CULTURAL CONTROL OF BROMUS SPECIES

IN WINTER WHEAT

By

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CHAPTER I

INTRODUCTION

Wheat is grown commercially in 42 states of the union (1). Oklahoma ranks fourth among the states in total wheat production and is the second leading state in hard red winter wheat production (11). However, within the past decade Oklahoma wheat farmers have experienced increasing problems with several of the *Bromus* species in wheat production, with cheat (*Bromus secalinus* L.) being the most severe. Peeper (30) reported that an estimated $44 million in losses were caused in Oklahoma in 1976 by the various brome species. Losses caused by the bromes are due not only to yield reduction by competition but also dockage, the cost of seed cleaning, and a slowdown in harvesting operations.

Several of the introduced bromegrasses are weed problems over much of the United States. Downy brome (*Bromus tectorum* L.), hairy chess (*Bromus commutatus* Schrad.), japanese chess (*Bromus japonicus* Thunb.), and cheat occur as weeds in wheat fields and in numerous other places (18). The increasing severity of the brome problem in Oklahoma has been attributed to the increasing popularity of minimum tillage and/or stubble mulching, and also to the early sowing of wheat for pasturing purposes (30). Rydrych (34) reported in 1968 that cultural practices which stress soil and water conservation, particularly stubble mulch culture, have aggravated the downy brome problem by allowing downy brome to become established and produce seed. The increasing severity has also been coupled with the fact that no herbicides have been labeled for the control of these weeds in winter wheat in the Great Plains.

Since there have been no herbicides available for the control of these weeds, the objective of this research was to determine the influence of selected cultural practices on the severity of various *Bromus* species in winter wheat. Cultural practices investigated include tillage programs, wheat variety selection and rate of seeding, time of planting, row spacing, and fertility practice.

CHAPTER II

LITERATURE REVIEW

Plant Species

Hard red winter wheat, Triticum aestivum L., is a winter annual species which grows from 60 to 120 cm tall and is characterized by a terminal spike inflorescence containing two to five flowered, solitary sessile spikelets attached at each node of the rachis (15). The legal weight, test weight, for a hectoliter of wheat in a business transaction is 77.4 kg (28). Winter wheat is adapted throughout Oklahoma, with over 2.4 million hectares planted each year. Generally, wheat is seeded between September 15 and October 15, but the date varies widely depending on available moisture and grazing needs (25).

Cheat or chess is a weedy annual brome species introduced from Europe. It is the best known of the annual bromes and is found throughout temperate North America (18, 22). Cheat has erect culms, 30 to 60 cm tall. The foliage is glabrous or the lower sheaths sometimes puberulent. The inflorescence is a panicle, pyramidal shaped, nodding, 7 to 12 cm long. Spikelets are ovoid-lanceolate, 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, the second 7-nerved, 6 to 7 mm long. Lemmas are 7-nerved, 6 to 8 mm long, elliptic, obtuse, and smooth. The margin is strongly involute at maturity and the undulate awns are usually 3 to 5 mm long, or sometimes very short or obsolete. The palea is about as long as the lemma (22). Cheat was reported present in Oklahoma as early as 1900 (5).

Japanese brome or japanese chess (Bromus japonicus Thunb.) is one of the annual bromegrasses described as a weed problem over much of the United States (18). Japanese brome has erect culms, 40 to 70 cm tall. The sheaths and blades are pilose. The inflorescence is a panicle, broadly pyramidal and somewhat drooping, with all branches being more or less flexuous. Glumes are rather broad, the first acute, 3-nerved, 4 to 6 mm long, and the second obtuse, 5-nerved, and 6 to 8 mm long. Lemmas are broad, obtuse, smooth, 7 to 9 mm long, and 9-nerved. The hyaline margin is obtusely angled above the middle, and the apex is blunt and emarginate. Awns are 8 to 10 mm long, usually somewhat twisted and flexuous at maturity; however, one variety has straight awns. The lower florets are shorter than the upper and the palea is 1.5 to 2 mm shorter than the lemma (22).

Downy brome or downy chess (Bromus tectorum L.) has been reported to cause serious economic losses to wheat producers in the Pacific Northwest (34). It is also becoming an increasing weed problem to Oklahoma wheat farmers (30). Downy brome has culms which are erect or spreading, slender, and 30 to 60 cm tall with pubescent sheaths and blades. The inflorescence is a panicle 5 to 25 cm long, rather dense, soft, drooping, and often purple. Spikelets are nodding and 12 to 20 mm long. Glumes are villous, the first 4 to 6 mm long and the second 8 to 10 mm long. Lemmas are lanceolate, villous, and 10 to 12 mm long with a 12 to 14 mm awn (22).

Wild oat (Avena fatua L.) has become a severe problem throughout the Rolling Plains and Northern Blacklands of Texas, as well as Western Oklahoma (26). Wild oats have erect, stout culms, 30 to 75 cm tall. Leaves are numerous and the blades are usually 4 to 8 mm wide. The panicle inflorescence is loose and open with slender branches usually horizontally spreading. Spikelets are usually three-flowered, glumes about 2.5 cm long, and the rachilla and lower part of the lemma clothed with long, stiff, brownish or sometimes whitish hairs which are occasionally scant. The awns are 3 to 4 cm long, bent and twisted below the bend (22).

Weed species, as previously described by Hitchcock (22), are often taller and have varying characteristics when found growing in competition with cultivated crops.

Effects of Tillage Practices on Bromus Infestations

A tremendous amount of research has been conducted over the past years on various tillage operations and procedures. Early considerations were mainly efficiency of weed control during fallow and seedbed preparation. More recent research has been concerned with conservation of soil, water, and energy. Wiese and Army (39) stated that improved soil and moisture conservation practices are essential for a continuing agriculture economy in the Great Plains. Subsurface tillage (stubble mulching) is recommended for weed control, wind and water erosion control, and, in some areas, for moisture conservation during the fallow period. Davidson and Santelmann (12) reported that food and fiber requirements in the United States continue to rise, but higher grower operational expenses demand that these production increases be achieved more economically than in the past. As a result of these two pressures, new tillage systems requiring less mechanical energy are being developed and evaluated. One such method is minimum tillage, which involves less traffic over the soils. The fact that minimum tillage and stubble mulching practices are being used more and more has led to an increasingly severe problem with the Bromus spp. Fenster et al. (16) reported that in the semi-arid regions of the Great Plains, an alternate wheat fallow rotation is essential for conserving moisture to produce profitable crops. However, when stubble mulch farming is used in this rotation, downy brome is difficult to control and becomes a serious weed. Davidson and Santelmann (12) found that cheat became an increasing problem in chemical fallow plots, but was not a problem where the moldboard plow was used for primary tillage after harvest. Rydrych and Muzik (34) reported that control of downy brome in cropland is accomplished by use of cultural practices. Infestations are retarded by deep moldboard plowing which buries the seed to a depth from which emergence is impossible. Wicks et al. (38) found that emergence of downy brome from different depths varied with soil type. Downy brome emergence from 0.63 cm was quicker and more efficient in silt loam and silty clay loam soils than in a sandy loam soil. However, just the opposite was true when seeds were buried 5.1 cm deep, and no downy brome emerged from a depth of 10.2 cm in any soil. McNeil and Peeper (29) reported emergence of cheat was greatest from a soil depth of 2.54 cm, but only 1% seedling emergence was noted from 10.2 cm and zero emergence was noted when cheat was buried 15.2 cm deep. They also reported neither of two species of wild oats emerged from a depth of 20.3 cm. Wicks et al. (38) found that downy brome seed does not have a long period of enforced dormancy, but germinates when moisture and temperature conditions are favorable; thus, moldboard plowing should be a satisfactory method for controlling downy brome. It has also been reported that cheat seed does not live long in the soil (1). An experiment was conducted in continuous winter wheat on tillage practices, in which a moldboard plow, a one-way disk, a sweep plow, and a treatment in which wheat stubble was burned then moldboard plowed each year for 12 years. Downy brome counts taken after 12 years showed no downy brome in either treatment where the moldboard was used, 20 plants/.84m^2 in the one-way disk treatment, and 78 plants/ .84m^2 in the sweep plow treatment (38). It was concluded that the moldboard plow was the most effective tillage implement in reducing the downy brome population in a continuous winter wheat cropping system, and that the sweep plow, when used after harvest, controls weed present and prepares a seedbed for downy brome. Finnell (17) concluded that cultivation, though it does use surface moisture, is much preferred over weeds, since the most drastic kind of tillage will result in much less water loss than that lost to weeds.

Effects of Planting Date on Crop and Weed Species

Small grain pastures are an important source of protein for wintering cattle in Oklahoma (13). Staton and Heller (35), reporting on grazing experiments, stated that farmers planted wheat early--September 6 to September 15--in order to get fall pasture. Peeper (30), in 1977, partially attributed the increasing severity of *Bromus* species to the early sowing of wheat for pasturing purposes. Carter et al. (10) found that wheat was a much better competitor than cheat. He stated that when cheat seedlings start with wheat seedlings they are at a great disadvantage because wheat starts growth much more quickly than cheat, although the cheat germinates just as quickly. Burtis and Moorehouse (9) found that the optimum time to plant wheat in Oklahoma was from September 20 to October 10. They stated that late seeded plants got a poor start and were not as able to stand adverse conditions as well as established plants. Carter et al. (10) indicated that wheat and cheat had the same potential winter hardiness, but under conditions of late planting the wheat had considerably greater capacity to survive than cheat. He found that when grown together the survival of both was reduced, but under conditions of late planting the relative reduction of the cheat was the greatest. Finnerty et al. (18) reported phenological data on downy brome, cheat, and japanese brome, which indicated that considerable winterkilling occurred in poorly established late fall plantings of these weeds but little winterkill was noted when the weeds were planted in the early fall. It has been suggested that planting wheat during the later part of the recommended planting period will permit an additional tillage operation. This often reduces the infestation of winter annual grasses (1). It was reported in 1976 that an important cultural means of controlling wild oats was to delay sowing the crop to allow wild oats to germinate so they could be destroyed by cultivation (23).

Other Cultural Practices

Profitable production of any crop requires that competition from weeds be minimized (2). Manipulation of cultural practices to give the crop the greatest competitive advantage possible is of primary importance. It has been suggested that weeds can usually be controlled by good farming methods such as use of appropriate varieties, good seedbed preparation, proper time and rate of seeding, and effective fertilization (1). Carter et al. (10), working with cheat in wheat, suggested that one practical way to control cheat is to maintain such a high state of soil productivity and to establish such a vigorous uniform stand of wheat that the cheat will be held to a minimum by direct competition. He also suggested that varieties of wheat may differ in their capacity to compete with cheat, and that a variety possessing the capacity to tiller profusely might be the most successful for this purpose. Rummel (33), investigating some effects of downy brome competition on crested wheatgrass and bluestem, concluded that a species which germinates early in the season and which makes rapid growth following emergence can resist downy brome competition more successfully than can a slower growing species. This indicates that a wheat variety with rapid early growth characteristics may also afford similar results. The possibility of differences in competition due to variety height might also be a factor which would aid the crop. Bornkamm (6), investigating the competition for light on cheat and other weeds, found that the yield of dry matter of all species decreased with decreasing light intensity. Puckridge (32) suggested that the potential for grain yield of a wheat ear was affected by the light environment of the shoot at any stage before ear emergence.

Crop competition with weeds may also be improved by adjustment of seeding rate. Jones (23), reporting on wild oats in world agriculture, stated that it is generally agreed that a high seeding rate is necessary to give the maximum competition at a critical period when the wild oats are in an early stage of development. Esipov and Shcherbakova (14), working in Russia, reported that increased sowing densities of wheat reduced the productivity of most weed species. Carter et al. (10) stated that cheat plants were not killed by thick stands of wheat, but stems were slender with no tillers. Tingey (36) reported that cereals sown at 67.2 kg/ha contained 32% more wild oat panicles and yielded 8% less grain than when sown at 134.4 kg/ha. Research has also indicated that the benefits of increased yield and forage production due to increasing the seeding rate is limited. Burtis and Moorehouse (9) found that seeding rates of 84 to 101 kg/ha were better than 50.4 to 67.2 kg/ha, but increasing the seeding rate further was of no benefit. Pendleton and Dungan (31) compared six seeding rates ranging from 50.4 to 302.4 kg/ha and found that the 101 kg/ha seeding rate returned the highest yield. Kiesselbach (24) studied the relation of seeding practices to crop quality and reported similar results.

Row spacing is another factor which may be manipulated to increase crop density and improve competition. Harper (20) found no differences in wheat yield between 17.8 and 35.6 cm rows. He reported that the smaller number of plants in the wider rows were taller, more vigorous, and had an increased number of tillers. Bjerninger and Granstrom (3) investigated row spacings in spring sown cereals of 12.5, 15, 17.5, and 20 cm and found that yields did not differ greatly between the different spacings. However, in heavy weed infestations, yields were higher for the 12.5 cm spacing in spring wheat. Tingey (36), working with wild oats in small grains, reported that in row-spacing trials with winter wheat, plots in which the crop was sown in rows 40.6 cm apart and cultivated to control wild oats contained 20 to 25% fewer wild oat panicles than plots on which the row-spacing was 15.2 cm, yet the crop sown in 15.2 cm rows yielded 20% more in one trial and 18% more in another.

Past research has shown that the nutrient status of the soil associated with applications of fertilizer is an important factor affecting crop vigor. Blackman and Templeman (4), working with competition between cereal crops and annual weeds, suggested that by addition of nitrogen the yield of a weedy crop could be raised to the same level as that of a clean crop. Esipov and Shcherbakova (14) concluded that high rates of nitrogen, phosphorus, and potassium, combined with high stand densities, sharply reduced weed seed production. However, Hammerton (19), working on the effects of weed control and nitrogen application rate in kale, concluded that the application of nutrients did not reduce or nullify the effects of weeds on crops. Fertilizer applications to wheat have demonstrated the ability to improve growth factors which result in increased yield and also possible competitive advantages. Woodward (40), working with nitrogen and phosphorus applications in semi-dwarf spring wheat, found that increased yields due to nitrogen were due mostly to increases in tillers per unit area. Elder (13) reported that phosphorus was extremely important in the establishment and early forage growth of all small grain crops. Maximum response of crops to fertilizers depends upon the availability of all nutrients. Brensing and Lynd (7, 8) conducted soil fertility studies for improved wheat production and found that wheat yields increased with nitrogen fertilizer only when the nitrogen treatments were combined with adequate phosphorus and potassium. Fertilizer placement is another important factor in winter wheat production and could be a valuable tool in weed control. Fertilizer, placed where it would be more available to the crop than weeds, would give the crop a competitive advantage. Lynd et al. (27) reported that proper fertilizer placement is of great importance, particularly for stand establishment. Broadcasting fertilizers for establishing stands of small grains and other crops is wasteful and inefficient. For small grains they suggested drilling the fertilizer in the row with the seed rather than broadcasting starter fertilizer. Vavra and Bray (37), working with fertilization of wheat, concluded that in soils low in available phosphorus, maximum yields could be obtained by applying soluble phosphorus in the row at planting. Harper et al. (21) also recommended drilling phosphorus in the row when seeding wheat.

CHAPTER III

METHODS AND MATERIALS

Field studies were conducted at several locations in Oklahoma to evaluate the effects of tillage practice, date of seeding, seeding rate, row spacing, and fertility practice on the severity of various Bromus species infestations in winter wheat.

All data except population density evaluations and visual ratings were analyzed statistically. Treatment effects were compared using L.S.D.'s at the .05 level of significance unless otherwise stated. Visual ratings of crop injury or weed control were based on either a 0-10 scale, with 0 equal to no effect and 10 equal to complete plant kill, or on percent ground cover.

Tillage Practices

A field experiment was initiated on a Hollister-Tillman clay loam soil (Pachic Paleustolls-Typic Paleustolls) at the Irrigation Research Station near Altus, Oklahoma in the summer of 1976. The purpose was to evaluate the effects of several tillage programs on the severity of Bromus infestations in winter wheat. Four separate areas were seeded with either japanese brome, cheat, downy Brome, or wild oats. Wild oats were included for competitive comparisons. Various tillage programs were set up using 3.66 x 18.30 meter plots in a randomized complete block design replicated four times. Tillage programs consisted of a primary tillage July 1, after wheat harvest and a secondary tillage conducted August 24. Eight tillage programs plus a no-till program were evaluated. Tillage programs, in the order of primary then final tillage, included: (1, 2, 3, 4) moldboard plowing 20 or 31 cm deep for primary tillage, followed by disking 8 or 10-18 cm deep for each depth of moldboarding; (5) disking 8 cm deep, disking 10-18 cm deep; (6) disking 8 cm deep, chisel plowing 10 cm deep; (7) chisel plowing 10 cm deep, disking 10-18 cm deep; (8) chosen plowing 10 cm deep for both primary and final tillages.

Equipment used to carry out programs included a John Deere 4020 tractor, a moldboard plow-3 bottom, 40.6 cm, flipover with scalloped rolling colters, a 4.2 meter offset tandom disc, and a 13 shank chisel plow with duck feet attached for primary tillages, and points attached for final tillages. The chisel also contained a homemade single row of straight spikes attached behind.

Glyphosate at a rate of 2.24 kg/ha was used for summer weed control in the no-till treatment. Only one application on June 30 was necessary to control summer annuals throughout the summer. Weeds present at the time of application included: tumble pigweed (Amaranthus albus L.) 10.2 to 30.5 cm tall and purslane (Portulaca oleracea L.), 10.2 to 45.7 cm in diameter. The glyphosate treatment was applied with a hand carried CO_2 sprayer with a three nozzle boom equipped with 8005 flat fan nozzle tips spaced 45.7 cm from center to center. Application was made in a carrier volume of 280.5 L/ha.

In October, 1976 estimates of the various brome species population were taken. Estimates were based on actual plant counts of random selected areas in each plot and are reported as the plants/67 m^2 average of four replications. Triumph-64 wheat was sown at a seeding rate of 67.2 kg/ha with a hoe-type drill with point openers on November 4, 1976. Wheat yields were taken from a 1.5 x 18.3 m area in each plot on June 28, 1977. Harvest data was obtained by harvesting each plot with a small plot combine. Plot yield and test weight were determined in the field.

A second tillage study was established in 1976 on a Grant siltloam soil (Udic Argiustolls) at the North Central Research Station near Lahoma, Oklahoma. The objective was to evaluate the effect of several tillage programs used consecutively for several years on the severity of a cheat and a downy brome infestation in winter wheat. The area used for the experiments had a natural infestation of cheat, and was mowed in May, 1976, when the wheat and cheat were in the dough stage. Prior to the first tillage, the field was divided into two areas and cleaned cheat seed was broadcast over each plot in one area at a rate of 1.4 kg/plot or 156.9 kg/ha, and downy brome at a rate of .2 kg/plot or 22.4 kg/ha was broadcast in the other area. The resulting cheat and downy brome stands were approximately 161 to 269 plants per m^2 and 53 to 161 plants per m^2, respectively, as estimated in the no-till plots where the most dense stand was obtained. However, the population in the downy brome area proved to be a mixture of the natural infestation of cheat and some downy brome. Five tillage programs plus a no-till program were evaluated using 7.3 x 12.2 m plots in a randomized complete block design, replicated four times. The tillage programs, repeated on the same plots for three years, consisted of a primary, secondary, and final tillage, except in 1978 when the secondary tillage operation was conducted twice. Timing of tillage operations was dictated by emergence and growth of summer weeds. Tillage programs, in the order of primary, secondary, and final were: (1) moldboard plow-15 cm deep, disk, springtooth; (2) moldboard plow-23 cm deep, disk, springtooth; (3) disk, disk, disk; (4) sweep, sweep, sweep; (5) chisel, chisel, sweep.

The equipment and procedures used in the tillage operations were: (1) moldboard plow-3 bottom, 41 cm flipover with scalloped rolling coulters; (2) disk-3.4 m flexible offset tandem, which ran 8 to 10 cm deep for the primary tillage and slightly deeper in the secondary and final tillage operations; (3) sweep-single 2.4 m Noble blade with a single gang trend mulcher attached. The blade was operated approximately 8 cm deep; (4) chisel-3.1 m wide, 13 shank with 35.6 cm sweeps attached and operated at a depth of 5 to 8 cm; (5) springtooth harrow 3.7 m wide with a spiketooth harrow attachment containing two rows of spikes.

Tillage dates for the three years were: 1976--July 7, August 9, and October 5; 1977--July 5, August 8, and September 7; 1978--June 15, July 17, August 8, and October 2.

In the no-till program glyphosate at 2.24 kg/ha was used when needed for summer weed control. During the summer of 1976 and 1977 two applications were needed: one at the time of primary tillage and one at the time of final tillage. However in 1978, glyphosate applications were needed at the time of the second, third, and fourth tillage operations. In all cases glyphosate was applied with a compressed air plot sprayer and in a carrier volume of 280.5 L/ha. A five nozzle boom containing 11004 flat fan nozzle tips on a 50.8 cm spacing was used. Danne wheat was sown each year at a seeding rate of 67.2 kg/ha. In 1976, planting was done with a John Deere hoe-type drill on October 5, and in 1977 and 1978 with a special design no-till drill on September 21 and October 2, respectively. Granule fertilizer was broadcast at a rate of 89.6 kg/ha nitrogen and 51.5 kg/ha phosphorus on August 16, 1976; September 1, 1977; and August 18, 1978.

In 1976 visual ratings were taken for summer weed control 29 days after tillage or herbicide treatment. Further ratings were taken for cheat and mixed brome control and wheat stand and/or vigor, 161 days after wheat was sown. All ratings are an average of four replications (based on a rating scale of 0-10 where 10 = complete weed control or crop kill). The weed species and densities at the time primary treatments were applied in 1976 included Tumble pigweed (*Amaranthus albus* L.) 10-20/m^2; Kochia (*Kochia scoporia* (L) Roth), 10-20/m^2; Horseweed (*Erigeron canadensis* L.), 10-20/m^2, Wild lettuce (*Lactuca scariola* L.), 10-30/m^2; Redroot pigweed (*Amaranthus retroflexus* L.) 10-20/2; Green foxtail (*Setaria viridis* L. Beauv.), 10-20/m^2; Witchgrass (*Panicum capillare* L.), 10-20/m^2; [Gumweed Grindelia squarrosa (Bursh) Dunal] 10-20/m^2.

In 1977 visual ratings of summer weed control were taken 16 days after the first tillage or herbicide application and one day prior to final tillage and planting. Visual ratings were also taken for cheat, mixed brome control, and wheat vigor 99 days after planting. Summer weeds present in 1977 were primarily the same as those present in 1976, with the addition of prairie cupgrass (*Eriochloa contracta* Hitchc.), and carpetweed (*Mollugo verticillata* L.).

In 1978 visual ratings for summer weed control were taken 32 days after the first tillage and 22 days after the second tillage operation or herbicide application. Cheat and mixed brome density estimates were also taken just prior to the final tillage and herbicide treatment, or 22 days after the second tillage operation. Densities are based on actual plant counts of random selected areas. Yields were determined on June 23 (downy brome area) and June 29, 1977; June 14, 1978; and June 14, 1979, by harvesting a 6.1 x 12.2 m area in each plot. A small plot combine was used in 1977 and 1978 and a commercial type self propelled combine with a 3.1 m header was used in 1979.

Planting Date

A field experiment was established September 10, 1976, on a Grant fine silty loam soil (Udic Argiustolls) at the North Central Research Station near Lahoma, Oklahoma to evaluate the feasibility of using delayed planting as a method to reduce cheat populations. The experimental design was a split plot replicated four times. The main plot treatments were the presence or absence of a cheat infestation, and sub-plots were planting dates. The main plots were established by over seeding one half of the experiment with cheat, and then harrowing the entire plot area on September 10, 1976. Danne wheat was sown at 67.2 kg/ha with a hoe type drill in 25.4 cm rows on three week intervals starting September 10 and continuing until December 22. One treatment was left undisturbed after September 10, and not planted to give some indication of unhampered cheat population. Immediately prior to planting, each plot was springtooth harrowed twice to destroy emerged cheat and volunteer. The same procedure and planting dates were used in the same plots for two consecutive years. On May 23, 1978, preharvest visual ratings were taken to evaluate wheat and cheat stand and vigor and summer annual weed emergence. Ratings on wheat and cheat are based on a 0-10 scale where 0 is no reduction of population or vigor and 10 is zero wheat or cheat population. Yields were determined on June 30, 1977, and June 20, 1978, by harvesting a 1.5 x 9.2 m area in each plot. Harvest data was obtained in 1977 by weighing and taking test weight of grain samples in the field. Yield and test weight is therefore that of uncleaned grain. In 1978 samples were bagged in the field, then later weighed, cleaned, and reweighed in order to determine percent dockage and actual grain yield.

Wheat Variety Selection and Rate of Seeding

In the fall of 1976 a field experiment was initiated on a Hollister, Tillman clay loam soil (Pachic Paleustolls-Typic Paleustolls) at the Irrigation Research Station near Altus, Oklahoma, to evaluate the influence of wheat variety height and rate of seeding on a cheat infestation. The experimental design was a split plot replicated four times. The main plot was wheat varieties and the sub-plots were seeding rates. The experiment was overseeded with cleaned cheat seed, then springtooth harrowed before planting. Planting was done with a crustbuster hoe-type drill with 25.4 cm row spacings on November 9, 1976. Wheat varieties included: Tam-W-101, a semi-dwarf variety; Triumph-64, a mid-tall standard height variety; and Osage, a tall variety. Each variety was seeded at rates of 33.6, 67.2, 100.8, and 134.4 kg/ha.

Wheat yield and quality were determined by harvesting two 1.5 x 9.2 m samples from each plot on June 30, 1977.

A second variety selection and rate of seeding experiment was conducted during 1978-79 on a Teller loam soil (Udic Argiustolls) at the Agronomy Research Station near Perkins, Oklahoma. The same experimental procedures were used as described in the previous experiment. The wheat varieties evaluated in this experiment were two semi-dwarf varieties, TAM-W-101 and Newton, which vary in tillering ability. Seeding rates evaluated were 39.2, 50.4, 68.3, 90.7, and 115.4 kg/ha. Wheat was sown with a crust-buster hoe-type drill on October 3, 1978. Grain yield and quality were determined by harvesting a 1.5 x 9.2 m area in each plot on June 15, 1979. Samples were weighed and bagged in the field. Samples were then cleaned, reweighed, and grain yield and percent dockage determined.

Row Spacings

A field experiment was conducted in 1977-78 on a Norge loam soil (Udic Paleustolls) at the Agronomy Research Station, Stillwater, Oklahoma, to evaluate the effect of wheat row spacing on a cheat infestation and wheat production. The experimental design was a split plot replicated four times. The main plots were wheat with or without cheat and the sub-plots were row spacings. The wheat with cheat main plots were heavily overseeded with cleaned cheat and springtooth harrowed prior to seeding the wheat. Newton wheat was seeded at 67.2 kg/ha with a John Deere model "FB" drill with single disk openers, modified to obtain row spacings of 15.2, 17.8, 20.3, 25.4, 30.5, and 35.6 cm. Grain samples were obtained by harvesting a 1.5 x 6.1 m area in each plot on June 10, 1978. Samples were bagged in the field and later weighed, cleaned, and reweighed to determine yield and percent dockage.

Fertility Practice

An experiment was established on November 15, 1977, on a Grant fine silty loam soil (Udic Argiustolls) at the North Central Research Station near Lahoma, Oklahoma. The purpose of this experiment was to determine the effects of various fertilizing practices on cheat infestations and winter wheat production. The experimental design was a randomized complete block, replicated four times. Soil analysis of this area prior to the experiment showed 12.3 kg/ha surface nitrate nitrogen, 81.8 kg/ha phosphorus, and 735.8 kg/ha potassium. The area was overseeded with cleaned cheat, springtooth harrowed, and fertility practices initiated. Treatments included band applications with the seed of 18-46-0 fertilizer at 59.4 and 123.2 kg/ha; band applications of 18-46-0 at 59.4 and 123.2 kg/ha followed by 168 kg/ha of 33-0-0 in the spring; broadcast applications of 18-46-0 at 59.4 and 123.2 kg/ha prior to seeding; and the broadcast applications followed by 33-0-0 in the spring; 33-0-0 top dressed in the spring with no fall application; and an unfertilized check.

A John Deere model LZ 1010 hoe-type drill with a fertilizer attachment was used for fall fertilization and seeding. Fall broadcast treatments were made by allowing fertilizer to drop freely from fertilizer or grain tubes approximately 15.2 cm above the ground and distributing the fertilizer on the plots. After the broadcast treatments were applied the entire area was springtooth harrowed one time and

Triumph-64 wheat was sown at 67.2 kg/ha. Spring applications were made with an eight foot Gandy fertilizer applicator. Yields were determined by harvesting a 1.5 x 9.2 m area from each plot on June 20, 1978. Samples were bagged in the field then later weighed, cleaned, and reweighed. Clean grain yield was recorded and percent dockage calculated.

CHAPTER IV

RESULTS AND DISCUSSION

Tillage Practices

In October, 1976, at Altus, Oklahoma, estimates of the various brome species and wild oat populations were taken to evaluate the effects of the tillage programs on the severity of the infestations (Table I). In all the programs utilizing the moldboard plow for primary tillage, the populations of japanese brome, cheat, downy brome, and wild oats were much lower than in other tillage programs, indicating that the moldboard plow buried most of the seed to a depth from which it could not emerge. Downy brome and wild oat populations were lower in the no-till treatments, probably because of lack of surface germination. No substantial differences were noted between the moldboard plow treatments with the exception of a slightly higher cheat population when either depth of moldboard plowing was disked 10 to 18 cm deep. This deeper disking may have brought some of the deep buried cheat seed closer to the surface, thus permitting greater emergence. Brome populations reported are not indicative of the competitive population existing throughout the growing season. These populations were estimated prior to sowing the wheat with a hoe-type drill which reduced the existing weed population in each plot. The only difference in yield noted in the japanese brome infested plots (Table II) was the higher yield of the

TABLE I

WEED POPULATIONS IN OCTOBER, 1976 (ALTUS)

Tillage Program[1] (Depth cm)		Weed Populations (plts/67m²)			
		Jap Brome	Cheat	Downy Brome	Wild Oats
MP 20	Di 10 - 18	106	425	17	112
MP 20	Di 8	138	131	16	163
MP 31	Di 10 - 18	138	531	23	175
MP 31	Di 8	106	213	16	138
Di 8	Ch 10 - 18	1550	2375	121	1375
Di 8	Ch 10 (pts)	1250	2325	163	1800
Ch 10 (df)	Di 10 - 18	2100	2500	83	1550
Ch 10 (df)	Ch 10 (pts)	2050	2575	188	1450
Gly 2.24 kg/ha		1825	1450	63	59

[1]MP-Moldboard Plow, Di-Disc, Ch-Chisel with (pt) points or (df) duckfeet, Gly-Glyphosate.

TABLE II

EFFECT OF TILLAGE PROGRAMS ON JAPANESE BROME AND WHEAT PRODUCTION (ALTUS)

Tillage Program[1] (Depth cm)		Yield (hl/ha)	Test Wt. (kg/hl)
MP 20	Di 10 - 18	25	71
MP 20	Di 8	27	74
MP 31	Di 10 - 18	24	70
MP 31	Di 8	28	70
Di 8	Di 10 - 18	23	66
Di 8	Ch 10 (pts)	25	65
Ch 10 (df)	Di 10 - 18	24	65
Ch 10 (df)	Ch 10 (pts)	20	67
Gly 2.24 kg/ha		27	59
LSD .05		6	4
CV (%)		17	8

[1]MP-Moldboard Plow, Di-Disc, Ch-Chisel with (pt) points or (df) duckfeet, Gly-Glyphosate.

moldboard plow at 31 cm followed by disking at 8 cm treatment over the treatment with the chisel only. Grain harvested from all programs where the moldboard plow was used for primary tillage have higher test weights than the no-till program.

In the cheat infested plot area the tillage program consisting of moldboarding 31 cm deep, followed by disking 10 to 18 cm deep, resulted in a higher yield than moldboarding 20 cm deep, followed by disking 10 to 18 cm deep (Table III). All moldboard plow, then disk programs, with the exception of moldboarding 20 cm, followed by disking 10 to 18 cm, gave higher yields than either the disk followed by a chisel, the chisel followed by a chisel, or the no-till programs. Higher test weights were obtained from all moldboard and disk programs than all others.

Effects of tillage programs on wheat production in a downy brome investation (Table IV) were minimal. As indicated in Table I, the downy brome stand was very light and was of less significance than a dense stand might have been. However, tillage programs including moldboard plowing 20 cm, disking 8 cm, moldboard plowing 31 cm, disking 10 to 18 cm, and disking then chiseling, resulted in higher yields than the no-till programs.

In the wild oat infested area both tillage programs where the moldboard plow at 31 cm was used for primary tillage resulted in higher yields than both programs where the disk was the primary tillage implement, the program consisting of chiseling twice and the no-till program (Table V). The moldboard plow at 31 cm followed by disking 8 cm also resulted in a higher yield than the modlboard plow at 20 cm

TABLE III

EFFECT OF TILLAGE PROGRAMS ON CHEAT AND WHEAT PRODUCTION (ALTUS)

Tillage Program[1] (Depth cm)		Yield (hl/ha)	Test Wt. (kg/hl)
MP 20	Di 10 - 18	23	67
MP 20	Di 8	26	72
MP 31	Di 10 - 18	28	68
MP 31	Di 8	26	70
Di 8	Di 10 - 18	23	52
Di 8	Ch 10 (pts)	20	52
Ch 10 (df)	Di 10 - 18	22	54
Ch 10 (df)	Ch 10 (pts)	21	53
Gly 2.24 kg/ha		20	46
LSD .05		4	9
CV (%)		11	11

[1]MP-Moldboard Plow, Di-Disc, Ch-Chisel with (pt) points or (df) duckfeet, Gly-Tlyphosate.

TABLE IV

EFFECT OF TILLAGE PROGRAMS ON DOWNY BROME AND WHEAT PRODUCTION (ALTUS)

Tillage Program[1] (Depth cm)		Yield (hl/ha)	Test Wt. (kg/hl)
MP 20	Di 10 - 18	23	77
MP 20	Di 8	25	76
MP 31	Di 10 - 18	25	77
MP 31	Di 8	24	77
Di 8	Di 10 - 18	23	77
Di 8	Ch 10 (pts)	25	74
Ch 10 (df)	Di 10 - 18	24	76
Ch 10 (df)	Ch 10 (pts)	23	76
Gly 2.24 kg/ha		21	75
LSD .05		3	NSD
CV (%)		7	3

[1]MP-Moldboard Plow, Di-Disc, Ch-Chisel with (pt) points or (df) duckfeet, Gly-Glyphosate.

TABLE V

EFFECT OF TILLAGE PROGRAMS ON WILD OATS AND WHEAT PRODUCTION (ALTUS)

Tillage Program[1] (Depth cm)		Yield (hl/ha)	Test Wt. (kg/hl)
MP 20	Di 10 - 18	21.6	76
MP 20	Di 8	20.2	77
MP 31	Di 10 - 18	22.7	76
MP 31	Di 8	23.3	76
Di 8	Di 10 - 18	19.5	76
Di 8	Ch 10 (pts)	19.3	75
Ch 10 (df)	Di 10 - 18	20.4	76
Ch 10 (df)	Ch 10 (pts)	19.6	76
Gly 2.24 kg/ha		19.5	75
LSD .05		2.9	NSD
CV (%)		10	2

[1]MP-Moldboard Plow, Di-Disc, Ch-Chisel with (pt) points or (df) duckfeet, Gly-Glyphosate.

followed by disking 8 cm. Due to the fact that most of the wild oats had shattered prior to harvest, there were not significant differences in test weight.

The tillage experiment at Lahoma was initiated on July 7, 1976, by applying the first tillage operations and herbicide application to the no-till treatment. Visual ratings of summer weed control in the cheat area 28 days later showed that only moldboard plowing at 15 cm controlled all the weeds (Table VI). All other initial operations controlled most of the summer annuals, but left some weeds living. However, in the downy brome area, all weeds were controlled by both moldboard plow treatments and the glyphosate application on the no-till plots. Visual evaluations of wheat stand vigor and brome control made 161 days after planting revealed that the highest cheat density (161-270 plants/m^2) and the highest mixed brome density in the downy brome area (54-161 plants/m^2) was present in the no-till programs (Table V). This was considered zero control on a 0-10 scale for evaluating other treatments. Both tillage programs where the moldboard plow was used gave excellent brome control in both areas. The program in which the disk was used for primary tillage gave some control, but other programs showed little or no brome control. Wheat vigor ratings are generally a reflection of the extent of cheat control. Severe stunting and lack of vigor was indicated in the no-till program and in the programs where the sweep or chisel was used for primary tillage. Wheat in the disk program also displayed stunting, but not as severe as in the previously mentioned programs. Wheat vigor reduction which could not be attributed to the presence of cheat was noted in the program which

TABLE VI

EFFECT OF TILLAGE PROGRAMS ON WEED CONTROL AND WHEAT PRODUCTION (LAHOMA, SUMMER OF 1976)

Tillage Program[1] (Depth cm)	Visual Ratings[3]: 28 Days After 1st Tillage[2]							Visual Ratings[3]: 161 Days After Pltg.		Harvest Data	
	TUP	KOC	HOW	WIL	REP	GRA	GUW	WH	BR	Yield (hl/ha)	Test Wt. (kg/hl)
Cheat Area											
1. MP 15; Di; SH 2X	10	10	10	10	10	10	10	0	9.9	29.6 a[4]	74.3 a
2. MP 23; Di; SH 2X	10	9	9	10	10	10	10	3	9.8	25.6 a	71.9 a,b
3. Di; Di; Di	9	8	9	9	10	10	10	2	3.0	25.8 a	72.1 a,b
4. Sw; Sw; Sw	9	8	10	10	10	9	10	5	0.0	17.5 b	70.3 b
5. Ch; Ch; Sw	9	9	9	9	10	10	10	5	1.0	17.7 b	70.2 b,c
6. Gly; ---; Gly	10	10	10	9	10	10	10	7	0.0	14.4 b	69.1 c
Downy Brome Area											
1. MP 15; Di; SH 2X	10	10	10	10	10	10	10	0	9.8	25.6[5]	75.7[5]
2. MP 23; Di; SH 2X	10	10	10	10	10	10	10	1	9.9	26.5	74.3
3. Di; Di; Di	8	8	9	9	10	9	10	2	5.0	23.6	72.9

TABLE VI (Continued)

Tillage Program[1] (Depth cm)	Visual Ratings[5]									Harvest Data	
	28 Days After 1st Tillage[2]							161 Days After Pltg.		Yield (hl/ha)	Test Wt. (kg/hl)
	TUP	KOC	HOW	WIL	REP	GRA	GUW	WH	BR		
Downy Brome Area (Cont.)											
4. Sw; Sw; Sw	9	7	10	10	9	10	10	5	1.0	23.4	73.4
5. Ch; Ch; Sw	9	9	10	10	10	10	10	3	3.0	23.1	73.3
6. Gly; ---; Gly	10	10	10	10	10	10	10	7	0.0	23.2	73.3

[1]MP-Moldboard Plow, Di-Disc, Sw-Sweep, Ch-Chisel, SH-Springtooth Harrow (2X=Twice), Gly-Glyphosate at 2.24 kg/ha.

[2]TUP-Tumble Pigweed, KOC-Kochia, HOW-Horseweed, WIL-Wild Lettuce, REP-Redroot Pigweed, GRA-Foxtail and Witchgrass, GUW-Gumweed, WH-Wheat, BR-Bromes.

[3]Visual ratings are based on a scale of 0-10, with 0 being no plant injury and 10 being complete plant kill or elimination. (Wheat "injury" is based on stand and/or vigor.)

[4]Numbers followed by the same letter are not significantly different at the 5% level of Duncan's new multiple range test.

[5]No significant difference at the 5% level.

moldboard plowing at 23 cm deep was used for primary tillage. Observations indicate lack of vigor in this program was due to surfacing of less productive subsoil by the deep moldboard plowing.

In the cheat area higher yields (Table VI) over all other programs were obtained by the programs using the moldboard plow at 15 cm and 23 cm deep or the disk for primary tillages. The moldboard plow at 15 cm gave a higher test weight than either the sweep, chisel, or no-till programs. All programs, with the exception of the chisel program, had higher test weights than the no-till program. Much of the cheat had shattered before the harvest, thus less impact was noted on test weights than on yield. There were no differences in yield or test weight between programs in the downy brome area. This is probably due to the lack of competition from the downy brome and cheat population present. However, it is significant to note that there were no differences due to tillage program alone.

Visual ratings taken 16 days after the first tillage or herbicide treatment in 1977-78 (Table VII) showed excellent summer weed control by all programs except the sweep program. This program gave adequate control of all species except prairie cupgrass in both areas. Visual ratings based on percent ground cover were also taken 29 days after the second tillage or one day before the final tillage (Table VIII). At this time in addition to summer annuals a population of brome and volunteer wheat had emerged. Evaluation of percent ground cover of summer annuals by species indicate that the moldboard plow 23 cm sweep and chisel programs provided better control of tumble pigweed than did the no-till, disc, and moldboard plow at 15 cm. All programs appeared to give better control of prairie cupgrass than the sweep program in the

TABLE VII

WEED CONTROL OBTAINED BY THE PRIMARY TILLAGE OPERATION (LAHOMA, SUMMER OF 1977)

Tillage Program[1] (Depth cm)	Visual Ratings[2] 16 Days After 1st Tillage[3]						
	TUP	KOC	WIL	REP	PCG	CW	GUW
Cheat Area							
1. MP 15; Di; SH 2X	9.9	9.7	10	10	9.0	9.9	10
2. MP 23; Di; SH 2X	10	8.0	9.9	10	10	10	9.9
3. Di; Di; Di	9.9	9.9	10	9.9	9.5	9.6	10
4. Sw; Sw; Sw	9.3	8.0	9.9	9.9	0.0	9.1	9.9
5. Ch; Ch; Sw	9.0	8.0	9.9	9.9	9.0	9.0	10
6. Gly; ---; Gly	10	10	9.9	10	9.9	10	10
Downy Brome Area							
1. MP 15; Di; SH 2X	10	9.9	10	10	9.2	10	10
2. MP 23; Di; SH 2X	10	9.0	10	9.9	9.2	10	9.9
3. Di; Di; Di	10	9.7	10	10	9.1	10	10
4. Sw; Sw; Sw	9.7	8.0	9.9	9.7	1.0	9.4	10
5. Ch; Ch; Sw	9.5	8.0	10	9.9	9.0	9.9	10
6. Gly; ---; Gly	9.8	9.6	9.0	9.8	9.8	9.5	10

[1]MP-Moldboard Plow, Di-Disc, Sw-Sweep, Ch-Chisel, SH-Spring-tooth Harrow (2X=Twice), Gly-Glyphosate at 2.24 kg/ha.

[2]Visual ratings are based on a scale of 0-10, with 0 being no plant injury and 10 being complete plant kill or elimination.

[3]TUP-Tumble Pigweed, KOC-Kochia, WIL-Wild Lettuce, REP-Redroot Pigweed, PCG-Prairie Cupgrass, CW-Carpetweed, GUW-Gumweed.

TABLE VIII

WEED CONTROL 29 DAYS AFTER THE SECOND TILLAGE (LAHOMA, SUMMER OF 1977)

Tillage Program[1] (Depth cm)	Visual Ratings[2]						
	TUP	KOC	REP	PCG	CW	VOL	BS[3]
Cheat Area							
1. MP 15; Di; SH 2X	11	0	0	1	2	7	0
2. MP 23; Di; SH 2X	5	6	0	0	1	3	0
3. Di; Di; Di	14	0	2	0	2	26	0
4. Sw; Sw; Sw	3	0	0	3	2	36	23
5. Ch; Ch; Sw	6	0	3	1	1	36	3
6. Gly; ---; Gly	25	0	1	0	0	25	26
Downy Brome Area							
1. MP 15; Di; SH 2X	9	0	0	1	3	10	0
2. MP 23; Di; SH 2X	7	3	1	1	2	8	0
3. Di; Di; Di	12	1	1	1	2	38	0
4. Sw; Sw; Sw	2	1	1	0	2	69	3
5. Ch; Ch; Sw	4	2	1	1	2	55	10
6. Gly; ---; Gly	9	0	0	1	0	50	25

[1]MP-Moldboard Plow, Di-Disc, Sw-Sweep, Ch-Chisel, SH-Spring-tooth Harrow (2X=Twice), Gly-Glyphosate at 2.24 kg/ha.

[2]Visual ratings are based on percent ground cover occupied by each species.

[3]TUP-Tumble Pigweed, KOC-Kochia, REP-Redroot Pigweed, PCG-Prairie Cupgrass, CW-Carpetweed, VOL-Volunteer Wheat, BS-Brome Species (mostly Cheat).

cheat area, but the opposite was true in the downy brome area, and all programs appeared to give better control of kochia than the moldboard plow at 23 cm program. Percent ground cover occupied by volunteer wheat was 18-33% lower in both moldboard plow programs than all other programs. Zero percent ground cover of the bromes was noted in both moldboard plow programs and the disk program as compared to 23% and 3%, respectively, for cheat and downy brome areas in the sweep program, 26% and 25% in the no-till program, and 3% and 10% in the chisel program. Further visual ratings (based on 0-10 scale) for cheat control and wheat vigor were taken 99 days after planting (Table IX), again revealing large differences in brome populations. In the cheat and downy brome areas, brome densities in treatments rated zero were 6,000-7,000 plants per m^2 and 22 to 32 plants per m^2, respectively. Both moldboard plow programs gave excellent brome control. The disk program gave some control, with other treatments giving little or no brome control. Wheat vigor was not affected in either of the moldboard plow programs or the disk program in the cheat area, but slight stunting was obvious in the sweep, chisel, and no-till programs. Yield of both combined or uncleaned grain, and cleaned grain for the cheat area, and yield of uncleaned grain for the downy brome area are reported in Table IX. Test weights are those of uncleaned grain. In the cheat area the only difference in yield of uncleaned grain was the higher yield obtained by the moldboard plow at 15 cm program over the no-till program. However, cleaned grain yield revealed that the moldboard plow at 15 cm program produced more wheat than all programs where the moldboard was not used. Also, both moldboard plow programs had higher yields than either the sweep, chisel, or no-till program. The disk program resulted in higher

TABLE IX

EFFECT OF TILLAGE PROGRAMS ON WEED CONTROL AND WHEAT PRODUCTION (LAHOMA, 1977-78)

Tillage Program[1] (Depth cm)	Visual Ratings[2] 99 DAP[3]		Harvest Data		
	WH	BS	Combine Yield (hl/ha)	Test Wt. (kg/hl)	Cleaned Yield (hl/ha)
Cheat Area					
1. MP 15; Di; SH 2X	0	9.9	33.5	76	33
2. MP 23; Di; SH 2X	0	9.9	31.5	74	31
3. Di; Di; Di	0	2.0	31.7	69	28
4. Sw; Sw; Sw	2	0.0	31.3	49	20
5. Ch; Ch; Sw	1	1.0	32.7	57	21
6. Gly; ---; Gly	2	1.0	30.2	63	25
		LSD .05[4]	2.8	10	5
		CV (%)	6	10	13
Downy Brome Area					
1. MP 15; Di; SH 2X	0	10	35.0	77	-
2. MP 23; Di; SH 2X	0	10	35.0	78	-
3. Di; Di; Di	1	6	33.0	74	-

TABLE IX (Continued)

Tillage Program[1] (Depth cm)	Visual Ratings[2] 99 DAP[3] WH	BS	Harvest Data: Combine Yield (hl/ha)	Test Wt. (kg/hl)	Cleaned Yield (hl/ha)
Downy Brome Area (Cont.)					
4. Sw; Sw; Sw	1	1	28.0	62	-
5. Ch; Ch; Sw	1	4	32.0	71	-
6. Gly; ---; Gly	2	0	30.0	75	-
		LSD .05	3.0	6	-
		CV (%)	6	6	-

[1]MP-Moldboard Plow, DI-Disc, Sw-Sweep, Ch-Chisel, SH-Springtooth Harrow (2X=Twice), Gly-Glyphosate.

[2]Visual ratings are based on a scale of 0-10, with 0 being no plant injury and 10 being complete plant elimination. (Wheat injury is based on stand and/or vigor.)

[3]DAP-Days After Planting, WH-Wheat, BS-Brome Species.

[4]LSD.05-Least significant difference at the 5% level.

yields than the chisel or sweep program. Generally, test weights are good indicators of the amount of cheat seed present in a grain sample, i.e., the lower the test weight the more cheat seed present. Both moldboard plow programs have higher test weights than either the sweep, chisel, or no-till programs. The disk program resulted in a higher test weight than the sweep or chisel program and the no-till program had a higher test weight than the sweep program. The test weight data corresponds closely to the yield data, which simply demonstrates that as the cheat yield increased the wheat yield decreased. The combined yield data indicates that with a cheat infestation, the amount of cheat seed produced reduces the wheat yield proportionally. In the downy brome area, combine yields indicated that the moldboard plow programs yielded more than either the sweep, chisel, or no-till programs, and the disk and chisel programs yielded more than the sweep program. Both moldboard plow programs also have higher test weights than either the sweep, chisel, or no-till programs, and all programs have higher test weights than the sweep program.

Visual ratings for summer annual weed control based on percent ground cover were taken 32 days after the primary tillage operation or chemical treatment (Table X) in 1978. The dominant species was tumble pigweed. The disk program gave the least control of tumble pigweed in both areas, with 53% and 43% ground cover as compared to an average of 31% and 18% ground cover by all other programs. Carpetweed, the second most abundant summer annual, appeared to be controlled best by moldboard plowing 23 cm deep or by glyphosate in the no-till program in the cheat area. In the downy brome area carpetweed was best controlled by the two moldboard plow programs. In both areas the no-till program contained

TABLE X

WEED CONTROL OBTAINED BY THE PRIMARY TILLATE OPERATION (LAHOMA, SUMMER OF 1978)

Tillage Program[1] (Depth cm)	Visual Ratings[2] 32 Days After 1st Tillage				
	TUP	KOC	REP	PCG	CW[3]
Cheat Area					
1. MP 15; Di; Di; SH 2X	33	1	1	0	8
2. MP 23; Di; Di; SH 2X	28	0	0	0	1
3. Di; Di; Di; Di	53	1	0	0	7
4. Sw; Sw; Sw; Sw	29	1	3	1	6
5. Ch; Ch; Ch; Sw	36	1	1	0	8
6. ---; Gly; Gly; Gly	29	4	2	3	3
Downy Brome Area					
1. MP 15; Di; Di; SH 2X	20	0	0	0	1
2. MP 23; Di; Di; SH 2X	11	0	1	0	0
3. Di; Di; Di; Di	43	1	3	2	3
4. Sw; Sw; Sw; Sw	20	2	3	7	4
5. Ch; Ch; Ch; Sw	26	1	1	4	4
6. ---; Gly; Gly; Gly	12	5	0	38	5

[1]MP-Moldboard Plow, Di-Disc, Sw-Sweep, Ch-Chisel, SH-Spring-tooth Harrow (2X=Twice), Gly-Glyphosate at 2.24 kg/ha.

[2]Visual ratings are based on percent ground cover occupied by each species.

[3]TUP-Tumble Pigweed, KOC-Kochia, REP-Redroot Pigweed, PCG-Prairie Cupgrass, CW-Carpetweed.

the highest populations of the remaining species (redroot pigweed, kochia, and prairie cupgrass), with the exception that the sweep program in the cheat area and the sweep and chisel program in the downy brome area contained 3% ground cover of redroot pigweed. In both areas prairie cupgrass was most prevalent in the sweep and no-till programs, with the highest population found in the no-till program.

Visual ratings taken 22 days after the second tillage operation were also based on percent ground cover (Table XI). Again, tumble pigweed was the dominant species present. The disk program again gave the least control of this species with 31% and 15% ground cover, followed by the moldboard plow at 15 cm program, with 17% and 7% ground cover, and the moldboard plow at 23 cm program with 8% and 3% ground cover, respectively, for the cheat and downy brome areas. The sweep, chisel, and no-till programs had 2, 3, and 9% and 2, 1, and 0% ground cover, respectively, for both areas. Other weed species present were adequately controlled by all programs, with the exception of prairie cupgrass in the sweep and no-till programs in the downy brome area.

Brome density estimates taken just prior to the final tillage and herbicide treatment showed no bromes emerging in either moldboard plow program (Table XII). However, significant populations had emerged in all other programs. The disk program had a population of approximately 226 plants/m^2 and 65 plants/m^2 in the cheat and downy brome areas, respectively. The sweep, chisel, and no-till program had very dense populations, ranging from 4,688 plants/m^2 to 6,280 plants/m^2 in the cheat area and 6,106 plants/m^2 to 9,328 plants/m^2 in the downy brome area.

The final tillage and herbicide treatments conducted after these estimates were made destroyed all emerged bromes and no cheat emerged

TABLE XI

WEED CONTROL 22 DAYS AFTER THE SECOND TILLAGE OPERATION (LAHOMA, SUMMER OF 1978)

Tillage Program[1] (Depth cm)	Visual Ratings[2]					
	TUP	KOC	REP	PCG	CW	VOL[3]
Cheat Area						
1. MP 15; Di; Di; SH 2X	17	0	0	0	1	0
2. MP 23; Di; Di; SH 2X	8	0	0	0	1	0
3. Di; Di; Di; Di	31	1	1	0	1	1
4. Sw; Sw; Sw; Sw	2	1	0	1	1	1
5. Ch; Ch; Ch; Sw	3	0	0	0	0	1
6. ---; Gly; Gly; Gly	0	1	0	0	0	0
Downy Brome Area						
1. MP 15; Di; Di; SH 2X	7	0	0	1	1	0
2. MP 23; Di; Di; SH 2X	3	0	0	1	0	0
3. Di; Di; Di; Di	15	0	0	1	1	1
4. Sw; Sw; Sw; Sw	2	0	0	8	1	1
5. Ch; Ch; Ch; Sw	1	0	0	1	0	1
6. ---; Gly; Gly; Gly	0	1	0	48	0	0

[1]MP-Moldboard Plow, Di- Disc, Sw-Sweep, Ch-Chisel, SH-Springtooth Harrow (2X=Twice), Gly-Glyphosate at 2.24 kg/ha.

[2]Visual ratings are based on percent ground cover occupied by each species.

[3]TUP-Tumble Pigweed, KOC-Kochia, REP-Redroot Pigweed, PCG-Prairie Cupgrass, CW-Carpetweed, VOL-Volunteer Wheat.

TABLE XII

EFFECT OF TILLAGE PROGRAMS ON WEED CONTROL AND WHEAT PRODUCTION (LAHOMA, 1978-79)

Tillage Program[1] (Depth cm)	Brome Density[2] (plts./m^2)	Harvest Data Yield (hl/ha)	Harvest Data Test Wt. (kg/hl)
Cheat Area			
1. MP 15; Di; Di; SH 2X	0	41[3]	77[3]
2. MP 23; Di; Di; SH 2X	0	44	78
3. Di; Di; Di; Di	226	46	78
4. Sw; Sw; Sw; Sw	6287	42	76
5. Ch; Ch; Ch; Sw	5156	44	76
6. ---; Gly; Gly; Gly	4694	44	76
	CV (%)	7	5
Downy Brome Area			
1. MP 15; Di; Di; SH 2X	0	42[3]	78[3]
2. MP 23; Di; Di; SH 2X	0	38	78
3. Di; Di; Di; Di	65	41	78
4. Sw; Sw; Sw; Sw	9328	36	72
5. Ch; Ch; Ch; Sw	6106	39	78
6. ---; Gly; Gly; Gly	6168	37	77
	CV (%)	15	4

[1]MP-Moldboard Plow, Di-Disc, Sw-Sweep, Ch-Chisel, SH-Springtooth Harrow (2X=Twice), Gly-Glyphosate at 2.24 kg/ha.

[2]Cheat and mixed brome densities were estimated just prior to the final tillage or herbicide treatment.

[3]No significant difference at the 5% level.

after this. Grain yield and test weight (Table XII) reflected the absence of the bromes by showing no significant differences between any program.

Planting Date

Analysis of the 1977 yield data (Table XIII) revealed that averaged over planting dates the wheat without cheat yielded 4.4 hl/ha more than wheat with cheat. Planting date means confirmed that seeding date has a major impact on yield. October 5 sown wheat yielded more than September, November, or December sown wheat. There was no planting date by main plot interaction, indicating that delayed seeding did not eliminate the cheat infestation. Since the wheat was harvested late in June, most of the cheat had shattered, thus there was little impact of cheat seed on test weight. However, October sown wheat still had higher test weights than either September or December sown wheat.

Pre-harvest visual ratings taken on May 23, 1978 (Table XIV), and based on a 0-10 scale indicate that some cheat had emerged in the plots designated as wheat without cheat. However, the only treatments having any notable cheat population were the October 21 and November 11 planting dates.

Ratings of wheat with cheat indicate little effect on cheat population due to planting date until the December planting. However, comparing ratings of the wheat where cheat was or was not present indicates that the presence of the cheat did affect wheat stand and vigor. Also, no matter whether cheat was or was not present, wheat stands were severely reduced by the December plantings.

TABLE XIII

EFFECT OF PLANTING DATE ON CHEAT AND WHEAT PRODUCTION (LAHOMA, 1977)

Planting	Yield (hl/ha)			Test Wt. (kg/hl)		
Date	W+C[1]	W-C	Mean	W+C	W-C	Mean
Sept. 10	17.2	23.1	20.1	71.3	73.3	72.2
Oct. 5	25.4	26.2	25.8	73.5	73.9	73.7
Oct. 22	20.7	24.6	22.7	73.0	74.2	73.7
Nov. 11	20.2	23.2	21.7	72.6	72.2	72.4
Dec. 2	18.6	21.3	19.9	70.2	72.0	71.1
Dec. 22	11.1	16.4	13.7	68.4	69.7	69.0
Vol. -	12.9	22.3	17.6	70.3	72.2	71.3
Mean[2]	18.0	22.4		71.3	72.5	
LSD .05[3]			3.2			1.4
CV (%)			15			2

[1]W+C=Cheat infested Wheat, W-C=Wheat with no cheat infestation.

[2]Analysis of variance indicates that at the .05 level of probability, averaged over all planting dates, wheat without cheat yielded more than wheat with cheat, but there was no significant difference between test weight average.

[3]LSD .05-Least significant difference at the 5% level.

TABLE XIV

EFFECT OF PLANTING DATE ON CHEAT AND WHEAT PRODUCTION (LAHOMA, 1978)

Planting Date	Visual Ratings[1] W+C WH	CH	SA	W-C[2] WH	CH	SA	Yield (hl/ha) W+C	W-C	Mean
Sept. 10	4	2	0	1	8	0	12.2[3]	23.3[3]	17.7
Oct. 5	5	2	0	0	9	5	16.9	32.5	24.7
Oct. 22	5	1	0	2	6	0	13.7	19.8	16.7
Nov. 11	9	0	0	3	8	35	10.1	14.4	12.3
Dec. 2	6	8	38	3	9.8	60	11.5	13.4	12.5
Dec. 22	8	9	70	9	9.6	92	7.4	4.8	6.1
Vol. -	9	0	0	8	8	0			
LSD .05							4.0	4.0	2.9
CV (%)									19

[1]Visual ratings for summer annuals (SA) were made May 23, 1978, and are based on percent of ground cover. Visual ratings for wheat (WH) and cheat (CH) are based on a scale of 0-10, with 0 being best plant stand and vigor and 10 being complete plant absence.

[2]W+C=Cheat infested wheat, W-C=Wheat with no cheat infestation.

[3]LSD .05-Between W+C and W-C at the same planting date = 3.5 hl/ha.

Ratings on percent of ground cover of summer annual broadleaf weeds (Table XIV) generally indicate where wheat stands were thinned by late planting summer annuals had emerged.

Analysis of the 1978 harvest data again demonstrated a yield loss due to cheat (Table XIV). Averaged over all seeding dates, the cheat infested area yielded 5.3 hl/ha less than the wheat area with no cheat. Also, October 5 seeded wheat again produced more yield than wheat seeded earlier or later. Wheat sown after October yielded less than September or October seeded wheat. More importantly, there was a seeding date by species interaction which indicated that cheat did not reduce the yield of December sown wheat. However, the yield of wheat sown in December, in the area without cheat, was less than one-half the yield of October 5 sown wheat in the same area. Within the cheat infested area, wheat sown October 5 yielded more than September, November, or December sown wheat, indicating that in a cheat infested field, delaying seeding until November to eliminate or reduce the cheat problem, will result in less wheat yield than sowing in early October. This observation appeared to hold true for both 1977 and 1978.

Wheat Variety Selection and Rate of Seeding

Wheat yield and test weight at Altus in 1977 (Tables XV and XVI) showed no evidence that use of a semi-dwarf variety increased the cheat problem. Averaged over all seeding rates, the semi-dwarf variety (TAM-W-101) yielded more than either Triumph-64 or Osage. Also, the only difference in test weight was the lower test weight of the tall variety Osage. However, when the wheat was harvested, the Osage had lodged and

TABLE XV

PERFORMANCE OF THREE WHEAT VARIETIES IN A CHEAT INFESTED AREA, AVERAGED OVER SEEDING RATES (ALTUS, 1977)

Varieties	Harvest Data Yield (hl/ha)	Test Wt. (kg/hl)
Osage	29.6	65.8
TAM-W-101	32.8	71.0
Triumph-64	29.0	72.2
LSD .05[1]	1.7	2.1
CV (%)	6	3

[1]LSD .05-Least significant difference at the 5% level.

TABLE XVI

AVERAGE EFFECT OF SEEDING RATE ON YIELD AND TEST WEIGHT IN A CHEAT INFESTED AREA (ALTUS, 1977)

Seeding Rate (kg/ha)	Harvest Data Yield (hl/ha)	Test Wt. (kg/hl)
33.6	28.2	66.6
67.2	32.2	70.3
100.8	31.3	71.4
134.4	30.5	71.1
LSD .05[1]	1.9	1.3
CV (%)	7	2

[1]LSD .05-Least significant difference at the 5% level.

the combine header had to be lowered closer to the ground to pick up the wheat, thus also picking up more cheat. There was no variety by seeding rate interaction for either yield or test weight. Averaged over all varieties, seeding rates at or above 67 kg/ha decreased the cheat problem, as indicated by yield and grain test weight at harvest compared to the 33 kg/ha seeding rate.

At Perkins in 1979, there were no differences between the two semi-dwarf varieties in yield or percent dockage obtained (Table XVII). There was no variety by seeding rate interaction; however, wheat seeded at 92 kg/ha contained less dockage at harvest than wheat seeded at 39, 50, or 68 kg/ha.

Row Spacings

At Stillwater in 1978, varying the row spacing from 15.2 to 35.6 cm significantly affected wheat yield, but differences are inconclusive (Table XVIII). However, when averaged over row spacings, wheat growing with cheat produced 6 hl/ha less than wheat growing without cheat. There was no significant effect of row spacing on dockage, but averaged over all row spacings the presence of cheat increased dockage by 9%. These results indicate that reducing row spacing from the standard 25.4 cm row would not be an effective method of reducing the dockage due to a cheat infestation.

Fertility Practice

Data from the fertility practice experiment indicates that both the quantity of fertilizer applied and the method of application can

TABLE XVII

EFFECT OF SEEDING RATE ON YIELD AND DOCKAGE IN A CHEAT INFESTED AREA (PERKINS, 1979)

Seeding Rate (kg/ha)	Yield (hl/ha)	Dockage (%)
39	34	13.2
50	35	11.4
68	33	13.0
92	36	5.7
115	36	8.5
LSD .05[1]	NSD[2]	4.8
CV (%)		45

[1]LSD .05-Least significant difference at the 5% level.

[2]NSD-No significant difference.

TABLE XVIII

EFFECT OF ROW SPACINGS ON YIELD AND DOCKAGE
WITH AND WITHOUT A CHEAT INFESTATION
(STILLWATER, 1978)

Row Spacing (cm)	Yield (hl/ha)			Percent Dockage	
	W+C	W-C[1]	Mean	W+C	W-C
15.2	34	41	37.3 a,b[3]	10	2
17.8	35	41	37.7 a	11	2
20.3	29	37	33.2 c	14	2
25.4	32	36	34.2 b,c	10	3
30.5	32	39	35.2 a-c	16	1
35.6	29	36	32.1 c	15	2
Mean[2]	32(b)	38(a)		11(a)	2(b)
CV (%)			9		

[1]W+C=Cheat infested wheat, W-C=Wheat with no cheat infestation.

[2]Analysis of variance indicates that at the .05 level of probability, averaged over all seeding rates, wheat without cheat yielded more and had less dockage than cheat infested wheat.

[3]Numbers followed by the same letter are not significantly different at the 5% level of Duncan's new multiple range test.

have a major impact on the utilization of nutrients by both cheat and wheat. Data on total combine yield of wheat and cheat together indicated yields were increased by all fertilizer treatments, except the two treatments where only a fall broadcast application was made. Comparison of treatments also reveals a clear, total yield advantage obtained by banding fertilizer with the seed rather than broadcasting before seeding. Recleaning the wheat and calculating percent dockage reveals some rather large differences due to fertilizer treatment. First, comparing treatments where no spring topdressing was applied, there are no differences in dockage at all. But when 33-0-0 was applied in the spring, the dockage was dramatically higher where no fall fertilizer was applied or where fall fertilizer was broadcast, compared to where fall fertilizer was banded. Perhaps the full impact of the influence of fertility practice is most apparent when the increase in wheat yield and the effect on cheat yield are calculated for each treatment, compared to the unfertilized check. These calculations indicate that with only a fall broadcast application, the increase in wheat and cheat production was similar. But when the spring topdressing was applied, the cheat responded much more to the nitrogen than the wheat did. The situation where no fall fertilizer was used also indicates that cheat responded more to topdressing than the wheat. These results are more easily understood by recalling the work of Carter et al. (10), who demonstrated that cheat has a more shallow root system than wheat. Cheat might therefore be in a better situation to intercept the nitrogen before the wheat as the nutrient leached down into the soil.

TABLE XIX

EFFECT OF FERTILITY PRACTICE ON YIELD AND DOCKAGE OF CHEAT INFESTED WHEAT (LAHOMA, 1978)

Fert. Applied (kg/ha) Fall (18-46-0)	Fert. Applied (kg/ha) Spring (33-0-0)	Total Yield (hl/ha)	Clean Grain Yield (hl/ha)	Dockage (%)	Yield Increase[1] (% of Unfertilized) WH	Yield Increase[1] (% of Unfertilized) CH	After Cleaning Test Wt. (kg/hl)
59 Band	0	18.3	16.6	10.0	+50	-14	72
123 Band	0	22.1	18.7	15.5	+69	+77	72
59 Band	168	21.2	18.2	14.2	+65	+59	71
123 Band	168	23.5	21.3	8.0	+93	+18	70
59 Broadcast	0	14.8	12.6	14.7	+14	+14	69
123 Broadcast	0	15.1	12.8	15.6	+16	+18	68
59 Broadcast	168	20.1	14.8	26.1	+35	+173	66
123 Broadcast	168	20.6	15.5	23.5	+40	+168	65
0	168	18.6	14.1	23.5	+28	+132	66
0	0	13.0	11.0	15.2	0	0	69
LSD .05[2]		2.7	2.9	10.5			NSD
CV (%)		9	13	44			4

[1]Percent yield increase obtained by fertilizer treatment, WH-Wheat, CH-Cheat.

[2]LSD .05-Least significant difference at the 5% level. NSD-No Significant Difference.

CHAPTER V

SUMMARY

Field experiments were conducted to determine the influence of selected cultural practices on the severity of Bromus species infestations in winter wheat.

In tillage experiments, tillage programs in which the moldboard plow was used for the primary tillage tool gave good control of the various brome species. However, programs utilizing stubble mulch type implements such as the Noble blade or chisel plow gave no control of the bromes, except when they were used late. Yield and test weight was consistently reduced in brome infestations where tillage practices consisted of no-tillage or use of the chisel plow or Noble blade for summer weed control and seedbed preparation. However, when these tillage programs were evaluated without the presence of winter annual bromes, there were no differences in yield or test weight due to tillage practice.

In wheat variety selection and rate of seeding experiments, there was no evidence that there was an influence on the severity of brome infestations due to varieties. However, seeding rates of 67.2 kg/ha and higher tended to increase yields and decrease dockage when compared to lower seeding rates. When the optimum seeding rate was obtained for these results, there were no further benefits from an additional increase in seeding rate.

Date of planting studies within a cheat infested area showed that wheat sown October 5 yielded more than September, November, or December sown wheat, indicating that in a cheat infested field, delaying seeding until November to eliminate or reduce the cheat problem will result in less wheat yield than sowing in early October.

Wheat yield was affected by row spacing but results are inconclusive. Test weight and percent dockage was not affected by varying row spacings, either with or without a cheat infestation. However, when averaged over all row spacings, wheat yield decreased and dockage increased in a cheat infested area, as opposed to an area where there was no cheat.

Data from the fertility practice experiment indicated that when no spring topdressing was applied, there were no differences in dockage (i.e., cheat present) when comparing band versus broadcast methods of application. But when 33-0-0 was applied in the spring, the dockage was drastically higher where no fall fertilizer was applied or where fall fertilizer was broadcast, compared to where fall fertilizer was banded. Treatments also revealed a clear total yield advantage obtained by banding fertilizer with the seed rather than broadcasting fertilizer prior to seeding.

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APPENDIX

RAINFALL DATA TABLES

TABLE XX

RAINFALL DATA - IRRIGATION RESEARCH STATION, ALTUS, OKLAHOMA (JULY 1, 1976- JUNE 30, 1977)

Date	Centimeters	Date	Centimeters
July 11	.2	Jan. 24	.1
July 29	1.4	Feb. 3	.3
Aug. 18	.1	Feb. 4	.2
Aug. 24	.1	Feb. 11	1.8
Aug. 28	1.0	Feb. 12	.4
Aug. 29	.1	Feb. 26	.9
Aug. 30	1.4	Feb. 27	.1
Aug. 31	1.4	Mar. 27	1.0
Sept. 9	.1	Mar. 28	.3
Sept. 13	1.6	Apr. 14	.1
Sept. 14	2.5	Apr. 15	2.1
Sept. 17	2.9	Apr. 17	4.1
Sept. 20	.6	Apr. 18	.4
Sept. 28	1.0	Apr. 20	.6
Oct. 7	.5	Apr. 21	.3
Oct. 8	.8	May 2	1.7
Oct. 16	.8	May 3	1.8
Oct. 24	.2	May 4	1.2
Oct. 27	.4	May 6	2.8
Oct. 28	.1	May 10	4.1
Oct. 29	1.8	May 11	.3
Oct. 30	2.2	May 20	3.0
Nov. 13	7.6	May 21	3.3
Nov. 15	.3	May 23	.1
Nov. 28	2.5	May 26	.4
Dec. 6	.3	June 1	1.1
Jan. 9	.2	June 22	.1
Jan. 13	1.4	June 23	2.3
Jan. 23	1.5	June 26	.2
		June 27	.4

TABLE XXI

RAINFALL DATA - NORTH CENTRAL RESEARCH STATION, LAHOMA, OKLAHOMA (JULY 1, 1976- JUNE 30, 1979)

Date	Centimeters	Date	Centimeters
July 1	.4	Jan. 13	.1
July 2	1.8	Jan. 23	.3
July 3	.3	Feb. 3	.1
July 16	.1	Feb. 12	3.0
July 29	.5	Feb. 26	.7
Aug. 2	.8	Mar. 3	.1
Aug. 3	.4	Mar. 11	2.2
Aug. 5	.2	Mar. 28	1.4
Aug. 6	2.5	Apr. 14	.4
Aug. 16	3.9	Apr. 18	2.5
Sept. 1	.4	Apr. 20	.5
Sept. 9	.1	Apr. 21	.1
Sept. 13	.3	Apr. 22	.1
Sept. 14	.5	Apr. 23	2.0
Sept. 16	1.2	Apr. 29	1.7
Sept. 17	.1	May 2	.4
Sept. 20	.4	May 3	.1
Sept. 25	1.8	May 4	.4
Sept. 26	1.3	May 6	1.4
Oct. 4	.3	May 17	4.3
Oct. 7	.4	May 20	2.3
Oct. 8	.5	May 23	5.1
Oct. 25	.1	May 27	1.5
Oct. 27	.4	May 31	2.7
Oct. 28	.1	June 1	.7
Oct. 29	.7	June 2	1.3
Oct. 31	2.9	June 13	.2
Nov. 12	.1	June 23	1.1
Jan. 6	.1	June 24	.4
Jan. 10	.5	June 25	2.9

TABLE XXI (Continued)

Date	Centimeters	Date	Centimeters
June 29	.8	Nov. 2	.2
July 8	5.1	Nov. 6	.1
July 22	.4	Nov. 8	1.4
July 26	.1	Nov. 9	1.6
July 27	.2	Nov. 29	.1
July 31	1.9	Dec. 1	.3
Aug. 2	1.0	Dec. 5	.4
Aug. 10	.1	Jan. 1	.1
Aug. 11	1.9	Jan. 16	.7
Aug. 12	1.3	Jan. 17	.3
Aug. 13	2.0	Jan. 19	.2
Aug. 14	2.1	Feb. 1	.1
Aug. 17	1.4	Feb. 2	.1
Aug. 18	.2	Feb. 9	.3
Aug. 19	.1	Feb. 13	3.2
Aug. 20	.6	Feb. 20	.2
Aug. 23	1.8	Mar. 3	.7
Aug. 25	3.0	Mar. 13	.3
Aug. 28	.7	Mar. 15	.4
Aug. 31	.1	Mar. 16	.6
Sept. 6	1.4	Mar. 23	.1
Sept. 11	.5	Mar. 24	.1
Sept. 13	.2	Apr. 3	.1
Sept. 14	.3	Apr. 4	1.8
Sept. 15	.1	Apr. 10	1.3
Sept. 16	.6	Apr. 15	.3
Sept. 17	.1	May 1	1.4
Sept. 21	.1	May 3	2.8
Oct. 10	.1	May 4	.7
Oct. 24	.4	May 6	.1
Oct. 30	.1	May 7	1.0
Oct. 31	.3	May 18	.2

TABLE XXI (Continued)

Date	Centimeters	Date	Centimeters
May 20	.9	Nov. 16	.3
May 21	.6	Nov. 17	.3
May 26	1.4	Nov. 22	.3
May 27	3.4	Nov. 26	.4
May 28	5.0	Nov. 26	.7
June 2	.1	Dec. 31	.4
June 5	2.5	Jan. 6	.1
June 6	.2	Jan. 12	.3
June 8	.2	Jan. 19	1.4
June 19	1.3	Jan. 30	.1
June 22	3.3	Feb. 7	.1
June 23	.3	Feb. 21	.2
July 6	.1	Feb. 28	.6
July 15	1.2	Mar. 2	2.8
July 22	.7	Mar. 18	5.1
July 23	1.3	Mar. 22	3.6
Aug. 3	.3	Mar. 23	.4
Aug. 4	1.3	Apr. 1	1.0
Aug. 5	.1	Apr. 4	1.3
Aug. 10	.1	Apr. 11	2.9
Aug. 11	.1	Apr. 18	.3
Aug. 26	.2	Apr. 22	.4
Aug. 28	1.2	Apr. 29	.5
Sept. 9	.1	May 2	2.5
Sept. 16	.3	May 3	3.9
Sept. 18	.4	May 4	2.4
Sept. 20	1.8	May 6	.1
Sept. 21	2.6	May 10	.8
Sept. 26	3.0	May 11	.1
Nov. 6	1.7	May 18	1.1
Nov. 12	.7	May 21	1.3
Nov. 15	1.5	May 27	.3

TABLE XXI (Continued)

Date	Centimeters
June 1	.1
June 6	.6
June 7	.3
June 8	.5
June 10	3.0
June 24	3.7

TABLE XXII

RAINFALL DATA - AGRONOMY RESEARCH STATION, PERKINS, OKLAHOMA (OCTOBER 1, 1978- JUNE 15, 1979)

Date	Centimeters	Date	Centimeters
Oct. 9	4.5	Apr. 1	1.5
Oct. 23	.5	Apr. 3	.2
Nov. 6	1.7	Apr. 4	.5
Nov. 13	.2	Apr. 11	4.6
Nov. 14	1.0	Apr. 18	.2
Nov. 15	3.0	Apr. 21	1.6
Nov. 16	.9	Apr. 28	.2
Nov. 17	.7	Apr. 29	.4
Nov. 21	.1	May 3	7.3
Nov. 22	.4	May 4	4.0
Nov. 25	.7	May 5	.5
Nov. 27	.8	May 11	.4
Jan. 2	1.1	May 19	.4
Jan. 7	.1	May 21	2.1
Jan. 8	.3	May 22	3.1
Jan. 11	.1	May 27	.8
Jan. 15	.3	May 28	.1
Jan. 18	2.9	June 7	.2
Jan. 26	.4	June 9	4.9
Jan. 27	.2	June 10	3.8
Jan. 30	.2		
Feb. 7	.6		
Mar. 3	2.3		
Mar. 17	.4		
Mar. 18	3.8		
Mar. 19	.5		
Mar. 20	.2		
Mar. 22	2.5		
Mar. 23	.1		

TABLE XXIII

RAINFALL DATA - AGRONOMY RESEARCH STATION, STILLWATER, OKLAHOMA (SEPT. 20, 1977- JUNE 10, 1978)

Date	Centimeters	Date	Centimeters
Sept. 29	.2	Mar. 15	.2
Oct. 5	.1	Mar. 23	.3
Oct. 6	.1	Mar. 24	1.6
Oct. 8	.2	Apr. 4	1.7
Oct. 24	2.1	Apr. 6	.6
Oct. 31	.7	Apr. 15	.3
Nov. 2	.9	Apr. 28	.1
Nov. 3	.1	Apr. 29	.6
Nov. 8	.8	May 1	1.3
Nov. 9	2.9	May 3	2.0
Dec. 5	.4	May 4	.7
Dec. 29	.2	May 6	.2
Dec. 31	.1	May 7	.6
Jan. 12	.4	May 18	.5
Jan. 17	.1	May 20	2.8
Jan. 19	.9	May 21	1.0
Jan. 25	.1	May 22	.1
Feb. 1	.2	May 26	.3
Feb. 7	.2	May 27	2.5
Feb. 8	.1	May 28	4.7
Feb. 9	.3	June 5	2.3
Feb. 12	1.5	June 6	.6
Feb. 13	3.5	June 7	.5
Feb. 15	.1		
Feb. 18	.1		
Feb. 28	.4		
Mar. 3	.1		
Mar. 7	1.4		
Mar. 8	.6		

VITA 2

Tomie Jack Runyan

Candidate for the Degree of

Master of Science

Thesis: CULTURAL CONTROL OF BROMUS SPECIES IN WINTER WHEAT

Major Field: Agronomy

Biographical:

Personal: Born May 8, 1951, at Lawton, Oklahoma, the son of Perry O. and Imogene Runyan; wife-Debbie Lee and son-Clayton Zachery.

Education: Graduated from Cache High School, Cache, Oklahoma, in May, 1969; received the Bachelor of Science degree in Agriculture from Cameron University, Lawton, Oklahoma, in May, 1976; completed requirements for the Master of Science degree in Agronomy at Oklahoma State University, Stillwater, Oklahoma, in May, 1980.

Professional Experience: Medical laboratory technician, U.S. Army, Specialist 5th class, 1971-72; construction worker and plumber's assistant, 1973-74; research technician, Oklahoma State University, September, 1976 through May, 1980.

Professional Organization: Southern Weed Science Society, Council for Agriculture Science and Technology.