Phytotoxicity and Efficacy Using Tank Mixtures of Harmony® Extra with Growth Regulating Herbicides on Selected Southern Turfgrasses

By

Matthew Patrick Shipp, B.S.

Presented to the Faculty of the Graduate School of

Stephen F. Austin State University

In Partial Fulfillment

of the Requirements

For the Degree of

Master of Science

STEPHEN F. AUSTIN STATE UNIVERSITY

MAY 2001

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APPROVED:

Dr. J. Leon Young, Thesis Director

Dr. Scott Senseman, Committee Member

Dr. Leland Thompson, Committee Member

Dr. David Jeffrey
Associate Vice President for
Graduate Studies and Research

ABSTRACT

Research was conducted to evaluate the phytotoxicity and efficacy of tank mixtures of MCPP, 2,4-D, and Harmony® Extra on southern turfgrass species and common broadleaf weed species. The objective was to devise a combination that provided lower phytotoxicity and comparable weed efficacy to Trimec® (MCPP+2,4-D+dicamba). The target turfgrass species was Floratam St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Ktze.], a particularly sensitive species to phenoxy herbicides. In addition to Floratam, other popular southern turfgrass species were assayed for phytotoxicity. These included common St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Ktze.], common bermudagrass [*Cynodon dactylon* (L.) Pers.], and common centipedegrass [*Eremochloa ophiuroides* (Munro) Hack.]. Broadleaf weed species selected for efficacy included white clover (*Trifolium repens* L.), annual aster (*Aster subulatus* Michx.), lawn burweed [*Soliva pterosperma* (Juss.) Less.], and bristly mallow [*Modiola caroliniana* (L.) G. Don]. After field evaluations, a tank mixture was applied consisting of MCPP plus 2,4-D plus Harmony® Extra at the rate of 840+280+33 g ai ha^{-1}. This provided lower phytotoxicity to selected southern turfgrass species and comparable weed efficacy to dicot weed species when compared to Trimec®.

ACKNOWLEDGEMENTS

The author wishes to thank The Holy Trinity and The Blessed Mother for the gift of knowledge and the ability to use it productively.

The author would like to express appreciation to Dr. Leon Young for his support and guidance throughout this study. Thanks also to Dr. Leland Thompson for participating as a committee member. Special thanks to Dr. Scott Senseman of Texas A&M University for participating as an adjunct committee member. His support was invaluable.

The author wishes to thank Michael Mitchell and Dr. David Pate for spearheading a concept and allowing me to expand that concept into a Master's thesis.

Lastly, the author wishes to express great appreciation to his wife, Brandie, for her encouragement and endurance throughout this process, and to his children: Andrew, Sadie, Lydia, and Nicholas for their undying affection.

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INTRODUCTION

A common goal shared by many homeowners is to establish and maintain a lawn of vigorous, high-quality turfgrass. The necessary components of a balanced turfgrass management program include proper watering, fertilization, mowing, and pest control. Weeds are the major pests on many turfgrass sites and compete for space, sunlight, moisture, and plant nutrients. Additionally, weeds are aesthetically unpleasant and detract from the natural beauty of a uniform turfgrass stand due to marked differences in color, shape, size, and growth habit. It is not surprising that homeowners spend a fair amount of time attempting to control weeds. One commonly used method of control is chemical through the application of herbicides.

Atrazine (6-chloro-*N*-ethyl-*N'*-(1-methylethyl)-1,3,5-triazine-2,4-diamine) is an effective low-cost corn and sorghum herbicide. It was adopted by Florida sod growers around 1958 as the main postemergence herbicide for broadleaf weed control in St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Ktze.] and centipedegrass [*Eremochloa ophiuroides* (Munro) Hack.] (White and Busey 1987). Because of its detection in surface and ground water, atrazine may not be a long-term option for future weed control in southern turfgrass (Buttler et al. 1993). Many debates exist as to the significance of the loss of atrazine as a turf product. If atrazine is removed, a void among herbicides will need to be filled. Not only will the void be felt among farmers and row crops, but it will also be felt among turfgrass managers and sod farms. Therefore, the need for replacement herbicides for atrazine will increase in the future.

An area of concern in the turfgrass industry involves St. Augustinegrass varieties like Floratam grown on sandy soils in Florida (Steigler et al. 1991). Atrazine has an increased leaching potential in these soils and is used extensively for weed control in these areas (Garner et al. 1986). Due to the sensitivity of Floratam St. Augustinegrass to phenoxy herbicides, these chemicals are not commonly used for weed control in this turf variety (Hensley et al. 1996). However, phenoxy herbicides rarely cause ground water problems due to rapid soil degradation (Bovey and Young 1980). Additionally, phenoxy herbicides offer a broad spectrum of weed control (Ross and Lembi 1999).

Phenoxy herbicides such as 2,4-D ((2,4-dichlorophenoxy) acetic acid) and MCPP (2-(4-chloro-2-methylphenoxy) propanoic acid) will selectively control dicot or broadleaf weeds in most turfgrasses (Anderson 1996). This class of herbicides has postemergent activity and is widely used in large-scale agricultural applications as well as recreational and commercial turfgrass (Ashton and Monaco 1991). As mentioned before, this class of herbicides suffers the disadvantage of causing injury to sensitive warm-season turfgrasses such as St. Augustinegrass and bermudagrass [*Cynodon dactylon* (L.) Pers.] (Fermanian et al. 1997). This injury is even more accentuated in gulf coast or sub-tropical areas because sensitive turfgrasses predominate and many perennial broadleaf weeds require multiple applications to achieve acceptable weed control (Kelly and Coats 2000a).

Sulfonylurea herbicides are used mainly in cereal crops to control a wide range of broadleaf weeds and some grassy weeds (Anonymous 1996). These herbicides are known for their selectivity and low use rates. Harmony® Extra is a combination of 50% thifensulfuron-methyl [methyl 3-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]-2-thiophenecarboxylate]+ 25% tribenuron-methyl [methyl 2-[[[[N-(4-methoxy-6-methyl-1,3,5-triazin-2-yl) methylamino]carbonyl]amino]sulfonyl]benzoate]. The label for this product indicates that tank mixing 2,4-D, MCPP, and other selected broadleaf herbicides can reduce crop injury caused by the use of Harmony® Extra on some wheat varieties (Anonymous 2000). Mitchell and Pate (1982) observed the opposite effect where a different sulfonylurea herbicide, chlorsulfuron [2-chloro-N-[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]benzenesulfonamide], reduced the injury of 2,4-D on St. Augustinegrass. An application of 2,4-D at 1200 g ai ha^{-1} (grams active ingredient per hectare) caused injury exceeding 65% to Floratam St. Augustinegrass based on visual ratings. When tank mixed with chlorsulfuron at 18 g ai ha^{-1}, the injury was reduced to 15%. Mitchell and Pate (1985) also demonstrated that the combination of chlorsulfuron did not compromise weed control. The above combination controlled black medic (*Medicago lupulina* L.) and wild geranium (*Geranium carolinianum* L.) comparable to Trimec® [MCPP (2-(4-chloro-2-methylphenoxy)propanoic acid), 2,4-D ((2,4-dichlorophenoxy)acetic acid), and dicamba (3,6-dichloro-2-methoxybenzoic acid)].

The objective of this work was to assess the potential reduction of injury to sensitive turfgrasses due to phenoxy herbicides by tank mixing thifensulfuron-methyl + tribenuron-methyl with reduced rates of 2,4-D and MCPP. This tank mixture was applied to two varieties of St. Augustinegrass, and one variety each of centipedegrass, and bermudagrass. In addition, the mixture must not compromise weed efficacy to white clover (*Trifolium repens* L.), annual aster (*Aster subulatus* Michx.), lawn burweed [*Soliva pterosperma* (Juss.) Less.], and bristly mallow [*Modiola caroliniana* (L.) G. Don]; broadleaf weeds commonly seen growing in these southern turfgrasses.

LITERATURE REVIEW

Turfgrasses

St. Augustinegrass

St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Ktze.] is a versatile, sod forming, warm-season turfgrass that is native to the West Indies (Beard 1973). It is found from the Carolinas to Florida, and westward along the Gulf Coast of Texas. It is also seen in California. Because of its lack of winter hardiness, St. Augustinegrass is restricted to areas with mild winter temperatures (Duble 1996). It forms an attractive blue-green, low growing turf of medium density and very coarse leaf texture. St. Augustinegrass is well adapted to moist, organic soils with pH ranges of 6.5 to 7.5. Known as an aggressive warm-season turfgrass, it spreads by means of long, thick stolons. Propagation is primarily by vegetative means such as sprigs, plugs, or sod (Beard 1973).

Floratam St. Augustinegrass was released by the Florida and Texas Agricultural Experiment Stations in 1972 as a disease-resistant and insect-tolerant variety. Leaf blades are wider and longer than common St. Augustinegrass. Floratam is not as cold tolerant as the common type and should be restricted to South Florida, South Texas, and the coastal zones of other states. It also lacks the shade tolerance of other St. Augustinegrass varieties.

Centipedegrass

Centipedegrass [*Eremochloa ophiuroides* (Munro) Hack.] is a native of southern China and was introduced into the United States in 1916 (Beard 1973). It has since become widely grown in the southeastern United States from South Carolina to Florida, and westward along the Gulf Coast states to Texas (Duble 1996). Centipedegrass is best adapted to sandy, acid soils with a pH range of 4.5 to 5.5 and thrives on moderate fertility. It is a medium-coarse textured, slow growing species that spreads by means of short, leafy stolons having fairly short internodes. Due to its slow rate of establishment from seed, centipedegrass is usually propagated vegetatively by sprigs, plugs, or sod (Beard 1973).

Bermudagrass

Bermudagrass [*Cynodon dactylon* (L.) Pers.] originated in eastern Africa and is one of the most important and widely adapted of the warm-season turfgrasses (Beard 1973). Uses include lawns, cemeteries, and high traffic areas such as golf courses, sports fields, and playgrounds. In the United States the distribution of bermudagrass extends from New Jersey and Maryland, southward to Florida, and westward to Kansas and Texas. Under irrigation its distribution extends westward to southern New Mexico, Arizona, and to most major valleys in California (Duble 1996). Bermudagrass is best adapted to well-drained fertile soils but will tolerate a wide range of soils with pH ranges from 5.5 to 7.5. It forms a very vigorous, aggressive turfgrass of high shoot density and variable leaf texture from medium to very fine according to species. Propagation is primarily vegetative by means of sprigs, plugs or sod (Beard 1973). Common bermudagrass can be established from seed, and recently hybrid seed has become available.

Weed Species

White clover

White clover (*Trifolium repens* L.) is found throughout the continental United States and Canada. It is a low-growing perennial with creeping stems that root at the nodes. Stems may be glabrous or partly covered with hairs. Leaves are made up of three elliptic to oval shaped leaflets with marginal teeth. Flowers may be white or pink arranged in round heads. White clover reproduces by seed (Murphy et al. 1996)

Annual aster

Annual aster (*Aster subulatus* Michx.) is found primarily in the warmer areas of the United States: South Carolina, Missouri, Kansas, Texas, Arizona, and California. It is an upright, robust annual that can reach a meter in height but thrives in home lawns even when maintained at a short height. Stems are pubescent, solitary to several, wiry, and dark green. Leaves with entire margins are alternate with the upper leaves much smaller. Ray flowers are white to purplish and disc flowers are yellow. Reproduction is by seed (Ajilvsgi 1984).

Lawn burweed

Lawn burweed [*Soliva pterosperma* (Juss.) Less.] is found from North Carolina south to Florida, and west to Texas. It is a low-growing, freely branched winter annual. Leaves are opposite and flowers are small and inconspicuous. Fruits clustered in leaf axils have sharp spines that can cause injury to humans. Lawn burweed reproduces by seed (Murphy et al. 1996).

Bristly mallow

Bristly mallow [*Modiola caroliniana* (L.) G. Don] can be seen from Virginia south to Florida, and west to Texas. It also occurs in California and Hawaii. It is a creeping prostrate perennial that roots at the nodes. Leaves are opposite with six to seven lobes and irregular tooted margins. Flowers are orange-red born singly radiating from a single point of attachment. Reproduction is by seed (Murphy et al. 1996).

Phenoxy Herbicides

History

By 1940, a large number of chemical agents were known to produce a bewildering array of effects on plant growth, some of which were of practical agricultural and horticultural value (Wittwer 1971). The introduction of the phenoxy herbicides in the mid 1940's, immediately after World War II, revolutionized weed control (Ashton and Monaco 1991). It is thought of as a revolution because this class of herbicides kills many annual and perennial broadleaf weeds without harming cereals and other grass crops (Zimdahl 1993). Following their introduction, the chemical industry began synthesis and evaluation programs, which, in part, were responsible for the wide array of herbicides that are available today. In addition to being effective as weed killers, phenoxy herbicides are inexpensive and make weed control economical. They have low mammalian toxicity, are non-staining, nonflammable, and do not have long environmental persistence. Broadleaf weed control in turfgrass usually consists of applying a phenoxy or benzoic type herbicide alone or in two- or three-way combinations (Kelly and Coats 2000b). The unique ability of phenoxy herbicides to control broadleaf weeds in turfgrass makes this class of herbicides very beneficial to both the professional turfgrass manager as well as the homeowner.

Chemistry

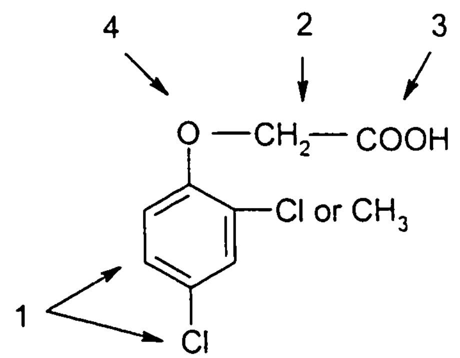

Figure 1. The chemical structure of a phenoxy herbicide showing structural components.

Structurally, phenoxy herbicides are characterized by the following: (1) an aromatic (benzene) ring, with several substituents possible on the ring; (2) a side chain consisting of straight chain alkyl groups; (3) an acidic group or a group easily converted to an acidic group at the end of the alkyl group; and (4) an ether linkage or oxygen bridge connecting the aromatic ring with the alkyl group (Engel and Ilnicki 1969) (Figure 1). These herbicides are usually distinguished from one another by the length of the side chain, by the particular substituents and their location on the ring, or both (Anderson 1996). Substitutions on the aromatic ring usually involve chlorine atoms, methyl groups, or combinations of both. Differences in the alkyl group beyond the oxygen bridge can give rise to three subfamilies: the acetic acid group, the propionic acid group, and the butyric acid group. These differences can affect activity as well as selectivity on various weed species. In general, the acetic acid form is used in grass crops and turfgrass, the propionic acid form is used in woody plant control and turfgrass, and the butyric acid form is used in leguminous crop species.

Phenoxy herbicides are usually formulated as salts and esters of their respective parent acids (Anderson 1996). The acid form is not commonly used because it is only moderately soluble in water, slightly volatile, and relatively expensive to formulate (Ashton and Monaco 1991). Amine salts are the most popular salt formulations used today. Inorganic salts such as ammonium, potassium, and sodium are used to a lesser degree and some are no longer available. Amines are the most commonly used form of phenoxy herbicides because of their high water solubility, low volatility, ease of handling, and overall low cost. They are usually formulated as aqueous concentrates and can be applied at high rates using low-volume equipment.

Ester formulations of phenoxy herbicides are oil soluble and usually are applied as emulsions in water (Loos 1975). The ester forms of most phenoxy herbicides are more efficacious than the acid forms when applied to the foliage because they are more readily absorbed through plant cuticles and cell membranes (Devine et. al. 1993). Phenoxy herbicides in the ester form require activation to become phytotoxic and are hydrolyzed within the plant to release the active moiety. Esters can be either low-volatile esters or high-volatile esters with the length of the side-chain as the determining factor (Anderson 1996). Short-chain esters can be very volatile and present a serious hazard especially under hot conditions (Ross and Lembi 1999). Their use is prohibited in many areas. Long-chain esters are less volatile but can still present a potential hazard by vaporizing and drifting to susceptible, adjacent crops.

Mode of Action

The primary mode of entry of phenoxy herbicides is through the leaves or foliage. Although some root and stem absorption is worth mentioning, foliar absorption is generally more active. Both the upper and lower leaf surfaces are capable of herbicide absorption with the lower surface usually being penetrated more easily. Leaves readily absorb nonpolar forms (acid, esters, oil-soluble amines) of phenoxy herbicides, whereas polar forms (salts, water-soluble amines) are absorbed more slowly (Ashton and Monaco 1991). Once the herbicide is applied to the surface of the leaf, the molecules diffuse through the cuticle. Immediately below the cuticle are cellulose and pectin materials of the epidermal cell walls (Loos 1975). Absorption increases with an increase in temperature and humidity. Rain soon after application can reduce the effectiveness. However, rainfall 6 to 12 hr (hours) after application usually has little adverse effect on weed control.

Once the herbicide has traversed the cuticle, it has two possible paths for movement through the plant. One path is the living symplast continuum consisting of the cell protoplasts connected by plasmodesmata and including the sieve tube system of the phloem. The other is the nonliving apoplast consisting of the continuous cell-wall system and xylem conducting elements (Loos 1975). The path of herbicide movement after penetrating the cuticle is more common through the epidermis and mesophyll cells of the phloem. Movement is both basipetal and acropetal with the flow of assimilates from the leaves (sources) to sites of active, meristematic growth that include roots, flowers, and fruits (sinks). Translocation of the foliar applied herbicide to sinks such as roots and rhizomes is essential for the control of perennial weed species.

The discovery of the phytotoxic properties of phenoxy herbicides came from basic research on plant hormones and growth regulators. The action of the phenoxy herbicide results in characteristic symptoms such as epinasty (twisting), distorted and feathered leaves in broadleaf plants (Ashton and Monaco 1991).

These herbicides stimulate ethylene production, which may, in some cases, produce the characteristic epinastic symptoms (Rao 2000). The effects are most obvious in meristematic (growing) tissue. Meristematic cells cease dividing while elongating cells stop longitudinal growth but continue radial expansion. In mature plant parts, parenchyma cells swell and soon divide, producing callus tissue and expanding leaf primordia (Ashton and Crafts 1981). Roots no longer absorb water, photosynthesis is inhibited, and the phloem becomes plugged.

Auxins are plant hormones that are responsible for cell elongation and enlargement. The phenoxy herbicides like benzoic herbicides appear to mimic auxin. For this reason, they are often referred to as auxin-like herbicides because they induce twisting and curvature of petioles and stems of broadleaf plants reminiscent of high rates of endogenous auxin, indole-3-acetic acid (Ashton and Monaco 1991).

In addition to cell wall plasticity, the primary action of the phenoxy herbicides appears to involve nucleic acid metabolism (Rao 2000). The primary mechanism would also involve various reactions related to gene action. RNA increases in expanding tissues, but decreases in necrotic cells (Ashton and Crafts 1981). This action in nucleic acid metabolism could in part explain the herbicide effect on cell wall loosening associated with the cell elongation symptom (Loos 1975).

2,4-D

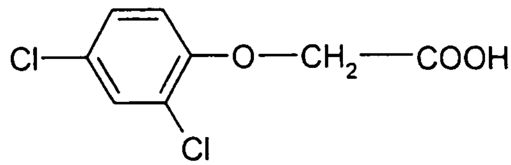

Figure 2. The chemical structure of 2,4-D.

There are many forms or derivatives of 2,4-D ((2,4-dichlorophenoxy) acetic acid) including esters, amines, and salts. It is a chlorinated phenoxy compound that functions as a systemic herbicide and is used to control many types of broadleaf weeds found in cultivated agriculture, pastures, rangeland, and turfgrass (Figure 2). It can be formulated as an emulsion, an aqueous solution, or as a dry compound. Acid, ester, and salt forms are available. Over half a century after its discovery, 2,4-D remains one of the most widely used herbicides in the world (Szmedra 1997). It has low soil persistence with a half-life less than 7 d (days) (Wauchope et al. 1992). Soil microbes are primarily responsible for its disappearance (Howard 1991). Despite its short half-life in soil and in aquatic environments, 2,4-D has been detected in groundwater supplies in at least five states and in Canada (Howard 1991). Very low concentrations have been detected in surface waters throughout the U.S. (Anonymous 1992b). Except for some algae, it does not bioaccumulate in aquatic or terrestrial organisms because of its rapid degradation (Anonymous 1993). Uptake of the compound is through leaves, stems, and roots. Breakdown in plants is by a variety of biological and chemical pathways (Anonymous 1988). It is toxic to most broadleaf crops, especially cotton, tomatoes, grapes, and fruit trees (Thomson 1997).

MCPP

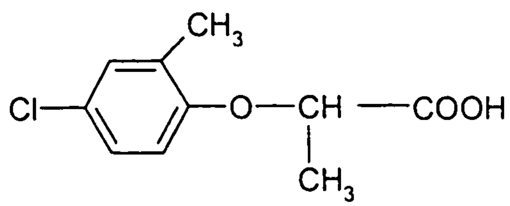

Figure 3. The chemical structure of MCPP.

MCPP (2-(4-chloro-2-methylphenoxy) propanoic acid) is a selective, hormone-type phenoxy herbicide (Figure 3). It is applied postemergence and is used on ornamentals and turfgrass, for forest site preparation, and on drainage ditch banks for selective control of broadleaf weeds such as clovers, chickweed, and plantain. It is also used in wheat, barley, and oats (Anonymous 1996). MCPP is absorbed by plant leaves and is translocated to the roots. MCPP's weed spectrum is similar to 2,4-D, but its activity is slower requiring 3 to 4 wk (weeks) for optimum control (Thomson 1997). However, MCPP controls chickweed and clover better than 2,4-D. It is available as a liquid concentrate or granular and is sprayed on fertilizer pellets to produce weed and feed products (Anonymous 1988).

The average half-life of MCPP in soil is about 21 d (Anonymous 1994). Adsorption of MCPP increases with an increase in organic matter in the soil. Because of its solubility, it may potentially leach into groundwater. However, in general, phenoxy herbicides are not persistent enough to reach groundwater (Anonymous 1988).

Sulfonylurea Herbicides

History

In the realm of modern weed science, occasionally a discovery is made that shapes how chemical weed control is approached. The advent of the sulfonylurea class of herbicides has been one of those discoveries. With their specificity of herbicidal activity, use rates have been substantially reduced. Rapid advances of similar chemistries will, without a doubt, continue and help shape the future of modern chemical weed control.

The herbicidal properties of the sulfonylurea class of herbicides were discovered in the late 1960's (Beyer et al. 1988). This is often crowned as the most dramatic breakthrough in chemical weed control for many decades. These compounds were developed with the goal of providing a safer, more environmentally friendly weed control source for farmers in the production of food and feed crops. Researchers at Du Pont produced sulfonylurea herbicides that exhibited 100 times the herbicidal activity of conventional herbicides (Anonymous 1992a). This increased level of activity allowed significant decreases in herbicidal use rates. Sulfonylureas could be applied in grams rather than kilograms per hectare as with conventional herbicides (Anonymous 1992a). Other benefits include improved crop selectivity and superior control of problem weed species.

<u>**Chemistry**</u>

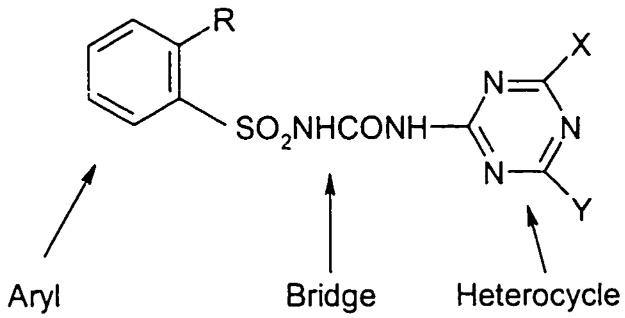

Figure 4. A generic chemical structure of a sulfonylurea herbicide showing the characteristic components.

A sulfonylurea herbicide molecule is composed of three parts: an aryl group, a sulfonylurea bridge, and a nitrogen containing heterocycle (Figure 4). When the aryl portion is a phenyl group, the highest herbicidal activity occurs when this group contains a substituent ortho to the sulfonylurea bridge (Beyer et al. 1988). However, sulfonylureas containing an aryl group other than a phenyl group can also show activity. An example of this would be thifensulfuron-methyl (Harmony®) which contains a thiophene as the aryl. As with a phenyl aryl, the presence of an R-group (substituent) ortho to the bridge enhances activity (Beyer et al. 1988).

Sulfonylureas usually exhibit the highest herbicidal activity when the heterocyclic portion is a symmetrical pyrimidine or symmetrical triazine that contains an alkyl or alkoxy substituents. Compounds that contain asymmetrical triazines generally have lower activity (Beyer et al. 1988).

The sulfonylureas are formulated as dry flowables (DF) or water-dispersible granules (WDG, WG) which disperse easily in spray tanks, are virtually dust-free, and can be tank-mixed with a variety of other pesticides (Anonymous 1992a). They are by nature weak acids with pKa's ranging from 3.3 to 5.2. As with ionizable molecules, the neutral or uncharged form of the molecule is much more lipophilic than the ionized, anionic form (Beyer et al. 1988). The octanol-water partition coefficients are 50 to 100 times higher at pH 5.0 than at pH 7.0. At the lower pH they are more permeable to cell membranes because a greater proportion of the molecules are in the protonated state.

Several inferences or conclusions can be drawn from the above physiochemical properties. The sulfonylureas should be phloem mobile based on their weakly acidic properties (Devine et al. 1993). Acidic molecules are trapped in the phloem due to the change in membrane permeability occurring when the molecule moves from the apoplast (pH 5.5-6.0) to the more alkaline phloem sap (pH 7.5-8.2) (Beyer et al. 1988). As sulfonylurea molecules reach the acidic cell wall environment either via foliar or root uptake, some molecules are neutral and highly permeable and therefore are able to cross the phloem tube/companion cell plasma membrane thereby entering the phloem (Beyer et al. 1988). Upon entering the higher pH environment of the phloem, the sulfonylurea molecule dissociates and becomes trapped in the ionic form. Once trapped, it moves systemically by mass flow with sucrose and other phloem solutes (Beyer et al. 1988).

Mode of Action

Sulfonylurea herbicides are strong inhibitors of plant cell division and subsequent plant growth. However, seed germination is not usually affected. Once the seed has germinated, the subsequent root and shoot growth can be severely inhibited. Visual symptoms are usually rapid and can appear in 1 to 2 d (Beyer et al. 1988).

Depending on the plant species and environmental conditions, secondary plant responses can develop. Some of these include loss of leaf nyctinasty (leaf folding) which can be seen in many legumes; abscission, death of the terminal bud, chlorosis, and necrosis (Beyer et al. 1988). These secondary effects are usually slow to develop, with total plant death not occurring until 3 to 4 wk after treatment (Rao 2000).

Both foliage and roots readily absorb sulfonylurea herbicides. When applied to the foliage, sulfonylureas translocate more to shoot-growing points and less to the roots, while root-applied herbicides translocate efficiently to all parts of the shoots, including meristematic regions (Anderson 1996). They are phloem mobile since they are trapped as a result of differences in pH between the cell wall area and the phloem sap (Beyer et al. 1988). Sulfonylureas move in the xylem by mass flow along with phloem solutes and accumulate predominantly in the meristematic regions (Beyer et al. 1988).

The sulfonylurea herbicides inhibit the enzyme acetolactate synthase (ALS), also called acetohydroxyacid synthase (AHAS) (Anderson 1996). Since ALS is the catalyst in the first step of the biosynthesis of the three branched-chain amino acids valine, leucine, and isoleucine, the primary action of these herbicides thereby deprives the plant of these essential amino acids (Devine et al. 1993). Subsequently, protein synthesis and cell division are disrupted. Plants die as a result of starvation for these amino acids in growing tissues, but not mature tissues. The addition of the three amino acids reverses the toxic effect (Beyer et al. 1988).

ALS is found in the biosynthetic pathway of bacteria, fungi, and higher plants. It requires thiamine pyrophosphase, Mg^{2+}, and Flavin adenine dinucleotide (FAD) even though the reactions catalyzed by this enzyme involve no net oxidation or reduction (Beyer et al. 1988). ALS catalyzes: (1) the condensation of one molecule of pyruvate to form CO_2 and alpha-acetolactate, which leads to valine and leucine synthesis, and (2) the condensation of one molecule of pyruvate with alpha-ketobutyrate to form CO_2 and alpha-aceto-alpha-hydroxybutyrate, which leads to isoleucine synthesis (Beyer et al. 1988). The natural chain of events would dictate that, without ALS, there is no biosynthesis of these essential amino acids.

As a general rule, the rate of degradation of sulfonylurea herbicides in soil is fastest in warm, moist, light textured, low pH soils, and slowest in cold, dry, heavy, high pH soils (Beyer et al. 1988). Chemical hydrolysis and microbial breakdown are responsible for the degradation of sulfonylurea herbicides. Photolysis and volatilization play only minor roles in dissipation. The factors having the greatest influence on chemical hydrolysis and microbial breakdown include pH, temperature, soil moisture, and organic matter (Beyer et al. 1988).

Hydrolysis in soil is responsible for the cleavage of the sulfonylurea bridge to yield the corresponding sulfonamide and heterocyclic amine (Beyer et al. 1988). This cleavage is pH sensitive and parallels that of aqueous solutions. That is, as pH increases, chemical hydrolysis in the soil decreases. For example, the half-life of chlorsulfuron in a sterile soil at 30° C increased from 3 to about 45 wk as the pH of the soil increased from 5.9 to 8.0 (Joshi et al. 1985).

Moisture and temperature also have an effect on the persistence of sulfonylurea herbicides. It should be noted that in the case of chlorsulfuron, an increase in temperature from 20 to 40° C decreased the persistence in the soil (Anderson and Barrett 1985). Conversely, decreasing the soil moisture at a constant temperature resulted in a slower rate of chlorsulfuron degradation. When the moisture of the soil was held constant, decreasing the temperature increased the persistence of chlorsulfuron in the soil (Zimdahl et al. 1985). The moisture content and temperature level of the soil can alter microbial populations as well as reduce hydrolysis.

Several groups of microorganisms, including actinomycetes, fungi, and bacteria, have been shown to metabolize sulfonylureas (Joshi et al. 1985). Actinomycetes can convert methoxy groups to hydroxyl groups. They can also hydroxylate methyl groups. Chemical conversions like these often increase the solubility of the compound in water. Deesterification or the deformation of ester groups is another conversion by actinomycetes. Several fungi appear to hydrolyze the sulfonylurea bridge yielding the sulfonamide and heterocycle (Joshi and Brown 1985). These fungi are able to convert the methoxy group to a hydroxyl group on the heterocycle although this pathway is relatively minor.

Harmony® Extra

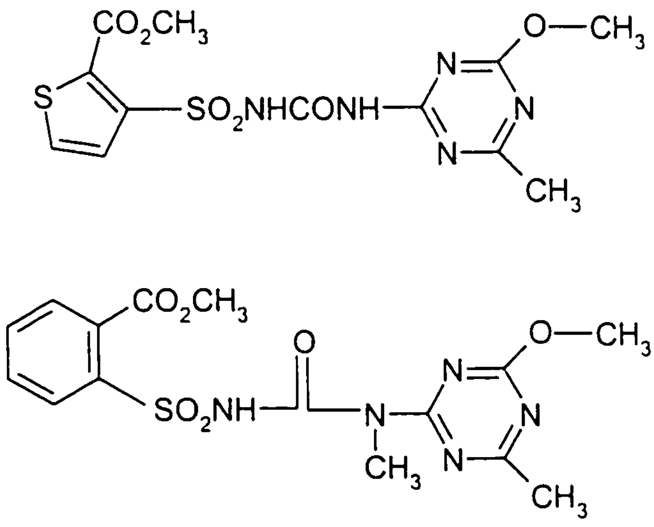

Figure 5. From top to bottom, the active ingredients of Harmony® Extra: thifensulfuron-methyl and tribenuron methyl.

Introduced in the early 1990's, Harmony® Extra is a commercial mixture of 25% tribenuron-methyl + 50% thifensulfuron-methyl by weight active ingredient (Figure 5). It is formulated as a dry flowable and can be used for selective postemergence broadleaf weed control in wheat (including durum), barley, oat, and fallow (Anonymous 2000). It is absorbed primarily through the foliage of plants, inhibiting the growth of susceptible weeds. One to three weeks after application, leaves of susceptible plants appear chlorotic, and the growing point subsequently dies. The half-life of Harmony® Extra in soil is about 10 d, and any rotational crop can be planted 60 d after application (Anonymous 1992a). It has very little to no soil activity and is rapidly degraded by hydrolysis and soil microbes (Anonymous 1994).

Phytotoxicity

Since auxin-like herbicides and other auxins will induce ethylene synthesis in a variety of plant species, it is important to catalog the range of effects that ethylene can have on plants (Audus 1976). Ethylene produces a wide range of plant responses that are both positive (growth promotion, dormancy release, fruit ripening) and negative (growth inhibition, chlorophyll destruction, abscission). These relationships make ethylene physiology important in herbicide research and use.

Auxin-like herbicides are generally phytotoxic to St. Augustinegrass, and in some cases, bermudagrass and centipedegrass. An extensive review of the literature indicated that these herbicides caused unacceptable turfgrass injury by increasing ethylene evolution and ammonium accumulation in meristematic tissues resulting in chlorosis, then necrosis leading to thinning of sod as grass leaves die and are not readily replaced (Feng and Barker 1992). Feng and Barker (1992) reported that these toxic symptoms and increased ethylene evolution are directly related to high ammonium accumulation. The logical approach to a solution was to concentrate on a herbicide combination that would suppress the evolution of ethylene and resultant accumulation of ammonium.

Safening of Phenoxy Herbicides by the Addition of Sulfonylurea Herbicides

The term safening or safener for practical purposes means protectant. That is, the addition of compound A to compound B when applied to a crop protects that crop from injury otherwise sustained from compound B alone. Compound A is deemed the safener. In a sense, safening is similar to antagonism. Antagonism occurs when the combined effect of two or more weed control chemicals is less than if they had been applied alone (Devine et al. 1993).

A paucity of literature exists to date that relates the safening of a phenoxy herbicide by a sulfonylurea herbicide. However, literature exists concerning a phenoxy herbicide safening a sulfonylurea herbicide, which is the opposite hypothesis. In field trials, an application of metsulfuron-methyl [methyl 2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2yl)amino]carbonyl]amino]sulfonyl] benzoate], alone at 2.1 or 4.3 g ai ha^{-1} caused significant stunting of sorghum. However, when it was applied in combination with 2,4-D ester at 1.1 kg ai ha^{-1}, sorghum growth was significantly improved (Ketchersid and Merkle 1991). In most cases, the sorghum treated with both 2,4-D and metsulfuron-methyl grew better than sorghum treated with metsulfuron-methyl alone. The theory postulated by Ketchersid and Merkle involved an increase in the metabolic rate caused by the addition of 2,4-D sufficient enough to increase the rate of degradation of the metsulfuron-methyl thus reducing the phytotoxic effects.

Simpson et al. (1994) observed something similar in corn involving 2,4-D safening the antagonism between nicosulfuron [2-[[[(4-6-dimethoxypyrimidin-2-yl)-aminocarbonyl]aminosulfonyl]-N,N-dimethyl-3-pyridinecarboximide] and terbufos [S[[(l,l-dimethylethyl)thio]methyl]O,O-diethylphosphorodithioate], an organophosphate insecticide used to control corn rootworms. Normal field applications of both terbufos and nicosulfuron caused decreased corn tolerance to nicosulfuron because terbufos inhibits nicosulfuron metabolism. Plants treated with nicosulfuron, terbufos and 2,4-D had significantly higher shoot dry weights than those treated with only nicosulfuron and terbufos. Metabolism of nicosulfuron in plants treated with terbufos was increased by 2,4-D to a rate equivalent to that in plants not treated with terbufos. The safening may have resulted from stimulation of the enzyme system responsible for nicosulfuron metabolism or by 2,4-D auxin activity increasing growth or production of cytochrome P-450 enzymes responsible for nicosulfuron metabolism (Simpson et al. 1994).

Researchers at Du Pont (Anonymous 1992a) have noted that tank mixing a phenoxy herbicide like 2,4-D with a sulfonylurea herbicide like Harmony® Extra sometimes reduced crop stress to wheat and barley. They have several theories for this safening action. Phenoxy herbicides may speed up the plant's metabolism, resulting in quicker breakdown of the sulfonylurea herbicide. Their research indicates 2,4-D actually increases the production of enzymes that metabolize sulfonylurea herbicides. Other research done by Du Pont scientists (Anonymous 1990) indicates that the fast action of the phenoxy herbicides slows sulfonylurea herbicide translocation in the plant. This allows more time for metabolism of the herbicide before it reaches the crop plant's growing point. The degree of safening depends on crop variety and environmental conditions.

These experiments were initiated based upon research done many years ago on turfgrass in Florida and Texas by scientists with whom the author has communicated personally. Because wheat, barley, and turfgrasses vary in their biology and sensitivity to chemicals, it is only natural to expect different results in metabolism. Eventually the author hopes to discover the phenomenon responsible for the mechanism of safening at the cellular level. However, that is beyond the scope of these experiments.

MATERIALS AND METHODS

General Field Procedures

All herbicide treatments were applied as a broadcast spray in 1018 L ha^{-1} of water to 1.52- by 1.52-m plots using a CO_2 pressurized sprayer at 138 kPa pressure equipped with one 8010E Tee Jet[1] even flat-fan nozzle. Chemicals were obtained from The Scotts Company and E. I. du Pont de Nemours and Company. Herbicides tested in the experimental treatments included MCPP with 2,4-D, thifensulfuron-methyl, and tribenuron-methyl (840+280+22+11, 840+280+37+19, 840+280+45+22, and 1120+280+22+11 g ai ha^{-1}). The standard treatments included MCPP plus 2,4-D and dicamba at 1X and 2X rates (719+211+89 and 1438+422+178 g ai ha^{-1}). Three replications of each treatment were arranged in a randomized complete block design. The duration of each field experiment ranged from 3 to 8 wk. Weather information at time of application can be found in Table 1. All data were subjected to ANOVA, and means were separated at the 5% level of significance using LSD.

Phytotoxicity experiments were conducted on turfgrasses maintained at a 5- or 8-cm clip height depending on turfgrass species typical of a home lawn. All locations received sprinkler irrigation. Turfgrass injury was assessed on a 0 to 100% scale where 0 = no phytotoxicity and 100 = plant death (Table 2).

[1]Spraying Systems Co., North Avenue, Wheaton, IL 60188.

Table 1. Weather information at time of application.

Location	Date	%Cloud Cover	Wind Velocity ($km\ hr^{-1}$)	Air (°C)	Soil at 5-cm (°C)	%Relative Humidity
Bay City, TX	6-3-97	0	11 S	24	25	50
La Feria, TX	1-15-98	0	16 NW	21	18	40
Tyler, TX	1-23-98	60	5 N	10	12	40
Tyler, TX	1-30-98	0	5 S	22	16	30
Tyler, TX	3-31-98	0	8 NW	20	15	30
Tyler, TX	4-17-98	65	16 N	14	16	55
Tyler, TX	6-24-00	40	10 S	27	24	60
Bullard, TX	6-26-00	35	3 S	29	23	50

Table 2. Description of rating scale in terms of turfgrass injury.

Rating%	Effect on turfgrass	Description of injury
0	none	normal growth and no injury
10	slight	slight discoloration
20	slight	discoloration and stunting
30	slight	pronounced injury – recoverable
40	moderate	more pronounced injury – recovery is doubtful
50	moderate	more persistent injury – recovery is doubtful
60	moderate	near severe injury – recovery impossible
70	severe	severe injury and stand loss
80	severe	crop stand destroyed – a few plants remaining
90	severe	very few plants remaining
100	complete	total destruction of turfgrass

(Raju 1997).

These ratings are subjective and are based upon field experience. Injury is considered commercially unacceptable at ≥20%. The typical homeowner would notice injury of this magnitude. Some temporary discoloration is tolerable as turfgrasses often recover.

Efficacy experiments were conducted on natural infestations of broadleaf weed species. All experiments were conducted in areas maintained as either a lawn or a golf course rough. Test sites received mowing at a 5-cm clip height removing no more than $^{1}/_{3}$ of the turfgrass canopy at each mowing. Supplemental irrigation was unnecessary due to adequate rainfall. Percent of plot area covered with target weed was assessed on a 0 to 100% scale where 0 = no weed population and 100 = entire plot area covered (Figure 6). Weed control was evaluated using the same scale where 0 = no control and 100 = necrosis and plant death (Table 3). These ratings are also subjective and are based upon field experience.

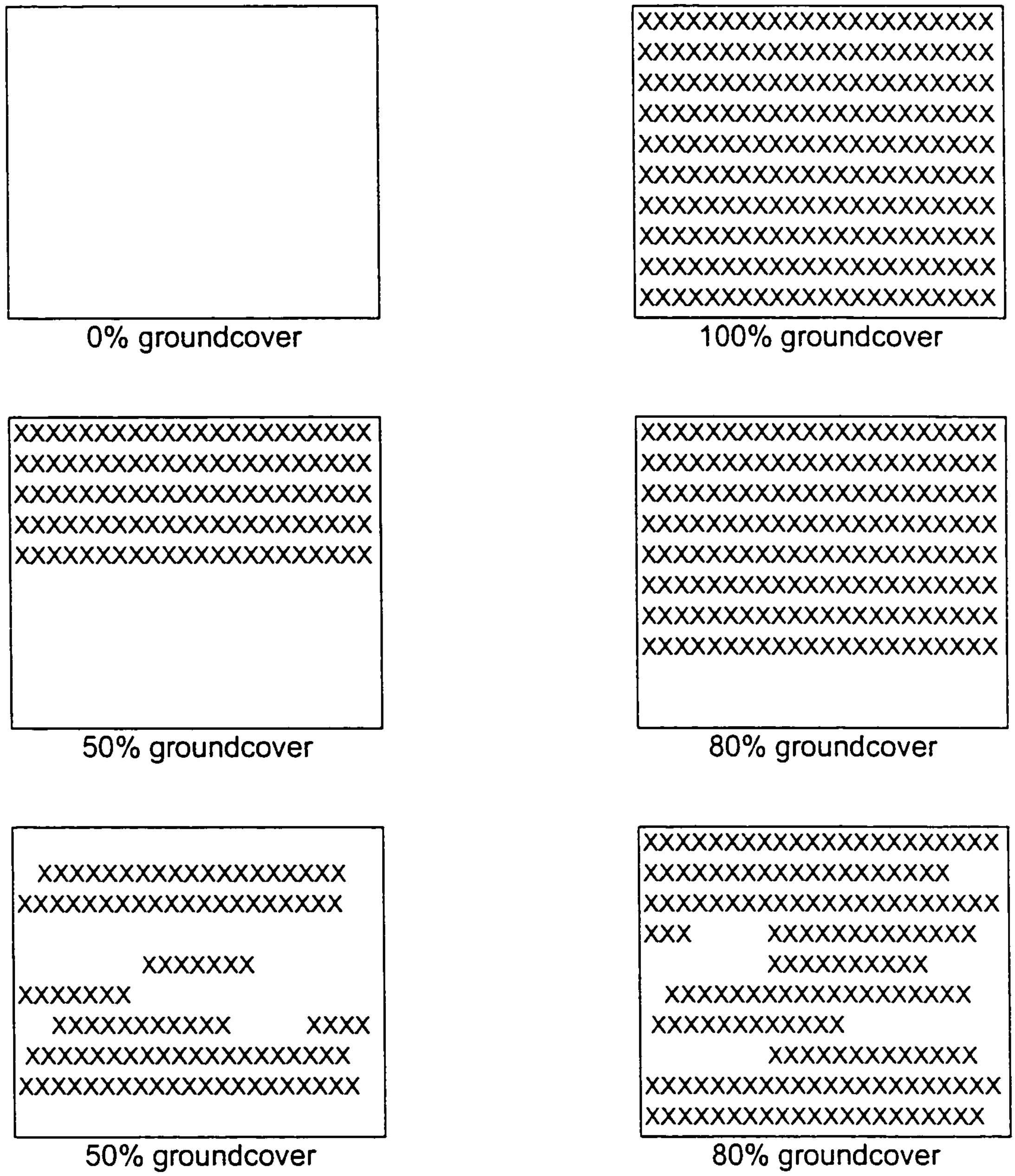

Figure 6. Sample plots showing percent area covered by target weed species.

Table 3. Description of rating scale in terms of weed control.

Rating %	Effect on weed	Description of weed control
0	none	no weed injury and no control
10	slight	very poor control
20	slight	poor control
30	slight	poor to deficient control
40	moderate	deficient control
50	moderate	deficient to moderate control
60	moderate	moderate control
70	severe	satisfactory control
80	severe	good control
90	severe	good to excellent control
100	complete	complete control

(Raju 1997).

Phytotoxicity

Floratam St. Augustinegrass - 1997

Experiment was initiated June 3, at Milberger Turfgrass Farm, Bay City, Texas. Turfgrass was actively growing at an 8-cm clip height with a 93% visual color rating. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 and 1120+280+22+11 g ai ha^{-1}. Both combinations were compared to the standard treatment of MCPP plus 2,4-D and dicamba at 719+211+89 g ai ha^{-1}. Soil type was a Dacosta sandy clay loam (fine, smectitic, hyperthermic Vertic Argiudolls) with <2% organic matter and pH of 7.1.

Floratam St. Augustinegrass - 1998

Experiment was initiated January 15, at Shofner Turfgrass Farm, La Feria, Texas. Turfgrass was actively growing at an 8-cm clip height with a 95% visual color rating. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 and 840+280+37+19 g ai ha^{-1}. Both combinations were compared to the standard treatment of MCPP plus 2,4-D and dicamba at 719+211+89 g ai ha^{-1}. Soil type was a Harlingen clay (very-fine, smectitic, hyperthermic Sodic Haplusterts) with <2% organic matter and pH of 7.5.

Common St. Augustinegrass and Common Centipedegrass - 1998

Experiments were initiated March 31, at Scotts Southern Research Center, Tyler, Texas. Turfgrasses were actively growing at a 5-cm clip height. Common St. Augustinegrass showed 20%, and common centipedegrass showed 35% visual color ratings. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 and 840+280+37+19 g ai ha^{-1}. Both combinations were compared to the standard treatment of MCPP plus 2,4-D and dicamba at 719+211+89 g ai ha^{-1}. Soil type was a Wolfpen loamy fine sand (loamy, siliceous, thermic Arenic Paleudalfs) with <2% organic matter and pH of 6.7.

Common Bermudagrass - 1998

Experiment was initiated on April 17, at Scotts Southern Research Center, Tyler, Texas. Turfgrass was actively growing at a 5-cm clip height and 30% visual color rating. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 and 840+280+37+19 g ai ha^{-1}. Both combinations were compared to the standard treatments (1X and 2X) of MCPP plus 2,4-D and dicamba at 719+211+89 and 1438+422+178 g ai ha^{-1}. Soil type was a Wolfpen loamy fine sand (loamy, siliceous, thermic Arenic Paleudalfs) with <2% organic matter and pH of 6.7.

Common St. Augustinegrass and Common Bermudagrass - 2000

Experiments were initiated June 24, at the home lawn of the author, Tyler, Texas. Turfgrasses were actively growing at a 5-cm clip height. Common St. Augustinegrass showed 95%, and common bermudagrass showed 96% visual color ratings. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 and 840+280+45+22 g ai ha^{-1}. For common bermudagrass, both combinations were compared to the standard treatments (1X and 2X) of MCPP plus 2,4-D and dicamba at 719+211+89 and 1438+422+178 g ai ha^{-1}. For common St. Augustinegrass, only the 1X rate of the standard was used. Soil type was a Cuthbert fine sandy loam (fine, mixed, semiactive, thermic Typic Hapludults) with <2% organic matter and pH of 6.8.

Common Centipedegrass - 2000

Experiment was initiated June 24, at Rose Hill Cemetery, Tyler, Texas. Turfgrass was actively growing at an 8-cm clip height and 85% visual color rating. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 g ai ha^{-1} and 840+280+45+22 g ai ha^{-1}. Both combinations were compared to the standard treatment of MCPP plus 2,4-D and dicamba at 719+211+89 g ai ha^{-1}. Soil type for experiment was a Redsprings very gravelly sandy loam (fine, kaolinitic, thermic Ultic Hapludalfs) with <2% organic matter and pH of 6.8.

Efficacy

White Clover - 1998

Experiment was initiated January 23, at Tyler Rose Garden, Tyler, Texas. White clover was actively growing at 10-cm in full bloom. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 and 840+280+45+22 g ai ha^{-1}. Both combinations were compared to the standard treatment of MCPP plus 2,4-D and dicamba at 719+211+89 g ai ha^{-1}. Soil type was a Redsprings very gravelly sandy loam (fine, kaolinitic, thermic Ultic Hapludalfs) with <2% organic matter and a pH of 6.9.

Lawn Burweed - 1998

Experiment was initiated January 30, at Bellwood Golf Course, Tyler, Texas. Lawn burweed was actively growing at 2-cm in a vegetative state. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 and 840+280+45+22 g ai ha^{-1}. Both combinations were compared to the standard treatment of MCPP plus 2,4-D and dicamba at 719+211+89 g ai ha^{-1}. Soil type was a Cuthbert fine sandy loam (fine, mixed, semiactive, thermic Typic Hapludults) with <2% organic matter and pH of 6.6.

White Clover and Annual Aster - 2000

Experiments were initiated June 24, at Rose Hill Cemetery, Tyler, Texas. White clover was actively growing at 11-cm in full bloom. Annual aster was actively growing at 5-cm in early bloom. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 g ha^{-1} and 840+280+45+22-g ai ha^{-1}. Both combinations were compared to the standard treatment of MCPP plus 2,4-D and dicamba at 719+211+89 g ai ha^{-1}. The 2X rate of the standard treatment (1438+422+178 g ha^{-1}) was included in the annual aster experiment. Soil type for the white clover experiment was a Kirvin gravelly fine sandy (fine, mixed, semiactive, thermic Typic Hapludults) with <2% organic matter and pH of 6.6. Soil type for the annual aster experiment was a Redsprings very gravelly sandy loam (fine, kaolinitic, thermic Ultic Hapludalfs) with <2% organic matter and pH of 6.8.

Bristly Mallow - 2000

Experiment was initiated June 26, at Peach Tree Golf Course, Bullard, Texas. Bristly mallow was actively growing at 6-cm in a vegetative state. Treatments included MCPP with 2,4-D, thifensulfuron, and tribenuron at 840+280+22+11 and 840+280+45+22 g ai ha^{-1}. Both combinations were compared to the standard treatment of MCPP plus 2,4-D and dicamba at 719+211+89 g ai ha^{-1}. Soil type was a Redsprings very gravelly sandy loam (fine, kaolinitic, thermic Ultic Hapludalfs) with <2% organic matter and pH of 6.5.

RESULTS AND DISCUSSION

Phytotoxicity

Floratam St. Augustinegrass - 1997

Both experimental treatments of MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 and 1120+280+22+11 g ai ha^{-1}) were marginally phytotoxic at 3 weeks after treatment (WAT) showing less than 17% visual injury (Table 4). Floratam St. Augustinegrass (FSAG) recovered to 10% injury at 6 WAT for both MCPP rates. The standard treatment of MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}) showed objectionable phytotoxicity 3 WAT with greater than 21% injury. At 1, 2, 3, and 5 WAT, the standard treatment means were significantly different (P=0.05) although not all of the means were considered objectionable. By 6 WAT, the standard had recovered to 12% injury. Chlorosis and reduced density of the turfgrass were visible in the standard treatment.

Floratam St. Augustinegrass - 1998

At 6 WAT, MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+37+19 g ai ha^{-1}) caused 14% visual injury to FSAG (Table 5). The lower rates of thifensulfuron and tribenuron (840+280+22+11 g ai ha^{-1}) caused 10% injury. At 6 WAT, greater than 20% injury was observed with the standard treatment of MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}). At 2, 3, and 6 WAT, the standard treatment means were significantly different at P=0.05. Noticeable

Table 4. Floratam St. Augustinegrass injury from MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations applied June, 1997, at Bay City, TX.

Herbicide	Rate	Floratam St. Augustinegrass injury[1] (wk after treatment) 1	2	3	5	6
	$g\ ai\ ha^{-1}$	----	----	%	----	----
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	7.3 b	13.3 b	15.7 b	14.7 b	10.0 a
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	1120 280 22 11	11.3 ab	15.0 b	16.7 b	16.7 ab	10.0 a
MCPP+ 2,4-D+ dicamba	719 211 89	11.7 a	18.3 a	21.3 a[2]	20.7 a[2]	12.3 a
Untreated		0.0 c	0.0 c	0.0 c	0.0 c	0.0 b

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).

[1] = Means obtained from visual, subjective ratings.

[2] = Mean ratings of ≥20% are considered objectionable.

Table 5. Floratam St. Augustinegrass injury from MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations applied January, 1998, at La Feria, TX.

Herbicide	Rate	Floratam St. Augustinegrass injury[1] (wk after treatment)			
		1	2	3	6
	g ai ha^{-1}	%			
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	0.3 a	2.3 ab	4.0 ab	10.0 b
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 37 19	0.0 a	0.3 b	0.7 b	14.0 b
MCPP+ 2,4-D+ dicamba	719 211 89	0.3 a	5.3 a	7.7 a	20.7 a[2]
Untreated		0.0 a	0.0 b	0.0 b	0.0 c

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).
[1] = Means obtained from visual, subjective ratings.
[2] = Mean ratings of ≥ 20% are considered objectionable.

injury to FSAG was chlorosis, height reduction, and slight thinning of the turfgrass canopy.

Common St. Augustinegrass - 1998

Of the two experimental treatments, MCPP with 2,4-D, thifensulfuron and tribenuron (840+280+37+19 g ai ha^{-1}) caused less than 12% at 2 WAT (Table 6). Common St. Augustinegrass completely recovered from slight discoloration at 5 WAT. The lower rates of thifensulfuron and tribenuron (840+280+22+11 g ai ha^{-1}) caused less than 8% injury showing 2 WAT. The turfgrass at this rate also fully recovered by 5 WAT. The standard treatment of MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}) caused objectionable phytotoxicity beginning 2 WAT with 20% injury. The standard treatment means were significantly different (P=0.05) at 2, 3, and 5 WAT. Grass suffered from chlorosis. At 5 WAT, this treatment had recovered to an acceptable 5% injury.

Common St. Augustinegrass - 2000

MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 g ai ha^{-1}) showed less than 3% injury to common St. Augustinegrass at 4 WAT (Table 7). This treatment completely recovered at 6 WAT. The higher rates of thifensulfuron and tribenuron (840+280+45+22 g ai ha^{-1}) exhibited 5% or less injury throughout the duration of the experiment. The standard treatment of MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}) displayed incremental phytotoxicity causing slight but acceptable injury of less than 12% at 6 WAT.

Table 6. Common St. Augustinegrass injury from MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations applied March, 1998, at Tyler, TX.

Herbicide	Rate	Common St. Augustinegrass injury[1] (wk after treatment) 1	2	3	5
	g ai ha^{-1}	%			
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	0.0 a	7.3 bc	4.3 b	0.0 b
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 37 19	0.0 a	11.7 ab	7.7 b	0.0 b
MCPP+ 2,4-D+ dicamba	719 211 89	0.0 a	20.0 a[2]	20.3 a[2]	5.0 a
Untreated		0.0 a	0.0 c	0.0 b	0.0 b

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).
[1] = Means obtained from visual, subjective ratings.
[2] = Mean ratings of ≥ 20% are considered objectionable.

Table 7. Common St. Augustinegrass injury from MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations applied June, 2000, at Tyler, TX.

Herbicide	Rate	Common St. Augustinegrass injury[1] (wk after treatment) 1	2	3	4	5	6
	g ai ha^{-1}	%					
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	0.0 a	0.0 a	1.7 a	2.3 a	1.3 b	0.0 b
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 45 22	0.0 a	1.7 a	3.3 a	5.0 a	5.0 ab	5.0 ab
MCPP+ 2,4-D+ Dicamba	719 211 89	0.3 a	0.7 a	1.0 a	6.7 a	10.7 a	11.3 a
Untreated		0.0 a	0.0 a	0.0 a	0.0 a	0.0 b	0.0 b

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).

[1] = Means obtained from visual, subjective ratings.

[2] = Mean ratings of ≥ 20% are considered objectionable.

Treatment means were significantly different (P=0.05) at 5 and 6 WAT. Only slight chlorosis was noted with the standard treatment.

Common Centipedegrass - 1998

Minor injury to common centipedegrass was observed with MCPP plus 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 g ai ha^{-1}) at 2 and 3 WAT with less than 8% injury (Table 8). Injury was similar at 840+280+37+19 g ai ha^{-1} with less than 9% injury. Although injury was not considered objectionable, treatment means were significantly different (P=0.05) at 2 and 3 WAT. Discoloration was short-lived, and both treatments completely recovered by 5 WAT. The standard treatment of MCPP plus 2,4-D and dicamba (719+211+89 and 1438+422+178 g ai ha^{-1}) did not visibly injure common centipedegrass.

Common Centipedegrass - 2000

Insignificant injury to common centipedegrass was observed with MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 g ai ha^{-1}) at 2 and 3 WAT with less than 3% injury (Table 9). Injury was similar at 840+280+45+22 g ai ha^{-1} with less than 3% for each rating interval. Both rates recovered to less than 1% injury by 6 WAT. The standard treatment of MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}) was not injurious during this experiment. All treatments were essentially nonphytotoxic with no significant differences in treatment means at P=0.05.

Table 8. Common centipedegrass injury from MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) herbicide combinations applied March, 1998, at Tyler, TX.

Herbicide	Rate	Common centipedegrass injury[1] (wk after treatment)			
		1	2	3	5
	g ai ha^{-1}	%			
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	0.0 a	7.7 a	4.3 a	0.0 a
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 37 19	0.0 a	8.3 a	6.7 a	0.0 a
MCPP+ 2,4-D+ dicamba	719 211 89	0.0 a	0.0 b	0.0 b	0.0 a
Untreated		0.0 a	0.0 b	0.0 b	0.0 a

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).

[1] = Means obtained from visual, subjective ratings.

Table 9. Common centipedegrass injury from MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations applied June, 2000, at Tyler, TX.

Herbicide	Rate	Common centipedegrass injury[1] (wk after treatment)			
		1	2	3	6
	g ai ha^{-1}	%			
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	0.0 a	1.0 a	2.7 a	0.0 a
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 45 22	0.0 a	2.3 a	1.7 a	0.7 a
MCPP+ 2,4-D+ dicamba	719 211 89	0.0 a	0.0 a	0.0 a	0.0 a
Untreated		0.0 a	0.0 a	0.0 a	0.0 a

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).
[1] = Means obtained from visual, subjective ratings.

Common Bermudagrass - 1998

Previous research has shown common bermudagrass to be tolerant of phenoxy herbicides to 4480 g ai ha^{-1} or less when grown as forage (Bovey et al. 1974). No injury was observed with either experimental treatment of MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 and 1120+280+22+11 g ai ha^{-1}) (Table 10). Likewise, neither standard treatment (1X or 2X) of MCPP plus 2,4-D and dicamba (719+211+89 and 1438+422+178 g ai ha^{-1}) was injurious to common bermudagrass.

Common Bermudagrass - 2000

Common bermudagrass was not injured with either experimental treatment of MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 and 1120+280+22+11 g ai ha^{-1}) (Table 11). Similarly, no injury was observed with the 1X rate of the standard treatment MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}). However, the 2X rate (1438+422+178 g ai ha^{-1}) caused slight but acceptable injury of 9% at 2 WAT. Treatment means for the 2X rate were significantly different at P=0.05. Injury at this rate was reduced to less than 5% by 6 WAT.

Table 10. Common bermudagrass injury from MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations applied April 1998 at Tyler, TX.

Herbicide	Rate	Common bermudagrass injury[1] (wk after treatment) 1	2	3	4
	g ai ha^{-1}	%			
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	0.0 a	0.0 a	0.0 a	0.0 a
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 37 19	0.0 a	0.0 a	0.0 a	0.0 a
MCPP+ 2,4-D+ dicamba	719 211 89	0.0 a	0.0 a	0.0 a	0.0 a
MCPP+ 2,4-D+ dicamba	1438 422 178	0.0 a	0.0 a	0.0 a	0.0 a
Untreated		0.0 a	0.0 a	0.0 a	0.0 a

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).
[1] = Means obtained from visual, subjective ratings.

Table 11. Common bermudagrass injury from MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations applied June, 2000, at Tyler, TX.

		Common bermudagrass injury[1] (wk after treatment)			
Herbicide	Rate	1	2	3	6
	g ai ha^{-1}	%			
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	0.0 b	0.0 b	0.0 b	0.0 b
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 45 22	0.0 b	0.0 b	0.0 b	0.0 b
MCPP+ 2,4-D+ dicamba	719 211 89	0.0 b	0.0 b	0.0 b	0.0 b
MCPP+ 2,4-D+ dicamba	1438 422 178	5.0 a	9.0 a	6.7 a	4.7 a
Untreated		0.0 b	0.0 b	0.0 b	0.0 b

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).
[1] = Means obtained from visual, subjective ratings.

Efficacy

White Clover - 1998

At 7 WAT, MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 and 840+280+45+22g ai ha^{-1}) and the standard treatment of MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}) controlled white clover greater than 98% (Table 12). An increase in control was observed from 1 to 6 WAT for all treatments. The two experimental treatments are deemed comparable to the standard treatment at P=0.05.

White Clover - 2000

White clover control exceeding 95% was achieved with MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 and 840+280+45+22 g ai ha^{-1}), and the standard treatment of MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}) (Table 13). The standard treatment showed a significant increase in efficacy (P=0.05) 1, 2, and 6 WAT. This indicates a slight increase in herbicidal activity over time at these intervals. Calculated control became analogous among treatments by 6 WAT.

Table 12. Effect of MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations on white clover control applied January, 1998, at Tyler, TX.

		(wk after treatment)						
		control[1]				groundcover pre-rating	groundcover post-rating	calculated control[2]
Herbicide	Rate	1	2	5	6	0	7	7
	$g\ ai\ ha^{-1}$	%						
MCPP+ 2,4-D+ thifensulfuron+ ribenuron	840 280 22 11	30.0 a	36.7 a	79.0 a	90.0 a	75.0 a	0.4 b	99.6 a
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 45 22	23.3 b	28.3 b	75.0 a	85.7 a	99.7 a	1.2 b	98.8 a
MCPP+ 2,4-D+ dicamba	719 211 89	25.0 b	28.3 b	74.3 a	86.7 a	99.0 a	0.4 b	99.6 a
Untreated		0.0 c	0.0 c	0.0 b	0.0 b	90.0 a	82.3 a	9.9 b

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).

[1] = Control values reflect the effect of time on herbicidal activity.

[2] = [(clover groundcover pre-rating – clover groundcover post-rating)/clover groundcover pre-rating] X 100.

Table 13. Effect of MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations on white clover control applied June, 2000, at Tyler, TX.

		(wk after treatment)						
		control[1]				groundcover pre-rating	groundcover post-rating	calculated control[2]
Herbicide	Rate	1	2	4	6	0	6	6
	g ai ha^{-1}	%						
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	10.7 c	21.7 c	60.7 a	96.7 b	46.7 a	2.0 b	95.7 a
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 45 22	12.0 b	25.0 b	59.0 a	97.3 ab	45.0 a	1.7 b	96.3 a
MCPP+ 2,4-D+ dicamba	719 211 89	15.0 a	29.0 a	60.0 a	98.7 a	38.3 a	1.3 b	96.7 a
Untreated		0.0 d	0.0 d	0.0 b	0.0 c	45.0 a	50.7 a	0.0 b

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).
[1] = Control values reflect the effect of time on herbicidal activity.
[2] = [(clover groundcover pre-rating – clover groundcover post-rating)/clover groundcover pre-rating] X 100.

Lawn Burweed - 1998

By 9 WAT, MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 and 840+280+45+22 g ai ha^{-1}) controlled lawn burweed 72 and 62%, respectively (Table 14). The standard treatment MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}) controlled lawn burweed greater than 60%. All three treatment means were not significantly different at P=0.05. At 3 WAT, MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 g ai ha^{-1}) showed a significant increase in efficacy (P=0.05) at 6% or greater control over the other treatments that showed 4% or less. However, no significant differences in means were observed beyond 3 WAT. Based upon the author's experience with this difficult to control weed, lawn burweed efficacy was considered moderate.

Annual Aster - 2000

Based upon the author's experience, annual aster is known to be a difficult and troublesome weed to control in turfgrass. It was not surprising that the data reflects this fact. Therefore, this experiment included a 2X rate of the standard treatment not included in previous efficacy experiments. At 6 WAT, the 2X rate of the standard treatment MCPP plus 2,4-D and dicamba (1438+422+178 g ai ha^{-1}) gave greater than 20% control (Table 15). This mean was significantly different (P=0.05) than the two experimental treatments of MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 and 840+280+45+22 g ai ha^{-1}) and the 1X rate of the standard treatment (719+211+89 g ai ha^{-1}). These 3

Table 14. Effect of MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations on lawn burweed control applied January, 1998, at Tyler, TX.

		(wk after treatment)						
		control[1]				groundcover pre-rating	groundcover post-rating	calculated control[2]
Herbicide	Rate	1	3	5	8	0	9	9
	g ai ha^{-1}	%						
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	3.7 a	6.7 a	20.0 a	46.7 a	93.3 a	26.7 b	71.5 a
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 45 22	2.3 ab	3.0 b	20.0 a	31.7 a	96.3 a	36.7 b	61.9 a
MCPP+ 2,4-D+ dicamba	719 211 89	3.0 a	3.7 b	14.3 a	38.3 a	92.3 a	36.7 b	60.5 a
Untreated		0.0 b	0.0 c	0.0 b	0.0 b	95.3 a	90.0 a	5.6 b

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).
[1] = Control values reflect the effect of time on herbicidal activity.
[2] = [(burweed groundcover pre-rating – burweed groundcover post-rating)/burweed groundcover pre-rating] X 100.

Table 15. Effect of MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations on annual aster control applied June, 2000, at Tyler, TX.

		(wk after treatment) control[1]				groundcover pre-rating	groundcover post-rating	calculated control[2]
Herbicide	Rate	1	2	3	6	0	6	6
	g ai ha^{-1}	%						
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	1.0 b	2.0 b	2.7 b	8.3 b	66.7 ab	60.7 ab	10.2 ab
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 45 22	1.0 b	2.0 b	3.0 b	9.0 b	45.0 b	38.3 c	12.5 ab
MCPP+ 2,4-D+ dicamba	719 211 89	1.3 b	2.0 b	3.3 b	9.3 b	53.3 ab	47.0 bc	11.4 ab
MCPP+ 2,4-D+ dicamba	1438 422 178	3.3 a	6.3 a	8.7 a	16.7 a	56.7 ab	46.0 bc	20.3 a
Untreated		0.0 c	0.0 c	0.0 c	0.0 c	76.7 a	80.0 a	0.0 b

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).

[1] = Control values reflect the effect of time on herbicidal activity.

[2] = [(aster groundcover pre-rating – aster groundcover post-rating)/aster groundcover pre-rating] X 100.

treatments controlled annual aster less than 13%. Only the 2X rate gave control of annual aster that was significantly different (P=0.05) during this experiment. All treatments merely suppressed annual aster. This weed is much easier to control when young, actively growing, in the 2- to 6-leaf stage. The author recognizes that the typical homeowner would not notice it until it flowers. This explains the application at early bloom.

Bristly Mallow - 2000

Control of bristly mallow of 97% or greater was observed with MCPP plus 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 and 840+280+45+22 g ai ha^{-1}) and the standard treatment of MCPP plus 2,4-D and dicamba (719+211+89 g ai ha^{-1}) (Table 16). The standard treatment gave 45% control 1 WAT. This was significantly greater (P=0.05) than either experimental treatment at this rating interval. However, from 2 WAT to the completion of the experiment, all treatments controlled mallow with no significant differences in treatment means.

Table 16. Effect of MCPP, 2,4-D, and thifensulfuron+tribenuron (Harmony® Extra) combinations on bristly mallow control applied June, 2000, at Bullard, TX.

Herbicide	Rate	control[1]			groundcover pre-rating	groundcover post-rating	calculated control[2]
		(wk after treatment)					
		1	2	3	0	3	3
	g ai ha^{-1}	%					
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 22 11	33.3 b	85.0 a	96.7 a	77.7 a	2.3 b	97.3 a
MCPP+ 2,4-D+ thifensulfuron+ tribenuron	840 280 45 22	36.7 ab	86.0 a	97.3 a	65.0 a	1.7 b	97.0 a
MCPP+ 2,4-D+ dicamba	719 211 89	45.0 a	91.7 a	98.7 a	75.0 a	1.3 b	98.3 a
Untreated		0.0 c	0.0 b	0.0 b	56.7 a	63.3 a	0.0 b

Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).

[1] = Control values reflect the effect of time on herbicidal activity.

[2] = [(mallow groundcover pre-rating – mallow groundcover post-rating)/mallow groundcover pre-rating] X 100.

CONCLUSION

Through field experiments, combinations of MCPP with 2,4-D, thifensulfuron, and tribenuron were tested at various rates (840+280+22+11, 840+280+37+19, 840+280+45+22, and 1120+280+22+11 g ai ha^{-1}) against Trimec® [(MCPP+2,4-D+dicamba) (719+211+89 g ai ha^{-1})] for phytotoxicity on Floratam St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Ktze.], common St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Ktze.], common bermudagrass [*Cynodon dactylon* (L.) Pers.], and common centipedegrass [*Eremochloa ophiuroides* (Munro) Hack.]. Two of the above formulations (840+280+22+11 and 840+280+45+22 g ai ha^{-1}) were screened for efficacy against Trimec® on white clover (*Trifolium repens* L.), annual aster (*Aster subulatus* Michx.), lawn burweed [*Soliva pterosperma* (Juss.) Less.], and bristly mallow [*Modiola caroliniana* (L.) G. Don].

In two field experiments on Floratam St. Augustinegrass, treatments MCPP with 2,4-D, thifensulfuron and tribenuron (840+280+22+11, 840+280+37+19 and 1120+280+22+11 g ai ha^{-1}) provided lower phytotoxicity than Trimec®. Injury levels of ≥20% for Trimec® in both experiments were considered objectionable. Injury of ≥20% with Trimec® was also noticed in another experiment involving common St. Augustinegrass. No objectionable injury was noticed on common bermudagrass or common centipedegrass.

MCPP with 2,4-D, thifensulfuron, and tribenuron (840+280+22+11 and 840+280+45+22 g ai ha^{-1}) provided comparable weed efficacy to Trimec® in 4 of 5 experiments. The 2X rate of Trimec® provided greater control of annual aster than did the 1X rate or the experimental treatments. However, only one of the turfgrass species assayed, common bermudagrass, has a known tolerance for Trimec® at this rate. In all 5 experiments, both experimental treatments gave comparable weed efficacy to the 1X rate of Trimec®, which is the recommended rate for the more sensitive southern turfgrasses such as common St. Augustinegrass and common centipedegrass.

At this point, the author can only hypothesize as to the reason behind the safening mechanism of a phenoxy herbicide by a sulfonylurea herbicide. Since cereal crops and warm-season, tropical grasses vary in biology, it could possibly involve varied metabolism; that is, how each crop differs in their ability to metabolize various xenobiotics. Cereal crops can be sensitive to sulfonylurea herbicides, and crop injury is often reduced by the addition of a phenoxy herbicide. Tropical grasses, such as St. Augustinegrass, are sensitive to phenoxy herbicides, and the author has observed injury reduced by the addition of a sulfonylurea herbicide. The enhanced metabolism could be seen both ways. This is only conjecture, and more research involving radiolabeled (^{14}C) materials for translocation studies are needed to find a definitive answer.

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APPENDIX

FLORATAM ST. AUGUSTINEGRASS INJURY - 1997
Protocol Number:00-00-00-00
EXPERIMENT #: 1
Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot	STPSE PTOX%SV 8-18-97 FLORATAM 7 DAT	STPSE PTOX%SV 8-27-97 FLORATAM 14 DAT	STPSE PTOX%SV 9-3-97 FLORATAM 21 DAT	STPSE PTOX%SV 9-17-97 FLORATAM 35 DAT	STPSE PTOX%SV 9-24-97 FLORATAM 42 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	101	10.0	15.0	17.0	15.0	10.0
1	2,4-D AMINE	1.258	SL	280	AI g/ha	204	5.0	12.0	15.0	15.0	12.0
1	HARMONY EXTRA	75	DF	33	AI g/ha	301	7.0	13.0	15.0	14.0	8.0
						Mean =	7.3	13.3	15.7	14.7	10.0
2	MCPP-AMINE	4	EC	1120	AI g/ha	102	10.0	15.0	20.0	20.0	14.0
2	2,4-D AMINE	1.258	SL	280	AI g/ha	203	12.0	15.0	15.0	15.0	8.0
2	HARMONY EXTRA	75	DF	33	AI g/ha	302	12.0	15.0	15.0	15.0	8.0
						Mean =	11.3	15.0	16.7	16.7	10.0
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	103	10.0	20.0	25.0	25.0	15.0
						202	10.0	15.0	17.0	15.0	10.0
						304	15.0	20.0	22.0	22.0	12.0
						Mean =	11.7	18.3	21.3	20.7	12.3
4	UNTREATED CHECK	0	ND	0		104	0.0	0.0	0.0	0.0	0.0
						201	0.0	0.0	0.0	0.0	0.0
						303	0.0	0.0	0.0	0.0	0.0
						Mean =	0.0	0.0	0.0	0.0	0.0

Row labels for the column headers: BAYER code (STPSE); EVALUATION type (PTOX%SV); RATING date; VARIETY (FLORATAM); TRT-EVAL Interval.

FLORATAM ST. AUGUSTINEGRASS INJURY - 1997
Protocol Number:00-00-00-00
EXPERIMENT #: 1 Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	STPSE PTOX%SV 8-18-97 FLORATAM 7 DAT	STPSE PTOX%SV 8-27-97 FLORATAM 14 DAT	STPSE PTOX%SV 9-3-97 FLORATAM 21 DAT	STPSE PTOX%SV 9-17-97 FLORATAM 35 DAT	STPSE PTOX%SV 9-24-97 FLORATAM 42 DAT
	BAYER code / EVALUATION type / RATING date / VARIETY / TRT-EVAL Interval									
1	MCPP-AMINE	4	EC	840	AI g/ha	7 3 b	13 3 b	15 7 b	14 7 b	10 0 a
1	2,4-D AMINE	1 258	SL	280	AI g/ha					
1	HARMONY EXTRA	75	DF	33	AI g/ha					
2	MCPP-AMINE	4	EC	1120	AI g/ha	11 3 ab	15 0 b	16 7 b	16 7 ab	10 0 a
2	2,4-D AMINE	1 258	SL	280	AI g/ha					
2	HARMONY EXTRA	75	DF	33	AI g/ha					
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	11 7 a	18 3 a	21 3 a	20 7 a	12 3 a
4	UNTREATED CHECK	0	ND	0		0 0 c	0 0 c	0 0 c	0 0 c	0 0 b
	LSD (P= 05)					4 15	2 90	3 90	5 25	4 28
	Standard Deviation					2 07	1 45	1 95	2 63	2 14
	CV					27 36	12 45	14 54	20 23	26 49
	Replicate F					0 716	2 053	3 832	2 060	1 873
	Replicate Prob(F)					0 5261	0 2093	0 0847	0 2084	0 2334
	Treatment F					20 510	92 105	67 876	35 277	19 800
	Treatment Prob(F)					0 0015	0 0001	0 0001	0 0003	0 0016

Means followed by same letter do not significantly differ (P= 05, LSD)

FLORATAM ST. AUGUSTINEGRASS INJURY - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 2

Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot	STPSE	STPSE	STPSE	STPSE
	BAYER code						STPSE	STPSE	STPSE	STPSE
	EVALUATION type						PTOX%SV	PTOX%SV	PTOX%SV	PTOX%SV
	RATING date						1-21-98	1-28-98	2-5-98	2-25-98
	VARIETY						FLORATAM	FLORATAM	FLORATAM	FLORATAM
	TRT-EVAL Interval						6 DAT	13 DAT	21 DAT	42 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	101	0.0	0.0	2.0	5.0
1	2,4-D AMINE	1.258	SL	280	AI g/ha	204	0.0	2.0	2.0	15.0
1	HARMONY EXTRA	75	DF	33	AI g/ha	301	1.0	5.0	8.0	10.0
						Mean =	0.3	2.3	4.0	10.0
2	MCPP-AMINE	4	EC	840	AI g/ha	102	0.0	0.0	0.0	15.0
2	2,4-D AMINE	1.258	SL	280	AI g/ha	203	0.0	1.0	2.0	15.0
2	HARMONY EXTRA	75	DF	56	AI g/ha	302	0.0	0.0	0.0	12.0
						Mean =	0.0	0.3	0.7	14.0
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	103	0.0	5.0	8.0	20.0
						202	1.0	8.0	10.0	20.0
						304	0.0	3.0	5.0	22.0
						Mean =	0.3	5.3	7.7	20.7
4	UNTREATED CHECK	0	ND	0		104	0.0	0.0	0.0	0.0
						201	0.0	0.0	0.0	0.0
						303	0.0	0.0	0.0	0.0
						Mean =	0.0	0.0	0.0	0.0

FLORATAM ST. AUGUSTINEGRASS INJURY - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 2
Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit				
	BAYER code					STPSE	STPSE	STPSE	STPSE
	EVALUATION type					PTOX%SV	PTOX%SV	PTOX%SV	PTOX%SV
	RATING date					1-21-98	1-28-98	2-5-98	2-25-98
	VARIETY					FLORATAM	FLORATAM	FLORATAM	FLORATAM
	TRT-EVAL Interval					6 DAT	13 DAT	21 DAT	42 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	0.3 a	2 3 ab	4 0 ab	10 0 b
1	2,4-D AMINE	1 258	SL	280	AI g/ha				
1	HARMONY EXTRA	75	DF	33	AI g/ha				
2	MCPP-AMINE	4	EC	840	AI g/ha	0 0 a	0 3 b	0 7 b	14.0 b
2	2,4-D AMINE	1 258	SL	280	AI g/ha				
2	HARMONY EXTRA	75	DF	56	AI g/ha				
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	0 3 a	5 3 a	7 7 a	20 7 a
4	UNTREATED CHECK	0	ND	0		0 0 a	0 0 b	0 0 b	0 0 c
	LSD (P= 05)					0 88	3 78	4 97	5 53
	Standard Deviation					0 44	1 89	2 49	2 77
	CV					264 58	94 65	80 72	24 8
	Replicate F					0 429	0 628	0 175	0 826
	Replicate Prob(F)					0 6699	0 5655	0 8437	0 4821
	Treatment F					0.571	5 023	6 004	29 261
	Treatment Prob(F)					0 6542	0 0448	0 0307	0 0006

Means followed by same letter do not significantly differ (P= 05, LSD)

COMMON ST. AUGUSTINEGRASS INJURY - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 3

Investigator: Matt Shipp

Trt No.	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot	STPSE PTOX%SV 4-7-98 COMMON 7 DAT	STPSE PTOX%SV 4-14-98 COMMON 14 DAT	STPSE PTOX%SV 4-21-98 COMMON 21 DAT	STPSE PTOX%SV 5-5-98 COMMON 35 DAT
	BAYER code						STPSE	STPSE	STPSE	STPSE
	EVALUATION type						PTOX%SV	PTOX%SV	PTOX%SV	PTOX%SV
	RATING date						4-7-98	4-14-98	4-21-98	5-5-98
	VARIETY						COMMON	COMMON	COMMON	COMMON
	TRT-EVAL Interval						7 DAT	14 DAT	21 DAT	35 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	101	0 0	0 0	0.0	0.0
1	2,4-D AMINE	1 258	SL	280	AI g/ha	204	0.0	12 0	3 0	0.0
1	HARMONY EXTRA	75	DF	33	AI g/ha	301	0.0	10 0	10 0	0 0
						Mean =	0.0	7 3	4 3	0 0
2	MCPP-AMINE	4	EC	840	AI g/ha	102	0.0	5 0	10.0	0 0
2	2,4-D AMINE	1 258	SL	280	AI g/ha	203	0 0	10.0	8.0	0 0
2	HARMONY EXTRA	75	DF	56	AI g/ha	302	0.0	20 0	5 0	0.0
						Mean =	0 0	11 7	7 7	0 0
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	103	0.0	20 0	18 0	5.0
						202	0 0	20 0	25 0	5.0
						304	0 0	20 0	18 0	5 0
						Mean =	0 0	20 0	20.3	5 0
4	UNTREATED CHECK	0	ND	0		104	0 0	0 0	0 0	0 0
						201	0 0	0 0	0 0	0 0
						303	0 0	0 0	0 0	0 0
						Mean =	0 0	0 0	0 0	0 0

COMMON ST. AUGUSTINEGRASS INJURY - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 3 Investigator: Matt Shipp

BAYER code					STPSE	STPSE	STPSE	STPSE
EVALUATION type					PTOX%SV	PTOX%SV	PTOX%SV	PTOX%SV
RATING date					4-7-98	4-14-98	4-21-98	5-5-98
VARIETY					COMMON	COMMON	COMMON	COMMON
TRT-EVAL Interval					7 DAT	14 DAT	21 DAT	35 DAT
Trt No. Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit				
1 MCPP-AMINE	4	EC	840	AI g/ha	0.0 a	7 3 bc	4 3 b	0 0 b
1 2,4-D AMINE	1 258	SL	280	AI g/ha				
1 HARMONY EXTRA	75	DF	33	AI g/ha				
2 MCPP-AMINE	4	EC	840	AI g/ha	0 0 a	11 7 ab	7 7 b	0 0 b
2 2,4-D AMINE	1 258	SL	280	AI g/ha				
2 HARMONY EXTRA	75	DF	56	AI g/ha				
3 TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	0 0 a	20 0 a	20 3 a	5 0 a
4 UNTREATED CHECK	0	ND	0		0 0 a	0 0 c	0 0 b	0 0 b
LSD (P= 05)					0 00	8 85	7 73	0 00
Standard Deviation					0 00	4 43	3 87	0 00
CV					0 0	45 45	47 87	0 0
Replicate F					0 000	2 075	0 273	0 000
Replicate Prob(F)					1 0000	0 2066	0 7703	1 0000
Treatment F					0 000	10 675	15 338	0 000
Treatment Prob(F)					1 0000	0 0081	0 0032	1 0000

Means followed by same letter do not significantly differ (P= 05, LSD)

COMMON ST. AUGUSTINEGRASS INJURY - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 4
Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot	STPSE PTOX%SV 7-1-00 COMMON 7 DAT	STPSE PTOX%SV 7-8-00 COMMON 14 DAT	STPSE PTOX%SV 7-15-00 COMMON 21 DAT	STPSE PTOX%SV 7-22-00 COMMON 28 DAT	STPSE PTOX%SV 7-29-00 COMMON 35 DAT	STPSE PTOX%SV 8-5-00 COMMON 42 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	101	0.0	0.0	5.0	7.0	4.0	0.0
1	2,4-D AMINE	1.258	SL	280	AI g/ha	204	0.0	0.0	0.0	0.0	0.0	0.0
1	HARMONY EXTRA	75	DF	33	AI g/ha	301	0.0	0.0	0.0	0.0	0.0	0.0
						Mean =	0.0	0.0	1.7	2.3	1.3	0.0
2	MCPP-AMINE	4	EC	840	AI g/ha	102	0.0	5.0	10.0	15.0	15.0	15.0
2	2,4-D AMINE	1.258	SL	280	AI g/ha	203	0.0	0.0	0.0	0.0	0.0	0.0
2	HARMONY EXTRA	75	DF	67	AI g/ha	302	0.0	0.0	0.0	0.0	0.0	0.0
						Mean =	0.0	1.7	3.3	5.0	5.0	5.0
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	103	0.0	0.0	0.0	5.0	10.0	12.0
						202	0.0	0.0	0.0	5.0	10.0	12.0
						304	1.0	2.0	3.0	10.0	12.0	10.0
						Mean =	0.3	0.7	1.0	6.7	10.7	11.3
4	UNTREATED CHECK	0	ND	0		104	0.0	0.0	0.0	0.0	0.0	0.0
						201	0.0	0.0	0.0	0.0	0.0	0.0
						303	0.0	0.0	0.0	0.0	0.0	0.0
						Mean =	0.0	0.0	0.0	0.0	0.0	0.0

Header rows: BAYER code; EVALUATION type; RATING date; VARIETY; TRT-EVAL Interval

COMMON ST. AUGUSTINEGRASS INJURY - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 4 Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	STPSE PTOX%SV 7-1-00 COMMON 7 DAT	STPSE PTOX%SV 7-8-00 COMMON 14 DAT	STPSE PTOX%SV 7-15-00 COMMON 21 DAT	STPSE PTOX%SV 7-22-00 COMMON 28 DAT	STPSE PTOX%SV 7-29-00 COMMON 35 DAT	STPSE PTOX%SV 8-5-00 COMMON 42 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	0.0 a	0 0 a	1 7 a	2.3 a	1 3 b	0.0 b
1	2,4-D AMINE	1 258	SL	280	AI g/ha						
1	HARMONY EXTRA	75	DF	33	AI g/ha						
2	MCPP-AMINE	4	EC	840	AI g/ha	0 0 a	1 7 a	3.3 a	5 0 a	5 0 ab	5 0 ab
2	2,4-D AMINE	1 258	SL	280	AI g/ha						
2	HARMONY EXTRA	75	DF	67	AI g/ha						
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	0.3 a	0 7 a	1 0 a	6 7 a	10 7 a	11 3 a
4	UNTREATED CHECK	0	ND	0		0 0 a	0 0 a	0 0 a	0 0 a	0 0 b	0 0 b
	LSD (P= 05)					0 58	3 28	6 20	9.40	8 51	8 54
	Standard Deviation					0 29	1 64	3 10	4 71	4 26	4 27
	CV					346 41	281 4	206 98	134.43	100 21	104 62
	Replicate F					1 000	0 588	1 634	1 502	1 502	1 183
	Replicate Prob(F)					0 4219	0 5847	0 2713	0 2959	0 2958	0 3690
	Treatment F					1 000	0 691	0 611	1 169	3 766	4 753
	Treatment Prob(F)					0 4547	0 5902	0 6322	0.3964	0 0785	0 0501

Means followed by same letter do not significantly differ (P= 05, LSD)

COMMON CENTIPEDEGRASS INJURY - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 5 Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot	STPSE PTOX%SV 4-7-98 COMMON 7 DAT	STPSE PTOX%SV 4-14-98 COMMON 14 DAT	STPSE PTOX%SV 4-21-98 COMMON 21 DAT	STPSE PTOX%SV 5-5-98 COMMON 35 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	101	0 0	10 0	3 0	0 0
1	2,4-D AMINE	1 258	SL	280	AI g/ha	204	0 0	5 0	5 0	0 0
1	HARMONY EXTRA	75	DF	33	AI g/ha	301	0 0	8 0	5 0	0 0
						Mean =	0 0	7 7	4 3	0 0
2	MCPP-AMINE	4	EC	840	AI g/ha	102	0 0	5 0	5.0	0.0
2	2,4-D AMINE	1 258	SL	280	AI g/ha	203	0 0	12 0	10 0	0 0
2	HARMONY EXTRA	75	DF	56	AI g/ha	302	0 0	8 0	5 0	0 0
						Mean =	0 0	8 3	6.7	0 0
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	103	0 0	0 0	0 0	0 0
						202	0 0	0 0	0 0	0 0
						304	0 0	0 0	0 0	0 0
						Mean =	0 0	0 0	0 0	0 0
4	UNTREATED CHECK	0	ND	0		104	0 0	0 0	0 0	0 0
						201	0 0	0 0	0 0	0 0
						303	0 0	0 0	0 0	0 0
						Mean =	0 0	0 0	0 0	0 0

COMMON CENTIPEDEGRASS INJURY - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 5
Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	STPSE PTOX%SV 4-7-98 COMMON 7 DAT	STPSE PTOX%SV 4-14-98 COMMON 14 DAT	STPSE PTOX%SV 4-21-98 COMMON 21 DAT	STPSE PTOX%SV 5-5-98 COMMON 35 DAT
	BAYER code					STPSE	STPSE	STPSE	STPSE
	EVALUATION type					PTOX%SV	PTOX%SV	PTOX%SV	PTOX%SV
	RATING date					4-7-98	4-14-98	4-21-98	5-5-98
	VARIETY					COMMON	COMMON	COMMON	COMMON
	TRT-EVAL Interval					7 DAT	14 DAT	21 DAT	35 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	0 0 a	7 7 a	4 3 a	0 0 a
1	2,4-D AMINE	1 258	SL	280	AI g/ha				
1	HARMONY EXTRA	75	DF	33	AI g/ha				
2	MCPP-AMINE	4	EC	840	AI g/ha	0 0 a	8 3 a	6 7 a	0 0 a
2	2,4-D AMINE	1 258	SL	280	AI g/ha				
2	HARMONY EXTRA	75	DF	56	AI g/ha				
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	0 0 a	0 0 b	0 0 b	0 0 a
4	UNTREATED CHECK	0	ND	0		0 0 a	0 0 b	0 0 b	0 0 a
	LSD (P= 05)					0 00	4 95	2 92	0 00
	Standard Deviation					0 00	2 48	1 46	0 00
	CV					0 0	61 94	53 18	0 0
	Replicate F					0 000	0 041	1 519	0 000
	Replicate Prob(F)					1 0000	0 9604	0 2925	1.0000
	Treatment F					0 000	10 462	15 416	0.000
	Treatment Prob(F)					1 0000	0 0085	0 0032	1 0000

Means followed by same letter do not significantly differ (P= 05, LSD)

COMMON CENTIPEDEGRASS INJURY - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 6
Investigator: Matt Chipp

BAYER code						STPSE	STPSE	STPSE	STPSE
EVALUATION type						PTOX%SV	PTOX%SV	PTOX%SV	PTOX%SV
RATING date						7-1-00	7-8-00	7-15-00	8-5-00
VARIETY						COMMON	COMMON	COMMON	COMMON
TRT-EVAL Interval						7 DAT	14 DAT	21 DAT	42 DAT
Trt No Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot				
1 MCPP-AMINE	4	EC	840	AI g/ha	101	0 0	3 0	3 0	0 0
1 2,4-D AMINE	1 258	SL	280	AI g/ha	204	0 0	0 0	2 0	0 0
1 HARMONY EXTRA	75	DF	33	AI g/ha	301	0.0	0 0	3 0	0 0
					Mean =	0 0	1 0	2 7	0 0
2 MCPP-AMINE	4	EC	840	AI g/ha	102	0 0	4 0	5 0	2 0
2 2,4-D AMINE	1 258	SL	280	AI g/ha	203	0 0	3 0	0 0	0 0
2 HARMONY EXTRA	75	DF	67	AI g/ha	302	0 0	0 0	0 0	0 0
					Mean =	0 0	2 3	1 7	0 7
3 TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	103	0 0	0 0	0 0	0 0
					202	0 0	0 0	0 0	0 0
					304	0 0	0 0	0 0	0 0
					Mean =	0 0	0 0	0 0	0 0
4 UNTREATED CHECK	0	ND	0		104	0 0	0 0	0 0	0 0
					201	0 0	0 0	0 0	0 0
					303	0 0	0 0	0 0	0 0
					Mean =	0 0	0 0	0 0	0 0

COMMON CENTIPEDEGRASS INJURY - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 6
Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	STPSE PTOX%SV 7-1-00 COMMON 7 DAT	STPSE PTOX%SV 7-8-00 COMMON 14 DAT	STPSE PTOX%SV 7-15-00 COMMON 21 DAT	STPSE PTOX%SV 8-5-00 COMMON 42 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	0 0 a	1 0 a	2 7 a	0 0 a
1	2,4-D AMINE	1 258	SL	280	AI g/ha				
1	HARMONY EXTRA	75	DF	33	AI g/ha				
2	MCPP-AMINE	4	EC	840	AI g/ha	0 0 a	2 3 a	1 7 a	0 7 a
2	2,4-D AMINE	1 258	SL	280	AI g/ha				
2	HARMONY EXTRA	75	DF	67	AI g/ha				
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	0 0 a	0 0 a	0 0 a	0 0 a
4	UNTREATED CHECK	0	ND	0		0 0 a	0 0 a	0 0 a	0 0 a
LSD (P= 05)						0 00	2 38	2 85	1 15
Standard Deviation						0 00	1 19	1 42	0 58
CV						0 0	142 83	131.45	346 41
Replicate F						0 000	2 176	1 274	1 000
Replicate Prob(F)						1 0000	0 1947	0 3458	0 4219
Treatment F						0 000	2 588	2 562	1 000
Treatment Prob(F)						1 0000	0 1484	0 1507	0 4547

Means followed by same letter do not significantly differ (P= 05, LSD)

COMMON BERMUDAGRASS INJURY - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 7 Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot	CYNDA PTOX%SEV 4-24-98 COMMON 7 DAT	CYNDA PTOX%SEV 5-1-98 COMMON 14 DAT	CYNDA PTOX%SEV 5-8-98 COMMON 21 DAT	CYNDA PTOX%SEV 5-15-98 COMMON 28 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	101	0 0	0 0	0.0	0 0
1	2,4-D AMINE	1 258	SL	280	AI g/ha	203	0.0	0 0	0 0	0 0
1	HARMONY EXTRA	75	DF	33	AI g/ha	304	0 0	0 0	0 0	0 0
						Mean =	0 0	0 0	0 0	0 0
2	MCPP-AMINE	4	EC	840	AI g/ha	102	0 0	0 0	0 0	0 0
2	2,4-D AMINE	1 258	SL	280	AI g/ha	201	0 0	0 0	0 0	0 0
2	HARMONY EXTRA	75	DF	56	AI g/ha	302	0 0	0 0	0 0	0 0
						Mean =	0 0	0 0	0 0	0 0
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	103	0 0	0 0	0 0	0 0
						205	0 0	0 0	0 0	0 0
						303	0 0	0 0	0 0	0 0
						Mean =	0 0	0 0	0 0	0 0
4	TRIMEC SOUTHERN	1.06	SL	2038	AI g/ha	104	0 0	0 0	0 0	0 0
						202	0 0	0 0	0 0	0 0
						305	0 0	0 0	0 0	0 0
						Mean =	0 0	0 0	0 0	0 0
5	UNTREATED CHECK	0	ND	0		105	0 0	0 0	0 0	0 0
						204	0 0	0 0	0 0	0 0
						301	0 0	0 0	0 0	0 0
						Mean =	0 0	0 0	0 0	0 0

COMMON BERMUDAGRASS INJURY - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 7 Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit				
	BAYER code					CYNDA	CYNDA	CYNDA	CYNDA
	EVALUATION type					PTOX%SEV	PTOX%SEV	PTOX%SEV	PTOX%SEV
	RATING date					4-24-98	5-1-98	5-8-98	5-15-98
	VARIETY					COMMON	COMMON	COMMON	COMMON
	TRT-EVAL Interval					7 DAT	14 DAT	21 DAT	28 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	0 0 a	0 0 a	0 0 a	0 0 a
1	2,4-D AMINE	1 258	SL	280	AI g/ha				
1	HARMONY EXTRA	75	DF	33	AI g/ha				
2	MCPP-AMINE	4	EC	840	AI g/ha	0 0 a	0 0 a	0 0 a	0 0 a
2	2,4-D AMINE	1 258	SL	280	AI g/ha				
2	HARMONY EXTRA	75	DF	56	AI g/ha				
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	0 0 a	0 0 a	0 0 a	0 0 a
4	TRIMEC SOUTHERN	1 06	SL	2038	AI g/ha	0 0 a	0 0 a	0 0 a	0 0 a
5	UNTREATED CHECK	0	ND	0		0 0 a	0 0 a	0 0 a	0 0 a
	LSD (P= 05)					0 00	0 00	0 00	0 00
	Standard Deviation					0 00	0 00	0 00	0 00
	CV					0 0	0 0	0 0	0 0
	Replicate F					0 000	0 000	0 000	0 000
	Replicate Prob(F)					1 0000	1 0000	1 0000	1 0000
	Treatment F					0 000	0 000	0 000	0 000
	Treatment Prob(F)					1 0000	1 0000	1 0000	1 0000

Means followed by same letter do not significantly differ (P= 05, LSD)

COMMON BERMUDAGRASS INJURY - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 5 Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot	CYNDA	CYNDA	CYNDA	CYNDA
	BAYER code						CYNDA	CYNDA	CYNDA	CYNDA
	EVALUATION type						PTOX%SV	PTOX%SV	PTOX%SV	PTOX%SV
	RATING date						7-1-00	7-8-00	7-15-00	8-5-00
	VARIETY						COMMON	COMMON	COMMON	COMMON
	TRT-EVAL Interval						7 DAT	14 DAT	21 DAT	42 DAT
1	MCPP AMINE 4M	4	EC	840	AI g/ha	101	0.0	0.0	0.0	0.0
1	SF19403	1.258	SL	280	AI g/ha	203	0.0	0.0	0.0	0.0
1	HARMONY EXTRA	75	DF	33	AI g/ha	304	0.0	0.0	0.0	0.0
						Mean =	0.0	0.0	0.0	0.0
2	MCPP AMINE 4M	4	EC	840	AI g/ha	102	0.0	0.0	0.0	0.0
2	SF19403	1.258	SL	280	AI g/ha	204	0.0	0.0	0.0	0.0
2	HARMONY EXTRA	75	DF	67	AI g/ha	301	0.0	0.0	0.0	0.0
						Mean =	0.0	0.0	0.0	0.0
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	103	0.0	0.0	0.0	0.0
						202	0.0	0.0	0.0	0.0
						303	0.0	0.0	0.0	0.0
						Mean =	0.0	0.0	0.0	0.0
4	TRIMEC SOUTHERN	1.06	SL	2038	AI g/ha	104	5.0	7.0	5.0	3.0
						205	5.0	10.0	7.0	5.0
						302	5.0	10.0	8.0	6.0
						Mean =	5.0	9.0	6.7	4.7
5	UNTREATED CHECK	0	ND	0		105	0.0	0.0	0.0	0.0
						201	0.0	0.0	0.0	0.0
						305	0.0	0.0	0.0	0.0
						Mean =	0.0	0.0	0.0	0.0

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COMMON BERMUDAGRASS INJURY - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 8
Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	CYNDA PTOX%SV 7-1-00 COMMON 7 DAT	CYNDA PTOX%SV 7-8-00 COMMON 14 DAT	CYNDA PTOX%SV 7-15-00 COMMON 21 DAT	CYNDA PTOX%SV 8-5-00 COMMON 42 DAT
1	MCPP AMINE 4M	4	EC	840	AI g/ha	0 0 b	0.0 b	0 0 b	0 0 b
1	SF19403	1 258	SL	280	AI g/ha				
1	HARMONY EXTRA	75	DF	33	AI g/ha				
2	MCPP AMINE 4M	4	EC	840	AI g/ha	0 0 b	0 0 b	0 0 b	0 0 b
2	SF19403	1 258	SL	280	AI g/ha				
2	HARMCNY EXTRA	75	DF	67	AI g/ha				
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	0 0 b	0 0 b	0 0 b	0 0 b
4	TRIMEC SOUTHERN	1 06	SL	2038	AI g/ha	5 0 a	9 0 a	6 7 a	4 7 a
5	UNTREATED CHECK	0	ND	0		0 0 b	0 0 b	0 0 b	0 0 b
	LSD (P= 05)					0 00	1 46	1.29	1 29
	Standard Deviation					0 00	0 77	0 68	0 68
	CV					0 0	43 03	51 23	73 19
	Replicate F					0 000	1 000	1 000	1 000
	Replicate Prob(F)					1 0000	0 4096	0 4096	0 4096
	Treatment F					0 000	81 000	57 143	28 000
	Treatment Prob(F)					1 0000	0 0001	0 0001	0 0001

Means followed by same letter do not significantly differ (P= 05, LSD)

WHITE CLOVER CONTROL - 1998
Protocol Number: 00-00-00-00
EXPERIMENT #: 9 Investigator: Matt Shipp

BAYER code EVALUATION type RATING date TRT-EVAL Interval							TRFRE %GRDCOVR 1-23-97 0 DAT	TRFRE % CTRL 2-2-98 10 DAT	TRFRE % CTRL 2-6-98 14 DAT	TRFRE % CTRL 2-14-98 22 DAT	TRFRE % CTRL 2-24-98 32 DAT	TRFRE % CTRL 3-6-98 42 DAT	TRFRE %GRDCOVR 3-13-98 49 DAT	TRFRE %GRDCOVR 3-13-98 49 DAT
Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot								
1	MCPP AMINE 4M	4	EC	840	AI g/ha	101	40 0	30 0	35 0	60 0	80 0	95 0	0 10	99 80
1	SF19403	1 258	SL	280	AI g/ha	203	100 0	30 0	35 0	55 0	72 0	78 0	1 00	99 00
1	HARMONY EXTRA	75	DF	33	AI g/ha	303	85 0	30 0	40 0	60 0	85 0	97 0	0 10	99 90
						Mean =	75 0	30 0	36 7	58 3	79 0	90 0	0 40	99 57
2	MCPP AMINE 4M	4	EC	840	AI g/ha	102	100 0	25 0	25 0	50 0	75 0	85 0	1 50	98 50
2	SF19403	1 258	SL	280	AI g/ha	202	100 0	20 0	25 0	35 0	65 0	75 0	2 00	98 00
2	HARMONY EXTRA	75	DF	67	AI g/ha	301	99 0	25 0	35 0	60 0	85 0	97 0	0 20	99.80
						Mean =	99 7	23 3	28 3	48 3	75 0	85 7	1 23	98 77
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	103	100 0	25 0	30 0	40 0	85 0	97 0	0 10	99 90
						201	99 0	25 0	30 0	45 0	70 0	88 0	0 70	99 30
						304	98 0	25 0	25 0	40 0	68 0	75 0	0 50	99 50
						Mean =	99 0	25 0	28 3	41 7	74 3	86 7	0 43	99 57
4	UNTREATED CHECK	0	ND			104	90 0	0 0	0 0	0 0	0 0	0 0	98 00	-8 90
						204	100 0	0 0	0 0	0 0	0 0	0 0	99 00	1 00
						302	80 0	0 0	0 0	0 0	0 0	0 0	50 00	37 50
						Mean =	90 0	0 0	0 0	0 0	0 0	0 0	82 33	9 87

WHITE CLOVER CONTROL - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 9 Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE
	EVALUATION type					%GRDCOVR	% CTRL	% CTRL	% CTRL	% CTRL	% CTRL	%GRDCOVR	%GRDCOVR
	RATING date					1-23-97	2-2-98	2-6-98	2-14-98	2-24-98	3-6-98	3-13-98	3-13-98
	TRT-EVAL Interval					0 DAT	10 DAT	14 DAT	22 DAT	32 DAT	42 DAT	49 DAT	49 DAT
1	MCPP AMINE 4M	4	EC	840	AI g/ha	75 0 a	30 0 a	36 7 a	58 3 a	79 0 a	90 0 a	0 40 b	99 57 a
1	SF19403	1 258	SL	280	AI g/ha								
1	HARMONY EXTRA	75	DF	33	AI g/ha								
2	MCPP AMINE 4M	4	EC	840	AI g/ha	99 7 a	23 3 b	28 3 b	48 3 ab	75 0 a	85 7 a	1 23 b	98 77 a
2	SF19403	1 258	SL	280	AI g/ha								
2	HARMONY EXTRA	75	DF	67	AI g/ha								
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	99 0 a	25 0 b	28 3 b	41 7 b	74 3 a	86 7 a	0 43 b	99 57 a
4	UNTREATED CHECK	0	ND			90 0 a	0 0 c	0 0 c	0 0 c	0 0 b	0 0 b	82 33 a	9 87 b
	LSD (P= 05)					32 18	2 88	7 45	13 42	13 83	18 72	27 620	24 126
	Standard Deviation					16 11	1 44	3 73	6 72	6 92	9 37	13 824	12 075
	CV					17 72	7 37	15 97	18 12	12 13	14 29	65 52	15 69
	Replicate F					1 149	1 000	0 600	0 877	1 786	1 018	1 111	1 104
	Replicate Prob(F)					0 3780	0 4219	0 5787	0 4633	0 2463	0 4163	0 3887	0 3906
	Treatment F					1 527	257 000	55 600	43 738	90 937	65 452	26 162	41 143
	Treatment Prob(F)					0 3011	0 0001	0 0001	0 0002	0 0001	0 0001	0 0008	0 0002

Note: the first header row is BAYER code (TRFRE).

Means followed by same letter do not significantly differ (P= 05, LSD)

WHITE CLOVER CONTROL - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 10

Investigator: Matt Shipp

BAYER code							TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE
EVALUATION type							%GRDCOVR	% CTRL	% CTRL	% CTRL	% CTRL	% CTRL	% CTRL	%GRDCOVR	%POSTCTL
RATING date							6-24-00	7-1-00	7-8-00	7-15-00	7-22-00	7-29-00	8-5-00	8-5-00	8-5-00
TRT-EVAL Interval							Pre-rate	7 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	42 DAT	42 DAT
Trt No.	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot									
1	MCPP AMINE 4M	4	EC	840	AI g/ha	101	40.0	10.0	25.0	35.0	62.0	90.0	97.0	2.0	95.0
1	SF19403	1.258	SL	280	AI g/ha	203	60.0	12.0	20.0	38.0	65.0	85.0	97.0	2.0	97.0
1	HARMONY EXTRA	75	DF	33	AI g/ha	304	40.0	10.0	20.0	40.0	55.0	88.0	96.0	2.0	95.0
						Mean =	46.7	10.7	21.7	37.7	60.7	87.7	96.7	2.0	95.7
2	MCPP AMINE 4M	4	EC	840	AI g/ha	102	50.0	12.0	25.0	40.0	62.0	90.0	98.0	2.0	96.0
2	SF19403	1.258	SL	280	AI g/ha	204	50.0	12.0	25.0	40.0	60.0	90.0	96.0	2.0	96.0
2	HARMONY EXTRA	75	DF	67	AI g/ha	301	35.0	12.0	25.0	35.0	55.0	85.0	98.0	1.0	97.0
						Mean =	45.0	12.0	25.0	38.3	59.0	88.3	97.3	1.7	96.3
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	103	50.0	15.0	30.0	45.0	65.0	90.0	99.0	2.0	96.0
						202	35.0	15.0	27.0	40.0	60.0	90.0	98.0	1.0	97.0
						303	30.0	15.0	30.0	36.0	55.0	95.0	99.0	1.0	97.0
						Mean =	38.3	15.0	29.0	40.3	60.0	91.7	98.7	1.3	96.7
4	UNTREATED CHECK	0	ND	0		104	50.0	0.0	0.0	0.0	0.0	0.0	0.0	55.0	0.0
						201	45.0	0.0	0.0	0.0	0.0	0.0	0.0	47.0	0.0
						302	40.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0
						Mean =	45.0	0.0	0.0	0.0	0.0	0.0	0.0	50.7	0.0

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WHITE CLOVER CONTROL - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 10

Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE	TRFRE
	EVALUATION type					%GRDCOVR	% CTRL	% CTRL	% CTRL	% CTRL	% CTRL	% CTRL	%GRDCOVR	%POSTCTL
	RATING date					6-24-00	7-1-00	7-8-00	7-15-00	7-22-00	7-29-00	8-5-00	8-5-00	8-5-00
	TRT-EVAL Interval					Pre-rate	7 DAT	14 DAT	21 DAT	28 DAT	35 DAT	42 DAT	42 DAT	42 DAT
1	MCPP AMINE 4M	4	EC	840	Al g/ha	46.7 a	10 7 c	21 7 c	37 7 a	60.7 a	87 7 a	96 7 b	2 0 b	95 7 a
1	SF19403	1 258	SL	280	Al g/ha									
1	HARMONY EXTRA	75	DF	33	Al g/ha									
2	MCPP AMINE 4M	4	EC	840	Al g/ha	45.0 a	12 0 b	25 0 b	38 3 a	59 0 a	88 3 a	97 3 ab	1 7 b	96 3 a
2	SF19403	1 258	SL	280	Al g/ha									
2	HARMONY EXTRA	75	DF	67	Al g/ha									
3	TRIMEC SOUTHERN	1 06	SL	1019	Al g/ha	38 3 a	15 0 a	29 0 a	40 3 a	60 0 a	91 7 a	98 7 a	1 3 b	96 7 a
4	UNTREATED CHECK	0	ND	0		45 0 a	0 0 d	0 0 d	0 0 b	0 0 b	0 0 b	0 0 c	50 7 a	0 0 b
	LSD (P= 05)					15 17	1 15	3 11	6 26	5 53	5 34	1 37	3 90	1 37
	Standard Deviation					7 59	0 58	1 55	3 13	2 77	2 67	0 69	1 95	0 69
	CV					17 35	6 13	8 22	10 77	6 16	3 99	0 94	14 02	0 95
	Replicate F					2 928	1 000	1 690	0 569	5 391	0 222	1 235	1 467	1 235
	Replicate Prob(F)					0 1296	0 4219	0 2618	0 5937	0 0457	0 8074	0 3554	0 3029	0 3554
	Treatment F					0 711	384 250	208 586	115 408	351 054	837 615	15119 770	473 248	14706 120
	Treatment Prob(F)					0 5801	0 0001	0 0001	0 0001	0 0001	0 0001	0 0001	0 0001	0 0001

(First header row: BAYER code.)

Means followed by same letter do not significantly differ (P= 05, LSD)

LAWN BURWEED CONTROL - 1998
Protocol Number: 00-00-00-00
EXPERIMENT #: 11

Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot	SOVPT %GRDCOVR 1-30-98 0 DAT	SOVPT % CTRL 2-6-98 7 DAT	SOVPT % CTRL 2-20-98 21 DAT	SOVPT % CTRL 3-6-98 35 DAT	SOVPT % CTRL 3-27-98 56 DAT	SOVPT %GRDCOVR 4-3-98 63 DAT	SOVPT %POSTCTL 4-3-98 63 DAT
1	MCPP AMINE 4M	4	EC	840	AI g/ha	101	95 0	5.0	10 0	20.0	50 0	35 0	63 160
1	SF19403	1 258	SL	280	AI g/ha	203	94 0	3.0	5 0	20.0	45 0	25 0	73 400
1	HARMONY EXTRA	75	DF	33	AI g/ha	304	91.0	3 0	5 0	20.0	45.0	20 0	78.020
						Mean =	93 3	3.7	6 7	20 0	46 7	26.7	71 527
2	MCPP AMINE 4M	4	EC	840	AI g/ha	102	96 0	1 0	3 0	15.0	25 0	40.0	58.330
2	SF19403	1 258	SL	280	AI g/ha	204	96.0	5.0	3 0	25 0	45.0	35 0	63.540
2	HARMONY EXTRA	75	DF	67	AI g/ha	301	97 0	1 0	3 0	20.0	25 0	35.0	63.920
						Mean =	96.3	2 3	3 0	20.0	31 7	36 7	61 930
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	103	92 0	4 0	5 0	20 0	60 0	25.0	72 830
						201	97 0	3 0	3 0	8 0	20 0	50 0	48 450
						302	88 0	2 0	3 0	15 0	35 0	35 0	60 230
						Mean =	92 3	3 0	3 7	14 3	38 3	36.7	60.503
4	UNTREATED CHECK	0	ND	0		104	95 0	0 0	0 0	0 0	0 0	85 0	10 530
						202	95 0	0 0	0 0	0 0	0 0	95 0	0 000
						303	96 0	0 0	0 0	0 0	0 0	90 0	6 250
						Mean =	95 3	0 0	0 0	0 0	0 0	90 0	5 593

BAYER code / EVALUATION type / RATING date / TRT-EVAL Interval (header rows above data columns)

LAWN BURWEED CONTROL - 1998
Protocol Number:00-00-00-00
EXPERIMENT #: 11
Investigator: Matt Shipp

BAYER code						SOVPT	SOVPT	SOVPT	SOVPT	SOVPT	SOVPT	SOVPT
EVALUATION type						%GRDCOVR	% CTRL	% CTRL	% CTRL	% CTRL	%GRDCOVR	%POSTCTL
RATING date						1-30-98	2-6-98	2-20-98	3-6-98	3-27-98	4-3-98	4-3-98
TRT-EVAL Interval						0 DAT	7 DAT	21 DAT	35 DAT	56 DAT	63 DAT	63 DAT
Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit							
1	MCPP AMINE 4M	4	EC	840	AI g/ha	93.3 a	3 7 a	6 7 a	20 0 a	46.7 a	26 7 b	71 527 a
1	SF19403	1 258	SL	280	AI g/ha							
1	HARMONY EXTRA	75	DF	33	AI g/ha							
2	MCPP AMINE 4M	4	EC	840	AI g/ha	96 3 a	2.3 ab	3 0 b	20 0 a	31 7 a	36 7 b	61 930 a
2	SF19403	1 258	SL	280	AI g/ha							
2	HARMONY EXTRA	75	DF	67	AI g/ha							
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	92 3 a	3 0 a	3 7 b	14 3 a	38 3 a	36 7 b	60 503 a
4	UNTREATED CHECK	0	ND	0		95 3 a	0 0 b	0 0 c	0 0 b	0 0 b	90 0 a	5 593 b
LSD (P= 05)						5 03	2 81	2 73	9 01	25 41	16 57	16 5515
Standard Deviation						2 52	1 40	1 36	4 51	12 72	8 29	8.2842
CV						2 67	62 42	40 93	33 2	43 61	17 46	16 61
Replicate F						1 000	0 887	2 194	0 016	0 399	0 636	0 560
Replicate Prob(F)						0 4219	0 4596	0 1927	0 9838	0 6875	0 5615	0 5986
Treatment F						1 579	3 873	12 060	13 152	7 708	36 000	39 167
Treatment Prob(F)						0 2898	0 0745	0 0060	0 0048	0 0176	0 0003	0 0002

Means followed by same letter do not significantly differ (P= 05, LSD)

ANNUAL ASTER CONTROL - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 12

Investigator: Matt Shipp

Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot	ASTEX	ASTEX	ASTEX	ASTEX	ASTEX	ASTEX	ASTEX
	BAYER code						ASTEX	ASTEX	ASTEX	ASTEX	ASTEX	ASTEX	ASTEX
	EVALUATION type						%GRDCOVR	% CTRL	% CTRL	% CTRL	% CTRL	%GRDCOVR	%POSTCTL
	RATING date						6-24-00	7-1-00	7-8-00	7-15-00	8-5-00	8-5-00	8-5-00
	TRT-EVAL Interval						Pre-rate	7 DAT	14 DAT	21 DAT	42 DAT	42 DAT	42 DAT
1	MCPP-AMINE	4	EC	840	AI g/ha	101	50.0	1.0	2.0	3.0	9.0	55.0	0.00
1	2,4-D AMINE	1.258	SL	280	AI g/ha	203	65.0	1.0	2.0	3.0	7.0	55.0	15.40
1	HARMONY EXTRA	75	DF	33	AI g/ha	304	85.0	1.0	2.0	2.0	9.0	72.0	15.30
						Mean =	66.7	1.0	2.0	2.7	8.3	60.7	10.23
2	MCPP-AMINE	4	EC	840	AI g/ha	102	40.0	1.0	2.0	3.0	9.0	35.0	12.50
2	2,4-D AMINE	1.258	SL	280	AI g/ha	201	60.0	1.0	2.0	3.0	8.0	45.0	25.00
2	HARMONY EXTRA	75	DF	56	AI g/ha	302	35.0	1.0	2.0	3.0	10.0	35.0	0.00
						Mean =	45.0	1.0	2.0	3.0	9.0	38.3	12.50
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	103	40.0	2.0	3.0	5.0	12.0	36.0	10.00
						205	70.0	1.0	1.0	2.0	8.0	60.0	14.30
						303	50.0	1.0	2.0	3.0	8.0	45.0	10.00
						Mean =	53.3	1.3	2.0	3.3	9.3	47.0	11.43
4	TRIMEC SOUTHERN	1.06	SL	2038	AI g/ha	104	60.0	4.0	7.0	9.0	18.0	50.0	16.70
						202	65.0	3.0	5.0	8.0	14.0	58.0	10.80
						305	45.0	3.0	7.0	9.0	18.0	30.0	33.30
						Mean =	56.7	3.3	6.3	8.7	16.7	46.0	20.27
5	UNTREATED CHECK	0	ND	0		105	85.0	0.0	0.0	0.0	0.0	88.0	0.00
						204	65.0	0.0	0.0	0.0	0.0	70.0	0.00
						301	80.0	0.0	0.0	0.0	0.0	82.0	0.00
						Mean =	76.7	0.0	0.0	0.0	0.0	80.0	0.00

ANNUAL ASTER CONTROL - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 12

Investigator: Matt Shipp

Trt No.	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	ASTEX %GRDCOVR 6-24-00 Pre-rate	ASTEX % CTRL 7-1-00 7 DAT	ASTEX % CTRL 7-8-00 14 DAT	ASTEX % CTRL 7-15-00 21 DAT	ASTEX % CTRL 8-5-00 42 DAT	ASTEX %GRDCOVR 8-5-00 42 DAT	ASTEX %POSTCTL 8-5-00 42 DAT
	BAYER code / EVALUATION type / RATING date / TRT-EVAL Interval											
1	MCPP-AMINE	4	EC	840	AI g/ha	66.7 ab	1 0 b	2 0 b	2.7 b	8.3 b	60.7 ab	10.23 ab
1	2,4-D AMINE	1.258	SL	280	AI g/ha							
1	HARMONY EXTRA	75	DF	33	AI g/ha							
2	MCPP-AMINE	4	EC	840	AI g/ha	45 0 b	1.0 b	2 0 b	3 0 b	9.0 b	38 3 c	12 50 ab
2	2,4-D AMINE	1.258	SL	280	AI g/ha							
2	HARMONY EXTRA	75	DF	56	AI g/ha							
3	TRIMEC SOUTHERN	1 06	SL	1019	AI g/ha	53 3 ab	1 3 b	2 0 b	3 3 b	9 3 b	47 0 bc	11 43 ab
4	TRIMEC SOUTHERN	1 06	SL	2038	AI g/ha	56.7 ab	3 3 a	6 3 a	8 7 a	16 7 a	46 0 bc	20 27 a
5	UNTREATED CHECK	0	ND	0		76 7 a	0 0 c	0 0 c	0 0 c	0 0 c	80 0 a	0 00 b
	LSD (P= 05)					26 74	0 60	1 14	1 38	2 41	21 68	17.356
	Standard Deviation					14 20	0 32	0.61	0.73	1 28	11 51	9.218
	CV					23 8	23.72	24 55	20 67	14.75	21.16	84 67
	Replicate F					0 628	2 667	2 364	1 625	3 959	0 290	0 438
	Replicate Prob(F)					0 5580	0 1296	0 1561	0 2557	0 0638	0 7560	0 6601
	Treatment F					2 240	45 000	44 364	56 125	64 184	6 099	1 852
	Treatment Prob(F)					0 1542	0 0001	0 0001	0 0001	0 0001	0 0149	0 2124

Means followed by same letter do not significantly differ (P= 05, LSD)

BRISTLY MALLOW CONTROL - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 13

Investigator: Matt Shipp

BAYER code							MODCA	MODCA	MODCA	MODCA	MODCA	MODCA
EVALUATION type							%GRDCOVR	% CTRL	% CTRL	% CTRL	%GRDCOVR	%POSTCTL
RATING date							6-26-00	7-3-00	7-10-00	7-17-00	7-17-00	7-17-00
TRT-EVAL Interval							Pre-rate	7 DAT	14 DAT	21 DAT	21 DAT	21 DAT
Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit	Plot						
1	MCPP AMINE 4M	4	EC	840	AI g/ha	101	70 0	30 0	80.0	96.0	3 0	96.0
1	SF19403	1 258	SL	280	AI g/ha	203	93 0	30 0	80 0	95 0	3 0	97 0
1	HARMONY EXTRA	75	DF	33	AI g/ha	304	70 0	40 0	95 0	99.0	1 0	99 0
						Mean =	77 7	33 3	85.0	96 7	2.3	97 3
2	MCPP AMINE 4M	4	EC	840	AI g/ha	102	60 0	40 0	85 0	98 0	1 0	98.0
2	SF19403	1.258	SL	280	AI g/ha	204	95 0	35 0	85 0	97 0	2 0	98.0
2	HARMONY EXTRA	75	DF	67	AI g/ha	301	40.0	35.0	88.0	97 0	2.0	95.0
						Mean =	65.0	36 7	86 0	97 3	1.7	97 0
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	103	55 0	50 0	95 0	99 0	1 0	98 0
						202	90 0	45 0	85 0	99 0	1 0	99 0
						303	80 0	40 0	95 0	98 0	2 0	98 0
						Mean =	75 0	45 0	91 7	98 7	1 3	98 3
4	UNTREATED CHECK	0	ND	0		104	50 0	0 0	0 0	0 0	55 0	0.0
						201	50 0	0 0	0 0	0 0	60 0	0 0
						302	70 0	0 0	0 0	0 0	75 0	0 0
						Mean =	56 7	0 0	0 0	0 0	63 3	0 0

BRISTLY MALLOW CONTROL - 2000
Protocol Number:00-00-00-00
EXPERIMENT #: 13 Investigator: Matt Shipp

BAYER code						MODCA	MODCA	MODCA	MODCA	MODCA	MODCA
EVALUATION type						%GRDCOVR	% CTRL	% CTRL	% CTRL	%GRDCOVR	%POSTCTL
RATING date						6-26-00	7-3-00	7-10-00	7-17-00	7-17-00	7-17-00
TRT-EVAL Interval						Pre-rate	7 DAT	14 DAT	21 DAT	21 DAT	21 DAT
Trt No	Treatment Name	Form Amt	Fm Ds	Rate	Rate Unit						
1	MCPP AMINE 4M	4	EC	840	AI g/ha	77 7 a	33 3 b	85 0 a	96 7 a	2.3 b	97 3 a
1	SF19403	1 258	SL	280	AI g/ha						
1	HARMONY EXTRA	75	DF	33	AI g/ha						
2	MCPP AMINE 4M	4	EC	840	AI g/ha	65 0 a	36.7 ab	86 0 a	97 3 a	1 7 b	97 0 a
2	SF19403	1 258	SL	280	AI g/ha						
2	HARMONY EXTRA	75	DF	67	AI g/ha						
3	TRIMEC SOUTHERN	1.06	SL	1019	AI g/ha	75.0 a	45 0 a	91 7 a	98 7 a	1 3 b	98 3 a
4	UNTREATED CHECK	0	ND	0		56.7 a	0 0 c	0 0 b	0 0 b	63 3 a	0 0 b
LSD (P= 05)						33 24	8 97	9 01	2 42	10 57	2 66
Standard Deviation						16 64	4 49	4 51	1.21	5 29	1 33
CV						24 26	15 61	6 87	1 66	30 82	1 82
Replicate F						2.092	0 310	2 475	0 396	0 940	0 188
Replicate Prob(F)						0 2046	0 7443	0 1645	0 6892	0 4413	0 8337
Treatment F						1 006	58 310	284 033	4849 736	101 512	4015 563
Treatment Prob(F)						0 4525	0 0001	0 0001	0 0001	0 0001	0 0001

Means followed by same letter do not significantly differ (P= 05, LSD)

VITA

Matt Shipp graduated from Longview High School in 1990. He then attended Kilgore College for 3 years. In January of 1994, Matt enrolled at Texas A&M University in College Station earning a Bachelor of Science degree in Agronomy (Turfgrass Science emphasis) in December of 1996. While at Texas A&M he was a member of the Turf Club and Agriculture Student Council. Upon graduation, he took a job as Field Research Technician with The Solaris Group, a Lawn & Garden research division of The Monsanto Company, in Tyler, Texas. In spring of 1997, Matt entered the graduate school of Stephen F. Austin State University to pursue a Master of Science degree in Agriculture with an emphasis in Turfgrass Weed Science. In 1999, The Scotts Company acquired the Solaris Group, and Matt is presently Senior Research Specialist at the same location while concurrently completing work on his Master's thesis. The thesis was completed in May of 2001 to satisfy the requirements for Master's degree. Matt is a member of The American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, Weed Science Society of America, European Weed Research Society, and Botanical Society of America.

Permanent Address: 939 Magnolia Drive
Tyler, TX 75701-2140

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This thesis was typed by Matt Shipp.