Effect of Phosphine and Methyl Bromide Fumigation of Different Life Stages of Peanut Bruchid, *Caryedon serratus* Olivier

G.V. Ranga Rao*, Upendra Ravi, A. Surender, K.S. Murthy and N.C. Joshi
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh 502 324

Abstract

To ensure seed quality, peanut seeds received for export by the Plant Quarantine Unit of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) were subjected to phosphine and methyl bromide fumigation. Effective control of eggs, larvae, and adults of *Caryedon serratus* Olivier was achieved with methyl bromide vacuum fumigation (16 g/m³ for 4 h exposure). Under normal atmospheric pressure (NAP), phosphine fumigation @ 0.5, 1.0, and 2.0 g a.i./m³ for 24, and also with 0.25 g a.i. for 72 h gave effective control of eggs and larvae. Phosphine (1.0 g a.i./40 kg burlap bag) with bruchid infested pods for 120 h resulted in 100% larval and 93% adult mortality. Both the fumigants did not impair the viability of peanut seeds. A dosage of 16 g/m³ of methyl bromide for 4 h under vacuum or 0.25 g a.i./m³ of phosphine for 72 h under NAP or placing 1.0 g a.i. of phosphine in dry pods stored in 40 kg burlap bag covered with polythene sheets for 120 h can satisfy the seed health requirements.

Introduction

Among various insects that attack stored peanut (*Arachis hypogaea* L.), peanut bruchid *Caryedon serratus* Olivier is considered the most important one (Dick, 1987). This species is found in many parts of tropical Asia and Africa, and feeds on common legumes such as *Tamarindus indica*, *Pilostima* sp., and *Cassia* sp (Feakin, 1973). The larva damages the kernel from inside but no sign of damage is visible externally until the mature larva emerges out partially or completely from the pod for pupation. Since no work has been done on the use of fumigants for its control, studies were conducted at ICRISAT's Plant quarantine Unit to study the effectiveness of phosphine and methyl bromide on egg, larval, and adult mortality so as to improve seed health by eliminating the chances of escape of this insect in groundnut seed lots meant for export, and to workout an effective fumigation dosage for control of this potentially dangerous quarantine pest.

Materials and Methods

The test insects were obtained from a laboratory culture maintained on peanut pods (var. Robut 33-1) at ICRISAT. One hundred freshly laid eggs (< 24 h old) and 100 medium sized larvae (15 days old) were used in each treatment, and replicated three times. Three dosages 16, 32, and 64 g/m³ of methyl bromide with an exposure period of 4 h were tested initially. Subsequently, dosages of 16, 12, 8, and 4 g/m³ for 1 and 2 h were also tested. The dosages and exposure periods were the same for both egg and larval studies.

Similarly, three dosages 0.5, 1.0 and 2.0 g a.i./m 3 of phosphine with an exposure period of 72 h were tested initially, followed by 0.25 and 0.5 g a.i. for 24 and 48 h. Methyl bromide fumigation was carried out in sustained vacuum condition in 1 m³ capacity fumitorium. Phosphine fumigation was carried out under normal atmospheric pressure (NAP) in 1 m³ capacity fumitorium fabricated at ICRISAT. In order to assess the effect of fumigants on adult mortality, 15 newly emerged adults (<24 h old) were exposed to 16 g of methyl bromide/m³ for 4, 2, and 1 h, and replicated three times. Similarly, 15 adults were also exposed to 1.0 g a.i. of phosphine in a 40 kg capacity burlap bag covered with polythene sheet for 72 and 120 h. During the experimental period, the temperature in the fumitoria ranged from 27-30°C. The effect of fumigants at different dosages and exposure periods on seed viability was studied by placing sixty randomly

Table 1. Effect of methyl bromide vacuum fumigation on egg, larval and adult mortality of *Caryedon serratus* Olivier

	Dosage and period of exposure	% mortality		
		Eggs	Larvae	Adults
1	64 g/4 h	100	100	-
2	32 g/4 h	100	100	-
3	16 g/4 h	100	100	100
4	16 g/2 h	100	100	97
5	16 g/1 h	100	100	87
6	12 g/2 h	100	100	-
7	12 g/1 h	95	100	-
8	8 g/2 h	82	100	-
9	8 g/1 h	58	100	-
10	4 g/2 h	52	92	-
11	4 g/1 h	47	53	-
SE±		1.57	3.06	3.85

selected seeds per treatment on wet filter papers in 20 cm diameter petri plates. The results of various tests were subjected to statistical analysis using randomized block design.

Results and Discussion

Methyl bromide (@ 12 g/m^3 or more) for 2 - 4 h gave maximum egg and larval mortality (Table 1). The larvae of the bruchid exposed to lower concentration (8 g/m^3) for even 1 h exposure period resulted in 100% mortality. Cent percent egg mortality was also obtained with the lowest concentration of 12 g and 2 h exposure. These concentrations and exposure periods had no adverse effect on the viability of peanut seed. Concentration below 12 g for 1 - 2 h exposure did not result in satisfactory control of eggs.

Cent percent adult mortality was recorded with 16 g methyl bromide with 4 h exposure period. The exposure of adults for 1 and 2 h at 16 g also resulted in 87 and 97% mortality. Leesch *et al.* (1979), reported effective control of rust red flour beetle, *Tribolium castaneum* (Herbst), rice weevil, *Sitophilus oryzae* (L.), and Indian meal moth, *Plodia interpunctella* (Hübner) with methyl bromide under NAP, but with considerable reduction in the viability of peanut seeds due to repeated fumigation with methyl bromide.

Phosphine at 0.5 g a.i./m^3 and above under NAP produced 100% egg and larval mortality with 24 h exposure period. The exposure of eggs and larvae for 72 h with a 0.25 g a.i./m^3 resulted in 100% mortality indicating the versatility of the fumigant (Table 2). Exposure of infested pods with adults and larvae to 1.0 g a.i. for 72 h in a burlap bag covered with a polythene sheet resulted in 87% larval and 73% adult mortality. An extension of exposure period to 120 h with 1.0 g a.i. resulted in 100% larval and 93% adult mortality, indicating the applicability of this technique to local on farm situations. There was no adverse effect on the germination of peanut seed (Table 3). Effective control of saw-toothed grain beetle, *Oryzaephilus surinamensis* (Oliv.) and maize weevil *Sitophilus zeamais* (Motschulsky) without any phosphine contamination in the peanut stocks has been reported from Zambia (Proctor and Ashman, 1972).

A number of studies revealed residue-free status of many food stuffs after phosphine fumigation with no adverse effects on seed viability of green gram, cowpea, and peas even with 4 and 8 g a.i. of phosphine/ton (Dhaliwal, 1976; and Singh and Srivastava, 1980).

Thus, a schedule of 16 g/m^3 of methyl bromide for 4 h under vacuum conditions or 0.25 g a.i./m^3 of phosphine for 72 h or placing 1.0 g a.i. (one tablet 3.0 g) of phosphine in dry pods stored in 40 kg burlap bag covered with polythene sheet for 120 h can safely be recommended for the control of eggs, larvae, and adults of *C. serratus*.

Table 2. Effect of phosphine fumigation at normal atmospheric pressure on eggs and larvae of *Caryedon serratus* Olivier

Dosage and period of exposure	% mortality	
	Eggs	Larvae
0.5g a.i./72 h	100	100
1.0g a.i./72 h	100	100
2.0g a.i./72 h	100	100
0.5g a.i./48 h	100	100
0.5g a.i./24 h	100	100
0.25g a.i./72 h	100	100
0.25g a.i./48 h	95	92
0.25g a.i./24 h	83	70
SE ±	1.36	1.24

Table 3. Effect of phosphine and methyl bromide fumigation on the viability of peanut seeds

Treatment	Percentage germination	
	Phosphine	Methyl bromide
T1	100	98
T2	97	100
T3	98	97
T4	100	100
SE ±	1.98	1.08
T1	0.5 g a.i./72 h	16 g/4 h
T2	1.0 g a.i./72 h	32 g/4 h
T3	2.0 g a.i./72 h	64 g/4 h
T4	Control (no fumigation)	

Acknowledgements

We are thankful to Dr. Y.L. Nene, Deputy Director General, for his encouragement and providing facilities in the Unit, and to Mr. S.V. Prasad Rao for computerization of the manuscript.

References

Dhaliwal, G.S. 1976. The occurrence and significance of phosphine residues in fumigated food stuffs. *Indian Chemical Manufacturer* 14: 37-38.

Dick, K.M. 1987. Pest management in stored groundnuts. *Information Bulletin* No. 22. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, A.P. 502 324, India. pp. 28.

Feakin, S.D. (ed.). 1973. *Pest control in Groundnuts. PANS Manual No. 2.* Centre for Overseas Pest Research, London, U.K. pp. 197.

Leesch, J.G., H.B. Gillenwater, R. Davis and Wilson Jr., R. 1979. Phosphine and methyl bromide fumigation of shelled peanuts. *Peanut Science* 6: 18-26.

Proctor, D.L. and Ashman, F. 1972. The control of insects in exported Zambian groundnuts using phosphine and polythene lined sacks. *Journal of Stored Products Research* 8: 127-137.

Redlinger, L.M. and Davis, R. 1982. Insect control in post harvest peanuts, pp.520-571. *Peanut Science and Technology* (ed. Pattee, H.E. and Young, C.T.). American Peanut Research and Educational Society, Yoakum, Texas, USA. pp. 520-571.

Singh, K.N. and Srivastava, B.P. 1980. Studies on the efficacy and extent of residues of phosphine in stored pulses. *Pesticides* 14(2): 32.

Received: 17.12.1993. Revised: 28.8.1993.