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Effectiveness of Some Botanical Extracts on Bean Aphids Attacking Yard-Long Beans

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Abstract: The effect of five different botanical extracts-tobacco, neem, garlic, eucalyptus and mehogony-on aphid population on yard long bean was assessed in field, net-house and laboratory conditions at Khulna University, Bangladesh. Aphids were deliberately exposed to the above botanical extracts and then the numbers of live and dead aphids were counted. The botanical extracts showed significant effect on the numbers of live aphids. Tobacco leaf extract had inflicted consistently the maximum level of aphid mortality; about 74-90% of the aphids were killed by the treatment in different conditions. Killing about 53-64% of the aphids on treated plants, the extract of neem followed the extract of tobacco. Garlic extract showed similar performance to that of neem. Eucalyptus and mehogany reduced aphid population but differed among the field, net-house and laboratory conditions. Contrasting to the case with aphid numbers, the botanical extracts did not affect the most common and recognized predators, ladybird beetles in the laboratory. Botanical extracts had significant effects on yield of yard long beans. Tobacco extract treated plants produced the greatest number, amount and biomass of yard-long beans; the treatment was followed by neem and garlic. The latter two treatments did not show significant effect.

Key words: Tobacco, neem, garlic, eucalyptus, mehogony, ladybird beetles

INTRODUCTION

Yard-long bean, *Vigna unguiculata* subsp *sesquipedalis* L. (Leguminosae), is a very common and important vegetable crop, which is cultivated year-around in Bangladesh. The production of yard-long bean is affected due to the frequent occurrence of aphids, *Aphis* spp. (Homoptera: Aphididae), a ubiquitous group of arthropods (Begum *et al*., 1991; Pedigo, 2002). Attacking yard-long beans from seedling to pod-maturing stages of plants, aphids cause significant and economic damages to different crops including beans (Attle *et al*., 1987). The insect attacks plant stems, buds, leaves, flowers and pods of the plants (Shrivastava and Singh, 1986). Both nymphs and adults of the insect suck cell sap of infested plants and while feeding they inject a toxin along with the salivary secretion into host plants. Aphids also secrete honeydew, which, by enhancing the growth of sooty moulds, interferes with the photosynthetic ability of plants (El-Defrawi, 1987; El-Fatah, 1991; Rizkalla *et al*., 1994). In addition, the pest may transmit virus diseases to plants. According to Singh and Allen (1980), the pest causes up to 40% reduction of crop yields in Asia. Attle *et al*. (1987) reported as high as 100% yield reduction of different bean crops due to aphid infestation.

In order to protect their crops from damages of aphid infestation, growers in Bangladesh often apply synthetic chemical insecticides. Although synthetic insecticides usually provide quick and adequate control for the time being, they are usually expensive and leave long-lasting residues over the exposed surface of the crops, in soil and water (Hussain, 1989). In addition, due to other problems such as health hazards, undesirable side effects, development of pest genotypes resistant to pesticides,

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resurgence and upset of pests and environmental pollution caused by the continuous use of synthetic chemical pesticides (Nas, 2004), there is renewed interest in the application of botanical pesticides for crop protection (Debach and Rosen, 1991; Pedigo, 2002).

There have been a large number of plant-products, which possess pesticidal properties and have been used successfully for controlling various pests in field and laboratory conditions (Bajpai and Sehgal, 2000; Pedigo, 2002). Botanical products like tobacco extract, neem oil and extract, which can be easily and cheaply collected in rural Bangladesh, have been found promising and useful for pest control (Roy *et al*., 2005; Hussain, 1989; Luckman and Metchalf, 1978). Although they have been found promising for protection of stored products, botanicals have received little attention for field crops in Bangladesh (Pers. Comm., Prof. Masum Ahmad). The present study was, therefore, undertaken in order to examine the effectiveness of the botanical extracts of five common plants- Tobacco, *Nicotiana tabacum*, Neem, *Azadirachta indica*, Garlic, *Allium sativum*, Eucalyptus, *Eucalyptus camaldulemsis* and Mehogony, *Swietenia mehagani*, for controlling aphids attacking yard-long bean plants.

MATERIALS AND METHODS

The experiment was conducted during Rabi August, 2005 to January, 2006 in the Laboratory, net-house and field laboratory of Agrotechnology Discipline, Khulna University, Bangladesh.

Preparation of Botanical Extracts

The tobacco extract was prepared by soaking 10 g of cured tobacco leaves in one liter of water for 45 min in a beaker. After soaking, the leaf was hand-squeezed to extract the juice in the same water used for soaking the leaves in the beaker. Extracts of the neem and eucalyptus were prepared separately from 100 g fresh leaves of each, blended in 125 mL water. Then the blend was squeezed and the extract gathered was collected separately, which was further diluted adding 300 mL to each and filtered before their being made ready for use. Similarly, extracts of garlic and mehogony were prepared separately from garlic bulbs and young mehogony fruits, respectively. One drop of fragrance-free liquid detergent was added as a surfactant and spreading agent to each extract before spraying.

Biological Specimens

A plot of yard-long bean was established following Rashid (1993) and maintained free from insecticide application. The plants were allowed to be naturally infested and colonized by aphids. These aphids and ladybird beetles (Coleoptera: Coccinellidae), who arrived probably in search of food in the plot were used for studies carried out under different conditions.

Lab Experiment

Fresh young leaves were collected from yard-long bean plants raised following Rashid (1993) in a net-house. Soaking the collected leaves of bean in assigned botanical extracts for 60 min, the leaves were air-cured for a few min so that excessive water dried away. Placing each leaf separately upside down in a Petri dish, 5.5 cm (dia), 6 aphids were released on each leaf by means of a camel-hair brush. The experiment was laid out in a Completely Randomized Design with four replications. Number of dead aphids was recorded in each Petri dish 12, 24 and 36 h after releasing the aphids. Similarly, the effects of the botanical extracts were assessed on ladybird beetles, releasing two new adults and two third instar larvae on an assigned extract-soaked leaf in each petri dish. The number of dead aphids and ladybird beetles were recovered and expressed in percentage.

Net-house Experiment

Twenty four blackish plastic pots, 20 (dia) x 20 (height) cm each, were prepared filling three-quarters each with a growing mixture. Recommended fertilizers were added (Rashid, 1993) to the mixture and

then watered. Four seeds of yard-long beans were sown in each pot. The pots were placed in a net-house made of white and single-mesh common mosquito net procured from local market. Fourteen days after sowing, two inferior seedlings were discarded, allowing two relatively healthier and luxurious plants to grow in each pot. The experiment was laid out in a Completely Randomized Design (CRD) with six treatments and four replications. Treatments were applied on 22 day old plants. The day before treatments were applied, twenty aphids were released on the upper two leaves of each plot. Allowing 24 h for the aphids to settle down and establish on plants, the number of live aphids on plants in each pot were counted and the plants assigned under each treatment were sprayed with corresponding extract using a hand sprayer. Plants under the control treatment received spray of tap-water only. Following the spray, aphid numbers were recorded on each potted-plant 12 and 24 h after treatments were applied. The percentage of aphids reduced on plants was calculated. At harvesting time, the number of pods per plant, weight of individual pod (g), total weight of pods (g), fresh and dry weight of plant biomass (g) were recorded.

Field Experiment

Yard long bean seeds were sown and successive seedlings were grown following Rashid (1993) in individual field-plots, 4×2 m each. There were four replications and six treatments, which were laid out in a Randomized Completely Block Design. Intercultural operations were done as needed (Rashid, 1993), except the fact that plants were allowed to be naturally infested and colonized by aphids. Before application of treatments, two plants were selected randomly in each plot and two shoots were marked on each plant and aphid numbers on the upper 10 cm of the marked shoots were recorded. Then treatments were applied similarly as in the net-house and aphid numbers on the marked shoots were recorded 12 and 24 h after the application of treatment. The percentage of reduced aphids was calculated similarly as in the net-house study.

Data Analyses

The collected data were analyzed for the Analysis of Variance (ANOVA) using MSTAT-C software. Data were Arcsine transformed as appropriate and treatment means were separated from each other by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS

Lab Experiment

Among the five different botanical extracts, the highest percentage of aphids were killed consistently across the time after application by tobacco leaf extracts, which was statistically significantly different from the percentages of aphids killed by the other treatments (Table 1). The mortality inflicted by the tobacco leaf extract was followed by that did by the neem, garlic, eucalyptus and mehogony extracts. The latter four treatments did not differ from each other in this regard 12 h after the treatments were applied. However, 24 h after the application of treatments, aphid mortality caused by neem was significantly greater than the other three treatments. Although the rank-order of the treatments appeared to be inconsistent across different post-treatment times, it was evident that aphid mortality consistently increased with the progress of time after treatments were applied (Table 1). Conversely, there were no deaths of ladybird beetles, adults or larvae, as found in the present study (data has not been tabulated logically).

Net House Experiment

Like in the laboratory, there was significant effect of the treatments on aphid numbers; the botanical extracts greatly differed among themselves in this regard (Table 2). As indicated in Table 2,

Table 1: Aphid mortality (%) as influenced by different treatments in the laboratory

	Percent mortality at different time after exposure to treatments		
Treatments	At 12 h	At 18 h	24 h
Tobacco	69.39a	83.44a	88.89a
	(79.17)	(95.83)	(100)
Neem	26.90b	37.72b	63.14b
	(20.45)	(37.50)	(79.16)
Garlic	21.16b	23.59bc	45.02c
	(16.66)	(20.83)	(50.00)
Eucalyptus	6.89b	21.16bc	45.02c
	(4.17)	(16.67)	(50.00)
Mehogony	1.15b	6.89c	29.18c
	(0)	(4.17)	(29.16)
Control	1.15b	1.15c	1.15d
	(0)	(0)	(0)
Level of significance	**	**	**

** Significant at 1% level, Means within a column followed by the same letter are statistically similar to each other
Values are based on Arcsine transformation and values in parentheses represent the original mean values

Table 2: Reduction of aphid numbers (%) at different time after treatments applied in the net-house

	Reduction rate of aphids at different times after spraying (%)	
Treatments	At 12 h	24 h
Tobacco	75.43a	83.05a
Neem	56.18b	56.85b
Garlic	43.86b	44.51b
Eucalyptus	42.35b	44.29b
Mehogony	27.74c	28.29c
Control	15.88c	16.62c
Level of significant	**	**

** Significant at 1% level, Means within a column followed by the same letter are statistically similar to each other

Table 3: Reduction of aphid numbers (%) at different time after treatments applied in the field

	Reduction rate of aphids at different times after spraying (%)	
Treatments	At 12 h	24 h
Tobacco	66.71a	73.42a
Neem	50.93b	52.24b
Garlic	37.53c	42.00c
Eucalyptus	35.58c	40.52c
Mehogony	22.70d	25.27d
Control	3.23e	3.23e
Level of significant	**	**

** Significant at 1% level, Means within a column followed by the same letter are statistically similar to each other

the treatment of tobacco extract consistently caused the most reduction of aphids at different time after treatment application. The effectiveness of tobacco extracts in reducing aphid numbers was followed by those of neem, garlic and eucalyptus extracts. The latter three treatments did not differ among themselves in this regard. Although not significant, there was an increasing trend of aphid number reduction across time after the application of treatments (Table 2).

Field Experiment

Results in the field experiment were consistent with those in the laboratory and net-house conditions; different botanical extracts had significant effect on aphid numbers (Table 3). In the field, significantly greatest percent reduction of aphid number was obtained in plots treated with tobacco extract, which was followed by those in plots treated with the neem extract (Table 3). Extracts of garlic and eucalyptus, which reduced less than 60% of tobacco extract, did not differ from each other, producing significantly lower reduction of aphid numbers compared with neem (Table 3). There was an increasing trend of aphid number reduction across time after the treatments were applied (Table 3).

Table 4: Effects of botanical extract on Yield performance of yard long bean

Treatments	No. of pods per plant	Total pods weight (g)	Fresh weight of biomass (g)	Dry weight of biomass (g)
Tobacco	8.00a	271.20a	84.00a	11.675a
Neem	4.62b	111.93b	74.00b	8.80b
Garlic	3.62bc	77.72c	64.00c	6.80c
Eucalyptus	2.87cd	60.20c	54.00d	5.80d
Mehogony	1.62de	25.31d	44.00e	3.80e
Control	0.50e	5.52d	29.00f	2.80f
Level of significant	**	**	**	**

** Significant at 1% level, Means within a column followed by the same letter are statistically similar to each other

Effect of Botanical Extracts on Yield of Yard-Long Bean

There was a significant effect of treatments on yard-long bean yields with respect to mean number of pods per plant, pod weight and weight of plant biomass (Table 4). Consistent to the aphid reduction, the highest percent reduction of aphid numbers was obtained in the tobacco extract treated plants. Aphid control by the treatment of neem extract yielded an intermediate level of pod production. The other extracts did not produce much appreciable results, as treatments of them resulted in around 50% of pods produced by tobacco extract (Table 4). Botanical extract also had significant effect on pod weight and plant biomass. Weight of total pods harvested from the tobacco leaf extract-treated plants was the greatest, which was followed by that obtained from plants treated with the neem extract (Table 4). Treatments of garlic and eucalyptus extracts resulted in intermediate levels of pod weight, which were better than mehogony and the control treatments (Table 4). In the case of both fresh and dry weight of plant biomass, the trends of results were more or less similar to results associated with the number and weight of pods produced, excepting that each treatment differed from each other in this regard (Table 4).

DISCUSSION

Results in the present study conducted in different conditions indicated that different botanical extracts had notable effects on reduction of aphid numbers and increase of yard-long bean yield. In all the three conditions, tobacco extracts gave the best results, as both aphid number reduction and yield were greatest in plants received this treatment. This may not be unusual and is consistent with previous reports (Chari *et al*., 1996; Bajpai *et al*., 2000). The insecticidal property of tobacco extract has long been known and well documented against various insect pests including aphids (Pedigo, 2002). Tobacco contains nicotine sulfate, which probably deter or kill insects and has been found to be toxic to *Glyptapanteles africanus* and *Telenomus remus* individuals up to 72 h after spraying (Chari *et al*., 1996). Nicotine has been reported to control various pests including root aphids and fungus gnats, leaf-feeding aphids, immature scales, leaf hoppers, thrips, leaf miners and pear psylla (http://www.tracker-outdoors.com/organic_insect_control.htm). Bajpai *et al*. (2000) also reported that treatment of nicotine sulfate produced satisfactory control of pests and thereby increased production of chickpea.

In the present study, neem was found to produce appreciable results. Neem has been used against various insects and the insecticidal capability of neem as found in the present study is in agreement with previous reports from elsewhere (Dangan *et al*., 1994; Chakraborti and Chatargee, 1999; Markandeya *et al*., 1999; Pedigo, 2002; Saikia *et al*., 2000; Isman, 1987). Saikia *et al*. (2000) reported that leaf (10-50%) and seed kernel (5%) extracts of neem caused significant mortality of the bean aphid, *A. craccivora*. Chakraborti and Chatargee (1999) reported that application of neem extract at rates of 7 and 9 mL a.i. L^{-1} resulted up to 77% mortality of *D. carthami*.

As described in the results, reduction of aphid numbers increased with increase of the time after treatments were applied, which is a usual phenomenon for most insecticides. Although botanical insecticides are biodegradable and they often breakdown quickly after being exposed to the surrounding environmental conditions like sunlight, moisture and air (Pedigo, 2002); results in the represent study suggest that the botanical extracts remained effective at least 24 h after being applied. Increased control with time progress may also indicate that the process of environmental breakdown, if already started by then, probably resulted in intermediate compound(s) that was more toxic to aphids. Although the extracts of garlic, eucalyptus and mehogony reduced aphid population, they did not appear to be appreciable. This seems to be rather unexpected, at least for the treatment of garlic extract. Garlic has a very strong and pungent odour. Further thorough studies are needed before concluding the effect of garlic extract.

The laboratory experiment revealed that there was no toxic effect of the examined botanical extracts on ladybird beetles and this result agrees to Markandeya *et al*. (1999), who found no effect of some of our botanical compounds on predatory beetles. This is primarily because, either the predators have evolved detoxification mechanism against the compounds or it might require more time for the compounds to inflict toxicity to ladybird beetles. Although the present study did not detect any direct effect of the botanical extracts on ladybird beetles, it does not preclude any indirect effect that the extract might have on ladybird beetles. Such effect is likely to take long time before being detected.

It was evident from results in the present study that botanical extracts benefited bean yield and plant biomass, which was presumably due to reduction of aphid numbers; protection of crops from pest pressure has frequently been found to result in yield increases (Pedigo, 2002). The present study provides evidence that botanical extracts of tobacco and possibly of neem can be used for controlling aphids on year-long beans. Tobacco and neem is commonly available and the extract preparation and handling is simple and safe, which is very important in the context of the socio-economic conditions of rural Bangladesh.

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