Indian J. Hort. 69(2), June 2012: 295-298

Short communication

Effect of foliar spray of boron on biology, egg laying activity and control of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.)

S. Satpathy*, Akhilesh Kumar, T.M. Shivalingaswamy and A.B. Rai**
Indian Institute of Vegetable Research, Jakhini, Shahanshahpur, Varanasi 321 005, Uttar Pradesh

ABSTRACT

The effect of foliar spray of borax on biology, egg laying activity and control of brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guen. was evaluated in field and laboratory experiments conducted in the Research Farm of Indian Institute of Vegetable Research, Varanasi. Irrespective of cultivars, the borer infestation was less (23.36%) in 75 ppm boron treated plot, which was at par with 50 ppm treatment (25.11%) compared to 31.17% in control. Among the two cultivars, level of fruit infestation by BSFB was significantly less (23.27%) in Punjab Barsati compared to Punjab Sadabahar (29.62%). Maximum yield (270.59 q/ha) was recorded in 75 ppm boron treated plots. The number of eggs laid in the borer treated plants (36.41 to 50.33/plant) was significantly less than the eggs deposited in the untreated plants. The leaf surface of the boron treated plants inflicted deterrent action on the adults causing less deposit of eggs. Trend of larval and pupal weight in the boron-treated plants indicated that there was gradual reduction in growth of the larvae with increase in the borax concentration.

Key words: Boron application, brinjal, egg laying, shoot and fruit borer.

Brinjal, *Solanum melongena* Linn. is one of the most important vegetables grown in India. Brinjal plant is attacked by several insect pests and amongst array of insect pests infesting brinjal, shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guen. is the most destructive one. The yield loss due to the attack of this pest varies from 37 to 63% in various states of India (Dhankar, 3). In Uttar Pradesh, the yield loss is very high which varies from 48.30 - 70.00% in various regions (Jat and Pareek, 9). There is continuous population build up in intensive brinjal growing areas resulting in repeated insecticide application, which enhances the cost of protection and probability of persistent toxic residues in/or fruits. In Gangetic belt of North India, 58.5% farm-gate brinjal samples were reported to be contaminated with pesticides, 9.8% of which had residues above maximum residue level (MRL) (Agnihotri, 1). To subsidise excessive insecticide use in this crop alternate control method particularly application of micronutrients either for induced resistance or having impact on the pest infestation needs attention. Sodium tetraborate, a non-volatile, slow-acting inorganic insecticide has long been used in urban pest management because of their low mammalian toxicity (Cochran, 2). Beside the role as micro-nutrient for plants, particularly horticultural crops, the boron compounds are effective for controlling many insect pests belonging to diverse orders like Hymenoptera, Diptera, Isoptera, and Lepidoptera (Grace, 6; Klotz *et al*., 11; Mullens and Rodriguez, 12; Hyrsl *et al*., 8). Plants sprayed with boron and zinc chelates could induce resistance in paddy against a spectrum of lepidopteran pests (Premila and Dale, 13).The impact of boron compounds on fitness and toxicity to lepidopteran insects have not yet been well established. These information on insecticidal activity of boron compounds imparts the reason to study the potential role of boron compounds applied as foliar spray on suppressing the infestation caused by the Pyralid, *L. orbonalis* on brinjal, the possible interference on the normal egg laying activity of the adult on the foliage of boron-treated plants and the impaired biology of the larvae reared on fruits of the treated plants.

Field and laboratory experiments were conducted at IIIVR, Varanasi to study the effect of foliar application of boron on *L. orbonalis* infestation and possible adverse effect on egg laying behaviour and larval growth. Healthy seeds of brinjal cultivars Punjab Sadabahar and Punjab Barsati were sown in the nursery. The seedlings were protected with muslin cloth-cages to avoid early pest infestation. Healthy seedlings (25-day-old) were transplanted in the last week of July in 3.5 m × 3.0 m plots with 70 cm row to row and 60 cm plant to plant spacing. The experiment was laid out in a randomised complete block design (RCBD) with two factors, *i.e.* variety (V_1 - Punjab

*Corresponding author's present address: Central Research Institute for Jute and Allied Fibres, Barrackpore 700 120, Kolkata; E-mail: satp1@rediffmal.com
**National Bureau of Agriculturally Important Insects, HA Farm post, Bengaluru 560 024, Karnataka

Sadabahar and V_2 - Punjab Barsati) and boron foliar spray (B_1 - 25 ppm, B_2 - 50 ppm, B_3 - 75 ppm and B_4 - control). There were eight treatment combinations (V_1B_1, V_1B_2, V_1B_3, V_1B_4, V_2B_1, V_2B_2, V_2B_3 and V_2B_4) with four replications. Borax was applied four times as foliar spray @ 25, 50 and 75 ppm from 50 days after planting at 10 days interval. Observations on number of total and damaged fruits during each harvest from 60 to 120 days after transplanting (DAT) were taken. The yield (total and marketable) was recorded after each harvest.

The experiment to study the egg laying deterrence was conducted on cv. Punjab Sadabahar. Twenty five-day-old healthy seedlings were transplanted on thermocoal pots (4.5 basal dia, 7.0 cm top dia, 9.0 cm height) filled with a mixture of soil and FYM (4:1) and were kept insect-free under a muslin cloth cage for another 25 days. The plants were sprayed with the boron solution (same concentration as applied in the field). After drying of the sprayed solution on the leaves, each plant was kept inside an egg-laying chamber (20 cm high, 16 cm dia) and was exposed to a pair of male and female moth emerged from mass reared pupae in the laboratory. The experiment was conducted in CRD with 8 replications, by considering each plant as treatment. Number of eggs laid by the female on the leaves of the treated plants after 24 h exposure for egg laying was recorded.

Biological parameters of BSFB fed on fruits treated with boron collected from treated plants from the field experiment. Fresh and small fruits of Punjab Sadabahar were sampled randomly from the field at 80 DAT to study the effect of boron-treated fruits on growth of the larvae. Four fruits of each treatment were picked from each replication. These fruits were kept replication-wise in the plastic rearing boxes (16.0 cm long × 12.5 cm wide × 6.5 cm high). A layer of white tissue paper was spread in the inner side of the boxes to absorb moisture and excreta released by the feeding larvae. The experiment was carried out in CRD with eight replications. In each replication, 10 neonate larvae of *L. orbonalis* (collected from laboratory culture) were released on four fruits. The fruits were cut open and the larvae were transferred onto fresh set of fruits collected from respective treatments at two days interval. The weight of larvae in each replication was taken at 8 and 13 days after release. The fruits were carefully cut opened and the internally feeding larvae were removed with the help of insect brush (zero number) and weighed in precision electronic balance (Sartorius®). One day after pupation, weight of each pupa in each replication was recorded. The means of larval and pupal weight of BSFB fed on fruits of different boron treatments were statistically analyzed. Significant difference in the treatment means at 5% level were compared by least significant difference (LSD).

Periodical fruit damage trend indicated that the impact of boron foliar spray was more prominent in case of Punjab Sadabahar than Punjab Barsati (Table 1). Irrespective of cultivars, least borer infestation (23.36%) was recorded in 75 ppm boron-treated plot, which was at par with 50 ppm treatment (25.11%) and significantly less than the damage observed in 25 ppm borax-treated and untreated crop with 26.30% and 31.17% fruit damage respectively. The boron treatments showed significant reduction in fruit damage caused by *L. orbonalis*. The level of fruit damage in all boron treated crop was significantly less (23.36 to 26.13%) than control. Toxicity parameters for boron have been well-established in the literature, and there is a clear dose-dependent mortality relationship with insects (Gentz and Grace, 5). Among the two cultivars, level of fruit infestation by BSFB was significantly less (23.27%) in Punjab Barsati compared to Punjab Sadabahar (29.62%). There was no significant difference in yield between the two varieties. Maximum yield (270.59 q/ha) was recorded in 75 ppm boron treatment, which was at par with other two lower concentrations and significantly more than the yield obtained from the untreated crop (245.44 q/ha).

Relative egg-laying trend on the leaves of the brinjal plants treated with different concentrations of boron indicated that there was significant effect on preference of egg-laying by the adults of BSFB (Table 2). Number of eggs laid by the adult varied from 36.41/ plant in the plants treated with 75 ppm borax to 59.55 per plant in untreated plant. The number of eggs laid in 50 and 25 ppm borax treatments was 44.99 and 50.33 per plant, respectively, which indicates the deterrent effect of the borax treatment on egg laying activity of adult BSFB. The number of eggs laid in the borer treated plants (36.41 to 50.33/ plant) was significantly less than the numbers of eggs recorded in the untreated plants. It indicates that the leaf surface of the boron treated plants inflicted repellent action on the adults causing less deposit of eggs on such plants. Previous studies also evidenced that boric acid had repellency to house fly (Jerome and Koehler, 10).

As indicated from periodical larval growth during the early stage of larvae, there was variation in weight of larvae feeding on boron-treated and untreated fruits (Table 2). It was more prominent in the growth of 13-day-old larvae and pupae. The weight of 8-day-old larvae in boron treated fruits was restricted to 3.20 at 75 ppm concentration, which was almost double (7.13 mg) in the control. After 13 days of feeding on the normal fruits the larval

Table 1. Effect of foliar spray of boron on *L. orbonalis* infestation and yield of brinjal.

Treatment	Punjab Sadabahar	Punjab Barsati	Mean
		Damage (%)	
Boron (25 ppm)	29.17	23.10	26.13[B]
Boron (50 ppm)	27.70	22.52	25.11[BC]
Boron (75 ppm)	25.64	21.10	23.36[C]
Control	35.97	26.37	31.17[A]
Mean	29.62[a]	23.27[b]	
CD (P = 0.05)	V = 1.65	T = 2.33	V x T = NS
		Yield (q/ha)*	
Boron (25 ppm)	248.18	257.70	252.94[AB]
Boron (50 ppm)	253.41	257.38	255.40[AB]
Boron (75 ppm)	268.03	278.05	270.54[A]
Control	240.09	250.79	245.44[B]
Mean	259.73[a]	252.43[a]	
LSD (P = 0.05)	V = NS	T = 17.23	V x T = NS

V = Variety, T = Boron treatment, V x T = Interaction
Means followed by the same upper (for vertical comparisons) and lower (for horizontal comparisons) case letters are not significantly different.

Table 2. Effect of boron application on egg laying, larval and pupal weight of *L. orbonalis* reared on boron-treated plants.

Treatment	Eggs/plant	Larval weight (mg)		Pupal weight (mg)
		8-day old	13-day old	
Boron (25 ppm)	50.23[b]	5.78[b]	57.68[b]	60.54[a]
Boron (50 ppm)	44.85[b]	4.30[c]	50.64[bc]	44.32[b]
Boron (75 ppm)	36.41[b]	3.20[c]	44.53[c]	32.74[c]
Control	59.55[a]	7.13[a]	68.22[a]	66.96[a]
LSD (P = 0.05)	5.63	1.12	9.79	8.43

Means followed by the same letters are not significantly different

weight attained 68.22 mg, which was significantly less, *i.e.* 44.53, 50.63 and 57.68 mg on 75, 50 and 25 ppm boron-treated fruits,respectively. The weight of pupae obtained from the larva reared on boron-treated fruits was also significantly less (32.74, 44.32 and 68.54 mg) than the weight of pupae from normal brinjal (66.96 mg). Trend of larval and pupal weight in the boron-treated brinjal indicated that there was gradual reduction in growth of the larvae with increase in the concentration of borax. The ingested boric acid and sodium tetraborate had adverse effect on survival, development and fecundity of insects exposed to these compounds (Hyrsl *et al.*, 8). Boric acid induced glutathione S-transferase activity and inhibited acetylcholinesterase activity in the German cockroach, *Blattella germanica* (L.) (Habes *et al.*, 7). The survivorship of *Galleria mellonella* was negatively correlated with increasing concentration of sodium tetraborate (Durmus and Buyuguzel, 4). The application of borax might have elevated the level of boron in the brinjal fruits, which caused toxicity to the larvae feeding on it causing reduced larval and pupal growth and the damage caused by *L. orbonalis*.

REFERENCES

1. Agnihotri N.P. 1999. *Pesticide Safely Evaluation and Monitoring*. All India Co-ordinated Research Project on Pesticide Residues, Division of Agricultural Chemicals, I.A.R.I., New Delhi, 173 p.

2. Cochran, D.C. 1995. Toxic effects of boric acid on the German cockroach. *Experentia*, **51**: 561-63.

3. Dhankhar B.S. 1988. Progress in resistance studies in the eggplant (*Solanum melongena* L.) against shoot and fruit borer (*Leucinodes orbonalis* Guen.) infestation. *Tropical Pest Mangt.* **34**: 343-54.

4. Durmus, Y. and Buyukguzel, K. 2008. Biological and immune response of *Galleria mellonella* (Lepidoptera: Pyralidae) to sodium tetraborate. *J. Econ. Entom.* **101**: 777-83.

5. Gentz, M.C. and Grace, J.K. 2006. A review of boron toxicity in insects with an emphasis on termites. *J. Agric. Urban Entom.* **23**: 201-7.

6. Grace, J.K. 1991. Response of eastern and Formosan sub-terranean termites (Isoptera: Rhinotermitadae) to borate dust and soil treatments. *J. Econ. Entom.* **84**: 1753-57.

7. Habes, D., Morakchi, S., Aribi, N., Farine, J.P. and Soltani, N. 2006**.** Boric acid toxicity to the German cockroach, *Blattella germanica*: alterations in midgut structure, and acetylcholinesterase and glutathione S-transferase activity. *Pest. Biochem. Physiol.* **84**: 17-24.

8. Hyrsl, P., Buyukguzel, E. and Buyukguzel, K. 2007. The effects of boric acid-induced oxidative stress on antioxidant enzymes and survivorship in *Galleria mellonella. Arch. Insect Biochem.* **66**: 23-31

9. Jat, K.L. and Pareek, B.L. 2003. Bio-physical and bio-chemical factors of resistance in brinjal against *Leucinodes orbonalis*. *Indian J. Entom.* **65**: 252-58.

10. Jerome, A. Hogsette and Koehler, G. Philip. 1994. Repellency of aqueous solutions of boric acid and polybor 3 to house flies (Diptera: Muscidae). *J. Econom. Entom.* **87**: 1033-37.

11. Klotz, J.H., Vail, K.M. and Williams, D.F. 1997. Toxicity of boric-acid sucrose water bait to *Solenopsis invicta* (Hymenoptera: Formicidae). *J. Econom. Entom.* **90**: 488-91.

12. Mullens, B.A. and Rodriguez, J.L. 1992. Effects of disodium octaborate tetrahydrate on survival, behaviour and egg viability of adult muscoid flies (Diptera: Muscidae). *J. Econ. Entom.* **85**: 137-43.

13. Premila, K.S. and Dale, D. 1984. Induction of resistance in rice plants to insect pests by the application of chelated metal complexes. *Crop Prot.* **3**: 187-92.

Received: July, 2011; Revised: January, 2012;
Accepted: April, 2012