http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 3 (5): 874-875, 2000

Resistance/ Susceptibility Levels of Phosphine Gas to Various Strains of *Tribolium Castaneum* Hbst. (Coleoptera:Tenebrionidae)

Imtiaz Hussain, Arshed Makhdoom Sabir[1], Anjum Suhail and Waseem Akram
Department of Agri. Entomology, University of Agriculture, Faisalabad
[1]Beekeeping and Hill Fruit Pest Research Sub-Station, Murree, Pakistan

Abstract: Study was carried out to determine the level of resistance in *Tribolium castaneum* (Hbst.). Strains collected from various localities of the Punjab and exposed to different concentrations of phosphine, viz; 0.01, 0.02, 0.03, 0.04 and 0.05%. Higher concentration (0.05 percent) gave higher mortality (90.721-100 percent) under test. While LC 50 values calculated for Sargodha, Kalar-Kahar, Chiniot, Moza Matu, Noorwala, Okara, Jhang, Mamukanjan, Faisalabad, Lahore and susceptible strains of *T. castaneum* were 0.0220, 0.0115, 0.0176, 0.0132, 0.0136, 0.0163, 0.2010, 0.0186, 0.0193, 0.0192 and 0.0030, respectively, and the level of resistance in these strains ranged from 3.787 to 7.255.

Key words: Resistance, Phosphine , *Tribolium castaneum*

Introduction

Grain protectants and fumigants are mainly used for the control of insect pests of stored grains. Complaints against the effectiveness of fumigation treatments are very often heared. This could most probably be due to improper storage structures from where the gas leaks out or fumigants themselves have gone ineffective and the insects have developed resistance against them. Since fumigants are very commonly used by the Government agencies, it is important that development of resistance is carefully watched.

Hamid *et al.* (1988) reported that the strain of *T. castaneum* showed 1.25 to 1.58; 0.75 to 2.30; 1.26 to 1.88 and 1.03 to 1.25 time resistance, respectively, over the susceptible strain collected from Multan, Sahiwal, Khanewal and Basti Ferozen (Farm level storage). Taylor (1989) reported that the sub-standard fumigation techniques in case of phosphine and methyl bromide resulted in developing resistance. Hobbs and Bund (1989) reported that the *T. castaneum* when exposed to repeated treatment with a sub-lethal dose of phosphine (LD 10), mortality increased from 10 – 28 percent. Pacheco *et al*. (1990) observed in a laboratory bioassay that out of 10 strains, nine strains of *T. castaneum* were found resistant to fumigant when exposed to discriminating concentrations of phosphine gas for 20 hours. Rajendran (1992) reported the responses of the life stages of *T. castaneum* when compared with those of untreated control with 24 hours exposure of phosphine with those of untreated control with 24 hours exposure of phosphine and mortality was assessed for 8-14 day.

Materials and Methods

Adults of *T. castaneum* were collected with the help of sampler from bins, house type godowns and stores of Food Department at Faisalabad, Mamunkanjan. Sargodha, Chiniot, Mianwali, Kaler Kahar, Jhang, Noorwala, Moza Matu, Okara and Lahore . The collected specimens from each particular locality was pooled together and designated as one strain and kept in wide mouth bottles covered with muslin cloth containing wheat grains. Each strain was labelled and reared separately in the laboratory and susceptible strains of these insects were also obtained and kept aside and labelled. The strains provided data of relative degree of resistance in the field collected strains. Samples were placed in incubator set at 30 ± 2°C and 70 ± 5 percent relative humidisty and were held then for three days. Presumed to be of equal age, were further held of a period of 2 weeks before testing.

The procedure followed for testing each strains of *T. castaneum* against phosphine gas was as under: For each individual test 20 adult insects of each strain in one beaker, in five repeats, were placed in a desiccator at phosphine concentrations 0.01, 0.02, 0.03, 0.04 and 0.05 percent. The insects of each strain in one beaker placed in a desiccator where no gas was present, then it served as control treatment. The amount of phosphine required for the test was calculated using the formula; Concentration x Desiccator volume x 836.81. After 20 hours exposure period for each concentration the desiccators were opened and number of insect alive and dead were noted. Insect mortality was corrected by using Abots formula.

$$\frac{\text{\% age mortality - control mortality}}{\text{100 - control mortality}} \times 100$$

The effect of treatment was computed following CRD analysis of variance. The treatment means were compared by DMR test at p = 0.05.

Results and Discussion

The lag profit regression and LC 50 for different strains was calculated from the data given in Table 1. The LC. 50 values for strains of *T. castaneum* ranged from 0.003 to 0.00220. The level of resistance in these strains ranged from 3.787 to 7.255. This has shown that resistance level varied from strain to strain. It was maximum for Sargodha strain. The resistance fold level in the strain collected from Jhang, Mamukanjan, Faisalabad and Lahore was approximately equal (more than 6 times). The resistance level of Chiniot and Okara strains was more than 5 times. The strains collected from Moiza Matu and Noorwala village were 4.369 and 4.482 times, respectively. The present investigation leads to the conclusion that the resistance to phosphine is increasing rapidly. Similar studies carried out in the Punjab province by Hamid *et al.* (1988) also reported the prevalence of resistance in *T. castaneum*, but the intensity of resistance at that time was not as high as

Table 1: Level of resistance in test strains of *T. castaneum*

Strain	LC50	Resistance/ Susceptible Strain	100 R° (%)
Sargodha	0.0220	7.255	95.3
Kalar Kahar	0.0115	3.787	86.1
Chiniot	0.0176	5.817	81.9
Moiza Matu	0.0132	4.369	88.3
Noor Wala	0.0136	4.482	84.1
Okara	0.0163	5.391	81.1
Jhang	0.0201	6.616	89.9
Mamukanjan	0.0186	6.136	87.5
Faisalabad	0.0193	6.376	87.9
Lahore	0.0192	6.333	85.6
Laboratory (Susceptible)	0.0030	-	77.6

Table 2: Mortality trend of different strains of *Tribolium castaneum* (Hbst) exposed to different concentrations of phosphine

Stations	Concentrations Mortality	Mean	Corrected Mortality (%)
Sargodha	0.00	0.06 f	-
	0.01	4.60 e	20.618
	0.02	6.60 d	30.927
	0.03	13.60 c	68.041
	0.04	16.20 b	80.412
	0.05	18.20 a	90.721
Kalar Kahar	0.00	1.00 d	-
	0.01	11.00 c	45.263
	0.02	15.60 b	76.842
	0.03	17.40 b	86.315
	0.04	20.00 a	100.00
	0.05	20.00 a	100.00
Chiniot	0.00	0.80 e	-
	0.01	3.60 d	14.583
	0.02	13.00 c	63.540
	0.03	16.20 b	80.208
	0.04	18.20 a	90.625
	0.05	18.80 a	93.750
Moiza Matu	0.00	0.80 e	-
	0.01	8.20 d	38.541
	0.02	13.20 c	64.583
	0.03	18.00 b	89.583
	0.04	20.00 a	100.00
	0.05	20.00 a	100.00
Noor Wala	0.00	0.80 b	-
	0.01	7.40 c	35.100
	0.02	13.40 b	65.625
	0.03	18.80 a	93.725
	0.04	19.20 a	95.833
	0.05	20.00 a	100.00
Okara	0.00	0.60 d	-
	0.01	5.80 c	26.804
	0.02	8.40 b	40.206
	0.03	19.40 a	98.907
	0.04	20.00 a	100.00
	0.05	20.00 a	100.00
Jhang	0.00	0.40 c	-
	0.01	4.40 d	20.408
	0.02	6.80 c	32.653
	0.03	15.80 b	78.571
	0.04	18.80 a	89.795
	0.05	18.60 a	92.857
Mamukanjan			
	0.00	0.60 b	-
	0.01	5.20 c	23.711
	0.02	6.80 d	31.958
	0.03	17.20 c	85.567
	0.04	18.80 b	93.814
	0.05	20.00 a	100.00
Faisalabad	0.00	0.60 b	-
	0.01	4.80 e	21.649
	0.02	6.40 d	29.896
	0.03	17.00 c	84.536
	0.04	16.40 b	91.752
	0.05	20.00 a	100.00
Lahore	0.00	0.40 d	-
	0.01	4.40 c	20.408
	0.02	5.00 c	28.571
	0.03	17.60 b	87.755
	0.04	19.80 a	93.877
	0.05	20.00 a	100.00
Laboratory	0.00	1.40 c	-
	0.01	17.60 b	91.397
	0.02	19.20 a	95.693
	0.03	20.00 a	100.00
	0.04	20.00 a	100.00
	0.05	20.00 a	100.00

Means sharing similar letters are not significantly different by DMR Test at p = 0.05

observed in the present studies. His results showed that the resistance to phosphine in *T. castaneum*, over the susceptible strain at that time was found to vary between 1.03 and 1.88 time. The more alarming situation is that the resistance to phosphine in this species has greatly increased over the years. Kem (1978) also found 3 fold resistance to phosphine over susceptible strains, while Saxena and Bhatia (1980) observed 5.94 resistance against phosphine over the parent strain.

Table 2 also revealed that the higher phosphine concentration resulted in maximum mortality of the adult insects and the vice versa. The corrected mortality range was 14.583-91.397, 28.571-95.693, 68.041-100, 80.412-100 and 90.712-100 percent when exposed to 0.01, 0.02, 0.03, 0.04 and 0.05. These results depict that the mortality increase as the phosphine concentration increase. The present investigation can be partially compared with those of Nakakita and Kurock (1986), Winks (1986), Pacheco *et al.* (1990) and Rajendran (1992) owing to difference in their methodology but like the present study they confirmed that phosphine induce resistance in *T. castaneum*.

References

Hamid, A., M. Ahmad, M. Hassan and A.A. Sabir, 1988. Survey of resistance to phosphine gas in various strains of *Tribolium castaneum* (Hbst.) and *Rhyzopertha dominica* (F.). Pak. Entomol., 10: 49-52.

Hobbs, S.K. and E.J. Bund, 1989. Response of *T. castaneum* to sub lethal treatments with phosphine. J. Stored Prod. Res., 25: 137-146.

Kem, T.R., 1978. Cross resistance characteristics of a phosphine-resistant strain of *Tribolium castaneum* (Herbst) to some fumigants. J. Entomol. Res., 2: 206-288.

Nakakita, H. and J. Kurock, 1986. Differences in phosphine uptake between susceptible and resistant strains of insects. J. Pestic. Sci., 11: 21-26.

Pacheco, I.A., M.R. Santori and R.W.D. Taylor, 1990. Survey of phosphine resistance in stored grain insect pests in the state of Sao Paulo. Coletanea do Instituto de Tecnologia de Alimentos, 20: 144-154.

Rajendran, S., 1992. Selection for resistance to phosphine or methyl bromide in *Tribolium castaneum* (Coleoptera: Tenebrionidae). Bull. Entomol. Res., 82: 119-124.

Saxena, J.D. and S.K. Bhatia, 1980. Laboratory selection of the red flour beetle, *Tribolium castaneum* (Herbst) for resistance to phosphine. Entomon, 5: 301-306.

Taylor, R.W.D., 1989. Phosphine: A major grain fumigant at risk. Int. Pest Control, 31: 10-14.

Winks, R.G., 1986. The significance of response time in the detection and measurement of fumigant resistance in insects with special reference to phosphine. Pestic. Sci., 17: 165-174