HERBICIDE AND CROP ROTATION EFFECTS ON THE WEED COMPLEX

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A B S T R A C T

A four-season trial was conducted using continuous maize (Zea mays L.) and soybeans (Glicine max (L.) Merr.) with the continuous use, rotation or combination of various herbicides to determine weed species shifts. No weed species increased in maize treated for four seasons with atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) or the combination atrazine + alachlor (2-chloro-2',6'-diethyl-N-(methoxy-methyl)acetanilide). Four seasons of alachlor allowed a 6 and 21% increase in broadleaf weeds in maize and soybeans, respectively, while maintaining excellent grass weed control. In soybeans a 21% increase in broadleaf weeds occurred after four seasons of linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea). Linuron combined with alachlor gave the best weed control in soybeans while the rotation of herbicides was less effective. In both crops, two hand weedings for four seasons tended to reduce the weed population the following year.

I N T R O D U C T I O N

The use of preemergence herbicides in Latin America is increasing rapidly. Often claims are made that weeds are becoming resistant to herbicides when in fact an ecological shift is taking place with secondary weed problems becoming primary ones.

Horowitz et al. (1974) observed species shifts by applying ten herbicides in the same plots during four years. Anagollis coerula (Gouan.) was eliminated by substituted urea herbicides while Convolvulus arevenis L. tended to increase. Species which were only partially controlled by the initial applications persisted even after repeated applications.

Using a rotation of cotton (Gossypium hirsutum L.), peanuts (Arachis hypogoea L.) and maize (Zea mays L.) and various intensities of chemical and mechanical weed control measures, Hauser et al. (1974) obtained a great reduction in Cyperus esculentus L. infestations. Digitaria sanguinalis (L.) Scop. and Xanthium pensylvanicum Wallr. populations also decreased, while

Euphorbia maculata L. increased. All treatments significantly reduced the total number of weeds after three years.

In a similar study, Weber et al. (1974) found that after three seasons of trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) D. sanguinalis and Dactyloctenium aegyptium (L.) Richter were controlled, but C. esculentus had completely infested the area. This shows how rapidly dramatic species shifts can occur.

Another aspect of effectively controlling weeds during many seasons is the overall weed population reductions which should result. Roberts and Dawkings (1967), in a 6-year study observed 22, 30 and 36% decreases in the number of viable weed seeds in the upper 23 cm of the soil with 0, 2 or 4 tillage operations per year, respectively. This indicates that by preventing weed seed production, weed infestations can be greatly reduced over time. However, Weber et al. (1974) found the total weed density unaffected after applying prometryne and trifluralin for three years without planting a crop.

No such information has been reported for tropical Latin America. Therefore, a four season trial was designed to study the weed species shifts which occur with the continued use, rotation or combination of herbicides in maize and soybeans, and to compare the effects of hand weedings and chemical control on the weed population after four seasons of intensive control.

METHODS AND MATERIALS

Atrazine (2 kg/ha) and alachlor (2.5 kg/ha) were applied repeatedly, in combination (half rate of each) or in rotation, during four consecutive seasons in maize (a while brachytic line). Linuron (1.5 kg/ha) and alachlor (2.5 kg/ha) were similarly applied in soybeans (var. ICA-Lily). The plantings and applications were made in a clay soil with 3.9% O.M. and a pH of 7.2 A split-plot design with four replications was used where the crop was the main plot and the weed control treatment the split-plot. After each harvest, the entire area was tilled and the plots relocated in exactly the same position as in the first planting.

Herbicides were applied with a CO_2 plot sprayer equipped with four 8003 TeeJet nozzles at 2.1 kg/cm^2 pressure in 215 l/ha of water. Percentage weed cover by species was determined 30 and 60 days after planting with the line intercept method (Phillips, 1959). The principal grasses were Leptochloa filiformis (Lam.) Beauv., Echinochloa colonum (L.) Link, Eleusine indica

(L.) Gaertn. and D. sanguinalis and the broadleaves were Amaranthus dubius Mart., Portulaca oleracea L., Ipomoea tiliacea (Willd.) Choisy, Euphorbia hypericifolia L. and Cucumis melo L.. All except Ipomoea were broadcast seeded at the time of the first planting only. Percentage weed cover was also determined during the fifth season when neither crops were sown nor herbicides applied after plowing and double-disking in order to determine the long-term effects of the control measures on the weed population.

RESULTS AND DISCUSSION

The consecutive use of atrazine for four seasons gave excellent weed control without reducing maize yields (Fig. 1 and Table 1). Alachlor controlled all the grasses but a trend toward a buildup of broadleaf species was observed, especially of I. tiliacea and C. melo. Both the combination or rotation of the two herbicides were effective in controlling nearly all the weeds and not allowing any resistant species buildups.

Chemical weed control was less effective in soybeans after the first season (Fig. 1). Linuron permitted both broadleaves (primarily E. hypericifolia) and grasses to increase while alachlor maintained excellent grass control but allowed buildups of I. tiliacea and C. melo. The combination of linuron and alachlor during four seasons gave the best weed control in soybeans. Rotating these products allowed higher grass coverage in the seasons linuron was applied and higher broadleaf coverage in those with alachlor. Both mixing or rotating linuron and alachlor prevented a buildup of resistant species and tended to increase soybean yields more than did the continuous use of either product (Table 1). Soybean yields were not affected by apparently high weed infestations probably due to the creeping nature of the resistant broadleaves which made them poor competitors for light.

A relationship was found between the degree of weed cover and the crop species when herbicides are used. Comparing the effectiveness of alachlor in maize and soybeans, one observes that the first season's broadleaf coverage results are very similar but in subsequent seasons alachlor allowed three times more broadleaf coverage in soybeans than in maize. Thus, the buildup of resistant species is crop dependent.

Two hand weedings 30 and 60 days after planting for four seasons reduced both grass and broadleaf coverage in maize but only the broadleaf coverage in soybeans (Figure 2). Hand weedings were consistently more effective in maize than in soybeans. Thus the effectiveness and long term effects of

manual or mechanical control are also crop dependent. Considerable seasonal variation in the weed coverage occurred in the non-weeded plots, principally due to weather fluctuations. After the first season, there was more total weed coverage in the non-weeded soybeans than in non-weeded maize and proportionately more grasses in soybeans and more broadleaves in maize. Thus, for the weed species in this study, monocot weeds adapted better to the dicot crop and vice versa.

Observations made during the fifth season, when no crops were planted or herbicides applied after land preparation, show that there was little beneficial effect of excellent weed control during four previous seasons (Table 1). All treatments were more than half-covered with weeds 60 days after the land was tilled. Continuous atrazine or linuron use had the greatest grass coverages. Four seasons of atrazine gave the lowest total weed infestation while no soybean treatment gave significant reductions the fifth season. In the non-weeded plots, three times more grass was present after four seasons of soybeans as compared to four seasons of non-weeded maize.

REFERENCES

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Table 1. Maize and soybean grain yields during four seasons with the continued use, combination, or rotation of herbicides and the percent weed cover during the fifth season without a crop.

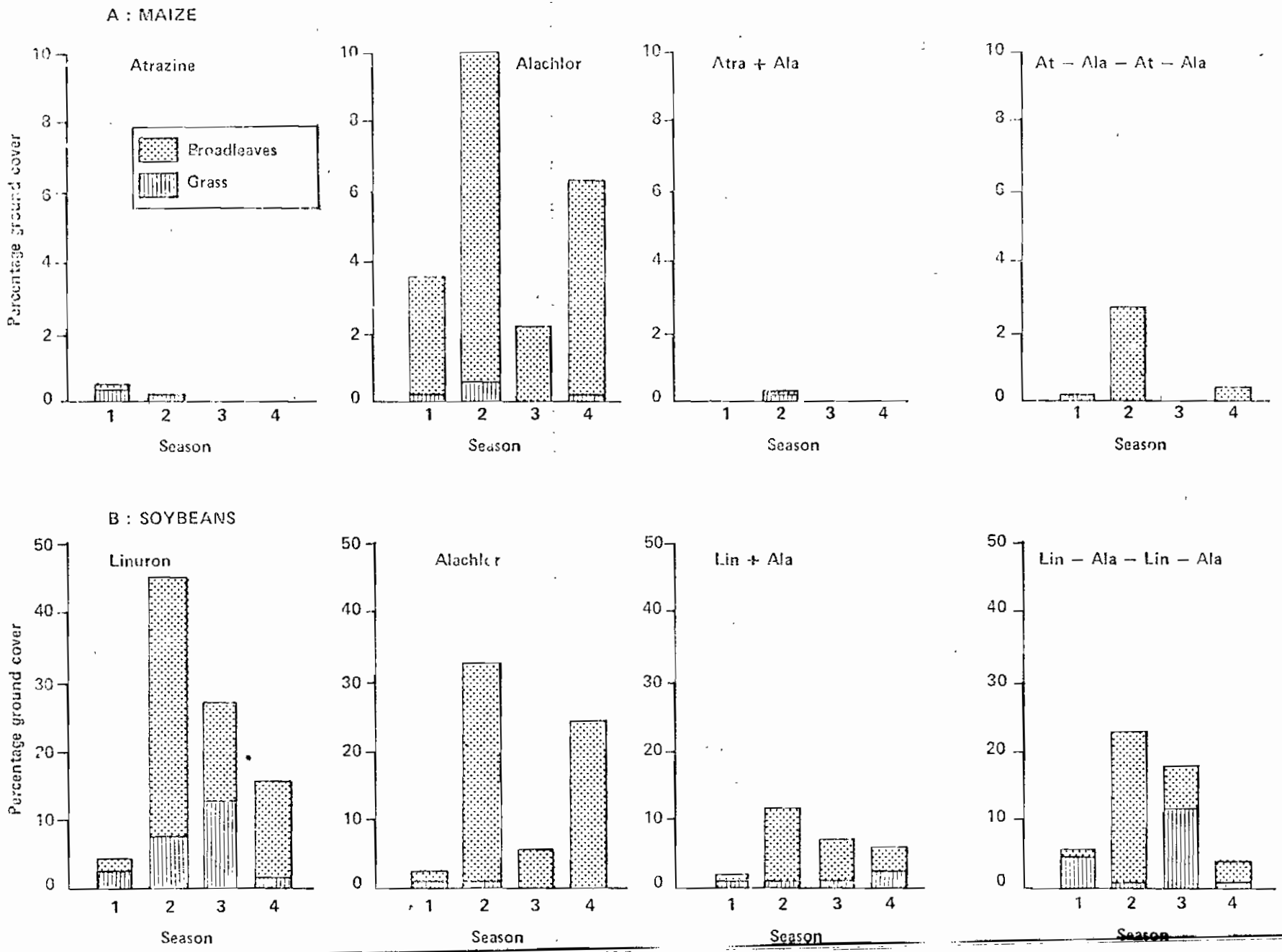
CROP	HERBICIDE	COMPARATIVE YIELD[1] SEASON					WEED COVER[2] 5th SEASON (%)	
		1st	2nd	3rd	4th	$\bar{X}$	B.L.	Gr.
Maize	Atrazine	85	83	105	103	94	38	16
Maize	Alachlor	103	100	95	101	100	87	1
Maize	Atraz+Alac	94	109	113	99	104	64	1
Maize	Atr/Alac/Atr/Alac	87	84	99	99	92	73	8
Maize	Weedy Check	75	53	74	60	66	81	5
Soybeans	Linuron	89	97	85	84	89	67	12
Soybeans	Alachlor	88	87	107	93	94	72	1
Soybeans	Lin+Alac	85	144	109	88	106	83	3
Soybeans	Lin/Alac/Lin/Alac	99	139	79	83	100	77	1
Soybeans	Weedy Check	76	17	36	43	43	65	15

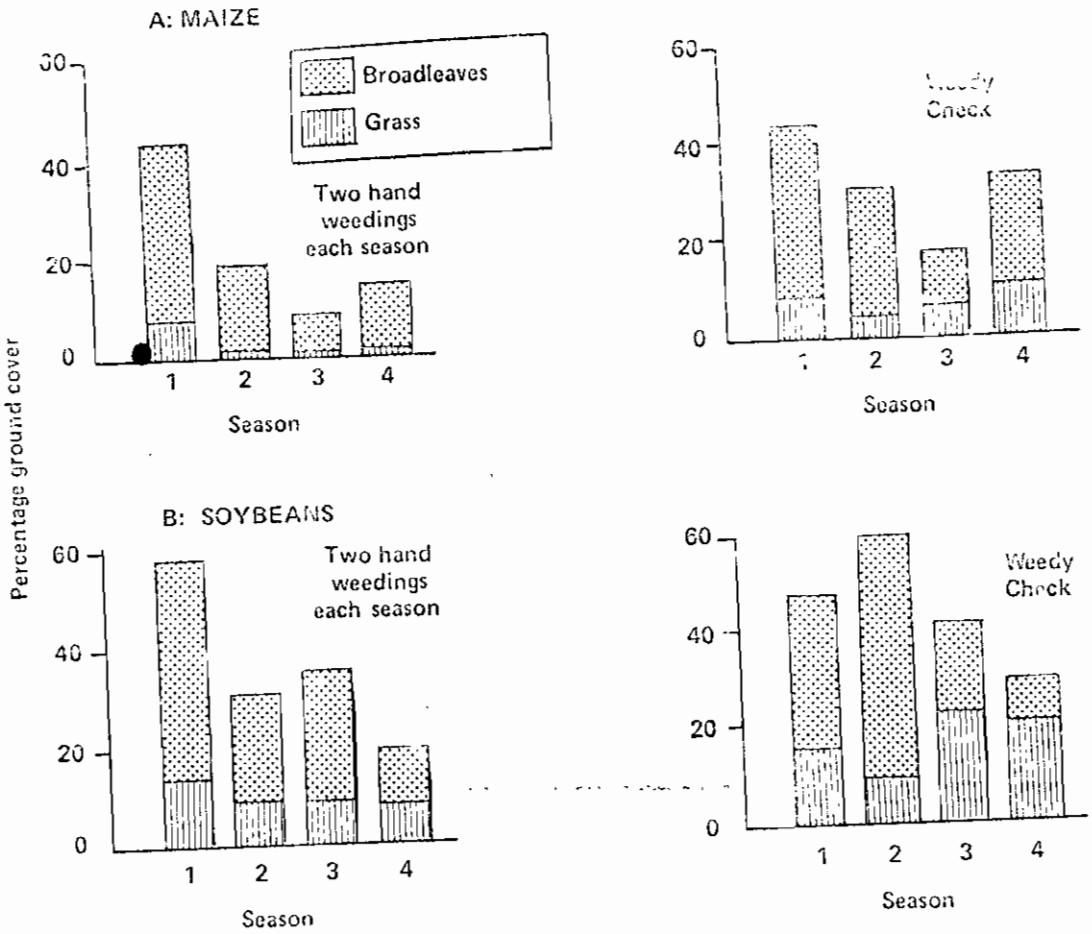
[1] Yield expressed as a percentage of hand-weeded plots
[2] Sixty days after preparing the land

CAPTIONS FOR FIGURES

Figure 1. Effect of the continued use, combination or rotation of atrazine and alachlor in maize and linuron and alachlor in soybeans on the percentage of cover by grass and broadleaf weeds 60 days after planting (A) maize and (B) soybeans during four seasons.

Figure 2. Effect of two hand weedings and no weedings on the percentage of cover by grass and broadleaf weeds 30 days after planting (A) maize and (B) soybeans during four seasons.


A : MAIZE
Atrazine
Alachlor
Atra + Ala
At – Ala – At – Ala
Broadleaves
Grass
Percentage ground cover
Season
B : SOYBEANS
Linuron
Alachlor
Lin + Ala
Lin – Ala – Lin – Ala


A: MAIZE
Broadleaves
Grass
Two hand weedings each season
Weedy Check
B: SOYBEANS
Two hand weedings each season
Weedy Check
Percentage ground cover
Season
0
20
40
60
1
2
3
4