# EFFICACY OF SOME COMMONLY USED INSECTICIDE ON THE RED FLOUR BEETLE *Tribolium castaneum* (HERBST)

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**ABSTRACT**

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The experiments were conducted in the laboratory of the Department of Entomology, BAU, Mymensingh during April 2002 to December 2002 to find out the resistance level of different insecticides by insect strains in Bangladesh. Wheat samples containing adult beetles were collected from 9 different locations of Bangladesh and then the collected insects were reared. Field strains of the red flour beetle, *Tribolium castaneum* (Herbst) (Tenebrionicae: Coleoptera) collected from eight storage depot and one silo, were tested for susceptibility to malathion, dichlorvos, fenitrothion, pirimiphos-methyl and phosphine. Results of discriminating dose tests of the red flour beetle indicated that all strains were resistant against all the test insecticides. Highest resistance was observed against malathion followed by dichlorvos, phosphine, pirimiphos-methyl and fenitrothion. Ghatail and Tangail populations of the beetle showed higher degree of resistance against malathion, Sheddirganj populations showed against dichlorvos and tangail populations observed against phosphine compared to other populations.

**Key words:** Efficacy, insecticide, red flour beetle,

## INTRODUCTION

The red flour beetle, *Tribolium castaneum* (Herbst), is one of the most serious stored product insect pests. In Bangladesh, the annual grain loss costs in storage estimated 10million taka (Alam1971). Alam (1971) reported 5-8 % annual damage of stored grains by stored product insect pests. Some specific insecticides are being used consistently over many years to control different stored product insects in different parts of the world. As a result, the treated insect species developed resistance to the insecticides. Therefore, effectiveness of these particular insecticides has reduced considerably. Resistance to pesticides among native populations of red flour beetle, *T. castaneum*, is widespread throughout the world (Anon, 1973). After more than 15 years of continuous use of pesticides, in different countries of the world red flour beetles started to show high levels of resistance to DDT (Speris *et al*. 1971), malathin (Speris *et al* . 1967, Zettler, 1974, 1975) and cross-resistance to other insecticides (Speris and Zettler, 1969). Phosphine resistance in stored product insects was first reported by Champ and Dyte in1976. Their global survey revealed increased tolerance to phosphine and pest control failures due to insecticide resistance began to occur in the late 1970s in India (Borach and Chahal, 1979) and then occurred in Bangladesh (Tyler *et al*. 1983).

In Bangladesh, insecticides are being used regularly in the public sector storage but very little in the farmer house storage of the subsistence farmers. In large storage malathion, fenitrothion, pirimiphos-methyl, dichlorvos, methyl-bromide and aluminum phosphide are being commonly used. Therefore, a study was undertaken to evaluate the resistance level to red flour beetle populations against these commonly used insecticides.

## MATERIALS AND METHODS

Wheat samples containing adult red flour beetle were collected from eight different storage, one silo and one flour mill from different locations viz. Mymensingh, Dhaka, Narayanganj, Sheddirganj, Tangail, Ghatail, Jamalpur, Kishoreganj, and Serajganj of Bangladesh during April to May 2002. About 500-600 adult beetles were collected from each storage or trader shop. Insects were put into polythene bag with their food media (whole and broken wheat) providing aeration and carried to the laboratory of the Department of Entomology of Bangladesh Agricultural University at Mymensingh.

The collected insects were reared in the laboratory where flour was used as rearing media. About 40-50g of wheat flour placed in plastic jar (9.5 X 7.5 cm) and 100-200 insects were then release in each jar for feeding and oviposition. The jar was placed in a locust rearing cage (55 X 38 cm). The temperature and RH of locust cage were maintained at $30\pm1^0$ C and 75±5% respectively.

Based on the information collected from different government storage and silo, five commonly used insecticides were selected for the test. Among these four were Organophosphorus (Zithiol 57EC, Nogos 100EC, Sumithion 50EC and Actellic 50EC) and one Phosphine gas (Celphos tablet) insecticides.
Efficacy of Emulsiable Concentrate insecticides were tested by using topical application method (Talukder and Howse 1994 and 1995). Different concentrations (0.01%, 0.02%, 0.05%, 0.5%, 1.0% and 2.0%) were prepared by diluting insecticide with analytical grade acetone. Adult beetles were chilled for a period of 10 minutes. Then the immobilized insects were picked up individually and 1.0 µl (microlitre) of insecticide solution was applied topically on dorsal surface of the thorax of each insect using micro-capillary tube. Fifty unsexed adult beetles were treated by each dose and another 50 insects were treated with acetone only as control. Insects were then transferred into petridish (10 insects/petridish) containing wheat flour.

Efficacy of phosphine gas was tested in 4 liters gas tight pyrex desicator. Phosphine gas was prepared by exposing celphos (3 g) tablet to the air in a 1300-ml glass bottle. Five (9.0 cm dia) petridishes each containing 10 adult beetles with some flour are placed in a desecrator. Then phosphine gas at required concentration was injected into the desecrator by a 30cc syringe. Three concentrations 2cc/1000ml, 3cc/1000ml and 4cc/1000ml were tested. One set of insects (5x10) was kept in a desecrator without phosphine, which served as control. All the petridishes and desicators with insects were kept in an environmental chamber at 30±1$^0$C and 75±5% RH and photoperiod of 12:12 (Light :Dark).Treated insects were examined at 24, 48 and 72 hours after treatment and those unable to move or respond to gentle touch were recorded as dead. In the case of phosphine 20 hours of exposure the petridishes were removed from the desicator and insect mortalities were recorded. The data were corrected by Abbott's (1987) formula and then analyzed using ANOVA and Duncan's multiple range test (1951) was adopted to compare treatment means. Median lethal concentration ($LC_{50}$) was calculated using probit-analysis (Finney, 1971) with a $\log_{10}$ transformation of concentration of insecticides by MSTAT statistical microcomputer software.

## RESULTS AND DISCUSSION

Mortality of red flour beetles at 72 hours after treatment (HAT) due to malathion and dichlorvos (Table 1.). When compared with the control population, most of the treated populations had higher $LC_{50}$ values. At 72 HAT the Ghatail Local Storage Depot] population was most tolerant ($LC_{50}$=19.67) to malathion treatment, followed by Tangail LSD population ($LC_{50}$=15.44). On the other hand, Serajganj LSD population was most susceptible ($LC_{50}$=3.11) to malathion treatment, among the treated populations. The control population had lowest $LC_{50}$ (1.078) values, which indicate their highest susceptibility to malathion. But, in case of dichlorvos, the Sheddirganj Silo population was most tolerant to dichlorvos ($LC_{50}$=0.069) at 72 HAT, whereas Ghatail and Serajganj LSD populations were most susceptible ($LC_{50}$=0.016) to dichlorvos.

Table1. $LC_{50}$ value of malathion and dichlorvos against red flour beetle at 72 hours after topical treatment.

| Pest population | Malathion | | | Dichlorvos | | |
|---|---|---|---|---|---|---|
| | $LC_{50}$ value (%) | 95% fiducial limit | $\chi^2$ | $LC_{50}$ value (%) | 95% fiducial limit | $\chi^2$ |
| Narayanganj C.S.D. | 6.448 | 1.819-22.853 | 0.375 | 0.022 | 0.017-0.028 | 2.663 |
| Kishoreganj L.S.D. | 5.983 | 1.345-26.626 | 0.024 | 0.026 | 0.020-0.033 | 1.611 |
| Tejgaon C.S.D. | 9.550 | 1.142-79.844 | 2.436 | 0.022 | 0.017-0.029 | 1.047 |
| Sheddirganj Silo | 6.013 | 0.925-39.090 | 0.011 | 0.069 | 0.029-0.169 | 0.081 |
| Tangail L.S.D. | 15.439 | 0.664-358.913 | 0.261 | 0.031 | 0.023-0.041 | 0.044 |
| Ghatail L.S.D. | 19.675 | 0.746-519.406 | 0.188 | 0.016 | 0.013-0.020 | 5.248 |
| Mymensingh C.S.D. | 4.886 | 1.853-12.882 | 1.879 | 0.026 | 0.023-0.030 | 0.303 |
| Jamalpur L.S.D. | 5.430 | 1.520-19.411 | 0.433 | 0.026 | 0.020-0.033 | 1.048 |
| Serajganj L.S.D. | 3.114 | 1.274-7.611 | 0.748 | 0.016 | 0.013-0.019 | 0.011 |
| Mymensingh (control) | 1.078 | 0.807-1.442 | 0.105 | 0.009 | 0.007-0.012 | 1.359 |

* $\chi^2$ (Chi-squire) test of goodness of fit (Tabulated value is 3.84 with d.f=1, p<0.05, Values were based on the three concentrations, five replicates of 10 beetles each. Tropical treatment= Means insecticides apply dorsal surface of the thorax of insects.

The results on probit analysis for fenitrothion and pirimiphos-methyl (Table-2) shows probit mortality for 10 different red flour beetle populations at 72 HAT. When compared with the control population, most of the treated populations had higher $LC_{50}$ values. The control population had lowest $LC_{50}$ (0.007), which indicate their highest susceptibility to fenitrothion. The populations of Narayanganj and Jamalpur were tolerant ($LC_{50}$=0.015) to fenitrothion, whereas, Sheddirganj Silo population was susceptible ($LC_{50}$= 0.011) to fenitrothion. On the other hand, the Tangail LSD red flour beetle population was tolerant ($LC_{50}$= 0.019) to pirimiphos-methyl. Whereas, Serajganj and Narayanganj populations were susceptible ($LC_{50}$= 0.012) to pirimiphos-methyl.

Table2. $LC_{50}$ value of fenitrothion and primiphos-methyl against red flour beetle at 72 hours after topical treatment

| Pest population | Fenitrothion | | | Pirimiphos-methyl | | |
|---|---|---|---|---|---|---|
| | $LC_{50}$ value (%) | 95% fiducial limit | $\chi^2$ | $LC_{50}$ value (%) | 95% fiducial limit | $\chi^2$ |
| Narayanganj C.S.D. | 0.015 | 0.011-0.019 | 0.584 | 0.012 | 0.010-0.015 | 5.565 |
| Kishoreganj L.S.D. | 0.012 | 0.009-0.015 | 1.795 | 0.013 | 0.011-0.016 | 5.382 |
| Tejgaon C.S.D. | 0.014 | 0.011-0.017 | 3.210 | 0.016 | 0.013-0.021 | 3.927 |
| Sheddirganj Silo | 0.011 | 0.008-0.016 | 0.648 | 0.018 | 0.014-0.024 | 3.191 |
| Tangail L.S.D. | 0.012 | 0.009-0.017 | 0.004 | 0.019 | 0.015-0.024 | 0.029 |
| Ghatail L.S.D. | 0.013 | 0.011-0.016 | 2.659 | 0.016 | 0.013-0.019 | 3.338 |
| Mymensingh C.S.D. | 0.014 | 0.012-0.016 | 0.853 | 0.017 | 0.015-0.019 | 0.901 |
| Jamalpur L.S.D. | 0.015 | 0.013-0.017 | 0.496 | 0.015 | 0.012-0.019 | 1.892 |
| Serajganj L.S.D. | 0.013 | 0.010-0.017 | 0.634 | 0.012 | 0.009-0.014 | 3.261 |
| Mymensingh (control) | 0.007 | 0.004-0.010 | 0.132 | 0.007 | 0.005-0.010 | 0.003 |

* $\chi^2$ (Chi-squire) test of goodness of fit (Tabulated value is 3.84 with d.f=1, $p<0.05$. Values were based on the three concentrations, five replicates of 10 beetles each. Tropical treatment= Means insecticides apply dorsal surface of the thorax of insects.

The results on probit analysis for aluminumphosphide (Table-3) show probit-motality for ten different red flour beetle populations at 20 HAT. Compared with the control population, most of the treated populations had higher $LC_{50}$ values. The Tangail population was most tolerant to aluminumphosphide ($LC_{50}$=11.453), followed by Jamalpur population ($LC_{50}$=10.808). On the hand, Serajganj population was most susceptible ($LC_{50}$=3.275) to aluminiumphosphide among the treated populations. The control population had lowest $LC_{50}$ (2.155) values, which indicate their highest susceptibility to aluminumphosphide.

Table3. $LC_{50}$ value of aluminiumphosphide against red flour beetle at 20 hours after treatment (in desicator)

| Pest population | Aluminum phosphide | | $\chi^2$ |
|---|---|---|---|
| | $LC_{50}$ value (%) | 95% fiducial limit | |
| Narayanganj C.S.D. | 7.113 | 3.451-14.666 | 0.029 |
| Kishoreganj L.S.D. | 10.283 | 1.716-61.617 | 0.007 |
| Tejgaon C.S.D. | 7.268 | 3.188-16.569 | 0.227 |
| Sheddirganj Silo | 5.836 | 3.831-8.885 | 0.628 |
| Tangail L.S.D. | 11.453 | 2.040-64.313 | 0.003 |
| Ghatail L.S.D. | 5.344 | 3.446-8.288 | 0.051 |
| Mymensingh C.S.D. | 9.165 | 2.593-32.384 | 0.008 |
| Jamalpur L.S.D. | 10.808 | 1.792-65.247 | 0.006 |
| Serajganj L.S.D. | 3.275 | 2.602-4.119 | 0.012 |
| Mymensingh (control) | 2.155 | 1.835-2.530 | 0.093 |

* $\chi^2$ (Chi-squire) test of goodness of fit (Tabulated value is 3.84 with d.f=1, $p<0.05$. Values were based on the three concentrations, five replicates of 10 beetles each.

Again resistance of different population of red flour beetles against treated insecticides shows (Table 4.). The resistance factors for malathion treated populations showed that Ghatails LSD beetle population had the highest R/F value, followed by Tangail LSD population. On the other hand, Serajganj LSD population had lowest Resistance/Factor (R/F) value among the treated population. The Sheddirgang Silo population had highest R/F value, whereas, Ghatail and Serajganj LSD populations had lowest R/F values to dichlorvos treatment among the treated population. In case of fenitrothion, Narayanganj Cental Storage Depot (CSD) and Serajganj LSD populations had highest R/F values, where as Sheddirgang Silo population had lowest R/F value by the fenitrothion treated population. But Tangail LSD population had highest R/F value and Serajganj LSD population had lowest R/F value both pirimiphos-methoil and phosphine gas treatment among the treated population. On the other hand Narayanganj CSD and Serajganj LSD populations had lowest R/F values to pirimiphos - methyl treatment; where as, Serajganj LSD population had lowest R/F value among the phosphine gas treated population. This result also supports the trends of $LC_{50}$ values presented in previous three Tables.

Table 4. Resistance of different population of red flour beetles against few commonly used insecticide in Bangladesh.

| Pest population | Resistance factor (R/F) for LC50 of used insecticides | | | | |
|---|---|---|---|---|---|
| | Malathion | Dichlorvos | Fenitrothion | Pirimiphos- methyl | Phosphine |
| Narayanganj C.S.D. | 5.98 | 2.54 | 2.41 | 1.71 | 3.30 |
| Kishoreganj L.S.D. | 5.55 | 2.89 | 1.71 | 1.86 | 4.77 |
| Tejgaon C.S.D. | 8.86 | 2.45 | 2.00 | 2.28 | 3.37 |
| Sheddirganj Silo | 5.58 | 7.67 | 1.57 | 2.57 | 2.70 |
| Tangail L.S.D. | 14.32 | 3.45 | 1.71 | 2.71 | 5.31 |
| Ghatail L.S.D. | 18.25 | 1.78 | 1.86 | 2.28 | 2.48 |
| Mymensingh C.S.D. | 4.53 | 2.89 | 2.00 | 2.43 | 4.25 |
| Jamalpur L.S.D. | 5.04 | 2.89 | 2.14 | 2.14 | 5.02 |
| Serajganj L.S.D. | 2.89 | 1.78 | 1.86 | 1.71 | 1.52 |
| Mymensingh (control) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

## REFERENCES


Abbott, W.S. 1987. A method of computing the effectiveness of an insecticide *J. America Mosquito Control Assoc*. 3, 302-303

Alam, M.Z. 1971. Pest of stored grains and other stored products and their control. *Agriculture Information Service* Dhaka.61p

Anonymous. 1973. FAO global survey of pesticide susceptibility of stored grain pests. Report of the 9th session of the FAO working party of experts on pest resistance Pesticides. June 18-22, Rome, Italy.17p

Borach, B. and Chahal, B. S. 1979. Development of resistance in *Trogoderma granarium* (Everts) to phosphine in punjab. FAO *Plant Prot. Bull*. 27, 77-80

Champ, B.R. & Dyte, C.E. 1976. Report of the FAO global survey of pesticide susceptibility of stored grain pests. FAO *Plant Prot. Ser*. No. 5. FAO, Rome.279p

Duncan, B.D. 1951. A significance test for differences between ranked treatments in an analysis of variance. *Virginia J. Sc*. 2, 171-189

Finney,D.J. 1971. Statistical Method in Biological Assay, *2nd edition*, Griffin, London: 668p

Speris, R.D., Redlinger, L.M. & Boles, H.P. 1967. Malathin resistance in red flour beetle. *J. Econ. Entomol*. 60, 1373-1374

Speris, R.D. & Zettler, J.L. 1969. Toxicity of organophosphorus compounds and pyrethrin to malathion resistant *Tribolium castaneum* (Herbst) (Coleoptera : Tenibrionidae). *J. Stored Prod. Res*. 4, 279-283

Speris, R.D., Redlinger, L.M. & Jone, R.D. 1971. DDT resistant in red flour beetles from a Georgina peanunts sheller. *Ibd.* 64, 1328-1329

Talukder, F.A. and Howse, P.E. 1994. Laboratory evaluation of toxic and repellent properties of the Pithraj tree *Aphanamixis polystachya* Wall and Parker, against Sitophilus oryzae. Int. J. Pest Management 40(3): 274-279

Talukder, F.A. and Howse, P.E. 1995. Evaluation of *Aphanamixis polystachya* as repellents, antifeedants, toxicants and protectants in storage against *Tribolium castaneum* (Hebst). J. stored Prod. Res. 31(1): 55-61.

Tyler, P.C., Taylor,R.W.D. & Rees, D.P. 1983. Insect resistance to phosphine fumigation in food warehouse in Bangladesh. *Int. Pest Control*. 25, 10-13, 21

Zettler, J.L. 1974. Malathion resistance in *Tribolium castaneum* collected from stored peanuts. *Ibd*. 67, 339-340.

Zettler, J.L. 1975. Malathion resistance in *Tribolium castaneum* collected from rice the USA. *J. Stored Prod. Res*. 11, 115-117