DEVELOPMENT, COMPETITION AND CONTROL OF TANSY MUSTARD, JOINTED GOATGRASS AND FIELD BINDWEED IN WINTER WHEAT

By

LOYD VERNON HILL

Bachelor of Science
Oklahoma State University
Stillwater, Oklahoma
1956

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1969

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
July, 1976

DEVELOPMENT, COMPETITION AND CONTROL OF
TANSY MUSTARD, JOINTED GOATGRASS AND
FIELD BINDWEED IN WINTER WHEAT

Thesis Approved:

Paul W. Santelmann
Thesis Adviser

Jimmy F. Stritzke

Lester W. Reed

Eddie Basler

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

The author wishes to express his appreciation to his major adviser, Dr. P. W. Santelmann, for his guidance and assistance throughout this study. Appreciation is also expressed to the other committee members, Dr. Eddie Basler, Dr. Lester Reed and Dr. Jim Stritzke, for their invaluable assistance in the preparation of the final manuscript.

The author extends his appreciation to Northwestern Oklahoma State University for the use of land and equipment in conducting the field studies and for the year leave to complete the course work for the degree.

Credit is due to Mary, the author's wife, for her encouragement and patience while working on this project. Appreciation is also extended to the author's children, Wilma, April, Debra, Jane and Jack for their help and understanding during the furthering of his education.

Thanks is given to Troy Kirthart, Jack Reddick, and Jerry Sturgeon for their help in the field during the research project and to Diane Monn for the typing of this manuscript.

TABLE OF CONTENTS

LIST OF TABLES

Table | Page

CHAPTER I

INTRODUCTION

Weed control is important in order to maintain maximum production of winter wheat (Triticum aestivum L.) in Oklahoma. There are over 6 million acres of wheat planted each year in Oklahoma, which is more acres than all other cultivated crops in the state (9,18).

Tansy mustard (Descurinia pinnata (Walt.) Britt.), jointed goatgrass (Aegilops cylindrica Host.) and field bindweed (Convolvulus arvensis L.) are serious problems in winter wheat production in Oklahoma. Cultural practices, tillage methods and equipment used in the production of winter wheat have changed with time. One of the most recent changes involves utilization of minimum tillage practices (stubble-mulch plowing). This appears to be causing increasing weed problems, particularly with field bindweed and winter annual grasses. Chemical and mechanical weed control practices can better be evaluated if the yield reductions caused by different weed species were determined. In order to determine the profitability of controlling a specific weed problem the total cost for applying a particular control measure must be known as well as the economic loss if the weed problem is not controlled.

The purpose of this study was to (1) determine yield reductions of winter wheat as affected by weed growth of tansy mustard and jointed goatgrass at varied densities, (2) evaluate the effect of cultural practices upon tansy mustard and jointed goatgrass plant populations, (3) study the growth patterns of tansy mustard and jointed goatgrass, and (4) evaluate chemical control methods for the control of these two species and field bindweed.

CHAPTER II

LITERATURE REVIEW

Plant Species

Hard red winter wheat is a winter annual species which grows from 60 to 100 cm high. The inflorescence is a spike with 2 to 5 florets per spikelet (15). Winter wheat is adapted throughout Oklahoma, from the 46 cm rainfall area of the western Panhandle to the 152 cm rainfall areas of southeastern Oklahoma, with the greatest concentration of acreage located in the northcentral part of the state. Wheat grows best in well-drained, medium to fine-textured soils. Most wheat is seeded between September 15 and October 15 and varies widely with available moisture and grazing needs (18).

Tansy mustard is an annual herb. The stems are erect either simple or branched 1 to 8 dm tall. Leaves are oblong, alternate and pinnately dissected. Inflorescence is a raceme up to 3 dm long with yellow flower petals. Siliques are narrowly club shaped on widely divergent to erect pedicels. The weed is found in waste places and prairies, on dry or sandy soils, and is especially abundant in arid and semiarid regions. The plant is a native plant and is widely distributed throughout the United States (2).

Jointed goatgrass is a winter annual weedy grass with erect culms which are branching at the base, 40 to 60 cm tall. Its inflorescence is a cylindric spike with 2 to 5 florets per spikelet. Awns are very scabrous, those of upper spikelets about 5 cm long, those of lower spikelets progressively shorter. The weed is found in grainfields and waste places and was naturalized from Europe (2,15). Chaffin (8) reported jointed goatgrass as being a problem in wheat production in Oklahoma in 1947.

Field bindweed is a perennial herb, reproducing by seed and creeping roots. The root system is very extensive and may penetrate down 6 to 9 m. The stems are slender, long twining or spreading over surface of the ground. The flowers, usually borne singly in leaf axils, have white to pink corolla which are funnel-shaped. The fruit is 2 celled containing 4 seed which are ovoid, dull, dark brownish with 1 rounded and 2 flattened sides. The weed is found in waste places, grainfields and gardens and is able to grow under most cultivated conditions. It was introduced and naturalized from Eurasia (2). A most serious weed which occurs throughout Oklahoma (8), it was reported as becoming a serious problem in wheat production as early as 1907 in central and western Kansas (35).

Weed Competition

Weeds compete directly with crops for light, water and nutrients. The extent of competition varies with the crop species, weed species, weed duration in the crop, time of growth in crop and weed density (20). Blackman and Templeman (4) and Swan and Furtick (34) indicated that higher yield reductions due to weeds were associated with adequate early season moisture. Early season moisture apparently has the effect of establishing higher populations of weeds which later compete severely with the crop for available soil moisture. Wiese (39) found tansy mustard that emerged in October did not utilize soil moisture in excess of the amount of evaporation from bare soil until after March 15 at Bushland, Texas.

Weed populations of 1, 3, and 9 blue mustard (Chlorispora tellella (Willd.) DC) plants per .093 square meter decreased significantly the yield of winter wheat as weed populations increased at Pullman, Washington (33). Carter et al. (6) found that heavy stands of field pepperweed (Lepidium campestre L. R. Br.) reduced wheat yields by 45% and lesser degrees of infestation reduced the yield proportionately. Swan and Furtick (34) reported that one coastal fiddleneck (Amsinkis intermedia Fisch. and May) per .093 square meter reduced yields, although as weed populations were increased, wheat yields were not further decreased. Wiese and Davis (44) reported a correlation coefficient of -0.77 was obtained between the weight of tansy mustard infesting winter wheat and total dry matter of the wheat and a correlation coefficient of -0.73 between the weight of tansy mustard and grain yields. When a tansy mustard density of 1 plant per .093 square meter grew in a winter wheat crop the yield loss was estimated to be not less than 242 kg/ha.

Competition of weedy grasses has been observed and measured several times (4,7,26,27). Carter et al. (7) reported that cheat (Bromus secalinus L.) reduced yields of wheat. However, thick stands of wheat reduced cheat seed production, but the weed was not eradicated. Rydrych and Muzik (27) observed that wheat yields in Pullman, Washington were reduced 28 to 92% by 5 to 50 downy brome (Bromus tectorum L.) plants per .093 square meter. Downy brome competition was not proportional to weed population over the 3 year period, as the date of crop and weed emergence also were factors.

Competition tends to be greatest between plants of similar vegetative characteristics and climatic requirements such as soil, water, and nutrients. Grassy weeds, for example, compete more with cereals because they tend to have roots of similar spread and depth, and broadleaf weeds compete more in broadleaf crops (20,21).

Weed Development

Numerous investigators have been concerned with the viability of seed buried in the soil for varied periods of time (19,24,25,38). Lewis (19) reported the most rapid depletion of seed numbers in the soil took place during the first year of burial. Dormancy of the seed extends its life span in the soil. Roberts and Feast (24) in a 4 year study found the rate of loss of viable weed seeds in a soil was 34%, 42% and 56% from undisturbed soil and soil cultivated twice a year and seven times a year respectively. Seed of chickweed (*Stellaria media* (L.) Vill.), freshly harvested, when buried in 2 to 5 cm of soil germinated after 14 weeks. Seeds exposed to intermittent light all germinated at a range of constant and alternating temperatures whether moistened with water or potassium nitrate (25). Larger seeded weedy grasses such as downy brome exhibit primary dormancy following maturity. The period extends 4 to 5 weeks after which germination occurs readily at temperatures of 20 to 25^{o}C. Neither light nor alternating temperatures are requisite for germination (32).

The growth of seedlings of quackgrass (*Agropyron repens* (L.) Beauv. and black bentgrass (*Agrostis gigantea* Roth.) grew faster than wheat, mainly because they had a larger leaf area per plant. Tillering began first in wheat, but continued longer in weedy grasses, which eventually produced more shoots (45). Budd (5) working with annual bluegrass (Poa trivialis L.), showed that seedlings germinated in the early fall produced more and earlier seed heads the following spring than seedlings emerging later in the fall. Cheat plants tillered abundantly and produced large quantities of seed when in thin wheat stands (7). Pawlowski et al. (22), working with 102 weed species, found very small seeded annual plants produced the most seed per plant, while larger seeded annuals were less prolific and the perennial species were least prolific.

Cultural Methods and Weed Density

In cultivated crops such as wheat the weeds that are favored by the cultural practices will tend to persist. The method of management, especially cultivation, is often more critical than the crop species involved so far as determining the weed problem (20,39). Steinbauer and Grigsby (32) working with cheat and downy brome, found that plowing wheat residues under caused less emergence of the grass species of weeds in winter wheat when compared to other cultivation methods. Wicks et al. (38) reported downy brome seedling emergence was greatest from soil depth of 1 inch or less, but occasionally seedlings emerged from depths of 4 inches. They also reported the moldboard plow was more effective in reducing downy brome populations than a sweep plow or one-way disc in continuous winter wheat cropping systems.

The time of seeding is an important cultural practice in the production of wheat as Swan and Furtick (34) found that early established crops of wheat competed effectively with the broadleaf weed fiddleneck. Proper fertilization is another important cultural practice and increased usage of fertilizers is occurring in the production of wheat in Oklahoma (18). Fertilizers of 40 kg/ha of nitrogen, 40 kg/ha of phosphorus and 40 kg/ha of potassium in winter wheat helped suppress flixweed (Desurainia sophia (L.) Webb) (36).

Chemical Control

Field bindweed is a very persistent perennial weed which is difficult to control because many of the control measures later damage the crop (42,43). Phillips (23) using very high rates of fenac, 2,4,5-T, silvex and 2,3,6-TBA (chemical names of all herbicides used are listed in Table I) effectively controlled bindweed; however, subsequent crops were damaged for 2 years. Dicamba when applied at 4.5 kg/ha and picloram at 3.4 kg/ha both gave excellent control of bindweed but both damaged later crops (29,40). To reduce crop damage Lavake and Wiese (17) applied only 0.3 kg/ha of picloram for 3 to 4 years which did not injure wheat and gave excellent bindweed control. The combination of cultivation and 2,4-D for 3 years gave satisfactory control of bindweed without injury to wheat (28). Glyphosate has shown excellent control of field bindweed when used at 3.4 to 4.5 kg/ha (11).

In the more recent years several researchers have applied herbicides with the use of subsurface layering (SSL) for field bindweed control (1,3,10,16,30,37). Trifluralin applied with the use of a moldboard plow and flood spray nozzles at 4.5 kg/ha resulted in excellent bindweed control (37). Addison et al. (1) applied

TABLE I

COMMON AND CHEMICAL NAMES OF HERBICIDES

Common Names	Chemical Names
butralin	N-sec-butyl-4-tert-butyl-2,6-dinitroaniline
chlorpropham	isopropyl-m-chlorocarbanilate
cyanazine	2-(4-chloro-6-(ethylamino)-s-triazin-2-yl) amino)-2-methylpropionitrile
dicamba	N^4,N^4-diethyl-α,α,α-trifluoro-3,5-dinitrotoluene-2,4-diamine
fenac	(2,3,6-trichlorophenyl) acetic acid
fluchloralin	N-(w-chloroethyl)-2,6-dinitro-N-propyl-4-(trifluoromethyl) aniline
glyphosate	N-(phosphonomethyl) glycine
linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (N-(3,4-dichlorophenyl)-N-methoxy-N-methylurea)
methazole	2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione
metribuzin	4-amino-6-tert-butyl-3-(methylthio)-as-triazine-5-(4H) one
penoxalin	N(1-ethylpropyl)-3,4-dimethyl-1,2,6-dinitrobenzenamine
picloram	4-amino-3,5,6-trichloropicolinic acid
profluralin	N-(cyclopropylmethyl)-α,α,α-trifluoro-2,6-dinitro-N-propyl-p-toluidine
propham	isopropyl carbanilate
silvex	2-(2,4,5-trichlorophenoxy)propionic acid
terbutryn	2-(tert-butylamino)-4-(ethylamino)-6-(methylthio)-s-triazine(2-methylthio-4-ethylamino-6-tert-butyamino-s-triazine)
trifluralin	α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine
2,3,6-TBA	2,3,6-trichlorobenzoic acid
2,4-D	2,4-dichlorophenoxy acetic acid (amine salt)
2,4,5-T	(2,4,5-trichlorophenoxy) acetic acid (ester)

trifluralin by SSL and showed no yield reductions in wheat at 2.24 kg/ha. However, 4.5 kg/ha of trifluralin significantly reduced wheat yields. Banks et al. (3) applied trifluralin at 2.2, profluralin at 2.2 and 4.5 and dinitramine at 1.7 and 3.4 kg/ha by SSL and showed a significant yield increase compared to weedy check. Kemper et al. (16) applied several dinitroaniline herbicides by SSL for bindweed control, of which trifluralin, profluralin and dinitramine were the most effective when applied 12 to 14 cm deep. Cooley et al. (10) found that dinitroaniline herbicides subsurface layered 15 to 20 cm gave 87 to 100% control of bindweed for at least 2 months.

Greer (13,14) suggested the use of bromoxynil, dicamba, MCPA and 2,4-D for control of tansy mustard in wheat. Both MCPA and 2,4-D are approved for use in wheat while it is in tillering to jointing stage of growth. Dicamba is approved for use in the spring on winter wheat. Wiese (41) reported in preliminary evaluations that control of treacle mustard (Erysimun repandum L.) was good with linuron at 1.6 to 1.7, metribuzin at 0.3 to 0.6, linuron + 2,4-D ester at 0.6 + 0.13 and 0.6 + 0.3 and terbutryn at 1.1 to 2.2 kg/ha. Wheat injury was modest from all treatments. French et al. (12) reported cyanazine at 1.1, 2.2 and 3.4 kg/ha controlled mustard (Brassica spp.), particularly at higher rates with little injury to alfalfa (Medicago sativa L.).

CHAPTER III

METHODS AND MATERIALS

Field studies were conducted on a Pondcreek silt loam soil (fine silty mixed, Thermic, Pachic Argiustoll) or Yahola very fine sand loam soil (coarse, loamy, mixed, calcareous, Thermic Typic Ustifluvents) during the years of 1972, 1973, 1974 and 1975 near Alva, Oklahoma. Additional field studies were conducted near Keys, Oklahoma on Richfield silt loam soil (fine montmorillontic mesic Typic Argriustolls). Greenhouse and germination studies were conducted at Alva, Oklahoma. All experimental data was subjected to analysis of variance and Duncan's new multiple range test at .05% level of significance (31).

Jointed Goatgrass

Seed Burial

Freshly harvested fully mature seed of jointed goatgrass were buried 5.1, 10.2 and 15.2 cm in a field near Alva in Pondcreek silt loam soil June 15, 1974. A cotton cloth packet containing 0.9 kg of seeds, in the intact spikelet, were buried at each depth.

Seeds were removed from the three depths at monthly intervals for germination testing. A factorial design was utilized with factors of (a) depth of burial of seeds, (b) light or absence of light during germination and (c) different germinating temperatures. Fluorescent light was used for the light source, while darkness was achieved by enclosing the seeds in a double cardboard box. Three germinating temperatures were, 10°C. in laboratory refrigerator, room temperature of 21 to 25°C. and 30°C. in a seed germinator. Seeds were germinated in 10 cm petri dishes, with 100 of the appropriate caryopsis placed on a germination pad which had been moistened with water. The seeds were watered with tap water as needed to keep the germination pad moist. The number of germinating seeds were determined 14 days after removal from soil.

Depth of Emergence

Jointed goatgrass was seeded in 10 cm straight sided pots and placed in greenhouse September 18, 1974 to study the emergence from various depths. A randomized block design was used with 6 replications with the following treatments: seeds were planted 0.0, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0 and 8.0 cm deep.

Air dried Pondcreek silt loam soil was used in the study. The desired amount of soil was placed in bottom of pot while tamping, then 10 sound shelled seed of jointed goatgrass was scattered on the soil layer and the remaining soil added to the appropriate depth while tamping. The pots were initially subirrigated, then were surface irrigated daily and fertilized with 15-30-15 fertilizer every two weeks.

A greenhouse night temperature of 21°C. was maintained while the daytime temperature varied from 21 to 32°C. according to outdoor temperature and sunlight. An emerged plant count was taken 28 days after planting.

Growth Characteristics

Field Study I. Jointed goatgrass was seeded September 15, 1974 on Pondcreek silt loam soil with a garden planter. A randomized block design was used with 5 replications, and a plot size of 1.5 by 3.1 m. Plant spacing treatments of 15, 31, 61 and 91 cm spacing within rows and between rows was established. The initial seeding rate was a seed per 5 cm of row which was thinned to desired density 20 days after seeding. The number of tillers per plant and leaves per tiller was counted 34, 41 and 62 days after planting by counting three plants at random within each plot.

June 12, 1975 one plant per plot was selected at random from each plot and the number of spikes produced was determined. Ten spikes of the previous selected plants were taken at random and the number of seeds produced per spike was determined.

Competitive Effects of Jointed Goatgrass

Field Study IV. A study to determine the competitive effects of jointed goatgrass in winter wheat was established on a Yahola very fine sandy loam soil September 16, 1974. Tam 101 wheat was sown with a standard 20.3 cm drill. Jointed goatgrass was then seeded with garden planter between wheat rows at a rate of 12 seeds per 30.5 cm and at a depth of 2.5 cm. A randomized block arrangement of treatments with 5 replications was utilized. The treatments were:

a) weed free

b) 1 jointed goatgrass per 4.6 square meters

c) 2 jointed goatgrass per 4.6 square meters

d) 5 jointed goatgrass per 4.6 square meters

e) 10 jointed goatgrass per 4.6 square meters

f) 50 jointed goatgrass per 4.6 square meters

g) 100 jointed goatgrass per 4.6 square meters

The plot size was 1.5 (7 wheat rows) by 3.1 m with an alley width of 0.9 m and a 0.3 m alley between treatments.

Treatments were thinned to desired weed density October 6, November 2, 1974 and February 28, 1975. Fresh weed weight was determined from the first 3 replications by hand pulling weeds from within each plot, removing the soil from roots and weighing on June 22, 1975. Wheat yields were taken June 23, 1975, after trimming plots to an area of 1.5 by 3.1 m, by using a 1.5 m combine. A one minute cleaning time was allowed at the end of each plot and grain collected and weighed.

Cultural Methods Effect on Jointed Goatgrass

Field Study VI. The effects of tillage methods and seeding date of wheat on populations of jointed goatgrass were studied on the Pondcreek silt loam soil. Jointed goatgrass was seeded at a heavy rate with a hand seeder in wheat stubble on June 18, 1974. A split-plot randomized block arrangement of treatments with 6 replications was utilized. The main plot treatments, tillage methods, were: (I) moldboard plowing, and then discing twice, (II) stubble mulch sweeping (Noble Blade) three times, and (III) one-way plowing three times. The subplot treatments were wheat planting dates of September 15, October 6, and November 2, 1974. Each subplot area was 4.6 by 4.6 m.

The first tillage date was June 18, 1974. Assigned treatments were tilled as follows: I-moldboard plowing 15 to 18 cm deep, II-stubble mulch plowing at 10 to 12 cm deep, and III-one-way plowing at 10 to 12 cm deep. On July 12 and on September 2 the treatments were tilled as follows: I-tandem disced at a depth of 5 to 10 cm, II-swept at 10 to 12 cm, and III-tilled at 7.5 to 10 cm depth.

Tam 101 wheat was seeded into assigned subplots September 15, October 6 and November 2. All treatments were disced 5 to 7.5 cm deep immediately prior to wheat seeding to kill existing weeds and volunteer wheat.

Jointed goatgrass plants were counted March 9, 1975 from an area of 2.5 square meters taken at random within each plot. Wheat yields were taken with a 1.5 m combine June 21, 1975 after trimming plots to an area of 1.5 by 3.1 m. A cleaning time of one minute was allowed at the end of each plot and the grain collected and weighed.

<u>Herbicide Control of Jointed Goatgrass</u>

Field Study VIII. A study was established on the Pondcreek silt loam soil on September 20, 1974, to evaluate several herbicides for the control of jointed goatgrass in wheat. Treatments were applied with a water carrier in 280.5 l/ha with an experimental plot sprayer. The treatments were: metribuzin at 0.3 and 0.4; cyanazine plus metribuzin (tank mix) at 0.6 + 0.1, 0.6 + 0.3, 1.1 + 0.1 and 1.1 + 0.3; propham at 0.8, 1.7 and 3.4; chlorpropham at 0.8, 1.7 and 3.4 kg/ha and a weedy check. Treatments were applied September 20 (preplant), October 20 (preemergence) and November 3, 1974 (postemergence) in a randomized block design replicated 4 times. Plot size was 1.5 by 9.1 m. The preplant plots (September 20) were disced 5 to 7.5 cm deep after treatment and jointed goatgrass was seeded at a depth of 5 to 7.6 cm. Tam 101 wheat was sown in preplant treatments then wheat and jointed goatgrass seeds were mixed and sown together October 20 and then the preemergence herbicide treatments were applied. Postemergence treatments were applied when the wheat and jointed goatgrass were in 2 to 3 leaf stage of growth.

Visual ratings were obtained of jointed goatgrass control 14, 30, 41, 199, and 251 days after initial treatments were applied and wheat injury ratings were observed 41, 199 and 251 days after treatment. Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or no crop injury, ranging up to 10 which indicate complete weed control or crop kill. Wheat yields were determined by harvesting an area of 1.5 by 8.2 m with a 1.5 m combine 292 days after the initial treatment.

Tansy Mustard

Seed Burial

Freshly harvested fully mature seed of tansy mustard was buried 5.1, 10.2 and 15.2 cm deep in Pondcreek silt loam soil June 15, 1974. A cotton cloth packet containing 454 grams of seed was buried at each depth. All treatment methods, procedures and dates were the same as described for seed burial study with jointed goatgrass, with the exception that germination pad was moistened with 0.02% KNO_3 solution.

Depth of Emergence

Tansy mustard was seeded in 10 cm straight sided pots in the greenhouse to determine the depth from which the seedlings would emerge. A randomized block design was used with 6 replications with the following treatments: 0.0, 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 and 4.0 cm planting depth.

The desired amount of air dried Pondcreek silt loam soil was placed in the bottom of the pot while tamping, then 25 tansy mustard seeds were scattered on the soil surface and the remaining soil added with continuous tamping. Pots were subirrigated initially and on alternate days and fertilized with 15-30-15 fertilizer every two weeks. An emerged plant count was made 20 days after planting.

A greenhouse temperature of 21^{o}C. was maintained at night and day temperatures varied from 21 to 32^{o}C. depending upon the outdoor temperatures and intensity of sunlight.

Growth Characteristics

Field Study II. Tansy mustard was seeded on finely tilled Pondcreek silt loam soil September 15, 1974 with a hand seeder. A randomized block design with 5 replications and plot size of 1.5 by 3.1 m was established October 5. The treatments were 15, 31, 61, and 91 cm spacing between plants. The number of leaves per rosette were counted 34, 41, and 62 days after planting by counting leaves of three plants selected at random per plot. Plant densities were maintained by hoeing at 34, 41 and 62 days after seeding.

June 1, 1975 one plant per plot was selected at random and plant height, number of leaves, branches and siliques produced per plant was determined. Ten siliques of the previous selected plants were taken at random and the numberof seed produced per silique was determined.

Ecotype Study

Field Study III. A study was established October 5, 1974 to determine if ecotypes exist within the tansy mustard species. A randomized block design with plot size of 1.5 by 3.1 m and three replications were utilized. Seeds were collected from native populations at:

a) Lubbock, Texas

b) Amarillo, Texas

c) Colby, Kansas

d) Coldwater, Kansas

e) Pratt, Kansas

f) Guymon, Oklahoma

g) Seiling, Oklahoma

h) Medford, Oklahoma

i) Alva, Oklahoma

The seed sources represented a north to south distance of 670 kilometers from Colby, Kansas to Lubbock, Texas and an east to west distance of 400 kilometers from Medford, Oklahoma to Guymon, Oklahoma.

The soil, Yahola very fine sandy loam, was tilled finely before seeding. The seed was seeded by hand within each plot then raked very lightly with a garden rake. The plots were thinned to 5 plants per 0.93 square meters November 2 and further thinned to 1 plant per

.093 square meters Marcy 1, 1975. Height of plant measurements were made of 4 plants per plot selected at random on March 22. Initiation of flowering observations were made March 29, April 5, April 12, April 26, May 3 and May 10. Three plants per plot were selected at random on June 1 and the height of plant, number of branches and number of siliques produced were determined. Ten siliques were selected at random from each of the selected plants and the number of seed produced per silique was determined.

Competitive Effects of Tansy Mustard

Field Study V. A study to determine the competitive effects of tansy mustard in winter wheat was established on Yahola very fine sandy loam soil September 16, 1974. Tam 101 wheat was sown with a disc grain drill in 0.2 m rows. A very heavy rate of tansy mustard was sown on the surface of soil with a hand seeder. A randomized block design with 5 replications and a plot size of 1.5 (7 wheat rows) by 3.1 m was utilized. An alley of 0.9 m between replications and 0.3 m between treatments was established with the following treatments:

a) weed free

b) 1 tansy mustard plant per 4.6 square meters

c) 2 tansy mustard plants per 4.6 square meters

d) 5 tansy mustard plants per 4.6 square meters

e) 10 tansy mustard plants per 4.6 square meters

f) 50 tansy mustard plants per 4.6 square meters

g) 100 tansy mustard plants per 4.6 square meters

Plots were thinned to desired weed densities October 6, 1974, February 28 and March 12, 1975. The thinning was accomplished by hand pulling excess plants within a 1.5 by 1.5 m square frame which was subdivided with heavy cord into areas of .093 square meters.

Fresh weed yields were determined on June 22 by hand pulling weeds from within each plot, removing soil from roots, and weighing. Wheat yields were obtained June 23 by using a 1.5 m combine. A cleaning time of one minute was allowed at the end of each plot and grain collected and weighed.

Cultural Methods Effect on Tansy Mustard

Field Study VII. An experiment was established June 18, 1974 on the Pondcreek silt loam soil to study the effects of tillage methods and wheat seeding date on population of tansy mustard. Tansy mustard was seeded with a hand seeder June 18, 1974. All treatment methods, procedures and dates were the same as described for field study number VI with jointed goatgrass.

Tansy mustard plants were counted March 2, 1975 from an area of 2.5 square meters taken at random within each plot. Wheat yields were obtained on June 20 using a 1.5 m combine, after trimming plots to an area of 1.5 by 3.1 m.

Herbicide Control of Tansy Mustard

Field Study IX. A study was established near Alva on the Pondcreek silt loam soil to evaluate herbicides for the control of tansy mustard. The treatments were applied with a water carrier in 280.5 l/ha and replicated 4 times in a randomized block arrangement. Treatments, applied with a hand plot sprayer were: chlorpropham at 1.1 and 2.2; propham at 1.1 and 2.2; terbutryn at 0.6, 0.8, 1.1, 1.7 and 2.2;

metribuzin 0.6, 1.1 and 2.2; 2,4-D (amine) at 0.6; linuron at 0.6 and 0.8; cyanazine at 0.6, 0.8 and 1.1; dicamba at 0.1, 0.3 and 0.6; methazole plus dicamba (tank mix) at 0.6 + 0.1, and 0.8 + 0.1; methazole at 1.1 and 2.2 kg/ha, and a weedy check. The treatments were applied February 25, 1976 when wheat was in 6 to 10 tiller dormant stage and tansy mustard was in the rosette stage. The high temperature on the day previous to treatment was $3^{o}C$ and $7^{o}C$ on day of application.

Visual ratings of weed control and wheat injury were made 22 and 56 days after treatment. Wheat yields were obtained 116 days after treatment from an area 1.5 by 7.62 of each plot with a 1.5 m combine.

Field Study X. A study to evaluate the effect of herbicide application on the control of tansy mustard was established on Yahola very fine sandy loam soil near Alva. Herbicides were applied on October 13, 1973 (preemergence); October 27 (wheat 2 to 3 leaf stage) or February 2, 1974 (wheat dormant stage). Treatments were replicated 4 times in a randomized block design and applied with a water carrier in 280.5 l/ha with an experimental plot sprayer. Tansy mustard was hand seeded after the Tam 101 wheat was sown with 0.2 m disc grain drill October 13, 1973. The treatments were: terbutryn at 0.6, 0.8 and 1.1 (preemergence); metribuzin at 0.3, 0.4 and 0.6 (2 to 3 leaf stage of wheat); metribuzin at 0.3, 0.6 and 1.1; chlorpropham at 0.6, 0.8, and 1.1; propham at 0.6 and 1.1; terbutryn at 0.6, 1.1 and 2.2; 2,4-D amine at 0.1; cyanazine at 0.3, 0.6 and 1.1 kg/ha and check. The treatments were applied when wheat was in dormant stage except where indicated otherwise. The first rainfall was 1.5 cm which fell October 18.

Visual ratings were made 14, 77, 112 and 156 days after initial treatments were applied on tansy mustard and wheat. Yields of wheat were obtained 239 days after initial treatment by harvesting with a 1.5 m combine from an area of 1.5 by 6.1 m from each plot.

Field Study XI. A study was established to further evaluate the effects of time of application of herbicides for tansy mustard control in winter wheat in 1974. The study was located near Capron on a Pondcreek silt loam soil. Treatments were replicated 4 times in a randomized block design and applied with a water carrier in 280.5 l/ha with an experimental plot sprayer. Scout 66 wheat was planted October 9 with 0.2 m disc wheat drill, then tansy mustard was seeded with a hand seeder. When wheat was in 2 to 3 leaf stage October 19, 1974 the following treatments were applied; metribuzin at 0.3; cyanazine plus metribuzin (tank mix) at 0.6 + 0.1, 0.6 + 0.3, 1.1 + 0.1 and 1.1 + 0.3; cyanazine at 0.6 and 1.1 kg/ha. When wheat was in 7 to 9 tiller stage and tansy mustard was in rosette stage on December 28, the following treatments were applied: propham at 0.6, 0.8 and 1.1; metribuzin at 0.3 and 0.4; cyanazine plus metribuzin (tank mix) at 0.6 + 0.1, 0.6 + 0.3, 1.1 + 0.1 and 1.1 + 0.3; cyanazine at 0.6 and 1.1; and 2,4-D at 0.3 kg/ha. When wheat was in 9 to 12 tiller stage and tansy mustard was beginning to break dormancy on March 1, 1975, the following treatments were applied: propham at 0.6, 0.8 and 1.1; metribuzin at 0.3 and 0.4; cyanazine plus metribuzin (tank mix) at 0.6 + 0.1, 0.6 + 0.3, 1.1 + 0.1 and 1.1 + 0.3; cyanazine at 0.6 and 1.1 kg/ha.

Visual ratings were made 24, 101, 142 and 176 days after initial treatment of wheat and tansy mustard. Wheat yields were taken 262 days after the initial treatment from an area 1.5 by 6.1 m using a 1.5 m combine.

Field Bindweed

Topical Applied Herbicides

Field Study XII. An experiment was established near Alva on Pondcreek silt loam soil to evaluate several herbicides for field bindweed control in winter wheat. The treatments were: 2,3,6-TBA + polymer (SRC 176) (tank mix) at 0.3 + 0.07, 0.6 + 0.14, 1.1 + 0.28, 2.2 + 0.56 and 4.5 + 1.12; 2,4-D plus polymer (SRC 176) at 0.6 + 0.14; 2,4-D plus polymer (SRC 177) at 0.6 + 0.14; and glyphosate (acid equivalent) at 3.4, 5.6 and 7.8 kg/ha and check. The polymers, provided by Scientific Research Corporation, Alva, Oklahoma were designed to extend the life of herbicides. The treatments were replicated 4 times in a randomized block design and applied with a water carrier in 280.5 l/ha with the exception of 2,4-D + polymer treatments which were applied with an acetone carrier in 280.5 l/ha. The treatments were applied September 13, 1972, with a hand plot sprayer to field bindweed in bud to blooming stage. Triumph wheat was planted September 27, 1972.

Visual ratings of bindweed control were taken 10, 17, 31, 249, 335 and 388 days after treatment and wheat injury ratings were obtained 31 days after herbicide treatment. Wheat yields were taken from an area of 1.5 by 6.1 m with a 1.5 m combine, 281 days after herbicide treatment.

Field Study XIII. An experiment was established on Pondcreek silt loam soil near Alva to evaluate two herbicides applied pre-harvest to winter wheat. The treatments were applied on May 26, 1973 and were: glyphosate at 3.4, 4.5 and 5.6 kg/ha, 2,4-D low volatile ester at 1.1, 2.2 and 3.4 kg/ha and a weed check. The treatments were replicated 4 times in a randomized block design and applied with a water carrier in 280.5 l/ha with a hand plot sprayer. Triumph wheat was planted September 27, 1972.

Visual ratings were taken of bindweed control 22, 78, and 131 days after treatment. Wheat yields were taken from an area of 1.5 by 6.1 m with a 1.5 m combine 26 days after herbicide treatment. The treatments were moldboard plowed 28 days after treatment, and disced 57 and 100 days after treatment.

Field Study XIV. A study was established on Pondcreek silt loam soil near Alva to evaluate two herbicides when applied in late summer for bindweed control in winter wheat. The treatments were glyphosate at 3.4, 4.5 and 5.6 kg/ha applied on August 13, 1973, when bindweed was in runner stage of growth; and glyphosate at 3.4, 4.5, and 5.6 kg/ha, dicamba at 2.2, 3.4 and 4.5 kg/ha applied August 24 when bindweed was in a blooming stage of growth. The treatments were replicated 3 times in a randomized block design and applied with a water carrier in 187 l/ha using an experimental plot sprayer. Centurk wheat was sown October 13, 1973.

Visual ratings of bindweed control and wheat injury were made 68 and 306 days after initial herbicide treatment. Wheat yield was obtained from an area 1.5 by 4.57 m with a 1.5 m combine from each plot, 306 days after initial herbicide treatment.

Field Study XV. A study to evaluate two herbicides when applied at two stages of growth to bindweed was established on a Richfield silt loam soil near Keys, Oklahoma. The treatments were the same as used in field study XIV but were applied on August 8, 1973 when bindweed was in runner stage of growth and on August 20, 1973 when bindweed was in blooming stage of growth. The treatments were replicated 3 times in a randomized block design and applied with a water carrier in 187 l/ha using an experimental plot sprayer. Wheat was not sown in the plots.

Visual ratings were taken 12, 71, 293 and 373 days after initial treatments were applied.

Field Study XVI. Another experiment was established on the Richfield silt loam soil in 1975 to evaluate topical applied herbicides for control of field bindweed in winter wheat. The treatments were: picloram at 0.6, 1.1 and 1.7; dicamba at 2.2, 4.5 and 6.7; 2,4-D at 1.1, 2.2 and 4.5; glyphosate at 2.2, 3.4 and 4.5 kg/ha; and weedy check. The treatments were replicated 3 times, with a plot size of 3.05 by 15.2 m, in a randomized block design and were applied to field bindweed which was blooming on July 12, 1975. The treatments were applied with a water carrier in 280.5 l/ha with a plot sprayer. Wheat was sown October 7, 1975 but failed to emerge because of drought.

Visual ratings were made 316 days after the treatments were applied.

Subsurface Applied Herbicides

Field Study XVII. A study was established on Pondcreek silt loam soil near Alva on August 17, 1973, to evaluate several dinitroaniline herbicides when applied with a 3-sweep blade in a subsurface layer (SSL) for bindweed control. The treatments were: trifluralin at 2.2 and 4.5; dinitramine at 1.7; profluralin at 2.2 and 4.5; and butralin at 3.4 kg/ha. The treatments were replicated 3 times in a randomized block design and applied with a water carrier 280.5 l/ha at a soil depth of 15 cm. The plot sizes were 3.05 by 60.9 m with a treated area of 2.13 by 60.9 m. Tam 101 wheat was sown October 15, 1973.

Visual ratings of bindweed control and wheat injury were made 64 and 286 days after treatment. Wheat yields were obtained 297 days after treatment from an area 1.5 by 57.9 m of each plot with a 1.5 m combine.

Field Study XVIII. Another SSL study was established on Richfield silt loam soil near Keys August 21, 1973, to further evaluate several dinitroaniline herbicides. The SSL treatments were: trifluralin 2.2, 3.4 and 4.5; dinitramine 1.7 and 3.4; profluralin at 2.2, 3.4 and 4.5; butralin at 3.4, 4.5 and 6.7 kg/ha and control. Treatments were replicated 4 times, applied with a water carrier in 280.5 l/ha, and applied at a soil depth of 15 to 20 cm. The plot size was 3.1 by 60.9 m with a treated area of 2.1 by 60.9 m. Scout 66 wheat was sown with 0.2 m disc grain drill September 15, 1974, over a year after treatment.

Visual ratings of bindweed control were taken 59, 276, 356, 631 and 1006 days after treatment and wheat injury ratings were taken 631 days after treatment. Plots were harvested 631 days after treatment with a combine from an area of 3.05 by 57.9 m.

Field Study XIX. A similar SSL study was established on the Richfield silt loam soil on July 12, 1975. The treatments utilized this time were: 2,4-D (amine) at 1.1, 2.2 and 4.5; 2,4,5-T (ester) at 2.2, 4.5 and 6.72; picloram at 0.6, 1.1 and 2.2; trifluralin at 1.1, 2.2 and 3.4; butralin at 2.2, 3.4 and 4.5; profluralin at 2.2, 3.4 and 4.5; penoxalin at 1.1, 2.2 and 3.4; and fluchloralin at 2.2, 3.4 and 4.5 kg/ha, with an untreated check. The treatments were replicated 3 times in a randomized block design, applied with a water carrier in 280.5 l/ha in water to plots 2.5 by 30.5 m. The treatments were applied with a sweep-blade 15 to 20 cm below the soil surface. Scout 66 wheat was sown October 7, 1975, but failed to emerge because of drought.

Visual ratings were made of field bindweed control 316 days after treatment.

CHAPTER IV

RESULTS AND DISCUSSION

Seed Burial

Seeds of jointed goatgrass and tansy mustard were buried to determine the effects of depth of burial, duration of burial, temperature and light on the germination of seed. Seeds were sometimes moldy which may account for lower viability of tansy mustard.

Results of seed burial at 5.1, 10.2 and 15.2 cm of jointed goatgrass showed that germination was at a peak 2 months after burial (Table II). The viability of the seed decreased significantly after 6 months of burial. The highest percentage of germination was obtained during the period of August 15 through December 15. Burial depth of 10.2 and 15.2 cm decreased significantly the percentage of germination when compared to seed buried 5.1 cm when averaged over duration of burial, temperature and light factors. Light during germination had no effect on the germination of jointed goatgrass when averaged over duration of burial, temperature and depth of burial (Table III). Temperatures of 10 and 30^{o}C. had significantly less germination when compared to seed germinated at 21 to 25^{o}C. when averaged over other factors.

Results of tansy mustard seed burial showed a significant increase in percentage of germination between 2 and 3 months after burial and

TABLE II

EFFECTS OF BURIAL DURATION AND BURIAL DEPTH ON THE GERMINATION OF JOINTED GOATGRASS

Months of Burial	Percent Germination[1]			
	5.1 cm[2]	10.2 cm	15.2 cm	Average
0	2 o[3]	3 no	3 o	2.7
1	8 l-n	9 l-n	6 m-o	7.6
2	66 a	59 b	45 d	56.8
3	60 b	44 d	48 cd	50.8
4	49 cd	52 c	49 cd	50.0
5	58 b	57 b	47 cd	54.0
6	52 c	50 cd	39 e	47.1
7	45 d	27 fg	23 gh	31.8
8	30 f	17 h-j	16 ij	20.8
9	28 f	22 k	14 j-k	21.1
10	20 hi	13 j-l	9 k-m	13.9
11	16 ij	9 l-n	7 n-o	10.3
Average	36.2	30.2	25.4	

[1]Mean germination percentage when averaged over effects of light and germinating temperatures.

[2]Depth of burial of seeds.

[3]Numbers followed by the same letter are not significantly different at the 0.05 level.

TABLE III

EFFECTS OF LIGHT AND TEMPERATURE ON THE GERMINATION OF JOINTED GOATGRASS

Germinating Temperature	Percent Germination[1] 12 Hours Light	24 Hours Darkness	Average
10°C	28 b[2]	28 b	28.2
21 - 25°C	37 a	35 a	36.3
30°C	27 b	28 b	27.2
Average	30.7	30.3	

[1]Mean germination percentage when averaged over effects of burial depth and burial duration.

[2]Numbers followed by the same letter are not significantly different at the 0.05 level.

significant increase between 3 and 4 months after burial, therefore, the percentage of germination was not affected by burial time (Table IV). Burial depth of tansy mustard seed in the ranges utilized was not shown to affect the percentage of germination of seed. Fluorescent light for 12 hours and 12 hours of darkness increased significantly the percentage of germination when compared to seeds germinated in 24 hours of darkness (Table V). Germination temperature of 21 to 25°C. significantly increased the percentage of germination of tansy mustard seed when compared to seed germination at 10°C. and 30°C. when seeds were germinated in presence of 12 hours of light.

Depth of Emergence

The emergence depth of jointed goatgrass and tansy mustard was studied in Greenhouse Studies I and II.

Jointed goatgrass seeds placed at a depth of 3 cm and shallower in soil were not significantly different in the number of seedlings produced (Table VI). Seedling emergence from depth of 4.0 and 5.0 cm were not significantly different but had significantly less seedling emergence than seeds placed above 3.0 cm in the soil. Seeds of jointed goatgrass placed at 6.0, 7.0 and 8.0 cm in soil produced significantly fewer seedlings than those at 5.0 cm and shallower, which indicates that jointed goatgrass emerges primarily from depths of 5.0 cm or less. Seedlings that did not emerge from lower depths appeared to have expended the seed's energy resources before reaching the soil surface and died.

Tansy mustard depth of emergence study (Greenhouse Study II) showed significantly more seedlings emerged from the 0.25 to 0.5 cm

TABLE IV

EFFECTS OF BURIAL DURATION AND BURIAL DEPTH ON THE GERMINATION OF TANSY MUSTARD

Months of Burial	Percent Germination[1]			
	5.1 cm[2]	10.2 cm	15.2 cm	Average
0	0 h[3]	1 h	0 h	0.4
1	1 h	1 h	0 h	0.7
2	2 gh	2 gh	1 h	1.7
4	15 a	13 ab	8 d-f	12.3
5	14 ab	12 a-e	12 a-e	12.4
6	12 a-e	11 b-e	12 a-e	11.7
7	11 b-e	12 a-e	12 a-e	11.5
8	10 b-e	11 b-e	13 ab	11.2
9	10 b-e	10 b-e	12 a-e	10.6
10	11 b-e	11 b-e	11 b-e	10.8
11	10 b-e	13 ab	12 a-e	11.6
Average	8.5	8.7	8.3	

[1]Mean germination percentage when averaged over effects of light and germinating temperatures.

[2]Depth of burial of seeds.

[3]Numbers followed by the same letter are not significantly different at the 0.05 level.

TABLE V

EFFECTS OF LIGHT AND TEMPERATURE ON THE GERMINATION OF TANSY MUSTARD

Germinating Temperature	Percent Germination[1]		
	12 Hours Light	24 Hours Darkness	Average
$10^{o}C$	12 b[2]	4 c	8.0
21 - $25^{o}C$	17 a	5 c	11.4
$30^{o}C$	9 b	3 c	6.2
Average	12.9	4.1	

[1]Mean germination percentage when averaged over effects of burial depth and burial duration.

[2]Numbers followed by the same letter are not significantly different at the 0.05 level.

TABLE VI

EFFECTS OF PLANTING DEPTH ON EMERGENCE OF JOINTED GOATGRASS AND TANSY MUSTARD SEEDLINGS

Planting Depth	Mean Percentage of Emergence	
	Jointed Goatgrass	Tansy Mustard
0.0 (Surface Planted)	81.6 a[1]	58.6 b[1]
0.25 cm	-	77.3 a
0.5 cm	95.0 a	71.3 a
1.0 cm	90.0 a	44.0 c
1.5 cm	-	19.3 d
2.0 cm	93.3 a	8.0 e
2.5 cm	-	0.0 e
3.0 cm	85.0 a	0.0 e
3.5 cm	-	0.0 e
4.0 cm	56.6 b	0.0 e
5.0 cm	41.6 b	-
6.0 cm	18.3 c	-
7.0 cm	8.3 c	-
8.0 cm	5.0 c	-

[1]Numbers in each column followed by the same letter are not significantly different at the 0.05 level.

soil depth than all other depths of seed placement (Table VI). Seeds planted on the surface developed significantly more seedlings than seeds planted at 1.0 cm depth and deeper. Plant emergence from 1.0, 1.5 and 2.0 cm was significantly less as depth of placement increased.

No tansy mustard seedlings emerged from a depth of greater than 2.0 cm which may be influenced by the amount of light penetrating the soil. Light was shown to influence tansy seed germination (Table III).

Growth Pattern of Jointed Goatgrass

Field Study I was established to determine the growth characteristics of jointed goatgrass. Results showed no difference in tiller number per plant between the 31 and 61 cm spacing until after 34 and 41 days after planting. However, all other densities at all four dates of observation showed increased number of tillers as plant spacing increased (Table VII). It was noted that jointed goatgrass branches at the base of older tillers and as many as 3 new tillers may arise from nodes of older tillers, which may account for the large increase in tiller numbers from 62 to 270 days after planting. This is in agreement with description of jointed goatgrass by Hitchcock (15).

Jointed goatgrass plants which were spaced either 61 and 91 cm apart did not vary in leaf numbers per tiller at all observation dates. Plants spaced 15 cm apart had fewer leaves per tiller than those spaced 61 and 91 cm at the 34 and 41 observation days, but not 62 days after planting (Table VIII). The calculated mean number of leaves per plant at 31 and 41 days observation showed no difference between 31 and 61 cm spaced plants, but differed with plants of other spacings. Leaf

TABLE VII

EFFECTS OF PLANT DENSITY ON TILLERING CHARACTERISTICS OF JOINTED GOATGRASS - FIELD STUDY I

Plant Spacing	Mean Tillers Per Plant			
	34 Days [1]	41 Days	62 Days	270 Days
15 cm	6.9 c[2]	12.5 c[2]	27.9 d[2]	56 d[2]
31 cm	9.1 b	18.2 b	45.4 c	81 c
61 cm	10.4 b	18.9 b	80.0 b	168 b
91 cm	13.0 a	29.3 a	114.0 a	478 a

[1]Days after seeding jointed goatgrass.

[2]Numbers in each column followed by the same letter are not significantly different at the 0.05 level.

TABLE VIII

EFFECTS OF PLANT DENSITY ON LEAFINESS OF JOINTED GOATGRASS. FIELD STUDY I.

Plant Spacing	Mean Leaves Per Tiller			Calculated Mean Leaves Per Plant		
	34 Days[1]	41 Days	62 days	34 Days	41 Days	62 Days
15 cm	2.5 c[2]	3.0 c[2]	3.0 a[2]	17 c[2]	38 c[2]	84 d[2]
31 cm	3.0 bc	3.4 bc	3.2 a	28 b	62 b	146 c
61 cm	3.5 ab	3.7 ab	3.4 a	36 b	70 b	272 b
91 cm	3.6 a	4.0 a	3.4 a	47 a	117 a	388 a

[1]Days after seeding jointed goatgrass.

[2]Numbers in each column followed by the same letter are not significantly different at the 0.05 level.

numbers at 62 day observation were significantly different at all plant spacings.

Observation made 270 days after planting showed jointed goatgrass planted at 15, 31, 61 and 91 cm spacing had significantly more spikes per plant and seeds per plant as plant spacing increased (Table IX). The mean number of seeds per inflorescence at the 31 and 61 cm spacings were not different. However, those two spacings produced more seeds than plants spaced 15 cm and less than plants spaced 91 cm (Table IX).

Growth Pattern of Tansy Mustard

Field Study II was established to study the growth characteristics of tansy mustard. Plant spacings of 15, 31, 61 and 91 cm apart did not affect the number of leaves produced by tansy mustard plants observed 34, 41 and 62 days after planting (Table X). The plants that were spaced 15 and 31 cm did not vary significantly but had fewer leaves than plants spaced 61 and 91 cm apart 259 days after planting.

Tansy mustard grown in a spacing of 15 cm were shorter than plants grown at other spacings 259 days after planting (Table XI). Mustard plants that grew at a spacing of 31 and 61 cm were not different in plant height, nor were those that grew at spacings of 61 and 91 cm. The mean number of branches which grew on plants spaced 15 to 91 cm increased with spacing although plants which grew at spacings of 15 and 31 and 61 and 91 cm were not different.

The mean number of siliques and mean seed numbers per plant which were produced by tansy mustard were significantly increased as plant spacings increased. The mean number of seeds produced per silique did not vary significantly regardless of plant spacing. The data suggest

TABLE IX

EFFECTS OF PLANT DENSITY ON REPRODUCTIVE CHARACTERISTICS OF JOINTED GOATGRASS 270 DAYS AFTER SEEDING. FIELD STUDY I.

Plant Spacing	Mean Seeds Per Inflorescence	Mean Spikes Per Plant	Calculated Mean Seeds Per Plant
15 cm	10.7 c[1]	56 d[1]	600 d[1]
31 cm	12.1 b	81 c	980 c
61 cm	12.5 b	168 b	2,100 b
91 cm	15.6 a	478 a	7,456 a

[1]Numbers followed by the same letter are not significantly different at the 0.05 level.

TABLE X

EFFECTS OF PLANT DENSITY ON LEAFINESS OF TANSY MUSTARD. FIELD STUDY II.

Plant Spacing	Mean Leaves Per Plant			
	34 Days[1]	41 Days	62 Days	259 Days
15 cm	2.1 a[2]	3.2 a[2]	6.1 a[2]	9.3 b[2]
31 cm	2.0 a	3.3 a	5.8 a	12.1 b
61 cm	1.8 a	3.5 a	6.0 a	15.3 a
91 cm	1.9 a	3.2 a	6.2 a	17.3 a

[1] Days after planting tansy mustard.

[2] Numbers in each column followed by the same letter are not significantly different at 0.05 level.

TABLE XI

EFFECTS OF PLANT DENSITY ON GROWTH CHARACTERISTICS OF TANSY MUSTARD 259 DAYS AFTER PLANTING. FIELD STUDY II.

Plant Spacing	Mean Plant Height cm.	Mean Branches Per Plant	Mean Silique Per Plant	Mean Seeds Per Silique	Mean Seeds Per Plant
15 cm	46 c[1]	2.3 b[1]	172 d[1]	29.6 a[1]	5,091 d[1]
31 cm	69 b	4.6 b	586 c	31.3 a	18,342 c
61 cm	71 ab	7.3 a	820 b	33.3 a	27,142 b
91 cm	81 a	8.6 a	1,283 a	32.3 a	41,441 a

[1]Numbers in each column followed by the same letter are not significantly different at 0.05 level.

tansy mustard if given space will produce more leaves, branches, siliques and seed per plant and is a plant of opportunity.

Ecotypes of Tansy Mustard

Seed from nine different locations in Oklahoma, Kansas and Texas were used for determining variations within the species. Results indicate that a difference in plant heights occurred 166 days after planting, with plants from the Colby seed source significantly taller than plants of other seed sources (Table XII). No plants from Oklahoma seed sources were significantly different in height 166 days after planting. Plants from seed sources of Pratt and Coldwater, Kansas also were not different. Plants from different seed sources grew at different rates during the 73 day time period of 166 days to 239 days after planting. Plants from Colby, Alva and Amarillo were not significantly different in height 239 days after planting, but were different from plants from Lubbock, Pratt, Coldwater, Guymon and Seiling. There is no indication that latitude change affected plant height after 239 days.

Observations of the initiation of flowering were taken at weekly intervals, and showed a trend for plants of northern seed sources to begin flowering before plants of a southern origin (Table XIII). The difference in flowering initiation may be due to photoperiod, temperature, soils or other factors of the locations to which the plants are native.

Plants of the seed from Alva and Colby branched more than plants from other locations. Plants from seed sources of Coldwater, Guymon, Seiling, Medford, Amarillo and Lubbock were not different in branching

TABLE XII

EFFECTS OF SEED SOURCE ON PLANT HEIGHT OF TANSY MUSTARD. FIELD STUDY III.

Seed Source Location	Mean Plant Height (cm)	
	166 Days[1]	239 Days
Colby, Kansas	28.6 a[2]	71.6 a[2]
Pratt, Kansas	24.8 b	52.1 c
Coldwater, Kansas	22.5 bc	62.8 b
Guymon, Oklahoma	16.7 d	54.6 c
Seiling, Oklahoma	14.8 de	56.0 c
Medford, Oklahoma	15.6 de	65.4 ab
Alva, Oklahoma	15.0 de	72.1 a
Amarillo, Texas	20.4 c	67.6 ab
Lubbock, Texas	12.3 e	63.4 b

[1]Days after planting tansy mustard.

[2]Numbers in each column followed by the same letter are not significantly different at 0.05 level.

TABLE XIII

EFFECTS OF SEED SOURCES OF TANSY MUSTARD ON INITIATION OF FLOWERING. FIELD STUDY III.

Seed Source Location	Days After Planting				
	166	173	180	187	194
Colby, Kansas		----------	----------	----------	----------
Pratt, Kansas			----------	----------	----------
Coldwater, Kansas				----------	----------
Guymon, Oklahoma				----------	----------
Seiling, Oklahoma				----------	----------
Medford, Oklahoma				----------	----------
Alva, Oklahoma				----------	----------
Amarillo, Texas				----------	----------
Lubbock, Texas					----

---- Indicates plants blooming.

characteristics. Branching of plants directly influence the number of siliques produced as indicated in mean siliques per plant and also influences the total seed produced per plant (Table XIV). Sufficient differences in plants from different seed source locations indicated that ecotypes do exist within tansy mustard.

Weed Competition

Field Studies IV and V were established to determine the competitive effects of tansy mustard and jointed goatgrass on winter wheat. Tansy mustard at densities of 1 or 2 weeds per 4.6 m^2 did not significantly reduce the yield of wheat when compared to weed free conditions (Table XV). However, plant densities of 5 weeds per 4.6 m^2 or greater reduced wheat yields.

The fresh weight of tansy mustard at densities of 1, 2 and 5 weeds per 4.6 m^2 were similar (Table XVI). Fresh weight of tansy mustard when at densities of 50 and 100 weeds per 4.6 m^2 were significantly greater than all other treatments.

The yield of wheat was reduced significantly by all densities of jointed goatgrass when compared to weed free treatment (Table XV). The yield reductions of wheat from 50 and 100 weeds per 4.6 m^2 were not different. However, both reduced wheat yields more than all other treatments. The yield of wheat was not different at plant densities of 5 and 10 weeds per 4.6 m^2, but both densities were significantly different from all other treatments.

The yield in fresh weight of jointed goatgrass was greatest at densities of 50 and 100 weeds per 4.6 m^2 which were significantly different from all other treatments (Table XVI). The results indicate

TABLE XIV

EFFECTS OF SEED SOURCE ON PLANT CHARACTERISTICS OF TANSY MUSTARD 239 DAYS AFTER PLANTING. FIELD STUDY III.

Seed Source Location	Mean Number Branches/Plant	Mean Siliques Per Plant	Mean Seed Per Silique	Mean Seeds Per Plant
Colby, Kansas	6.6 a[1]	1163 ab[1]	29.8 a[1]	34,657 a[1]
Pratt, Kansas	4.4 c	892 c	31.2 a	27,830 b
Coldwater, Kansas	4.9 bc	958 c	30.6 a	29,315 b
Guymon, Oklahoma	4.9 bc	930 c	31.2 a	29,016 b
Seiling, Oklahoma	4.7 bc	930 c	32.3 a	30,039 b
Medford, Oklahoma	5.2 bc	981 c	31.8 a	31,196 ab
Alva, Oklahoma	6.7 a	1188 a	29.6	35,165 a
Amarillo, Texas	5.5 b	1042 b	30.3 a	31,573 ab
Lubbock, Texas	4.9 bc	876 c	32.5 a	28,470 b

[1] Numbers in each column followed by the same letter are not significantly different at 0.05 level.

TABLE XV

YIELD OF WHEAT AS INFLUENCED BY WEED DENSITY OF TANSY MUSTARD AND JOINTED GOATGRASS. FIELD STUDIES IV AND V.

Weed Density Per m^2	Wheat Yield (kg/ha)	
	Tansy Mustard	Jointed Goatgrass
Weed Free	1717 a[1]	2146 a[1]
1 weed/4.6	1678 a	1971 b
2 weeds/4.6	1658 a	1854 b
5 weeds/4.6	1483 b	1580 c
10 weeds/4.6	1405 bc	1464 c
50 weeds/4.6	1268 cd	1093 d
100 weeds/4.6	1249 d	1073 d

[1]Numbers in each column followed by the same letter are not significantly different at 0.05 level.

TABLE XVI

YIELD OF WEEDS AS INFLUENCED BY WEED DENSITY OF TANSY MUSTARD AND JOINTED GOATGRASS. FIELD STUDIES IV AND V.

Weed Density Per m^2	Fresh Weed Weight (kg/ha)	
	Tansy Mustard	Jointed Goatgrass
Weed Free	-	-
1 weed/4.6	162 c[1]	130 c[1]
2 weeds/4.6	179 c	228 c
5 weeds/4.6	293 bc	423 bc
10 weeds/4.6	357 b	748 b
50 weeds/4.6	1561 a	2374 a
100 weeds/4.6	1688 a	2523 a

[1]Numbers in each column followed by the same letter are not significantly different at 0.05 level.

jointed goatgrass was more competitive than tansy mustard in winter wheat.

Cultural Methods Effects on Weed Population

Field Studies VI and VII were established to determine the effects of tillage methods and the seeding date of wheat on weed populations of tansy mustard and jointed goatgrass. Tansy mustard and jointed goatgrass populations were significantly decreased as the seeding date of wheat was delayed (Table XVII). Tansy mustard density was not altered significantly by sweep plowing and one-way plowing tillage methods. However, moldboard plowing significantly increased the density of tansy mustard when compared to the two other tillage methods (Table XVIII). The plot area was known to be infested with tansy mustard the previous growing season and moldboard plowing can bring back to the surface of soil some of the previous years seed.

Stubble mulch sweep method of tillage had more jointed goatgrass when compared with the two other tillage methods (Table XVIII). Mold board and one-way plowing are possibly burying jointed goatgrass seed to a depth from which emergence is less.

The coefficient of variability of the yield of wheat was excessive in both Field Study VI and VII, therefore, the data is not included.

Herbicide Control of Jointed Goatgrass

Several herbicides were evaluated for control of jointed goatgrass in wheat. The yield of wheat increased significantly when treated with metribuzin at 0.4 kg/ha applied preplant to wheat. Treatments of metribuzin at 0.3 and 0.4, cyanazine + metribuzin at 1.1 + 0.3, propham at 1.6

TABLE XVII

EFFECTS OF WHEAT PLANTING DATE ON WEED POPULATIONS. FIELD STUDY VI AND VII.

Planting Date	Mean Weeds Per Square Meter	
	Tansy Mustard	Jointed Goatgrass
September 15, 1974	15.7 a[1]	1.3 a[1]
October 6, 1974	4.8 b	0.6 b
November 2, 1974	2.2 c	0.2 c

[1]Numbers in each column followed by the same letter are not significantly different at 0.05 level.

TABLE XVIII

EFFECTS OF TILLAGE METHODS OF WHEAT ON WEED POPULATIONS. FIELD STUDIES VI AND VII.

Tillage Method	Mean Weeds Per Square Meter	
	Tansy Mustard	Jointed Goatgrass
Moldboard Plow - Disc - Disc	10.1 a[1]	0.5 b[1]
Sweep - Sweep - Sweep	5.5 b	1.1 a
One-way Plow - One-way Plow - One-way Plow	7.0 b	0.4 b

[1]Numbers in each column followed by the same letter are not significantly different at 0.05 level.

and chlorpropham at 0.8 kg/ha when applied preplant to wheat significantly increased wheat yields when compared to weedy check. The most effective weed control rate of each herbicide in study was metribuzin at 0.4 kg/ha, cyanazine + metribuzin at 1.1 + 0.3, propham at 1.6, and chlorpropham at 0.8 kg/ha when applied 30 days prior to sowing wheat (Table XIX, XX and XXI). The trend was for wheat stands reductions to be severe when control of jointed goatgrass control was good. However, a small degree of selectivity was achieved by applying herbicides preplant to wheat. Other herbicides should be studied to determine if increased selectivity can be achieved.

Herbicide Control of Tansy Mustard

Several herbicides gave good control of tansy mustard with little injury to winter wheat (Table XXII, XXIII, and XXIV). The treatment of terbutryn at 0.6 kg/ha both preemergence and postemergence gave excellent weed control, but the yield of wheat was not increased significantly when compared to weedy check. Dicamba and 2,4-D at 0.1 kg/ha and methazole at 1.1 kg/ha applied when wheat was in 9 to 12 tiller stage of growth provided good mustard control with no wheat injury. Cyanazine at 0.6 and linuron at 1.1 kg/ha and applied when wheat was in 9 to 12 tiller stage gave good control of mustard with slight injury to wheat. Metribuzin at 0.3 kg/ha applied to wheat in 2 to 3 leaf stage and 7 to 9 tiller stage resulted in very good control of tansy mustard, however, rates of 1.1 and 2.2 kg/ha caused excessive wheat injury.

Metribuzin, cyanazine and mixtures of metribuzin and cyanazine applied at the 2 to 3 leaf stage of wheat in Study XI generally

TABLE XIX

EFFECTS OF PREPLANT APPLIED HERBICIDES ON JOINTED GOATGRASS CONTROL, WHEAT INJURY AND WHEAT YIELD

Herbicide Treatment	Rate (kg/ha)	Visual Ratings (Days After Treatment)[2]								Wheat Yield
		Jointed Goatgrass					Wheat			(kg/ha)
		14	30	41	199	251	41	199	251	293 Days
metribuzin	0.3	3	3	3	1	0	1	0	0	1290 b[1]
metribuzin	0.4	5	5	4	3	3	2	1	1	1431 a
cyanazine + metribuzin	0.6 + 0.1	0	1	0	0	0	1	0	0	1048 c
cyanazine + metribuzin	0.6 + 0.3	2	3	3	1	2	2	1	0	1028 c
cyanazine + metribuzin	1.1 + 0.1	3	4	4	5	4	3	2	1	1081 c
cyanazine + metribuzin	1.1 + 0.3	5	7	8	7	6	4	2	0	1284 b
propham	0.8	3	1	0	0	0	1	0	0	1081 c
propham	1.6	7	5	5	3	1	3	3	1	1290 b
propham	3.4	9	8	7	8	6	8	7	7	753 fgh
chlorpropham	0.8	2	5	6	3	2	5	5	2	1250 b
chlorpropham	1.6	5	7	5	4	3	7	6	5	894 def
chlorpropham	3.4	7	9	9	8	7	6	5	4	1014 cd
weedy check	---	0	0	0	0	0	0	0	0	1095 c

[1]Numbers followed by the same letter are not significantly different at 0.05 level.

[2]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

TABLE XX

EFFECTS OF PREEMERGENCE APPLIED HERBICIDES ON JOINTED GOATGRASS CONTROL, WHEAT INJURY AND WHEAT YIELD

Herbicide Treatment	Rate (kg/ha)	Visual Rating (Days After Treatment)[2]						Wheat Yield (kg/ha)
		Jointed Goatgrass			Wheat			
		11	169	221	11	169	221	263 Days
metribuzin	0.3	7	5	4	6	5	3	1250 a[1]
metribuzin	0.4	8	6	4	6	6	4	1042 b
cyanazine + metribuzin	0.6 + 0.1	5	3	1	5	3	3	1075 b
cyanazine + metribuzin	0.6 + 0.3	8	6	4	6	3	4	1028 b
cyanazine + metribuzin	1.1 + 0.1	9	6	5	6	4	5	887 cde
cyanazine + metribuzin	1.1 + 0.3	8	7	6	8	7	7	766 efg
propham	0.8	5	3	2	6	5	6	827 ef
propham	1.6	9	9	7	8	7	5	820 ef
propham	3.4	9	9	8	8	8	7	726 fg
chlorpropham	0.8	5	3	3	6	6	4	988 bc
chlorpropham	1.6	7	5	6	8	7	6	847 def
chlorpropham	3.4	9	9	8	8	7	7	780 efg
weedy check	----	0	0	0	0	0	0	1095 b

[1]Numbers followed by the same letter are not significantly different at 0.05 level.

[2]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

TABLE XXI

EFFECTS OF POSTEMERGENCE APPLIED HERBICIDES ON JOINTED GOATGRASS CONTROL WHEAT INJURY AND WHEAT YIELD

Herbicide Treatment	Rate (kg/ha)	Visual Rating (Days After Treatment)[2]				Wheat Yield (kg/ha)
		Jointed Goatgrass		Wheat		
		158	210	158	210	252 Days
metribuzin	0.3	6	5	3	3	1061 b[1]
metribuzin	0.4	4	5	5	4	988 bc
cyanazine + metribuzin	0.6 + 0.1	4	4	3	3	1042 b
cyanazine + metribuzin	0.6 + 0.3	4	3	3	4	1001 bc
cyanazine + metribuzin	1.1 + 0.1	5	4	6	5	988 bc
cyanazine + metribuzin	1.1 + 0.3	4	5	5	5	974 bcd
propham	0.8	4	4	6	5	974 bcd
propham	1.6	9	8	7	7	780 efg
propham	3.4	8	8	8	8	578 h
chlorpropham	0.8	4	4	5	4	1001 bc
chlorpropham	1.6	7	7	7	7	679 gh
chlorpropham	3.4	9	8	9	8	551 h
weedy check	----	0	0	0	0	1095 b

[1]Numbers followed by the same letter are not significantly different at 0.05 level.

[2]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

TABLE XXII

EFFECTS OF HERBICIDES ON CONTROL OF TANSY MUSTARD, WHEAT INJURY AND WHEAT YIELD. FIELD STUDY IX.

Herbicide Treatment	Rate (kg/ha)	Visual Rating (Days After Treatment)[2] Tansy Mustard 22	Tansy Mustard 56	Wheat 22	Wheat 56	Wheat Yield (kg/ha) 116 Days
chlorpropham	1.1	2	0	1	0	2050 abc[1]
chlorpropham	2.2	2	2	2	1	1996 bc
propham	1.1	0	2	0	1	2292 ab
propham	2.2	3	3	3	2	2144 abc
terbutryn	0.6	4	8	0	0	2171 abc
terbutryn	0.8	6	9	0	0	2220 ab
terbutryn	1.1	8	10	0	0	2074 abc
terbutryn	1.9	10	10	1	0	2171 abc
terbutryn	2.2	10	10	2	2	2074 abc
metribuzin	0.3	6	7	0	0	2171 abc
metribuzin	0.6	6	8	0	0	2098 abc
metribuzin	1.1	9	10	2	1	1613 cd
metribuzin	2.2	10	10	5	4	1439 d
2,4-D (amine)	0.6	5	8	0	1	2001 bc
linuron	0.6	5	9	0	0	2098 abc
linuron	0.8	7	9	0	0	2122 abc
linuron	1.1	10	10	1	0	2244 ab
cyanazine	0.6	8	9	0	0	2049 abc
cyanazine	0.8	9	9	1	0	2074 abc
cyanazine	1.1	10	10	3	1	1874 bcd
dicamba	0.1	5	5	0	0	2410 a
dicamba	0.3	5	4	0	0	2191 ab
dicamba	0.6	7	9	2	1	2146 abc
dicamba + methazole	0.6 + 0.1	9	10	0	0	2220 ab
dicamba + methazole	0.8 + 0.1	10	10	0	0	2342 ab
methazole	1.1	9	10	0	0	2318 ab
methazole	2.2	10	10	3	2	1947 bcd
weedy check	-	0	0	0	0	2390 ab

[1]Numbers followed by the same letter are not significantly different at 0.05 level.

[2]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

TABLE XXIII

EFFECTS OF HERBICIDES ON CONTROL OF TANSY MUSTARD, WHEAT INJURY AND WHEAT YIELD. FIELD STUDY X.

Herbicide Treatment	Rate (kg/ha)	Growth Stage at Application	Visual Rating (Days After Treatment)[2]						Wheat Yield (kg/ha) 239 Days
			Tansy Mustard			Wheat			
			14	77	158	14	77	158	
tertbutryn	0.6	Preemergence	10	10	8	1	0	0	2036 ab[1]
tertbutryn	0.8		10	10	10	3	2	0	1962 ab
tertbutryn	1.1		10	10	10	3	3	0	1888 ab
metribuzin	0.3	2 to 3	--	10	10	--	2	0	2103 a
metribuzin	0.4	Leaf	--	10	10	--	2	0	2070 a
metribuzin	0.6	Stage	--	10	10	--	4	3	2009 ab
metribuzin	0.3	9 to 12	--	--	10	--	--	3	1861 ab
metribuzin	0.4	Tiller	--	--	10	--	--	4	1922 ab
metribuzin	0.6	Stage	--	--	10	--	--	5	1767 ab
chlorpropham	0.6		--	--	8	--	--	5	2003 ab
chlorpropham	0.8		--	--	10	--	--	5	1835 ab
chlorpropham	1.1		--	--	10	--	--	8	591 c
propham	0.6		--	--	10	--	--	6	1660 b
propham	1.1		--	--	10	--	--	8	766 c
tertbutryn	0.6		--	--	9	--	--	1	2063 a
tertbutryn	1.1		--	--	10	--	--	3	1956 ab
2, 4-D (amine)	0.1		--	--	8	--	--	0	1962 ab
2, 4-D (amine)	0.3		--	--	10	--	--	0	1888 ab
cyanazine	0.6		--	--	10	--	--	2	2016 ab
cyanazine	1.1		--	--	10	--	--	4	1970 ab
weedy check	----		0	0	0	0	0	0	1929 ab

[1]Numbers followed by the same letter are not significantly different at 0.05 level.

[2]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

TABLE XXIV

EFFECTS OF HERBICIDES ON CONTROL OF TANSY MUSTARD, WHEAT INJURY AND WHEAT YIELD. FIELD STUDY XI.

Herbicide Treatment	Rate (kg/ha)	Growth Stage at Application	Visual Rating (Days After Treatment)[2] Tansy Mustard 24	Tansy Mustard 101	Tansy Mustard 176	Wheat 24	Wheat 101	Wheat 176	Wheat Yield (kg/ha) 262 Days
metribuzin	0.3	2 to 3	8	10	10	2	1	0	2244 a[1]
cyanazine + metribuzin	0.6 + 0.1	Leaf	9	10	10	3	2	1	2164 ab
cyanazine + metribuzin	0.6 + 0.3	Stage	10	10	10	4	3	3	1996 b-g
cyanazine + metribuzin	1.1 + 0.1		10	10	10	5	5	4	1801 g-k
cyanazine + metribuzin	1.1 + 0.3		10	10	10	4	6	5	1700 i-e
cyanazine	0.6		10	10	10	2	3	2	1868 e-j
cyanazine	1.1		10	10	10	4	4	4	1835 g-j
metribuzin	0.3	7 to 9	--	6	9	--	1	0	2244 a
cyanazine + metribuzin	0.6 + 0.1	Tiller	--	9	10	--	2	2	1989 b-g
cyanazine + metribuzin	0.6 + 0.3	Stage	--	10	10	--	2	3	1989 b-g
cyanazine + metribuzin	1.1 + 0.1		--	10	10	--	4	5	1693 i-l
cyanazine + metribuzin	1.1 + 0.3		--	10	10	--	5	4	1700 i-l
cyanazine	0.6		--	10	10	--	2	4	1687 i-l
cyanazine	1.1		--	10	10	--	4	4	1592 k-l
metribuzin	0.3	9 to 12	--	--	8	--	--	3	1855 f-j
cyanazine + metribuzin	0.6 + 0.1	Tiller	--	--	10	--	--	3	1902 d-i
cyanazine + metribuzin	0.6 + 0.3	Stage	--	--	10	--	--	5	1687 i-l
cyanazine + metribuzin	1.1 + 0.1		--	--	10	--	--	5	1660 j-l
cyanazine + metribuzin	1.1 + 0.3		--	--	10	--	--	6	1559 l
cyanazine	0.6		--	--	10	--	--	2	2117 a-d
cyanazine	1.1		--	--	10	--	--	4	1828 g-j
weedy check	----		0	0	0	0	0	0	1922 c-h

[1]Numbers followed by the same letter are not significantly different at 0.05 level.

[2]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

resulted in more wheat yield than when the same treatments were applied at later stages of wheat growth. Significantly higher wheat yields than the weedy check were produced from treatments of metribuzin at 0.3 kg/ha and the combination of cyanazine plus metribuzin at 0.6 + 0.1 kg/ha applied when wheat was in 2 to 3 leaf stage of growth and metribuzin at 0.3 kg/ha applied when wheat was in 7 to 9 tiller stage of wheat growth.

Topical Applied Herbicide Control of Field Bindweed

Several topical applied herbicides were evaluated for control of field bindweed in winter wheat. When applied 14 days before the wheat was planted 2,3,6-TBA + polymer at 2.2 + 0.6 and 4.5 + 1.1 kg/ha resulted in good initial bindweed control, but control was not persistent and wheat yields were significantly reduced compared to weedy check wheat yield (Table XXV). The three lowest rates of 2,3,6-TBA + polymer did not control bindweed. The 2,4-D + polymer treatments did not provide control of field bindweed and significantly reduced wheat yields when compared to weedy check. Glyphosate treatments all resulted in bindweed control. Wheat yields in plots treated with 3.4 and 5.6 kg/ha increased significantly when compared to weedy check.

Herbicides were evaluated when applied pre-harvest to wheat (Field Study XII). No treatment significantly altered wheat yields when compared to weedy check (Table XXVI). Initial control of bindweed, 22 days after treatment, was sufficient to reduce problems encountered in harvesting weedy wheat. The plots treated with

TABLE XXV

EFFECTS OF TOPICAL APPLIED HERBICIDES ON FIELD BINDWEED CONTROL, WHEAT INJURY AND WHEAT YIELD. FIELD STUDY XII.

Herbicide Treatment	Rate (kg/ha)	Visual Rating (Days After Treatment)[2]						Wheat Yield (kg/ha) 281 Days
		Field Bindweed					Wheat	
		17	31	249	355	388	17	
2,3,6-TBA + polymer	0.3 + 0.1	3	3	0	0	0	0	2236 b[1]
2,3,6-TBA + polymer	0.6 + 0.1	2	3	2	1	0	1	2107 b
2,3,6-TBA + polymer	1.1 + 0.3	5	5	3	2	0	3	1943 bc
2,3,6-TBA + polymer	2.2 + 0.6	8	8	6	2	2	7	1295 d
2,3,6-TBA + polymer	4.5 + 1.1	9	9	8	5	4	9	851 e
glyphosate	3.4	9	9	9	8	8	0	2649 a
glyphosate	5.6	10	10	9	9	8	0	2562 a
glyphosate	7.8	10	10	9	9	8	0	2549 ab
2,4-D + polymer (SRC 177)	0.6 + 0.1	4	3	2	0	0	3	1598 c
2,4-D + polymer (SRC 176)	0.6 + 0.1	5	5	3	0	0	5	1198 de
weedy check	----	0	0	0	0	0	0	2162 b

[1]Numbers followed by the same letter are not significantly different at the 0.05 level.

[2]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

TABLE XXVI

EFFECTS OF PRE-HARVEST TOPICAL APPLIED HERBICIDES ON FIELD BINDWEED CONTROL AND WHEAT YIELDS. FIELD STUDY XIII.

Herbicide Treatment	Rate (kg/ha)	Visual Ratings[1] (Days After Treatment) Field Bindweed			Wheat Yield (kg/ha)
		22	78	131	26 Days
glyphosate	3.4	9	8	8	2237 a[2]
glyphosate	4.5	10	9	9	2299 a
glyphosate	5.6	9	9	8	2271 a
2, 4-D (amine)	1.1	7	3	2	2207 a
2, 4-D	2.2	6	3	1	2222 a
2, 4-D	3.4	7	2	2	2145 a
weedy check	---	0	0	0	2270 a

[1]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

[2]Numbers followed by the same letter are not significantly different at 0.05 level.

glyphosate controlled bindweed after normal tillage operations in summer.

Glyphosate was evaluated when applied at two different stages of field bindweed growth, and dicamba when applied at the bloom stage of growth (Field Studies XIV and XV). When applied at bloom, glyphosate resulted in slightly better control of bindweed than when applied in runner stage of growth (Table XXVII). Wheat yields were higher when treated with glyphosate at 4.5 or 5.6 kg/ha compared to all other treatments. Dicamba treatments resulted in good control of bindweed, but wheat yields at 4.5 kg/ha were reduced (Table XXVIII).

Herbicides applied topically to field bindweed in bloom were evaluated in Field Study XVI. Picloram at all rates and dicamba at 4.5 and 6.7 kg/ha controlled bindweed. Glyphosate and 2,4-D provided some control, but some bindweed escaped control after 316 days (Table XXIX). Normal tillage was carried out before wheat was sown and land was cultivated to control soil erosion in early spring.

Apparently glyphosate should be applied topically to bindweed at the bloom stage for best results and glyphosate will not harm wheat when applied prior to planting wheat. Dicamba will control bindweed when applied topically at 4.5 kg/ha but wheat yields will be reduced. Treatments of 2,4-D will give good initial control of bindweed, however, control is normally short in duration. Treatments of 2,3,6-TBA + polymer at 2.2 + 0.6 and 4.5 + 1.1 kg/ha controlled bindweed but reduced wheat yields.

TABLE XXVII

EFFECTS OF TOPICAL APPLIED HERBICIDES ON FIELD BINDWEED CONTROL, WHEAT INJURY AND WHEAT YIELD. FIELD STUDY XIV.

Herbicide Treatment	Rate (kg/ha)	Visual Ratings[1] (Days After Initial Treatment) Field Bindweed 68	Field Bindweed 306	Wheat 68	Wheat 306	Wheat Yield (kg/ha) 306 Days	
	Applied In Runner Stage of Bindweed						
glyphosate	3.4	8	6	0	0	1277	bc[2]
glyphosate	4.5	6	6	0	0	1257	bc
glyphosate	5.6	8	7	0	0	1297	bc
	Applied In Bloom Stage of Bindweed						
glyphosate	3.4	8	5	0	0	1324	b
glyphosate	4.5	8	8	0	0	1613	a
glyphosate	5.6	8	9	0	0	1767	a
dicamba	2.2	9	9	4	5	1122	bcd
dicamba	3.4	9	6	5	7	1015	d
dicamba	4.5	10	10	7	9	423	e
weedy check	---	0	0	0	0	1088	cd

[1]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

[2]Numbers followed by the same letter are not significantly different at 0.05 level.

TABLE XXVIII

EFFECTS OF TOPICAL APPLIED HERBICIDES ON FIELD BINDWEED CONTROL. FIELD STUDY XV.

Herbicide Treatment	Rate (kg/ha)	Visual Ratings[1] (Days After Initial Treatment)			
		12	71	293	373
	Applied at Runner Stage of Bindweed				
glyphosate	3.4	5	8	7	5
glyphosate	4.5	5	9	8	6
glyphosate	5.6	7	8	7	6
	Applied at Bloom Stage of Bindweed				
glyphosate	3.4	--	7	6	5
glyphosate	4.5	--	8	7	7
glyphosate	5.6	--	9	8	8
dicamba	2.2	--	9	6	4
dicamba	3.4	--	10	8	6
dicamba	4.5	--	10	9	9
weedy check	---	0	0	0	0

[1]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

TABLE XXIX

EFFECTS OF TOPICAL APPLIED HERBICIDES ON FIELD BINWEED CONTROL. FIELD STUDY XVI.

Herbicide Treatment	Rate (kg/ha)	Visual Rating[1] (316 Days After Treatment)
picloram	0.6	10
picloram	1.1	10
picloram	1.7	10
dicamba	2.2	6
dicamba	4.5	8
dicamba	6.7	10
2, 4-D (amine)	1.1	6
2, 4-D	2.2	6
2, 4-D	4.5	8
glyphosate	2.2	5
glyphosate	3.4	7
glyphosate	4.5	7
weedy check	---	0

[1]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed, ranging up to 10 which indicated complete weed control.

Subsurface Applied Herbicide Control of Field Bindweed

Several herbicides were applied as a subsurface layer (SSL) for field bindweed control in winter wheat at Alva (Field Study XVII) and at Keys (Field Studies XVII and XIX). Trifluralin at 2.2 and 4.5 kg/ha controlled bindweed very well when used as a SSL but 4.5 kg/ha reduced wheat yields when compared to the 2.2 kg/ha treatment (Table XXX). Dinitramine at 1.7 and 2.2 kg/ha controlled bindweed good and wheat yields were not affected. Profluralin at both rates controlled bindweed good, but the 4.5 kg/ha treatment reduced wheat yields. Butralin at 3.4 kg/ha controlled bindweed good and wheat yield was highest of all treatments in the study. The wheat injury for the SSL treatments was in form of stand reduction and weak plants.

At Keys, trifluralin and profluralin are very persistent when applied as a SSL, even after 1006 days (Table XXXI). Both herbicides injured wheat 631 days after treatment, and wheat yields were reduced. Dinitramine and butralin were less persistent than trifluralin and profluralin. Dinitramine and butralin did not reduce wheat yields from the weedy check, with the exception of butralin at 6.7 kg/ha.

Field Study XIX showed that 2,4-D at 2.2, butralin at 2.2, penoxalin at 1.1 and 2.2 and fluchloralin at 2.2 kg/ha were permitting bindweed to emerge through the subsurface layer (Table XXXII). Other herbicide treatments produced better control. These results may have been influenced by the excessive drought conditions since application of herbicides. Normal tillage was carried out before wheat was sown and land was cultivated to control soil erosion in early spring.

TABLE XXX

EFFECTS OF SUBSURFACE APPLIED HERBICIDES ON FIELD BINDWEED CONTROL, WHEAT INJURY AND WHEAT YIELD. FIELD STUDY XVII.

Herbicide Treatment	Rate (kg/ha)	Visual Ratings[1] (Days After Treatment)				Wheat Yield (kg/ha)	
		Bindweed		Wheat			
		64	286	64	286	297 Days	
trifluralin	2.2	9	9	0	2	1263	ab[2]
trifluralin	4.5	10	10	0	5	941	c
dinitramine	1.7	10	8	0	0	1364	a
profluralin	2.2	9	9	0	1	1344	a
profluralin	4.5	10	10	0	4	1109	bc
butralin	3.4	9	7	0	0	1389	a

[1]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

[2]Numbers followed by the same letter are not significantly different at 0.05 level.

TABLE XXXI

EFFECTS OF SUBSURFACE APPLIED HERBICIDES ON FIELD BINDWEED CONTROL, WHEAT INJURY AND WHEAT YIELD. FIELD STUDY XVIII.

Herbicide Treatment	Rate (kg/ha)	Visual Ratings (Days After Treatment)[2] Field Bindweed 59	276	356	631	1006	Wheat 631	Wheat Yield (kg/ha) 631 Days	
trifluralin	2.2	9	10	10	10	7	7	188	ef[1]
trifluralin	3.4	10	10	10	10	8	8	87	f
trifluralin	4.5	10	10	10	10	9	8	134	ef
dinitramine	1.7	9	7	5	1	0	0	719	a
dinitramine	3.4	9	8	5	2	1	1	659	ab
profluralin	2.2	9	9	9	9	4	5	356	d
profluralin	3.4	10	10	10	10	7	8	222	e
profluralin	4.5	10	10	10	10	8	8	202	e
butralin	3.4	9	8	6	2	1	0	739	a
butralin	4.5	9	8	8	4	1	2	591	bc
butralin	6.7	9	9	9	6	3	1	531	c
weedy check	---	0	0	0	0	0	0	685	ab

[1]Numbers followed by the same letter are not significantly different at 0.05 level.

[2]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

TABLE XXXII

EFFECTS OF SUBSURFACE APPLIED HERBICIDES ON FIELD BINDWEED CONTROL. FIELD STUDY XIX

Herbicide Treatment	Rate (kg/ha)	Visual Rating of Bindweed[1] (316 Days After Treatment)
2,4-D	1.1	4
2,4-D	2.2	8
2,4-D	4.5	9
2,4,5-T	2.2	9
2,4,5-T	4.5	9
2,4,5-T	6.7	8
picloram	0.6	10
picloram	1.1	10
picloram	2.2	10
trifluralin	1.1	8
trifluralin	2.2	10
trifluralin	3.4	10
butralin	2.2	6
butralin	3.4	8
butralin	4.5	9
profluralin	2.2	8
profluralin	3.4	8
profluralin	4.5	8
penoxalin	1.1	7
penoxalin	2.2	7
penoxalin	3.4	8
fluchloralin	2.2	7
fluchloralin	3.4	8
fluchloralin	4.5	8
weedy check	---	0

[1]Visual ratings were made on a scale of 0 to 10, where 0 indicated no control of the weed or crop injury, ranging up to 10 which indicated complete weed control or crop kill.

General Discussion

The growth characteristics of jointed goatgrass are similar to wheat which allows the weed to become established in wheat fields. The weed has characteristics as seedlings emerge after a 2 month dormant period from a depth of 5.0 cm or less and plants which are prolific if growing space is available which allows the weed to become an invader of wheat fields. Eliminating the source of infestation is the best method of control, such as eliminating weeds from waste areas and fence rows, spreading by machines such as combines, and weeds in seed wheat planted. The control of established weed populations is best accomplished with a combination of cultural methods and herbicide control. Moldboard plowing to bury seeds to a depth from which fewer seedlings will emerge, planting wheat in higher plant populations to reduce growing space of the weed, and treating known areas of infestation with metribuzin, cyanazine + metribuzin or chlorpropham 30 days prior to sowing wheat appear to be the most feasible methods of controlling jointed goatgrass in wheat.

Additional research is needed to evaluate herbicides for greater selectivity between wheat and jointed goatgrass. We also need to evaluate the effect of seeding rates of wheat on the weed stands. Additional seed burial studies should be done which are longer in duration to determine more fully if seeds remain viable for more than one growing season. Possible crop rotations to summer crops to disrupt the life cycle of the weed in infested areas should be evaluated, as should the practice of burning wheat stubble off infested areas to reduce jointed goatgrass. Additional competition studies under different climatic and edaphic conditions to more fully determine wheat yield reductions are needed.

Tansy mustard seedlings emerged after a 3 to 4 month dormant period from a depth of 0.5 cm or less and seeds are sensitive to light during germination. Tansy mustard is a plant of opportunity, if moisture and space are available the plant will thrive and produce large numbers of seeds. Ecotypes do vary somewhat from different geographic locations but available growing space had a greater effect on the reproductive characteristics of the plant. The density of the tansy mustard population should be evaluated before any control measures are initiated. Weed densities greater than five weeds per 4.6 m^2 was required to reduce wheat yields. Several herbicides applied in 2 to 3 leaf stage of wheat will provide excellent control of tansy mustard with little wheat injury.

Additional research is needed to evaluate seed viability in the soil and duration of viability. The influence of cultural methods on weed populations should be studied. Research is also needed on fertilization practices and their effects on tansy mustard populations in wheat. Additional competition studies under different climatic and edaphic conditions would provide a more complete understanding of yield reductions of wheat.

Bindweed when in bloom is controlled well with glyphosate without injury to wheat. Several dinitroaniline herbicides used SSL provided excellent control of bindweed at Alva, but reduced wheat yields at Keys.

CHAPTER V

SUMMARY

The development and competitive effects of two weed species and control of three weed species were studied in field and greenhouse to determine the influences of these factors on the production of winter wheat.

Seeds of jointed goatgrass buried in soil, germinated after 2 months of burial, while tansy mustard germination was delayed 3 to 4 months. Light during germination had no effect on jointed goatgrass but increased germination of tansy mustard. Burial depth of seed in soil had no effect on tansy mustard, but jointed goatgrass germination decreased as depth of burial increased. Temperatures of 21 to 25^{o}C. during germination increased germination of jointed goatgrass while 10^{o} and 21 to 25^{o}C. were not different for tansy mustard.

The largest percentage of seed of jointed goatgrass emerged from 3.0 cm or less depth in soil, while tansy mustard seed emerged at highest percentage from .25 to .5 cm soil depth.

The number of tillers, total leaves, spikes, and total seed of mature jointed goatgrass plants increased as plant spacing increased. The number of leaves per tiller and seeds per inflorescence were not influenced as greatly by plant spacing. Tansy mustard plants grew taller, produced more leaves, siliques and seeds per plant as spacing increased. The number of seeds per silique was not altered by plant spacing.

Seeds of tansy mustard from nine different geographic locations in Oklahoma, Kansas and Texas showed variations in blooming time, plant height, numbers of branches, siliques per plant and seeds produced per plant which indicate differences exist within the species.

Competitive effects of jointed goatgrass reduced wheat yields at all densities studied, however, tansy mustard at a density of five weeds per 4.6 square meters or heavier densities were required to reduce wheat yields. The competitive effects of jointed goatgrass is more severe than tansy mustard at the same density in winter wheat.

Moldboard plowing increased tansy mustard population, while stubble mulch sweeping increased jointed goatgrass weed population in winter wheat. Weed populations were decreased as planting dates were delayed.

Several herbicides were studied for the control of jointed goatgrass in wheat. Of these, metribuzin, combinations of cyanazine plus metribuzin and chlorpropham applied as preplant treatment to wheat were most effective. The herbicides studied lack selectivity between wheat and jointed goatgrass. Other herbicides should be evaluated for greater degree of selectivity.

Several of the herbicides studied for control of tansy mustard performed well with good control of mustard with little or no injury to wheat. Herbicides which were applied at the 2 to 3 leaf stage of wheat produced more wheat than the same treatments applied at a later stage of wheat growth.

Herbicides applied topical to field bindweed during wheat fallow periods were studied. Glyphosate applied in blooming stage of field bindweed controlled bindweed without injury to wheat. Dicamba controlled bindweed at 4.5 kg/ha, but wheat was injured and yields reduced.

Glyphosate and 2,4-D applied pre-harvest to wheat will aid in reducing harvesting problems of wheat and glyphosate will give good control of bindweed through the fallow period of wheat.

Several herbicides were applied in subsurface layer to control field bindweed. Trifluralin at 2.2, dinitramine at 1.7, profluralin at 2.2 and butralin at 3.4 kg/ha controlled bindweed with little yield reduction at Alva. The studies at Keys showed trifluralin and profluralin to be very persistent and reduced wheat yields. It appears location and possibly rainfall may influence persistence of these herbicides. More research is needed to determine proper rates and persistence of herbicides.

LITERATURE CITED

1. Addison, D. A., J. C. Walker and W. R. Arnold. 1974. Trifluralin applied as a subsurface layer for perennial weed control in Southeast. Proc. S. Weed Sci. Soc. 27:155-160.

2. Anonymous. 1970. Selected weeds of the United States. USDA Handbook No. 363.

3. Banks, P. A., L. V. Hill and P. W. Santelmann. 1975. Subsurface layering of dinitroaniline herbicides for horsenettle and bindweed control. Proc. S. Weed Sci. Soc. 28:44.

4. Blackman, G. E. and W. G. Templeman. 1938. The nature of the competition between cereal crops and annual weeds. J. Agri. Sci. 28:247-271.

5. Budd, E. G. 1970. Seasonal germination patterns of Poa trivialis L. and subsequent plant behaviors. Weed Res. 10:243-149.

6. Carter, A. S., J. H. Leforge, and L. C. Shenberger. 1946. A study of the effect of infestations of field peppergrass on the yield of wheat. Proc. Ass. Offic. Seed Anal. 36:103-105.

7. Carter, H. W., H. W. Norton and G. H. Dungan. 1957. Wheat and cheat. Agron. J. 49:261-267.

8. Chaffin, Wesley. 1947. Wheat in Oklahoma. Okla. A&M College Ext. Cir. 447.

9. Cochrane, John E., H. J. Peterson and W. H. Kastens. 1976. Crop Production. Okla. Crop and Livestock Rep. Ser. CP No. 76-5.

10. Cooley, A. W., R. C. Berner and D. T. Smith. 1973. Subsurface layering for perennial weed control. Proc. S. Weed Sci. Soc. 26:453.

11. Derting, C. W., O. N. Andrews, Jr., R. G. Duncan, and K. R. Frost, Jr. 1973. Two year of perennial weed control investigations with glyphosate. Proc. S. Weed Sci. Soc. 26:44-50.

12. French, C. M., P. W. Santelmann and H. A. L. Greer. 1974. Susceptibility of several crop and weeds to cyanazine. Proc. S. Weed Sci. Soc. 27:52-56.

13. Greer, H. A. L. 1970. Henbit and mustard control in wheat and alfalfa. Okla. State Univ. Extension Fact No. 2758.

14. Greer, H. A. L. 1975. Weed control in agronomic crops 1975. Okla. State Univ. Extension Fact No. 2751.

15. Hitchcock, A. S. 1951. Manual of the grasses of the United States. USDA Misc. Publ. No. 200.

16. Kempen, Harold M., Harry Agamalian, Clyde Elmore and Dr. Arthur Lange. 1973. Subsurface layering of herbicides in California irrigated crops. Proc. S. Weed Sci. Soc. 26:460-462.

17. Lavake, Dwane E. and A. F. Wiese. 1969. Bindweed control following repeated small applications of picloram. Proc. S. Weed Sci. Soc. 22:164.

18. LeGrand, F. E. 1971. Wheat production in Oklahoma. Okla. State Univ. Extension Fact No. 2024.

19. Lewis, J. 1961. Influence of water level, soil depth and type on the survival of crop and weed seeds. Proc. Int. Seed Test Assoc. 26:68-85.

20. Muzik, Thomas J. 1970. Weed biology and control. McGraw and Hill, New York, New York.

21. Pavlychenko, T. K. 1949. Plant competition and weed control. Agri. Inst. Rev. 4:142-145.

22. Pawlowski, F., Kapeluszny J., A. Kolasa, Z. Lecyk. 1970. The prolificacy of weeds in various habitats. Annals Univ. Mariae Curie-Sklodowska E. 25:61-75.

23. Phillips, W. M. 1960. The chloro-substituted benzoic acids for control of field bindweed. Weeds 8:63-70.

24. Roberts, H. A. and Patricia M. Feast. 1973. Changes in the numbers of viable weed seeds in soil under different regimes. Weed Res. 13:298-303.

25. Roberts, H. A. and Patricia M. Lockett. 1974. Germination of buried and dry-stored seeds of Stellaria media. Weed Res. 15:199-204.

26. Rydrych, D. J. 1974. Competition between winter wheat and downy brome. Weed Sci. 22:211-214.

27. Rydrych, D. J. and T. J. Muzik. 1968. Downy brome competition and control in dryland wheat. Agron. J. 60:279-280.

28. Russ, O. G. and L. E. Anderson. 1960. Field bindweed control by combinations of cropping, cultivation and 2,4-D. Weeds 8: 397-401.

29. Schweizer, E. E. and J. F. Swink. 1971. Field bindweed control with dicamba and 2,4-D, and crop response to chemical residues. Weed Sci. 19:717-721.

30. Skelton, I. W., H. P. Alley and G. A. Lee. 1973. Comparison of injection and surface application of herbicides for control of field bindweed and resulting crop tolerances. Proc. W. Soc. of Weed Sci. 26:27.

31. Steel, R. G. D. and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc., N. Y. 491 p.

32. Steinbauer, G. P. and Buford H. Grigsby. 1957. Field and laboratory studies on the dormancy and germination of seeds of chess Bromus secalinus L. and downy bromegrass Bromus techorum L. Weeds 5:1-4.

33. Swan, D. G. 1971. Competition of blue mustard in winter wheat. Weed Sci. 19:340-342.

34. Swan, Dean G. and W. R. Furtick. 1962. Competition of fiddleneck with wheat. Weeds 10:121-123.

35. Timmons, F. L. 1941. Results of bindweed control experiments at the Fort Hays Branch Station, Hays, Kansas, 1935 to 1940. Kansas Agri. Exp. Sta. Bul. 296, p. 5.

36. Vorobev, N. E., Yu K. Kudzin, and A. V. Fisyunov. 1974. The effects of fertilizers on the inter-relationships of crop and weed plants in field plant associations on the steppes of the Black Sea littoral of the Ukranian SSR. Agrokhimiya 11:75-83.

37. Warner, L. C. 1973. Subsurface layering of trifluralin with a moldboard plow for field bindweed control. Proc. W. Soc. of Weed Sci. 26:27-28.

38. Wicks, G. A., O. C. Burnside, and C. R. Fenster. 1971. Influence of soil type and depth of planting on downy brome seed. Weed Sci. 19:82-85.

39. Wiese, A. F. 1960. Effects of tansy mustard (Descuraina intemedia) on moisture storage during fallow. Weeds 8:683-685.

40. Wiese, A. F. 1965. Perennial weed control of picloram. Proc. S. Weed Sci. Soc. 18:63-64.

41. Wiese, A. F. 1976. Weeds in agronomic crop-small grains. Res. Rep. S. Weed Sci. Soc. 29:96.

42. Wiese, A. F. and H. E. Rea. 1960. Field bindweed (_Convolvulus arvensis_) control with soil applications of phenoxy herbicides. Weeds 8:418-421.

43. Wiese, A. F. and H. E. Rea. 1961. Factors affecting the toxicity of phenoxy herbicides to field bindweed. Weeds 10:58-61.

44. Wiese, A. L. and R. G. Davis. 1962. Effects of weeds on sorghum and wheat yields. Proc. N. Cent. Weed Control Conf. 19:32.

45. Williams, E. D. 1970. Studies of the growth of seedlings of _Agropyron repense_ (L.) Beauv. and _Agrostis gigantea_ Roth. Weed Res. 10:321-330.

VITA

Loyd Vernon Hill

Candidate for the Degree of

Doctor of Philosophy

Thesis: DEVELOPMENT, COMPETITION AND CONTROL OF TANSY MUSTARD, JOINTED GOATGRASS AND FIELD BINDWEED IN WINTER WHEAT

Major Field: Crop Science

Biographical:

Personal Data: Born near Tribune, Kansas, June 1, 1934, the son of Carl H. and Minnie D. Hill.

Education: Graduated from Manchester High School, Manchester, Oklahoma, in May, 1952; received Bachelor of Science degree in Agronomy from Oklahoma State University in 1956; received Master of Science in Agronomy from Oklahoma State University in 1969; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in July, 1976.

Professional Experience: Officer in United States Air Force, 1956-65; soil scientist, Soil Conservation Service, 1965-66; graduate assistant and research technician, Oklahoma State University, 1966-69; instructor of agriculture, Northwestern Oklahoma State University, 1969-76.

Professional Organizations: Sigma Xi, Oklahoma Educational Association.