Persistence of Metamitron in a Sandy Loam Soil

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Metamitron, 4-amino-4,5-dihydro-3-methyl-6-phenyl-1,2,4-triazin-5-one, is a member of the triazinone group and is under commercial development as a selective herbicide for use in the sugar beet crop (SCHMIDT et al. 1975). Field tests at the National Vegetable Research Station have given promising results also in red garden beet, a crop which occupies the ground for a shorter period than sugar beet. In order to assess possible risks to succeeding crops, determinations were made of the phytotoxic activity remaining in the soil following field applications of metamitron. The pattern of loss of activity under conditions of controlled temperature and soil moisture content was also determined.

METHODS

The soil was a sandy loam containing 1.2% carbon (Walkley-Black) and 18% clay. Metamitron, as a 70% wettable powder formulation, was applied to field plots in 1100 l/ha water and either allowed to remain on the soil surface or incorporated into the top 5 cm by a single pass of a rotary power harrow working to a depth of 10 cm. Cores were taken with a 2.5-cm diameter borer to a depth of 7 cm, except where stated. The samples were sieved, their weight noted, and then stored at -10°C until assayed.

Bioassay

Samples for bioassay were serially diluted with untreated soil to give a range of dilutions from 1.0 to 0.016. The soil mixtures were placed in 6-cm plastic pots and sown with seeds of lettuce (*Lactuca sativa* L. cv. Borough Wonder) which had been pre-germinated at 20°C for 24 h. Six seeds per pot were sown 1 cm deep and the seedlings later thinned to five per pot. The pots were randomised on a glasshouse bench and watered from beneath as necessary. Shoot fresh weights were determined after 21 days and the dilution which reduced fresh weight by 50% from that of the untreated controls was derived from the response curve. On each assay occasion a standard series of known concentrations was run and the dose required for 50% reduction in fresh weight (ED50) was determined. The mean ED50 for 58 standards run between April and October 1975 was 0.20 ± 0.09 mg/kg air-dry soil. From the results of the bioassays, the

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known weight of the sample and the number of cores of which it was made up, the amount of herbicide present could be calculated for the depth of soil sampled. The mean recovery from 98 samples taken immediately after application was 97.6 ± 2.46% of the nominal dose.

Loss of activity under controlled conditions

Freshly collected sandy loam soil was sieved (2 mm) and left overnight on the glasshouse bench. Separate 6-kg amounts of soil were taken and treated with 23.5 mg metamitron in 120 ml water, to give a moisture content of 3.1%. Mixing was achieved by passing the soil several times through a 2-mm sieve. Soil moisture contents of 6.2, 9.6 and 10.5% were obtained by adding further water and mixing thoroughly. The soils were stored in polyethylene bags and duplicate bags for each moisture content were maintained at constant 25°C in the dark. Additional duplicate bags of soil with a moisture content of 10.5% were maintained at constant temperatures of 4, 12, 20 and 30°C. Samples were removed for bioassay twice weekly, and on each occasion the soil in the bags was mixed thoroughly and restored to the correct weight by adding water.

RESULTS AND DISCUSSION

Persistence of metamitron in the field

Paired field plots were sprayed with metamitron at 4.5 and 9.0 kg/ha on 16 April and on one plot of each pair, the herbicide was incorporated. A second series was sprayed on 23 July 1975. After spraying, and then at irregular intervals, 30 cores per plot were taken at randomised positions and a bulked sample for each plot obtained. Two sub-samples from each bulked sample were bioassayed.

The results for the two doses were closely similar when expressed as percent. activity remaining, and mean values are therefore shown in Fig. 1. During the period of this experiment, the weather was exceptionally hot and dry. Although rainfall in July and September was normal, in May and August it was only half the long-term average, while total rainfall in June was less than 10 mm. It is likely that under such conditions degradation would be restricted, and comparison with the results of JARCZYK (1975) for two soils suggests that this was so. The results for the surface-applied and incorporated treatments are in close agreement (Fig. 1), and it would appear that there were no detectable losses from the soil surface as a result of volatilisation or photodecomposition.

Metamitron was examined in two field trials with red beet in 1975. The herbicide was incorporated pre-drilling, applied pre-emergence to the soil surface, or applied as an overall spray when the crop plants had two true leaves. The treatments

were replicated three times and samples of ten cores to a depth of 7 cm were taken from each plot after spraying and again at harvest. The results (Table 1) show that there was again little difference between the surface-applied and incorporated treatments and that with these, about 20% of the initial activity remained at harvest, whichever dose was applied. With the post-emergence treatments, greater activity was present, in the second trial equivalent to more than half of the dose applied.

As JARCZYK (1975) has pointed out, the relatively high water solubility of metamitron (1.8 g/l) suggests that leaching might occur under the influence of rainfall. To test this, applications were made to the soil surface on two occasions about 1 month apart. Four replicate plots were each sampled

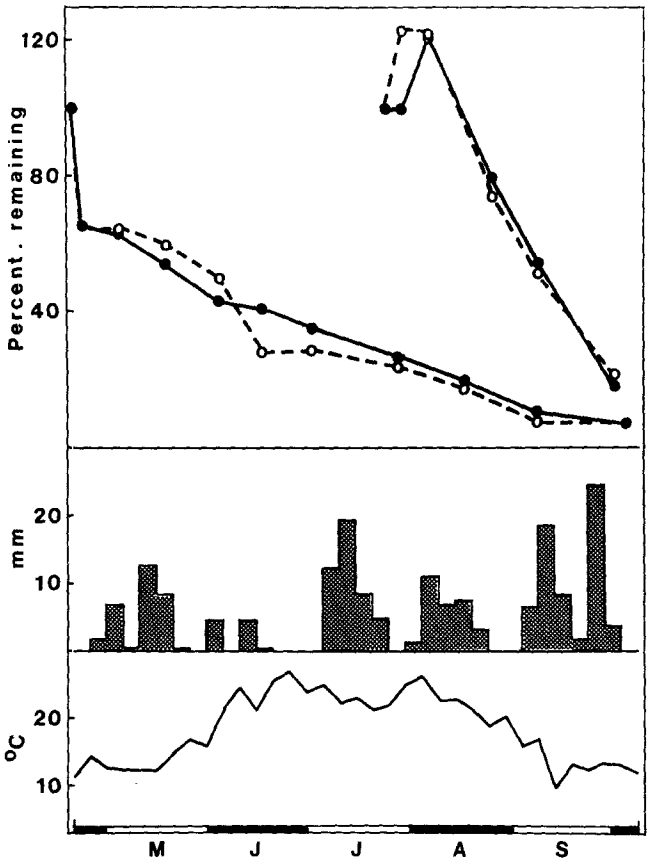

Fig. 1. Percent. activity remaining from applications of metamitron (means of 4.5 and 9.0 kg/ha) made on 16 April and 23 July 1975, either on the soil surface (●) or incorporated into the top 5 cm of soil (o). Rainfall is shown as 5-day totals; temperatures are 5-day means of the 10-cm soil temperature at 0900 hours GMT.

TABLE 1

Amounts remaining (kg/ha in 7 cm soil) at harvest in two experiments with metamitron in crops of red beet

Applied	Exp. 1; harvest 7 Aug			Exp.2; harvest 19 Aug		
	1 May		3 Jun	20 May		13 Jun
	Inc.	Surface	Overall	Inc.	Surface	Overall
2.8 kg/ha	0.48	0.57	0.96	0.60	0.88	1.57
4.2 kg/ha	0.75	0.89	1.02	0.95	0.97	2.50

TABLE 2

Vertical distribution of metamitron (kg/ha) following application to the soil surface at 4.2 kg/ha

Depth (cm)	Days after application on 24 April			Days after application on 20 May		
	60	90	120	30	60	90
0 - 2.5	0.81	0.65	0.41	0.99	0.65	0.39
2.5 - 5.0	0.35	0.20	0.11	0.26	0.10	0.09
5.0 - 7.5	0.16	0.15	0.08	0.21	0.04	0.10
7.5 - 10.0	0.16	0.12	0.06	0.17	0.03	0.08
Cumulative rainfall (mm)	39*	82	113	9*	50	82

* Additional sprinkler irrigation of 25-30 mm within first 14 days

TABLE 3

Half-lives (days) for metamitron in a sandy loam under different temperature and moisture regimes

Soil moisture (%)	Temperature (°C)				
	4	12	20	25	30
3.1	-	-	-	42	-
6.2	-	-	-	24	-
9.6	-	-	-	14	-
10.5	91	42	25	8.5	9.8

initially and then on three further occasions; thirty cores 10 cm deep were taken from each plot and sectioned into 2.5-cm segments. The results (Table 2) show that on each sampling occasion some activity could be found at the 7.5-10 cm depth but that this represented no more than 10% of the total in the whole 10-cm soil layer. More than half of the total was always found in the surface 2.5 cm. JARCZYK (1975), in leaching experiments with soil columns and a simulated rainfall of 200 mm in 48 h, found that only with a pure sandy soil were appreciable amounts of metamitron leached from a 30-cm column.

Loss of activity under controlled conditions

The logarithms of the herbicidal activity remaining (% of initial activity) were plotted against time. Straight lines were obtained for all conditions examined, with correlations greater than 0.90. This indicates that degradation follows the first-order rate law, a conclusion which is supported by the similarity in percent. activity remaining from applications of 2.8 and 4.2 kg/ha in the field (Table 1). From the slopes of the lines, half-lives for the different temperatures and soil moisture contents were calculated, and are shown in Table 3. Loss of activity was most rapid at the highest soil moisture content (about 75% of field capacity) and 25°C. The results suggest that over the range of conditions likely to be experienced in the field in England, temperature may be more important than soil moisture in limiting degradation of metamitron.

CONCLUSION

Metamitron seems most likely to be applied at drilling or shortly afterwards. The results show that even under abnormally dry conditions, no more than 20% of the initial activity remained in the top 7 cm of soil at the time red beet were harvested. Some activity was detectable at a depth of 7.5-10 cm, but more than half of that still present was in the surface 2.5 cm. The tests under controlled conditions showed that both temperature and soil moisture content affect the rate of degradation of metamitron, but it appears that in comparison with other herbicides the loss of phytotoxicity from soil applications of metamitron is relatively rapid.

ACKNOWLEDGEMENTS

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