Soil Persistence and Bioavailability of Fluometuron Under Rye and Balansa Clover Cover Crops in Cotton Production

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INTRODUCTION

The phenylurea herbicide fluometuron is applied preemergence in cotton (*Gossypium hirsutum* L.) production in the Southeastern US and has been reported in surface water in regions where it is widely used. Conservation management practices such as reduced tillage and cover crops have been recommended to mitigate herbicide loss associated with leaching and runoff. Therefore, a five year field study was conducted to assess the implications of tillage (no-tillage or reduced tillage) and cover crops [rye (*Secale cereale*), balansa clover (*Trifolium michelianum ssp. balansae*), or none] on fluometuron persistence and bioavailability in plant residues and several soil depths.

MATERIALS AND METHODS

Site description. A split-plot experiment arranged as a randomized complete block (4 blocks) was established on a Dundee silt loam (Fine-silty, mixed, thermic, Aeric Ochraqualf) at the Southern Weed Science Research Unit Farm near Stoneville, MS in Fall 2000. Tillage [reduced tillage (RT) or no-tillage (NT)] was the whole plot and cover crop [rye cover (RC), balansa clover (BC), or no-cover (NC)] was the sub-plot. RT consisted of disking and rowing into beds in the fall after harvest, with beds knocked down prior to plant in the spring. NT involved planting directly into the row beds from the previous year's crop. RC was planted in the fall each year and killed with paraquat or glyphosate 2 wk before planting cotton the following spring.

Table 1. Plant residue density early and late season.

Year	Day	Cover Crop		
		Clover	None	Rye
		Residue mass (kg ha^{-1})		
2001	5	2834	1472	3259
	56	1243	319	1929
2002	5	3541	678	3107
	42	2023	108	2563
2003	3	5313	2621	3974
	56	2765	176	2061
2004	3	3310	1093	3266
	64	769	200	2541

MATERIALS AND METHODS (cont.)

Sample collection, preparation, and analysis. Soil and surface plant residues were collected for approximately 8 wks after herbicide application to determine herbicide dissipation and bioavailability. Soil sampling depths were 0 to 2 cm, 2 to 5 cm, and 5 to 15 cm, and five 15 x 15 cm areas were sampled for plant residues. Soil and plant samples were processed immediately or were frozen and stored until processing.

Stored soil was weighed without drying into Nalgene HDPE flasks and extracted with either methanol (1:1 w:v, soil:methanol) or water (1:1 w:v, soil:water) for 24 h. Samples were centrifuged, aliquots of supernatant filtered, and stored in HPLC vials until analysis. Samples were analyzed for fluometuron and desmethyl fluometuron (DMF) using an HPLC. Plant samples were processed immediately by chopping into 2 cm lengths, weighing Nalgene flasks, and extracted with methanol (1:10 w:v, plant:methanol), and processed as described for soil samples

Fluometuron and DMF were quantified using a Waters 2695 HPLC separations module (Waters Corp., Milford, MA) equipped with a Waters 996 photodiode array detector (Waters Corp., Milford, MA) fitted with a Waters Symmetry^{TM} C_{18} column. The mobile phase was isocratic acetonitrile and water (55:45 v/v) with a flow rate of 1.0 mL min^{-1}. The limit for fluometuron and DMF was 10.0 µg L^{-1}.

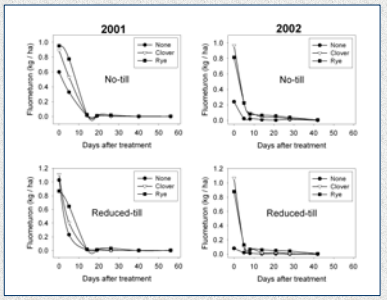

Figure 2. Fluometuron in plant residues.

Figure 1. Rye and clover cover crops in early spring.

RESULTS

- Although different levels of crop residues accumulated each year, mass of residues in balansa clover and rye averaged 3750 and 3401 kg ha^{-1} compared to 1466 in no cover. (Table 1). Rye residues were more persistent compared to balansa clover.

- Relatively high levels of fluometuron were intercepted by plant residues (100 to > 300 mg kg^{-1}), with less than 10% of this amount remaining in residues 14 d after application (Figure 2).

- Levels of fluometuron observed in the upper 2 cm of clover soils were < 50% of that in no cover soils for the first 21 DAP (Figure 3), while results from rye soils were mixed.

- No consistent trend in leaching to the lower depths in relation to cover crop management or tillage was observed as no consistent effect of treatment on herbicide concentrations was observed in the 2 to 5 cm depth (Figure 4). Recovery of herbicide and metabolite at the 5-15 cm depth was infrequent and erratic (data not shown).

- Following one to two wks after treatment, levels of the DMF metabolite accumulated to levels as high as 2.0 mg / kg and its relative ratio to the parent exceeded 1.0 or greater (Figure 5).

- During the initial week after fluometuron application, water extractable residues represented ~ 65% of the methanol extractable residues, while after 14 days < 20% of the methanol extractable fluometuron was recovered by water extraction (Fig. 6). A relatively lower amount of the metabolite DMF was water extractable indicating its ability to persist, perhaps with resistance to microbial degradation.

- These studies indicate a rapid decrease in bioavailability for either weed control or vulnerability to microbial degradation as represented by a dual phase degradation kinetics.

- Results indicated little influence of tillage on fluometuron persistence in this study, but that concentrations of fluometuron were significantly affected by cover crop residue, and that balansa clover could accelerate dissipation in surface soil. However, retention of fluometuron in plant residues and accelerated degradation may provide lower amounts of fluometuron available for weed control.

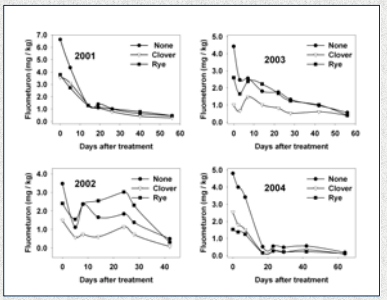

Figure 3. Fluometuron (MeOH-extracted) in the soil surface (0-2 cm).

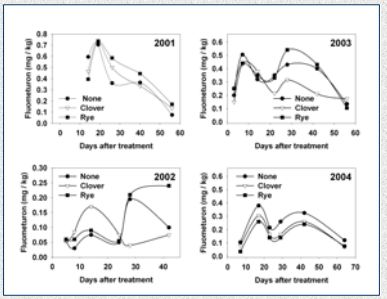

Figure 4. Fluometuron (MeOH-extracted) in the soil 2 to 5 cm.

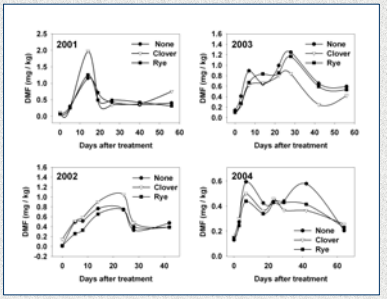

Figure 5. Desmethyl fluometuron (MeOH-extracted) in the soil surface (0-2 cm).

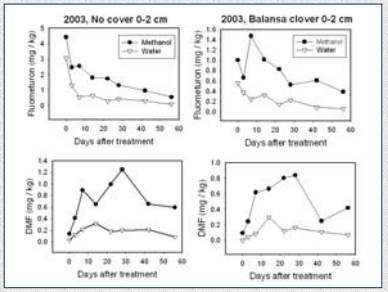

Figure 6. Comparative extraction of fluometuron with MeOH and water in the soil surface (0-2 cm).

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