Journal of Biopesticides, 3(3): 617 - 621 (2010)

Toxicological effects of neem *Azadirachta indica* A. Juss leaf powder against the ontogeny of *Corcyra cephalonica* (Staint.) (Lepidoptera: Pyralidae)

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ABSTRACT

Larvicidal and pupicidal effects of neem leaf were made on the third instar larvae of *Corcyra cephalonica* (Staint.). The observations revealed that 3.50% dose level of neem leaf caused 100% larval mortality indicating absolute toxicity to the pest.

Key words : Neem leaf, toxicity, *Corcyra cephalonica*, ontogeny.

INTRODUCTION

According to an FAO study, world - wide loss in store approximates 10% of all stored grain, i.e., 13 million tons of grain lost due to insects or 100 million tons to failure to store properly (Wolpert, 1967). The rice - moth, *Corcyra cephalonica* (Staint.) is a notorious pest of stored cereals and cereal commodities in India as well as in other tropical and subtropical regions of the world. This moth was first identified and reported by Stainton (1866), who named it *Melissoblaptes cephalonica*. The only recognized species of this genus is *cephalonica*. Ayyar (1919a) made the first record of *Corcyra cephalonica*. Its larval stages cause serious damage to rice, gram, sorghum, maize, ground nut, cotton seeds, peanuts, linseeds, raisins, nutmeg, chocolates, army biscuits, wheat, coffee, cocoa beans and milled products (Atwal, 1976; Piltz, 1977; Cox *et al.*, 1981; Allotey and Kumar, 1985; Allotey, 1991).

Sufficient knowledge exists on the nutritional and reproductive physiology of this lepidopterous pest (Krishna and Narain, 1976; Srivastava and Krishna, 1976, 1978; Bhatt and Krishna, 1980, 1982, 1984a, 1984b, 1986 and Mishra and Krishna, 1980). The influence of certain organochlorines, organophosphates and synthetic pyrethroids have also been reported against the ontogeny as well as larval biochemistry of this pest (Tiwari and Bhatt, 1987, 1992, 1994a, 1994b, 1994c, 1999a, 1999b, 2000; Tiwari and Tripathi, 2001, 2006). The continuous use of chemical pesticides for control of stored grain pests has resulted serious problems such as hazards to the environment including human health and non-target organisms (Sighamony *et al.*, 1986), residue in food grains (Fishwick, 1988), environmental pollution (Wright *et al.*, 1993., WMO, 1995) and development of resistant strains (Champ and Dyte, 1976; Zettler, 1982; Zettler and Cuperus, 1990; Yusof and Ho, 1992; White, 1995). Hence, there is urgent need for safe but effective, biodegradable pesticides with no toxic effect on non-target organisms. This has created a world-wide interest in the development of alternative strategies, including the search for new type of insecticides, and the re-evaluation and use of age-old, traditional botanical pest control agents (Heyde *et al.*, 1983). Botanical insecticides are broad-spectrum in pest control, and many are safe to apply, unique in action and can be easily processed and used. Locally available plants materials have been widely used in the pest to protect stored produce against damage by insect infestation (Golob and Webley, 1980). The main advantage of botanicals is that they are easily produced by farmers and small-scale industries and are potentially less expensive.

In the present study, *Azadirachta indica* has been selected as one of the safer substitutes to control the stored cereal pest rice-moth, *Corcyra cephalonica*. Hence, as an objective of such programme the present work, for the first time has been designed and conducted to investigate the effect of neem leaf powder against the ontogeny of rice-moth.

MATERIALS AND METHODS

Neem leaf was collected from adjacent areas in Gorakhpur, U.P, India. The neem leaf was separated from the branches of the plant body, properly washed with fresh tap water and then air dried at the room temperature for 5 to 7 days. Now, dried leaves were ground in electric grinder. From the laboratory maintained culture on ground jowar mixed with 5% yeast powder, newly emerged males and females were transferred to oviposition glass chambers. Eggs laid by the females were collected and then placed in glass chambers (35 mm diameter, 200 mm height) for hatching. Freshly hatched larvae of *Corcyra cephalonica* were allowed to feed on a normal dietary medium mixed with 5% yeast powder (w/w) kept inside 250 ml beaker for exactly 15 days. On the 16th day of larval hatching 25 third instar larvae were transferred to each similar rearing chambers (250 ml beakers) containing 50 gm of dietary medium mixed and treated separately with 8 different dose levels i.e. 0.25, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00 and 3.50% of neem leaf powder, using 5 replications of each treated as well as control group. On the completion of the life cycle, number of adults emerged and dead pupae were recorded to calculate % pupation and % larval mortality. The values have been expressed as the mean ± S.D. of five replicates. Straight line regression equation was applied between different dose levels of neem leaf powder and percent larval death/percent pupation/percent pupal death and percent adult emergence to observe the significant correlation.

RESULTS

Results presented in table 1reveal that a significant larval mortality was obtained with the increase of neem leaf concentration. At 0.25% dose level of neem leaf larval mortality was only 17 ± 1.78% while 100% mortality was recorded at 3.50% dose level of neem leaf. As the neem leaf concentration increases, a significant reduction in pupation and adult emergence did occur. Pupation was 83 ± 1.78% at 0.25% dose level which decreased to 7 ± 3.34% at 3.00% dose level of the neem leaf. Similarly, 83 ± 1.78% adult emergences was recorded at 0.25% dose level which decreased to 7 ± 1.78% at 2.50% dose level of neem leaf (Table 1). Pupal mortality increased insignificantly with the increase of the neem leaf concentration. It was 2.77 ± 2.19% at 0.50% dose level which enhanced to 100% at 3.00% dose level of neem leaf. Percent larval death (y = 10.68+27.96x; r = 0.99, P < 0.001) and pupal death (y = -13.90 + 29.77x; r = 0.91) were positively correlated whereas percent pupation (y = 91.06 - 29.18x; r = -0.99; P < 0.001) and emergence (y = 92.94 - 35.95x; r = -0.99; P < 0.001) were negatively correlated to the plant powder concentrations.

DISCUSSION

The present investigation showed that different dose levels of neem leaf exerted a depressive effect on the life cycle stages of *Corcyra cephalonica*. The toxicity of neem leaf powder increases significantly with the increase in its concentration on each developmental stage i.e. larva, pupa and adult (Table 1). On the basis of percent larval death, pupation, pupal death and adult emergence, at different dose levels of neem leaf powder, it is possible to categorise the relative effectiveness of their dose levels (Fitzpatrick and Dowell, 1981).

Though azadirachtin was found to be toxic to larval and adult stages of *Cryptolestes pusillus* (Schon.) yet larval stages were more susceptible than the adult stage (Rahman *et al.*, 2005). Similarly other bioactive principles like andrographolide affect pupal and adult transformation of *C. cephalonica* (Jagajothi and Martin, 2010). The neem leaf powder brought about a severe reduction in growth rate of several stages of *Trogoderma granarium* (Everts) indicated that the azadirachtin which is the predominant insecticidal ingredient of neem powder, acted as a powerful antifeedent or growth inhibitor (Jood *et al.*, 1993). The chemical complexity of azadirachtin and the diverse structural requirements for insect's bioactivity restrict the synthesis of this molecule, and therefore, commercial neem products will depend on neem seed extract. However,

Table 1. Toxicity of neem leaf powder against the ontogeny of *Corcyra cephalonica*

Percent neem leaf concentration with 5% (w/w) yeast powder	Larval death (in %)	Pupation (in %)	Pupal death (in %)	Emergence (in %)	Acute toxicity to the pest
Control	0	100	0	100	-
0.25	17 ± 1.78	83 ± 1.78	0	83 ± 1.78	Poorly toxic
0.50	28 ± 4.00	72 ± 4.00	2.77 ± 2.19	70 ± 4.56	Moderately toxic
1.00	42 ± 3.57	58 ± 3.57	3.45 ± 2.19	56 ± 2.82	Moderately severe
1.50	58 ± 2.19	42 ± 2.19	16.66 ± 2.19	35 ± 3.34	Moderately severe
2.00	70 ± 2.19	30 ± 2.19	30.00 ± 1.78	21 ± 2.19	Severely toxic
2.50	84 ± 4.00	16 ± 4.00	56.30 ± 4.38	7 ± 1.78	Severely toxic
3.00	93 ± 3.34	7 ± 3.34	100	-	Severely toxic
3.50	100	-	-	-	Extremely toxic

*Values have been expressed as the mean ± S.D. of five replicates. Straight line regression equation was applied between different concentrations of neem leaf powder and their corresponding percent larval death/percent pupation/percent pupal death / percent emergence to observe the significant correlation.

azadirachtin content in neem extracts shows considerable variability, depending on their geographic origin (Ermel *et al*., 1987). Azadirachtin content is highly correlated with both behavioral and physiological effects of neem extracts on lepidopterans (Isman *et al.*, 1990). There are several other chemicals in neem extracts that have been shown toxic to insects (Ley *et al.*, 1993; Mordue [Luntz] and Blackwell 1993), which could cause additional mortality. The use of neem extracts as an insecticide is an advantage because the isolation of azadirachtin is difficult. In addition to neem, other meliaceous plants like *Melia toosendan* extract which possesses a limonoid toosendanin is also an insect antifeedant, growth inhibitor and stomach poison, is effective against stored cereal pests (Zhang and Chiu, 1983; Chiu, 1985, 1989; Chiu and Zhang 1987; Sahayaraj *et al.*, 2007), but *M. toosendan* extract is comperatively less effective than azadirachatin and azadirachtin-rich neem extract as reported by Xie *et al*. (1995) in case of rusty grain beetles, *Cryptolestes ferrugineus* (Stephens), rice weevil, *Sitophilus oryzae* (L.), and the red flour beetle, *Tribolium castaneum* (Herbest).

The azadirachtin, the main insecticidal constituent of neem seed, inhibits the release of prothoracicotropic hormones and allatotropics (Banken and Stark, 1997), there by affecting metamorphosis in insects (Schmutterer and Rembold, 1995) is well documented. It also alters insect behaviour because of its antifeedant and repellent action and it modifies insect development by inhibiting the release of prothoracicotropic hormones and allatotropins (Mordue (Luntz) and Blackwell, 1993; Williams and Mansingh, 1996). Sharma (1992) investigated that the growth inhibiting properties of azadirachtin, a bioeffective triterpenoid compound isolated from neem seeds. By topical application of various azadirachtin doses (0.5 - 10 µg / larvae) in methanol to last instar spinning stage larvae, development was inhibited. The effect was dose-dependent. At higher doses many of the insects remained in the larval stage (55% with 10µg / larvae). Disturbance of both larval - pupal and pupal - adult moulting is discussed and interpreted as interference with the morphogenetic hormone pool size.

In the present investigation it may be concluded that azadirachtin, the main constituent of the neem, as well as its other chemical constituents function as antifeedant, growth inhibitor and stomach poison, they inhibit the release of prothoracicotropic and allotropic hormones also and consequently they may affect metamorphosis. Thus toxicity in the present study may be accounted as a mixed venture of azadirachtin and the other chemical constituents present in neem leaf powder due to their antifeedant, growth inhibitor and stomach poison activity as well as inhibition of release of prothoracicotropic and allatotropic hormones. It also deserves mention that 3.50% dose level of neem leaf powder caused 100% larval mortality and hence, this dose level may be used for the effective control of *Corcyra cephalonica* in particular and insect pest population in general.

ACKNOWLEDGEMENT

Authors thank U.G.C, New Delhi for providing financial support (Ref.No. F.No.34-478/2008, S.R.) to Dr. S. K. Tiwari.

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Received: September 23, 2010 Revised: October 15, 2010 Accepted: November 9, 2010