Bull. Environ. Contam. Toxicol. (1987) 39:280–285

Environmental Contamination and Toxicology

Dissipation of Methyl Parathion and Ethyl Parathion from Cotton Foliage as Affected by Formulation

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Insecticide use on cotton has shifted away from the organochlorine compounds toward the organophosphate, carbamate and pyrethroid compounds. These latter three groups of compounds are generally less environmentally persistent and frequently more selective than the organochlorine compounds. However, the conventional emulsifiable concentrate (e.c.) formulations of the organophosphates, methyl parathion (MP) and ethyl parathion (EP) are extremely hazardous for the applicator and other field workers. Because of the limited residual insecticidal activity of the e.c. formulations of MP and EP, repeat applications at 3 or 4 day intervals are frequently necessary for effective insect control (Louisiana Cooperative Extension Service 1985). Microencapsulated (encaps.) formulations of MP (Penncap-M) and EP (Penncap-E) are now available and have been reported to provide extended persistence on tobacco (Leidy et al. 1977) and peach trees (Winterlin et al. 1975), reduced volatilization to the atmosphere (Jackson and Lewis 1979) and reduced mammalian toxicity with increased user safety (Ivy 1972). However, Pass and Dorough (1973) reported that e.c. and encaps. formulations of MP gave equal weevil control in alfalfa and that the dissipation rates of the two MP formulations were the same.

The present study was undertaken to compare the persistence of MP and EP, applied as e.c. and encaps. formulations, on cotton foliage under field conditions in the Mid-South. This paper presents the results of research only. Mention of a pesticide does not constitute a recommendation for use by the U.S. Dept. of Agriculture nor does it imply registration under FIFRA as amended. Names of products are included for the benefit of the reader and do not imply endorsement or preferential treatment by the U. S. Dept. of Agriculture.

MATERIALS AND METHODS

The study was conducted in a 10-ha cotton field on the S. F.

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Johnson farm near Oxford, MS in August 1982, 1983. MP and EP were applied together, each at a rate of 0.28 kg ha , by ground equipment to mature cotton and to absorbent paper (1.0 x 1.5m placed at plant canopy height). The absorbent paper was used to estimate initial pesticide loads as described preiously (Willis et al. 1985). In both 1982 and 1983, pesticide application was replicated 4 times, each time on a new plot (8 rows wide, 1-m row spacing). Two of the replications were as e.c. formulations and two were as encaps. formulations.

Immediately after pesticide application and at 0.25, 0.5, 1.5, 2, 6, and 24 h afterwards, all the cotton plants along 1.5 m of row were collected and placed in a 113-L open-head metal barrel (pre-rinsed with methanol) to which 38 L methanol was immediately added. The barrel lids were replaced to prevent solvent evaporation. In 1983, a 48-h sampling time after application was also used. At each sampling time, there were 4 replications of whole plant cuttings, each on a different row. After a minimum 4 h complete immersion at ambient temperature, the plants were removed from the barrel and a 0.8-L sample was taken from the remaining methanol and placed in a 0.9-L glass jar with a teflon-lined lid. Methanol extracts were stored at 4 C for pesticide analysis by gas chromatography. Insecticide extraction efficiencies from plants (and absorbent paper) were >95% as determined from laboratory studies with fortified samples.

A Tracor Model 222 gas chromatograph, equipped with a ^{63}Ni high-temperature electron capture detector and Hewlett-Packard Model 3385 plotting integrator, was used to analyze the methanol extracts (diluted in benzene) of the plants and absorbent papers for MP and EP. The column was a U-shaped Pyrex glass tube (2 m x 6 mm O.D. x 4 mm I.D.) packed with 5% OV-1 on 100/120 mesh Chromosorb W (HP, AW, DMCS). The carrier gas (filter-dried N , 99.99% minimum purity) flow rate was 180 mL min^{-1}. The column oven, detector, and inlet temperatures were 180, 270, and 245 C, respectively. Under these conditions, retention times were 2.2 and 3.1 min for MP and EP, respectively. The limit of quantitative detection was 0.0005μg mL^{-1} for each insecticide in the methanol extracts.

RESULTS AND DISCUSSION

The measured MP and EP loads intercepted by absorbent paper and cotton plants in 1982 and 1983 are given in Table 1. In 1982, about 61±11 and 63±11% of the MP and EP, respectively, applied as e.c. formulations were intercepted by the cotton foliage. As the result of a refrigerator explosion and fire, plant load samples from the 1982 encaps. treatments were partially destroyed and satisfactory data could not be obtained. For the e.c. formulations in 1983, MP and EP measured plant loads were about 91±5 and 124±18%, respectively, of that applied. The corresponding encaps. loads were about 108±22

and 180±8% of applied. The measured pesticide loads on the absorbent paper reflect the pesticide amounts reaching the plane of the foliage canopy and tended to vary in a manner similar to the measured plant loads. Formulation apparently did not affect the amounts of MP and EP reaching the plant canopy surface. Based on absorbent paper values, the amounts of EP actually applied were about 104±16 and 112±12% of the amounts intended to be applied. As indicated above, the measured amounts of EP on the cotton plants were also somewhat higher than anticipated. This may reflect errors in the amounts of EP loaded into the spray applicator. The overall variability of the measured pesticide loads in Table 1 is typical for these types of studies and as noted by Willis et al. (1985) is probably the result of "the characteristic variability associated with spray application equipment/techniques and plant canopy nonuniformity". Variations in weather parameters from day to day and year to year undoubtedly result in variations in spray droplet evaporation and drift. The predicted initial pesticide loads on cotton foliage are also given in Table 1 and average about 90% of the corresponding measured amounts.

Equations describing the MP and EP loads on and dissipation from cotton plants are given in Table 2. For the e.c. formulations in 1982, the slopes of the best-fit linear regression equations were -18.6 (MP) and -16.7 (EP) and indicated that MP dissipation was slightly faster than EP dissipation. Calculated 50% disappearance times (DT_{50}) were 5.4 and 6.9 h, respectively, for MP and EP. This agrees with the trend reported previously by Ware et al. (1974) who measured dislodgable MP and EP residues on cotton foliage. However, calculated DT_{50}'s from their data were 12.0 h for MP and 16.8 h for EP and reflect the mean dissipation rate for the longer study period of 96 h. The data in the present study more completely reflect the very rapid pesticide dissipation that often occurs within a few hours after foliage application (Willis et al. 1985).

In 1983 the calculated DT_{50}'s were 4.4 and 5.2 h, respectively, for MP and EP applied as e.c. formulations and thus generally agreed with the 1982 data. However, for MP and EP applied as encaps. formulations, the calculated DT_{50}'s were 28.1 and 70.8 h, respectively, or about 6.4 and 13.6 times the calculated DT_{50}'s for the corresponding e.c. formulations. Based on the data of Ware et al. (1974), the calculated DT_{50} for MP applied as encaps. was 69.6 h, about 5.8 times that for MP applied as an e.c. Data for EP applied encaps. to cotton foliage were not heretofore available. Ware et al. (1978) reported that on cotton plants, diazinon applied encaps. was about 2 times as persistent as diazinon applied e.c.

The results of this study confirm that microencapsulating a

Table 1. Amounts of MP and EP intercepted by absorbent paper and cotton plants.

Pesticide	Formulation	Application Rate	Measured: Absorbent Paper[a]	Measured: Cotton Plants[b]	Predicted[c]
		kg ha^{-1}			
1982 MP	e.c.	0.28	0.171±0.010	0.170±0.030	0.158
	encaps.	0.28	0.156±0.012	----------	------
EP	e.c.	0.28	0.184±0.011	0.177±0.032	0.165
	encaps.	0.28	0.185±0.015	----------	-----
1983 MP	e.c.	0.28	0.251±0.045	0.254±0.013	0.236
	encaps.	0.28	0.245±0.029	0.304±0.062	0.277
EP	e.c.	0.28	0.291±0.045	0.347±0.051	0.319
	encaps.	0.28	0.314±0.034	0.505±0.023	0.454

[a] Mean ± standard deviation of 20 replications.

[b] Mean ± standard deviation of 8 replications.

[c] Predicted by best-fit equations in Table 2.

Table 2. Best-fit linear regression equations for MP and EP dissipation from cotton plants with time.

Pesticide	Formulation	Equation[a]	r^2
1982 MP	e.c.	$PL = 93.101-18.610t^{0.5}$	0.83
EP	e.c.	$PL = 93.355-16.742t^{0.5}$	0.82
1983 MP	e.c.	$PL = 93.287-20.602t^{0.5}$	0.79
	encaps.	$PL = 91.183-7.764t^{0.5}$	0.56
EP	e.c.	$PL = 92.045-18.492t^{0.5}$	0.73
	encaps.	$PL = 89.762-4.725t^{0.5}$	0.57

[a] Developed from 8 measured values/sampling time after application. PL = plant load (% of mean measured load intercepted by cotton plants) and t = time after application (hours).

pesticide enhances its persistence, at least on cotton foliage, and suggest that the magnitude of enhancement depends on the specific pesticide involved.

Acknowledgments. We thank S.F. Johnson, the landowner, for his cooperation, and are grateful for the able assistance of H.F. Pack, USDA-ARS, Baton Rouge, and K.L. Dalton, S.L. Tutor, USDA-ARS, Oxford, in conducting this study.

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Received November 14, 1986; Accepted April 1, 1987.