

Research results in wheat and pasture indicate excellent crop tolerance to Rave. Rave's performance has been excellent on economically important weeds such as ALS-resistant Kochia, mustards, thistles, wild buckwheat, marshelder, western ragweed, and woolly croton.

Rave has the potential to slow the spread of ALS-resistant weed species and help prevent development of resistance in other species.

**GROUNDING, A DEPOSITION AGENT FOR SOIL APPLIED PESTICIDES.** J. M. Thomas, III, R. E. Mack, G. Volgas, and J. R. Roberts, Helena Chemical Company, Memphis, TN 38120.

#### ABSTRACT

Traditionally, adjuvants have been used with post-emergence herbicides to increase efficacy through better coverage or penetration of the leaf surface. Adjuvants have not been related to soil-applied herbicides. To be effective, soil-applied herbicides must reach the soil surface, stay in the target area, cover the target area, and should not injure the crop. With these parameters in mind, studies were established to evaluate HM9679-A (Grounding) as an adjuvant for soil-applied herbicides. Replicated small plot studies were initiated across the Southern states with various pre-emergence and pre-plant incorporated herbicides in soybeans. Herbicide use rates were the upper label rates for crop and soil type. HM9679-A was applied at 1 pt/A product tank-mixed with the herbicide. Herbicides included cloransulam at 0.75 oz/A applied pre-emergence, flumetsulam WDG at 1.33 oz/A applied pre-emergence, flumetsulam + metolachlor at 2.5 pt/A applied pre-emergence, pendimethalin 3.3 EC at 3 pt/A applied pre-plant incorporated, dimethenamid 6EC at 32 oz/A applied pre-emergence, metribuzin 4F at 1.25 pt/A applied pre-emergence, or clomazone 3ME at 2.5 pt/A applied pre-emergence.

One of the functions of HM9679-A is to reduce the amount of product being leached from the surface area of soil to a lower area below the germinating weeds and into the area where the crop is germinating resulting in possible crop injury. This was demonstrated in the lab using a pendimethalin solution leached through sand and the leachate collected in glass tubes. Without the HM9679-A, the yellow color was much more visible.

In Arkansas, the control of morningglory was improved for cloransulam and flumetsulam at 7 and 14 days after the treatment. Palmer amaranth (*Amaranthus palmeri*) control was improved for pendimethalin, flumetsulam + metolachlor, dimethenamid, and metribuzin especially at 28 days after treatment. In Tennessee, yellow nutsedge (*Cyperus esculentus*) and morningglory control was improved with clomazone, metribuzin, and pendimethalin again especially at 28 days after treatment. Also, redroot pigweed (*Amaranthus retroflexus*) control was improved with pendimethalin. In Louisiana, barnyardgrass (*Echinochloa crus-galli*) control was improved with pendimethalin and clomazone at 28 days after treatment. Hemp sesbania (*Sesbania exaltata*) control was improved at 14 days after treatment of metribuzin. Pitted morningglory (*Ipomoea lacunosa*) control was improved at 14 days after treatment with flumetsulam.

HM9679-A (Grounding) has shown efficacy improvement with soil-applied herbicides as well as reduced leaching through sandy soils. Additional work should include additional products and crops as well as various soil types.

**PESTICIDE SORPTION BY INORGANIC AMENDMENTS USED ON GOLF PUTTING GREENS.** G. Wehtje, R. H. Walker and J. N. Shaw. Alabama Agric. Exp. Stn., Auburn. AL 36849.

#### ABSTRACT

Adsorptive ability of seven inorganic amendments, which are used in golf putting greens, toward oxadiazon, fenarimol and imazaquin were evaluated using a soil solution technique. Amendments evaluated included Clinolite, Ecolite, Pro's Choice, Motan Plus, Isolite, Profile, Axis, and Green's Choice. These amendments are derived from various naturally-occurring deposits of zeolites, diatomaceous earths and/or clays; typically they are fired. Intent is to provide long-lived, stable, and uniform-sized, particle that can contribute favorable water- and nutrient-retention properties. Their use

includes incorporation into the media during greens construction and as a top dressing following mechanical arification. Amendments offer an alternative to sand/peat mixtures which are historically used for these purposes. Samples of the amendments were wetted to field capacity and spiked to 1 ppm (dry weight basis) with the aforementioned pesticides using both formulated and <sup>14</sup>C-labelled materials. Water was extracted by centrifugation after a 24-h equilibration period. Aliquots were subjected to quantification of radioactivity. Samples were rewetted with fresh water at a volume equivalent to that extracted. Five cycles of extraction, rewetting and equilibration were conducted over a five-day period. Sand, peat and a native soil (Dothan loamy sand) were included for comparative purposes. Amendments evaluated had considerable variation in CEC, surface area and field capacity. 'Retention' of pesticides (i.e. quantity not recovered in extracted solution) was also variable; but generally more than that of sand and frequently equivalent to peat. Calcium saturation reduced fenarimol 'retention' by at least 2% (Green's choice), and up to 56% (Clinolite). Pesticide 'retention' by amendments is probably the sum of both true adsorption and entrapment. Scanning electron microscopy revealed that the particles of some amendments are extremely porous. Since the addition of amendments to putting greens generally does not exceed 20% (v/v), their impact on pesticide performance is probably minimal. In the extreme, they can be considered as comparable to peat.

**CYANAZINE AND METOLACHLOR LOSSES IN SURFACE RUNOFF: EFFECTS OF SOIL TYPE AND PRECIPITATION TIMING.** S. M. Schraer, D. R. Shaw, W. L. Kingery, M. Boyette, and C. R. Medlin, Department of Plant and Soil Sciences, Mississippi State University, Mississippi State, MS 39762.

#### ABSTRACT

Previous research at Mississippi State University has monitored cyanazine and metolachlor concentrations in the Mississippi Delta. This research indicated that surface water concentrations of cyanazine were correlated to the predominant soil type in the drainage basin. Metolachlor concentrations were also correlated with sampling date, indicating that higher concentrations could be expected at earlier sampling dates; i.e. closer to time of application.

Research was initiated to evaluate the effects of precipitation timing and soil type on cyanazine and metolachlor losses in surface runoff. Research was conducted using raised-bed, micro-scale, runoff plots (0.25 x 0.5 x 1.2 m). Soils used in this research included a silty clay (1.6% organic matter [OM]) and two silt loam soils (0.7 and 1.8% OM). Cyanazine and metolachlor application rates were adjusted for soil texture and OM. Precipitation timings consisted of simulated rainfall events 0, 2, and 14 days after herbicide application. All surface runoff and leachate was collected for each rainfall event. High-pressure liquid chromatography (HPLC) and gas chromatography (GC) were used to determine cyanazine and metolachlor concentrations, respectively.

Precipitation timing and soil type did not affect total leachate volume or sediment yield. Mean leachate volume and sediment yield was 33000 L/ha and 143 kg/ha, respectively. Time to runoff initiation and total runoff volume was affected by soil type, but not precipitation timing. Less time was required for runoff initiation with the two silt loam soils (6 min) than was required by the silty clay soil (53 min). Total runoff was higher with the two silt loam soils (207000 and 171000 L/ha) compared to the silty clay soil (66000 L/ha). The two silt loam soils did not differ with respect to runoff initiation or total runoff. Cyanazine and metolachlor loss, expressed as total or as percent of applied, in leachate, runoff, or overall did not differ with respect to precipitation timing or soil type with one exception. Soil type significantly affected cyanazine loss. Cyanazine loss was 222 g/ha with the high OM silt loam soil. This was higher than 101 and 88 g/ha with the low OM silt loam and silty clay soils, respectively, which did not differ. Mean metolachlor loss was 108 g/ha.

Plot by plot regression analysis of log herbicide concentration against time revealed log concentrations decreased with time during a 90 min rainfall event. Additionally, averaged across soils, predicted initial cyanazine and metolachlor concentrations were 340 and 67 mg/mL, respectively. The slopes and intercepts were compared. Precipitation timing and soil type did not affect the rate of decrease in sample concentration for either cyanazine or metolachlor. Initial concentrations for cyanazine and metolachlor were significantly different between soil types. Initial cyanazine concentrations were similar between the silt loam soils and between the high OM silt loam and the silty clay soil. However, initial cyanazine concentrations from the silty clay soil were higher than from the low OM silt loam. Initial metolachlor concentrations were similar between the high OM silt loam and silty clay soils. However, initial metolachlor concentrations from these two soils were greater than from the low OM silt loam soil.

**EFFECT OF ADJUVANTS ON NORFLURAZON LEACHING IN A SANDY SOIL.** R. S. Chandran and M. Singh, University of Florida-Citrus Research and Education Center, Lake Alfred, FL 33880.

ABSTRACT

Thirty-six adjuvants were screened for efficacy to reduce leaching of the preemergence herbicide norflurazon in a Florida sandy soil. Soil columns bioassayed for herbicide leaching following a simulated rainfall event indicated that six of the adjuvants tested reduced herbicide leaching significantly. Of these, E-17-2, monazoline-O, and monazoline-T, were found more effective and were further tested at different application rates. E-17-2 reduced herbicide leaching by 58% when applied at equal proportion to the herbicide solution. Monazoline-T and monazoline-O were 15% less effective to reduce herbicide leaching compared to E-17-2. Linear regression models predicted 50, 25 and 10% reduction of norflurazon leaching by mixing E-17-2 at 75, 25, and 0.78% w/w, respectively, with the herbicide. Greenhouse studies with pigweed and barnyardgrass indicated that the effective adjuvants did not bind the herbicide to affect weed control even at the highest rate of adjuvant used. Counts and shoot fresh weights of weeds that received norflurazon with or without the adjuvants were similar.

**HERBICIDE AND SEDIMENT LOSSES IN RUNOFF AS AFFECTED BY PERENNIAL GRASSES.** A. Rankins, Jr., D. R. Shaw, M. Boyette, W. L. Kingery and M. C. Smith, Department of Plant and Soil Sciences, Mississippi State University, Mississippi State, MS 39762.

ABSTRACT

In recent years, much attention has been placed on reduced water quality due to nonpoint source pollution problems. Technological advances expanding pesticide detection limits have heightened these concerns. Vegetative filter strips as best management practices are increasingly being investigated for reducing the off-site movement of agrochemicals. Researchers have found that tall fescue (*Festuca arundinacea* Schreb.) filterstrips reduce sediment and herbicides losses in surface runoff. However, grasses with stiff, upright growth characteristics may be more tolerant to inundation from surface runoff.

Field experiments were conducted in 1996, 1997, and 1998 at Brooksville, MS, to investigate the utility of giant reed (*Arundo donox* L.), eastern gamagrass (*Tripsacum dactyloides* L.), big bluestem (*Andropogon gerardii* Vitman), switchgrass (*Panicum virgatum* L.), and tall fescue as filter strips for reducing sediment, fluometuron, and norflurazon losses in surface runoff. Cotton (*Gossypium hirsutum* L.) was planted in 4 x 22 m soil erosion plots, and fluometuron and norflurazon were each applied PRE at 1.7 kg/ha. Treatments consisted of a 0.3 m filter strip of each species and an untreated check with no filter strip. A rainfall simulator was used to supplement natural rainfall as needed to provide timely runoff events. Following each runoff event, runoff samples were collected from each plot and stored at 2 C until HPLC analysis. Sampling continued for 127 days after herbicide applications on July 7, 1996, June 26, 1997, and June 25, 1998. Sediment and herbicide loss data from all three years were subjected to regression analysis to describe loss patterns, and the slope equality of regression equations were used to determine treatment differences.

Giant reed and eastern gamagrass filter strips resulted in less cumulative runoff losses than the other three species evaluated. The presence of a filter strip reduced sediment losses in surface runoff, regardless of species. Fluometuron and norflurazon concentration in runoff was highest in the initial runoff events in all three years. Generally, filter strip effects on herbicide concentration in runoff were less dramatic than their effects on runoff and sediment losses. Differences in herbicide concentration in runoff across years were related to rainfall patterns and stand establishment of the filter strip species. Across years, 12% of the total applied fluometuron was lost in surface runoff when no filter strip was present. However, fluometuron losses in runoff did not exceed 5% of the total applied when a filter strip was present, regardless of species. Approximately 5% of the total applied norflurazon was lost in surface runoff when no filter strip was present. Norflurazon losses in runoff did not exceed 2% of the total applied when a giant reed, eastern gamagrass, or big bluestem filter strip was present.

**INFLUENCE OF FORMULATION AND METHODS OF APPLICATION ON SULFENTRAZONE DISSIPATION.** K. B. Collins, L. A. Weston, W. W. Witt, Department of Agronomy, University of Kentucky, Lexington, KY 40546.

#### ABSTRACT

Sulfentrazone has shown promise for control of yellow nutsedge and ivyleaf morningglory in field ornamental nursery setting and in cool season turf. This research investigated the rate of sulfentrazone wettable powder and granular formulations on the soil surface, incorporated into the soil, or applied to Kentucky bluegrass turf. A cotton root inhibition bioassay was utilized to determine the amount of bioavailable sulfentrazone in soil. Sulfentrazone dissipation was described by first order kinetics and calculated half-lives ranged from 1.7 to 4.6 days. The dissipation of a 5 G formulation was significantly greater in turf than on the soil surface.

#### INTRODUCTION

Sulfentrazone is a herbicide developed by the FMC Corporation for selective control of certain broadleaf and grass weed species (FMC, 1993). It has been registered for use in both soybeans (*Glycine max*) and tobacco (*Tabacum nicotiana*). Sulfentrazone has provided up to 12 weeks control of traditionally noxious weeds such as yellow nutsedge (*Cyperus esculantus*) and ivyleaf morningglory (*Ipomoea hederacea*) in a nursery setting. However, it has also caused phytotoxicity in some sensitive species (Collins et al., 1996). There has been concern about possible injury to rotational or cover crops due to sulfentrazone persistence in the soil. Sulfentrazone has a pKa value of 6.56, and a vapor pressure of  $1 \times 10^9$  mm Hg at 25 C. Sulfentrazone loss in soil appears to be primarily due to microbial degradation. It is not susceptible to photodecomposition or volatility when applied to the soil (FMC, 1993). Grey et al. (1997) found that soil pH was an important factor in determining the behavior of sulfentrazone. Because the pKa value falls within the range of normal field production pH values (6.0 to 7.5), adsorption could decrease and susceptibility to leaching could increase if the pH values were to exceed the pKa (Grey et al., 1997). They also determined that sulfentrazone persistence could be pH dependent.

Conservation efforts have encouraged farmers to use minimum tillage practices, including no-till, to reduce soil erosion. Several nurseries use grass covercrops between rows of nursery stock. Interception of herbicides by plant residues may affect herbicide persistence in the soil, especially those herbicides that need to reach the soil to provide weed control. Several factors can determine the amount of herbicide intercepted by plant residue, including the type, amount, and distribution of residue and the formulation (liquid vs. granular) of the herbicide. A herbicide intercepted by plant residue will often remain there until it is washed away by rainfall, volatilized in the air, or degraded. An applicator should be concerned with the occurrence and duration of the first rainfall after application and the photodegradability and/or volatility of the herbicide (Witt, 1992).

The objective of this study was to determine the dissipation rate of sulfentrazone as affected by formulation (granular or a wettable powder), soil surface characteristics (bare soil or turf), and placement (surface or soil incorporation) in a field nursery or turf condition.

#### MATERIALS AND METHODS

The experiment was conducted in 1997 at the University of Kentucky Horticulture Research Farm near Lexington, Kentucky on a Maury silt loam (mixed, mesic, Typic Paleudalf). The pH was 6.3 under bare ground and turf, while the organic matter was 4.6% under bare ground and 5.3% under turf. The treatments evaluated are listed in Table 1. The rate of 0.55 kg ai/ha sulfentrazone was selected because it is the greatest rate likely to be labeled in turf or ornamentals. Each plot was 2.1 x 9.1 m, with a 1.8 m border between each plot. Within each plot, 6 subplots were assigned randomly to a sampling week (0, 1, 2, 4, 8, and 16 WAT). Treatments were established May 23, 1997. Wettable powder treatments were applied in water using a CO<sub>2</sub> pressurized plot sprayer calibrated to deliver 236 liters per hectare at 207 kPa. Granular treatments were applied using a drop spreader calibrated to deliver 0.55 kg ai/ha. Each treatment was replicated 4 times, and the experiment was conducted in a randomized complete block design.

**SOIL SAMPLING PROCEDURES.** Soil samples were collected 0, 1, 2, 4, 8, and 16 weeks after treatment (WAT). A 10 cm diameter golf cup cutter was used to collect 3 cores to a depth of 10 cm from each plot. The cores were composited, and 50 grams from each sample was used to determine wet and dry weight of the soil. The remaining sample of approximately 1000 was stored at -80C until analysis. For each sampling date, 100 grams of soil of each control treatment was treated with a 5 ppm solution of sulfentrazone. This 5 ppm rate caused 50% phytotoxicity and root injury in cotton, the bioassay indicator species used in this study. This provided a background level of sulfentrazone to determine if degradation had occurred during the storage process.

**BIOASSAY PROCEDURE.** A bioassay procedure was used to determine bioavailable sulfentrazone concentration in the previously described soil samples. The soil was air dried and ground to pass through a 2 mm mesh screen. Three 150 g subsamples from each plot (for a total of 12 reps of each treatment) were placed in a plastic cone shaped bioassay tube plugged with cotton.

Ivy leaf morning glory (*Ipomoea hederacea*) and cotton (*Gossypium hirsutum* cult. Acala 90) were evaluated as indicator species during a preliminary greenhouse study. Sulfentrazone rates evaluated were: 0, 0.03, 0.07, 0.1, 0.5, 1, 2.5, and 5 ppm. The morning glory plants were extremely sensitive to all sulfentrazone treatments and all plants died above the rate of 0.5 ppm. However, cotton grew uniformly and exhibited moderate sensitivity. Cotton root injury, at increasing sulfentrazone concentrations, was found to be highly significant for a linear regression ( $p < 0.0001$ ,  $R^2 = 0.97$ ).

The bioassay consisted of germinating cotton seeds at 30 C for 30-48 hours in darkness until radicles were 3-9 mm in length. Two of these seeds were planted in the bioassay tubes, with radicles down, approximately 0.6 cm deep (plants were thinned to 1 plant/tube after emergence). After planting, 5 mls of water were added to the top of each tube to prevent desiccation of the cotton seeds. The tubes were placed in racks and subirrigated overnight. The next morning, the racks were placed in a growth chamber environment of 16 h daylight and 8 h darkness at 30 C and 25 C, respectively. Each tube was watered to 70% field capacity (w/w) daily. Seedling height and phytotoxicity ratings, measured on a 0 to 10 scale, where 0 represented no phytotoxicity and 10 represented plant death, were taken every three days. After 3 weeks, the plants were harvested, roots separated from the shoots on each plant, and root length and fresh weight of both the root and the shoot were measured. A visual root rating, based on a 0 to 10 scale, where 0 represented no damage compared to the control and 10 represented root death was also recorded at this time.

Each bioassay set was accompanied by a set of standard concentrations of sulfentrazone based on the rates used in the preliminary greenhouse experiment. Sulfentrazone concentrations were 0, 0.03, 0.07, 0.1, 0.5, 1, 2.5, and 5 ppm sulfentrazone. Three replicates from each herbicide concentration were bioassayed as previously described. The mean cotton root weight, shoot weight, root injury rating, phytotoxicity rating, root length, and plant height from each standard curve was combined and regressed upon the natural log of the soil concentrations.

## RESULTS AND DISCUSSION

**BIOASSAY.** The natural log of the standard soil concentrations of sulfentrazone was regressed against cotton seedling root length and plant height, and regressions were not significant. Sulfentrazone concentration regressed against root dry weight was significant. Predicted concentrations appeared reasonable and were within the limits of the applied concentrations. Therefore, root dry weight was determined to be the best parameter used to predict the concentration of sulfentrazone when it was regressed upon the natural log of the standard soil concentrations ( $P < 0.05$ ,  $R^2 = 0.72$ ).

**DISSIPATION.** For each treatment, the natural log of the predicted sulfentrazone concentration was regressed upon time (weeks after treatment). This yielded highly significant linear correlations for all treatments ( $P < 0.01$ ,  $R^2 = 0.78$ ); therefore, first-order kinetics appeared to describe sulfentrazone dissipation.

First-order reaction kinetics are often used to interpret results in soil persistence experiments where the rate of degradation is directly proportional to concentration:

$$dC/dt = -kC$$

where  $C$  is the concentration after time  $t$ , and  $k$  is the first-order rate constant, or dissipation rate. When the natural logarithm of the concentration is plotted against time, a straight line results with a slope proportional to the rate constant:

$$\ln C = \ln C_0 - kt$$

where  $C_0$  is the initial concentration. The dissipation half life ( $t_{1/2}$ ), or the time taken for 50% disappearance is given by:

$$t_{1/2} = \ln 2/k = 0.693/k$$

(Walker, 1987).

Herbicide dissipation rates and half lives for each treatment are given in Table 2. Half live values ranged from 1.7 days for the 5 G formulation applied to turf to 4.6 days for the 80 WP incorporated into soil. No differences in dissipation rates were found when comparing formulations and placement methods. However, the dissipation rate of sulfentrazone 5 G applied on bare ground was significantly less than the dissipation rate of sulfentrazone 5 G applied to turf as determined by a test of heterogeneity of slopes (Table 3) (Freund and Littell, 1981). This resulted in  $t_{1/2}$  values of 4 days in granular sulfentrazone applied on bare ground and 1.7 days in granular sulfentrazone applied on turf. The  $t_{1/2}$  values for the surface application of sulfentrazone 80 WP on bare ground was 2.4 days and for the incorporated application of sulfentrazone 80 WP on bare ground was 4.6 days. These values were not significantly different according to a test of heterogeneity of slopes (Table 3) (Freund and Littell, 1981).

Since no differences were found in the half-life of sulfentrazone when comparing formulations, either 5 G or 80 WP would persist equally in bare ground soil. The 80 WP formulation is not used on turf because of leaf injury, so a granular formulation is the only option in that situation. The persistence obtained from incorporation of sulfentrazone 80 WP on bare ground did not significantly differ from that of a surface application; therefore, placement did not alter sulfentrazone persistence. This study showed that granular sulfentrazone persisted slightly longer when applied to bare ground than when applied to turf. The very short persistence of sulfentrazone in Kentucky bluegrass turf may partially explain the relatively poor control in turf that has been observed.

#### LITERATURE CITED

- Collins, Kimberly, Leslie Weston and Robert McNiel. 1996. Use of sulfentrazone (F6285) for weed control in field-grown ornamentals. Southern Nurserymans Association Research Conference Proceedings. 41:79-82.
- FMC Corp. 1993. Tech. Bull. Of Sulfentrazone (F6285). Philadelphia: Agricultural Chemical Group. 6 p.
- Freund, R.J. and R.C. Littell. 1981. Heterogeneity of slopes. p. 200-205 In A.A. Ray, ed. SAS for Linear Models: A Guide to the ANOVA and GLM Procedures. SAS Institute Inc., Cary, N.C.
- Grey, T.L., R.H. Walker, G.R. Wehtje, and H.G. Hancock. 1997. Sulfentrazone adsorption and mobility as affected by soil and pH. Weed Sci. 45:733-738.
- Walker, A. 1987. Herbicide persistence in soil. In: Reviews of Weed Science: Volume 3. p. 1-18. Weed Science Society of America, Champaign.
- Witt, W.W. 1992. Interception of herbicidal sprays by plant residue. Agricultural Chemicals Short Course Abstracts, University of Missouri Extension. p. 70-73.

Table 1. Sulfentrazone treatments evaluated in 1997 at Lexington, KY for persistence on a Maury Silt Loam soil.

Site	Sulfentrazone		
	Formulation	Rate Kg/ha	Placement
1. Bareground control			
2. Bareground	5 G	0.55	surface
3. Bareground	80 WP	0.55	surface
4. Bareground	80 WP	0.55	incorporated 3-5 cm
5. Turf control			
6. Turf	5 G	0.55	surface

Table 2. Dissipation constants and half life of two sulfentrazone (0.55 Kg/ha) formulations applied to soil or turf in 1997.

Site	Formulation	K	r <sup>2</sup>	t 1/2
1. Soil Surface	5 G	-0.173	.82	4
2. Soil Surface	80 WP	-0.289	.78	2.4
3. Soil Incorporated	80 WP	-0.149	.78	4.6
4. Bluegrass Turf	5 G	-0.419	.87	1.7

Table 3. Comparison of sulfentrazone formulations and type of application based on heterogeneity of slopes.

Comparison	P Value
Soil Surface 5 G vs Soil Surface 80 WP	0.21
Soil Surface 5 G vs Kentucky Bluegrass turf 5 G	0.01
Soil Surface 80 WP vs Soil incorporated 80 WP	0.30

**DISSIPATION OF SULFENTRAZONE IN SURFACE SOIL.** G. A. Ohmes, R. M. Hayes, and T. C. Mueller. Dept. of Plant and Soil Science. The University of Tennessee, Knoxville, TN 37901.

#### ABSTRACT

Although a trend in herbicide use patterns is developing where more herbicide applications are made after the crop has emerged, soil-applied products will continue to be an important component in soybean weed management systems. Herbicide dissipation represents a compromise between residual control and rotational restrictions. These two attributes are influenced by the herbicide dissipation rate. Dissipation rate is influenced by environmental conditions (rainfall and temperature), soil properties (pH, organic matter, and texture), and transformation processes (microbial and chemical). Studies have indicated that sulfentrazone efficacy and availability in soil solution are related to organic matter and pH (1, 2). Currently there is limited information on sulfentrazone behavior in surface soil. Therefore, this study characterized sulfentrazone dissipation in surface soil under field conditions and evaluated potential injury to cotton, a common rotational crop.

Sulfentrazone dissipation was examined in field and laboratory studies. Field studies were conducted in 1995, 1996, and 1997 at Knoxville, TN on a Sequatchie loam with a pH of 6.1 and organic matter of 1.3%. Treatments (sulfentrazone at 0 and 840 g/ha) were applied preemergence over four row conventionally tilled plots with 75 cm row spacing using a CO<sub>2</sub> backpack sprayer. Plots were cropped using glyphosate tolerant soybeans and glyphosate was applied as needed for weed control. Soil samples were taken in each plot at a depth of 0 - 8 cm throughout the growing season. Cotton was no-till planted into the sulfentrazone plots in order to evaluate potential carryover. Cotton injury in the form of height reduction was taken and converted to percent injury based on the untreated check. The degradation experiment was conducted in the laboratory for a period of 336 days with a sampling interval of two weeks. Soil from two depths, 0-10 cm and 30-40 cm, was collected from the field site prior to sulfentrazone application.

Samples from the field studies were air dried, passed through a 2 mm sieve, and 40 g placed in 250 ml plastic bottles. In the degradation study, autoclaved and nonautoclaved treatments were evaluated with seven grams of moist soil placed into 20 ml glass vials, fortified with 1000 ppbw of sulfentrazone, and incubated in the dark at 30 C. Lab analysis for both field and lab experiments included adding methanol to the containers of soil based at 2 ml of methanol per 1 g of soil. Samples were agitated 16 h, filtered, and concentrations determined using high performance liquid chromatography (HPLC) with a 50:50 v/v acetonitrile:water+H<sub>3</sub>PO<sub>4</sub> mobile phase. Data were empirically fit to first order kinetics, half-lives (DT<sub>50</sub>) were calculated.

Field half-lives were correlated to rainfall. In 1995 and 1997, rainfall for 0-90 DAT was 17 and 24 cm, respectively. Sulfentrazone half-lives for these two years were 113 and 85 d, respectively. In 1996, rainfall for this period was 38 cm, which was higher than the other two years and subsequently sulfentrazone half-life was 25 d. Cotton injury was directly related to sulfentrazone half-life. In 1997, when the half-life from the previous year was only 25 d there was no visible injury. In 1996 and 1998, when half-lives were 113 and 85 d from the previous years, 60% and 35% cotton injury was observed, respectively. In the laboratory study the half-life in the autoclaved soil was 200 d. This was greater than the observed half-lives in the 0-10 and 30-40 cm nonautoclaved soils, which were 93 and 100 d, respectively. These data indicate that microbial degradation is a primary dissipation mechanism. However, the autoclaved soil followed a similar quadratic pattern to that of the nonautoclaved soils suggesting that chemical degradation is also involved in sulfentrazone dissipation.

1. Wehtje, G., R. H. Walker, T. L. Grey, and C. E. Spratlin. 1997. Soil effects of sulfentrazone. Proc. South. Weed Sci. Soc. 48:224.
2. Grey, T. L., R. H. Walker, G. R. Wehtje, and H. G. Hancock. 1997. Sulfentrazone adsorption and mobility as affected by soil and pH. Weed Sci. 45:733-738.

**DEGRADATION OF DICLOSULAM IN TILLED AND NON-TILLED SOIL.** S. W. Murdock, and W. W. Witt, Department of Agronomy, University of Kentucky, Lexington, KY 40546.

#### ABSTRACT

Field experiments were conducted in 1997 and 1998, near Princeton and Lexington, Kentucky, to evaluate the dissipation and persistence of diclosulam under conventional (moldboard plow), minimum (two diskings), and no-tillage. Diclosulam was applied at 0, 8.6, 13, 26, and 52 g/ha immediately after planting. Soil samples were collected to a 10 cm depth from the 0, 26, and 52 g/ha plots in Princeton on 0, 1, 2, 4, 8, 16, and 44 WAT in 1997, and 0, 1, 2, 4, 8, and 16 WAT in 1998. The amount of diclosulam reaching the soil decreased as the amount of tillage decreased. Diclosulam was not detected 8 WAT in seven of the twelve treatments and only detected in two treatments 16 WAT. The dissipation of diclosulam was linear and independent of rate. Thus, diclosulam followed first order rate kinetics and diclosulam dissipation was relatively rapid. Dissipation was more rapid in 1998 than in 1997 and this was attributed to increased rainfall. Diclosulam half-lives ranged from 10 to 16 days in 1997, and 7 to 9 days in 1998. Corn was planted in 1998 to evaluate the potential for crop injury following diclosulam applications in 1997. There was no corn injury or yield reduction from diclosulam persistence in any tillage at any rate.

**SOIL BINDING VALUES FOR HERBICIDES NEED TO BE STANDARDIZED.** J. B. Weber, J. W. Wilcut, G. G. Wilkerson, Crop Science Department and R. B. Leidy, Toxicology Department, North Carolina State University, Raleigh, NC 27695 and S. Senseman, W. W. Witt, W. K. Vencil, R. E. Talbert, D. R. Shaw, T. F. Peeper, T. Mueller, D. K. Miller, B. K. Brecke, and M. Barrett, Members of the S-286 Regional Research Technical Committee<sup>3</sup>.

#### ABSTRACT

Herbicide soil/solution distribution coefficients ( $K_d$ ) are used in mathematical models to predict the movement of herbicides in soils. Herbicides bind to various soil constituents to differing degrees. The universal soil colloid that binds most herbicides is organic matter, but clay minerals and metallic hydrous oxides are more retentive for cationic and phosphoric and arsenic acid compounds, and weakly basic herbicides bind to both organic and inorganic soil colloids. The soil organic carbon affinity coefficient ( $K_{oc}$ ) has become a common parameter for comparing herbicides binding in soil, but because organic matter and/or organic carbon determinations vary greatly from method to method and laboratory to laboratory,  $K_{oc}$  values vary greatly also. This paper discusses this phenomenon and offers suggestions for obtaining the most accurate  $K_d$  and  $K_{oc}$  values for selected herbicides.

#### INTRODUCTION

Herbicide soil/solution distribution coefficients ( $K_d$  or  $K_f$ ) are used in mathematical models to predict the movement of herbicides through the soil and in ground water plumes (2,3). A  $K_d$  value is the ratio of the amount of a specific herbicide bound to the concentration of the compound in the solution phase of a sorption experiment at or near equilibrium, i.e.,  $K_d = \text{amount of herbicide sorbed to soil} / \text{concentration of herbicide in solution}$ . A  $K_f$  value is obtained by using several concentrations of herbicide and utilizing the Freundlich equation ( $x/m = K_f C_e^{1/n}$ , where  $x/m = \text{nmole/g herbicide sorbed}$ ,  $K_f = \text{constant}$ ,  $C_e = \text{nmole/ml herbicide in solution}$ , and  $1/n = \text{constant}$ ) to compute the amount of herbicide bound to the soil at an equilibrium concentration of 1 nmole/ml, assuming a  $1/n$  value of one, i.e.,  $K_f = x/m \div C_e$ .

Nonionizable organic pesticides generally bind to soil organic matter (OM) more readily than to other soil colloids, so many investigators compute an organic carbon (OC) affinity value ( $K_{oc}$ ) for specific herbicides on specific soil samples. A  $K_{doc}$  or  $K_{foe}$  ( $K_{oc}$ ) value may then be obtained using the following equation:  $K_{oc} = K_f / \% \text{ organic carbon content} \times 100$ . The OM content of soil may be determined by many different methods, including dry or wet combustion, and generally ranges from 0 to 5% (5). The OC content of soil OM generally ranges from 50 to 58%, i.e., a soil with an OM content of 1% will thus have an OC content of 0.50 to 0.58%, and this is usually expressed as the OC/OM index. The method used to determine the % OC content of the soil should always be reported, as different methods result in different values and this directly affects the calculated  $K_{oc}$  values. In addition,  $K_{oc}$  values calculated for cationic herbicides, such as paraquat<sup>2+</sup>, or for herbicides with ionizable phosphoric acid groups, such as glyphosate, which bind much more strongly to inorganic soil colloids than to organic colloids cause the  $K_{oc}$  value to have little meaning (6).

Herbicide formulation has a great influence on the dissolution of a chemical in a tank of water or on a plant surface, but has little influence on the behavior of the compound in the soil because the soil media reacts with many compounds converting them to other forms or serves as a chromatographic media to separate the parent compound from the formulation additives (6). This is especially true of acidic compounds that are formulated as esters. Ester formulations are readily hydrolyzed to acid forms in soils (4) and this greatly influences their soil binding potential (6). These matters will be made clearer later on in this paper.

#### METHODS AND MATERIALS

All of the herbicide data reported in this paper has been taken from the Herbicide Handbook (1) but  $K_d$ ,  $K_f$ ,  $K_{doc}$  and  $K_{foe}$  values reported in various databases needed to be evaluated with the same scrutiny as those reported in the Herbicide Handbook.

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<sup>3</sup>We acknowledge the North Carolina State Agricultural Service for financial support.

## RESULTS AND DISCUSSION

Table 1 contains reported herbicide soil/solution distribution coefficient ( $K_d$ ), organic carbon affinity ( $K_{oc}$ ) and selected soil property values, and calculated organic carbon (OC) and OC/OM indices for four herbicides, examples of twenty-one compounds for which this comprehensive information is available in the Herbicide Handbook (1). The major problem with the use of some of these values for predicting herbicide mobility in soils is the large variation in the OC/OM indices, which range from 0.379 to 1.538 but should not range more than 0.50 to 0.58 (5), and reflects the accuracy of the reported  $K_{oc}$  values. It is recommended that the  $K_d$  values for these compounds be utilized, using the soil properties as a guide for soils with similar properties but unknown  $K_d$  values. To calculate  $K_{oc}$ , it is suggested that an OC/OM index of 0.54 be used to calculate %OC from the reported %OM values and  $K_{oc}$  values computed using  $K_{oc} = K_d/\%OC \times 100$ , e.g., for atrazine with  $K_d = 0.20$  and %OM = 0.9, %OC = OC/OM index  $\times$  %OM = 0.54  $\times$  0.9 = 0.49, and  $K_{oc} = 0.20/0.49 \times 100 = 40.8$ .

Table 2 contains reported  $K_d$  values and selected soil property values for three herbicides, examples of six compounds for which this information is available in the Herbicide Handbook (1). Since individual  $K_{oc}$  values are not provided for each soil, we assumed an OC/OM index of 0.54 in order to calculate %OC and  $K_{oc}$  values, e.g., for acetochlor with  $K_d = 0.4$  and %OM = 0.7, %OC = 0.54  $\times$  0.70 = 0.38 and  $K_{oc} = 0.4/0.38 \times 100 = 105$ . Where provided, soil property values may be used to compute  $K_d$  or  $K_{oc}$  values for additional soils with relatively similar properties.

Table 3 contains reported average organic carbon affinity ( $K_{oc}$ ) values and calculated herbicide soil/solution distribution coefficient ( $K_d$ ) values for six herbicides, assuming soils with 1.0, 2.5, and 5.0% OM contents and an OC/OM index of 0.54(5). Sixty six additional herbicides fall into this group of herbicides in the Herbicide Handbook(1).  $K_d$  values have been calculated since they are used in predicting plume movement (2). Calculated  $K_d$  values assumed an OC/OM index of 0.54, e.g., for acifluofen with  $K_{oc} = 113$  and a soil with 1.0% OM (0.54% OC),  $K_d = (K_{oc})(\%OC)/100 = (113)(0.54)/100 = 0.610$ . Several additional problems are apparent in the use of the  $K_{oc}$  values for the herbicides in Table 3. For some compounds, the range of reported  $K_{oc}$  values is large, e.g., for alachlor reported  $K_{oc}$  values ranged from 43 to 209, making it difficult to calculate accurate  $K_d$  values. For others, like bifenox, a  $K_{oc}$  value of 10,000 is reported for the ester formulation, but the compound is readily hydrolyzed to the acid anionic form in soils (4). The anion, estimated  $K_{oc} = 100$ , is much more mobile in soils than the ester form (6). For herbicides with arsenic acid groups like cacodylic acid, the  $K_{oc}$  is meaningless since these compounds react much more strongly with metallic hydrous oxides and clay minerals than with organic matter (6). For cationic herbicides like difenzoquat<sup>2+</sup>,  $K_{oc}$  is also meaningless since these compounds react primarily with clay minerals in soils (6). In these cases, the  $K_d$  values are much preferred parameters to use in modeling studies.

Table 4 contains reported herbicide soil/solution distribution coefficient ( $K_d$ ), Freundlich parameters ( $K_f$ , 1/n), organic carbon affinity ( $K_{oc}$ ) and selected soil property values for six herbicides, examples of twenty five herbicides in this group.  $K_d$  values for herbicides with reported  $K_{oc}$  values only may be computed by assuming an OC/OM ratio of 0.54 and soil organic matter contents of 0 to 5%, as was done for herbicides in Tables 2 and 3.

Reported  $K_d$  values were found to be correlated with selected soil properties for 19 of 28 herbicides listed in the Herbicide Handbook (1). Table 5 contains correlation coefficient values and equations for calculating  $K_d$  values for three herbicide as examples of the 19 compounds. Soil OM and CM contents and soil pH were found to be the most useful predictors of  $K_d$ , depending on the chemical properties of the herbicide involved.

## LITERATURE CITED

1. Ahrens, W.H., Ed. 1994. Herbicide Handbook, 7th Edition, Weed Science Society of America, Champaign, IL.
2. Anonymous; 1998. Seminars on Monitored Natural Attenuation for Ground Water. USEPA, Washington, DC.
3. Carsel, R.F., C.N. Smith, L.A. Mulkey, J.D. Dean and P. Jowise. 1989. User's Manual for the Pesticide Root Zone Model (PRZM). USEPA, Athens, GA.
4. Hill, I.R. and S.J.L. Wright. 1978. Pesticide Microbiology. Academic Press, Inc., London

5. Nelson, D.W., and L.E. Sommers. 1996. Total carbon, organic carbon, and organic matter. Pages 961-1010. *In* D.L. Sparks, A.L. Page, P.A. Helmke, R.H. Loeppert, P.N. Soltanpour, M.A. Tabataba, C.T. Johnston and M.E. Sumner, Eds., *Methods of Soil Analysis. Part 3-Chemical Methods. Book Series 5. Soil Science Society of America, Inc., Madison, WI.*
6. Weber, J.B. 1994. Properties and behavior of pesticides in soil. Pages 15 - 41. *In* R.C. Honeycutt and D.J. Schabaker, Eds., *Mechanisms of Pesticide Movement into Ground Water. Lewis Publ./CRC Press, Inc., Boca Raton, FL.*

Table 1. Reported herbicide soil/solution distribution coefficient ( $K_d$ ), organic carbon affinity ( $K_{oc}$ ) and selected soil properties, and calculated organic carbon (OC) and OC/OM indices (1).

Common Name	Reported values <sup>a</sup>					Calculated values	
	$K_d$	$K_{oc}$	OM	CM	pH	OC <sup>b</sup>	OC/OM index <sup>c</sup>
	ml/g		%			%	
Atrazine	0.20	39	0.9	2.2	6.5	0.51	0.570
	0.73	155	0.8	9.0	6.7	0.47	0.589
	0.79	70	1.9	16.8	7.5	1.13	0.594
	2.46	87	4.8	42.0	5.9	2.83	0.589
Haloxypop	0.5	47	2.3	nav	7.2	1.06	0.462
	2.0	76	2.9	nav	7.3	2.63	0.907
Nicosulfuron	0.16	38.4	1.1	nav	6.6	0.42	0.379
	0.28	28.8	2.1	nav	6.5	0.97	0.463
	1.73	78.8	4.3	nav	5.4	2.19	0.510
Primisulfuron	0.01	2.1	4.8	2.2	6.5	0.48	0.100
	0.04	4.0	0.9	16.8	7.5	1.00	1.110
	0.09	20.0	0.8	9.0	6.7	0.45	0.562
	0.38	13.0	1.9	42.0	5.9	2.92	1.538

<sup>a</sup>nav = not available

<sup>b</sup>%OC =  $K_d/K_{oc} \times 100$ .

<sup>c</sup>%OC/%OM ratio.

Table 2. Reported herbicide soil/solution distribution coefficient ( $K_d$ ), average organic carbon affinity ( $K_{oc}$ ) and selected soil property values, and calculated % organic carbon (OC) content and organic carbon affinity ( $K_{oc}$ ) values assuming an OC/OM index of 0.54(1).

Common Name	Reported values <sup>a</sup>					Assumed OC/OM Index <sup>b</sup>	Calculated	
	$K_d$	$K_{oc}$	OM	CM	pH		OC <sup>c</sup>	$K_{oc}$ <sup>d</sup>
	ml/g		%				%	ml/g
Acetochlor	0.4	nav	0.7	nav	nav	0.54	0.38	105
	1.1	nav	1.2	nav	nav	0.54	0.65	169
	1.6	nav	2.4	nav	nav	0.54	1.30	123
	2.7	nav	3.4	nav	nav	0.54	1.84	147
Chlorsulfuron	0.69	nav	4.3	nav	5.4	0.54	2.32	29.7
Average		40						
Dithiopyr	7.89	nav	0.8	8.0	8.0	0.54	0.43	1835
	12.82	nav	1.0	8.0	7.5	0.54	0.54	2393
	45.93	nav	3.2	59.0	6.2	0.54	1.73	2655
Average		1638						

<sup>a</sup>nav = not available

<sup>b</sup>OM ranges from 50 to 58%OC (mean = 54%)(5).

<sup>c</sup>OC = 0.54 (OM).

<sup>d</sup> $K_{oc} = K_d / \%OC \times 100$ .

Table 3. Reported average herbicide organic carbon affinity ( $K_{oc}$ ) values and calculated herbicide soil/solution distribution coefficient ( $K_d$ ) values, assuming soils with 1.0, 2.5, and 5.0% OM contents and an OC/OM index of 0.54(1).

Common Name	Reported Average $K_{oc}$	Calculated $K_d$ values <sup>a,b</sup>		
		Assumed 1.0% OM (0.54% OC)	Assumed 2.5% OM (1.35% OC)	Assumed 5.0% OM (2.70% OC)
Aciflurofen	113	0.610	1.53	3.05
Alachlor	124 <sup>c</sup>	0.670	1.67	3.35
Bifenox	100 <sup>d</sup>	0.540	1.35	2.70
Cacodylic acid	1000 <sup>e</sup>	5.40	13.5	27.0
Difenzoquat <sup>2+</sup>	54,500 <sup>f</sup>	294	736	1471
Maleic hydrazide	250 <sup>g</sup>	1.35	3.37	6.75

<sup>a</sup>%OM for most soils ranges from 0 to 5%, OM ranges from 50 to 58% OC (mean = 54%), assumed OC/OM index of 0.54(5).

<sup>b</sup> $K_d = (K_{oc})(\%OC) / 100$ .

<sup>c</sup>Reportedly ranges from 43 to 209.

<sup>d</sup>Reported as 10,000 for ester, which is transformed to acid in 10 days (4); value is estimate for acid.

<sup>e</sup>Binds to clay minerals and hydrous oxide primarily, so  $K_{oc}$  is meaningless (6).

<sup>f</sup>Binds to clay minerals primarily (6).

<sup>g</sup>Reported as 20 for salt formulation and 250 for acid form.

Table 4. Reported herbicide soil/solution distribution coefficient ( $K_d$ ), Freundlich parameters ( $K_f$ ,  $1/n$ ), organic carbon affinity ( $K_{oc}$ ) and selected soil property values (1).

Common Name	Reported values <sup>a</sup>							
	$K_d$	$K_f$	$1/n$	$K_{oc}$	OM	OC	CM	pH
	ml/g			ml/g	%			
Clethodim	0.05-0.23	nav	nav	nav	nav	nav	nav	nav
Clopyralid	0.41	nav	nav	6.0	nav	nav	nav	nav
Diuron	nav	nav	nav	480	nav	nav	nav	nav
Hexazinone	nav	nav	nav	54.0	nav	nav	nav	nav
	nav	0.2	0.95	nav	nav	nav	nav	nav
	nav	1.0	1.05	nav	nav	nav	nav	nav
Imazaquin	nav	nav	nav	20	nav	nav	nav	7.0
	nav	0.24	nav	nav	4.7	nav	30.4	7.6
	nav	0.33	nav	nav	1.6	nav	11.2	6.4
	nav	0.59	nav	nav	4.7	nav	19.2	7.0
	nav	3.57	nav	nav	53.1	nav	4.0	5.9
MSMA	nav	nav	nav	7000 <sup>b</sup>	nav	nav	nav	nav
	0.50	0.39	1.13	250 <sup>b</sup>	nav	nav	nav	nav
	11.4	13.3	0.70	2850 <sup>b</sup>	nav	nav	nav	nav
	18.7	20.0	0.77	1170 <sup>b</sup>	nav	nav	nav	nav
	39.4	34.8	0.68	2190 <sup>b</sup>	nav	nav	nav	nav

<sup>a</sup>nav = not available.<sup>b</sup>Binds to metallic hydrous oxides and clay minerals primarily, so  $K_{oc}$  is meaningless (6).Table 5. Correlation ( $r$ ) of herbicide soil/solution distribution coefficient ( $K_d$ ) values versus selected soil properties and equations for calculating  $K_d$  values when soil property values (1) are available.

Common name	Mean $K_d$	Soil property	$r^a$	Equation
	ml/g	%		
Acetochlor	1.40	OM	0.98*	$K_d = -0.052 + 0.78 (\%OM)$
Atrazine	1.04	OM	0.96*	$K_d = -0.018 + 0.506(\%OM)$
		CM	0.99**	$K_d = 0.072 + 0.056 (\%CM)$
Nicosulfuron	0.720	OM	0.97*	$K_d = -0.57 + 0.518 (\%OM)$
		pH	-0.99**	$K_d = 8.8 - 1.31 (pH)$

<sup>a</sup>Significant at the 0.05 (\*) and 0.01 (\*\*) level.

**DISSIPATION OF SULFONYLUREA HERBICIDES NICOSULFURON AND RIMSULFURON IN SURFACE SOIL.** C. A. Ashburn, R. M. Hayes, and T. C. Mueller. The University of Tennessee, Department of Plant and Soil Sciences, Knoxville, TN 37901.

#### ABSTRACT

Many factors influencing herbicide dissipation have been studied; however, the effect of the presence of one herbicide on another herbicide's dissipation rate has not been extensively investigated. This is a common concern when products are applied simultaneously. Basis Gold™ is a package mix containing a 48:1:1 ratio of atrazine, nicosulfuron, and rimsulfuron. Field studies were established in 1997 and 1998 on a Sequatchie silt loam in Knoxville, TN to investigate the dissipation of the two sulfonyleureas in this mixture. Treatments applied to tilled, bare ground included nicosulfuron (0.046 kg ai ha<sup>-1</sup>), rimsulfuron (0.046 kg ai ha<sup>-1</sup>), nicosulfuron (0.046 kg ai ha<sup>-1</sup>) + rimsulfuron (0.046 kg ai ha<sup>-1</sup>), and an untreated control. This is approximately a normal use rate for nicosulfuron and a 2X rate of rimsulfuron. Samples (0-8 cm) were collected from 0 to 31 days after treatment (DAT) in 1997 and 1998. Studies under controlled conditions were also conducted using the same soil. Soil was fortified at 50 ppb (µg g<sup>-1</sup>) with nicosulfuron, rimsulfuron, and nicosulfuron + rimsulfuron and equilibrated in a dark incubator at 30 C. Samples for the laboratory study were removed from the incubator 0, 1, 2, 3, and 7 DAT and frozen until extraction. Methods were a modification of those used by Powley and deBernard (1). Field samples were thoroughly mixed and 50 grams placed in a polyethylene bottle. Samples were extracted twice with 90:10 (v:v) 0.1 M aqueous ammonium carbonate/ acetone for 20 minutes. Solid phase extraction C<sub>18</sub> and silica columns were used for sample cleanup and concentration. Samples were analyzed using High Performance Liquid Chromatography. The mobile phase system utilized a tertiary gradient, with singular components being acetonitrile, potassium phosphate buffer (30mM) at pH 2.7, and potassium phosphate buffer (30mM) at pH 6.2. Neither rimsulfuron nor nicosulfuron dissipation was influenced by the presence of the other herbicide. Field studies in 1997 and 1998 determined that both herbicides alone and in mixture dissipated quickly. Rainfall within 12 hr of application in each year and a soil pH of 5.7 encouraged rapid degradation. In 1997, the half-life (DT<sub>50</sub>) of nicosulfuron was 5.3 d and the DT<sub>50</sub> of rimsulfuron was 3.1 d. When the two herbicides were applied in combination, the DT<sub>50</sub> of nicosulfuron was 4.2 d and the rimsulfuron DT<sub>50</sub> was 3.5 d. In 1998, all DT<sub>50</sub> were ≤ 2.2 d. Rapid degradation was observed in the soil fortification experiments with DT<sub>50</sub> for all treatments < 3.5 d. This indicated minimal residual weed control and slim chance of rotational crop injury. Sulfonyleurea dissipation is favored in warm, moist, light textured soil (2,3). Conditions of this study, including environmental and soil conditions, favored rapid breakdown via both chemical and microbial processes which supports previous research (4).

#### LITERATURE CITED

1. Powley, C.R. and P.A. de Bernard. 1998. Screening method for nine sulfonyleurea herbicides in soil and water by liquid chromatography with ultraviolet detection. *J. Agric. Food Chem.* 46:514-519.
2. Ashton and Monaco. 1991. *Weed Science, Principles and Practices*. Third Edition. J. Wiley Publishers, New York. p 266-272.
3. Beyer, E. 1986. Sulfonyleurea herbicides - Pioneering a new trend in weed control. *North Central Weed Science Society Proceedings* Vol. 41:137-142.
4. Thirunarayanan, K., R.L. Zimdahl, and D.E. Smika. 1985. Chlorsulfuron adsorption and degradation in soil. *Weed Sci.* 33:558-563.

**AN ASSESSMENT OF THE POTENTIAL FOR ENHANCED DEGRADATION OF CHLORIMURON, IMAZAQUIN, AND IMAZETHAPYR IN SOIL.** A. M. Young and M. Barrett, University of Kentucky, Lexington, KY 40546.

#### ABSTRACT

Maury silt loam soil (pH 6.3, OM 3%) that had been treated annually for six consecutive years with either chlorimuron (62 g/ha<sup>-1</sup>) or imazaquin (141 g/ha<sup>-1</sup>) was used to evaluate the potential for enhanced degradation of these herbicides plus imazethapyr. Enhanced degradation of a herbicide in soil is a common phenomena observed after repeated use of the material in an area. Soil was collected from the treated field areas and further conditioned by retreating the imazaquin soil monthly with imazaquin at 0.1 and 1.0 kg/ha<sup>-1</sup> or imazethapyr at 0.50 kg ha<sup>-1</sup>. The chlorimuron soil was retreated monthly with chlorimuron at 0.03 and 0.34 kg ha<sup>-1</sup>. The treated soil was placed in pots in the greenhouse with corn (Pioneer 3245IR) seed planted into the soil. Sufficient moisture and fertility were supplied to maintain corn growth.

Soil collected from the same area as the treated soil, but which never had any of these herbicides applied to it, was used as a control. At the end of each monthly period, the corn was removed and the soil retreated. The soil was treated for a total of twelve times. The degradation of chlorimuron, imazaquin, and imazethapyr was measured by treating 100 g of the soil with 0.68, 0.34, and 0.45 ppm, respectively, of  $^{14}\text{C}$ -herbicide. Moist soil (15.6% by weight) was incubated for zero and two weeks. Soil water was extracted by centrifugation at 1800 x g. Total radioactivity recovered in the soil water, the fraction of the radioactivity remaining in the aqueous phase following methylene chloride partitioning, and parent herbicide and metabolites in the organic phase were determined. Despite the repeated and concentrated herbicide treatments of the soil, we saw little to no evidence of enhanced degradation for any of these herbicides.

**ALTERNATIVE HERBICIDE PROGRAMS FOR DICLOFOP-RESISTANT ITALIAN RYEGRASS (*Lolium multiflorum*) IN WHEAT.** L. T. Barber, F. L. Baldwin, C. C. Wheeler, T. L. Dillon and L. R. Oliver. Department of Crop, Soil and Environmental Science, University of Arkansas, Fayetteville, AR 72704.

#### ABSTRACT

Diclofop (Hoelon)-resistant Italian ryegrass is becoming a major problem in Arkansas wheat production. Italian ryegrass is a very competitive weed, and an alternative control to diclofop has not been found. Studies were conducted at Willow Beach, Arkansas, in 1998 to determine alternative methods of control by utilizing various herbicides and cultural practices, such as conventional and no-till methods.

Two herbicide screening studies (one conventional tillage, one no-till) were conducted at Willow Beach on a clay loam soil. A natural infestation of diclofop-resistant ryegrass, which was resistant to 7.5 lb ai/A of diclofop, was present at this location. "Mason" wheat was drilled at a rate of 110 lb/A, with a row spacing of 7.5 in. The studies were randomized complete blocks with a plot width of 10 ft. and a length of 25 ft., with four replications. Treatments were sprayed with a backpack sprayer at 10 GPA. Visual ratings were taken at 28 days after treatment (DAT), 113 (DAT), and at harvest. Data were subjected to ANOVA, and the means were separated by least significant difference at the 0.05 level of significance ( $\text{LSD}_{0.05}$ ).

In the no-till experiment paraquat (Gramoxone Extra) at 0.5 lb ai/A, and glyphosate (Roundup Ultra) at 0.5 lb ai/A provided equivalent burndown control of 80 to 90% at 28 DAT. At 113 DAT, and at harvest, only treatments containing chlorsulfuron (Glean) provided 80 to 85% control. At harvest, 0.023 lb ai/A of chlorsulfuron provided 80 to 85% control, while all other treatments were less than 40%. The addition of tralkoxydim (Achieve) at 0.24 lb ai/A did not improve control over chlorsulfuron alone. In the conventional study, diclofop at 3.75 lb ai/A was again ineffective against Italian ryegrass. At 28 DAT preemergence treatments of pendimethalin (Prowl) + chlorsulfuron gave 68 to 82% control. Only chlorsulfuron treatments maintained Italian ryegrass control approximately 90% at 113 DAT. At harvest, chlorsulfuron still provided the highest level of control. Pendimethalin at 1.0 lb ai/A and tralkoxydim provided equivalent control at all three rating dates.

Italian ryegrass was resistant to diclofop. Chlorsulfuron was the only treatment that provided 75 to 90% control when applied burndown, preemergence, or delay-preemergence. Pendimethalin + tralkoxydim in the conventional study provided 48 to 65% control over the three rating dates. All treatments improved wheat yields over untreated check in both evaluations. Treatments containing chlorsulfuron had the highest yield.

**EFFECT OF PREEMERGENCE HERBICIDE AND TIMING OF POSTEMERGENCE APPLICATIONS ON WEED CONTROL AND YIELD IN ROUNDUP READY SOYBEAN.** D. K. Miller, J. L. Milligan, and C. F. Wilson, Louisiana State University Agricultural Center, Northeast Research Station, St. Joseph, LA 71366.

#### ABSTRACT

A field study was conducted in 1998 at the Northeast Research Station in St. Joseph, LA, on a silty clay loam soil. Experimental design was a randomized complete block with a factorial arrangement of PRE herbicides and Roundup Ultra POST application timings. At planting treatments consisted of Broadstrike + Dual (flumetsulam + metolachlor) at 2.5 pt/A, Turbo (metolachlor + metribuzin) at 2.25 pt/A, or no PRE herbicide. Due to lack of significant rainfall for the first 30 days after planting and subsequent lack of adequate weed population and stress on few weeds present, initial POST timings of 2, 3, 4, 5, 2 followed by 5, or 3 followed by 5 weeks after planting for Roundup Ultra at 1.5 pt/A were