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PERFORMANCE OF CYPERMETHRIN, DELTAMETHRIN AND NIMBICIDINE ON LARVAL DEVELOPMENT OF *TRIBOLIUM CASTANEUM* (HERBST)

R Khatun, W Islam*, K A M S H Mondal

Institute of Biological Sciences, University of Rajshahi, Bangladesh

Abstract

Context: Pyrethroid insecticides and natural products individually or in mixture can protect stored products by retarded growth and delayed larval period.

Objectives: To investigate the effects of cypermethrin, deltamethrin and azadirachtin either alone or in combinations on the larval development of *Tribolium castaneum* (Herbst).

Materials and Methods: *T. castaneum* larvae were reared in flour medium treated with cypermethrin, deltamethrin and nimbicidine alone and in combinations. Ten newly hatched larvae were placed in a petri dish (4cm diam) containing 1g of either fresh or treated flour and kept in an incubator (30 ± 0.5^0C). The larvae were regularly observed for pupation and the larval period was noted. The weights of the fourth and sixth instar larvae were taken on an electric balance. Twenty larvae from each age were weighed for different treatments.

Results: The larval period was 36.25 days in the treatment of combined cypermethrin, deltamethrin and nimbicidine. Both cypermethrin (20.55 days) and deltamethrin (20.38 days) failed to prolong the larval period significantly ($P>0.05$) in comparison with that control (19.68 days). In nimbicidine the average larval period was 30.38 days. Larval weight was significantly ($P<0.05$) reduced by nimbicidine alone and in combination with cypermethrin and deltamethrin in comparison with that of control. In control the average weight of 9 days old larvae was 188.60 μg. The lowest larval weight was 75.50 μg when nimbicidine was combined with cypermethrin and deltamethrin. In nimbicidine alone it was 84.25 μg. The average weight of 16 days old larvae in control was 2142.75 ± 62.67 μg with the lowest being 1955.05 μg in the treatment of combined cypermethrin, deltamethrin and nimbicidine.

Conclusion: Azadirachtin either alone or in combination with pyrethroid insecticides viz., cypermethrin and delatmethrin may reduce *T. castaneum* larval development and thus shows excellent protection of stored products.

Key words: Cypermethrin, Deltamethrin, Nimbicidine, Larvae, Growth, Development, *Tribolium*

Introduction

In *Tribolium* larval growth is affected by different environmental factors such as temperature, relative humidity and light. Besides conditioning of flour medium (Mondal 1986) and type of food (Hasan 1984, Hasan and Khan 1987) affect the larval growth of *T. castaneum*. Larval development was also affected by insecticides (Amin 2000, Hasnat 2003), quinones (Mondal 1984a, 1986, Rahman 1992) and botanicals (Mondal *et al.* 1989, Akhtar 1997, Amin 2000, Khanom 2004, Jbilou *et al.* 2006).

Depending on various conditions the number of larval instars ranges from 5 to 11 or more and larval period varies from 18 to over 100 days. At optimum temperature (30^0C) the majority of larvae have six instars and only a few have more (Mondal 1984a) and the larval period varies from 22-27 days (Good 1936). No information concerning the effect of sub lethal doses cypermethrin, deltamethrin and nimbicidine (commercial

* Corresponding author: mwislam2001@yahoo.com

grade) either alone or in combinations on the larval development of *T. castaneum* is available. This led to the present experiments.

Materials and Methods

Newly hatched larvae were reared in flour medium treated with low doses of cypermethrin (0.5 ppm), deltamethrin (1 ppm) and nimbicidine (6 ppm) alone or in different combinations. Groups of control larvae were maintained on flour medium treated with acetone only. Ten larvae were placed in a petri dish (4 cm diam) containing 1g of either fresh or treated flour medium and covered with the lid. They were kept in an incubator at 30 $\pm$ 0.5^{0}C without light and relative humidity control. After every 10 days, the medium was replaced to avoid conditioning by the larvae themselves. Larvae were regularly observed for pupation and the larval period was noted. The experiments were conducted for different treatments with five replications, each replication consisting of 10 larvae (N=50).

The weights of the larvae were taken on 9th and 16th day from hatching which correspond to the fourth and sixth instar in control respectively (Mondal 1984b). Although larval instars in the treated medium were not known, their weights were taken on these days to make comparison with those of control. Larvae were collected by sieving the medium through a 250 micrometer sieve and the surface of the larvae was thoroughly cleaned by a fine paint brush to remove the flour particles, if any. Larvae were individually weighed on an electric balance. Twenty larvae from each age were weighed for different treatments.

Results and Discussion

Larval Period: The results of the experiments are shown in Fig. 1. In control (acetone only) the average larval period was 19.68 ± 0.22 days with a minimum of 18 days and maximum 22 days. Both cypermethrin and deltamethrin failed to prolong the larval period significantly ($P<0.05$) in comparison with that of control. The average larval periods were 20.55 ± 0.29 and 20.38 ± 0.25 days for the treatment of cypermethrin and deltamethrin respectively. The present results contrast with the findings of Khan (1981), Mondal (1984a, 1986), Rahman (1992) and Kamaruzzaman *et al.* (2003), who reported the prolonged larval period in *T. castaneum* due to sub lethal doses of pirimiphos-methyl. Amin (2000) reported that both pirimiphos-methyl and sevin prolonged the larval period significantly ($P<0.05$) in comparison with that of control. Technical grade of deltamethrin also reduced the larval growth/development of *T. castaneum* (Hasnat 2003). The difference of present result with the deltamethrin might be due to the fact that the deltamethrin used in the present experiment was of the commercial grade. The same reason might be in case of cypermethrin. Besides, the sub lethal doses of cypermethrin (0.5 ppm) and deltamethrin (1ppm) might be too low to make any significant effect on larval development.

In the present experiment, the larval period of *T. castaneum* was 30.38 ± 0.31 days with minimum of 27 and maximum of 34 days in nimbicidine (6 ppm) treatment alone. When cypermethrin or deltamethrin was combined with the nimbicidine the larval period was not significantly increased compared with that of nimbicidine alone (31.75 ± 0.62 days in cypermethrin + nimbicidine, 31.63 ± 0.62 days in deltamethrin + nimbecidine). But when cypermethrin and deltamethrin were combined together with the nimbicidine the larval period was significantly ($P<0.05$) prolonged (36.25 ± 0.44 days with minimum of 29 days and maximum of 39 days) in comparison with both control and nimbicidine alone. The present results indicate the synergistic effect of nimbicidine when combined with both insecticides. Both cypermethrin and deltamethrin have the mortality effect, but do not have growth retardation effect. On the contrary, nimbicidine has the growth retardation effect on larval *T. castaneum*.

The present prolonged larval period of *T. castaneum* due to the latent effect of nimbicidine (azadirachtin) is similar to the results of Mondal *et al.* (1989) and Jbilou *et al.* (2006) who found some plant materials viz,

neem *Azadirachta indica*, *Peganum harmala* and *Raphanus raphanistrum* to inhibit the larval development. Banu (2004) studied the effect of technical grade of (98% a.i.) azadirachtin on the larval development of *T. castaneum* and *T. confusum* and reported that azadirachtin at a dose of 1 ppm prolonged the larval period up to 31.80 ± 0.64 days in *T. castaneum* (control 19.52 ± 0.20 days) and 32.24 ± 0.67 days in *T. confusum* (control 19.52 ± 0.20 days). Das *et al.* (2006) reported that the nimbicidine at sub-lethal doses did not affect the larval period of *T. castaneum* in the second generation when eggs of the first generation were treated with nimbicidine. The difference between present result and that of Das *et al.* (2006) might be due to that the nimbicidine treated eggs do not have any effect on the development of the subsequent larvae.

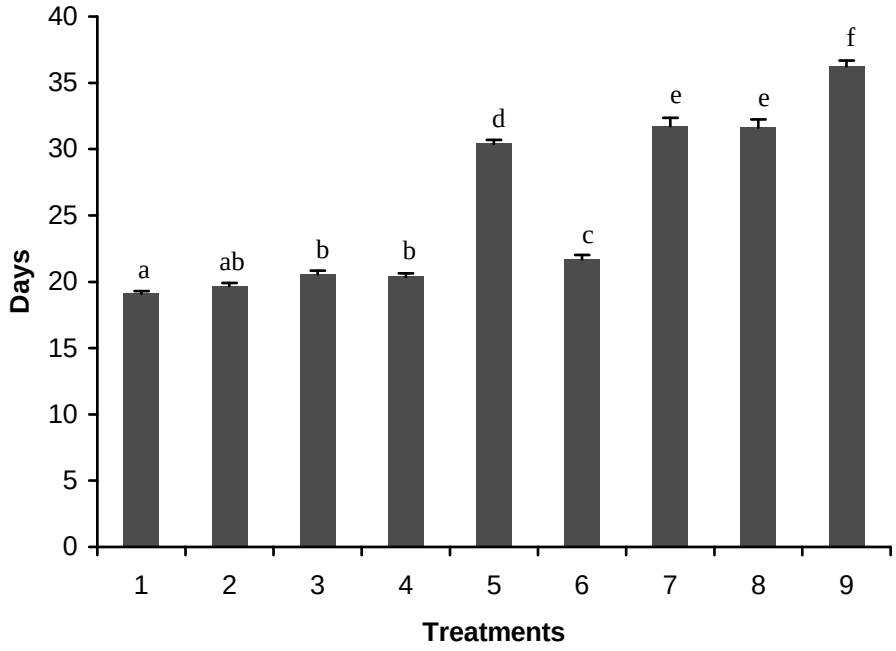

Fig 1. Larval period (days) of *T. castaneum* reared on the flour medium treated with Cypermethrin, Deltamethrin, Nimbicidine and their combinations (1=Control, 2=Acetone, 3=Cypermethrin (0.5ppm), 4=Deltamethrin (1ppm), 5=Nimbicidine (6ppm), 6=Cypermethrin + Deltamethrin, 7=Cypermethrin + Nimbicidine, 8=Deltamethrin + Nimbicidine, 9=Cypermethrin+ Deltamethrin + Nimbicidine). Bars bearing the same letters at the top indicate no significant (P>0.05) difference in larval period.

Larval Weight: In control (untreated) the average weight of 9 and 16 days old larvae were 188.9± 2.44 and 2142.75 ± 62.67 µg respectively, while in acetone treated media the average weight of 9 and 16 days old larvae were 188.6 ± 1.68 and 1955.05 ± 65.90 µg respectively. There were no significant differences of the weight of both 9 and 16 days old larvae between control and acetone treatment. In both cypermethrin and deltamethrin the larval weights were not significantly different from those of control (acetone only) which indicate that these insecticides do not have any effect on the larval weight of *T. castaneum*. On the other hand, nimbicidine either alone or in combination with insecticides - cypermethrin and deltamethrin significantly ($P<0.05$) reduced the weight of larvae of 9 and 16 days old. In nimbicidine alone, the average weights were 84.25 ± 1.42 and 776.50 ± 13.32 µg for 9 and 16 days old larvae respectively. The lowest weight of 9 days old larvae was 75.50 ± 1.53 µg and that of 16 days old larvae was 735.25 ± 8.53 µg in nimbicidine plus cypermethrin and deltamethrin treated flour medium. Nimbicidine, thus showed the synergistic effect on insecticides in reducing the larval weight in *T. castaneum.*

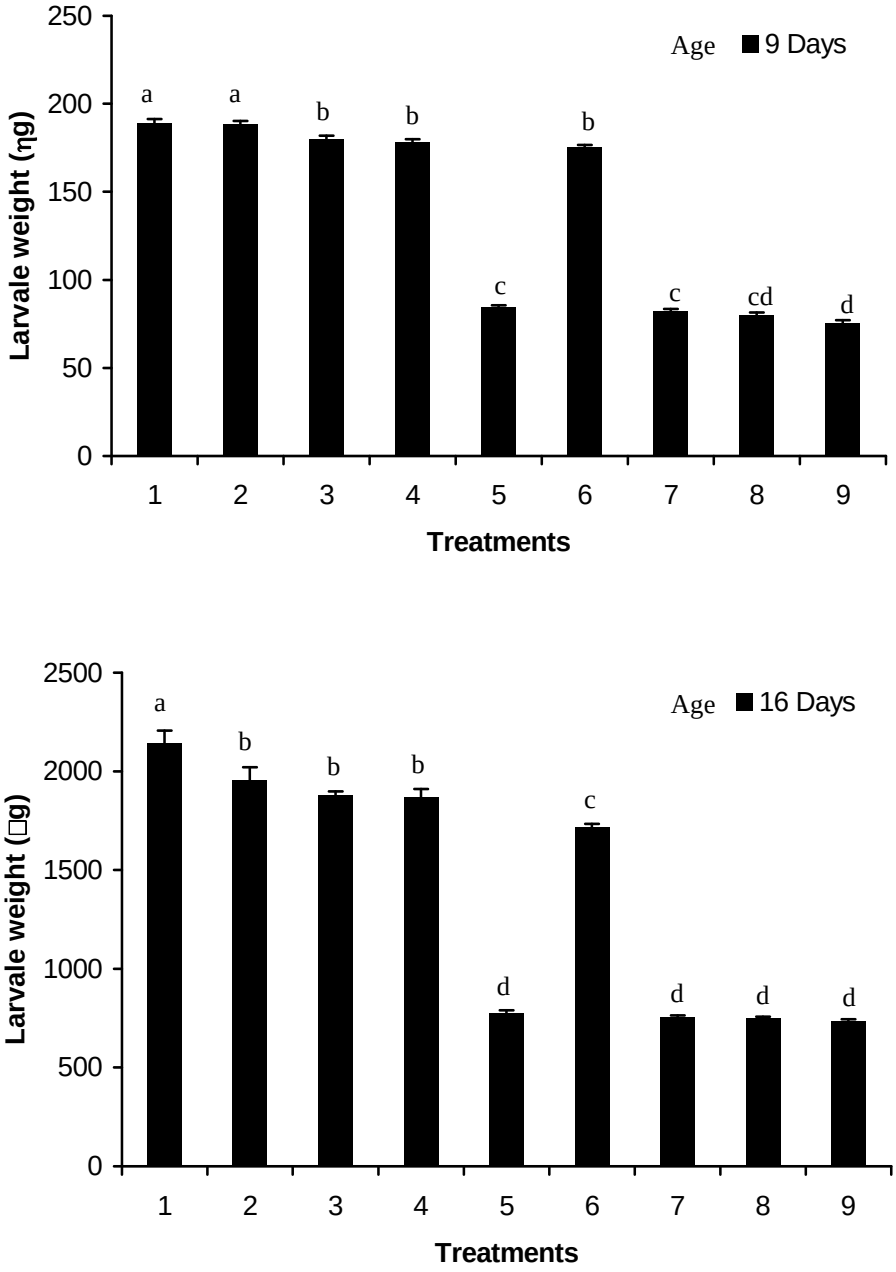

Fig 2. Larval weight (μg) (9 and 16 days) of *T. castaneum* reared on the fresh flour medium (Control) and flour medium treated with Cypermethrin, Deltamethrin, Nimbicidine and their combinations (1=Control, 2=Acetone, 3=Cypermethrin (0.5 ppm), 4=Deltamethrin (1ppm), 5=Nimbicidine (6 ppm), 6=Cypermethrin+Deltamethrin, 7=Cypermethrin+ Nimbicidine, 8=Deltamethrin + Nimbicidine, 9=Cypermethrin+ Deltamethrin + Nimbicidine). Bars bearing the same letters at the top indicate no significant (P>0.05) difference in larval weight (Duncan 1955).

The present results in cypermethrin and deltamethrin do not agree with the findings of Khan (1981), Mondal (1984a, 1986), Rahman (1992) and Amin (2000) , who reported the reduced larval weight when *T. castaneum* larvae were reared on flour medium treated with pirimiphos-methyl. Hasnat (2003) also reported that the deltamethrin of technical grade reduced the larval weight in *T. castaneum*. The difference between the present and Hasnat's results might be due to that Hasnat (2003) used the technical grade of deltamethrin (98% a.i) while in the present experiment commercial grade of deltamethrin (2.5% EC) was used.

The larval weight was significantly reduced in nimbicidine treated medium. This result is similar to the results of Banu (2004) who reported significantly reduced larval weight in both *T. castaneum* and *T. confusum* when newly hatched larvae were reared on flour medium treated with azadirachtin of technical grade. Das *et al.* (2006) also reported the similar results with nimbicidine which significantly reduced the weight of larvae. The present result is similar to those of the previous workers who reported the reduced larval weight of *Tribolium* spp. due to the effect of plant materials. Malek and Wilkins (1994, 1995) reported that *Annona squamosa* L. seed oil reduced larval weight of both FSS II and CTC-12 strains of *T. castaneum*. Turmeric oil, sweetflag oil, neem oil and margosan-O significantly ($P<0.05$) reduced the weight of *T. castaneum* larvae as reported by Jilani *et al.* (1988). Mondal *et al.* (1989) reported the reduced larval weight of *T. castaneum* by tobacco, neem, dhutura and nishinda. Rahman (1992) reported that the combined action of pirimiphos-methyl and dhutura reduced the larval weight of *T. castaneum* which agrees with the present findings.The result of present experiment also agrees with that of Amin (2000) who found reduced larval weight in *T. castaneum* due to neem and nishinda.

The reduction in larval weight and prolonged larval period in the present experiments might be due to the amount of nimbicidine treated food medium consumed by the larvae. The results also suggest that both larval weight and larval period might be affected due to long exposure of larvae to the treated medium. The reduced development of larvae might be due to that the complexity of nimbicidine with either digestive enzymes or membrane carrier proteins of the microvilli of the larval gut that might have allowed less food to be assimilated. Moreover, the disturbed production of the chitin delayed ecdysis which ultimately delayed the development (Rees and Beck 1976).

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