Control of Vegetable Insects with Neem Seed Extracts

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Introduction

Plant products have a great potential for providing new and novel materials for pest management. The Neem tree, *Axadirachta indica*, has provided researchers with materials which appear promising against a variety of organisms (9). This remarkable tree, which grows in hot and arid parts of the world, has been known for centuries to possess unique properties (3-4-5), among them, the ability to ward off insects and other pests. Neem seed is used for many practical purposes, and very little fractionation is necessary to provide materials with insecticidal, antifeedant, or growth modifying activity. Many parts of the tree are currently, and have for centuries been, used in medicine and cosmetics, an indication of the safety of these botanical materials.

This paper reports on results of experiments conducted to access the efficacy of crude formulations of neem seed against economically important insect pests of vegetables.

Materials and Methods

Experiments were conducted at Vincennes, IN during 1982-84. The neem formulations used were either a liquid formulation made up of an ethyl alcohol extract of neem seed flour as a 1:1 dilution, or a dust formulation made up of defatted ground neem seed in kaolin. The liquid formulations of neem had previously been found to be effective as antifeedants against striped cucumber beetle *Acalymma vittatum* (F,) (STCB) (6), and 2 of its principal components, azadirachtin and salannin, were shown to deter feeding of STCB and spotted cucumber beetle, *Diabrotica undecimpunctata howardi* Barber, in greenhouse experiments (7). In these tests, Triton B-1956® [3] was added at a 0.075% concentration to the liquid neem formulations.

Greenhouse tests—Muskmelon, var. Saticoy, seedlings were raised to a 2-leaf stage in 64 cup trays and thinned to 8 rows of 4 plants each. After cotyledon leaves were removed, treatments were applied to plants in the rows which had been randomly assigned. The experiment was replicated 3 times by treating 3 trays, each randomized differently, and placing them into separate 50x50x50-cm screen cages. The greenhouse was maintained at 29.5 ± 5°C, 60 RH ± 10% and 15:9 LD photoperiod regime. Dust was applied to individual plants with a puff duster whose nozzle was inserted into a 100-ml plastic cup placed over each plant to prevent cross contamination. STCB (50/cage) were immediately introduced into the cages. Plants were examined at 2-day intervals and damage was rated from 0 (no damage) to 6 (complete destruction or consumption of foliage).

Field tests—Sweet corn, 1982 and 1984. Sweet corn var. Silver Queen was planted in 8 x 1.8-m plots replicated 3 times in 1982 and 4 times in 1984. Silks were treated as they emerged by atomizing liquid formulations onto each ear to run-off using a Forestry tree paint sprayer in 1982 and a Solo backpack sprayer in 1984. Ears were treated 8 times in 1982 and 6 times in 1984 on an approximate 3-day schedule. All marketable ears were harvested 1 day after the last application and examined for corn earworm, *Heliothis zea* (CEW), and damage. In 1982, carbaryl and in 1984, Ammo® (cypermethrin), a synthetic pyrethroid was used as a standard insecticide.

Eggplant—1983. Eggplant var. Dusky was planted in 16 x 1.8-m plots replicated 3 times. Sprays were applied with a high clearance sprayer consisting of a 1-row boom composed of 1 central nozzle over the plants with a 2 dropped nozzles. Weekly applications were made (July 25-Sept 8) using 75 psi and 19 gpa. Dust treatments were applied with a Hudson plunger type puff duster. Ammo was used as a standard. Damage by flea beetle, *Epitrix fuscula* Crotch (FB) was rated on Aug 29 by applying a 2.5 cm^2 template over 5 randomly selected leaves from each of 10 plants in a row and counting the number of feeding holes. Colorado potato beetles *Leptinotarsa decemlineata* Say (CPB) were counted at weekly intervals. Marketable fruits were harvested Aug 29 and Sep 9, 1983.

Potatoes—1982. "Superior" potatoes were planted in 16 x 1.8 m plots replicated 4 times. Treatments were applied using a tractor mounted boom sprayer with 1 central and 2 dropped nozzles at 65 psi and 21 gpa. Monitor® was applied as a standard. Applications were made weekly from June 2 until July 8. Weekly counts were made of CPB adults and larvae.

Cabbage—1983. A fall cabbage crop, var. Danish Ballhead was planted on June 23 and transplanted into the field on Aug 8 in 16 x 1.8 m plots replicated 4 times. Weekly treatments were applied with the same equipment as used on eggplant and insect counts were made on weekly intervals from Sep 2 until Oct 14.

In all of the field experiments, a randomized complete block arrangement was used. Data from all experiments were transformed (x + 1) and submitted to ANOV and DNMR.

Results and Discussion

Greenhouse tests. In the experiment using neem seed formulations in kaolin (Table 10, the untreated plants were almost immediately consumed by STCB, but all dust treatments afforded some protection. Even kaolin alone provided some deterrent activity as long as other food was available. This avoidance by feeding beetles was probably due to physical factors alone and was easily overcome by starvation. Loss of activity by the higher dosages of neem after 3 days could be due to a lack of coverage after leaf growth, and treatments on a 2-3 day interval would be needed for continued protection, particularly in the absence of alternate food. Pure neem seed flour (100%), when applied to young seedlings, was very phytotoxic but no such phytotoxicity was observed with the 20% dosage, which maintained some effect up to 6 days after treatment.

TABLE 1. Antifeedant activity of neem seed dust formulations against striped cucumber beetle adults on muskmelon seedlings in the greenhouse.

		Damage rating[1] at indicated day after treatment				
Material	Dosage	1	2	3	5	6
Neem	100%	0^{a}	0^{a}	1.00^{ab}	2.67^{a}	2.67^{ab}
Neem	20%	0^{a}	0.08^{a}	0.33^{a}	1.58^{a}	1.58^{a}
Neem	20% (Celite)	0^{a}	0.33^{a}	1.50^{ab}	2.50^{a}	3.00^{b}
Neem	10%	0^{a}	0.08^{a}	0.67^{ab}	1.42^{a}	2.00^{ab}
Neem	5%	0^{a}	0^{a}	0.58^{ab}	1.92^{a}	3.08^{ab}
Neem	2%	0.67^{a}	0.75^{a}	1.67^{ab}	3.17^{a}	4.17^{ab}
Kaolin	—	0.33^{a}	1.25^{b}	2.75^{b}	4.67^{ab}	4.75^{ab}
Untreated	—	5.33^{b}	6.00^{c}	6.00^{c}	6.00^{b}	6.00^{b}

[1]Rating = 0-no feeding and 6-complete consumption or destruction.

[2]Means followed by the same letter are not significantly different (P = 0.05) by Duncan's New Multiple Range Test.

TABLE 2. Efficacy of neem seed extract against corn earworm on sweet corn.

Materials	Dosage	% Damaged Ears 1982	% Damaged Ears 1984
Carbaryl	.8%	3.4^{a}[1]	—
Neem	.2%	29.2^{b}	8.75^{ab}
Neem	.4%	26.2^{b}	16.70^{bc}
Ammo	0.6 lb/A	—	1.85^{a}
Untreated	—	69.9^{c}	23.60^{c}

[1]Means followed by the same letter are not significalty different (P = 0.05) by Duncan's New Multiple Range Test.

Field tests—Sweet corn, 1982 and 1984. Results of the trials on sweet corn are presented in Table 2. During both years, the standard insecticides used provided excellent control of CEW as expected. The neem formulations gave a significantly greater level of control than the untreated but this level would not satisfy the requirements of a commercial grower. In some instances, in the neem treatments, the observed damage was very slight and the young larvae were either dead or not found. Such damage would be tolerated in a home garden situation. There appeared to be little difference between the 2 neem dosages so that increasing the dosage would not increase efficacy to any extent.

TABLE 3. Efficacy of neem seed extract against flea-beetle (FB) and Colorado potato beetle (CPB) on eggplant.

Material	Dosage	No. FB holes/cm	No. CPB[1] Adult	No. CPB[1] Larvae	Total wt mkt. fruit (g)	Total no. mkt. fruit
Neem spray	.2%	1.2^{a}[2]	11.3	0.3^{a}	9641^{a}	35.7^{a}
Neem dust	20%	8.3^{b}	6.3	8.3^{b}	2723^{b}	11.3^{b}
Ammo	.06 lb ai/A	0.4^{a}	7.3	4.7^{a}	11726^{a}	42.3^{a}
Untreated	—	10.4^{b}	11.3^{ns}	10.7^{b}	2877^{b}	9.3^{b}

[1]Mean no./5 plants.
[2]Means followed by the same letter are not significantly different (P = 0.05) by Duncan's New Multiple Range Test.

Eggplant—1983. As shown in Table 3, Ammo, the standard insecticide was extremely effective against FB and CPB larvae. However, neem spray was just as effective against both of these insects, both being significantly better than the untreated. Also, there was no difference between number and weight of marketable fruit between the 2 treatments. None of the treatments appeared to control adult CPB, possibly due to new infestations moving in from adjacent plots. Neem dust was not effective against either FB or CPB and this was reflected in the number and weight of marketable fruit.

Potatoes—1982. CPB larvae were controlled by neem spray when applied to potatoes (Table 4). As with eggplant, however, adults were not controlled by either

TABLE 4. Efficacy of neem seed extract against Colorado potato beetle (CPB) on potatoes. 1982.

Material	Dosage	Mean no. for 5 plants Adults	Mean no. for 5 plants Larvae
Neem	.2%	6.0	1.0^{a}[1]
Monitor	.75 lb ai/A	4.3	1.3^{a}
Untreated	—	6.3^{ns}	6.0^{b}

[1]Means followed by the same letter are not significantly different (P = 0.05) by Duncan's New Multiple Range Test.

neem or the standard insecticide. Again, this may have been due to migration and not to lack of toxicity of the insecticide.

Cabbage—1983. During the fall crop, the major pest of cabbage is cabbage looper *Trichoplusia ni* (Hubner) (CL). Although neem spray was not as effective as the synthetic pyrethroid against CL on cabbage (Table 5), it did provide significantly greater control than the untreated. Whether activity of neem is related to direct toxicity or to a form of repellency is unknown at the present time.

TABLE 5. Efficacy of neem seed extracts against cabbage looper (CL) on cabbage. 1983.

Material	Dosage	Mean no. CL larvae/5 plants
Ammo	.06 lb ai/A	1.3[a,1]
Neem	.2%	13.3[b]
Untreated	—	53.3[c]

[1]Means followed by the same letter are not significantly different (P = 0.05) by Duncan's New Multiple Range Test.

One of the major insect antifeedants isolated from neem kernels, azadirachtin, has been shown to possess growth regulator activity against insects (1 and 8). The reduction in larval development was not related to feeding inhibition. Azadirachtin in both of these reported studies apparently interfered with the molting hormone pools and affected normal ecdysis. Neem extracts were also shown to have a phagodeterrent effect on a flea beetle, *Phyllotreta striolata* (F.) in the laboratory (2). Our research substantiates this report. These are only a few of the many references to neem effectiveness against insects, and indicate the great potential that this material may have in pest management. Although it does not have the immediate, highly toxic activity of many pesticides, its activity against a variety of insect orders, its mammalian safety and its environmentally non-disruptive nature should make it an ideal candidate for use in vegetable insect control. Where efficacy is not great enough to produce a commercial crop, home gardeners, because of their acceptance of greater injury levels, may be able to utilize neem effectively. Although neem sprays appear to be more effective as antifeedants, further work may be warranted with the dust formulations, particularly against certain insects.

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Footnotes

1. Present address: Asian Parasite Laboratory, c/o American Embassy, Seoul Korea, APO San Francisco 9630.
2. Present address: Oregon State University, Columbia Basin Agricultural Research Station, Box 105, Hermston, OR 97838.
3. This article reports the results of research only. Mention of a proprietary product does not imply an endorsement or a recommendation for its use by USDA.

Literature Cited

1. Kubo, I. and Kloche, J.A. 1982. Azadirachtin, insect ecdysis inhibitor. Agric. Biol. Chem. 46:1951-1953.
2. Meisner, J. and Mitchell, B.K. 1982. Phagodeterrent effect of neem extracts and azadirachtin on flea beetles, *Phyllotreta striolata* (F.). Z Pflkrankh. Pflschutz 89:463-467.
3. Radwanski, S. 1977. Neem tree 1. Commercial potential, characteristics and distribution. World Crops and Livestock 29:62-65.
4. ____. 1977. Neem tree 2. Uses and potential uses. World Crops and Livestock 29:111-113.
5. ____. 1977. Neem tree 3. Further uses and potential uses. World Crops and Livestock 29:167-168.
6. Reed, D.K., Jacobson, M., Warthen, J.D. Jr., Uebel, E.C., Tromley, N.J., Jurd, L. and Freedman, B. 1981. Cucumber beetles antifeedants: Laboratory screening of natural products. US Dep. Agri. SEA Tech. Bull. No. 1641. 13 pp.
7. Reed, D.K., Warthen, J.D. Jr., Uebel, E.C. and Reed, G.L. 1982. Effects of two triterpenoids from neem on feeding by cucumber beetles (Coleoptera:Chrysomelidae). J. Econ. Entomol. 75:1109-1113.
8. Rembold, H., Sharma, G.K., Czoppelt, Ch., and Schmutterer, H. 1982. Azadirachtin: A potent insect growth regulator of plant origin. Z. Ang. Ent. 93:12-17.
9. Warthen, J.D. Jr. 1979. *Azadirachta indica*: a source of insect feeding inhibitors and growth regulators. US Dep. Agri. Rev. Manuals. ARM-NE-4, 21 pp.