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Effect of Asulam on Cellulose Decomposition in Three Soils

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The possibility that herbicides may affect the decomposition of organic matter in the soil has been recognized for some time. In most studies the 'dilution-plate' technique has been used to determine effects of herbicides on numbers of cellulolytic micro-organisms in soil (GROSSBARD & WINGFIELD 1978). This technique, however, has several well known limitations (PARKINSON et al. 1971, GREAVES et al. 1976). Investigations into the effects of herbicides on the decomposition of cellulosic substrates buried in soil began comparatively recently (GROSSBARD & MARSH 1974). 'Artificial' substrates such as cotton cloth or filter paper are used because they are easier to handle and results are more reproducible than those obtained with naturally occurring cellulosic materials. There are, however, variations in the chemical constituents and weave of various types of cotton cloth which makes comparison of results difficult. The availability of the Shirley Test Cloth with its uniform characteristics may reduce this problem. This paper reports the results of experiments using this cloth to investigate the effects of the herbicide asulam on cellulose decomposition in 3 soils.

MATERIALS AND METHODS

Soils I and III were obtained from arable (I) and permanent grassland (III) fields at The Weed Research Organization and processed as described by GREAVES et al. (1978). Soil II was from an arable field in East Anglia. Some of the characteristics of the 3 soils are given in Table 1.

Shirley Test Cloth was obtained from the Shirley Institute, Didsbury, Manchester, M20 8RX. The cloth is manufactured under controlled conditions which produce a standard woven fabric for soil burial tests. The plain woven cloth contains combed 100% cotton yarns in a two-folded form. Further technical details of the cloth can be obtained from the Shirley Institute.

Asulam was applied to either soil or cloth as 'Asulox': active ingredient 40% w/v methyl [(4 - aminophenyl) sulphonyl] carbamate (as Na salt). A laboratory pot sprayer was used to apply the herbicide to the surface of a 2.5-cm layer of moist soil and, by the addition of water, to adjust the moisture content of the treated and control soils to 80% of the field capacity (GROSSBARD & WINGFIELD 1975). The herbicide was applied at rates

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TABLE 1

Soil characteristics

	SOIL		
	I	II	III
pH (in water)	6.2	6.1	5.3
Available P, $\mu gP.g^{-1}$ dry soil	23.3	52.5	19.7
Total-N, %	0.09	0.28	0.4
Organic-C, %	0.9	3.1	4.4
NH_4^+ -N, μg N g^{-1} dry soil	0.85	1.91	2.45
NO_3^- -N, μg N g^{-1} dry soil	2.69	40.0	7.85
CEC, mEq/100g	16	37	41
Clay, %	14	16	15
Silt, %	15	25	17
Fine Sand, %	35	47	40
Coarse Sand, %	36	12	27
Field capacity, % H_2O	19	29	32

such that, after thorough mixing, the soils contained either 16 or 160 ppm asulam on a dry soil basis. Single layers of cloth were sprayed on one side with herbicide at rates of 2 or 8 kg/ha using the pot sprayer.

Decomposition of strips of cloth was studied as described by GREAVES et al. (1978). The cloth was buried in soil contained in plastic boxes which were incubated at $19 \pm 1^{\circ}C$ for 8 weeks. 10 replicate strips of cloth contained in 2 boxes of soil were prepared for each treatment. After incubation the strips were removed, cleaned and loss in weight determined.

In a second experiment, using the lowest herbicide concentrations which affected decomposition in soils I and II, control and treated soil samples were incubated for 10 weeks at $19 \pm 1^{\circ}C$ before burial of the cloth. They were then incubated for a further 8 weeks.

RESULTS

All asulam treatments significantly reduced weight loss of the test cloth in soil I (Table 2a). In soil II weight loss was significantly reduced in treated soil at 160 ppm whereas in soil III reduction was significant when treated cloth (8 kg/ha) was buried in untreated soil.

Incubation of the soil for 10 weeks before burial of the substrate partially alleviated inhibitory effects of the herbicide on decomposition in soil I and completely alleviated effects in soil II (Table 2b).

TABLE 2

The effect of asulam on the decomposition of Shirley Test Cloth buried in soil (weight loss as % of initial weight).

a. Cloth buried immediately after soil treated with herbicide.

SOIL	CONTROL	SOIL TREATED		CLOTH TREATED		$\pm$ SE
		16 ppm (Cloth untreated)	160 ppm	2kg/ha (Soil untreated)	8kg/ha	
I	39	24	16	12	8	2.4
II	54	50	38	ND	ND	1.8
III	23	20	23	18	14	2.4

b. Treated and control soils incubated for 10 weeks at 19$\pm$1°C before burial of the cloth.

SOIL	CONTROL	$\pm$ SE	SOIL TREATED		$\pm$ SE
			16 ppm (Cloth untreated)	160 ppm	
I	46	3.6	36	ND	2.6
II	66	2.6	ND	65	2.6

ND Not determined.

DISCUSSION

The results show that the differing characteristics of the 3 soils have a marked influence on the decomposition of cellulose and its interaction with asulam. It is notable that the effect of the herbicide is greatest in soil I. This soil has lower organic -C, total -N, ammonium -N, nitrate -N, cation exchange capacity and field moisture capacity than the other two soils, especially soil III. In this soil (III) inhibition only occurs at the highest rate of herbicide applied directly to the cloth.

It is well known that organic carbon content can affect the adsorption of herbicides onto soils, thus influencing their activity on plants and, possibly, on the microorganisms in the soil. EGLITE (1969) has shown that inhibitory effects of simazine and dalapon on CO_2 production and nitrogen transformations are decreased with increasing soil organic matter content. Adsorption of paraquat onto humus in soils has been reported by Szegi (1972) to reduce inhibitory effects of the herbicide on cellulose decomposition.

Factors such as the breakdown or adsorption of asulam during the 10 week incubation period prior to the addition of the cloth may account for the decreased effects of the herbicide in the second experiment. It has been shown in bioassay tests, that at an application rate of 6.7 kg/ha the initial herbicidal activity of asulam can be reduced by 50% in 4 to 8 weeks at temperatures of 15 to 25^{o} (MAY & BAKER 1971).

Experiments using pure cultures of soil-inhabiting fungi and actinomycetes, some of which were cellulolytic, showed that asulam at 10 ppm (equivalent to 2.2 kg/ha incorporated in the top 2.5 cm of soil) had either no, or only a temporary, effect on growth (MAY & BAKER 1971).

From the work reported here it can be concluded that, provided there is good contact between soil and herbicide, decreased breakdown of organic matter in the field following the use of asulam, if it occurs at all, is likely to be of short duration. However a major use of asulam is in the control of bracken which can result in large quantities of herbicide-treated plant residues remaining on the soil surface. The decreased decomposition of Shirley Test Cloth treated with asulam indicates that breakdown of these residues might be delayed in the field. Direct verification is desirable.

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REFERENCES

ANON: Technical information on asulam selective weed killer. Ongar: May and Baker, (1971).

EGLITE, A. K.: Sb. 'Khimicheskaya Regulyatsiya Rosta i Razvitiya Rasteniĭ', 'Zinante', Riga, 157 (1969).

GREAVES, M. P., S. L. COOPER, H. A. DAVIES, J. A. P. MARSH and G. I. WINGFIELD: Technical Report Agricultural Research Council Weed Research Organization 45, pp 55 (1978).

GREAVES, M. P., H.A. DAVIES, J. A. P. MARSH and G. I. WINGFIELD: C.R.C. Crit. Rev. Microbiol. 5, 1 (1976).

GROSSBARD, E., and J. A. P. MARSH: Pestic. Sci. 5, 609 (1974).

GROSSBARD, E., and G. I. WINGFIELD: In Some Methods for Microbiological Assay, Society for Applied Bacteriology, Technical Series 8. London: Academic Press (1975).

GROSSBARD, E., and G. I. WINGFIELD: Weed Res. 18, 347 (1978).

PARKINSON, D., T.R.G. GRAY and S. T. WILLIAMS: Methods for Studying the Ecology of Soil Microorganisms, I.B.P. Handbook No. 19. Oxford: Blackwell Scientific Publications, (1971).

SZEGI, J.: In Symp. Biol. Hung. (Proc. Symp. Soil Microbiol.) 11, Budapest: Akadémiai Kiadó (1972).