Toxicity of two liquid fumigant mixtures to Tribolium castaneum (Herbst).

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A B S T R A C T

The relative toxicities of two fumigant mixtures: "Calandrex" a 10:26:64 W/W/W, mixture of carbon tetrachloride, carbon disulphide and trichloroethylene, and a 80:20 W/W mixture of carbon tetrachloride (CT) and methyl-bromide (MB), as well as of their separate components were examined under laboratory conditions. The fumigants were tested in fumigation flasks of 10,5 1 capacity equipped with a magnetic stirring device to ensure uniform distribution of the gases within the flask. Test insects were adult Tribolium castaneum (Herbst) beetles kept in the fumigation flasks at 27°C for 2 hours.

Results showed that the toxicity of "Calandrex" (LD_{95} = 217 mg/l) is an approximate mean of the toxicities of its components, whereas in the CT : MB mixture there is a wide divergence in toxicity between the components: LD_{95} for MB = 24.9 mg/l, LD_{95} for CT = 234 mg/l, while the toxicity of the mixture (LD_{95} = 69 mg/l) approached that of MB, thus sug- gesting a synergistic effect between the components.

Introduction

The use of liquid fumigant mixtures has numerous advantages such as the relative ease and safety of application, and the combination of desirable qualities of each component which are not to be found in any single fumigant.

Few references are found in the literature comparing the toxicities of fumigant mixtures to those of their components. Such a study has been carried out on an EDB:MB mixture (1). In the present work the toxicities of two fumigant mixtures were tested and compared to those of their components.

The fumigant "Calandrex", is widely used in Israel for the fumigation of grain in storage. It has the property of very good penetration to the depth of the grain bulk and is highly lethal to stored-product insects. However, in a recent preliminary study, the possibility of a detrimental effect on the baking properties of the fumigated wheat has been observed. This is now being investigated in this laboratory.

To gain a better understanding of the mode of action of the mixture it has been considered necessary to examine the relative toxicity of each component thereby enabling the formulation of the components in various proportions for optimal results.

The relative toxicity of an additional liquid mixture consisting of CT+MB and its components, has been tested in order to serve as a possible substitute for the "Calandrex" mixture.

Materials and Methods

Fumigants - Two fumigant mixtures and their components were used:

1. "Calandrex", consisting of carbon tetrachloride, carbon disulphide and trichloroethylene (10:26:64 W/W/W).

2. Carbon tetrachloride: methyl bromide (80:20 W/W).

The fumigation chamber. Spherical flat bottomed flasks of 10.5 l, capacity were designed to carry out the fumigations. The flasks were fitted with a one hole ground-glass stopper closed by a rubber tube, and holding a hook from which a cage was suspended by a nylon thread (fig. 1).

During the fumigation a small propeller at the base of each flask was set in motion from outside by a magnetic stirrer, thereby ensuring even distribution of the fumigant within the flask.

Test insect: Adults of the red flour beetle Tribolium castaneum (Herbst) 4-6 weeks, old, served as test insects. The insects were taken from stock cultures reared on a bran and flour(4:1) medium at 27°C and 70% R. H. for 3 years.

50 insects of both sexes were used for each experiment, and were suspended in a copper mesh cage at the center of the flask (fig. 1).

The fumigant procedure. Insects were put into the fumigation chamber which was then evacuated (10 mm Hg). The fumigants in liquid form were then introduced by means of a 1 ml tuberculine syringe directed to the bottom of the flask. In the case of methyl bromide the fumigant was introduced in gaseous form by means of a 20 ml syringe. After evaporation of the fumigants atmospheric pressure was restored in the flask. The stirring device was activated for period of 15 seconds at the beginning of the fumigation and then at half hour intervals. Each fumigation lasted 2 hours during which time the flask was held at a constant temperature.

At the end of the fumigation period, the insects were removed from the cages into 40 cc glass vials containing 1 gr of food (bran: flour 4:1), and held at 27°C and 70% R. H.

Mortality counts. Mortality counts were undertaken 7 days after fumigation. Dead insects were considered as those that failed to show movement after having been placed for 20 seconds beneath a table lamp and stroked with a camel hair brush.

Mortality of each concentration of every fumigant component was based on 4 replications (total 200 insects). Probit log concentration mortality curves were plotted for each fumigant, and these curves were used to determine the dosage level required for LD_{50} and LD_{95}, expressed in mg of fumigant per litre.

Results and Discussion

The results are given in Table 1.

Table 1: Toxicity of "Calandrex", and CT:MB and their components to Tribolium castaneum. Exposure time 2h, t: 27°C. (Values calculated from 4 replicates).

	dosage mg/l	% mortality (means)	SE±	LD_{50}	LD_{95}
Trichloroethylene	100	15.7	1.94		
	120	39.7	1.23	140	233
	140	55.6	2.60		
	160	70.0	5.10		
Carbon disulphide	100	40.2	1.84		
	125	65.0	4.77	108	170
	150	86.6	3.39		
	170	95.5	0.97		
Calandrex	125	21.3	3.38		
	150	57.7	6.05	148	217
	170	76.0	5.02		
	180	80.2	4.68		
Carbon tetrachloride	140	8.7	1.69		
	160	34.5	1.26		
	180	44.0	1.83	180	242
	200	70.0	1.94		
Methyl Bromide	18	11.5	3.28		
	20	31.5	2.40	20.8	24.0
	22	66.2	4.51		
	24	93.5	5.30		
CT:MB	50	11.7	2.15		
	55	29.0	3.79	57.8	69.0
	60	52.7	3.20		
	65	90.0	3.27		

The results indicate that the toxicity of "Calandrex" is an approximate mean of the toxicities of its components, which showed no wide divergence in the lethal dosages obtained.

The toxicity of the CT:MB mixture on the other hand does not represent the mean toxicities of the components, but is closer to that of MB even though CT constitutes 80% of the mixture. This phenomenon indicates the possibility of a synergistic effect obtained by mixing CT with MB in the given proportions.

Our toxicity results for the components of the fumigant mixtures are in close agreement with others (2, 3, 4, 5) considering the unequal conditions of all the experiments.

Sun (3) found differences in mortality of insects placed at different levels in the fumigation chamber, and his finding was confirmed in a preliminary experiment in this laboratory. In the present work the homogenous distribution of the fumigant was achieved by means of the stirring device described above. Thus, better and repetitive results could be obtained.

References

1. Kazmaier H. Fuller R. G. 1959 - Ethylene dibromide - Methyl bromide mixtures as fumigants against the confused flour bettle. J. econ. Entomol. 52. 1081- 5.

2. Kenaga, E. E. 1961 - Time, temperature and dosage relationships of several insecticidal fumigants.J econ. Entomol. 54:537-42.

3. Sun - Yun Pei, 1947 - An analysis of some important factors affecting the results of fumigation tests on insects. Univ. Minnesota. Tech. Bull. 177.

4. Richardson H. H. and Casanges A. H. 1942 - Toxicity of Acrylonitrile Chloroacetonitrile, Ethylene dichloride and other fumigants to the confused flour beetle. J. econ. Entomol. 35: 664-8.

5. Lindgren D. L, Vincent L. E., and Krohne H. E. 1954 - Relative effectiveness of ten fumigants to adults of eight species of stored product insects. J. econ.. Entomol. 47, 923-6.

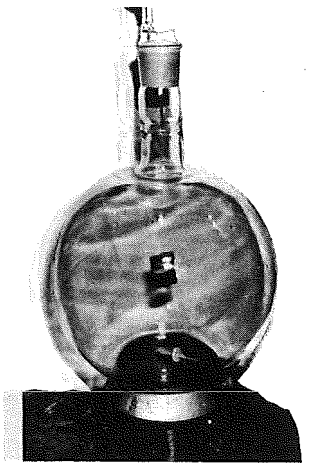

Fig. 1
The fumigation chamber