EFFECTS OF PREEMERGENCE HERBICIDE-SYSTEMIC INSECTICIDE COMBINATIONS ON SOYBEAN (*GLYCINE MAX* (L.) MERRILL) GROWTH AND DEVELOPMENT

by

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INTRODUCTION

Crop pest management systems require the use of a wide variety of pesticides. Simultaneous or sequential applications of herbicides, insecticides and fungicides are common in the production of many food and fiber crops. Whenever feasible, growers or commercial applicators choose to apply combinations of chemicals for obvious economic reasons. The fewer the trips across the field, the less the expenditure of labor and equipment. In addition, combinations of chemicals frequently increase the spectrum of plant pests that is controlled.

Problems arising from tank mixing of chemicals have been recognized for several decades. Physical or chemical changes may occur which render the mixture incompatible or reduce the effectiveness of one or more of the compounds. Increase phytotoxicity due to the combining of chemicals has been observed in such diverse crops as cotton (*Gossypium hirsutum*), corn (*Zea mays*), rice (*Oryza sativa*), peanuts (*Arachis hypogaea*), grain sorghum (*Sorghum bicolor* (L.) Moench) and others.

The concern of this study is with the responses on the growth and development of soybeans (*Glycine max* (L.) Merrill) grown in soil treated simultaneously with selected preemergence herbicides and systemic insecticides. The objective of the study is to collect data to determine if, under field conditions, combining these selected pesticides will result in responses not predictable from the performance of each chemical applied singly. Of particular interest are the synergistic or antagonistic responses which could occur.

REVIEW OF LITERATURE

Terminology

Many pesticide researchers have been vague in their description of responses occurring after applications of two or more chemicals. Terms such an enhancement or inhibition of activity, increased or decreased effectiveness, and apparent synergism, give the reader little knowledge regarding the quantitative nature of the relationship. The final goals of identifying an interaction, determining its nature, and thereby helping to resolve the basis for the interaction often have been obscured.

Tammes (44) employed four terms to describe responses obtained with combinations of herbicides, insecticides, and fungicides. These terms, as defined below, will be used to describe the responses observed in this herbicide-insecticide study.

1. Synergism: cooperative action of two components of a mixture, such that the total effect is greater or more prolonged than the sum of the effects of the two taken independently.
2. Addition: cooperative action, such that the total effect is equal to the sum of the effects of the components taken independently.
3. Independent effect: the total effect is equal to the effect of the most active component alone.
4. Antagonism: the total effect is smaller than the effect of the most active component alone.

Symptomology

Early reports of herbicide-insecticide interactions came from studies on cotton by Hacskaylo(12). Diuron and the organophosphate insecticides phorate or disulfoton interacted to cause severe loss of cotton seedlings. Nash (32, 33) later observed interactions with these pesticide combinations on oats. In contrast, trifluralin and phorate or disulfoton interacted antagonistically to increase cotton yield, possibly by allowing plants receiving the combination to produce more secondary roots in the zone of pesticide incorporations as reported by Arle (3), Ivy and Pfrimmer (20), and Hassaway and Hamilton (15). Corbin and Sheets (10) reported that several organophosphate insecticides antagonized the activity of vernolate on cucumbers (Cucumis sativus (L.)). No apparent combination effect on insecticide efficacy was evident, however. Cargill and Santelman (6) failed to find an interaction of disulfoton or phorate with trifluralin or chloramben on peanuts in the greenhouse.

The insecticide phorate has been reported by Johnson (22) to enhance soybean seedling growth; whereas the insecticide methomyl interacted with linuron to reduce soybean yields.

Boling and Hacskaylo (4) reported that cotton plants treated with the insecticide aldicarb and either trifluralin or chlorpropham were shorter than plants treated with either the herbicide or insecticide alone. In a three year field study, Ivy (19) found that in one out of the three years there was a significant reduction in cotton stand caused by the interaction of disulfoton with several herbicides. Russ and Ten Eyck (41) reported that in field experiments, the combination of the insecticide disulfoton with the herbicides norea and terbutryn markedly enhanced injury to sorghum seedlings. However, if the sorghum plant survived, damage was usually overcome. Parks (35) showed that the uptake of the s-triazine prometryne, at one micromole per liter was increased in bean (Phaseolus vulgaris) roots by the presence of ten, one, or one-tenth micromole phorate in the nutrient solution. Both phorate and prometryne inhibit state 3 respiration but the pesticide combination did not interact when applied simultaneously on the system.

Penner (37) found that supplying the roots of seven-day-old soybean seedlings with the combination of diazinon or fensulfothion with ^{14}C-atrazine for a four-hour treatment period caused a reduction in movement of the ^{14}C-atrazine to the shoots. Soybean seedlings grown in ten micromole atrazine together with either disulfoton, diazinon, or fensulfothion and then treated with the respective ^{14}C-atrazine insecticide combination for four hours showed similar ^{14}C-atrazine uptake as the control. Under these conditions, diazinon reduced the atrazine concentration in the roots. Fensulfothion has also been reported by Phatak (38) to interact synergistically with alachlor and cause stand reductions in broccoli (Brassica oleracea (L.), Italica group), and cauliflower (Brassica oleracea (L.) Botyris group).

Not all herbicide-insecticide interactions result in greater phytotoxicity. Smith (43) found that malathion protected both corn and wheat (Triticum aestivum) seedlings from trifluralin injury. This antagonistic interaction was not due to an incompatibility in the spray mixture. Hamill and Penner (13) observed several antagonistic herbicide-insecticide interactions including the combination of the insecticide carbaryl with the herbicide fluorodifen. They also observed synergistic interactions when the carbamate insecticide carborfuran was combined with alachlor, butylate, chlorbromuron, flurodifen, linuron, or propachlor.

Bowling and Hudgins (5) reported that organophosphate insecticides, but not organochlorine insecticides, interact with propanil to increase toxicity to rice. The organophosphate insecticides tested were malathion, phosphamidon, naled, azinphosmethyl, and trichlorfon. Propanil is a selective herbicide used in rice especially for the control of barnyardgrass (Echinochloa crusgalli (L.) Beauv.). The tolerance of rice to propanil is based on the rapid metabolism of the herbicide by an aryl acylamidase. Matsunka (27) reported that the synergistic action of these five insecticides with propanil has been utilized for the control of crabgrass (Digitaria sanquinalis (L.) Scop.) in citrus orchards. Both organophosphate and carbamate insecticides which act as acetylcholinesterase inhibitors interact synergistically with propanil to increase greatly its toxicity to rice.

McRae (28) suggested that the metabolism of propanil by rice leaves imparted selectivity. Furthermore, if carbaryl was also applied, selectivity was lost. Frear and Still (11) reported that rice leaves contained 60 times more of an aryl acylamadise which hydrolyzed propanil than did susceptible barnyardgrass leaves. Competitive inhibition of this enzyme by several insecticidal carbamates including carbaryl, methiocarb, and banol and organophosphates including malathion, parathion, demeton, and azinphosmethyl was noted.

McReynolds and Putnam (29) stated that field applications of formulated diazinon have been observed to increase chloroxuron injury to onions (Allium cepa (L.)). However, the solvent carrier for diazinon applied alone at the equivalent rate also gave a partial response.

METHODS AND MATERIALS

In 1976 and 1977, field experiments were conducted to evaluate the responses on the growth and development of soybeans grown in soil treated simultaneously with selected preemergence herbicides and systemic insecticides. Laboratory analyses were conducted to determine the percentages of crude protein, phosphorus, and potassium in the mature soybean seeds produced.

Field Experiments

In 1976, the soybean cultivar 'Williams', a semi-indeterminate with group three maturity, was established at two dates on a Pachic Haplustoll (Fine-silty, Mixed, Mesic) Muir silt loam soil with an organic matter content of 2.4 percent and a pH of 6.1 to a soil depth of 15.0 cm. The study was repeated on the silt loam soil in 1977 and was expanded to include a Typic Udifluvent (Coarse-silty, Mixed (Calcareous), Mesic) Haynie very fine sandy loam soil with an organic matter content of 0.6 percent and pH of 8.0 to a soil depth of 15.0 cm. The very fine sandy loam was included in the study to evaluate the responses of soybeans grown in a soil which had been treated with a pesticide not recommended for use on that soil type.

Pre-planting site preparation of the silt loam soil in 1976 included application of 157 kg/ha of 15-40-5 + 1% zinc fertilizer. (All plots were maintained at high fertility levels to prevent nutrient shortages.) The fertilizer was incorporated with a spring-tooth harrow and the plot area was clean-tilled until planting. Immediately before planting the plot area was prepared for planting with a tine-tooth harrow.

In 1977, 157 kg/ha of 18-46-0 fertilizer was applied to the silt loam plot area, being incorporated with a spring-tooth harrow. The plot area was clean-tilled until planting. Before final seedbed preparation with a tine-tooth harrow, soil samples to a depth of 15.0 cm were taken to determine the nematode population present in the soil.

The very fine sandy loam plot area in 1977 receive an application of 157 kg/ha of 18-46-0 fertilizer. The fertilizer was incorporated with a single pass of a tandem disk. The plot area was clean-tilled until planting. Prior to final seedbed preparation with a power driven rotary tiller, soil samples were taken to a depth of 15.0 cm for nematode population evaluation.

Statistical design of the experiment was a split-split plot with three replications where the whole plot treatment structure was dates of planting and subplot structure was a 3 by 4 factorial arrangement of three insecticides with four herbicides.

All plots in 1976 and 1977 were planted at a rate of 33 soybean seeds per meter of row at 4 kilometers per hour at a soil depth of 5.0 cm. An Allis Chalmers flex planter with double disk openers was used.

The treatment area consisted of four rows 75 cm apart and 9 meters long. Parameters evaluated in the study were taken from the two center rows. Border rows on the Muir silt loam soil were treated with 0.56 kg/ha of metribuzin and 2.24 kg/ha of alachlor. Borders on the Haynie very fine sandy loam were treated with 2.24 kg/ha of alachlor.

In 1976, the dates of planting were 21 May and 4 June. In 1977, the dates of planting for the silt loam location were 3 June and 28 June. The planting dates for the very fine sandy loam location were 19 May and 28 June.

Captan-Moly, a fungicide plus molybdenum was applied to all soybean seed to guard against fungal infection prior to emergence and to lubricate planter parts and provide molybdenum for nodulation.

Twelve treatments (Table 1.) were applied preemergence immediately following planting with a tractor-mounted spray boom 305 cm long and 45 cm from the soil surface. Compressed air was used for spray mixture agitation and spray pressure. Tee-Jet 8004SS nozzles were used at a spray pressure of 1.2 kilograms per square centimeter. The herbicides and insecticides were applied with water as the carrier at the rate of 187.0 liters per hectare. (Compatibility of pesticides was checked prior to field application.) Ground speed of the spray boom was 5 kilometers per hour.

Respirators and other protective clothing, as recommended on the insecticide labels, were used at all times in preparing and applying the insecticide treatments.

Throughout the growing season the plot area was maintained weed free, either by hand-hoeing or shallow rotary tilling, so that the soybean plants would respond to the herbicide-insecticide treatments under the given climatic conditions.

Stand count, recorded as plants per meter (hereafter P/M), was determined by averaging the number of plants from six (three counts from each of the two center rows) random sites within the plot area.

Plant height, recorded in centimeters (cm), was taken after leaf drop by visually averaging the height of all plants in the two center rows of the plot area.

The soybeans were harvested using a small plot combine. The soybeans collected were weighed for yield data. The yield was corrected to 12.5%

moisture. Subsamples of the harvested beans were taken and 100 beans were taken from the subsamples and the weight of these 100 beans was recorded in grams. Weight per 100 beans was also corrected to 12.5% moisture.

Laboratory Analysis

Subsamples of soybean seed from each of the treated plots were dried to a moisture level of 5% and ground for digestion with a Wiley mill. Digestion of beans for determination of percent crude protein, percent phosphorus, and percent potassium was the method employed by Isaac and Johnson (18).

Percent total nitrogen was multiplied by 6.25 to give percent of crude protein and percent phosphorus was determined by using industrial method No. 334-74W/B+, revised March 1977 (1). Percent potassium was determined using flame emission.

Table 1. Herbicide-Insecticide treatments.

Treatment*		Rates** (kg/ha)
1.	Metribuzin	0.56
2.	Metribuzin + Alachlor	0.56 + 2.24
3.	Metribuzin + Oryzalin	0.56 + 1.12
4.	Metribuzin + Fenamiphos	0.56 + 6.72
5.	Metribuzin + Carbofuran	0.56 + 6.72
6.	Metribuzin + Alachlor + Fenamiphos	0.56 + 2.24 + 6.72
7.	Metribuzin + Alachlor + Carbofuran	0.56 + 2.24 + 6.72
8.	Metribuzin + Oryzalin + Fenamiphos	0.56 + 1.12 + 6.72
9.	Metribuzin + Oryzalin + Carbofuran	0.56 + 1.12 + 6.72
10.	Fenamiphos	6.72
11.	Carbofuran	6.72
12.	Control	----

* Metribuzin, Alachlor, and Oryzalin are herbicides. Fenamiphos is a systemic organophosphate insecticide and Carbofuran is a systemic carbamate insecticide.

**Rates for the herbicides are those recommended for the Pachic Haplustolls soil and the insecticide rates are those recommended for nematode control.

RESULTS AND DISCUSSION

Statistical analyses of field and laboratory data collected in this study, as summarized in Table 6 and Table 7, indicated the selected preemergence herbicides and systemic insecticides applied simultaneously to soil in which soybeans were grown, resulted in independent responses in the growth and development of soybeans.

Pachic Haplustolls, 1976 and 1977

The Muir silt loam soil to which the twelve herbicide-insecticide treatments were applied, had organic matter and pH levels that fit within label requirements of all pesticides studied.

Statistical analyses, Table 6, provides no evidence of a herbicide-insecticide interaction occurring in soybeans grown in this silt loam soil.

There is, however, evidence that year of application; date of application; and interactions involving years and dates; years and insecticides; years and herbicides; and years; dates and herbicides; had significant effects on parameters measured.

YEARS

Variations in growing seasons can be extreme. Rainfall, Table 8, for the months of May through September of 1976 totalled 32.22 cm compared to 91.21 cm for 1977. Distribution of precipitation was also a factor in both 1976 and 1977. Total precipitation received in August 1976 (the primary period of seed development), was 0.74 cm as compared to a total of 18.51 cm in August, 1977. It can be assumed with vast differences in rainfall, there were also differences in solar radiation, temperature, and other growth and developmental influences.

Differences between the seasons of 1976 and 1977 resulted in the year of application showing evidence of significant effects on yield, stand, plant height, bean weight, percent crude protein, and percent phosphorus. There was no evidence of year of application affecting percent potassium, however (Table 2).

The period of germination is the most critical stage in soybean plant growth; excess or deficiency of soil moisture at this time being particularly injurious (17).

Deficiency of moisture at time of establishment in 1976 resulted in plant stand being only 58% of potential (if 100% germination is assumed). In 1977 plant stand was 87% of potential. Under favorable growing conditions, the ability of the soybean plant to compensate for erratic germination is well illustrated by experiments with skips in the row (8). Due to the shortage of moisture in 1976, the soybeans plants did not respond to a thin stand by producing lateral branches, and this is believed to have contributed to a decrease in yield.

Decreased plant height and decreased seed weight, contributed to lower soybean yield. A decrease in plant height is often associated with thinner plant stand(23).

Yield in 1977 was 50% higher than in 1976 due to a 50% better plant population, a 12% increase in plant height, and a 26% increase in seed weight. These yield components were greater, to a large extent, due to a 280% increase in rainfall in 1977. The rainfall was more evenly distributed throughout the 1977 growing season as well.

Higher protein levels found in beans produced in 1976 are believed to be a result of relatively lower yields in 1976. The beans may have matured at lower temperatures in 1976, which according to Cartter and Hartwig (7) could have produced higher protein levels.

Table 2. Effect of years on yield, stand, height, bean weight, percent protein, percent phosphorus and percent potassium.

Year	Yield	Stand	Height	Bean Weight	% Protein	% Phosphorus	% Potassium
1976	2197	19.2	83.4	17.5	39.87	.622	2.07
1977	3322	29.0	93.5	22.1	39.90	.686	2.14
LSD (.05)	186	1.97	7.54	.796	.49	.041	n.s.

Hardcastle, Wilkinson, and Young (14) reported that metribuzin did not significantly influence percent protein content of soybean seed.

Lower levels of phosphorus accumulated in the soybean seeds produced in 1976 are thought to have been related to the adverse climatic conditions. Moisture was limited during pod development and fill. Phosphorus uptake could also have been limited by a reduction in root development due to moisture stress.

Slight metribuzin injury, characterized by marginal leaf chlorosis, was noted on several plots. Less than one percent of the soybean leaves exhibited metribuzin injury; thus it is believed that the injury did not have any detrimental effects on the growth and development of the soybeans.

Nematode levels in the soil were not of a significant level to cause soybean injury. Therefore no yield increase was attributed to control of nematodes.

Dates

Date of planting affected yield, plant height, percent protein, percent phosphorus, and percent potassium. In 1976, fourteen days separated the two dates of planting. During 1977, the two dates of planting were twenty-five days apart. Because of the difference in elapsed time between planting dates, significant information will follow as within-year by date interactions and significant differences for dates across-years will not be presented.

Year x Date Interaction

Over the two year period and the two dates of planting in this study, there were statistically significant differences in yield and percent protein.

In 1976, a fourteen day interval between planting dates was not significant with respect to yield. However a twenty-five day spread between planting dates was significant with respect to yield in 1977 (Table 3).

In the Midwest, soybean plantings made during May vary little in yield; however, June and particularly July plantings yield progressively less (45, 34, 36, 26). Yields of soybeans planted on 20 May and 4 June 1976, were not significantly different at Mound Valley, Kansas, (Kelley and Nickell 24).

Percent crude protein in 1976 was affected by planting date, with beans produced from Date 1 having a significantly higher level of protein than Date 2 (Table 4). Cartter and Hartwig (7) reviewed the effect of planting date on the synthesis of oil and protein. A decrease in oil and a slight increase in protein generally occurs with a delay in planting. Data collected for this study did not follow this general pattern.

Table 3. Effect of planting date on soybean yield.

Date	Yield (kg/ha) 1976	1977
1	2157	3937
2	2237	2708
LSD (.05)	n.s.	634

Table 4. Effect of planting date on percent crude protein.

Date	% Crude Protein 1976	1977
1	40.32	38.93
2	39.43	38.88
LSD (.05)	.38	n.s.

OTHER INTERACTIONS

Because of the lack of evidence that the herbicide-insecticide treatments interacted to affect soybean growth and development and due to the variations in years and different intervals between planting dates over years, it is believed that the three-way interactions noted as being significant in Table 6, are due to climatic conditions.

It is important to state that the chemicals used in this study were compatible with the soil type on which they were applied, and thus no individual effects were anticipated. Moody and Bailey (30) and Shehane and Bass (42) reported that carbofuran had no significant affect on yield or the average weight of 100 seeds of soybean.

Pachic Haplustolls and Typic Udifluvents, 1977

In contrast to the Muir silt loam, the Haynie very fine sandy loam, with an organic matter content of 0.6% and a pH of 8.0, was outside the safe use recommendations on the metribuzin label (2), with respect to both organic matter and pH.

The purpose of including the Haynie very fine sandy loam location was to evaluate the effects of herbicide-insecticide combinations on a soil type where herbicide stress could occur.

Statistical analysis (Table 7) of data collected from the two locations in 1977 suggests no evidence of an herbicide-insecticide interaction having occurred. Soybeans grown in soil treated with an insecticide alone showed no evidence of being affected in any of the parameters measured.

Planting dates for the two locations were inconsistent for Date 1 (19 May and 3 June); however, beans were planted in both locations on the same day for Date 2 (28 June). Yields were significantly lower on Date 2 within the same location. However, yields from Date 2 across locations were not statistically different.

Because of the inconsistency of planting dates, statistical analysis and discussion will be related to only date and treatment effects within a given location.

Data summarized in Table 7 indicates locations, dates of planting and herbicides had significant effects on yield, plant stand, plant height, and seed weight. No evidence involving herbicides, insecticides, or herbicide-insecticide combinations was noted on the seed constituents of crude protein, phosphorus, and potassium. There was no evidence of an interaction occurring between any of the herbicide-insecticide treatments on any of the parameters evaluated within locations and dates, or across locations and dates.

Due to the lack of evidence of an interaction occurring among herbicide-insecticide treatments on the Muir silt loam soil, data presented and discussed here will relate to the information gathered from the Haynie very fine sandy loam soil.

Typic Udifluvents

Analysis of the effect of herbicides on yield, plant stand, plant height, and seed weight (Table 5) indicates metribuzin had significant effects on all four parameters. Because all herbicide treatments had significantly reduced yield as compared to the control, injury is believed to be due to the presence of metribuzin. (Border rows that received 2.24 kg/ha of alachlor alone exhibited no injury symptoms.) Metribuzin acted independently of alachlor and oryzalin. Royster and Kerr (40) reported that adding dinitroanilines to metribuzin did not affect soybean yield.

Hawf and Waggoner reported (16) that trials throughout the USA indicated that soybean can tolerate 0.84 to 1.12 kg/ha metribuzin applied preemergence. The authors also note that reaction of soybean to metribuzin was affected by soil type and environmental conditions.

Jennings (21) reported that metribuzin dosage in relation to soil types is critical in preventing metribuzin tendency to retard crop growth.

Moomaw, Martin and Burnside (31) and Ladlie, Maggitt, and Penner (25) reported that metribuzin applied preemergence resulted in increased phytotoxicity to soybeans, with increasing pH from 4.5 to 6.9. Crop injury ratings increased and plant height and grain yield decreased as the soil pH increased. In greenhouse studies, soybeans grown in soil showed decreased dry weights due to metribuzin as pH increased.

Timing of rainfall has been reported as having an effect on the activity of metribuzin. Pulver and Ceron (39) reported that soybeans are affected adversely if more than 9 cm of rain fell immediately after preemergence application of metribuzin.

Coble and Schrader (9) reported that tolerance of greenhouse-grown soybeans to preemergence applications of metribuzin was greatly influenced by soil organic matter and simulated rainfall after treatment.

Rainfall totalling 12.14 cm fell on the treated plots within 24 hours after Date 1 was planted. The rain came rapidly and crusting and compaction of the soil surface resulted. Rainfall immediately after application of metribuzin combined with crusting and compaction of the soil resulted in reduced plant height and plant stand, and ultimately reduced yield. The injury was somewhat overcome by the soybean plants producing three to five lateral branches due to decreased competition for space. Some leaching of metribuzin into the soil profile also may have occurred.

Significant rainfall on Date 2 planting did not occur for fourteen days. Because the rain fell gently and over an extended period of time, crusting and compaction did not occur. Plant stand was not reduced (Table 5). However seed weight, plant height, and yield were reduced significantly. Leaching of the metribuzin into the root zone is thought to have contributed to the injury. Typical metribuzin marginal chlorosis and eventually necrosis resulted.

Table 5. Effect of herbicides on yield, stand, plant height and seed weight on Typic Udifluvents, 1977

Herbicide	Yield kg/ha		Stand P/M		Plant Height cm		Seed Weight g/100	
	Date 1	Date 2	Date 1	Date 2	Date 1	Date 2	Date 1	Date 2
Metribuzin	3499	2307	13.0	32.0	84.0	75.0	20.4	20.4
Metribuzin + Alachlor	3575	2090	12.7	32.0	89.3	64.7	19.2	19.8
Metribuzin + Oryzalin	3369	2426	11.7	33.3	84.7	73.0	20.0	20.4
Control	3705	2719	14.0	33.0	94.7	86.7	19.9	21.9
LSD (.05) within dates	182	182	1.35	n.s.	5.55	5.55	.604	.604
LSD (.05) across dates	415		18.7		12.8		1.01	

Following the appearance of injury symptoms typical to metribuzin, the center two rows of the plot areas were rotary tilled to a depth of 5 cm to aid in keeping the plots weed free. The soybeans that had been closely tilled recovered more quickly from metribuzin injury than did soybeans not cultivated. This is believed to be in part due to increased soil aeration which led to more rapid microbial breakdown of metribuzin. Cultivation could have diluted the amount of metribuzin in close proximity to the soybean roots, thus slowing uptake of metribuzin into the plants. There was no difference in the rate of recovery noted among the plots receiving metribuzin.

Plates I, II, III, and IV, depict the effect of the metribuzin on plant height as compared to metribuzin plus another herbicide, metribuzin plus another herbicide plus an insecticide, an insecticide alone, and the control.

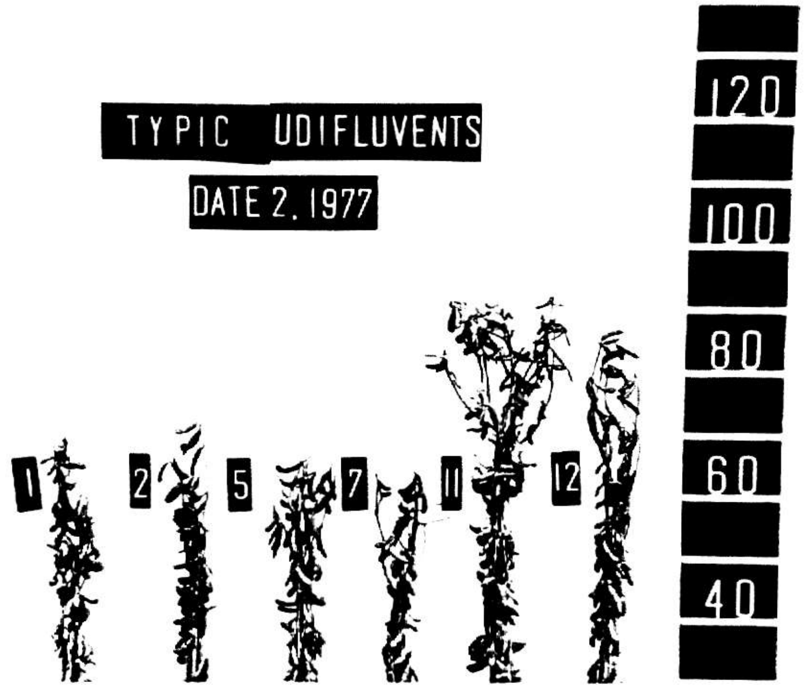

PLATE I

Effect of Herbicide-Insecticide treatments on plant height, Typic Udifluvents, Date 2, 1977.

Explanation of PLATE I. Metribuzin (1); Metribuzin + Alachlor (2); Metribuzin + Carbofuran (5); and Metribuzin + Alachlor + Carbofuran (7); resulted in significantly shorter plants than did Carbofuran (11) and Control (12) treatments. However, Metribuzin alone or in combination with Alachlor or Carbofuran, or in combination with Alachlor and Carbofuran were not significantly different, indicating that Metribuzin reacted independently in reducing plant height.

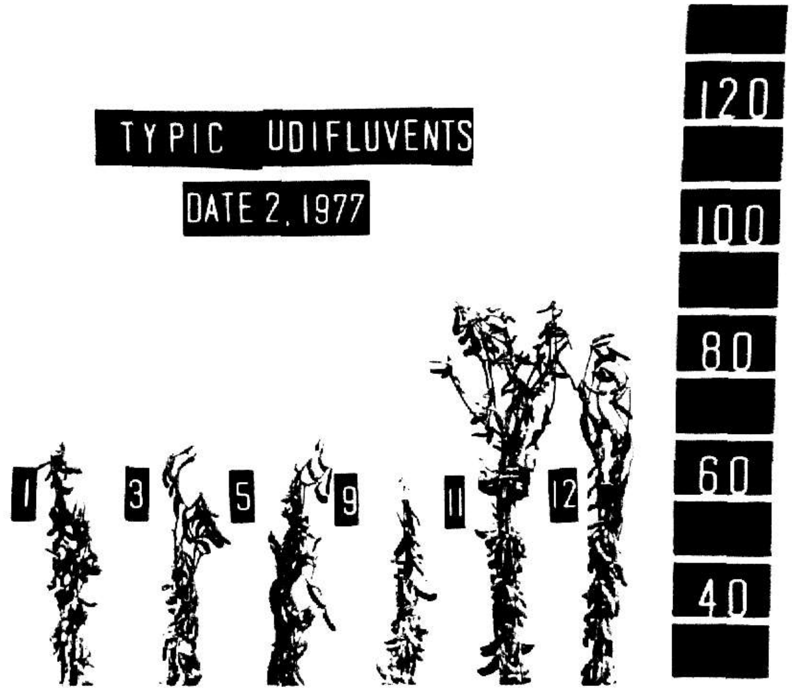

PLATE II

Effect of Herbicide-Insecticide treatments on plant height, Typic Udifluvents, Date 2, 1977.

Explanation of Plate II. Metribuzin (1); Metribuzin + Oryzalin (3); Metribuzin + Carbofuran (5); and Metribuzin + Oryzalin + Carbofuran (9); resulted in significantly shorter plants than did Carbofuran (11) and Control (12) treatments. However, Metribuzin alone or in combination with Oryzalin or Carbofuran, or in combination with Oryzalin and Carbofuran were not significantly different, indicating Metribuzin acted independently in reducing plant height.

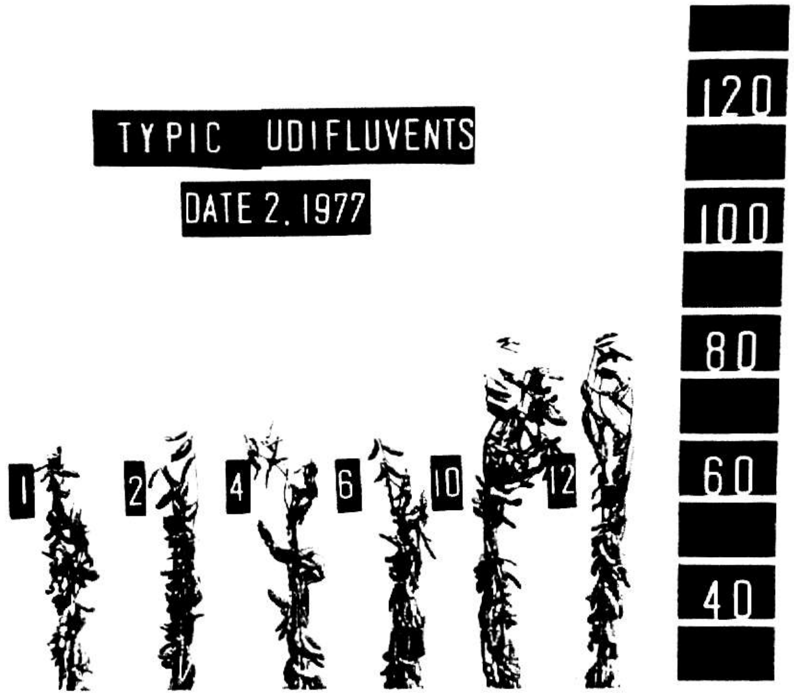

PLATE III

Effect of Herbicide-Insecticide treatments on plant height; Typic Udifluvents, Date 2, 1977.

Explanation of Plate III. Metribuzin (1); Metribuzin + Alachlor (2): Metribuzin + Fenamiphos (4); and Metribuzin + Alachlor + Fenamiphos (6); resulted in significantly shorter plants than did Fenamiphos (10) and Control (12) treatments. Metribuzin alone or in combination with Alachlor or Fenamiphos, or in combination with Alachlor and Fenamiphos were not significantly different, indicating Metribuzin acted independently in reducing plant height.

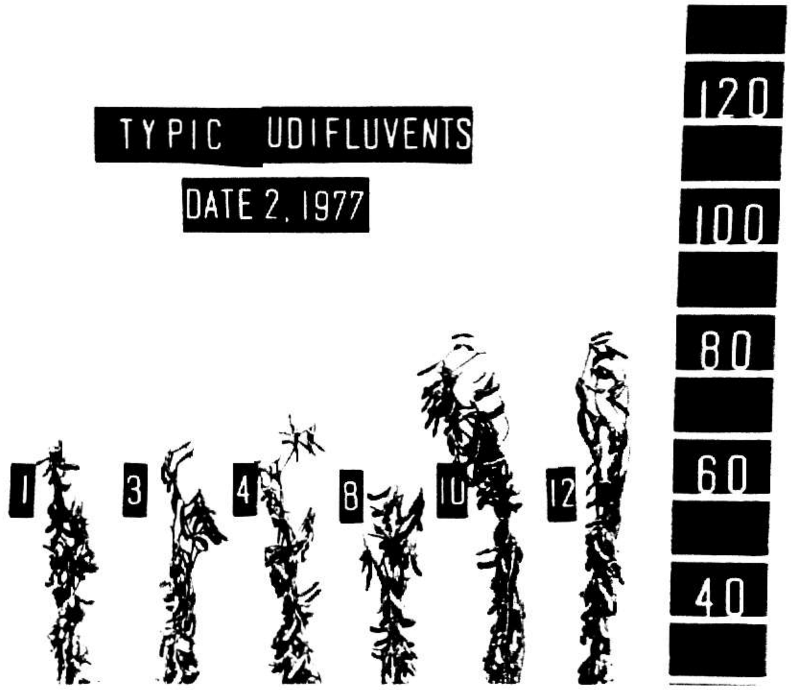

PLATE IV

Effect of Herbicide-Insecticide treatments on plant height; Typic Udifluvents, Date 2, 1977.

Explanation of Plate IV. Metribuzin (1); Metribuzin + Oryzalin (3); Metribuzin + Fenamiphos (4): and Metribuzin + Oryzalin + Fenamiphos (8); resulted in significantly shorter plants than did Fenamiphos (10) and Control (12) treatments. However, Metribuzin alone or in combination with Oryzalin or Fenamiphos, or in combination with Oryzalin and Fenamiphos were not significantly different, indicating Metribuzin acted independently in reducing plant height.

SUMMARY

Soybeans grown in soil treated with selected preemergence herbicides, systemic insecticides and combinations of the two classes of pesticides resulted in the chemicals behaving independently.

Variations in the growing seasons of 1976 and 1977 resulted in no evidence of herbicide-insecticide interactions. Application of the twelve treatments to a soil type not within label recommendations for all chemicals, provided stress on the soybean plants grown but provided no evidence of an interaction.

Rainfall amount and timing affected the activity of metribuzin on the Typic Udifluvents soil.

Statistical analysis indicated positive correlation between yield and plant height, yield and seed weight, and plants per meter of row and plant height.

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LITERATURE CITED

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APPENDIX

Table 6. Statistical summary for the Pachic Haplustolls soil, 1976 and 1977.

		Mean Squares						
Source of Variation	Degrees of Freedom	Yield	Stand	Height	Bean Weight	Protein	% P	% K
Replicates	2	1182890	13.650	1005.256	13.431	.105	.0030	.0223
Years (Y)	1	45541352**	3468.288**	3640.111*	760.380**	33.882*	.1447**	.1820
Error (a)	2	67742	7.562	108.173	1.234	.468	.0033	.0262
Dates (D)	1	11877558**	2.376	3043.361*	.011	7.779**	.0568**	.0802*
Y x D	1	15411120*	262.710	36.000	17.570	6.312*	.0021	.1034
Error (b)	4	932592	23.786	321.118	13.320	.331	.0014	.0084
Insecticides (I)	2	12654	.872	41.027	.078	.333	.0003	.0006
Herbicides (H)	3	7122	3.872	2.398	.144	.921	.0008	.0020
Y x I	2	7963	.334	50.777**	1.627*	.275	.0012*	.0032
Y x H	3	49654*	3.552	5.814	1.014	.229	.0002	.0004
D x I	2	28898	1.452	12.027	1.613	.626	.0000	.0005
D x H	3	31057	2.512	10.916	1.249	.266	.0000	.0032
I x H	6	18191	2.701	11.120	.558	.275	.0000	.0006
Y x D x I	2	17129	.373	1.750	.336	.173	.0005	.0011
Y x D x H	3	5828	5.438*	.518	.579	.079	.0001	.0069*
Y x I x H	6	29427	1.265	13.703	.401	.600	.0001	.0010
D x I x H	6	11511	1.658	2.361	.391	.393	.0004	.0023
Y x D x I x H	6	30263	.621	7.324	.248	.758	.0002	.0019
Error (c)	88	14701	1.646	8.113	.485	.535	.0003	.0018
C.V. (Error c)		4.39	5.30	3.21	3.51	1.85	2.64	2.02

*, ** significant at 0.05 and 0.01 levels of probability, respectively

Table 7. Statistical summary for the Pachic Haplustolls and Typic Udifluvents soils, 1977.

Source of Variation	Degrees of Freedom	Mean Squares						
		Yield	Stand	Height	Bean Weight	% Protein	% P	% K
Replicates	2	441918	16.145	180.631	3.209	.583	.0001	.0087
Locations (L)	1	5381433*	1463.062**	4466.694	120.450**	3.534	.1305*	.0469*
Error (a)	2	60693	5.145	502.298	1.048	1.278	.0040	.0017
Dates (D)	1	52312069**	4214.173**	8130.027**	3.770	.846	.0654**	.0023
L x D	1	19425	2525.062*	841.000	5.561	1.432	.0008	.0075*
Error (b)	4	345568	17.951	338.534	1.954	1.034	.0011	.0006
Insecticides (I)	2	19436	3.062	43.694	.779	.191	.0001	.0005
Herbicides (H)	3	281578**	2.988	259.314**	2.168	.424	.0001	.0032
L x I	2	6419	.395	9.694	.227	.767	.0004	.0013
L x H	3	154372**	3.155	249.453**	4.224**	.123	.0000	.0004
D x I	2	26240	1.048	164.111*	1.772*	.364	.0000	.0000
D x H	3	156595**	2.081	218.601**	2.908**	.368	.0001	.0012
I x H	6	43341	2.432	56.787	.685	.419	.0001	.0008
L x D x I	2	6979	2.270	66.083	.557	.091	.0004	.0009
L x D x H	3	163537**	6.303*	232.870**	3.090**	.368	.0000	.0004
L x I x H	6	40615	2.988	19.342	.502	.288	.0001	.0010
D x I x H	6	16916	2.344	32.574	.337	.288	.0001	.0025
L x D x I x H	6	36103	1.011	42.620	.158	.383	.0004	.0014
Error (c)	88	38083	2.078	35.181	.416	.500	.0002	.0012
C.V. (Error c)		6.23	5.56	6.74	3.04	1.81	2.15	1.60

*, ** significant at 0.05 and 0.01 levels of probability, respectively

Table 8. Growing Season Precipitation (Centimeters).

	May		June		July		August		September	
Day	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
1	.08	.05								3.18
2						.18		.13		.05
3				.03		.03		.05		.05
4		.03						2.46		.69
5	.03							.28		.05
6	3.10		.03	.23			.10	1.24		
7										
8								.08		
9						.25			.48	
10										
11			.03			2.64		1.63		
12	.03			5.23			.56	.03		2.97
13	.51								.58	6.50
14			.03	.08			.08		.03	
15	.10	.08	.15					1.45		
16	1.88				.20	.10		1.40	2.26	.13
17	.18	.56		.58	.43			.69		
18			4.32	15.95	1.63					.03
19				.86						
20		12.14		.10						
21		3.45		.56				.05		.15
								.10		
22	1.37	.08		3.35				3.81	.10	.20
23	2.03	2.41	2.67							.64
24	.08		4.22	2.08						
25				.25		.03				
26	.10							.13	2.34	
27	.33	.28								
28		.81	.56		.66			4.95		
								.03		.46
29		.81	.94							.03
30		3.02								
31		1.32								
Total	9.82	25.04	12.95	29.30	2.92	3.23	.74	18.51	5.79	15.13

Table 9. Pachic Haplustolls data by replicates, May 21, 1976.

Treatment	Yield kg/ha	Stand P/M	Height cm.	Seed Weight gm/100	% Crude Protein	% P	% K
1. Metribuzin	2146.2	19.5	93.0	15.1	41.72	.626	1.95
	2439.0	20.8	76.0	19.5	39.74	.605	2.05
	1821.0	22.7	90.0	15.7	40.44	.596	2.06
2. Metribuzin	2276.4	20.8	93.0	15.7	39.23	.580	2.04
Alachlor	2211.6	21.5	78.0	18.7	41.02	.651	2.08
	1918.8	22.3	92.0	16.6	40.32	.598	1.91
3. Metribuzin	2308.8	18.5	89.0	15.3	40.50	.629	2.07
Oryzalin	2372.5	19.2	79.0	18.3	38.52	.603	2.04
	1820.0	22.3	93.0	15.2	40.51	.598	1.92
4. Metribuzin	2276.4	19.2	85.0	16.0	40.96	.632	2.06
Fenamiphos	2341.2	18.7	80.0	20.5	41.08	.615	2.17
	1821.0	21.7	93.0	16.1	39.80	.596	1.96
5. Metribuzin	2276.4	19.8	92.0	16.8	40.19	.628	2.12
Carbofuran	2601.6	22.3	82.0	20.6	40.89	.615	2.17
	1951.2	21.2	94.0	16.8	41.92	.619	2.02
6. Metribuzin	2178.6	21.2	92.0	17.0	39.40	.599	2.02
Alachlor	2471.4	19.2	76.0	19.3	40.12	.571	2.06
Fenamiphos	1756.2	23.0	88.0	15.7	40.19	.593	1.92
7. Metribuzin	2081.4	19.3	93.0	16.8	40.32	.620	2.00
Alachlor	2211.6	21.0	83.0	18.2	41.15	.656	2.10
Carbofuran	1853.4	22.8	95.0	15.5	40.44	.605	1.96
8. Metribuzin	2406.6	18.2	88.0	17.0	41.79	.580	1.93
Oryzalin	2439.0	20.8	80.0	19.7	40.12	.626	2.15
Fenamiphos	1821.0	24.0	93.0	15.4	40.89	.586	1.98
9. Metribuzin	2049.0	19.0	94.0	16.7	40.38	.599	1.95
Oryzalin	2601.6	20.7	85.0	19.0	39.16	.610	2.07
Carbofuran	1853.4	23.3	90.0	17.0	40.18	.604	1.98
10. Fenamiphos	2146.2	20.8	93.0	16.9	40.44	.608	2.00
	2536.8	19.2	82.0	18.6	40.00	.573	2.03
	1690.8	21.8	92.0	16.1	39.56	.579	1.93
11. Carbofuran	2211.6	19.0	92.0	15.8	40.44	.606	1.94
	2471.4	19.8	83.0	17.8	40.83	.637	2.13
	1821.0	23.5	89.0	17.3	40.32	.595	2.02
12. Control	2081.4	18.3	88.0	16.9	39.36	.599	1.96
	2536.8	19.5	81.0	18.8	39.04	.620	2.11
	1886.4	22.0	86.0	16.2	40.44	.586	1.96

Table 10. Pachic Haplustolls data by replicates, June 4, 1976.

Treatment	Yield kg/ha	Stand P/M	Height cm.	Seed Weight gm/100	% Crude Protein	% P	% K
1. Metribuzin	2536.8	17.5	87.0	18.2	39.80	.628	2.12
	1853.4	14.2	71.0	17.5	39.55	.687	2.19
	2341.2	16.7	83.0	16.9	40.44	.624	2.04
2. Metribuzin	2894.4	18.2	83.0	18.5	39.16	.615	2.12
Alachlor	1864.0	16.7	73.0	17.1	39.55	.659	2.23
	2211.6	17.5	82.0	18.7	39.04	.628	2.16
3. Metribuzin	2601.6	18.8	83.0	18.3	39.36	.606	2.10
Oryzalin	1886.4	17.8	73.0	17.0	39.04	.640	2.11
	2341.2	19.3	83.0	17.7	39.16	.651	2.13
4. Metribuzin	2439.0	20.8	84.0	17.9	39.04	.628	2.10
Fenamiphos	1723.8	15.8	73.0	18.2	39.87	.677	2.13
	2049.0	17.0	81.0	17.5	38.78	.609	2.03
5. Metribuzin	2178.6	15.2	87.0	16.8	39.16	.651	2.05
Carbofuran	1951.2	17.2	76.0	16.8	40.96	.665	2.11
	2308.8	18.0	81.0	16.6	39.61	.656	2.13
6. Metribuzin	2276.4	18.0	85.0	16.6	41.08	.658	2.07
Alachlor	1951.2	15.7	71.0	17.3	38.72	.648	2.21
Fenamiphos	2146.2	17.3	79.0	18.7	39.68	.626	2.12
7. Metribuzin	2634.0	18.8	87.0	17.6	38.40	.633	2.09
Alachlor	1918.8	17.3	73.0	17.1	38.40	.640	2.14
Carbofuran	2341.2	16.7	81.0	18.0	38.46	.666	2.24
8. Metribuzin	2699.4	21.3	78.0	19.0	38.72	.620	2.14
Oryzalin	1951.2	17.7	70.0	18.5	39.16	.659	2.13
Fenamiphos	2211.6	18.8	82.0	17.5	39.80	.609	2.06
9. Metribuzin	2926.8	19.0	88.0	18.2	39.04	.647	2.20
Oryzalin	1886.4	17.0	77.0	16.5	38.78	.669	2.16
Carbofuran	2308.8	18.8	80.0	17.5	41.15	.628	2.10
10. Fenamiphos	2764.2	16.8	83.0	19.0	39.87	.622	2.10
	1821.0	17.8	73.0	17.9	40.51	.656	2.09
	2081.4	19.2	78.0	19.2	39.04	.618	2.15
11. Carbofuran	2699.4	21.3	83.0	18.9	39.80	.606	2.10
	1918.8	16.8	76.0	17.2	38.59	.654	2.11
	2113.8	16.7	83.0	18.0	38.91	.635	2.12
12. Control	2536.8	20.3	80.0	18.8	41.15	.590	2.08
	1886.4	15.7	72.0	18.8	39.55	.644	2.13
	2308.8	18.7	78.0	19.1	38.27	.635	2.16

Table 11. Pachic Haplustolls data by replicates, June 3, 1977

Treatment	Yield kg/ha	Stand P/M	Height cm.	Seed Weight gm/100	% Crude Protein	% P	% K
1. Metribuzin	4160.0	27.0	110.0	22.8	38.43	.690	2.15
	3640.0	27.0	90.0	23.3	39.75	.661	2.17
	3802.5	28.0	94.0	21.5	39.38	.660	2.15
2. Metribuzin	4062.5	26.0	100.0	23.3	38.00	.681	2.15
Alachlor	3802.5	29.0	85.0	22.4	38.38	.673	2.20
	3737.5	28.0	96.0	20.5	39.13	.671	2.10
3. Metribuzin	4127.5	28.0	105.0	22.7	38.75	.659	2.09
Oryzalin	3900.0	25.0	86.0	23.7	39.13	.651	2.17
	3835.0	27.0	105.0	20.4	38.75	.631	2.08
4. Metribuzin	4115.0	26.0	110.0	23.2	38.69	.689	2.13
Fenamiphos	3965.0	30.0	85.0	21.5	39.50	.648	2.05
	4030.0	26.0	99.0	22.9	39.13	.652	2.14
5. Metribuzin	4160.0	25.0	104.0	22.9	38.38	.681	2.16
Carbofuran	3672.5	29.0	89.0	23.4	39.50	.639	2.11
	3965.0	30.0	95.0	22.5	38.75	.659	2.18
6. Metribuzin	4062.5	27.0	114.0	22.9	38.75	.693	2.21
Alachlor	3770.0	27.0	96.0	23.1	39.75	.659	2.18
Fenamiphos	3997.5	25.0	97.0	22.3	39.06	.655	2.12
7. Metribuzin	4257.5	27.0	110.0	22.6	38.13	.667	2.16
Alachlor	3965.0	27.0	86.0	23.8	39.81	.639	2.11
Carbofuran	3900.0	28.0	100.0	22.5	38.38	.653	2.15
8. Metribuzin	4062.5	29.0	107.0	22.1	39.81	.718	2.20
Oryzalin	3835.0	30.0	93.0	23.4	38.00	.664	2.19
Fenamiphos	3542.5	26.0	103.0	20.5	38.38	.650	2.19
9. Metribuzin	4127.5	28.0	108.0	23.1	39.75	.682	2.15
Oryzalin	3835.0	28.0	91.0	22.7	39.50	.653	2.15
Carbofuran	3705.0	27.0	98.0	22.3	39.13	.633	2.13
10. Fenamiphos	4160.0	26.0	110.0	22.6	38.50	.702	2.22
	3900.0	29.0	96.0	22.2	38.75	.665	2.14
	3672.5	29.0	97.0	21.1	38.00	.605	2.14
11. Carbofuran	4192.5	28.0	106.0	23.0	39.75	.665	2.13
	3835.0	32.0	94.0	22.7	39.75	.651	2.15
	3932.5	28.0	102.0	21.4	38.75	.650	2.10
12. Control	4192.5	30.0	102.0	22.5	39.06	.685	2.17
	3802.5	30.0	88.0	23.2	38.75	.662	2.14
	3900.0	31.0	99.0	22.2	38.00	.653	2.15

Table 12. Pachic Haplustolls data by replicates, June 28, 1977

Treatment	Yield kg/ha	Stand P/M	Height cm.	Seed Weight gm/100	% Crude Protein	% P	% K
1. Metribuzin	2697.5	30.0	89.0	20.8	39.00	.762	2.25
	2340.0	28.0	95.0	20.8	39.38	.719	2.10
	2567.5	32.0	85.0	22.2	38.50	.704	2.10
2. Metribuzin	2860.0	30.0	85.0	21.5	38.00	.705	2.12
Alachlor	2762.5	28.0	86.0	21.6	39.63	.711	2.11
	3055.0	30.0	84.0	22.8	38.63	.707	2.16
3. Metribuzin	2762.5	31.0	84.0	21.7	39.75	.708	2.18
Oryzalin	2697.5	29.0	91.0	22.4	39.38	.728	2.15
	2535.0	30.0	90.0	22.4	38.38	.710	2.10
4. Metribuzin	2762.5	34.0	87.0	21.6	38.38	.709	2.20
Fenamiphos	2795.0	29.0	88.0	22.2	39.63	.718	2.12
	2697.5	31.0	86.0	21.5	39.38	.702	2.16
5. Metribuzin	2730.0	30.0	87.0	20.2	38.75	.712	2.17
Carbofuran	2730.0	30.0	90.0	23.4	38.00	.711	2.12
	2730.0	30.0	95.0	22.3	39.75	.709	2.13
6. Metribuzin	2860.0	30.0	86.0	21.5	39.75	.694	2.15
Alachlor	2730.0	28.0	90.0	22.4	38.31	.718	2.20
Fenamiphos	2600.0	31.0	95.0	21.0	38.00	.709	2.17
7. Metribuzin	2827.5	32.0	87.0	21.4	39.38	.685	2.14
Alachlor	2730.0	30.0	90.0	23.2	39.00	.698	2.13
Carbofuran	2437.5	30.0	85.0	22.0	38.13	.718	2.15
8. Metribuzin	2827.5	34.0	90.0	21.6	38.38	.698	2.13
Oryzalin	2665.0	29.0	92.0	21.5	38.06	.689	2.13
Fenamiphos	2502.5	31.0	85.0	21.8	39.00	.693	2.11
9. Metribuzin	2665.0	32.0	88.0	21.4	39.00	.705	2.18
Oryzalin	2632.5	30.0	87.0	22.5	38.00	.720	2.16
Carbofuran	2502.5	29.0	90.0	21.3	39.94	.730	2.16
10. Fenamiphos	2827.5	32.0	90.0	21.0	39.31	.740	2.21
	2535.0	27.0	92.0	21.8	38.44	.732	2.13
	2600.0	29.0	87.0	20.6	38.50	.675	2.06
11. Carbofuran	2762.5	31.0	87.0	22.2	39.75	.695	2.13
	2470.0	30.0	88.0	20.9	38.75	.722	2.11
	2795.0	32.0	87.0	21.9	39.50	.710	2.12
12. Control	2990.0	31.0	85.0	22.0	38.13	.730	2.14
	3022.5	30.0	93.0	22.6	39.38	.678	2.13
	2795.0	31.0	87.0	21.4	38.50	.703	2.07

Table 13. Typic Udifluvents data by replicates, May 19, 1977.

Treatment	Yield kg/ha	Stand P/M	Height cm.	Seed Weight gm/100	% Crude Protein	% P	% K
1. Metribuzin	3477.5	13.0	102.0	20.3	39.50	.611	2.16
	3737.5	12.0	83.0	20.5	38.25	.593	2.15
	3282.5	14.0	67.0	20.3	39.25	.609	2.19
2. Metribuzin	3250.0	12.0	80.0	19.9	39.50	.593	2.15
Alachlor	3412.5	13.0	95.0	19.2	38.50	.647	2.24
	4062.5	13.0	93.0	18.6	38.25	.588	2.15
3. Metribuzin	3705.0	13.0	75.0	19.1	39.63	.580	2.16
Oryzalin	3055.0	10.0	74.0	20.6	39.25	.607	2.20
	3347.5	12.0	105.0	20.2	38.19	.628	2.18
4. Metribuzin	3640.0	14.0	85.0	20.3	38.94	.578	2.19
Fenamiphos	3315.0	12.0	96.0	20.2	39.88	.622	2.15
	3542.5	12.0	105.0	21.3	39.50	.627	2.11
5. Metribuzin	3900.0	17.0	93.0	20.4	38.63	.580	2.15
Carbofuran	3575.0	14.0	95.0	21.6	28.50	.620	2.21
	3120.0	13.0	100.0	20.9	38.88	.618	2.16
6. Metribuzin	3802.5	16.0	96.0	20.0	39.63	.585	2.21
Alachlor	3900.0	12.0	95.0	20.3	39.63	.598	2.14
Fenamiphos	3412.5	16.0	110.0	20.4	38.25	.617	2.10
7. Metribuzin	3737.5	17.0	95.0	20.5	38.88	.595	2.21
Alachlor	3575.0	12.0	92.0	21.1	39.88	.618	2.22
Carbofuran	3315.0	14.0	105.0	20.3	39.88	.635	2.18
8. Metribuzin	3607.5	12.0	93.0	20.5	38.25	.609	2.19
Oryzalin	3510.0	11.0	94.0	20.2	38.19	.608	2.23
Fenamiphos	3120.0	13.0	100.0	19.3	39.56	.620	2.18
9. Metribuzin	3672.5	15.0	80.0	21.5	39.94	.608	2.19
Oryzalin	3250.0	10.0	82.0	19.9	38.25	.603	2.17
Carbofuran	3347.5	15.0	100.0	20.3	38.63	.621	2.16
10. Fenamiphos	4257.5	15.0	85.0	21.0	39.56	.618	2.15
	3477.5	12.0	94.0	20.6	39.63	.588	2.14
	2957.5	8.0	90.0	20.2	38.88	.618	2.16
11. Carbofuran	3965.0	15.0	87.0	20.4	38.25	.594	2.17
	3412.5	10.0	93.0	20.2	39.88	.601	2.16
	3120.0	13.0	100.0	19.3	39.56	.622	2.17
12. Control	4127.5	18.0	83.0	20.4	38.00	.579	2.12
	3770.0	10.0	98.0	20.1	38.25	.598	2.14
	3217.5	14.0	103.0	19.3	39.88	.618	2.15

Table 14. Typic Udifluvents data by replicates, June 28, 1977.

Treatment	Yield kg/ha	Stand P/M	Height cm.	Seed Weight gm/100	% Crude Protein	% P	% K
1. Metribuzin	2177.5	33.0	70.0	20.4	39.38	.610	2.14
	2112.5	31.0	75.0	20.7	40.00	.658	2.24
	2632.5	32.0	80.0	20.1	40.00	.652	2.19
2. Metribuzin	1885.0	32.0	61.0	19.7	36.88	.629	2.20
Alachlor	1982.5	32.0	68.0	20.6	40.63	.669	2.24
	2405.0	32.0	65.0	19.1	40.00	.647	2.21
3. Metribuzin	1982.5	33.0	73.0	20.1	39.06	.660	2.20
Oryzalin	2600.0	33.0	71.0	20.2	39.38	.611	2.14
	2697.5	34.0	75.0	21.0	39.69	.639	2.18
4. Metribuzin	2365.0	32.0	52.0	19.3	39.38	.661	2.28
Fenamiphos	1917.5	31.0	69.0	20.2	39.38	.651	2.23
	2340.0	34.0	71.0	21.0	39.38	.638	2.12
5. Metribuzin	2145.0	33.0	66.0	19.9	39.38	.652	2.21
Carbofuran	2535.0	31.0	83.0	19.8	39.38	.655	2.21
	2405.0	32.0	70.0	20.7	40.31	.655	2.18
6. Metribuzin	2242.5	31.0	76.0	19.7	38.75	.654	2.21
Alachlor	2307.5	34.0	70.0	18.7	38.13	.629	2.17
Fenamiphos	2242.5	30.0	60.0	20.1	40.63	.671	2.24
7. Metribuzin	1722.5	34.0	59.0	19.7	37.50	.620	2.20
Alachlor	2047.5	32.0	69.0	19.4	38.13	.612	2.18
Carbofuran	2080.0	30.0	77.0	19.0	39.69	.665	2.14
8. Metribuzin	2197.5	30.0	54.0	18.1	40.00	.671	2.20
Oryzalin	2120.0	32.0	60.0	19.1	40.00	.665	2.24
Fenamiphos	2050.0	31.0	68.0	18.8	39.38	.652	2.16
9. Metribuzin	1990.0	33.0	57.0	19.8	38.75	.632	2.21
Oryzalin	2227.5	34.0	55.0	19.5	38.75	.638	2.24
Carbofuran	2502.5	31.0	72.0	19.6	40.00	.650	2.18
10. Fenamiphos	2730.0	34.0	88.0	22.3	40.00	.638	2.15
	2892.5	33.0	85.0	22.1	40.41	.650	2.14
	2730.0	32.0	87.0	22.3	40.00	.635	2.17
11. Carbofuran	2795.0	33.0	90.0	21.2	38.13	.630	2.22
	2632.5	33.0	84.0	22.6	39.38	.645	2.13
	2567.5	32.0	88.0	21.2	40.63	.663	2.18
12. Control	2762.5	34.0	85.0	21.3	39.38	.660	2.22
	2632.5	33.0	90.0	22.8	39.38	.629	2.19
	2762.5	32.0	85.0	21.6	39.06	.620	2.16

EFFECTS OF PREEMERGENCE HERBICIDE-SYSTEMIC INSECTICIDE COMBINATIONS ON SOYBEAN (*GLYCINE MAX* (L.) MERRILL) GROWTH AND DEVELOPMENT

by

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Effects of preemergence herbicide-insecticide combinations on soybean (*Glycine max* (L.) Merrill) growth and development were studied in 1976 and 1977. The herbicides 4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4H)-one (metribuzin), 2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (alachlor), and (3,5-dinitro-N^4, N^4-dipropylsulfanilamide) (oryzalin) and the insecticides 2,3-Dihydro-2,2-dimethyl-7-benzofuranol methylcarbamate (carbofuran) and Ethyl 3-methyl-4-(methylthio) phenyl (1-methylethyl) phosphoramidate (fenamiphos) were used in combination to form twelve treatments. The study was conducted on two soil types, a Pachic Haplustolls (Fine-silty, Mixed, Mesic) and Typic Udifluvents (Coarse-silty, Mixed (Calcareous), Mesic), at two dates of planting.

Statistical analysis of data collected on grain yield, plant stand, plant height, bean weight, percent crude protein, percent phosphorus and percent potassium indicated the responses obtained were independent.

Soybeans grown in the Typic Udifluvents soil had significant reductions in grain yield, plant stand, plant height and bean weight due to metribuzin injury. Timing and amount of rainfall following treatment applications was a contributing factor in metribuzin activity.