Efficacy, Phytotoxicity, and Cover Crop Response of Herbicide Combinations in Dark Fire Cured Tobacco

Tracy Kelley
Western Kentucky University

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EFFICACY, PHYTOTOXICITY, AND COVER CROP RESPONSE
OF HERBICIDE COMBINATIONS IN DARK FIRE CURED TOBACCO

A Thesis

Presented to

the Faculty of the Department of Agriculture

Western Kentucky University

Bowling Green, Kentucky

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Tracey Dawn Kelley

May 2000
Efficacy, Phytotoxicity, and Cover Crop Response

of Herbicide Combinations in Dark Fire-Cured Tobacco

Date Recommended: 4/7/00

Director of Thesis:

Dean, Graduate Studies and Research: 5/4/00
DEDICATION

To all farmers, especially my grandfather, I dedicate this thesis.

Without my grandfather’s involvement in the tobacco industry, I would not have received such an honor and opportunity as this scholarship.
ACKNOWLEDGMENTS

To my parents who encouraged me to do my best and work hard. I love you both with all my heart.

To my sister, grandparents, aunt, and uncle who have given me support, encouragement, and love.

To Brad to whom I devote my heart, for he never lost faith in me or in my abilities.

To the faculty and staff of the Department of Agriculture—thank you for your guidance and direction.

To Dr. Willian—I sincerely appreciate your patience, guidance, support and advice as my advisor and friend throughout my graduate studies.

To Dr. Gilfillen—thank you for opening my eyes to possibilities and encouraging me.

To Dr. Liu—thank you for your help and guidance.

To Dr. Stiles—for his advisement and guidance in my undergraduate and graduate studies.

To my fellow graduate students—Trent Cash, Summer Dixon, Emily Troyer, and Chad Goldman—thank you for your friendship and advice.

My greatest thanks and appreciation is bestowed upon those of the United States Tobacco Company. Without their gracious and generous gift of scholarships to Western Kentucky University, I and many other tobacco growers would not have received such a promising education in the agriculture industry.
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EFFICACY, PHYTOTOXICITY, AND COVER CROP RESPONSE
OF HERBICIDE COMBINATIONS IN DARK FIRE CURED TOBACCO

Tracey Kelley

May 2000

Directed by: Dr. William T. Willian, Dr. Rebecca Gilfillen, and Dr. Haibo Liu

Department of Agriculture Western Kentucky University

Field studies were established during the summer of 1999 at the Agricultural Research and Education Complex of Western Kentucky University to evaluate efficacy, phytotoxicity, and cover crop response of herbicide combinations in dark fire cured tobacco. A randomized complete block design was used with nine treatments replicated three times. Hydroponic tobacco transplants (c.v. ‘TND950’) were established on May 20, 1999 in a conventionally tilled system on a Pembroke silt loam (Molllic Palleudalf) with a pH of 5.8 and an organic matter content of 1.2%. The transplants were established at a population of approximately 10,278 plants/ha.

Herbicide treatments were applied on May 19, 1999 with a CO₂ backpack sprayer. Sulfentrazone as Spartan 75DF was applied in all nine treatments at a rate of 0.47 kg pr/ha. Six of the nine treatments included various rates of clomazone as Command 3ME. Two of the nine treatments included napropamide as Devrinol 50DF. Visual evaluations of crop phytotoxicity due to herbicide application were recorded at 21 and 44 days after treatment (DAT). Weed control was evaluated at 21, 29, 44, and 58 DAT for the following species: Ipomoea hederacea L. (ivyleaf morningglory), Amaranthus hybridus
L. (smooth pigweed), and *Eleusine indica* L. (goosegrass). Crop injury and weed control evaluations were recorded on a 0-100% scale with 0 representing no injury and/or no control and 100 representing plant death.

After crop removal, two types of tillage were performed to examine wheat injury effects due to tillage. One subplot was moldboard plowed and disked while the other subplot was disked. Following tillage operations, winter wheat (*Triticum aestivum*) was planted on October 30, 1999 at a rate of 134.68 kg pr/ha. Visual wheat chlorosis evaluations of each subplot were recorded and based on a scale of 0-100%. Stand counts were taken in the subplots to examine stand loss due to treatment. Wheat aboveground biomass was harvested from each subplot to evaluate the relationship between wheat growth and herbicide rate.

Sulfentrazone alone provided >66% control of *Eleusine indica*, >96% control of *Ipomoea hederacea*, and >88% of *Amaranthus hybridus* at all evaluation dates. When combined with 0.584 L pr/ha clomazone, sulfentrazone provided >82% control of all weed species 58 DAT. Sulfentrazone combined with ≥ 1.17 L pr/ha clomazone provided > 86% *Eleusine indica* control, >60% *Ipomoea hederacea* control, and >84% *Amaranthus hybridus* control. Sulfentrazone combined with 1.12 kg pr/ha napropamide provided >71% control for all weed species at all evaluation dates. However, sulfentrazone plus 2.24 kg pr/ha napropamide provided only >55% control of species at all evaluation dates.

Wheat chlorosis was affected by increased rates of clomazone combined with sulfentrazone at both 25 and 41 DAP (days after planting). Fresh weight also exhibited a trend of decreased mass as clomazone application rate increased. Addition of ≥1.75 L
pr/ha clomazone decreased stand count at both evaluation dates, as compared to the sulfentrazone treatment. There were no differences in stand count between napropamide rates in either stand count evaluation.

Wheat chlorosis 25 and 41 DAP was greater in plots that were not moldboard plowed. Areas moldboard plowed and disked exhibited less chlorosis, but tillage had no significant effect on wheat biomass or stand count.
CHAPTER I

INTRODUCTION

Fire cured tobacco is of great importance to the agricultural economy of Kentucky, Tennessee, and Virginia. It is produced primarily for making snuff and plug chewing tobacco (Garner, 32). Throughout Tennessee and Kentucky, dark fire cured tobacco is prominently grown.

*Nicotiana tabacum* is a species of the Solanaceae family (Smiley, 5). It is grown as an annual in the United States and was first cultivated by the Aborigines. Commercial culture of tobacco began in North America in 1612 in Jamestown, Virginia. As time passed, the crop became more popular and production increased. As it became commercialized it also became highly specialized (Garner, 13).

Weed control is imperative to a successful tobacco crop. Crop rotation, cultivation, early weed root and stalk destruction, and the use of herbicides utilized in combination can provide a complete weed control program. Crop rotation is the most cost-effective way to increase efficiency of weed control but is not always an available option (Fowlkes, 9). Few herbicides are registered for use in tobacco due to low acreage of the crop; therefore, combinations are used in order to provide control of both broadleaf and grass weeds.
Napropamide, labeled as Devrinol® 50DF and 2E, is available for pre-emergence, pre-plant incorporation, and/or post transplant application. Possible carry-over in the soil can cause stunting of small grains, as well as possibly stunting of tobacco roots and early season growth. Napropamide provides fair control of common ragweed (*Ambrosia artemisiifolia L.*) and good control of redroot pigweed (*Amaranthus retroflexus L.*) (Palmer, 66).

Clomazone, labeled as Command®, is a selective herbicide that controls annual grasses such as large crabgrass (*Digitaria sanguinalis L.*), goosegrass (*Eleusine indica L.*), common ragweed, and broadleaf signalgrass (*Brachiaria platyphylla G.*). Clomazone does not control redroot pigweed. It may be applied early pre-plant, pre-emergence, or pre-plant incorporated. Clomazone is moderately persistent in the soil and degradation occurs primarily via microbial degradation. Clomazone soil residues may inhibit root and shoot growth of wheat plants (Mervosh, 538).

Sulfentrazone, labeled as Spartan®, provides a broad spectrum of control for weeds such as sedges (*Cyperus sp.*), morningglory (*Ipomoea sp.*), tall waterhemp (*Amaranthus tuberculatus M.*), nightshade (*Solanum ptycanthum D.*), and lambsquarters (*Chenopodium album L.*). Activation depends upon moisture and slight incorporation of sulfentrazone may be needed when moisture is insufficient for activation. A combination of sulfentrazone with either napropamide or clomazone is a popular weed control program for tobacco crops.

Small grains are a popular cover crop following tobacco crops; however, small grains such as wheat are subject to damage from the presence of certain herbicide residues. Clomazone and napropamide can injure wheat cover crops depending on the
rates applied and the dissipation rate of the herbicide in the soil. Tillage and soil moisture can also affect dissipation of these herbicides.

The objectives of this research project were:

(a) to evaluate the efficacy of herbicide combinations,

(b) to determine phytotoxicity of these herbicide combinations, and

(c) to evaluate wheat response to these herbicide combinations in dark fire-cured tobacco.
CHAPTER II

LITERATURE REVIEW

History of the Tobacco Plant

In 1753, Linnaeus established the genus *Nicotiana*. The genus designation, *Nicotiana*, was given in honor of the ambassador to Portugal, Jean Nicot, who introduced tobacco to the royal courts in Paris.

*Nicotiana tabacum* and *Nicotiana rustica* were the only two species included in Linnaeus’ original classification, chiefly cultivated by the American Aborigines and subsequently by the early colonists (Garner, 4). *Nicotiana rustica* was grown by the natives while *Nicotiana tabacum* was grown primarily by the Aborigines of the West Indies, Mexico, Central America, Colombia, Venezuela, the Guianas, and Brazil (Garner, 4).

Long before Columbus arrived in 1492 to the New World, the natives had been implementing tobacco into their lives (Smiley, 5). The commercial culture of tobacco in North America began in 1612 in Jamestown, Virginia with the undertaking of John Rolfe. In June 1619, 20,000 pounds of the previous years crop had been shipped to England. As time went by, the crop became more popular and production increased significantly.
Unfortunately, the crop's commercial cultivation soon declined until the state developed the cigar-leaf industry in the latter half of the nineteenth century (Garner, 23).

After the Revolutionary War, tobacco production spread into Ohio, Kentucky, Tennessee, and Missouri by way of settlers from Virginia and Maryland. Kentucky produced a small amount of tobacco for the New Orleans market in the 1780's. In 1810, tobacco was commercially grown in Logan County and then shipped to New Orleans in hogsheads down the Cumberland and Mississippi Rivers. Green, Barren, Hardin, and Warren Counties also began production at this time. By the close of the 18th century, central and eastern Kentucky considered tobacco a crop of economic importance (Garner, 31).

**Taxonomy**

Tobacco belongs to the Solanaceae family, also known as the nightshade family. Familiar relatives are garden peppers, Irish potatoes, eggplant, tomato, jimsonweed, belladonna, and petunias. The exact number of species in the genus *Nicotiana* is still unknown, but is in excess of 50 (Smiley, 5).

**Types of Tobacco**

Tobacco has become highly specialized since its commercialization. Various areas of the United States and world have supplied certain types and grades of tobacco leaf for particular tobacco products. Receiving tobacco from areas that are most suited to the soil and climatic conditions of a tobacco type has promoted particular geographic areas to specialize in certain tobacco varieties for optimum desired characteristics (Garner, 13, 17).
The Bureau of Agricultural Economics of the United States Department of Agriculture decided upon a classification system for leaf tobacco in 1929. This system separated tobacco into types, classes, and groups of grades (Garner, 17).

Each leaf crop is separated into types – broad units that are determined by variety of seed, the region in which the leaf is produced, method of curing, and uses for the type by manufacture. Manufacturers utilize this class system to develop the various products demanded by consumers (Garner, 14).

The color, body, leaf composition, and fermentation and aging properties are evaluated to further divide the tobacco leaf into different classes. Classes are then subdivided into grades. Stalk position, quality, color, and other leaf characteristics separate the grades from one another. Manufacturers use grades of tobacco to obtain the best cigarette blend and to reduce losses (Smiley, 6).

**Dark Fired Production Practices**

Tobacco is grown as an annual in the United States, although it is potentially perennial in habit. The normal leaf color is green to bluish-green, varying according to nutritional status. As the leaf approaches maturity, the dark green color changes to a lighter green. In the normal curing process, the color will develop a yellowish-orange hue and if dried slowly it will further change to shades of reddish brown (Garner, 7).

Fire cured tobacco, produced primarily in Kentucky, Tennessee, and Virginia, is used mainly for making snuff and plug chewing tobacco. In the early days of tobacco culture in Kentucky and Tennessee, the settlers closely followed the Virginia curing methods. A dark fire cured type similar to the Virginia product was extensively grown throughout Tennessee and Kentucky. In the western portion of Kentucky and the
adjoining region of Tennessee it remains the characteristic type of tobacco produced, although burley tobacco is also extensively grown in these areas (Garner, 32).

Type 22, Eastern district tobacco, is produced in southern Kentucky, east of the Tennessee River and in northern Tennessee. Type 23, Western district tobacco, is produced in western Kentucky and northwestern Tennessee between the Tennessee, Ohio, and Mississippi rivers (Cockrel, 74).

Tobacco has such small seeds that it cannot be directly seeded into the field. Instead, seed must be germinated in a plant or float bed and then transplanted into the field when seedlings are 6 to 8 inches in height (Smiley, 19).

Harvest yield and quality of tobacco are improved when adequate amounts of proper nutrients are incorporated. Yield and quality of both burley and dark tobacco are greatly influenced by fertilization practices. Liming is also important in order to maintain proper soil pH and thus optimize nutrient availability (Smiley, 23).

**Fertilization Practices**

Obtaining soil samples from tobacco fields and submitting them for testing should be the first step growers take in planning their tobacco nutrient management program. Nitrogen, potassium, and phosphorus are the nutrients needed in largest amounts by dark tobacco and the ones most important to desirable tobacco yield and quality. Equally important to yield and quality is proper soil pH, which strongly influences fertilization efficiency and plant growth (Fowlkes et. al., 8).

Tobacco fertilization programs supply nutrients for production of high quality tobacco as well as maintain nutrient levels of the soil. Fertilizer requirements of tobacco are somewhat greater than those of most other agronomic crops. Fertilizers should be
placed so that they are not in direct contact with roots of the transplants. Frequently the cause of poor stands and irregular crop growth is fertilizer injury.

Nitrogen affects the yield and cured leaf quality more than any other nutrient in tobacco. The amount of nitrogen to apply to dark tobacco from all sources should be from 168 to 224 kg/ha. Applying excessive amounts of nitrogen will produce rank growth, delay maturity, lower quality, reduce soil pH, and increase weed competition. Adequate phosphate must be applied for tobacco to encourage early season growth and to facilitate proper maturation. Recommendations from the University of Tennessee for phosphate range from 67 kg/ha for high testing soils to 168 kg/ha for soils testing low in phosphorus. Dark tobacco requires high levels of potassium. Recommendations range from 134 kg/ha potassium per acre for high testing soils to 336 kg/ha for low testing soils. Since excessive amounts of chlorine in tobacco slow curing and reduce quality, sulfate of potash should be used rather than muriate of potash (Fowlkes et. al., 8).

A pH range of 5.5-6.0 is desirable for dark tobacco soils. If the pH rises above 6.0, black root rot is likely to be a problem. If the soil pH falls below 5.5, manganese and aluminum toxicity can negatively influence tobacco growth. Therefore, soils should be limed based on soil test results to maintain pH in the desired range. Application of lime will increase pH and phosphorus absorption, as well as increase the amount of calcium and magnesium in the soil (Fowlkes et. al., 8).

**Weed Control**

Good weed control uses a combination of crop rotation, cultivation, early destruction of root and stalk of weeds, and herbicides. Cultivation and hoeing have traditionally been the primary methods of weed control for tobacco producers. The use
of herbicides along with crop rotation can prevent difficult to control weeds that reoccur each year in tobacco fields.

Producers of dark tobacco should give consideration to weed problems when selecting fields for tobacco production. Many weeds such as groundcherry (*Physalis sp.*), jimsonweed (*Datura stramonium L.*), horsenettle (*Solanum carolinense L.*), cocklebur (*Xanthium strumarium L.*), bermudagrass (*Cynodon dactylon L.*), and rhizome johnsongrass (*Sorghum halepense L.*) are often not adequately controlled by tobacco herbicides and should not be present in great abundance in the chosen field (Fowlkes et al., 9).

The most effective and inexpensive method that increases efficiency of dark fired production is crop rotation. Soil structure and nutrient balance are increased with crop rotation, increasing the efficiency of fertilizers and water absorption. Tobacco diseases, insects, and weeds may also be controlled by crop rotation. When rotating with other crops, care should be taken to avoid residual amounts of herbicide that could potentially be damaging to successive crops. Tobacco is very sensitive to persistent herbicides such as atrazine, simazine, and some soybean herbicides. Herbicide carry-over can reduce plant growth and in some cases may kill tobacco transplants. A combination of soil-applied herbicides and timely, shallow cultivation is required for adequate weed control in most fields (Fowlkes et al., 9).

**Herbicides**

Benefin, diphenamid, and isopropalin were once used to control most grasses and small-seeded broadleaves in tobacco crops. Since these were slightly volatile and subject to decomposition by sunlight, soil incorporation was necessary. Once labeled as Balan,
Enide, and Paarlan, respectively, these herbicides are no longer registered for use in tobacco crops.

Pendimethalin, more commonly known as Prowl®, controls most annual grasses, seedling johnsongrass, and some small-seeded broadleaf weeds, but does not adequately control ragweed or morningglory species. Pendimethalin is applied at 0.83 to 1.67 kg a.i./ha and should be incorporated within 7 days after application. Pendimethalin exhibits moderate soil persistence but its downward movement through the soil profile is negligible due to its low water solubility (Palmer, 66).

Napropamide, labeled as Devrinol® 50DF and 2E, is labeled in tobacco for preemergence, pre-plant incorporated and/or post transplant application. Its label indicates rotational restrictions because of possible soil carryover; soil residues may stunt small grain growth, especially when napropamide is soil incorporated. Napropamide has the potential to limit tobacco root growth and result in slow early season growth. It provides fair control of common ragweed and good control of redroot pigweed. Certain broadleaf weeds are extensively suppressed by napropamide (Palmer, 66).

Clomazone

Clomazone is a selective herbicide used for control of annual grasses and broadleaf weeds in tobacco and several other crops. It can be applied early pre-plant, pre-emergent or pre-plant incorporated. The mode of action of clomazone differs from other tobacco herbicides. Clomazone is absorbed by emerging roots and shoots and subsequently inhibits photosynthesis. Interference of chlorophyll development causes leaves of susceptible plants to lose pigmentation after treatment and thus appear chlorotic (Westberg et. al., 678).
Clomazone controls large crabgrass, goosegrass, common ragweed, and broadleaf signalgrass, especially when combined with pendimethalin or sulfentrazone. Clomazone does not control redroot pigweed (Westberg et al., 678).

Westberg reported that barnyardgrass (*Echinochloa crus-galli* L.), giant foxtail (*Setaria faberi*), goosegrass, large crabgrass, seedling johnsongrass, prickly sida (*Sida spinosa* L.), and velvetleaf (*Abutilon theophrasti*) were highly susceptible to clomazone at 280 g/ha applied preemergence. A rate of 560 g/ha also controlled balloonvine (*Cardiospermum halicacabum* L.), jimsonweed, pitted morningglory (*Ipomoea lacunosa* L.), redroot pigweed, and tall waterhemp. A 110g/ha rate controlled palmleaf morningglory (*Ipomoea wrightii* L.), smallflower morningglory (*Jacquemontia tamnifolia* L.), and smooth pigweed (*Amaranthus hybridus* L.) and suppressed growth of red rice (*Orzyla sativa* L.), common cocklebur, and sicklepod (*Senna obtusifolia* L.). Regardless of method of application, Palmer amaranth (*Amaranthus palmeri* S.) was the most tolerant pigweed species. Entireleaf (*Ipomoea hederacea var. integriuscula* L.), ivyleaf (*Ipomoea hederacea* L.), and purple (*Ipomoea turbinata* L.) morningglory were the most tolerant morningglory species.

Clomazone is moderately persistent in soil. Microbial degradation of clomazone is promoted by high soil moisture, warm temperatures, and by soil pH >6.5. Degradation is faster in a sandy loam than in silt or clay loams. In field studies, half-life of clomazone was 28 to 48 days, depending on soil type and organic matter content. Clomazone is highly soluble in water, but has a moderate tendency to adsorb to soil particles. It therefore has a low to moderate potential to contaminate groundwater. The product
Command® has low mobility in sandy loam, silt loam, and clay loam soils. Command® is moderately mobile in fine sand (Mervosh, 538).

Loux reported that clomazone inhibited shoot and root growth of wheat plants. Visual injury was expressed as tissue chlorosis followed by necrosis. The degree of wheat injury paralleled the rate of clomazone dissipation. Dissipation rates appear to be lower in high organic matter and finer textured soils. Crop rotation is an effective way to allow dissipation of clomazone soil residues prior to small grain establishment.

Command® 3ME is a low volatile formulation and is labeled for pre-transplant surface application, shallow incorporation, or overtop application within 7 days of transplanting. Environmental conditions such as temperature, soil moisture, precipitation, and wind speed can effect volatilization. Incorporation of clomazone into the soil can decrease volatilization (Thelen et. al., 323).

Sulfentrazone

Sulfentrazone obtained US registration in February 1997. It is one of a new family of herbicides developed by FMC that controls a broad spectrum of weeds, including such difficult to control species as sedges, morningglory, tall waterhemp, nightshade, and lambsquarters.

Sulfentrazone was the first herbicide to be developed from the phenyl triazolinone chemistry. Spartan® is a soil applied herbicide, formulated as a water dispersible granule containing 75% of the active ingredient sulfentrazone. Plant uptake occurs via roots and foliage; however, sulfentrazone movement in the phloem is assumed to be limited because of rapid foliar desiccation. The mechanism of action is plant cell membrane disruption, which is initiated by the inhibition of protoporphyringen oxidase in the
chlorophyll biosynthetic pathway, which leads to the build up of toxic intermediates. The primary selectivity mechanism appears to be differential metabolism, although other effects, such as retardation of root hair development in sensitive coffee senna \((Cassia occidentalis \text{ L.})\) and differential cellular damage in soybean cultivars are also important factors (Swantek et. al., 271).

Soybeans and tobacco can be planted on sulfentrazone treated land anytime after harvest. However, small grains require delays of 4 months after application; corn, rice, and sorghum require a 10 month interval; and other cereal grains, cotton, and sweet corn require 18 months or more. Conditions conducive to soybean injury include: low soil organic matter content and high soil moisture, with availability in the soil solution increasing as soil texture becomes coarser and pH increases (Swantek et. al., 271).

Clay and organic matter are the most significant soil components with respect to adsorbing herbicides when molecules are cationic or contain cationic components. Activation depends upon irrigation or amount of rainfall. Adequate moisture of 1.27 to 2.54 cm is needed within 7 to 10 days after treatment for optimum activity. Cultivation may be needed for incorporation if soil moisture is limiting. Sulfentrazone is relatively nonvolatile and microbial degradation is considered the primary method of soil dissipation. The sulfentrazone molecule is a weak acid and soil adsorption will be potentially both pH and soil series dependent. The rate of Spartan® is determined by the soil’s texture and the percent of organic matter present (Grey et. al., 733).

Studies conducted at University of Tennessee Greenville Experiment Station evaluated the efficacy of pre-transplant herbicides in no-till burley tobacco. All plots on which Spartan® had been applied had 95% control of smooth pigweed and >85% control
of cocklebur. When combined with Prowl®, Spartan® controlled 96% of large crabgrass and when combined with Command® controlled 92% of large crabgrass (Ellis et. al., 19).

Field trials were performed by University of Tennessee at Greenville and Springfield, Tennessee to determine the influence of herbicide incorporation depth on weed control, tobacco injury, and yield. Both Spartan® combinations with Command® and Prowl® provided greater than 90% control of smooth pigweed, large crabgrass, goosegrass, Pennsylvania smartweed (*Polygonum pensylvanicum* L.), carpetweed (*Mollugo verticillata* L.), and yellow nutsedge (*Cyperus esculentus* L.). Weed control was not influenced by depth of incorporation. However, incorporation increased crop injury, stunting, and chlorosis at 26 DAT, but declined to less than 5% at 64 DAT (Breeden et. al., 20).
 CHAPTER III

MATERIALS AND METHODS

Field studies were established during the summer of 1999 at the Agricultural Research and Education Complex of Western Kentucky University, Bowling Green, Kentucky. A randomized complete block design was used with nine treatments replicated three times. Hydroponic tobacco transplants (c.v. ‘TND950’) were established on May 20, 1999 in a conventionally tilled system on a Pembroke silt loam (Mollie Paleudalf) with a pH of 5.8 and an organic matter content of 1.2%. The transplants were established at a population of approximately 10,378 plants/ha. Dimensions of the experiment area were 6 rows that were 106.7 cm wide and 9.1 m in length.

Prior to establishment of the crop, 2,246.4 kg/ha of lime as CaCO_3 was applied to the plot area. NH_4NO_3 was applied to the plot area at a rate of 224 kg N/ha prior to transplanting. An additional 56 kg N/ha as NH_4NO_3 was surface applied to the row middles 61 DAT. Potassium sulfate was incorporated into the soil prior to transplanting at a rate of 112 kg K/ha.

Herbicide treatments were applied on May 19, 1999 with a CO_2 -backpack sprayer delivering 41 L/ha @ 30psi. Herbicide treatments were applied pre-transplant as follows:
Table 1: Pre-transplant Herbicide Treatments

<table>
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<tr>
<th>Treatment</th>
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<th>Napropamide kg pr/ha</th>
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<td>9</td>
<td>0.47</td>
<td>-</td>
<td>2.24</td>
</tr>
</tbody>
</table>

Visual evaluations of crop injury were made 21 and 44 DAT. Crop injury evaluations were based on a scale of 0 to 100 with 0 representing no injury and 100 representing crop death. Weed control for each treatment was evaluated at 21, 29, 44, and 58 DAT for ivyleaf morningglory, smooth pigweed, and goosegrass. An untreated area within the plots was utilized as a basis for evaluating efficacy. Weed control was based on a scale of 0 to 100 % with 0 representing no control and 100 representing plant death.

The crop was removed from the plot area at its maturity. Subsequently, two types of tillage were performed to examine wheat crop injury due to tillage effects. Each plot was divided into 2 subplots. One of these subplots was moldboard plowed on October 30, 1999. After plowing, the entire plot was disked prior to wheat establishment.
Triticum aestivum L. (c.v. ‘FFR-558W’) was planted on October 30, 1999 at a population of 134.68 kg/ha.

Visual wheat chlorosis evaluations of each subplot were taken at 25 and 44 DAP. Injury was based on a scale of 0 to 100% with 0% representing no response and 100% representing plant death. Plots receiving only sulfentrazone were utilized as a standard for comparison since wheat is typically tolerant of sulfentrazone soil residues.

Stand counts were taken at 41 and 55 DAP in each subplot. Two random areas in each subplot were evaluated. Wheat plants within a 0.305m² area were counted if they exhibited < 50% chlorosis.

Wheat aboveground biomass was harvested from each subplot at 77 DAP. Biomass was harvested from a single 0.305m² area within each subplot. All plants within the area were extracted and excess soil was removed from the roots prior to transport to the laboratory. Roots were removed and the combined aboveground biomass from each subplot was recorded as grams of fresh weight.

Statistical computations were performed using the Statistical Analysis System. All data were subjected to ANOVA for treatment and tillage effects on wheat response. Analyses indicated no treatment by tillage interactions, thus wheat response data are presented by treatment and by tillage. Means were separated with Fisher’s Protected LSD test at the 5% level.
CHAPTER IV

RESULTS AND DISCUSSION

Weed control

Goosegrass (*Eleusine indica*) control with sulfentrazone alone was > 66% at all evaluation dates. (Table 2) Sulfentrazone tank mixed with 0.58 L pr/ha clomazone provided 82.7 to 97.0% control depending on evaluation date. Sulfentrazone combined with 1.17 L pr/ha of clomazone provided > 86% goosegrass control at all evaluation dates. A tank mixture of sulfentrazone with 1.75 L pr/ha clomazone provided 90.7 to 98.3% control of goosegrass. Sulfentrazone combined with either 2.34, 2.92, or 3.5 L pr/ha of clomazone provided ≥ 95.0% control at all evaluation dates. A tank mixture of sulfentrazone and 1.12 kg pr/ha of napropamide provided 71.7 to 84.7% goosegrass control. Sulfentrazone and 2.24 kg pr/ha napropamide provided 55.0 to 83.3% control of goosegrass. All sulfentrazone and clomazone combinations provided greater goosegrass control at 29 and 44 DAT than did the sulfentrazone and napropamide tank mixes. At the 44 DAT evaluation date sulfentrazone and clomazone combinations provided greater control than did sulfentrazone alone. All sulfentrazone and clomazone combinations provided greater goosegrass control at 58 DAT than did sulfentrazone and 2.24 kg pr/ha napropamide.
Table 2: *Eleusine indica* control as influenced by tank mixtures of sulfentrazone plus clomazone or napropamide*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>29 DAT</th>
<th>44 DAT</th>
<th>58 DAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>sulfentrazone</td>
<td>0.47 kg pr/ha</td>
<td>93.0ab</td>
<td>80.3 b</td>
<td>66.7 cd</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 0.584 L pr/ha</td>
<td>97.0 a</td>
<td>91.3 a</td>
<td>82.7 abc</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 1.17 L pr/ha</td>
<td>98.3 a</td>
<td>95.7 a</td>
<td>86.3 abc</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 1.75 L pr/ha</td>
<td>98.3 a</td>
<td>94.7 a</td>
<td>90.7 ab</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 2.34 L pr/ha</td>
<td>96.3 a</td>
<td>95.7 a</td>
<td>95.0 a</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 2.92 L pr/ha</td>
<td>99.0 a</td>
<td>97.7 a</td>
<td>98.5 a</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 3.50 L pr/ha</td>
<td>99.0 a</td>
<td>99.0 a</td>
<td>98.3 a</td>
</tr>
<tr>
<td>sulfentrazone + napropamide</td>
<td>0.47 kg pr/ha + 1.12 kg pr/ha</td>
<td>84.7 b</td>
<td>75.7 b</td>
<td>71.7 bcd</td>
</tr>
<tr>
<td>sulfentrazone + napropamide</td>
<td>0.47 kg pr/ha + 2.24 kg pr/ha</td>
<td>83.3 b</td>
<td>80.0 b</td>
<td>55.0 d</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td>9.5</td>
<td>10.9</td>
<td>19.4</td>
</tr>
</tbody>
</table>

* * means sharing the same letter are not different (LSD=0.05)

^DAT=days after treatment
Sulfentrazone alone provided 96% ivyleaf morningglory (*Ipomoea hederacea*) control 21 DAT and 91.5% control 58 DAT. (Table 3) At 21 DAT, all sulfentrazone and clomazone combinations provided greater control than did sulfentrazone with 2.24 kg pr/ha napropamide. Addition of 1.75 L pr/ha or greater clomazone provided >92% control 29 DAT. The two lowest rates of clomazone addition provided 70% control 29 DAT. Tank mixtures of sulfentrazone and napropamide controlled < 75% of ivyleaf morningglory 29 DAT.

At 44 DAT, sulfentrazone mixed with 0.584 L pr/ha clomazone or 2.24 kg pr/ha napropamide provided poorer control than all other treatments. All treatments with the exception of sulfentrazone plus clomazone 2.92 L pr/ha and sulfentrazone plus napropamide 2.24 kg/ha controlled > 82% ivyleaf morningglory 58 DAT.

Smooth pigweed (*Amaranthus hybridus*) control with sulfentrazone alone was > 88% at all evaluation dates. (Table 4) Sulfentrazone combined with 0.584 L pr/ha clomazone provided 92.3 to 96.0% smooth pigweed control depending on evaluation date. A tank mixture of sulfentrazone with 1.17 L pr/ha clomazone provided 84.3 to 89.7% smooth pigweed control. Sulfentrazone combined with 1.75 L pr/ha of clomazone provided > 89% control of smooth pigweed at all evaluation dates. Sulfentrazone tank mixed with 2.34 L pr/ha clomazone provided 89.7 to 94.7% smooth pigweed control depending on evaluation date. Sulfentrazone tank mixed with 2.92 L pr/ha clomazone provided > 86% control of pigweed. A combination of sulfentrazone tank mixed with 3.50 L pr/ha clomazone provided > 94% control of pigweed at all evaluation dates.

Sulfentrazone mixed with 1.12 kg pr/ha of napropamide allowed for 85.0 to 88.0% control of pigweed, while sulfentrazone combined with 2.24 kg pr/ha of napropamide
Table 3: *Ipomoea hederacea* control as influenced by tank mixtures of sulfentrazone plus clomazone or napropamide *

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>21 DAT^</th>
<th>29 DAT</th>
<th>44 DAT</th>
<th>58 DAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>sulfentrazone</td>
<td>0.47 kg pr/ha</td>
<td>96.0 ab</td>
<td>ND</td>
<td>ND</td>
<td>91.5 ab</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 0.584 L pr/ha</td>
<td>96.0 ab</td>
<td>70.0 cd</td>
<td>50.0 c</td>
<td>82.5 bc</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 1.17 L pr/ha</td>
<td>95.0 ab</td>
<td>70.0 cd</td>
<td>95.0 a</td>
<td>90.0 ab</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 1.75 L pr/ha</td>
<td>98.3 a</td>
<td>95.0 ab</td>
<td>ND</td>
<td>96.0 a</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 2.34 L pr/ha</td>
<td>97.7 a</td>
<td>92.5 abc</td>
<td>93.0 a</td>
<td>83.5 bc</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 2.92 L pr/ha</td>
<td>91.7 ab</td>
<td>94.7 ab</td>
<td>88.0 a</td>
<td>60.0 d</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 3.50 L pr/ha</td>
<td>98.3 a</td>
<td>97.0 a</td>
<td>92.5 a</td>
<td>95.0 a</td>
</tr>
<tr>
<td>sulfentrazone + napropamide</td>
<td>0.47 kg pr/ha + 1.12 kg pr/ha</td>
<td>87.7 bc</td>
<td>73.3 bc</td>
<td>90.0 a</td>
<td>97.0 a</td>
</tr>
<tr>
<td>sulfentrazone + napropamide</td>
<td>0.47 kg pr/ha + 2.24 kg pr/ha</td>
<td>81.7 c</td>
<td>60.0 d</td>
<td>70.0 b</td>
<td>75.0 c</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td></td>
<td>8.9</td>
<td>23.1</td>
<td>9.9</td>
<td>10.3</td>
</tr>
</tbody>
</table>

* means sharing the same letter are not different (LSD=0.05)

^DAT=days after treatment

oND= no data
Table 4: *Amaranthus hybridus* control as influenced by tank mixtures of sulfentrazone plus clomazone or napropamide*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>21DAT</th>
<th>29DAT</th>
<th>44DAT</th>
<th>58DAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>sulfentrazone</td>
<td>0.47 kg pr/ha</td>
<td>94.3 a</td>
<td>91.0 a</td>
<td>90.3 ab</td>
<td>88.7 ab</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 0.584 L pr/ha</td>
<td>96.0 a</td>
<td>92.3 a</td>
<td>95.7 a</td>
<td>95.0 a</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 1.17 L pr/ha</td>
<td>88.7 a</td>
<td>87.3 a</td>
<td>89.7 ab</td>
<td>84.3 ab</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 1.75 L pr/ha</td>
<td>99.0 a</td>
<td>96.7 a</td>
<td>93.3 ab</td>
<td>91.3 ab</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 2.34 L pr/ha</td>
<td>94.7 a</td>
<td>89.7 a</td>
<td>91.7 ab</td>
<td>91.0 ab</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 2.92 L pr/ha</td>
<td>93.3 a</td>
<td>86.7 a</td>
<td>87.0 ab</td>
<td>87.3 ab</td>
</tr>
<tr>
<td>sulfentrazone + clomazone</td>
<td>0.47 kg pr/ha + 3.50 L pr/ha</td>
<td>97.7 a</td>
<td>97.0 a</td>
<td>95.3 a</td>
<td>94.7 a</td>
</tr>
<tr>
<td>sulfentrazone + napropamide</td>
<td>0.47 kg pr/ha + 1.12 kg pr/ha</td>
<td>88.0 a</td>
<td>86.0 a</td>
<td>85.0 ab</td>
<td>87.0 ab</td>
</tr>
<tr>
<td>sulfentrazone + napropamide</td>
<td>0.47 kg pr/ha + 2.24 kg pr/ha</td>
<td>91.7 a</td>
<td>78.3 a</td>
<td>78.3 b</td>
<td>73.3 b</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td>10.4</td>
<td>17.1</td>
<td>13.8</td>
<td>16.3</td>
</tr>
</tbody>
</table>

* means sharing the same letter are not different (LSD=0.05)

^DAT=days after treatment
provided 73.3 to 91.7% control of pigweed. At 21 DAT and 29 DAT, smooth pigweed control was not different among treatments. Differences in control among treatments were observed at 44 DAT with control ranging from 78 to 96%. Sulfentrazone and clomazone (0.58 L pr/ha) and sulfentrazone and clomazone (3.50 L pr/ha) provided greater control at 44 DAT and 58 DAT than did sulfentrazone and napropamide (2.24 kg pr/ha). All clomazone and sulfentrazone combinations provided equivalent smooth pigweed control at all evaluations dates.

**Wheat injury**

No treatment by tillage interactions were significant; therefore, treatment effects were analyzed separately from tillage effects.

Wheat cover crop was visually examined at 25 DAP (days after planting) for chlorosis injury. (Figure 1) Sulfentrazone applied at 0.47 kg pr/ha produced <5% injury, which was not greater than treatments including napropamide. All sulfentrazone plus clomazone tank mixes increased wheat injury compared to sulfentrazone alone or sulfentrazone plus napropamide treatments. Sulfentrazone mixed with 2.92 L p/ha clomazone resulted in 73% chlorosis and was not different from the sulfentrazone plus 3.5 L pr/ha clomazone treatment. All sulfentrazone and clomazone combinations with the exception of sulfentrazone plus 0.584 L p/ha clomazone resulted in >35% chlorosis 25 DAP.

Treatments with the two highest application rates of clomazone resulted in the greatest chlorosis. Small grain injury may be related to clomazone application rate, since the degree of wheat injury intensified as clomazone application rates increased. Previous research shows that clomazone at various application rates can bleach small grains at
Figure 1: Wheat Chlorosis at 25 DAP

Means sharing the same letter are not different.
various rates (Loux, 261). Drought conditions during the months following clomazone application may have contributed to the amount of observed chlorosis (Table 5). Research indicates that lack of soil moisture slows clomazone dissipation (Mervosh, 538). Small grains are known to be tolerant of sulfentrazone soil residues, this was confirmed by the low percentage of chlorosis observed (Swantek, 271). Neither rate of napropamide resulted in increased wheat chlorosis.

Wheat chlorosis was also examined at 41 DAP (Figure 2). Sulfentrazone applied at 0.47 kg pr/ha alone and applied with napropamide resulted in less chlorosis than the sulfentrazone plus clomazone treatments. Sulfentrazone tank mixed with 0.584 L pr/ha clomazone resulted in less chlorosis than all other sulfentrazone plus clomazone combinations. Sulfentrazone combined with either 1.17 or 1.75 L pr/ha clomazone resulted in equivalent wheat chlorosis. Sulfentrazone combined with ≥ 2.34 L pr/ha resulted in >65% chlorosis 41 DAP.

Wheat above ground biomass was collected 77 DAP and was examined by treatment effect (Figure 3). Wheat biomass did not differ among plots receiving 0.584 to 3.5 L pr/ha clomazone. Sulfentrazone plus 0.584 L pr/ha clomazone or 2.24 kg pr/ha napropamide applications did not reduce biomass more than sulfentrazone alone. Addition of ≥1.17 L pr/ha clomazone reduced wheat biomass when compared to either treatment containing napropamide. Sulfentrazone mixed with 3.5 L pr/ha clomazone resulted in < 3 g/0.305 m² fresh weight, while sulfentrazone combined with 1.12 kg pr/ha napropamide exhibited the maximum fresh weight observed.

Wheat plots treated with sulfentrazone and clomazone weighed < 15g/0.305 m². However, biomass from sulfentrazone and napropamide treated areas weighed
Table 5: 1999 Monthly Precipitation for Bowling Green, KY

1999 Precipitation for Bowling Green, Ky\(^a\)

<table>
<thead>
<tr>
<th>Month</th>
<th>Precipitation (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>10.69</td>
</tr>
<tr>
<td>February</td>
<td>5.61</td>
</tr>
<tr>
<td>March</td>
<td>7.62</td>
</tr>
<tr>
<td>April</td>
<td>3.35</td>
</tr>
<tr>
<td>May</td>
<td>8.48</td>
</tr>
<tr>
<td>June</td>
<td>9.91</td>
</tr>
<tr>
<td>July</td>
<td>3.61</td>
</tr>
<tr>
<td>August</td>
<td>2.67</td>
</tr>
<tr>
<td>September</td>
<td>5.64</td>
</tr>
<tr>
<td>October</td>
<td>7.16</td>
</tr>
<tr>
<td>November</td>
<td>4.11</td>
</tr>
<tr>
<td>December</td>
<td>10.19</td>
</tr>
<tr>
<td><strong>Year Total</strong></td>
<td><strong>78.46</strong></td>
</tr>
</tbody>
</table>

\(^a\) Kentucky Climate Center

Western Kentucky University

Department of Geography and Geology
Figure 2: Wheat Chlorosis at 41 DAP

\[ \text{means sharing the same letter are not different} \]
Figure 3: Wheat above ground biomass 77 DAP as influenced by treatment$^a$

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fresh Weight (g/0.305 m$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S 0.47 kg pr/ha</td>
<td>0</td>
</tr>
<tr>
<td>S + C 0.584 L pr/ha</td>
<td>5</td>
</tr>
<tr>
<td>S + C 1.17 L pr/ha</td>
<td>10</td>
</tr>
<tr>
<td>S + C 1.75 L pr/ha</td>
<td>15</td>
</tr>
<tr>
<td>S + C 2.34 L pr/ha</td>
<td>20</td>
</tr>
<tr>
<td>S + C 2.92 L pr/ha</td>
<td>25</td>
</tr>
<tr>
<td>S + C 3.50 L pr/ha</td>
<td>30</td>
</tr>
<tr>
<td>S + N 1.12 kg pr/ha</td>
<td>35</td>
</tr>
<tr>
<td>S + N 2.24 kg pr/ha</td>
<td>40</td>
</tr>
</tbody>
</table>

$^a$ means sharing the same letter are not different
> 20 g/0.305m$^2$. Both clomazone and napropamide treatments tended to decrease wheat biomass as rates increased.

Wheat stand counts 41 DAP were evaluated by treatment at the 0.05 level (Figure 4). Sulfentrazone treated plots had greater stand counts than all other treatments. Sulfentrazone combined with 0.584 L pr/ha clomazone and sulfentrazone combined with either napropamide rate resulted in equivalent stand counts. Sulfentrazone mixed with 1.17 to 3.50 L pr/ha clomazone decreased stand count to < 7 plants /0.305 m$^2$.

As clomazone rate increased, a trend emerged in which wheat stand count decreased and chlorotic injury increased. In general, napropamide applications were not as damaging to wheat stand or injury as were clomazone applications.

Wheat stand counts 55 DAP exhibited few treatment differences. (Figure 5) No differences in stand count were observed among sulfentrazone plus napropamide and sulfentrazone plus 0.584 or 1.17 L pr/ha clomazone treated plots. Applications of 1.75 to 3.50 L pr/ha clomazone combined with sulfentrazone resulted in lower stand counts than other treatments.

Wheat chlorosis as influenced by tillage was evaluated 25 DAP (Figure 6). Wheat chlorosis was greater in plot areas that were only disked. Moldboard plowing may have reduced wheat chlorosis by burying clomazone residues below the depth of wheat root penetration. Additionally, deep plowing may have diluted clomazone residues to a less injurious concentration.

Wheat chlorosis as influenced by tillage 41 DAP provided similar results to evaluations at 25 DAP (Figure 7). Areas moldboard plowed and disked exhibited less
Figure 4: Wheat stand count 41 DAP as influenced by treatment

Means sharing the same letter are not different.
Figure 10: Wheat Stand Count 55 DAP as influenced by treatment

- S 0.47 kg pr/ha
- S + C 0.584 L pr/ha
- S + C 1.17 L pr/ha
- S + C 1.75 L pr/ha
- S + C 2.34 L pr/ha
- S + C 2.92 L pr/ha
- S + C 3.50 L pr/ha
- S + N 1.12 kg pr/ha
- S + N 2.24 kg pr/ha

*a* means sharing the same letter are not different
Figure 6: Wheat Chlorosis 25 DAP as influenced by tillage

- moldboard plow + disk
- disk

*Means sharing the same letter are not different*
Figure 7: Wheat Chlorosis 41 DAP as influenced by tillage

*means sharing the same letter are not different

- moldboard plow + disk
- disk
chlorosis than areas only disked. However, moldboard plowed areas still resulted in 35% chlorosis 41 DAP.

Wheat chlorosis at 25 and 41 DAP was less evident in subplots which were moldboard plowed and disked. As would be expected, areas that receive deeper tillage bury the herbicides deeper thus preventing wheat roots from growing into areas where herbicide residues are more prevalent.

Wheat above ground biomass was evaluated 77 DAP as influenced by tillage method (Figure 8). Aboveground biomass was not influenced by tillage method. Fresh weights evaluated were < 12 g/0.305 m$^2$.

Wheat stand count 41 DAP as influenced by tillage were evaluated in each plot (Figure 9). Subplots that were moldboard plowed and disked exhibited slightly fewer plants/0.305 m$^2$ than areas only disked, but tillage treatments were not different at the .05 level. Wheat plants with <50% chlorosis were included in a stand count of each subplot evaluated at 55 DAP as influenced by tillage (Figure 10). Plots which were moldboard plowed and disked resulted in slightly more plants/0.305 m$^2$ than areas only disked; however, tillage treatments were not statistically different at the .05 level.
Figure 8: Wheat above ground biomass 77 DAP as influenced by tillage

*a means sharing the same letter are not different
Figure 9: Wheat stand count 41 DAP as influenced by tillage$^a$

$^a$ means sharing the same letter are not different
Figure 10: Wheat stand count 55 DAP as influenced by tillage

- moldboard plow + disk
- disk

*a* means sharing the same letter are not different
CHAPTER V

SUMMARY

The development of herbicides for use in tobacco is limited due to low acreage of the crop. However, with the herbicides that are available, combinations can be utilized to control both broadleaf and grass weeds. The herbicide combinations of sulfentrazone with clomazone or napropamide provide an option for a pretransplant application for broad-spectrum weed control.

Sulfentrazone provided good control of all weeds 21 DAT but control decreased as DAT increased. Sulfentrazone provided better goosegrass control when applied in a tank mix with either clomazone or napropamide. Although addition of clomazone provided improved goosegrass control, injury to the wheat cover crop was increased. Increasing the rate of napropamide did not improve weed control.

Wheat chlorosis increased when clomazone was combined with sulfentrazone at both 25 and 41 DAT. Fresh weight exhibited a trend of decreased wheat biomass with increasing clomazone rate. Clomazone at ≥ 1.17 L pr/ha reduced stand count when compared to 0.584 L pr/ha 41 DAP. At 55 DAP, clomazone at ≥ 1.75 L pr/ha reduced stand count to < 5 plants /0.305 m². There were no differences in stand count at either napropamide rate at either stand count evaluation.

Wheat injury was affected by tillage; however, biomass and stand count were not affected by tillage. Wheat chlorosis 25 and 41 DAT tended to increase in plots that were
only disked. Areas moldboard plowed and disked were less chlorotic but did not exhibit differences in wheat biomass or stand count.

Field studies indicate that the combination of weed specific herbicides at appropriate rates can indeed provide enhanced weed control. Small grain cover crop injury may be significant if clomazone dissipation is slowed due to environmental factors and/or cultural practices.

These data indicate that deep tillage prior to small grain cover crop establishment does not significantly reduce wheat injury due to clomazone soil residue. Further study is needed in order to quantify small grain cover crop response when herbicide combinations are applied under variable soil and moisture regimes.
WORKS CITED


Palmer, G. Herbicide and weed control-other chemical controls. Tobacco in Kentucky University of Kentucky College of Agriculture Extension Service. ID-73


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