylenebisdithiocarbamate
metribuzin	4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4H)-one
simazine	6-chloro-N,N'-diethyl-1,3,5-triazine-2,4-diamine
triadimefon	1-(4-chlorophenoxy)-3,3-dimethyl-1-(1H, 2,4-triazol-1-yl)-2-butanone
triallate	S-(2,3,3-trichloro-2-propenyl)bis(1-methylethyl) carbamothioate
2,4-D	(2,4-dichlorophenoxy) acetic acid

1. The proposed name "ethyl-metribuzin" has not yet been accepted by the Weed Science Society of America. Its code numbers are BAY SMY 1500 (Mobay Chemical Corp.) and DPX R 7910 (E.I. duPont de Nemours and Co., Inc.)

2. The formulation of glyphosate + 2,4-D used herein is marketed as Landmaster® by Monsanto Agricultural Products Company.

CHAPTER II

LITERATURE REVIEW

Wheat

Wheat (Triticum aestivum L.) is the world's principal cereal grain crop (35). Predominantly produced in continuous production with a short fallow period between crops, winter wheat is adapted throughout Oklahoma and is grown on more land area than all other cultivated crops combined (15,31). Hard red winter wheat is a winter annual characterized by a terminal spike inflorescence containing 2 to 5 flowered, solitary sessile spikelets attached at each node of the rachis, and grows in height from 60 to 120 cm (3). Wheat also has erect culms that are freely branching at the base, and blades that are 1 to 2 cm wide (25).

In Oklahoma, the optimum seeding date for grain production is from September 15 to October 15, but satisfactory grain yields may be obtained from seeding dates through December if moisture is adequate (31). The optimum seeding date for forage production is August 22, with forage yield reductions of 672 to 1120 kg/ha for every 2 week delay in seeding.

Most wheat is seeded with either single disc, double disc, or furrow (hoe and shoe) drills. However, single disc drills are used most commonly, but in the western plains area where surface moisture is lacking at seeding time, furrow drills are used to move dry soil from the row and place seed in moist soil (9).

In areas and in years when sufficient moisture is available at wheat seeding time to produce good germination, relatively shallow seeding depths of from 2.5 to 3.8 cm will usually result in good stands. However, when the soil surface is dry at seeding in the Big Bend regions of the Pacific Northwest it is not uncommon for wheat to be seeded to a depth of 10 to 12 cm. Nevertheless, deep seeding often results in poor emergence (2). Wheat seeded in dry soil should be drilled from 5 to 7 cm deep, to avoid germination after light showers, but allow for normal emergence and growth when ample moisture is received (2,29).

Wheat seeding rates in Oklahoma usually vary from 34 to 50 kg/ha in the western portion of the state to 84 to 101 kg/ha in the central and eastern portions. However, 50 to 67 kg/ha of high quality seed is usually adequate. If pasturing is anticipated, an additional 17 to 34 kg/ha will increase the amount of forage obtained and will not decrease grain yield (31).

Cheat

Cheat (Bromus secalinus L.), also known by the synonyms chess and rye bromegrass, is a weedy annual species introduced from Europe. It is a winter annual found throughout the United States as a weed in grain fields (13,20,25). Although, a troublesome weed in many fields of winter cereals, cheat is occasionally utilized for hay in Washington and Oregon (13,25). Greer et al. (22) reported in Oklahoma that when moisture is adequate and soil temperatures become cooler in late September or October, cheat begins to germinate. Greer et al. (21) further reported that cheat often matures later than wheat.

Cheat is characterized by erect culms, 30 to 60 cm tall, but it may grow over 60 cm tall in competition with other crops (25). The inflorescence is a pyramidal shaped panicle, nodding, 7 to 12 cm long, with 3 to 5 unequal lower branches that are slightly drooping. Spikelets are ovoidlanceolate, 1 to 2 cm long, and 6 to 8 mm wide. Glumes are obtuse, the first 3 to 5-nerved, 4 to 6 mm long, and the second 7-nerved, 6 to 7 mm long. Cheat was reported in Oklahoma as early as 1900 (8).

Downy Brome

Downy brome (Bromus tectorum L.) has many localized names with cheatgrass among the most common. Other names include cheatgrass brome, downy bromegrass, military grass, downy chess, cheat, junegrass, wild oats, broncograss, Morman oats, and drooping bromegrass (19,26). Downy brome is a winter annual introduced into North America from southern Europe (25). It was first identified in the United States in 1861 in New York and Pennsylvania (25). By 1914, downy brome had spread throughout the North American continent (47). Competition between downy brome and winter wheat causes serious economic losses to growers in the Pacific Northwest and other areas (40). Fenster and Wicks (19) reported that densities of only 11 to 22 plants/m^2 depressed winter wheat yields by 30% in Nebraska. Peeper (34) has indicated that the increasing severity of this species in Oklahoma may be attributed to the popularity of stubble mulch or minimum tillage land preparation practices and early sowing of wheat for pasture. Massee and Higgins (32) reported that in Idaho downy brome seeds germinate in the fall, as most winter annuals do, but to a lesser extent they also germinate in the winter and spring, when temperatures are above freezing and soil moisture is sufficient for germination and root development. The seed will germinate readily on the soil surface or may emerge through as much as 5 cm of soil. Emerging seedlings are soft and downy and the new leaves are rolled. Finnerty and Klingman (20) reported that downy brome matures 1 to 2 weeks before hairy chess, Japanese brome, and cheat. It also generally matures before wheat in Oklahoma and is not considered by producers to be as bad as cheat.

Downy brome is characterized by culms which are erect or spreading, slender, and 30 to 60 cm tall with pubescent sheaths and blades. The inflorescence is a loose drooping panicle, 5 to 15 cm long, rather dense, soft, flexous, and often purple. Spikelets are nodding, 4 to 7-flowered, and 12 to 20 mm long. Glumes are villous, the first 4 to 6 mm long, the second 8 to 10 mm long. The awns are pubescent and 12 to 14 mm long (25).

Rescuegrass

Rescuegrass (Bromus catharticus Vahl.) is an erect winter annual or biennial. It is an introduction from South America, originally cultivated for winter forage in the southern states, but it escaped and became widely distributed over most of the United States (25). Other synonyms associated with this species are Bromus unioloides H.B.K., Bromus willdenowii Kunth, prairiegrass, rescue brome, and Schrader's bromegrass (25). Several cultivated varieties of rescuegrass including Chapel Hill, Gasel, Lamont (Reg. No. 7), Nakuru, Prairie, and Texas 46 (1) have been registered. However, seed of these is not currently produced for sale. Rescuegrass usually matures before wheat in Oklahoma and often shatters the seed before harvest.

Rescuegrass may grow as much as 100 cm tall. The inflorescence is an open drooping panicle, as long as 20 cm, composed of paired branches up to 15 cm long, naked at the base. Spikelets are 2 to 3 cm long, and 6 to 12-flowered. Glumes are acuminate, the first 6 to 12 mm long and the second, longer than the first. As with other Bromus spp. described by Hitchcock (25), it may vary in characteristics or grow taller when in competition with cultivated crops.

Seeding Methods and Chemical Bromus Control

Schirman et al. (41) reported in 1979 that a major problem associated with zero-tillage winter wheat production in southeastern Washington was lack of an effective control of winter annual grasses, particularly downy brome. Investigations on the use of s-triazines for downy brome control in wheat have produced variable results in regard to both downy brome control and crop injury (38,39). In the Northern Great Plains, atrazine and cyanazine at 0.56 to 1.12 kg/ha have effectively controlled Bromus spp. such as downy brome on native rangeland pastures (14,18). Wicks and Smika (52) reported in 1973 that numerous herbicides have been applied during the past 2 decades in an attempt to control all weeds and volunteer wheat for 5 to 14 months in winter wheat-fallow, winter wheat-sorghum (Sorghum bicolor (L.) Moench), corn (Zea mays L.) - fallow, and continuous winter wheat systems in Nebraska. However, the use of s-triazines for weed control in fallow systems does pose problems.

Fenster et al. (17) reported that atrazine applied at 2.24 kg/ha provided 100% downy brome control in Nebraska during an alternate winter wheat fallow period, but frequently injured the following wheat crop. Ghadiri et al. (23) reported in Nebraska that farmers who spray their wheat stubble after harvest with atrazine at 0.6 to 1.1 kg/ha cannot plant winter wheat until 12 months later. Furthermore, if more than 1.1 kg/ha of atrazine was applied they were committed to planting corn or sorghum because of possible crop injury if winter wheat was planted. Brinkman et al. (10) reported in 1980 that atrazine at 1.12, 2.24, 3.36, and 4.48 kg/ha applied postemergence in June of 1976 to corn in Wisconsin, could persist in the soil into the next growing season causing injury to spring oats (Avena sativa L.) planted in April of 1977.

Atrazine persistence is influenced by chemical and microbial degradation, both of which are influenced by moisture, light, and temperature. Talbert and Fletchall (48) postulated that microbial decomposition was the principle process involved in the dissipation of atrazine and simazine. However, Skipper et al. (43) reported that chemical hydrolysis of the s-triazines to their hydroxy analogs was the major pathway of degradation in soils, with microbial attack being of minor importance. Harris (24) reported that the initial hydrolysis of chlorine at the 2 position of the triazine ring occurred more readily than subsequent degradation steps. LeBaron (30) reported that chemical hydrolysis of atrazine to non-phytotoxic hydroxyatrazine was the predominant route of the detoxification of atrazine in soil. Skipper and Volk (44) reported in 1972 that degradation by soil microbes might be a function of qualitative, as well as quantitative differences in the microbial population. In the three Oregon soils investigated by these researchers, organic matter content and microbial population did not directly relate to atrazine degradation. Best and Weber (6) concluded that the pattern of atrazine degradation was characteristic of non-biological processes.

Atrazine and cyanazine are very closely related structurally. Cyanazine has a nitrile group where atrazine has an isopropyl-hydrogen. The addition of the nitrile group reduced vapor pressure from 3.0×10^{-7} to 1.6×10^{-9} mm Hg at 20 C, and increased water solubility from 33 to 171 ppm. More important are the changes which occur in the hydrolysis pattern because they affect the herbicidal properties (42).

Benyon et al. (7) reported that the phytotoxicity of cyanazine is reduced by sequential degradation of the nitrile group to the amide form by hydrolysis. They also reported that the ease of this conversion process separates cyanazine from many other _s_-triazines and is the basis for the rapid disappearance of herbicidal activity.

The degradation of atrazine produces 2 phytotoxic metabolites, deethylated atrazine and deisopropylated atrazine, while the degradation of cyanazine produces 1 phytotoxic metabolite, cyanazine amide (42). Of these three metabolites, deethylated atrazine is a potential herbicide, which might explain detected phytotoxicity in soils where analytical data indicated only low levels of parent atrazine. However, Benyon et al. (7) and Kaufman and Kearny (27) reported that the other 2 metabolites are less active than atrazine. According to Benyon et al. (7) the hydrolysis of cyanazine's nitrile group into carboxylic acid via amide is very fast. Sirons et al. (42) reported that this accelerated chemical conversion and the less phytotoxic metabolite produced by subsequent microbial degradation reduces the biological activity of cyanazine faster than that of atrazine. The resulting phytotoxicities of the cyanazine amide and acid are low and nil respectively.

Slack et al. (45) in 1973 investigated the persistence of s-triazine herbicides in Kentucky. Atrazine, simazine, and cyanazine were applied at rates of 0.0, 2.24, 4.48, and 6.72 kg/ha. Oat bioassays after 60 and 120 days indicated that simazine was the most persistent, atrazine was intermediately persistent, and cyanazine was the least persistent. Sixty days after application, oats planted in soil treated with 6.72 kg/ha of cyanazine grew normally.

Soil type also influences herbicide breakdown and is a major factor in governing how much herbicide residue is actually available. Burnside et al. (11) found atrazine carry over to be greater on coarse textured soils than on fine textured soils. Soils with the greatest to least carry over were sandy loams, silt loams, and silty clay loams.

Fenster et al. (17) obtained 100% control of downy brome with 2.24 kg/ha of atrazine during the fallow periods in western Nebraska, but determined that the rate of atrazine would have to be adjusted to soil type to avoid injury to the following wheat crop. In a silt loam, atrazine applied in April at 2.24 kg/ha did not injure wheat the following October. However, in a fine sandy loam, wheat injury occurred with 1.8 kg/ha. Severe wheat injury occurred in both soils with 3.6 kg/ha.

Smika and Sharman (46) in 1982 provided Colorado wheat producers with management guidelines to identify the soil factors most commonly associated with wheat stand reduction due to atrazine persistence in minimum tillage cropping systems. Standard correlation techniques were used to relate soil pH, total N, cation exchange capacity, organic matter content, and clay content to the associated wheat stand reductions. The correlation coefficients obtained for those factors were 0.70, 0.05, 0.62, 0.27, and 0.17 respectively. From these coefficients, soil pH and cation exchange capacity appeared to have the greatest affect on atrazine persistence. Since the correlation is positive for these factors, atrazine persistence increases with increasing soil pH and/or cation exchange capacity.

Since Slack et al. (45) reported that s-triazine herbicides were less persistent under no-tillage conditions than when the soil is tilled, chances of toxic residues remaining to injure subsequent crops of small grains, forage crops, or soybeans (Glycine max (L.) Merr.) should be less in a no-tillage situation. Burnside et al. (12) reported that in experiments at Lincoln and North Platte, Nebraska, oat yields indicated that soil persistence of normal use rates of atrazine to the subsequent year was only a minor residue problem under reduced tillage cropping systems. They also found that atrazine persistence was less of a problem under reduced tillage systems as compared to conventional tillage systems across Nebraska. Bauman and Ross (5) reported that gas liquid chromatograph analysis of soil core samples indicated that atrazine was less persistent under no-till than chisel or conventional plow tillage systems in the year of application. The residue in the no-till system initially prevented as much as 30% of the atrazine from reaching the soil surface. But, after 5 annual applications, atrazine residues were generally higher in the no-till system than in either the chisel or conventional tillage systems, but below levels considered to cause injury to rotational crops normally planted in Indiana. Therefore, tillage may influence the persistence of atrazine in soil by burying or diluting the residues (5). Kells et al. (28) reported that extractable atrazine decreased with time under both conventional and no-tillage, but the unextractable was higher under no-tillage. This indicates greater breakdown or adsorption of atrazine to soil organic matter under no-tillage.

Ferris et al.[1] investigated the effects of seeding depth on the tolerance of wheat to atrazine in a no-till cropping system in Tamworth, Australia. Atrazine was applied at 0.5 kg/ha on March 25, 1983. 'Kite' wheat was sown 4 or 8 cm deep in no-till plots on June 6, 1984. Atrazine reduced wheat establishment and increased the

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1. Ferris, I. G., W. L. Felton, and M. S. Bull. 1985. Unpublished Research Report. Critical atrazine levels for wheat in a no-tillage cropping system. Ed. Martin, R. J. and W. L. Felton. Dept. of Agric., Agric. Research Center, Tamworth, N.S.W. Australia. pp. 31-35.

percentage of seedlings showing symptoms of atrazine injury as determined by plant population density and ratings on August 11, 1983. Increased seeding depth did not reduce phytotoxicity levels. Residual atrazine was detected by high pressure liquid chromotography in the 0 to 5 and 5 to 15 cm soil layers from soil samples taken on August 12, 1983.

Wicks and Fenster (50) explored the possibility of using preplant atrazine applications to control downy brome in conventionally tilled wheat seeded with a deep furrow drill to remove the herbicide from the drill row. In their research, atrazine was applied at 1.1 and 2.2 kg/ha prior to planting winter wheat at Alliance and North Platte, Nebraska, in September, 1963. At North Platte, grain yields were 2286 and 1345 kg/ha after application of atrazine at 1.1 and 2.2 kg/ha respectively. Yield of the untreated check was 2623 kg/ha and yield of a hoed check was 2825 which indicates that both herbicide treatments reduced yield. However, atrazine at 1.1 and 2.2 kg/ha controlled downy brome 83 and 100% respectively. Grain yields from Alliance revealed no wheat injury from any rate of atrazine. Atrazine applied at 1.1 and 2.2 kg/ha provided 87 to 100% downy brome control. In further research, Wicks and Fenster (51) found that broadcasting diallate, triallate, diuron, and atrazine ahead of a deep furrow drill caused less crop injury than applying these herbicides preemergence, which indicates that the drill did move herbicide from the drill row. However, diuron reduced wheat yields at 1 of 5 locations in western Nebraska.

More recently Dowell et al. (16) reinvestigated the concept of placement selectivity by applying atrazine immediately prior to sowing wheat and removing the atrazine treated soil from the vicinity of the row with the drill openers in a no-till system. For purposes of this thesis, placement selectivity refers to placement of the herbicide relative to the placement of the seed in such a manner as to reduce injury to the wheat seedlings. The openers investigated were spear point openers spaced 25 cm apart, double disc openers spaced 25 cm apart, and a single 56 cm concave disc followed by paired spear point openers. They reported that preplant application of atrazine at 0.6 or 1.1 kg/ha reduced wheat stands only when wheat was seeded with the double disc opener. When atrazine was applied at 2.2 kg/ha, wheat seeded with the concave disc paired hoe opener developed a better stand than wheat seeded with the double disc and hoe openers. Also, when atrazine was applied at 3.4 kg/ha, less stand reduction occurred in wheat seeded with the concave disc paired hoe openers than in wheat seeded with the double disc openers. In his work, at the time of seeding, much of the cheat had emerged. By comparing yields obtained by seeding with the concave paired hoe opener with the hoe and double disc openers in the check, it was apparent that the tillage effects of seeding with the concave disc destroyed enough cheat to prevent yield reduction from cheat. With the concave disc opener, atrazine did not reduce wheat yield.

Dowell (16) also researched this approach in a second set of experiments with modified hoe-openers. The openers used were spear point openers, spear point openers modified with the addition of 5 cm wings, and spear point openers modified with 10 cm wings. He reported that wheat seeded with the 10 cm winged openers had significantly better stands than the spear point or 5 cm winged openers on a Teller sandy loam soil (56% sand, 26% silt, and 19% clay). Also, wheat seeded with the 5 cm winged openers and 10 cm winged openers had better wheat stands on a Port loam soil (32% sand, 42% silt, and 26% clay). Wheat stand counts/m of row and forage yields indicated that the best combination of drill components used in this experiment for removing atrazine treated soil was the 10 cm winged openers. In his work, he also reported that atrazine injury occurred at lower application rates in soils with a higher percentage of sand. He concluded that this approach had the potential for near or complete control of winter annual grasses in wheat, with minimal injury to the crop.

Therefore, the objectives of this research were to compare the efficacy of atrazine or cyanazine applied preplant broadcast for Bromus spp. control in no-till wheat, and to determine the optimum application rate for these 2 herbicides on 3 distinct types of Oklahoma soils. Since minimizing s-triazine contact with the wheat plant is essential for selectivity, atrazine and cyanazine were used in conjunction with drill openers designed to move the herbicide from the drill row for crop safety. The grain drills and openers used were a Tye[2] no-till drill with double disc openers and an experimental no-till drill. Three types of openers were mounted on the experimental drill. These

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2. Tye Company, Lockney, TX 79241.

included: standard John Deere[3] spear-point openers; standard John Deere spear-point openers modified by adding 5 cm wings to each side as described by Dowell (16); and John Deere 10 cm deep furrow shovel openers.

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3. Deere and Company, Moline, IL 61265.

CHAPTER III

METHODS AND MATERIALS

Three field experiments were established in 1985 to evaluate the effects of preplant broadcast applications of atrazine and cyanazine for *Bromus* spp. control in conjunction with different seeding methods for reducing the effect of the herbicides on no-till wheat. The locations were selected because they represented 3 distinct types of Oklahoma soils.

Preplant Atrazine and Cyanazine Applications for Cheat Control in No-till Wheat, Perkins

A field experiment was initiated on a Teller sandy loam (Udic Agriustoll) (Sa = 58%, Si = 27%, Cl = 16%, OM = 0.7%, pH of 5.9) at the Agronomy Research Station, Perkins, OK, to evaluate preplant applications of atrazine and cyanazine for cheat control in conjunction with different seeding methods to reduce wheat injury.

The experimental design was a split plot in strips with drill openers as the main plots and herbicide treatments as the subplots. Plot size was 2.4 m by 6.4 m. The experiment was replicated 4 times. All data was subjected to analysis of variance and drill opener type and herbicide treatment effects were compared using least significant differences at the 0.05 and/or 0.10 levels of significance.

To prepare an area for the experiment wheat stubble was maintained for seeding no-till wheat in the fall. Glyphosate + surfactant (Alkylaryl polyoxyethylene glycols) was broadcast on the area at 1.12 kg ai/ha + 1/2 % v/v on July 9, 1985, at which time a very sparse population of crabgrass (Digitaria sanguinulis (L.) Scop.); prickly lettuce (Lactuca serriola L.); cutleaf eveningprimrose (Oenothera laciniata Hill); and tumble pigweed (Amaranthus albus L.) were present. On September 6, 1985, glyphosate + 2,4-D at 0.425 kg ae/ha + 0.756 kg ae/ha were applied to control tumble pigweed (10/m^2 and 53 cm tall), prostrate spurge (Euphorbia humistrata Engelm. ex Gray) (10/m^2 with 30 cm stems), carpetweed (Mollugo verticillata L.) (10/m^2 with 38 cm stems), and volunteer wheat (485 to 538/m^2 and 15 cm tall). Carrier volume for both summer herbicide applications was 65 l/ha.

On September 13, 1985, 66 kg/ha of monoammonium phosphate (11-52-0) and 194 kg/ha of urea (46-0-0) were broadcast across the experimental area. On February 6, 1986, 84 kg/ha of ammonium nitrate (34-0-0) was broadcast across the experiment in accordance with soil test recommendations for a 56 kg/ha yield goal.

Preplant herbicide treatments on October 2, 1985, included atrazine and cyanazine at 0.56, 0.84, 1.12, and 2.24 kg ai/ha, and glyphosate at 1.12 kg ai/ha + 1/2 % v/v surfactant. The only postemergence treatment was ethyl-metribuzin applied at 1.12 kg ai/ha on November 7, 1985. All treatments were applied with a compressed nitrogen tractor sprayer. The boom had four 11005 nozzle tips on 50 cm spacing and the carrier volume was 280 l/ha. Spraying particulars, weed and crop sizes and densities are in Table II.

TABLE II

FIELD EXPERIMENT LOCATIONS, ENVIRONMENTAL CONDITIONS AND CROP AND WEED CONDITIONS AT THE TIME HERBICIDES WERE APPLIED (1985-1986)

Location:	Perkins		Lake Blackwell		Mangum	
Application stage:	Pre	Post	Pre	Post	Pre	Post
Date (1985):	Oct. 2	Nov. 7	Sept. 27,28	Nov. 7	Sept. 26	Oct. 31
Air temp (C):	20	21	20	16	20	18
Soil temp (C):	21	19	21	14	22	21
Soil moisture:	Good	Good	Dry	Good	Good	Good
Sun:	Bright	Bright	Bright	Bright	Bright	Bright
Wind (km/h):	0-6	6	0-8	5-8	0-3	0
Bromus spp. size:	2 to 5 cm tall	8 to 10 cm tall	2 to 5 cm tall	8 to 15 cm tall	---	5 to 8 cm tall
Bromus spp. density:	215 to 269/m^2	215 to 323/m^2	1614 to 2151/m^2	1614 to 2151/m^2	---	161 to 323/m^2
Wheat size:	2 to 5 cm tall	8 to 13 cm tall	---	10 to 13 cm tall	---	5 to 10 cm tall
Wheat growth stage:	----	2 to 3 tillers	---	2 to 4 tillers	---	1 tiller

The experiment was seeded with untreated TAM 105 wheat at 67.2 kg/ha with an operating speed of 6 km/hr immediately after application of the preplant herbicide treatments. The grain drills and openers used were a Tye no-till drill with double disc openers and an experimental hoe drill. The Tye double disc drill cut an approximate 1.3 cm wide slot in the soil and moved very little soil from the seed rows. The experimental drill designed by Dowell (16) used a 46 cm coulter for cutting straw and crop residues. Three types of hoe openers were mounted on the experimental drill. These included standard John Deere spear-point openers, which cleared a 2.5 cm wide furrow through the herbicide treated soil. The standard John Deere spear-point openers were modified by Dowell (16) who added wings to each side, which cleared a 5 cm wide furrow through the treated soil. The wings on these openers were positioned so that treated soil was separated from clean soil as soil flowed around the opener. The third opener, the John Deere 10 cm deep furrow openers, also cleared a 5 cm wide furrow through the treated soil. However, treated soil often fell back in the seed furrows with these openers. All openers mounted on the experimental drill were followed with 10 by 30 cm press wheels, which firmed the furrow walls. The row spacing was 25 cm on both drills. Although the 10 cm winged opener was the best opener in Dowell's research (16), preliminary investigations indicated that very poor trash clearance and occasional plugging was associated with these openers. Also, in hard ground penetration was a problem. Therefore, these openers were not evaluated in this research.

On March 20, 1986, malathion at 1.1 kg ai/ha was applied with a hydraulic pump tractor sprayer to control greenbugs (Schizaphis graminum (Rondani)). The boom had thirteen 11003 nozzle tips on 50 cm spacing and the carrier volume was 187 l/ha.

Cheat control and wheat injury were evaluated visually on October 22, December 12, March 7, and May 15, based on a rating scale of 0 to 100 where 100 = complete weed control or crop kill. Also, the number of wheat plants/m of row and cheat plants/m^2 were recorded on October 22, 1985.

A 1.5 m by 6.4 m area of each plot was harvested with a small plot combine on June 14, 1986. Dockage was determined by cleaning harvested grain with a small seed cleaner on June 16, 1986. Clean grain yield and test weight after cleaning were obtained. Grain moisture data was obtained by analyzing a sample of the grain with a portable moisture meter after the grain had been cleaned, 2 days after harvest.

Preplant Atrazine and Cyanazine Applications for Downy Brome Control in No-till Wheat, Lake Carl Blackwell

A second field experiment, with the same treatments as the first, was established on a Port loam (Cumulic Haplustoll) (Sa = 38%, Si = 41%, Cl = 22%, OM = 1.1%, pH of 5.8) at the Lake Carl Blackwell Research Area near Orlando, OK. The experimental design used, plot size, number of replications, and statistical analysis were as described for the experiment at Perkins.

The area selected was an old alfalfa (Medicago sativa L.) field with a dense infestation of downy brome. To prepare the site glyphosate + surfactant were applied at 4.48 kg ai/ha + 1/2 % v/v on July 7, 1985. At that time, the alfalfa population varied in density from about 915 to 969 stems/m^2 and the plants were about 61 cm tall. Very sparse populations of johnsongrass (Sorghum halepense (L.) Pers.) approximately 91 cm tall and prostate spurge were present. Since some alfalfa regrowth occurred, glyphosate + surfactant at 1.68 + 1/2 % v/v were applied on August 13, 1985. On August 1, 1985, the experimental area was fertilized with 112 kg/ha of urea, in accordance with soil test recommendations for a 56 kg/ha yield goal.

Preplant herbicide treatments were applied on September 27 and 28 in the same manner as at Perkins, and the postemergence treatment was applied on November 7, 1985. The plots were seeded on September 28, 1985, in the manner previously described.

Greenbugs were sprayed on March 20, 1986, in the manner previously described and on March 28, 1986, triadimefon + maneb + spreader-sticker (blend of alkyl aryl polyethoxylate and sodium salt of alkylsulfonated akylate) were applied at 0.14 + 1.8 kg/ha + 1/2 % v/v for leaf rust (Puccinia recondita f. sp. tritici) and powdery mildew (Erysiphe graminis f. sp. tritici) control. This treatment was applied with a CO_2 backpack sprayer. The boom had six 9501 nozzle tips on 50 cm nozzle spacing and the carrier volume was 187 l/ha.

Downy brome control and wheat injury were evaluated in the manner described at Perkins on October 17, December 9, March 10, and May 2. Also, the numbers of wheat plants/m of row and downy brome plants/m^2 were recorded on October 21, 1985. Henbit (Lamium amplexicaule L.) was found in the experiment in a population varying from about 54 to

$377/m^2$. Thus henbit control was recorded on January 3 and March 10, 1986. The plots were harvested and the grain was cleaned in the same manner as previously described.

Preplant Atrazine and Cyanazine Applications for
Rescuegrass Control in No-Till Wheat, Mangum

A third experiment was established on a Meno loamy sand (Arenic Haplustalf) (Sa = 84%, Si = 8%, Cl = 8%, OM = 0.4%, pH of 5.9) at the Sandyland Research Station Mangum, OK, with the same herbicide treatments and drill openers used at both other locations. However the dominant Bromus spp. was rescuegrass. Since there was more land available at this location, the experimental design was changed to a randomized complete block in a factorial arrangement with drill opener types and herbicide treatments as the factors. Plot size was 2.1 m by 7.6 m. The number of replications and statistical procedure were the same as previously mentioned.

On June 12, 1985, glyphosate was applied at 1.12 kg ai/ha for summer weed control on untilled wheat and rye stubble to control a sparse population of tumble pigweed. On September 5, 1985, 56 kg/ha of diammonium phosphate (18-46-0) and 56 kg/ha of muriate of potash (0-0-60) were broadcast across the experiment. On February 24, 1986, the experimental area was top dressed with 182 kg/ha of urea in accordance with soil test recommendations for a 56 kg/ha yield goal.

The preplant herbicide treatments were applied September 26 and the postemergence treatment was applied on October 31, 1985. When the preplant treatments were applied tumble pigweed about 51 to 61 cm tall was present in populations of about $1/m^2$. Seeding was completed in the same manner as in the previous experiments.

Rescuegrass control and wheat injury data were obtained on October 31, November 21, December 26, and March 14. Also, the numbers of wheat plants/m of row and rescuegrass plants/m^2 were recorded on October 31, 1985. Moderate infestations of cutleaf eveningprimrose, and a heavy infestation of hairy vetch (Vicia villosa Roth), and volunteer cultivated rye (Secale cereale L.) were also present at this site and were visually evaluated on March 14, 1985.

A 1.5 m by 7.6 m area from each plot was harvested on June 12, 1986, as previously described. The mixture of vetch, rye, rescuegrass, and wheat obtained from the plots was first separated with a small seed cleaner which removed straw, chaff, rescuegrass seed, and green weed material. Vetch content was determined by first separating much of the vetch seed from the rye and wheat with a spiral separator. Relative rye-wheat-vetch content was further clarified by counting the number of each type of seed in randomly selected 10 g samples. The percent by weight of wheat and rye was determined from these samples and was used to calculate the clean grain yields and dockage due to the various components.

CHAPTER IV

RESULTS AND DISCUSSION

Preplant Atrazine and Cyanazine Applications for Cheat Control in No-till Wheat, Perkins

Since cheat was present at the time of seeding, the stand counts (Table III) and the visual cheat control ratings (Table IV) in the plots with no herbicide, 20 days after treatment (DAT), are an excellent indicator of mechanical control. As such, they provide a good indication of the relative amount of soil disturbance by the various openers. The double disc openers disturbed little soil and controlled almost no cheat. The spear point and deep furrow openers controlled about half of the emerged cheat. Addition of wings to the spear point openers increased cheat control because some cheat was buried by soil thrown by the wings. In relatively heavy straw and residues there were clearance problems with the winged openers, but none of the other openers had clearance problems with the straw.

Since the field was relatively wet when planted, cheat was continuing to emerge. Therefore, complete cheat control was never recorded with the glyphosate treatment even though that treatment effectively killed the cheat present when it was applied. As with the mechanical control provided by the seeding operation, control with the

TABLE III

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON THE CHEAT POPULATION PRESENT 20 DAYS AFTER TREATMENT (PERKINS, OCTOBER 22, 1985)

			Cheat Plts/m²				
			Drill Opener Type[1] (Oct. 22)				
Treatment	Rate (kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	122	107	48	120	[99]
" "	0.84	" "	67	63	46	27	[51]
" "	1.12	" "	123	35	144	78	[95]
" "	2.24	" "	40	74	51	55	[55]
Cyanazine	0.56	" "	125	108	79	70	[95]
" "	0.84	" "	101	96	115	95	[102]
" "	1.12	" "	53	76	22	42	[48]
" "	2.24	" "	55	86	45	52	[60]
Glyphosate + S[2]	1.12 + 1/2	" "	130	134	26	65	[89]
Check	--	---	580	235	65	369	[312]
Mean			(140)	(101)	(64)	(97)	
L.S.D. 0.05[3]=				(38)	128	[107]	

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. value in [ ], is to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. value in ( ), is to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. value not in brackets or parentheses is an interaction L.S.D. to compare any drill opener type by herbicide treatment means.

TABLE IV

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON CHEAT CONTROL 20 AND 71 DAYS AFTER TREATMENT (PERKINS, OCTOBER 22 AND DECEMBER 12, 1985)

Treatment	Rate (kg ai/ha)	Stage	Cheat Control (%) Drill Opener Type[1] (Oct. 22) DoDi	SpPt	Wing	DFur	Mean	Drill Opener Type (Dec. 12) DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	55	50	81	69	[64]	89	69	82	86	[82]
" "	0.84	" "	75	84	94	82	[84]	97	95	92	87	[93]
" "	1.12	" "	66	82	81	85	[78]	97	97	92	94	[95]
" "	2.24	" "	94	87	95	85	[90]	100	100	99	99	[99]
Cyanazine	0.56	" "	54	67	72	76	[67]	71	67	79	81	[75]
" "	0.84	" "	72	79	85	81	[79]	87	86	86	85	[86]
" "	1.12	" "	84	81	91	84	[85]	97	85	89	82	[88]
" "	2.24	" "	77	82	95	86	[85]	99	96	94	94	[96]
Glyphosate + S[2]	1.12 + 1/2	" "	42	59	85	76	[66]	24	35	65	57	[45]
Ethyl-metribuzin	1.12	Post	--	--	--	--	--	5	27	44	21	[24]
Check	---	---	2	47	79	55	[46]	0	16	35	15	[17]
Mean			(62)	(72)	(86)	(78)		(70)	(70)	(78)	(73)	
L.S.D. 0.05[3] =					(11)	15	[14]			(NSD)	17	[14]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

preplant glyphosate treatments declined from October 22 to December 12, 1985.

At 20 DAT, cheat control attributable to atrazine and cyanazine was most obvious in plots seeded with the double disc opener, because of the low level of mechanical control in those plots. At that time, little difference could be seen between the control provided by the 2 herbicides. By December 12, cheat control from the atrazine and cyanazine treatments was higher than on October 22. In plots seeded with the double disc opener, cheat control with 0.56 kg/ha of atrazine was greater than control with 0.56 kg/ha of cyanazine.

The cheat control ratings on March 7, 156 DAT, revealed a steady decline in mechanical control obtained from the initial seeding operation (Table V). Likewise, control with the preplant glyphosate treatment continued to decline. Averaged over drill openers, little difference could be seen in control provided by the atrazine or cyanazine treatments. However, at the 0.10 level of significance, in plots seeded with the double disc opener, cheat control with 0.84 kg/ha of atrazine was greater than control with 0.84 kg/ha of cyanazine.

At 225 DAT, there were no interactions in the cheat control data. Averaged over drill opener types, control with 0.84, 1.12, and 2.24 kg/ha of atrazine was greater than control with respective rates of cyanazine. Averaged over herbicide treatments, cheat control was higher in plots seeded with the hoe-type openers than with the double disc opener.

Averaged over herbicide treatments, 20 DAT, significantly more wheat plants were established in plots seeded with the winged openers and deep furrow openers than with the double disc openers (Table VI).

TABLE V

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON CHEAT CONTROL 156 AND 225 DAYS AFTER TREATMENT (PERKINS, MARCH 7 AND MAY 15, 1986)

			Cheat Control (%)									
	Rate		Drill Opener Type[1] (March 7)					Drill Opener Type (May 15)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	65	69	74	87	[74]	45	54	52	84	[59]
" "	0.84	" "	97	100	96	99	[98]	86	98	90	92	[91]
" "	1.12	" "	97	100	99	99	[99]	95	100	91	99	[96]
" "	2.24	" "	100	100	100	100	[100]	100	100	99	100	[100]
Cyanazine	0.56	" "	56	62	89	88	[74]	25	56	59	72	[53]
" "	0.84	" "	65	91	92	90	[85]	30	74	64	84	[63]
" "	1.12	" "	91	89	92	97	[92]	52	62	75	81	[68]
" "	2.24	" "	97	98	96	96	[97]	52	84	87	77	[75]
Glyphosate + S[2]	1.12 + 1/2	" "	19	25	46	45	[34]	15	17	36	52	[30]
Ethyl-metribuzin	1.12	Post	21	67	84	67	[60]	50	71	84	69	[68]
Check	---	---	0	0	21	1	[5]	0	27	12	15	[14]
Mean			(64)	(73)	(81)	(79)		(50)	(68)	(68)	(75)	
L.S.D. 0.05[3] =					(NSD)	NSD	[21]			(10)	NSD	[20]
L.S.D. 0.10 =					(12)	19	--			--	NSD	--

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

TABLE VI

EFFECT OF DRILL OPENERS AND HERBICIDE TREATMENTS ON THE WHEAT STAND 20 DAYS AFTER TREATMENT (PERKINS, OCTOBER 22, 1985)

Treatment	Rate (kg ai/ha)	Stage	Wheat Plts/m of row — Drill Opener Type[1] (Oct. 22) DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	31	41	48	41	[40]
" "	0.84	" "	25	29	35	43	[33]
" "	1.12	" "	19	27	39	38	[31]
" "	2.24	" "	21	27	36	34	[29]
Cyanazine	0.56	" "	29	34	44	40	[37]
" "	0.84	" "	37	37	36	43	[38]
" "	1.12	" "	35	36	36	40	[37]
" "	2.24	" "	18	39	35	41	[33]
Glyphosate + S[2]	1.12 + 1/2	" "	30	39	40	52	[40]
Check	---	---	21	35	37	38	[33]
Mean			(26)	(35)	(39)	(41)	
L.S.D. 0.05[3]=				(10)	NSD		[NSD]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added 1/2 % v/v.
3. The L.S.D. value in [ ], is to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. value in ( ), is to compare drill opener type means averaged over herbicide treatments, which are also in ( ). There were no drill opener type by herbicide treatment interactions.

There were no herbicide treatment by drill opener interactions in the stand data, but it is noteworthy that within the plots with no herbicide treatment less wheat was present in the plots seeded with the double disc openers. At that time, averaged over drill openers, no herbicide treatments were reducing the stand of wheat.

Wheat injury ratings, 20 DAT, revealed major differences in injury between the various drill opener types (Table VII). Wheat injury due to atrazine was greater at higher rates with 3 of the 4 openers, but no significant injury was recorded on wheat seeded with the winged opener. Within each of the 3 higher atrazine rates, wheat injury was greater on wheat seeded with the spear point openers than with the winged openers and greater on wheat seeded with the double disc openers than with the spear point openers.

The response of wheat seeded with the double disc openers to atrazine was similar to its response to cyanazine. However, wheat seeded with the spear point and deep furrow openers was injured less by application of 2.24 kg/ha of cyanazine than by 2.24 kg/ha of atrazine.

The wheat injury ratings on December 12, 71 DAT, like the October 22 ratings, revealed major differences in wheat injury associated with the various drill opener types. Atrazine at 0.56 kg/ha killed 65% of the wheat seeded with the double disc openers, but no significant injury was recorded on wheat seeded with the hoe-type openers. In plots treated with atrazine at 0.84 and 1.12 kg/ha injury was greater on wheat seeded with the double disc openers than on wheat seeded with the spear point openers. Also, injury was greater on wheat seeded with spear point openers than with the winged openers or the deep furrow openers.

TABLE VII

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON WHEAT INJURY 20 AND 71 DAYS AFTER TREATMENT (PERKINS, OCTOBER 22 AND DECEMBER 12, 1985)

			Wheat Injury (%)									
	Rate		Drill Opener Type[1] (Oct. 22)					Drill Opener Type (Dec. 12)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	37	16	10	12	[19]	65	12	11	11	[25]
" "	0.84	" "	57	27	7	10	[26]	95	76	25	36	[58]
" "	1.12	" "	65	35	12	26	[35]	97	77	40	56	[68]
" "	2.24	" "	97	65	21	37	[55]	100	99	75	89	[91]
Cyanazine	0.56	" "	35	17	10	11	[18]	26	10	1	2	[10]
" "	0.84	" "	47	21	10	9	[22]	65	20	10	6	[25]
" "	1.12	" "	67	19	10	11	[27]	89	19	9	17	[34]
" "	2.24	" "	82	22	4	15	[31]	100	61	21	54	[59]
Glyphosate + S[2]	1.12 + 1/2	" "	21	19	6	11	[14]	2	2	0	0	[1]
Ethyl-metribuzin	1.12	Post	--	--	--	--	--	7	11	0	5	[6]
Check	--	---	25	17	9	12	[16]	0	0	0	0	[0]
Mean			(54)	(26)	(10)	(16)		(59)	(35)	(17)	(25)	
L.S.D. 0.05[3]=					(10)	19	[10]			(8)	19	[11]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

The injury on wheat seeded with the double disc openers was much higher in plots treated with the 2 lower rates of atrazine than in those treated with respective rates of cyanazine. Except at the lowest herbicide rates, wheat seeded with the hoe-type openers was injured much less by cyanazine than by equal rates of atrazine. Little wheat injury was noted on wheat seeded with the spear point and hoe openers from the cyanazine treatments up to 1.12 kg/ha. With the winged openers little injury was seen even when 2.24 kg/ha of cyanazine was applied.

At 156 DAT, injury on wheat seeded with the double disc openers and treated with atrazine at 0.56 kg/ha was more severe than recorded earlier (Table VIII). But, this treatment was still not significantly injuring wheat seeded with the hoe-type openers. Within the 0.84 kg/ha rate of atrazine, wheat injury was greater with the double disc openers than the spear point openers which was greater than the deep furrow openers which was greater than injury on wheat seeded with the winged openers. Within the 2 higher rates of atrazine, injury ratings on wheat seeded with any opener were almost exactly the same as they were on December 12. This was also true for wheat treated with the higher rates of cyanazine except that injury had increased in wheat seeded with the double disc openers.

In contrast to earlier wheat injury ratings, wheat injury ratings 225 DAT were very high in the untreated checks. This is more a reflection of wheat stand vigor reduction due to cheat interference than wheat injury. However, wheat stand vigor was better in plots seeded with the hoe-type openers than in plots seeded with the double

TABLE VIII

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON WHEAT INJURY 156 AND 225 DAYS AFTER TREATMENT (PERKINS, MARCH 7 AND MAY 15, 1986)

			Wheat Injury (%)									
	Rate		Drill Opener Type[1] (March 7)					Drill Opener Type (May 15)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	76	5	4	5	[22]	52	17	24	16	[27]
" "	0.84	" "	96	44	7	15	[41]	85	57	22	24	[47]
" "	1.12	" "	99	76	32	60	[67]	95	77	54	69	[74]
" "	2.24	" "	100	100	75	89	[91]	99	100	84	89	[93]
Cyanazine	0.56	" "	14	0	0	0	[3]	19	34	2	6	[15]
" "	0.84	" "	50	4	0	0	[13]	32	5	14	11	[16]
" "	1.12	" "	92	6	2	15	[29]	54	21	10	25	[27]
" "	2.24	" "	98	29	7	36	[43]	92	31	12	39	[44]
Glyphosate + S[2]	1.12 + 1/2	" "	4	0	0	0	[1]	50	26	9	9	[23]
Ethyl-metribuzin	1.12	Post	9	0	0	0	[2]	19	7	7	6	[10]
Check	--	---	2	2	0	0	[1]	81	54	36	41	[53]
Mean			(58)	(24)	(12)	(20)		(62)	(39)	(25)	(30)	
L.S.D. 0.05[3]=				(7)	18		[13]		(10)		23	[15]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

disc openers. This data agrees with the data on initial mechanical control.

Atrazine at 0.56 kg/ha killed 52% of the wheat seeded with the double disc openers, but much less injury was recorded on wheat seeded with the hoe-type openers. In plots treated with 0.84 kg/ha of atrazine, injury was greater on wheat seeded with the double disc than on wheat seeded with the spear point openers and wheat seeded with the winged and deep furrow openers had even less injury. In plots treated with 1.12 kg/ha of atrazine, wheat injury was greater in plots seeded with the double disc openers than in plots seeded with the winged and deep furrow openers.

Injury on wheat seeded with the double disc openers was higher in plots treated with atrazine at the 3 lower rates than in plots treated with respective rates of cyanazine. Except at the lowest herbicide rates, wheat seeded with the hoe-type openers was injured less by cyanazine than by atrazine at respective rates. At that time, injury on wheat seeded with the winged openers was lower in plots treated with cyanazine at the 2 higher rates than in plots treated with respective rates of atrazine.

The grain was very dry at harvest, thus no significant differences were found in the grain moisture data (Table IX). In the untreated check, and all herbicide treatments except the treatments with ethyl-metribuzin and the 2 lower rates of cyanazine the wheat seeded with double disc openers had lower test weights than wheat seeded with the winged and spear point openers. These 3 herbicide treatments were the only 3 with average wheat injury ratings of less than 20% on May 15.

TABLE IX

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON GRAIN MOISTURE AND TEST WEIGHT (PERKINS, JUNE 14, 1986)

			Moisture (%)					Test Wt. (kg/hl)				
	Rate		Drill Opener Type[1] (June 14)					Drill Opener Type (June 14)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	8.2	9.0	8.8	8.9	[8.7]	51.8	56.6	58.5	59.2	[56.5]
" "	0.84	" "	8.7	9.5	8.9	8.8	[9.0]	49.5	56.9	59.5	57.6	[56.8]
" "	1.12	" "	8.3	9.3	9.2	8.5	[8.9]	51.5	57.9	57.9	56.9	[59.4]
" "	2.24	" "	---	---	10.3	9.0	[9.5]	---	---	60.1	58.5	[59.4]
Cyanazine	0.56	" "	8.9	8.4	8.9	8.2	[8.6]	59.8	54.4	60.2	58.9	[58.3]
" "	0.84	" "	8.4	8.7	8.6	8.8	[8.6]	54.4	58.5	56.6	60.2	[57.4]
" "	1.12	" "	8.6	8.4	8.5	9.0	[8.6]	48.9	56.9	57.9	57.9	[55.4]
" "	2.24	" "	7.2	8.8	8.5	8.9	[8.6]	45.0	57.9	58.5	56.0	[55.7]
Glyphosate + S[2]	1.12 + 1/2	" "	8.1	8.0	8.3	8.9	[8.3]	54.0	58.5	59.2	60.6	[58.1]
Ethyl-metribuzin	1.12	Post	8.5	8.4	8.8	8.2	[8.5]	56.0	58.9	61.4	59.8	[59.0]
Check	--	---	7.6	8.3	8.5	8.4	[8.2]	50.5	55.7	56.6	53.4	[54.0]
Mean			(8.3)	(8.7)	(8.7)	(8.7)		(52.8)	(57.2)	(58.7)	(58.1)	
L.S.D. 0.05[3] =					(NSD)	NSD	[NSD]			(2.3)	3.9	[NSD]
L.S.D. 0.10 =					(NSD)	NSD	[NSD]			---	---	[2.6]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added 1/2% v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

When no herbicide was applied, dockage in wheat seeded with the winged or deep furrow openers was much lower than in wheat seeded with the double disc and spear point openers (Table X). All treatments of atrazine in combination with all openers reduced dockage substantially when compared to the untreated check. Even at the lowest rate, which provided 59% cheat control averaged across drill opener types, dockage was reduced from 37.1 to 10.3%. With the exception of wheat seeded with the double disc openers in plots treated with the high rate of cyanazine, all cyanazine treatments in combination with all other opener combinations reduced dockage when compared to the untreated check. In wheat seeded with the double disc openers, there was less dockage in plots treated with 1.12 kg/ha of atrazine than in plots treated with cyanazine at 1.12 kg/ha.

Wheat seeded with the double disc openers produced less yield than wheat seeded with the winged and deep furrow openers, both in the untreated check and averaged over all herbicide treatments. Also, in the untreated check, wheat seeded with the deep furrow openers produced higher yield than wheat seeded with the spear point openers.

Within the atrazine treatments the best yields were from plots treated with 0.56 kg/ha and seeded with any hoe-type opener, or from plots treated with 0.84 kg/ha and seeded with the winged or deep furrow openers. However, compared to the highest yielding treatments, the only atrazine treated plots without a yield reduction were those treated at 0.56 kg/ha and seeded with the deep furrow openers.

The yield of wheat seeded with double disc openers was less when treated with the 3 lower rates of atrazine than when treated with respective rates of cyanazine. Yields of wheat seeded with the winged

TABLE X

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON DOCKAGE AND GRAIN YIELD (PERKINS, JUNE 14, 1986)

			Seed Cleaner Dockage (%)[1]					Wheat Yield (kg/ha clean wheat)				
	Rate		Drill Opener Type[2] (June 14)					Drill Opener Type (June 14)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	16	11	9	4	[10]	570	964	1047	1240	[955]
" "	0.84	" "	2	4	3	3	[3]	127	503	1033	991	[664]
" "	1.12	" "	4	2	2	2	[2]	59	312	550	419	[335]
" "	2.24	" "	0	0	5	5	[3]	0	11	164	156	[83]
Cyanazine	0.56	" "	17	15	8	4	[11]	975	1095	1329	1471	[1218]
" "	0.84	" "	16	8	4	6	[8]	713	1229	1221	1313	[1119]
" "	1.12	" "	25	10	5	5	[11]	385	961	1122	1077	[886]
" "	2.24	" "	40	3	2	6	[13]	69	956	1121	830	[744]
Glyphosate + S[3]	1.12 + 1/2	" "	34	23	14	28	[25]	806	1145	1154	1061	[1042]
Ethyl-metribuzin	1.12	Post	16	6	7	8	[9]	957	1324	1282	1417	[1245]
Check	--	---	43	46	29	30	[37]	467	544	845	896	[688]
Mean			(19)	(12)	(9)	(9)		(466)	(822)	(988)	(988)	
L.S.D. 0.05[4]=					(5)	14	[9]			(209)	309	[227]

1. Seed cleaner dockage was composed of chaff, straw, cheat seed, and a little shriveled grain, that was removed by running the field sample through a clipper M2B seed cleaner.
2. Drill Opener Types: Dodi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Pointed Modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel)
3. S refers to Triton Ag-98 nonionic surfactant which was added 1/2 % v/v.
4. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

openers and treated with the 2 higher rates of atrazine, or seeded with the deep furrow or spear point openers and treated with the 3 higher rates of atrazine were lower than wheat yields from plots treated with respective rates of cyanazine.

The preplant application of glyphosate increased the yield of wheat except when seeded with the deep furrow openers. The lack of yield increase on the wheat seeded with deep furrow openers was due to the higher yield of the untreated plots seeded with these openers. The postemergence treatment with 1.12 kg/ha of ethyl-metribuzin increased yield to all plots to which it was applied.

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Because downy brome was present at the time of seeding, the stand counts 24 DAT (Table XI) and the visual downy brome control ratings 20 DAT in the plots with no herbicide (Table XII), are excellent indicators of the mechanical control provided by the various openers. As such, trends in mechanical control provided by the openers were similar to that in the experiment at Perkins. In the untreated check the double disc openers disturbed little soil and controlled almost no downy brome. However, the hoe-type openers controlled over 60% of the emerged downy brome.

Preplant application of 1.12 kg/ha of glyphosate had controlled about 80% of the emerged downy brome by 24 DAT. However, the initial mechanical control provided by the openers from the seeding operation in the untreated check and the control provided by the application of glyphosate declined from October 17 to December 9.

TABLE XI

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON THE DOWNY BROME POPULATION PRESENT 24 DAYS AFTER TREATMENT (LAKE CARL BLACKWELL, OCTOBER 21, 1985)

Treatment	Rate (kg ai/ha)	Stage	Downy Brome Plts/m[2] Drill Opener Type[1] (Oct. 21) DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	1	15	3	9	[7]
" "	0.84	" "	15	8	3	9	[9]
" "	1.12	" "	29	24	0	2	[14]
" "	2.24	" "	2	2	0	1	[1]
Cyanazine	0.56	" "	56	17	22	18	[28]
" "	0.84	" "	16	45	14	25	[25]
" "	1.12	" "	21	2	5	11	[10]
" "	2.24	" "	20	10	3	14	[12]
Glyphosate + S[2]	1.12 + 1/2	" "	77	80	86	63	[76]
Check	---	---	445	102	72	167	[197]
Mean			(68)	(30)	(21)	(32)	
L.S.D. 0.05[3] =					(NSD)	101	[60]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. value in [ ], is to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. value in ( ), is to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. value not in brackets or parentheses is an interaction L.S.D. to compare any drill opener type by herbicide treatment means.

TABLE XII

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON DOWNY BROME CONTROL 20 AND 73 DAYS AFTER TREATMENT (LAKE CARL BLACKWELL, OCTOBER 17 AND DECEMBER 9, 1985)

			Downy Brome Control (%)									
	Rate		Drill Opener Type[1] (Oct. 17)					Drill Opener Type (Dec. 9)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	82	77	94	86	[85]	92	90	92	91	[91]
" "	0.84	" "	77	84	94	94	[87]	100	92	97	99	[97]
" "	1.12	" "	84	86	96	95	[90]	100	100	95	100	[99]
" "	2.24	" "	92	95	94	91	[93]	100	100	99	100	[100]
Cyanazine	0.56	" "	51	82	92	94	[80]	45	65	80	79	[67]
" "	0.84	" "	76	89	94	96	[89]	77	85	84	90	[84]
" "	1.12	" "	79	91	95	96	[90]	86	90	91	92	[90]
" "	2.24	" "	90	95	99	98	[95]	97	97	96	96	[97]
Glyphosate + S[2]	1.12 + 1/2	Preplant	84	80	87	69	[80]	22	22	29	32	[27]
Ethyl-metribuzin	1.12	Post	--	--	--	--	--	0	22	32	27	[21]
Check	---	---	6	45	65	61	[44]	0	12	24	12	[12]
Mean			(72)	(82)	(91)	(88)		(65)	(71)	(74)	(74)	
L.S.D. 0.05[3] =					(10)	15	[8]			(NSD)	NSD	[11]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

At 20 DAT, visual downy brome control provided by atrazine and cyanazine was most obvious in plots seeded with the double disc openers because of the low level of mechanical control in those plots. At that time, control with the 3 higher rates was similar, but at 0.56 kg/ha, control with atrazine was better than control with cyanazine.

By December 9, 73 DAT, averaged over drill opener types, downy brome control with 0.56 and 0.84 kg/ha of atrazine was greater than with respective rates of cyanazine. Also, all treatments of atrazine and cyanazine were providing greater control than the glyphosate treatment. The postemergence ethyl-metribuzin treatment had not controlled any downy brome by December 9, even though it had been applied on November 7. Substantial rainfall occurred on November 15 which should have activated the herbicide. However, the weather pattern was very cold the month following application, with only 3 nights with above freezing temperatures. Such conditions are not conducive to rapid uptake of photosynthetic inhibitor herbicides. Through March 10, 164 DAT, control with the preplant treatment of glyphosate continued to decline (Table XIII). As in December, in plots seeded with the double disc and spear point openers, 0.56 kg/ha of atrazine was controlling more downy brome than 0.56 kg/ha of cyanazine.

At 217 DAT, there were no interactions in the downy brome control data. Averaged over drill opener types, control with 0.56, 0.84, and 1.12 kg/ha of atrazine was greater than control with respective rates of cyanazine.

Since henbit emerged after seeding, no henbit control was obtained from the preplant glyphosate treatment (Table XIV). Averaged over drill opener types all other herbicide treatments provided excellent

TABLE XIII

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON DOWNY BROME CONTROL 164 AND 217 DAYS AFTER TREATMENT (LAKE CARL BLACKWELL, MARCH 10 AND MAY 2, 1986)

			Downy Brome Control (%)									
	Rate		Drill Opener Type[1] (March 10)					Drill Opener Type (May 2)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	96	90	97	97	[95]	93	68	94	91	[87]
" "	0.84	" "	98	100	100	99	[99]	100	100	99	99	[99]
" "	1.12	" "	100	100	99	100	[100]	100	100	99	100	[100]
" "	2.24	" "	100	100	100	100	[100]	100	100	99	100	[100]
Cyanazine	0.56	" "	46	61	86	81	[69]	35	37	55	55	[46]
" "	0.84	" "	80	85	94	89	[87]	57	57	67	65	[62]
" "	1.12	" "	85	86	96	96	[91]	85	82	71	69	[77]
" "	2.24	" "	96	95	99	97	[97]	92	92	95	90	[92]
Glyphosate + S[2]	1.12 + 1/2	" "	7	0	7	12	[7]	2	12	5	29	[12]
Ethyl-metribuzin	1.12	Post	5	32	7	37	[33]	20	39	52	58	[42]
Check	---	---	0	16	12	0	[7]	0	5	2	5	[3]
Mean			(65)	(70)	(77)	(74)		(62)	(63)	(67)	(69)	
L.S.D. 0.05[3] =				(NSD)		18	[13]			(NSD)	NSD	[20]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

TABLE XIV

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON HENBIT CONTROL 67 AND 164 DAYS AFTER TREATMENT (LAKE CARL BLACKWELL, JANUARY 3 AND MARCH 10, 1986)

			Henbit Control (%)									
	Rate		Drill Opener Type[1] (Jan. 3)					Drill Opener Type (March 10)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	99	97	96	99	[98]	100	94	97	100	[98]
" "	0.84	" "	100	100	100	100	[100]	100	100	100	100	[100]
" "	1.12	" "	100	100	100	100	[100]	100	100	100	100	[100]
" "	2.24	" "	100	100	100	100	[100]	100	100	100	100	[100]
Cyanazine	0.56	" "	95	84	92	91	[91]	96	84	91	85	[89]
" "	0.84	" "	98	96	96	96	[97]	100	89	94	94	[84]
" "	1.12	" "	99	98	98	98	[98]	99	96	99	99	[98]
" "	2.24	" "	100	99	100	100	[100]	100	99	99	100	[99]
Glyphosate + S[2]	1.12 + 1/2	" "	0	0	0	0	[0]	0	0	0	0	[0]
Ethyl-metribuzin	1.12	Post	98	99	98	98	[98]	75	75	75	75	[75]
Check	---	---	0	0	0	0	[0]	0	0	0	0	[0]
Mean			(81)	(79)	(80)	(80)		(79)	(76)	(78)	(78)	
L.S.D. 0.05[3] =					(NSD)	NSD	[4]			(NSD)	NSD	[22]
L.S.D. 0.10 =					(NSD)	NSD	--			(NSD)	4	--

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

control of henbit. However, henbit control with 0.56 kg/ha of atrazine was greater than control with cyanazine at 0.56 kg/ha.

The henbit control ratings on March 10, 164 DAT, revealed a decline in control obtained with the ethyl-metribuzin treatment. This indicates that the ethyl-metribuzin treatment killed the henbit leaves but not the entire plant. Averaged over drill opener types, all atrazine and cyanazine treatments provided greater control than ethyl-metribuzin. However, within the 0.56 kg/ha of atrazine, at the 0.10 level of significance, henbit control in plots seeded with the deep furrow and double disc openers was greater than control in plots seeded with the spear point openers.

Within plots treated with 0.56 kg/ha of cyanazine, henbit control in plots seeded with the double disc openers was slightly higher than in plots seeded with the winged openers. Also control was lower in plots seeded with the deep furrow and spear point openers. Differences in henbit control were also observed in plots treated with 0.84 kg/ha of cyanazine.

Averaged over drill opener types, 24 DAT, significantly more wheat plants were established in plots treated with 1.12 and 2.24 kg/ha of cyanazine than with respective rates of atrazine (Table XV). Also, at that time, averaged over herbicide treatments, no significant differences in wheat stands were found among drill opener types.

Wheat injury ratings, 20 DAT, in the plots without herbicide are stand vigor ratings. Thus, wheat injury ratings in the herbicide treated plots need to be compared to the herbicide check or the glyphosate treatment (Table XVI). At the 10% level of significance, compared to the preplant glyphosate treatment, the 3 higher rates of

TABLE XV

EFFECT OF DRILL OPENERS AND HERBICIDE TREATMENTS ON THE WHEAT STAND 24 DAYS AFTER TREATMENT (LAKE CARL BLACKWELL, OCTOBER 21, 1985)

Treatment	Rate (kg ai/ha)	Stage	Wheat Plts/m of row, Drill Opener Type[1] (Oct. 21)				
			DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	24	27	37	29	[29]
" "	0.84	" "	21	34	35	27	[29]
" "	1.12	" "	24	23	37	19	[26]
" "	2.24	" "	9	25	30	11	[19]
Cyanazine	0.56	" "	31	31	34	35	[33]
" "	0.84	" "	35	27	39	35	[34]
" "	1.12	" "	44	34	37	32	[37]
" "	2.24	" "	28	33	42	28	[33]
Glyphosate + S[2]	1.12 + 1/2	" "	25	28	37	24	[27]
Check	---	---	28	29	36	27	[30]
Mean			(27)	(29)	(36)	(27)	
L.S.D. 0.05[3] =					(NSD)	NSD	[8]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. value in [ ], is to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. value in ( ), is to compare drill opener type means averaged over herbicide treatments, which are also in ( ). There were no drill opener type by herbicide treatment interactions.

TABLE XVI

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON WHEAT INJURY 20 AND 73 DAYS AFTER TREATMENT (LAKE CARL BLACKWELL, OCTOBER 17 AND DECEMBER 9, 1985)

			Wheat Injury (%)									
	Rate		Drill Opener Type[1] (Oct. 17)					Drill Opener Type (Dec. 9)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	31	37	12	20	[25]	64	64	34	44	[51]
" "	0.84	" "	57	27	11	9	[26]	96	72	25	66	[65]
" "	1.12	" "	50	37	20	21	[32]	99	87	45	85	[79]
" "	2.24	" "	75	40	15	4	[42]	100	96	74	97	[92]
Cyanazine	0.56	" "	32	25	11	7	[19]	30	31	12	20	[23]
" "	0.84	" "	22	36	12	5	[19]	25	40	10	9	[21]
" "	1.12	" "	30	39	14	6	[22]	36	40	9	20	[26]
" "	2.24	" "	47	44	6	4	[25]	62	44	6	22	[34]
Glyphosate + S[2]	1.12 + 1/2	" "	17	21	6	4	[12]	24	20	9	12	[16]
Ethyl-metribuzin	1.12	Post	--	--	--	--	--	26	29	9	14	[19]
Check	---	---	35	29	11	11	[22]	17	10	11	5	[11]
Mean			(40)	(34)	(13)	(15)		(53)	(48)	(22)	(36)	
L.S.D. 0.05[3] =				(NSD)		NSD	[14]			(NSD)	NSD	[16]
L.S.D. 0.10 =				(19)		19	--			(NSD)	NSD	--

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

atrazine and only the highest rate of cyanazine were injuring the wheat seeded with the double disc openers. The safening effect of the openers is clearly evident on wheat treated preplant with atrazine at 2.24 kg/ha. Wheat injury was lower in plots seeded with the deep furrow and winged openers than in plots seeded with the spear point openers. Injury was the highest on wheat seeded with double disc openers. The effects of the openers was also obvious with other treatments. Wheat seeded with the double disc openers was injured less by cyanazine at the 3 higher rates than by respective rates of atrazine. The wheat injury ratings on December 9, 73 DAT, averaged over openers, revealed major differences in wheat injury due to the various herbicide treatments. Wheat injury was greater with all rates of atrazine than respective rates of cyanazine. The difference in crop tolerance to cyanazine and atrazine was substantial. The lowest rate of atrazine caused more crop injury than the highest rate of cyanazine.

At 164 DAT, injury on wheat seeded with all combinations of openers and treated with all rates of atrazine was worse than recorded earlier (Table XVII). But differences in injury, due to different openers were still obvious. Within the 3 lower atrazine rates, injury to wheat seeded with 3 of the openers was greater than injury on wheat seeded with the winged openers. In contrast to the atrazine treatments, injury did not increase on wheat treated with cyanazine.

In contrast to all other wheat injury ratings, wheat injury 217 DAT was very high in the untreated checks. This is in agreement with data collected in the experiment at Perkins and is more of a reflection of wheat stand vigor reduction due to downy brome interference than wheat injury. Wheat injury with the 3 higher rates of cyanazine was

TABLE XVII

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON WHEAT INJURY 164 AND 217 DAYS AFTER TREATMENT (LAKE CARL BLACKWELL, MARCH 10 AND MAY 2, 1986)

			Wheat Injury (%)									
	Rate		Drill Opener Type[1] (March 10)					Drill Opener Type (May 2)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	61	52	26	35	[44]	55	60	34	42	[48]
" "	0.84	" "	94	70	19	64	[62]	92	86	30	65	[68]
" "	1.12	" "	96	79	37	84	[74]	97	82	44	84	[77]
" "	2.24	" "	100	94	72	95	[90]	100	94	74	96	[91]
Cyanazine	0.56	" "	24	22	4	15	[16]	64	64	35	55	[54]
" "	0.84	" "	2	29	6	4	[10]	30	49	25	27	[33]
" "	1.12	" "	10	26	1	1	[10]	29	45	22	26	[31]
" "	2.24	" "	35	24	0	6	[16]	50	42	7	29	[32]
Glyphosate + S[2]	1.12 + 1/2	" "	0	20	0	0	[5]	46	66	60	60	[58]
Ethyl-metribuzin	1.12	Post	2	20	1	4	[7]	66	69	40	47	[56]
Check	---	---	6	0	15	10	[8]	85	86	77	79	[82]
Mean			(39)	(40)	(16)	(29)		(65)	(68)	(41)	(56)	
L.S.D. 0.05[3]=					(NSD)	27	[15]			(19)	NSD	[14]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

less than injury with atrazine at respective rates. In regard to drill openers, wheat injury was less on wheat seeded with the winged openers than injury on wheat seeded with the double disc and spear point openers.

At harvest, averaged over drill openers, wheat grain yield in the untreated check was 48% lower than in plots treated with 1.12 kg/ha of glyphosate (Table XVIII). Also, none of the treatments had a higher yield than the glyphosate treatment. This indicates that the initial 80% reduction in downy brome from applying glyphosate preplant reduced or eliminated competition long enough to avoid yield reduction.

Interestingly, the late season control ratings were higher for ethyl-metribuzin than for glyphosate, but the wheat produced higher yield in the glyphosate treatment. This indicates that very early control is more important in avoiding yield loss than control later in the season.

Averaged over drill openers, wheat yield from plots treated with the low rate of atrazine and any rate of cyanazine were higher than those in the untreated check. However, as atrazine rates increased, grain yields decreased. The highest yield between atrazine treatments was with the lowest rate, but that treatment had lower grain yield than treatments with 0.84 or 1.12 kg/ha of cyanazine.

There were no differences in yield between the cyanazine treatments. Also, the yields from the cyanazine treatments were similar to the yield of plots treated preplant with glyphosate. The postemergence ethyl-metribuzin treatment did not provide good downy brome control, so it did not increase yields as much as some cyanazine treatments.

TABLE XVIII

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON GRAIN YIELD AND DOCKAGE (LAKE CARL BLACKWELL, JUNE 9, 1986)

			Wheat Yield (kg/ha clean wheat)					Seed Cleaner Dockage (%)				
			Drill Opener Type[1] (June 9)					Drill Opener Type (June 9)				
Treatment	Rate (kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	582	691	816	599	[672]	14	26	8	14	[15]
" "	0.84	" "	116	237	768	325	[361]	10	9	7	13	[10]
" "	1.12	" "	119	393	564	170	[312]	14	8	12	15	[12]
" "	2.24	" "	0	56	374	18	[112]	0	10	7	7	[6]
Cyanazine	0.56	" "	700	578	975	703	[739]	31	33	15	29	[27]
" "	0.84	" "	1027	634	772	817	[812]	16	27	12	16	[18]
" "	1.12	" "	957	766	929	877	[882]	16	15	8	10	[12]
" "	2.24	" "	521	906	743	606	[694]	15	9	7	10	[10]
Glyphosate + S[2]	1.12 + 1/2	" "	832	819	768	738	[789]	31	25	28	30	[29]
Ethyl-metribuzin	1.12	Post	460	468	698	638	[566]	35	29	12	17	[23]
Check	---	---	380	354	476	435	[411]	44	43	48	41	[44]
Mean			(518)	(537)	(717)	(539)		(21)	(21)	(15)	(18)	
L.S.D. 0.05[3] =					(NSD)	NSD	[129]			(NSD)	NSD	[10]
L.S.D. 0.10 =					(NSD)	257	---			(NSD)	NSD	---

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

Averaged over herbicides, there were no differences in grain yield due to drill opener types at the 0.05 or 0.10 levels of significance. However, there was a drill opener by herbicide treatment interaction at the 0.10 level of significance. Drill openers had a major effect on the wheat yield within the atrazine treatments. With all 4 rates of atrazine, wheat seeded with the winged openers produced higher yields than wheat seeded with any other opener. This indicates that the addition of wings to the openers had a safening effect by removing herbicide treated soil from the seed row and thus reducing injury to the wheat.

As was the case with atrazine, plots treated with the low rate of cyanazine and seeded with the winged openers had a higher yield than plots seeded with any other opener. The yield of wheat seeded with the double disc, spear point, or deep furrow openers was less in plots treated with the 3 higher rates of atrazine than in plots treated with respective rates of cyanazine. Also, the yield of wheat seeded with the winged openers was lower in plots treated with the 2 lower rates of atrazine than in plots treated with respective rates of cyanazine.

There were significant herbicide treatment effects, averaged over drill openers in the dockage data, but no opener effects or interactions. All herbicide treatments reduced dockage. However, dockage varied greatly between the herbicide treatments, due to variation in downy brome control. Considering both yield and dockage, 2 treatments appeared better than others. These were cyanazine at 0.84 and 1.12 kg/ha.

The experiment was harvested as early as the grain would thrash, in order to detect any treatment affect on grain maturity (Table XIX).

TABLE XIX

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON GRAIN MOISTURE AND TEST WEIGHT
(LAKE CARL BLACKWELL, JUNE 9, 1986)

			Moisture (%)					Test Wt. (kg/hl)				
	Rate		Drill Opener Type[1] (June 9)					Drill Opener Type (June 9)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	19.8	20.0	18.7	19.0	[19.4]	55.7	54.5	57.5	51.8	[54.7]
" "	0.84	" "	19.2	19.3	19.4	18.1	[19.0]	52.8	53.1	55.7	51.5	[53.3]
" "	1.12	" "	18.6	19.5	18.9	19.5	[19.2]	58.3	55.0	54.7	53.1	[55.1]
" "	2.24	" "	0.0	18.7	18.5	19.2	[18.8]	0.0	54.9	54.0	48.9	[53.1]
Cyanazine	0.56	" "	19.0	19.1	19.3	20.0	[19.4]	59.8	58.9	57.6	55.7	[58.0]
" "	0.84	" "	19.2	20.6	19.4	19.7	[19.7]	60.5	56.3	56.6	54.7	[57.0]
" "	1.12	" "	20.4	19.5	19.3	19.1	[19.6]	58.7	58.9	58.5	57.3	[58.3]
" "	2.24	" "	20.7	18.9	19.0	19.2	[19.5]	53.4	57.6	56.0	54.7	[55.4]
Glyphosate + S[2]	1.12 + 1/2	" "	18.3	17.7	18.3	19.3	[18.4]	57.3	60.2	57.6	56.6	[57.9]
Ethyl-metribuzin	1.12	Post	19.3	18.5	20.4	18.3	[19.1]	60.0	58.9	56.9	58.1	[58.5]
Check	---	---	18.2	18.2	18.5	18.9	[18.4]	60.2	60.5	56.9	58.9	[59.1]
Mean			(19.3)	(19.1)	(19.1)	(19.1)		(57.8)	(57.2)	(56.6)	(54.9)	
L.S.D. 0.05[3] =				(NSD)	NSD		[NSD]		(NSD)	NSD		[2.3]
L.S.D. 0.10 =				(NSD)	1.2		[NSD]		(NSD)	NSD		---

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

In the untreated check, no differences were found in grain moisture between plots seeded with the various openers at the 0.10 level of significance. However, slight herbicide induced increases in grain moisture were found in plots treated with 0.56 kg/ha of atrazine and seeded with the double disc and spear point openers. The delays in maturity correspond to higher wheat injury ratings recorded on May 2. Within the low rate of atrazine, the grain moisture was higher in plots seeded with the spear point openers than in plots seeded with the winged openers.

Within the 2 higher rates of cyanazine, grain moisture was higher in plots seeded with the double disc openers than in plots seeded with the hoe-type openers. In plots seeded with the spear point and deep furrow openers, grain moisture was higher in plots treated with 0.84 kg/ha of cyanazine than in those treated with 0.84 kg/ha of atrazine. Also, in plots seeded with the double disc openers, grain moisture was higher in plots treated with 1.12 kg/ha of cyanazine than in plots treated with 1.12 kg/ha of atrazine. However, because of the large differences in yield between these treatments, differences in grain moisture may not be important.

Averaged over drill openers, test weights were lower in plots treated with all 4 rates of atrazine or the high rate of cyanazine than those in the untreated check. Also, test weights were lower in plots with these treatments than in plots treated with glyphosate or ethyl-metribuzin. No significant differences in test weights were found when herbicide treatments were averaged over drill openers.

Preplant Atrazine and Cyanazine Applications for Rescuegrass Control in No-Till Wheat, Mangum

In contrast to the experiments at Perkins and Lake Carl Blackwell where the Bromus spp. were emerged before seeding, rescuegrass was not present at the time of seeding at Mangum. Therefore, the rescuegrass stand counts (Table XX) and visual control ratings (Table XXI) 36 DAT are more an indication of chemical control than mechanical control by the various openers. Compared to Bromus densities at the other sites, the population at this site was much lower. No interactions between drill openers and herbicide treatments were observed. Averaged over drill openers, 38% control was recorded with the preplant application of glyphosate. However, the stand count data revealed that glyphosate had not reduced the rescuegrass population.

At this early date the highest rate of atrazine was the only treatment that significantly reduced the rescuegrass population compared to the check. However, averaged over drill openers, all atrazine treatments provided greater visual rescuegrass control than respective rates of cyanazine.

On November 21, 57 DAT, visual ratings of rescuegrass control with atrazine were similar to control ratings on October 31. However, rescuegrass control ratings 57 DAT were slightly lower in plots treated with 3 of the 4 rates of cyanazine. At that time, averaged over herbicide treatments, only minor differences in control were observed between the various drill openers.

The rescuegrass control ratings on December 26, 92 DAT, revealed excellent rescuegrass control in plots treated postemergence with 1.12

TABLE XX

EFFECT OF DRILL OPENERS AND HERBICIDE TREATMENTS ON THE RESCUEGRASS POPULATION PRESENT 36 DAYS AFTER TREATMENT (MANGUM, OCTOBER 31, 1985)

Treatment	Rate (kg ai/ha)	Stage	Rescuegrass Plts/m² Drill Opener Type[1] (Oct. 31) DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	20	29	33	13	[24]
" "	0.84	" "	29	10	26	33	[25]
" "	1.12	" "	6	25	4	14	[12]
" "	2.24	" "	1	2	13	7	[6]
Cyanazine	0.56	" "	40	46	10	28	[31]
" "	0.84	" "	77	35	24	19	[39]
" "	1.12	" "	19	35	19	21	[23]
" "	2.24	" "	20	15	21	28	[21]
Glyphosate + S[2]	1.12 + 1/2	" "	32	28	56	14	[32]
Check	---	---	39	21	18	27	[26]
Mean			(28)	(25)	(22)	(20)	
L.S.D. 0.05[3]=				(NSD)		NSD	[19]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. value in [ ], is to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. value in ( ), is to compare drill opener type means averaged over herbicide treatments, which are also in ( ). There were no drill opener type by herbicide treatment interactions.

TABLE XXI

EFFECT OF DRILL OPENERS AND HERBICIDE TREATMENTS ON RESCUEGRASS CONTROL 36 AND 57 DAYS AFTER TREATMENT (MANGUM, OCTOBER 31 AND NOVEMBER 21, 1985)

Treatment	Rate (kg ai/ha)	Stage	Rescuegrass Control (%) — Drill Opener Type[1] (Oct. 31) DoDi	SpPt	Wing	DFur	Mean	Drill Opener Type (Nov. 21) DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	61	56	79	57	[63]	65	59	67	45	[59]
" "	0.84	" "	70	82	90	62	[76]	77	76	85	59	[74]
" "	1.12	" "	96	85	86	96	[91]	96	94	94	96	[95]
" "	2.24	" "	100	95	97	100	[98]	100	99	97	97	[98]
Cyanazine	0.56	" "	36	40	49	47	[43]	22	21	45	37	[32]
" "	0.84	" "	51	22	37	36	[37]	29	37	45	29	[35]
" "	1.12	" "	52	57	72	69	[63]	49	39	47	52	[47]
" "	2.24	" "	90	69	85	60	[76]	64	59	65	56	[61]
Glyphosate + S[2]	1.12 + 1.2	" "	39	41	30	42	[38]	35	12	24	22	[23]
Ethyl-metribuzin	1.12	Post	--	--	--	--	--	75	46	49	40	[52]
Check	---	---	4	2	4	14	[6]	12	0	24	12	[12]
Mean			(60)	(55)	(63)	(58)		(57)	(49)	(58)	(50)	
L.S.D. 0.05[3] =					(NSD)	NSD	[17]			(6)	NSD	[11]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). There were no drill opener type by herbicide treatment interactions.

kg/ha of ethyl-metribuzin (Table XXII). But, control from this treatment was not greater than control provided from the 3 higher rates of atrazine.

Averaged over drill openers, rescuegrass control was significantly higher in plots treated with the 3 higher rates of atrazine than in plots treated with respective rates of cyanazine. Also, averaged over herbicide treatments, rescuegrass control was higher in plots seeded with the winged openers than in plots seeded with the double disc and spear point openers.

The rescuegrass control ratings on March 14, 170 DAT, followed the trends of earlier ratings, in that very little control was recorded in plots treated with cyanazine. At that time, averaged over drill openers, rescuegrass control with ethyl-metribuzin or atrazine were similar to that recorded on December 26.

Averaged over herbicide treatments, at the 0.10 level of significance, rescuegrass control attributable to the various drill openers was greater in plots seeded with the winged openers than in plots seeded with any other opener. At 170 DAT, in plots treated with 0.56 kg/ha of atrazine, rescuegrass control was greater in plots seeded with the winged openers than in plots seeded with the double disc and deep furrow openers. Also, rescuegrass control was greater in plots seeded with all combinations of openers and treated with any rate of atrazine than control provided by respective rates of cyanazine.

Since cutleaf eveningprimrose emerged in the early spring, no control was obtained from the preplant glyphosate treatment (Table XXIII). Excellent control of cutleaf eveningprimrose was provided by the postemergence ethyl-metribuzin treatment. Cutleaf eveningprimrose

TABLE XXII

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON RESCUEGRASS CONTROL 92 AND 170 DAYS AFTER TREATMENT (MANGUM, DECEMBER 26, 1985 AND MARCH 14, 1986)

			Rescuegrass Control (%)									
	Rate		Drill Opener Type[1] (Dec. 26)					Drill Opener Type (March 14)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	61	56	94	91	[76]	69	80	97	66	[78]
" "	0.84	" "	99	89	100	74	[90]	97	96	100	79	[93]
" "	1.12	" "	100	100	100	100	[100]	94	75	100	97	[92]
" "	2.24	" "	100	100	100	100	[100]	100	96	100	100	[99]
Cyanazine	0.56	" "	12	27	35	2	[19]	5	0	25	0	[7]
" "	0.84	" "	20	11	57	47	[34]	0	0	5	22	[7]
" "	1.12	" "	50	57	59	62	[57]	22	0	40	5	[17]
" "	2.24	" "	42	65	87	79	[68]	12	21	30	21	[21]
Glyphosate + S[2]	1.12 + 1/2	" "	7	15	0	0	[6]	0	0	0	0	[0]
Ethyl-metribuzin	1.12	Post	96	97	89	93	[94]	100	100	100	75	[94]
Check	---	---	10	0	10	0	[5]	12	0	0	20	[8]
Mean			(54)	(56)	(66)	(59)		(47)	(43)	(54)	(44)	
L.S.D. 0.05[3] =					(9)	NSD	[15]			(NSD)	NSD	[16]
L.S.D. 0.10 =					--	NSD	--			(8)	27	--

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

TABLE XXIII

EFFECT OF DRILL OPENERS AND HERBICIDE TREATMENTS ON CUTLEAF EVENINGPRIMROSE CONTROL 170 DAYS AFTER TREATMENT (MANGUM, MARCH 14, 1986)

Treatment	Rate (kg ai/ha)	Stage	Cutleaf eveningprimrose Control (%) Drill Opener Type[1] (March 14)				
			DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	66	69	81	61	[69]
" "	0.84	" "	85	70	96	81	[83]
" "	1.12	" "	94	75	97	97	[91]
" "	2.24	" "	100	96	100	100	[99]
Cyanazine	0.56	" "	0	0	25	0	[6]
" "	0.84	" "	0	0	0	0	[0]
" "	1.12	" "	0	0	0	0	[0]
" "	2.24	" "	0	0	0	17	[4]
Glyphosate + S[2]	1.12 + 1/2	" "	0	0	0	0	[0]
Ethyl-metribuzin	1.12	Post	100	100	100	100	[100]
Check	---	---	0	0	0	0	[0]
Mean			(40)	(37)	(45)	(42)	
L.S.D. 0.05[3] =				(NSD)	NSD		[13]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. value in [ ], is to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. value in ( ), is to compare drill opener type means averaged over herbicide treatments, which are also in ( ). There were no drill opener type by herbicide treatment interactions.

control was also good to excellent in plots treated with the 3 higher rates of atrazine. However, cutleaf eveningprimrose control in plots treated with ethyl-metribuzin was greater than control in plots treated with 0.84 kg/ha of atrazine. Atrazine was much more effective on cutleaf eveningprimrose than cyanazine, which controlled almost none of it.

Since this experiment was established on an area that had been seeded to rye and vetch the previous year, it developed severe populations of those species (Table XXIV). Excellent control of both species was recorded in plots treated with ethyl-metribuzin. Averaged over drill openers, atrazine was much more effective to those species than cyanazine. However, averaged over herbicide treatments, rye control was slightly greater in plots seeded with the deep furrow openers than in plots seeded with the spear point openers.

In contrast to the previous experiments, there appeared to be a reduction in stand and vigor of wheat seeded with the hoe-opener treatments. This was attributed to an increased soil depth in which the seedlings emerged from, caused by 7.2 cm of rainfall 3 days after planting. This resulted in soil movement from the row middles into the seed furrows. Also, at the time of planting the sandy soil was observed to flow back into the furrows, particularly the wheat seeded with the deep furrow opener. The furrow walls were not as well formed at this location as at the the other sites. At this location where the soil had a high sand content, the 10 cm winged openers described by Dowell (16) may have performed better.

Wheat stand counts indicated that drill openers had a major effect on the establishment of wheat (Table XXV). At this time, there were no

TABLE XXIV

EFFECT OF DRILL OPENERS AND HERBICIDE TREATMENTS ON VETCH AND RYE CONTROL 170 DAYS AFTER TREATMENT (MANGUM, MARCH 14, 1986)

Treatment	Rate (kg ai/ha)	Stage	Vetch Control (%) Drill Opener Type[1] (March 14) DoDi	SpPt	Wing	DFur	Mean	Volunteer Rye Control (%) Drill Opener Type (March 14) DoDi	SpPt	Wing	FDur	Mean
Atrazine	0.56	Preplant	66	65	80	61	[68]	76	80	95	80	[83]
" "	0.84	" "	90	70	87	71	[80]	94	92	90	97	[93]
" "	1.12	" "	94	75	99	97	[91]	94	75	100	97	[91]
" "	2.24	" "	100	96	100	100	[99]	100	96	100	100	[99]
Cyanazine	0.56	" "	5	0	25	0	[7]	5	0	25	5	[9]
" "	0.84	" "	0	0	0	27	[7]	2	0	5	25	[8]
" "	1.12	" "	0	0	0	0	[0]	12	0	25	27	[16]
" "	2.24	" "	5	20	17	37	[20]	12	22	24	40	[25]
Glyphosate + S[2]	1.12 + 1/2	" "	17	0	0	0	[4]	0	0	0	0	[0]
Ethyl-metribuzin	1.12	Post	100	100	99	100	[99]	100	100	100	100	[100]
Check	---	---	0	0	0	0	[0]	12	0	0	20	[8]
Mean			(43)	(39)	(46)	(45)		(46)	(42)	(51)	(54)	
L.S.D. 0.05[3] =					(NSD)	NSD	[14]			(9)	NSD	[15]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). There were no drill opener type by herbicide treatment interactions.

TABLE XXV

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON THE WHEAT STAND 36 DAYS AFTER TREATMENT (MANGUM, OCTOBER 31, 1985)

			Wheat Plts/m of Row				
	Rate		Drill Opener Type[1] (Oct. 31)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	15	15	21	23	[18]
" "	0.84	" "	7	11	13	27	[15]
" "	1.12	" "	3	8	12	13	[9]
" "	2.24	" "	0	1	3	6	[3]
Cyanazine	0.56	" "	32	32	20	35	[30]
" "	0.84	" "	22	30	33	23	[27]
" "	1.12	" "	15	28	24	30	[24]
" "	2.24	" "	2	11	22	17	[13]
Glyphosate + S[2]	1.12 + 1/2	" "	36	31	36	29	[33]
Check	--	--	32	26	29	25	[28]
Mean			(17)	(19)	(21)	(23)	
L.S.D. 0.05[3] =					(3)	9	[5]

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added 1/2 % v/v.
3. The L.S.D. value in [ ], is to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. value in ( ), is to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. value not in brackets or parentheses is an interaction to compare any drill opener type by herbicide treatment means.

significant differences between any of drill opener types in the untreated check.

Wheat injury from atrazine was decreased substantially by using openers that moved soil from the seed rows. In plots treated with 0.84 kg/ha of atrazine, more wheat plants were established in plots seeded with the deep furrow openers than in plots seeded with any other openers. Also, in plots treated with 1.12 kg/ha of atrazine, crop establishment was greater in plots seeded with the deep furrow openers than in those seeded with the double disc openers.

Wheat stand reductions were greater in plots treated with any rate of atrazine with all combinations of openers than in plots treated with respective rates of cyanazine, except with the 2 lower rates of atrazine in plots seeded with the winged or deep furrow openers.

As with the wheat stand counts, wheat injury ratings 36 DAT revealed major differences in injury between the various drill opener types (Table XXVI). Wheat injury due to atrazine was greater at the low rate in plots seeded with the double disc openers than in those seeded with the hoe-type openers. However, in plots treated with 0.84 kg/ha of atrazine, injury was less in plots seeded with the deep furrow openers than in plots seeded with any other opener.

Also, in plots treated with the high rate of cyanazine, wheat injury was greater in plots seeded with the double disc openers than in those seeded with the hoe-type openers. The response to atrazine of wheat seeded with the double disc openers was greater at the 3 lower rates than its response to cyanazine. However, wheat seeded with the hoe-type openers was injured less by application of 2.24 kg/ha of cyanazine than by 2.24 kg/ha of atrazine.

TABLE XXVI

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON WHEAT INJURY 36 AND 57 DAYS AFTER TREATMENT (MANGUM, OCTOBER 31 AND NOVEMBER 21, 1985)

			Wheat Injury (%)									
	Rate		Drill Opener Type[1] (Oct. 31)					Drill Opener Type (Nov. 21)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	71	29	27	20	[37]	64	45	39	34	[45]
" "	0.84	" "	67	71	59	27	[56]	77	75	75	39	[67]
" "	1.12	" "	91	78	70	86	[81]	96	91	89	93	[92]
" "	2.24	" "	100	92	94	77	[91]	100	97	96	98	[98]
Cyanazine	0.56	" "	9	19	22	12	[16]	15	16	37	22	[23]
" "	0.84	" "	15	11	10	36	[18]	24	27	30	30	[28]
" "	1.12	" "	30	25	49	16	[30]	46	30	46	35	[39]
" "	2.24	" "	87	47	31	37	[51]	74	56	57	51	[60]
Glyphosate + S[2]	1.12 + 1/2	" "	2	9	11	7	[7]	4	11	15	11	[10]
Ethyl-metribuzin	1.12	Post	--	--	--	--	--	9	21	20	14	[16]
Check	---	---	4	5	4	7	[5]	7	2	9	11	[7]
Mean			(48)	(39)	(38)	(33)		(47)	(43)	(47)	(40)	
L.S.D. 0.05[3] =				(7)	23		[12]		(NSD)		NSD	[10]
L.S.D. 0.10 =				--	--		--		(5)		NSD	--

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

At 57 DAT, there were no interactions in the wheat injury data. However, averaged over drill openers, major differences in wheat injury due to the various herbicides were revealed. Wheat injury was greater with any rate of atrazine than with respective rates of cyanazine. The difference in crop tolerance to cyanazine and atrazine was substantial. The lowest rate of atrazine caused about as much injury to wheat as the highest rates of cyanazine.

Averaged over herbicide treatments, wheat injury was less in plots seeded with the deep furrow openers than in plots seeded with the double disc and winged openers at the 0.10 level of significance.

The wheat injury ratings on December 26, 92 DAT, were similar to those on November 21 (Table XXVII). Little wheat injury was recorded in plots treated with either glyphosate or ethyl-metribuzin. Like the ratings on November 21, wheat injury due to atrazine was greater than respective rates of cyanazine. However, overall injury associated with all cyanazine treatments had decreased at 92 DAT. As was the case previously, wheat injury was less in plots seeded with the deep furrow and spear point openers than in those seeded with the double disc openers.

At 170 DAT, little to no injury was recorded in plots treated with glyphosate and ethyl-metribuzin. Wheat injury due to atrazine was very similar to earlier responses. However, wheat injury due to cyanazine had decreased to very little.

At that time, in plots treated with 0.56 kg/ha of atrazine, wheat injury was greater in plots seeded with the double disc opener than in plots seeded with any other opener. Also, in plots treated with 0.84 kg/ha of atrazine, crop injury was greater with 3 of the openers than

TABLE XXVII

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON WHEAT INJURY 92 AND 170 DAYS AFTER TREATMENT (MANGUM, DECEMBER 26, 1985 AND MARCH 14, 1986)

			Wheat Injury (%)									
	Rate		Drill Opener Type1 (Dec. 26)					Drill Opener Type (March 14)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	40	27	31	30	[32]	64	22	30	10	[32]
" "	0.84	" "	85	57	64	20	[57]	69	67	59	16	[53]
" "	1.12	" "	92	87	84	91	[89]	95	72	92	96	[89]
" "	2.24	" "	100	95	95	96	[96]	100	96	95	99	[97]
Cyanazine	0.56	" "	0	0	22	0	[6]	0	0	17	0	[4]
" "	0.84	" "	5	5	5	17	[8]	0	0	0	5	[1]
" "	1.12	" "	40	7	25	22	[24]	2	0	0	0	[0.5]
" "	2.24	" "	61	45	31	45	[46]	65	0	0	0	[16]
Glyphosate + S[2]	1.12 + 1/2	" "	0	0	0	2	[0.5]	0	0	0	7	[2]
Ethyl-metribuzin	1.12	Post	4	6	10	0	[5]	0	0	0	0	[0]
Check	---	---	2	0	0	0	[0.5]	0	0	0	0	[0]
Mean			(39)	(30)	(33)	(29)		(36)	(23)	(27)	(21)	
L.S.D. 0.05[3] =				(NSD)		NSD	[14]		(7)	24		[12]
L.S.D. 0.10 =				(7)		NSD	--		--	--		--

1. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
2. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
3. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill opener type by herbicide treatment means.

with those seeded with the deep furrow openers. Injury on wheat seeded with all combinations of openers and treated with all rates of atrazine, except in plots seeded with the winged opener at the lowest rate, had substantially more injury than in plots treated with cyanazine.

In summary, excellent rescuegrass control was obtained from the postemergence treatment of ethyl-metribuzin and the 3 higher rates of atrazine. As was the case with the final rescuegrass control ratings, excellent control of cutleaf eveningprimrose, vetch, and volunteer rye was provided by the treatment of ethyl-metribuzin. Also, good to excellent control of these species was recorded at the 3 higher rates of atrazine. However, the final wheat injury ratings revealed that injury due to atrazine at the 3 higher rates ranged from 53% to 97% compared to 0% injury from ethyl-metribuzin.

The relative amount of wheat, rye, and vetch left after cleaning the original field samples provided a good indication of how well the herbicides controlled rye and vetch and further substantiated the visual control ratings. Averaged over drill openers, no significant reduction in the amount of vetch and/or rye was observed from the preplant treatment of glyphosate (Table XXVIII). Vetch content was significantly reduced from 18% in the untreated check to 1% with the postemergence treatment of ethyl-metribuzin. This data agreed with the visual control ratings on March 14, which indicated that vetch was controlled 99% with this treatment. Also, in agreement with the visual control ratings, significant reductions in the amount of vetch were recorded in plots treated with the 2 higher rates of atrazine. The 2

TABLE XXVIII

EFFECT OF DRILL OPENERS AND HERBICIDE TREATMENTS ON VETCH AND RYE DOCKAGE
(MANGUM, JUNE 12, 1986)

			Vetch Content (%)[1]					Rye Content (%)				
			Drill Opener Type[2] (June 12)					Drill Opener Type (June 12)				
Treatment	Rate (kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	FDur	Mean
Atrazine	0.56	Preplant	22	13	14	12	[15]	78	72	46	56	[63]
" "	0.84	" "	10	9	12	16	[12]	72	53	43	51	[55]
" "	1.12	" "	4	4	3	0	[3]	22	19	16	0	[14]
" "	2.24	" "	0	2	2	0	[1]	0	22	21	0	[11]
Cyanazine	0.56	" "	17	19	19	21	[19]	83	83	79	82	[82]
" "	0.84	" "	19	17	24	14	[19]	75	64	68	82	[72]
" "	1.12	" "	13	12	17	18	[15]	83	87	79	65	[78]
" "	2.24	" "	13	19	17	17	[16]	88	86	68	78	[80]
Glyphosate + S[3]	1.12 + 1/2	" "	26	19	22	15	[20]	73	82	84	87	[81]
Ethyl-metribuzin	1.12	Post	1	1	1	2	[1]	3	2	8	2	[4]
Check	--	---	13	18	22	17	[18]	73	88	84	77	[81]
Mean			(13)	(12)	(14)	(12)		(59)	(60)	(54)	(53)	
L.S.D. 0.05[4] =				(NSD)		NSD	[6]			(NSD)	NSD	[12]

1 Vetch content (or rye content) = vetch seed (or rye seed) weight as a percent of the wheat-rye- vetch mixture left after cleaning the field sample with the Clipper M2B to remove bulky or lightweight dockage.

2. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).

3. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.

4. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). There were no drill opener type by herbicide treatment interactions.

higher rates of atrazine were more effective in reducing dockage from vetch than the 2 higher rates of cyanazine.

As was the case with vetch, rye was almost completely controlled by the postemergence application of ethyl-metribuzin. Also, rye content was significantly reduced by all atrazine treatments, but not by the cyanazine treatments. The 2 higher atrazine rates were the most effective, but were not significantly better than the ethyl-metribuzin treatment.

The final hand separation of wheat from rye after the secondary cleaning also provided excellent information on rye control as well as final wheat yield data (Table XXIX, XXX). Averaged over drill openers, the relative amount of wheat/10 g sample in plots treated with glyphosate was similar to the untreated check. However, the amount of wheat was increased over 8 fold in plots treated with ethyl-metribuzin. Although, no differences were recorded in plots seeded with the various openers, the ethyl-metribuzin treatment was by far the best treatment of any for increasing yield. Ethyl-metribuzin was also the most effective treatment for selectively controlling the volunteer rye.

However, in plots treated with atrazine, the drill openers had a major effect on wheat yield. In plots treated with the low rate of atrazine, the wheat yield was greater in plots seeded with the winged and deep furrow openers than in plots seeded with the double disc or spear point openers. Also, in plots treated with 0.84 kg/ha of atrazine, wheat yield was greater in plots seeded with the deep furrow openers than in plots seeded with all other openers.

In plots treated with 1.12 kg/ha of cyanazine, wheat yield was greater in plots seeded with the deep furrow openers than in the those

TABLE XXIX

INTERACTION OF DRILL OPENERS AND HERBICIDE TREATMENTS ON THE RELATIVE CONTENT OF WHEAT AND RYE IN HARVESTED GRAIN (MANGUM, JUNE 12, 1986)

			Relative content of wheat and rye in harvested grain[1]									
			Wheat seeds/10 g					Rye seeds/10 g				
	Rate		Drill Opener Type[2] (June 12)					Drill Opener Type (June 12)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	63	90	196	149	[125]	380	342	210	275	[304]
" "	0.84	" "	105	78	100	162	[111]	348	272	227	255	[275]
" "	1.12	" "	3	17	32	0	[13]	112	94	74	0	[70]
" "	2.24	" "	0	11	17	0	[7]	0	112	90	0	[50]
Cyanazine	0.56	" "	34	38	60	43	[44]	389	403	386	387	[391]
" "	0.84	" "	64	46	70	66	[62]	373	379	314	381	[361]
" "	1.12	" "	42	31	48	94	[54]	390	420	396	317	[381]
" "	2.24	" "	27	34	103	59	[56]	419	404	326	365	[379]
Glyphosate + S[3]	1.12 + 1/2	" "	74	34	24	26	[39]	307	403	413	422	[386]
Ethyl-metribuzin	1.12	Post	359	365	339	361	[356]	16	9	38	17	[20]
Check	---	---	78	13	22	63	[44]	369	427	406	383	[396]
Mean			(77)	(69)	(92)	(93)		(282)	(297)	(263)	(255)	
L.S.D. 0.05[4] =				(16)	54		[27]		(NSD)		NSD	[60]
L.S.D. 0.10 =				--	--		--		(30)		NSD	

1. In addition to the wheat and rye, the 10 gram samples also contained cracked vetch and a little heavy foreign material.
2. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
3. S refers to Triton Ag-98 nonionic surfactant which was added at 1/2 % v/v.
4. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatment, which are also in ( ). The L.S.D. values not in brackets or parentheses are interaction L.S.D.'s to compare any drill type by treatment means.

TABLE XXX

EFFECT OF DRILL OPENERS AND HERBICIDE TREATMENTS ON DOCKAGE AND GRAIN YIELD
(MANGUM, JUNE 12, 1986)

			Seed Cleaner Dockage[1] (%)					Wheat Yield (kg/ha clean wheat)				
			Drill Opener Type[2] (June 12)					Drill Opener Type (June 12)				
Treatment	(kg ai/ha)	Stage	DoDi	SpPt	Wing	DFur	Mean	DoDi	SpPt	Wing	DFur	Mean
Atrazine	0.56	Preplant	13	13	12	14	[13]	59	208	290	246	[201]
" "	0.84	" "	18	14	13	12	[14]	112	43	102	237	[123]
" "	1.12	" "	10	2	2	0	[4]	1	44	26	0	[18]
" "	2.24	" "	0	4	7	0	[3]	0	9	8	0	[4]
Cyanazine	0.56	" "	13	13	15	14	[14]	84	69	76	79	[77]
" "	0.84	" "	14	17	13	11	[14]	122	97	151	185	[139]
" "	1.12	" "	12	13	16	18	[15]	106	60	82	178	[106]
" "	2.24	" "	14	13	10	12	[12]	59	68	316	128	[144]
Glyphosate + S[3]	1.12 + 1/2	" "	10	12	14	12	[12]	215	77	51	55	[99]
Ethyl-metribuzin	1.12	Post	3	3	3	3	[3]	1448	1398	1677	1745	[1567]
Check	--	---	15	13	13	13	[13]	156	31	58	111	[89]
Mean			(11)	(11)	(11)	(10)		(215)	(191)	(258)	(270)	
L.S.D. 0.05[4] =				(NSD)		NSD	[4]		(56)		NSD	[93]

1. Seed cleaner dockage was composed of chaff, straw, rescuegrass seed, cutleaf eveningprimrose material, vetch foliage and a little shriveled grain, that was removed by running the field sample through a Clipper M2B seed cleaner. Most of the vetch and rye were not removed.
2. Drill Opener Types: DoDi= (Double Disc); SpPt= (Spear Point); Wing= (Spear Point modified with 5 cm wings); DFur= (Deep Furrow 10 cm shovel).
3. S refers to Triton Ag-98 nonionic surfactant which was added to 1/2 % v/v.
4. The L.S.D. values in [ ], are to compare herbicide treatment means averaged over drill opener types, which are also in [ ]. The L.S.D. values in ( ), are to compare drill opener type means averaged over herbicide treatments, which are also in ( ). There were no drill opener type by herbicide treatment interactions.

seeded with the spear point openers. However, at the highest rate of cyanazine, wheat yield was greater in plots seeded with the winged openers than in plots seeded with all other openers.

In plots treated with the 2 higher rates of atrazine, wheat yield was less in plots seeded with the double disc and spear point openers than in those treated with respective rates of cyanazine.

In plots treated with the lowest rate of atrazine, wheat yield was greater in plots seeded with the winged openers than in those treated with the lowest rate of cyanazine. However, the opposite occurred at the highest rate of atrazine because wheat yield was lower than in plots treated with cyanazine. At the 2 lowest rates of atrazine, wheat yields were greater in plots seeded with the deep furrow openers than in plots treated with respective rates of cyanazine. Thus, at the 2 highest rates of atrazine, wheat injury that caused reductions in yield were greater in plots seeded with any combination of openers than in those treated with respective rates of cyanazine.

There were significant herbicide treatment effects, averaged over drill openers in the dockage data, but no drill opener effects or interactions. This data provides the best information on how well the herbicides controlled rescuegrass. As was the case with the relative content data, the most effective treatments for reducing dockage due to rescuegrass were the postemergence treatment of ethyl-metribuzin or the preplant treatments of atrazine at the 2 higher rates. Consistent with the visual control data, little reduction in dockage was observed from any of the cyanazine treatments.

At harvest, averaged over drill openers, no differences in grain yield were observed between the check and plots treated with 1.12 kg/ha of glyphosate. However, in plots treated with ethyl-metribuzin, grain yields were significantly increased over all other treatments and the check. The only other herbicide treatment that increased grain yield was the low rate of atrazine. However, consistent with the wheat injury ratings, as atrazine rates increased, yields decreased. At that time, there were no significant differences in grain yield between the cyanazine treatments.

CHAPTER V

SUMMARY

Bromus spp. control ratings for all three experiments were usually near or above 90% for the atrazine and cyanazine treatments at rates of 0.84 to 2.24 kg ai/ha. In the Teller sandy loam soil at Perkins, averaged across drill openers, cheat control was similar with equal rates of atrazine or cyanazine. In the Port loam soil at the Lake Carl Blackwell experiment, atrazine was more effective on downy brome than cyanazine, but cyanazine at 0.84 kg ai/ha provided 84 to 94% downy brome control. At the lower rates, *Bromus* spp. control increased with the amount of soil displaced from the seed row. In the Meno loamy sand soil in the experiment at Mangum, the ethyl-metribuzin treatment at 1.12 kg ai/ha was the most effective treatment for *Bromus* spp. control. In general less *Bromus* spp. control was apparent in plots seeded with the double disc openers than with the hoe-type openers, due to mechanical control obtained by the hoe-type during planting.

In the Teller sandy loam and Port loam soils, drill opener by herbicide treatment interactions were present in the wheat injury data. At all locations cyanazine caused less wheat injury than atrazine with all openers. In contrast to 70% wheat injury from atrazine, cyanazine at 2.24 kg ai/ha caused no wheat injury in these soils when the wheat was seeded with the winged opener. The winged openers were consistently the best opener for reducing wheat injury by removing the herbicide from the drill row. The deep furrow openers were the second best opener for reducing wheat injury, followed by the spear-point openers. The highest wheat injury was on wheat seeded with the double disc openers. Therefore, wheat injury was reduced more by openers which moved more soil from the seed row.

Drill opener by herbicide treatment interactions also occurred in the yield data from the Teller sandy loam and Port loam experiments. These interactions generally reflected Bromus spp. control and reductions in wheat injury. Yields from the Meno loamy sand location at Mangum were low, due to poor emergence caused by 7.2 centimeters of rain which fell approximately three days after the wheat was seeded and the development of a heavy infestation of volunteer vetch and rye in the spring.

In summary, the best overall preplant treatment combinations were 0.56 to 0.84 kg ai/ha of cyanazine applied preplant where the wheat was seeded with the winged openers. This combination could provide an economical way of obtaining effective Bromus spp. control in no-till wheat on most soils. However, where large amounts of straw and crop residues were present, the deep furrow openers gave better residue clearance.

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TABLE XXXI

PRECIPITATION DATA (0.1 cm QUANTITIES OR MORE) AND DATE OF INITIATION OF THE EXPERIMENT - AGRONOMY RESEARCH STATION, PERKINS, OKLAHOMA (JULY 1, 1985 - JUNE 14, 1986)

Date	Centimeters	Date	Centimeters
July 5, 1985	1.0	November 18	0.3
July 22	0.5	November 19	0.7
July 23	3.1	November 25	0.1
July 24	1.5	November 30	0.2
July 25	0.1	February 6, 1986	0.5
July 26	3.9	February 8	0.3
July 28	1.6	February 10	0.1
July 29	0.4	February 11	0.1
August 5	0.1	March 10	0.2
August 7	0.1	March 12	3.1
August 14	0.5	March 16	0.4
August 15	3.5	March 18	0.9
August 19	1.5	April 1	1.8
August 20	0.4	April 2	0.4
August 23	0.1	April 3	1.0
August 24	0.1	April 4	3.1
September 14	2.2	April 6	0.4
September 21	0.5	April 12	0.1
September 22	2.1	April 14	1.1
September 23	3.9	April 17	1.0
September 24	2.4	April 18	0.4
September 29	1.7	April 20	0.8
September 30	1.4	April 27	0.8
October 2 - Initiation of exp.		May 9	2.2
October 8	0.4	May 10	0.5
October 10	0.3	May 11	2.5
October 11	1.1	May 14	0.2
October 12	1.0	May 15	4.2
October 14	3.9	May 17	2.4
October 15	0.1	May 27	0.5
October 18	3.7	May 30	0.5
October 19	0.1	June 2	0.5
October 29	0.6	June 5	1.8
October 30	0.2	June 6	1.1
November 13	3.3	June 7	1.0
November 14	2.6	June 10	0.1
November 15	3.6	June 14	3.2

TABLE XXXII

PRECIPITATION DATA (0.1 cm QUANTITIES OR MORE) AND DATE OF INITIATION OF THE EXPERIMENT - LAKE CARL BLACKWELL RESEARCH AREA, NEAR ORLANDO, OKLAHOMA (JULY 1, 1985 - JUNE 9, 1986)[1]

Date	Centimeters	Date	Centimeters
July 5, 1985	0.2	November 13	0.9
July 17	0.6	November 14	0.4
July 22	3.0	November 15	4.1
July 25	0.3	December 1	0.7
July 26	0.1	December 11	0.8
July 28	0.5	December 13	0.2
July 29	0.2	February 8, 1986	1.1
August 6	0.2	February 10	0.2
August 14	1.8	March 12	0.9
August 15	1.1	March 16	0.3
August 19	1.5	March 18	0.3
August 20	0.5	April 1	1.9
August 22	0.1	April 2	0.7
August 24	0.6	April 3	1.2
September 10	0.8	April 4	1.7
September 11	2.6	April 14	0.6
September 14	1.1	April 17	1.1
September 21	0.3	April 18	0.7
September 22	0.4	April 27	2.0
September 23	4.0	April 28	1.0
September 25	2.2	May 9	3.6
September 27 & 28 - Initiation of exp.		May 10	0.6
September 29	2.1	May 11	2.7
September 30	0.7	May 14	0.3
October 9	2.1	May 15	1.5
October 10	0.4	May 17	3.1
October 11	0.3	May 25	0.6
October 12	0.5	May 27	1.3
October 14	0.8	May 30	0.4
October 18	7.5	June 2	0.4
October 26	0.1	June 6	1.9
October 29	0.1	June 7	2.2
November 12	0.3		

1. Rainfall data collected by NOAA observer (Central Fire Station) in Perry, Oklahoma, approximately 15 km from the experiment.

TABLE XXXIII

PRECIPITATION DATA (0.1 cm QUANTITIES OR MORE) AND DATE OF INITIATION OF THE EXPERIMENT - SANDYLAND RESEARCH STATION, MANGUM, OKLAHOMA (JULY 1, 1985 - JUNE 10, 1986)

Date	Centimeters	Date	Centimeters
July 17, 1985	0.3	December 11	0.1
July 25	1.4	December 13	0.3
August 5	0.3	February 7, 1986	0.6
August 14	2.9	February 8	0.9
August 15	0.1	February 9	0.4
August 21	0.1	February 10	0.6
August 24	0.3	March 15	0.7
September 14	0.3	March 16	0.5
September 20	0.1	April 2	1.6
September 21	2.5	April 3	1.0
September 22	0.2	April 20	1.3
September 26 - Initiation of exp.		April 27	1.2
September 29	7.2	May 7	0.1
October 9	0.2	May 9	1.2
October 10	4.4	May 10	3.1
October 12	0.2	May 15	0.9
October 14	1.3	May 17	3.9
October 18	6.5	May 18	0.6
October 22	0.2	May 25	2.1
November 1	0.3	May 27	0.8
November 13	0.1	May 30	0.2
November 14	0.1	June 5	1.4
November 15	3.7	June 7	0.5
November 25	0.1	June 8	0.2

VITA

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