THE TOXICITY OF SOME AGROCHEMICALS TO *PHEIDOLE* SP. (HYMENOPTERA: FORMICIDAE) A COMMON ANT IN NATAL CANE FIELDS

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Abstract

The toxicity of five agrochemicals to the ant *Pheidole* sp. was assessed in the laboratory. The chemicals used were the nematicide aldicarb (Temik) and the herbicides paraquat, Roundup, 2,4-D and MCPA. Results indicated that their toxicity differed, Temik showing the highest kill and MCPA the lowest.

Introduction

Since ants may influence populations of *Eldana saccharina* Walk., the cane borer at present a pest in Northern cane areas, it was decided to examine factors influencing ants in cane fields. Part of the investigation concerned the toxicity of agrochemicals to a species of *Pheidole* (probably *P. megacephala* F) which is particularly widespread and abundant in Natal cane fields. Evidence exists of the toxicity of agrochemicals to animals[1] but little information is obtainable on the toxicity to insects of chemicals other than insecticides.

Materials and method

The agrochemicals used were mainly herbicides. Aldicarb (Temik), a nematicide, was the only exception. Table 1 lists the chemicals used and other relevant information. Further work on other commonly used herbicides is in progress.

TABLE 1
Data on the five agrochemicals used

Compound	LD 50 rats mg/kg	Field rate	Experimental rates
Aldicarb (Temik)	0,9	30 kg/ha	3 g/m²
Roundup	4 900	6 l/ha	0,7 ml/m²
2,4-D[1]	400–500	4 l/ha	0,6 ml/m²
MCPA[2]	800	7 l/ha	0,4 ml/m²
Paraquat	100–200	3 l/ha	0,3 ml/m²

[1] 2,4-dichlorophenoxyacetic acid (2,4-D)
[2] 4-chloro-2-methylphenoxyacetic acid (MCPA)

In this study three *Pheidole* nests were used for ant samples. For each chemical and each exposure time a sub-sample of ten ants was used. This was repeated six times giving a combined sample of 60 ants for each chemical. The sub-sample of ten ants for each of the six runs had to come from the same nest, because mixing nests caused the ants to attack each other. Each sub-sample was taken from a different nest in rotation, to allow for variations in response between nests. Only workers were used in the experiments as it was thought that this caste would be the one most likely to come into contact with chemicals in the field.

For each sub-sample, ants were collected from the nests approximately 30 minutes before commencement of the trial. It has been shown[2] that there are fewer ants foraging early in the morning than in the late afternoon and it was thought that keeping samples overnight would cause some selection due to weaker ants dying in an unnatural environment. Generally there was no difficulty in obtaining the required number of ants.

The ants in the sub-samples were exposed to 1 m² area of white sand, sprayed with the chemicals at a rate equivalent to that used in field applications. The exposure times used were 2 minutes, 5 minutes, 10 minutes and 20 minutes. Choice of times was arbitrary, but times longer than 20 minutes caused problems on account of excessive deaths from desiccation. After the sub-samples had been exposed for the stated periods, they were collected and kept in a humid environment. The ants were placed in tubes covered with gauze. The tubes were placed in large jars, which had water-soaked paper towelling at the base. A similar layer of towelling was placed over the top and kept constantly wet. The humid environment was essential since pilot experiments had revealed high mortalities due to desiccation. Each sub-sample was observed at 2-hourly intervals, up to 12 hours, then at 24 and 48 hours. Numbers of dead ants were recorded at each observation time for each exposure time. Controls were run on the same pattern to allow for mortality caused by factors other than the chemicals.

Results

The results of the trials arranged in ascending order of exposure time for each chemical, are shown in Figures 1 and 2. Each figure shows two features (i) cumulative % deaths (continuous line) and (ii) % deaths recorded at each observation time (histograms). All values are corrected for control deaths. Figure 2 is a summary of the situation for each chemical after 24 hours. The 48 hour results have been included on the graphs but are considered unreliable.

Apparent anomalies between values in Figure 2 and in the preceding figure deserve comment. The natural time of death of individuals will differ regardless of treatment. Thus on occasions (mainly at later observation times) deaths occurred in the controls when none occurred in the experiment and these could be allowed for only if cumulative deaths were adjusted. Such a situation is presented in Figure 2.

Discussion

The series of graphs displays three factors for consideration:

1. *Cumulative death*

Each chemical displays a pattern of death as shown by these graphs. Temik gives a high kill in a short period, followed by a levelling off of deaths. Paraquat gives a low % kill until, in later observation times, the level rises sharply. Roundup produces a graph similar to that of Temik, though at a much lower level. The chemical 2,4-D gives low levels of kill, although the graph rises continually throughout the monitored period. Finally MCPA gives a very low but sustained level of kill which causes the graph to rise slowly.

2. *Two-hourly observed deaths*

After the initial high kill, deaths in the Temik sample drop off to low numbers after four hours. Paraquat gives its characteristically low level of kill until later observation times, when deaths increase over a short period. Roundup tends to resemble Temik, the graph showing an initial kill, then a slowing down of deaths. For 2,4-D deaths occur more towards

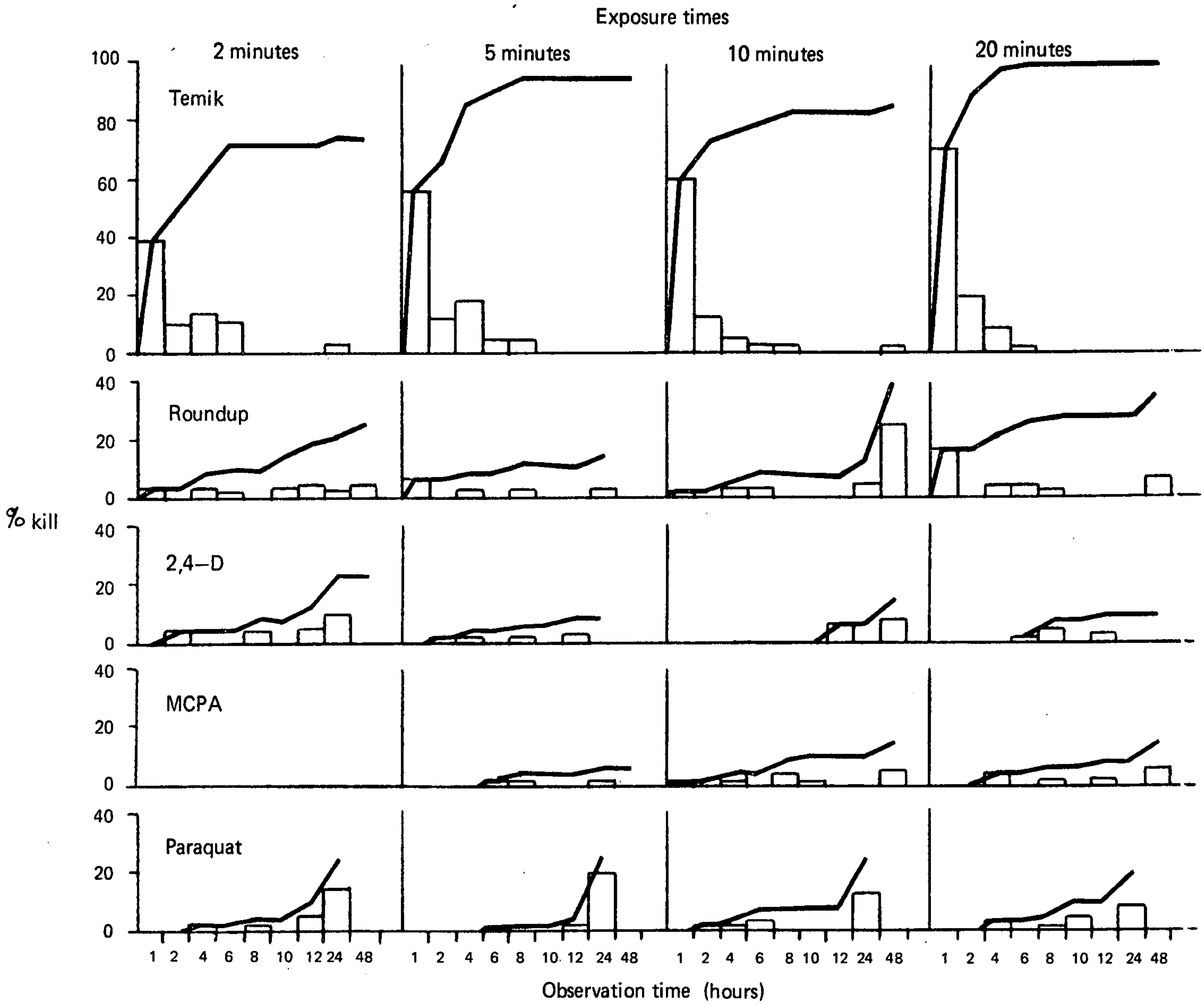

FIGURE 1 Ant deaths caused by the five agrochemicals used. Each graph displays cumulative mortality for each exposure time (continuous line) and deaths at each observation time (histograms).

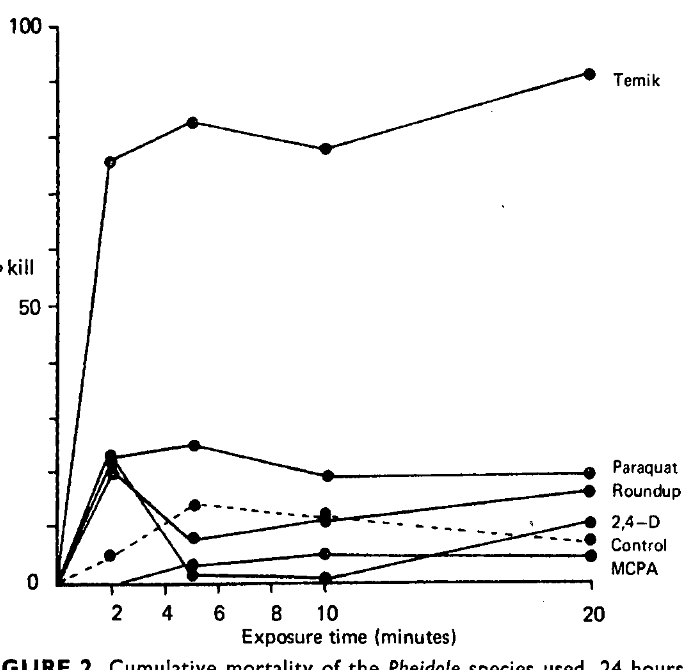

FIGURE 2 Cumulative mortality of the *Pheidole* species used, 24 hours after exposure to each chemical.

the longer observation times. In MCPA most deaths occur in the first eight hours, but at a very low level.

3. *Effect of exposure times*

Fig. 2 shows a 24 hour summary of % kill vs exposure time corrected for controls. Here, for Temik, deaths tend to increase with increasing exposure time. For MCPA deaths reach a very low value and remain low. Mortality caused by paraquat, Roundup and 2,4-D seems to reach a maximum in the two minute sample, but falls off and then slowly rises as exposure time increases. The reason for this two minute peak is not obvious but it could be related to factors influencing the availability of the chemicals concerned on the sand. On the same figure are plotted the control values (dotted line). These show a trend towards an early peak at low exposure times, but such control values cannot fully explain the two minute peak.

These sets of graphs give an indication of the mode of action of the chemicals. Temik appears to be a fast acting chemical, killing 50% of the samples within two hours. The other chemicals show different levels of kill but follow similar trends, indicating a slow increase in deaths as time progresses. The time of death is related to the susceptibility of the individual and to the degree of toxicity of the chemical under the conditions of the experiments.

From these results, the chemicals can be arranged in descending order of toxicity to the *Pheidole* species used, as follows: Temik > paraquat > Roundup > 2,4-D > MCPA. This arrangement is based on deaths occurring after 24 hours. It must be remembered that the chemicals were applied (in solution) to an area of exposed sand and that the released ants came into direct contact with the chemicals — a situation which may not often occur in the field. Such chemicals as paraquat[3] and Roundup[4] are readily inactivated when in contact with the soil which would reduce contact between the ants and the chemical in the field. In the laboratory experiments ants were exposed to field doses of the chemicals sprayed on open sand, where factors such as sorption and degradation are not as likely to occur as in the field. Other factors in the field may serve to reduce contact between ant and chemicals. Spraying practices, absorption of the chemical by plants, as well as volatilisation, would all act to reduce the quantity of active chemical to which the ants might be exposed.

Conclusion

The results clearly indicate that the agrochemicals tested had an effect on the ant species used. Most of the chemicals caused between 10% and 20% kill. Temik and MCPA were exceptions, killing 90% and 4% (at 24 hours) of the samples respectively. There are several environmental factors that might reduce the availability of chemicals. The significance of these results requires the support of field trials.

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