0971-4693/94 US $ 5.00
Allelopathy Journal 20 (2): 411-417 (2007)
Tables: 3, Fig : -

SHORT COMMUNICATION

Phytotoxicity of leaf extracts of multipurpose trees against insect pests in bitter gourd (*Momordica charantia*) and brinjal (*Solanum melongena*)

JACOB JOHN*, N.K. LEELA**, K.M. SREEKUMAR***, R.Y. ANESH and M. HEMA

Cropping Systems Research Centre, Kerala Agricultural University,
Karamana, Thiruvananthapuram 695 002, Kerala, India
E. Mail: jjkau@rediffmail.com

(Received in revised form: May 27, 2007)

ABSTRACT

Field studies were conducted to assess the allelopathic influence of leaf extract of multipurpose trees *viz*., Ailanthus (*Ailanthus triphysa* Dennst.), cashew (*Anacardium occidentale* L.), Casuarina (*Casuarina equisettifolia* L), gliricidia (*Gliricidia sepium* Steud.), jack (*Artocarpus heterophyllus* Lam.), Strychnos (*Strychnos nux-vomica* L.), mango (*Mangifera indica* L.), portia (*Thespesia populnea* (L.) Soland.), tamarind (*Tamarindus indicus* L.), teak (*Tectona grandis* L.F.), grown in multi-storey home gardens of Kerala, India on growth, yield and insect pests in vegetables *viz*., bitter gourd (*Momordica charantia* L. cv. Preethi) and brinjal (*Solanum melongena* L. cv. Haritha). Spraying with *Ailanthus* and cashew leaf extracts was as effective as insecticides in reducing fruit fly (*Daucus cucurbitae*) attack in bitter gourd and yield obtained was also identical to insecticides treatment. Ailanthus, cashew, tamarind and teak effectively controlled epilachna beetle (*Epilachna vigintiopunctata*). Insect control achieved by spraying tamarind and teak treatments was similar to insecticide spraying. In brinjal, extracts of *Ailanthus*, cashew and *casuarina* reduced fruit borer infestation (*Leucinodes orbonalis*) considerably. A*ilanthus* and cashew extracts also improved the yield and was on par with that obtained with spraying of insecticides. The leaf extract of the trees were analyzed by Thin Layer Chromatography (TLC) for the presence of five important groups of secondary metabolites *viz*., terpenoids, alkaloids, flavonoids, saponins and triterpenes. The results show the possible use of leaf extracts of Ailanthus and cashew, to control the insect pests in bitter gourd and brinjal.

Key words: Allelopathy, bitter gourd, brinjal, epilachna beetle, fruit borer, fruit fly, insecticide, leaf extract, multipurpose trees, phytotoxicity, secondary metabolites, vegetable, yield

INTRODUCTION

Vegetables are major constituents of human diet, but are more prone to pest attack mainly due to their tenderness and softness than other crops. In India, vegetable productivity is limited mainly by pests and insect pests inflicting crop losses upto 40 % (7). Bitter gourd and brinjal, two important vegetable crops, are infested by many insect pests which affect the yield. In India, 63 % yield loss in brinjal is due to shoot and fruit

*Correspondence Author; **Indian Institute of Spices Research, Kozhikode, Kerala; *** College of Agriculture, Padannakkad P.O., Kasaragod 671 328, Kerala.

borer and upto 80 % in bitter gourd due to fruit fly (7). Vegetable growers use insecticides with long residual effects. The exponential increase in the use of pesticides has poisoned the food cycle itself. Due to blatant misuse of insecticides by vegetable growers, most vegetables are becoming potent health hazards. Allelochemicals/Botanicals, an essential component in bio-intensive pest management, help to reduce the dependence on chemical pesticides and ecological deterioration. Botanicals serve as insecticides, insect repellents and insect antifeedants (5). There are several reports of effective control of insect pests using botanicals (1, 3). In multi-storey home gardens of Kerala, where numerous crops and trees are grown together, vegetables are essential components. The multipurpose trees comprise a virtually untapped reservoir of allelochemicals. The allelopathic effect of multipurpose trees on crops has already been revealed (8, 9). Hence, this investigation was undertaken to assess the allelopathic effect of leaf extract of certain multipurpose trees planted in home gardens of Kerala on growth and insect pests in bitter gourd and brinjal.

MATERIALS AND METHODS

Field studies were undertaken at the College of Agriculture, Padannakkad, Kasaragod, North Kerala during January to June 2004. The average maximum and minimum temperatures during the study period ranged between 31.33-33.05 ^{o}C and 19.76-25.41 ^{o}C respectively. The relative humidity varied from 74 to 87 % and total rainfall received during crop period was 9.5 cm.

Two separate experiments, one for each test crop, were conducted simultaneously with bitter gourd and brinjal. To reproduce natural conditions prevalent in home gardens, the crops were raised in small plots in interspaces (previously fallow) of coconut palms spaced at 7.6 m x 7.6 m. The soil type was sandy (littoral sand, Entisol) with pH 6.1 and organic carbon 0.29 %. The soil available N, P_2O_5 and K_2O status of the experimental site was 128.51 kg ha^{-1}, 41.59 kg ha^{-1} and 48.59 kg ha^{-1} respectively. Bitter gourd was spaced at 2.0 m x 2.0 m and brinjal at 0.60 m x 0.60 m. Both the test crops were manured with cow dung @ 20-25 t ha^{-1} and nutrients ($N:P_2O_5:K_2O$) were supplied, at the rate of 70:25:25 kg ha^{-1} for bitter gourd and 75:40:25 kg ha^{-1} for brinjal, as recommended in the Package of Practices Recommendations for crops in Kerala (6)

For preparing leaf extracts (10 %), fresh green leaves of fully-grown, mature trees viz., cashew, casuarina gliricidia, ailanthus, teak, jack, portia, mango, strychnos and tamarind were collected, cleaned and air dried to uniform moisture content. Leaves were selected from different parts of the tree (lower, middle and top portions) to get a representative sample of the entire tree canopy. Leaves that were dry or in senescent stage and ready to shed were avoided. Extract was prepared by blending the leaves with distilled water in ratio 1:10 (w/v) in blender. The extracts were filtered through Whatman Number 1 filter paper. Both, bitter gourd and brinjal crop was sprayed with the leaf extracts (prophylactic + whenever pest incidence noticed). Also, the developing bitter gourd fruits were immersed in the leaf extracts as preventive against fruit borer. Two controls were maintained. In the first, involving insecticide application, carbaryl (0.2 %) was sprayed as prophylactic and at flowering and fruit initiation at 15 days interval as per Package of Practices Recommendation for Kerala (6). In the second (absolute control), no plant protection measures were adopted. The experiment was laid out in randomized block

design and in both trials all treatments replicated thrice. Plant height and number of leaves was recorded at 1 and 2 MAP (months after planting) in bitter gourd and at 1 and 4 MAP in brinjal. Yield of both crops was assessed at harvest. Infestation/damage due to fruit fly (*Daucus cucurbitae*) and epilachna beetle (*Epilachna vigintiopunctata*) in bitter gourd and epilachna beetle and fruit and shoot borer (*Leucinodes orbonalis*) in brinjal was scored. The data were subjected to analysis of variance for randomized block design.

Chemical analysis: The leaf extract of the trees were analyzed by Thin Layer Chromatography (TLC) for the presence of five important groups of secondary metabolites *viz.*, terpenoids, alkaloids, flavonoids, saponins and triterpenes. The extracts were spotted on TLC plates coated with silica gel and developed using butanol-acetic-acid water (4:1:5) and sprayed with different reagents to detect the major classes of compounds. Alkaloids were detected by spraying with Dragendorff-Vaguifalvi reagent followed by 10 % sulphuric acid in alcohol. Exposure of the plates to ammonia vapour indicated the presence of flavonoids. Terpenoids were visualized by spraying with vanillin-sulphuric acid reagent. Spraying with Leibermann-Burchard reagent revealed the presence of triterpenes (10).

RESULTS AND DISCUSSION

Bitter gourd

Spraying with leaf extracts did not significantly influence the bitter gourd plant growth at 1 MAP (Table 1). At 2 MAP, though plant height was unaffected, the number of leaves produced differed significantly between treatments.

Spraying with casuarina, portia, tamarind and teak resulted in reduced number of leaves and was on par with the absolute control. Tamarind and teak were effective in reducing *Epilachna* beetle infestation but ineffective against fruit fly. So, the reduced number of leaves despite effective control of epilachna beetle reveals the growth inhibitory properties of teak and tamarind. The low yield obtained with teak and tamarind extracts is due to both fruit fly attack and phytotoxic effect. The yield obtained with spraying of Ailanthus, cashew and casuarina, ranged from 7.27-7.87 t ha^{-1}, and was on par with that obtained with insecticide spraying.

Fruit fly attack was reduced by ailanthus, cashew and mango when compared to absolute control. The fruit fly control achieved by spraying ailanthus and cashew was similar to insecticide spraying. The extracts of these trees also reduced epilachna attack to a certain extent when compared to absolute control. Hence, spraying and dipping of bitter gourd fruits in leaf extracts of Ailanthus and cashew can be considered as a relatively safer alternative to insecticides for control of fruit fly in bitter gourd. Ailanthus, cashew, tamarind and teak were effective in controlling epilachna beetle. Control achieved by spraying tamarind and teak was on par with insecticide spraying. Although casuarina did not control fruit fly and epilachna beetle, yield obtained was reasonable.

Brinjal

Growth of brinjal differed significantly between treatments at both 1 and 4 MAP (Table 1). At 1 MAP, spraying with leaf extract of all trees except *ailanthus* and cashew

reduced plants height than absolute control. Similarly, leaf number was also reduced with spraying of all extracts, except *ailanthus*, cashew and mango. Tamarind caused the most severe inhibition.

At 4 MAP, only tamarind inhibited increase in height of plant over absolute control. Leaf production was significantly less with *strychnos*, portia, tamarind and teak when compared to the insecticide sprayed plants. Teak and tamarind affected leaf production considerably when compared to absolute control, despite effective reduction of epilachna infestation, thus highlighting its inhibitory phytotoxic effect. Spraying with extracts of all trees, except portia, jack and casuarina reduced *Epilachna* beetle infestation and was identical to insecticide spraying. The reduced leaf number in plants sprayed with strychnos, mango, tamarind and teak, despite the very effective control of epilachna beetle, reveals phytotoxic effect of these tree leaf extracts on growth of brinjal. The yield obtained with spraying of ailanthus and cashew was on par with that obtained with spraying of insecticides. Extracts of ailanthus, cashew and casuarina considerably reduced fruit borer infestation and the control achieved was on par with insecticide spraying. Despite the effective control of fruit borer, casuarina leaf extracts reduced yield. Since growth of brinjal was unaffected by casuarina leaf extract, it is logical to conclude that the reduced yield may be due to inhibition of some processes contributing to the flowering or fruit development.

Leaf extracts of the trees were analyzed for the presence of five important groups of secondary metabolites that are classified as allelopathically active (Table 2). Triterpenes are present in Ailanthus, cashew, mango and teak. Ailanthus, cashew and mango leaf extract controlled fruit fly effectively. This reveals that some chemical under triterpene group is inhibitory to fruit fly and hence, responsible for the observed reduction of fruit fly attack. This particular triterpene may be present in lesser amounts or absent in teak and hence, is ineffective in controlling fruit fly.

Table 2. Secondary metabolites isolated from leaf extract of the test trees

Tree spp	Alkaloids	Flavonoids	Terpenoids	Triterpenes	Saponins
Ailanthus	A	A	A	P	A
Cashew	A	A	P	P	P
Casuarina	A	A	A	A	A
Gliricidia	A	P	P	A	A
Jack	A	P	P	A	A
Strychnos	P	A	A	A	A
Mango	A	A	P	P	A
Portia	P	A	A	A	P
Tamarind	A	P	P	A	A
Teak	A	A	A	P	A

A: Absent, P: Present.

Ailanthus, cashew, tamarind and teak effectively reduced epilachna attack in bitter gourd, which is also probably due to a triterpene or terpenoid, as these are the compounds common among the trees. This is confirmed by the poor control of epilachna beetle by extracts of casuarina and portia, both of which lack triterpenes or terpenoids.

Ailanthus leaf extract contains triterpenes while cashew has triterpenes, terpenoids and saponins. Any of these compounds may be responsible for the remarkable control of brinjal fruit borer by ailanthus and cashew. However, tamarind though effective in controlling fruit borer when compared to absolute control, reduced yield thereby clearly bringing out its crop inhibitory property. Some flavonoid or any other compound present in tamarind caused inhibition/yield reduction while terpenoid reduced borer infestation. Similar to tamarind, gliricidia leaf extract contains flavonoids and reduced brinjal yield. The efficient control of fruit borer by casuarina is due to some other compound, as all the tested compound groups are absent. Also, casuarina depressed brinjal fruit yield. Some of the phytochemicals identified in casuarina are Kaempferol-3-alpha-rhamnoside, quercetin-3-alpha-araboside, luteolin-3',4'-dimethoxy-7-beta-rhamnoside, kaempferol-3-betadirh-amnoside and quercetin-3-beta-glucoside (4).

The inhibitory effects of strychnos on bitter gourd yield and brinjal growth may be due to the alkaloids. The presence of alkaloids viz., strychnicine, strychnine in strychnos leaves has been reported (4). Alkaloids also possess insecticidal properties (2).

Plants produce many compounds that are insect repellents or act to alter insect feeding behavior, growth and development ecdysis (molting) and behavior during mating and oviposition. Most insect repellents are volatile terpenoids. In some cases, the same terpenoid can repel certain undesirable insects while attracting more beneficial insects. Plant terpenoids act as locomotor excitants, biting or piercing suppressants, ovipositioning deterrents, or mating behavior disruptants. More than a dozen plant-produced terpenoid juvenile hormone mimics effectively sterilize insects. (5)

The study reveals the possible use of leaf extracts of Ailanthus and cashew as a vital component of an integrated strategy to control the insect pests in bitter gourd and brinjal. However, further confirmatory field studies are needed, for which the results of this study will serve as a base. Considering the potential of leaf extracts of trees in insect control, studies should be extended to isolation, and fractionation guided bioassays.

ACKNOWLEDGEMENT

The research was conducted as part of a project funded by the Kerala State Council for Science, Technology and Environment. The authors are thankful to the Council for providing grants for the research work.

REFERENCES

1. Chiu, S.F. (1993). Investigations on botanical insecticides in South China-An update. In: *Proceedings, National Symposium on Botanical Pesticides in Integrated Pest Management* (Eds. M.S. Chari and G. Ramaprasad). p. 134-137. Central Tobacco Research Institute, Rajahmundry, India: Indian Society of Tobacco Science.
2. De, B. (1997). Alkaloids of *Strychnos nux-vomica. Journal of Medicinal and Aromatic Plant Sciences* **19**: 432-439.
3. Devaraj, K.C.U. and Srilatha, G.M. (1993). Antifeedant and repellant properties of certain plant extracts against the rice moth *Corcyra cephalonica* St. In: *Proceedings of the National Symposium on Botanical Pesticides in Integrated Pest Management* (Eds., M.S. Chari and G. Ramaprasad). p. 159-165. Central Tobacco Research Institute, Rajahmundry, India: Indian Society of Tobacco Science.

4. Duke, J. A. (1992). *Handbook of Phytochemical Constituents of Grass Herbs and Other Economic Plants*. Boca Raton, FL: CRC Press.
5. Duke, S.O. 1990. Natural pesticides from plants. In: *Advances in New Crops* (Eds., J. Janick and J.E. Simon). p. 511-517. Portland, OR: Timber Press.
6. Kerala Agricultural University (2002). *Package of Practices Recommendations: Crops* 12th Edition (Ed. A.I.Jose), pp.36-38, 151-152, 156-157. Kerala, India: Kerala Agricultural University.
7. Srinivasan, K. (1993). Pests of vegetable crops and their control. In: *Advances in Horticulture 6: Vegetable crops* (Eds., K.L. Chadha and G. Kalloo) p. 859-886. Malhotra Publishing House: New Delhi.
8. Suresh, K.K. and Rai, R.S.V. (1987). Studies on the allelopathic effects of some agroforestry tree crops. *International Tree Crops Journal* **4**: 109-115.
9. Suresh, K.K. and Rai, R.S.V. (1988). Allelopathic exclusion of understorey by a few multipurpose trees. *International Tree Crops Journal* **5**: 143-151.
10. Touchstone, J.C. and Dobbins, M.F. (1978). *Practice of Thin Layer Chromatography*. Wiley Inter-Science Publication, New York. p.383.

Ms. 663-07 Tables 1
& 2.doc