

Determination of Susceptibility Level of Phosphine in Various Strains of Dhora (*Callosobruchus maculatus* F.)

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ABSTRACT

Present studies were undertaken to determine the susceptibility level of phosphine treatment to Dhora (*Callosobruchus maculatus* F.), and to ascertain the effective concentration of phosphine fumigation combined with temperature against Dhora strains, collected from different localities of the Punjab (Pakistan). All the strains of Dhora were similar in response to phosphine treatment; even at three different temperature regimes (i.e., at 20, 25 and 30°C). 200 ppm concentration of phosphine was found to be the most effective in controlling Dhora. There was no appreciable level of resistance in *C. maculatus* to phosphine.

Key Words: Dhora; Resistance; Phosphine

INTRODUCTION

Stored pulses like mungbean are damaged by the infestation of Dhora (*Callosobruchus maculatus*). The extent of unchecked damage by Dhora has been estimated from 1-25% (Sukprakarn, 1985), 42-57% (Singh & Sharma, 1984) and as high as 70% (Munro, 1966; Ensminger, 1977). Apart from the quantitative losses, the qualitative ones are in no way of secondary importance. The control of Dhora has been achieved using grain protectants such as malathion, permethrin, deltamethrin and chlorpyrifos- methyl etc. (Evans, 1985; Daglish *et al.*, 1993). The application of grain protectants to control Dhora was abandoned owing to residue problem as the mungbean is stored for a short period of time and is used straightaway. Hence, control of Dhora with phosphine become inevitable because phosphine is the best fumigant currently available (Singh & Srivastava, 1983; Adu & Muthu, 1985). There is little work done to find out the level of susceptibility/resistance of Dhora to phosphine treatment. The present work was, therefore, undertaken to know this level in various strains of Dhora collected from different localities in the Punjab (Pakistan).

MATERIALS AND METHODS

The adults of Dhora (*Callosobruchus maculatus*) were collected from different localities of the Punjab (Pakistan). The Dhora collected from each locality were pooled together and designated as one strain. The collections were made from different stores in the grain market of Mianwali, Faisalabad, Nankanasahib, Sahiwal and Lahore separately and labelled. One strain was obtained from NIAB (Nuclear Institute for Agriculture and Biology), and it served as reference laboratory strain. The culture of these strains was maintained in the laboratory at temperature 30±2°C and

70±5% R.H. in the earthen jars and homogeneous population was developed for toxicity test.

The apparatus for generation of phosphine gas consisted of a 5 L beaker, a gas collecting tube (cylinder), an inverted funnel, 5% H₂SO₄ (sulphuric acid) solution, Gastoxin tablets and muslin cloth. Once phosphine gas was generated then various concentrations of phosphine gas were determined using Bellows Pump Model 31 (National Draeger, Inc., U.S.A.) and Drager tube (Dragerwerk Ag Lubeck, Germany) according to the procedure described in the instruction sheet. For determining the susceptibility level of each strain to phosphine, a batch of 60 Dhora adults was taken from the homogeneous population of each strain and then were treated with a series of phosphine concentrations (i.e., 50, 100, 150 & 200 ppm) to determine the LC₅₀. The observations on mortality following the phosphine treatment were taken after 24 h and mortality data was subjected to Probit analysis using Probit software. All the bioassays were replicated thrice. In order to find out temperature and concentration combination, Dhora were reared at 20, 25 and 30°C temperature regimes and then beetles were subjected to susceptibility level to phosphine gas as described above. The effect of temperature on toxicity of phosphine gas in Dhora was carried following CRD with three replications and mean LC₅₀ values were compared using one factor CRD analysis of variance by Duncan's Multiple Range Test at P<0.05 (Muhammad, 1995).

RESULTS

Table I shows LC₅₀, slope, confidence interval (C.I.), χ^2 value and resistance ratio (RR) of effect of phosphine on various strains of Dhora (*Callosobruchus maculatus*) after 24 hours of exposure period. The highest LC₅₀ value calculated by Probit analysis was found to be 82.07 (ppm)

Table I. LC₅₀ and fit of probit line of phosphine treatment in various strains of *C. maculatus*

Strain	LC ₅₀	C.I.	Fit of Probit Line		RR
	(ppm)	(95%)	Slope \pm S.E	χ^2	
NIAB	63.79	35 – 116	3.69 \pm 0.93	7.92	
Mianwali	69.86	28 – 172	3.48 \pm 1.09	12.15	1.09
Faisalabad	82.07	56 – 121	3.87 \pm 0.80	6.31	1.28
Nankana	72.84	39 – 134	3.76 \pm 0.97	9.14	1.14
Sahiwal	67.45	43 – 105	3.82 \pm 0.83	6.37	1.05
Lahore	80.74	49 – 134	3.63 \pm 0.86	7.80	1.27

Table II. Comparison of LC₅₀ of six strains of *C. maculatus* subjected to different temperatures

Strain	Temperatures (°C)		
	20	25	30
NIAB	59.63 \pm 1.13 a	66.79 \pm 0.46 b	60.95 \pm 2.64 a
Mianwali	62.19 \pm 2.09 a	74.74 \pm 2.80 b	64.08 \pm 3.95 a
Faisalabad	67.57 \pm 3.08 a	77.76 \pm 0.64 a	71.69 \pm 4.87 a
Nankanasahib	64.42 \pm 1.03 b	69.12 \pm 1.54 ab	75.88 \pm 3.88 a
Sahiwal	63.56 \pm 1.18 a	67.29 \pm 3.24 a	67.03 \pm 5.35 a
Lahore	66.24 \pm 2.72 b	85.59 \pm 1.82 a	82.38 \pm 3.28 a

Values are mean \pm S.E, differences in LC₅₀ was determined by DMR test at 5% level of significance. Means sharing common letter in a row are not significantly different at 5% level of significance

in case of Faisalabad strain. The overlapped C.I. suggest that there is no difference in LC₅₀ of phosphine to different strains of *C. maculatus*.

Comparison of LC₅₀ (ppm) of six strains of Dhora subjected to different temperatures is given in Table II. A non-significant difference of LC₅₀ value between Nankanasahib and Lahore strains was found, and these two strains differed significantly from other strains at 20°C. There was a non-significant difference of LC₅₀ values among NIAB, Mianwali and Nankanasahib strains, however, latter had non-significant difference with other three strains at 25°C. All the strains had non-significant difference of LC₅₀ values at 30°C.

DISCUSSION

Mungbean is stored with other storage grains like wheat, corn (maize) and rice etc., in the existing commercial storage facilities. Though storage time for mung bean is very short, but infestation by Dhora (*Callosobruchus* spp.) can be expected during this short storage period. The commercial storage facilities fumigate the grains to protect them from pest insects often in the current storage practices. The fumigation of grain is done with phosphine gas generated from aluminium phosphide tablets (Agtoxin etc.). There are reports of development of resistance to phosphine in storage beetle pests (*Tribolium castaneum*, *Rhizopertha dominica* and *Trogoderma granarium*) (Hamid *et al.*, 1988; Taylor, 1991; Irsahd & Iqbal, 1994; Hussain, 1994; Bell & Wilson, 1995). Keeping in view this observation, the present study was designed to ascertain the status of phosphine susceptibility/resistance in *Callosobruchus maculatus*, because this bruchid is also exposed to phosphide simultaneously along with other storage pest insects.

The LC₅₀ values and resistance ratio in case of all six strains (Mianwali, Faisalabad, Nankanasahib, Sahiwal, Lahore & NIAB) of *C. maculatus* showed that there was no resistance level in the strains when compared with reference strain. These strains were also reared at three different temperature regimes (i.e., at 20, 25 & 30°C) and then LC₅₀ values were determined. Results described that more or less all strains showed the similar response to phosphine when treated at different temperatures.

Earlier different workers used phosphine gas in controlling this particular pest insect (*C. maculatus*) with great effect (Chiang *et al.*, 1977; Sadomov, 1984; Gupta & Kashyap, 1995). El-Lakwah *et al.* (1995) reported that *C. maculatus* had the genetic potential to develop resistant strain to phosphine owing to difference in oviposition between resistant and susceptible strains. In case of *C. maculatus* there was no comparable study so it had become difficult to compare our results with others reported elsewhere. All strains collected from different ecological locations showed similar response to phosphine treatment, even at three different temperature regimes. It is, thus, concluded that the *C. maculatus* can be effectively controlled (100% mortality) with 200 ppm concentration of phosphine. Ahmad (2000) found 200 ppm phosphine concentration to be the most effective against *T. castaneum* in storage for 14 days.

CONCLUSION

The phosphine treatment in storage against storage pest insects like *T. castaneum*, *T. granarium*, and *R. dominica* is not posing a threat of the development of phosphine resistance in *Callosobruchus maculatus*.

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