Plant-based Pesticide for Control of *Helicoverpa armigera* on *Cucumis sativus*

Jitendra Kulkarni[1], Nitin Kapse[1], and DK Kulkarni[2]

1. Nature Life Science Institute, Chinchwad, Pune 411033, Maharashtra, India
2. Plant Science Division, Agharkar Research Institute, GG Agarkar Road, Pune 411004, Maharashtra, India (email: dilipkkulkarni@gmail.com)

Agricultural crops are attacked by many insects and pests. The world food production is adversely affected by insects and pests during crop growth, harvest, and storage. The Indian tradition of controlling or repelling insects/pests has ancient roots in Sanskrit literature. Ancient agriculturists had different forms of control such as prayer, magic spells, cultivation techniques, mechanical practices, and application of several organic and inorganic substances to protect their crops from the depredations of weeds, diseases, and insect pests.

Helicoverpa armigera is a cosmopolitan, polyphagous insect causing serious damage to cultivated crops in India such as cotton (*Gossypium* sp.), tomato (*Lycopersicon lycopersicum*), pigeonpea (*Cajanus cajan*), chickpea (*Cicer arietinum*), maize (*Zea mays*), sorghum (*Sorghum bicolor*), and coriander (*Coriandrum sativum*). Infestation of the pest was observed both at vegetative and reproductive phase of coriander. Serious damage occurs when the insect population increases significantly during the reproductive phase. Chaudhary *et al.* (2003) used four insecticides against this insect on chickpea crop at Kota and Aklera in Rajasthan. They reported profenofos to be most effective. However, these hazardous chemical insecticides affect the environment. Also, due to indiscriminate use of chemical pesticides, *H. armigera* has developed resistance to some insecticides at several locations in the country. Therefore, there is a need to find out suitable plant-based pesticides. In the past decades very few natural pesticides/insecticides such as Nimikrin, Nimbidin, and Nimbicidine were derived from plant resources like *Azadirachta indica* (neem). Neem originated in India and is traditionally used for controlling many insects/pests due to azadirachtin content. Singh and Yadav (2007) studied the comparative efficacy of insecticides, biopesticides, and neem formulations (Nimbicidine and Neemarine) against *H. armigera* on chickpea.

Our ancient literature such as Rigveda, Atharvaveda, and Kallavagga mentioned protection of crops from locusts, mice, borers, mildews, blight, birds, etc. by using plant resources, by performing ceremonies, by making noise, or by setting traps. In Vrikshayurveda, Surapala (c. 1000 AD) has mentioned that fumigation with the fumes of a

mixture of white mustard (*Brassica alba*), *ramatha* (*Ferula assafoetida*), *vidanga* (*Embelia ribes*), *vaca* (*Zingiber zerumbet*), *usana* (*Piper nigrum*; black pepper), and water mixed with beef, horn of a buffalo, flesh of a pigeon, and the powder of *bhillata* (*Semecarpus anacardium*; marking nut tree), at once destroys the colonies of 'worms' (insects) infesting the trees (Sadhale, 1996). Application of white mustard, sesame (*Sesamum indicum*), and *vidanga* mixed with ghee, followed by irrigation with diluted milk for seven days is effective in destroying insects like *kandara* (possibly a borer – eds.). Several such practices of insect control were used in ancient India (Raychaudhuri, 1964).

Nene (1999) reported pests/diseases that are named in Sanskrit and which affected crops during the time of Sage Parashara (c. 400 BC). These are *gandhi*, *shankhi*, *dhuli*, etc. *Gandhi* (offensive odor) is the gandhi bug (*Leptocorisa varicornis*), *shankhi* must be a snail (*Pila* sp.), and *dhuli* means powder and perhaps refers to powdery mildew (Nene, 1999).

In Ayurvedic literature, Acharya Charaka classified animal origin poison as *Jangam Visha* and vegetable origin poison as *Sthavar Visha*. Insects and pests are grouped under animal origin poison and called *Kitalatu Visha*. They are differentiated into 20 types of *krimi* (worms, vermin, etc.). It is also mentioned that animal and plant origin poisons have antagonistic effect on each other. Plants like *karavira* (*Nerium indicum; kaner*) and *dhatura* (*Argemone mexicana*; *pivla dhotra*) are categorized under *Upavisha Varga* and they have pesticidal property against lice, insects, and pests grouped under *Bhahya Krimi* (external parasites). In the present study, extracts of *Nerium* and *Argemone* were tested for their repellent effect on *H. armigera*. Savnur (1950) mentioned that preparation of good quality of medicament (*bheshaja*) should be a mixture of polyherbs suitable for specific diseases in multiple forms like juice, decoction, and paste and should have potency.

Helicoverpa armigera *is a cosmopolitan, polyphagous insect causing serious damage to cultivated crops in India such as cotton* (Gossypium *sp.*), *tomato* (Lycopersicon lycopersicum), *pigeonpea* (Cajanus cajan), *chickpea* (Cicer arietinum), *maize* (Zea mays), *sorghum* (Sorghum bicolor), *and coriander* (Coriandrum sativum).

Methodology

Fresh and dried leaves of *Nerium indicum* and *Argemone mexicana* were collected and processed by discarding the tender top leaves and bottom old leaves. Only fresh middle leaves were washed thoroughly and chopped into small pieces and dried at room temperature. The extract was prepared by steeping cold method using organic solvents and water. The prepared extract was filtered and a stock solution of 1000 ml was made. Different dilutions were made from the stock solution by using distilled water. The extracts were sprayed at 1 ml L^{-1}.

A preliminary field trial was conducted at BAIF Development Research Foundation,

Our ancient literature such as Rigveda, Atharvaveda, and Kallavagga mentioned protection of crops from locusts, mice, borers, mildews, blight, birds, etc. by using plant resources, by performing ceremonies, by making noise, or by setting traps.

Central Research Station, Uruli Kanchan, Pune, Maharashtra for a period of 3 months (22 January to 21 April 2004) on the crop *Cucumis sativus* (*kakadi*; cucumber). The individual extracts of *Nerium* and *Argemone* and 'Amogh', a combination of the two extracts were tested in comparison with Nimbicidine, a standard neem-based product to assess the repellent effect on *H. armigera* that had infested *C. sativus* variety Himangi. The experiment was carried out with five treatments in five replications using randomized block design. The plot size was 5.5 m × 6.5 m and crop spacing was 1.5 m × 0.5 m. Two applications of the plant-based pesticides were sprayed at 4-days interval after the crop was infested. Five randomly selected plants were taken for larval counts (Table 1) and the percentage of repellency was calculated.

Results and discussion

'Amogh' (extracts of *Nerium* and *Argemone*) showed higher repellent activity (89.29%) as compared to Nimbicidine (78.58%). Individual extracts of *Argemone* and *Nerium* showed 64.49% and 51.28% repellent activity, respectively. Thus a simple procedure for preparation of plant extracts and application of these extracts

Table 1. Repellent effect of plant pesticides on *Helicoverpa armigera* larvae infesting *Cucumis sativus*.

		Number of repelled larvae after spraying				
		First application		Second application		
Treatment[1]	Precount[2]	2 days	4 days	2 days	4 days	Average
T1	5.60 (2.47)[3]	4.98 (2.34)	5.23 (2.39)	4.81 (2.30)	5.00 (2.35)	5.00
T2	5.18 (2.38)	4.15 (2.16)	4.38 (2.21)	3.83 (2.08)	3.90 (2.10)	3.95
T3	5.65 (2.48)	3.38 (1.97)	3.85 (2.09)	3.60 (2.02)	3.75 (2.06)	3.65
T4	5.88 (2.85)	2.63 (1.77)	3.03 (1.88)	3.10 (1.90)	3.25 (1.94)	3.00
T5	5.68 (2.48)	6.90 (2.74)	7.00 (2.74)	8.15 (2.94)	7.50 (2.84)	7.39
SE	NS[4]	0.56	0.47	0.43	0.47	
CD at 5%	NS	1.446	1.349	1.308	1.348	

1. T1 = Amogh (extracts of leaves of *Nerium indicum* and *Argemone mexicana*); T2 = Nimbicidine; T3 = Extract of leaves of *Argemone mexicana*; T4 = Extract of leaves of *Nerium indicum*; and T5 = Control. (Note: Larvae were repelled in T5 perhaps due to natural conditions.)
2. Number of larvae before treatment (spraying).
3. Figures in parentheses are square root values of transformations.
4. NS = Not significant.

is suitable for insect repellent activity (Kumar *et al.*, 2002).

Agricultural production today is dependent on commercially available chemical pesticides to combat a variety of weeds, insects, fungi, and other agricultural pests. Some of these pesticides are considered to be acutely or chronically toxic to human and other segments of the environment and pose potentially serious health risks to non-target organisms and species. These are hazardous chemicals formulated as synthetic pesticides which need to be replaced by exploitation of plant-based products. Plants like *Mentha piperita*, *Acorus calamus* (sweet flag), *Piper nigrum* (black pepper), *Pongamia pinnata* (pongam), and *Azadirachta indica* (neem) have been evaluated as protectors against stored grain pests and found satisfactory. Neem has attracted global attention as new formulations are being derived for control of locusts, gypsy moths, cockroaches, and other insects. Such plant resources have been receiving attention in recent years.

These plant chemicals have different properties like attractants, ovicides, insecticides, and anti-feedants (Muruganm *et al.*, 1998). Majority of insects have particular semiochemicals. (A semiochemical is a generic term used for a chemical substance or mixture that carries a message. It is usually used in the field of chemical ecology to encompass pheromones, allomones, kairomones, attractants, and repellents.) Hence, different insecticidal properties of plants need to be studied. Much of the insect's behavior is mediated by chemicals in its environment. By using these chemicals to our own advantage, it is possible to attract pests to traps or baits or repel them from our homes, crops, or domestic animals (Singh and Upadhyay, 1993; Singh, 1999; Sharma *et al.*, 2000).

This tradition of pest control needs to be revitalized in Indian pest management programs. Most of the crop pests are native and have attained equilibrium with their natural enemies. Worldwide increase in commerce, tourism, and transportation has a direct relationship with the increase in introduction of exotic pests, diseases, and weeds. Such exotic insects, pests, and weeds were introduced without their natural enemies into the new and favorable environment wherein they became serious pests and weeds. Introduction of effective natural enemies from their native areas

***Plants like* karavira (Nerium indicum; kaner) *and* dhatura (Argemone mexicana; pivla dhotra) *are categorized under* Upavisha Varga *and they have pesticidal property against lice, insects, and pests grouped under* Bhahya Krimi (*external parasites*).**

***A preliminary field trial was conducted at BAIF Development Research Foundation, Central Research Station, Uruli Kanchan, Pune, Maharashtra for a period of 3 months (22 January to 21 April 2004) on the crop* Cucumis sativus (kakadi; *cucumber*).**

'Amogh' (extracts of* Nerium *and* Argemone*) showed higher repellent activity (89.29%) as compared to Nimbicidine (78.58%). Individual extracts of* Argemone *and* Nerium *showed 64.49% and 51.28% repellent activity, respectively.

normally results in successful suppression. Monitoring exotic pests and weeds that have already invaded neighboring countries and which could be expected to reach India within the next few years is necessary so as to mobilize resources to tackle an exotic weed or pest immediately after identifying its establishment. On the other hand, biological control is economical, effective, and environmentally safe when implemented properly (Muniappan and Viraktamath, 1993). In this respect, our traditional knowledge in the literature and indigenous knowledge of tribals need to be tested in a scientific way (Kulkarni and Kumbhojkar, 1996; 2003).

Acknowledgment

Authors are thankful to the Director, Agharkar Research Institute and Director, Nature Life Science Institute, Pune for providing basic facilities to conduct field trials.

References

Chaudhary HR, Mathus AK, Sharma KP, and **Girdhar Gopal.** 2003. Efficacy of some insecticides against *Helicoverpa armigera*. Indian Journal of Applied Entomology 17(1):59–61.

Kulkarni DK and **Kumbhojkar MS.** 1996. Pest control in tribal area – an ethnobotanical approach. Ethnobotany 8:56–59.

Kulkarni DK and **Kumbhojkar MS.** 2003. Ethno-agricultural study of Mahadeokolis in Maharashtra, India. Asian Agri-History 7(4):295–312.

Kumar S, Singh SK, Basias RK, Ghildiyal JC, and **Saxena AK.** 2002. Lousicidal properties of aqueous plant extracts. Indian Veterinary Journal 79(11):1136–1140.

Muniappan R and **Viraktamath CV.** 1993. Biological control programme in India: A review in retrospect. Current Science 65(12):899–901.

Muruganm K, Raju NS, Jeyubalan Kuman D, and **Varamkrishan SS.** 1998. Evaluation of certain tropical plant extracts for their antifeedant properties against *Spodoptera litura*. Journal of Insect Science 11(2):186–187.

Nene YL. 1999. Commentary: Agriculture in general. In: Krishi-Parashara (Agriculture by Parashara) (Sadhale Nalini, Tr.). Agri-History Bulletin No. 2. Asian Agri-History Foundation, Secunderabad 500009, India. pp. 81–94.

Raychaudhari S. 1964. Agriculture in Ancient India. Indian Council of Agricultural Research, New Delhi, India.

Sadhale Nalini. (Tr.) 1996. Surapala's Vrikshayurveda (The Science of Plant Life by Surapala). Agri-History Bulletin No. 1. Asian Agri-History Foundation, Secunderabad 500009, India. 94 pp.

Savnur HV. 1950. A Handbook of Ayurvedic Materia Medica. Vol. I and II. Dr. Jathar and Sons, Maruti Street, Belgaum, India.

Sharma SS, Gill MS, and **Maik OP.** 2000. Insecticidal antifeedant activities of essential

oils of some medicinal plants. Journal of Medicinal and Aromatic Plant Sciences 22(4), 23(1A):373–377.

Singh Gurdip. 1999. Studies on the biocidal activities of certain essential oils. Journal of Medicinal and Aromatic Plant Sciences 21:1119–1130.

Singh Gurdip and **Upadhyay RK.** 1993. Essential oils: a potent source of natural pesticides. Journal of Scientific and Industrial Research 52(10):676–683.

Singh SS and **Yadav SK.** 2007. Comparative efficacy of insecticides, biopesticides and neem formulations against *Helicoverpa armigera* on chickpea. Annals of Plant Protection Sciences 15(2):1–6.