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Effect of Plant Extracts on *Okra mosaic virus* Incidence and Yield Related Parameters of Okra

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Abstract: The experiment was conducted to find out the incidence of *Okra mosaic virus* (OMV) and its severity on yield and nutrition of okra under different phytopesticidal treatments. Four different plant extracts such as extracts of neem (*Azadiracta indica*) fruits, garlic (*Allium sativum*) bulbs, karamja (*Pongamia pinnata*) leaves and mehogoni (*Swietenia macrophylla*) seeds were considered as phytopesticidal treatments in this study. Plots with no phytopesticidal management were used as control. Highest rate incidence of okra mosaic virus was found in the plots with no phytopesticidal management. Though all the phytopesticides produced better performance than control, but *karamja* extract treated plants had minimal rate of incidence of this virus, with maximum plant height, flower production, fruits formation and highest yield.

Key words: Incidence, severity, phytopesticides, plant extracts, OMV, Okra

INTRODUCTION

Okra (*Abelmoscus esculentus* (L.) Moench), originated in tropical Africa (Purseglove, 1987) is an important vegetable crop of Bangladesh and other subtropical and tropical countries (Indira Gandhi *et al*., 2006; Ali *et al*., 2000). The production of this crop is hampered due to several biotic and abiotic factors. Plant virus is an important biotic factor causing severe constraints on the productivity of a wide range of economically important crops world wide (Kareem and Taiwo, 2007; Das Gupta *et al*., 2003). There are a large number of viruses that infect plants and cause production losses both in terms of yield and quality. *Okra mosaic virus* (OMV) is one of them. Although viral diseases are considered minor in okra or even excluded in the list of common diseases (Simone, 1999), they may cause a considerable loss in fruit yield and quality.

The vegetable, okra, is susceptible to at least 19 plant viruses with *Okra mosaic virus* (OMV) and *Okra leaf curl virus* (OLCV) being the most common and well studied (Brunt *et al*., 1990; Swanson and Harrison, 1993). In 2000 and 2001, in the states of Karnataka and Tamil Nadu, the virus caused yield losses as much as 63% (Krishnareddy *et al*., 2003). OMV is transmitted by insects belonging to *Podagrica* species (Brunt *et al*., 1996). The virus induces mosaic, vein chlorosis and banding and plant stunting (Krishnareddy *et al*., 2003; Brown, 1994; Brunt *et al*., 1990). At present, control of viral disease has become a great concern to world scientists. It is well established that virus is a living organism and can survive outside a host for a considerable time; however they cannot multiply without a living host. During the process of their multiplication within the host organism, they compete with plants for their nutritional components. Usually viral infestation can be controlled by preventing their vectors to attack plants as there was a positive correlation between disease incidence and population of the vector (Bhagabati and Goswami, 1992; Nath *et al*., 1992).

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Although most of the research on control of virus and its vector oriented with chemical control, but in several research works plant extracts had been used as seed dresser against sucking pest (Indira Gandhi *et al*., 2006) and virus inhibitor (Baranwal and Verma, 1992). Though a number of plant virus inhibitors of plant origin have been studied by applied biologists, but only a few of them has been characterized (Verma *et al*., 1995a). Bennet (1953) selected some extracts from a number of plants to inhibit the infection and multiplication of plant viruses. In Bangladesh, the uses of phytopesticides or plant extract as a means of viral disease management is yet to be established. Therefore, the present study was undertaken to determine the influence of phytopesticides on the incidence of *Okra mosaic virus* and its severity on yield and yield related characters.

MATERIALS AND METHODS

The study was conducted at the experimental field of the Department of Genetics and Plant Breeding and in the Laboratories of the Department of Agricultural Chemistry and Biochemistry, Bangladesh Agricultural University, Mymensingh during November, 2005 to April, 2006. The treatments used in the study were extracts of *neem* (*Azadiracta indica*) fruits, garlic (*Allium sativum*) bulbs, karamja (*Pongamia pinnata*) leaves and mehogoni (*Swietenia macrophylla*) seeds and control where no phytopesticides were applied. The field experiment was laid out in a randomized complete block design with four replications. Plant samples were ground in distilled water at 100 g L^{-1} (10% concentration) in blender and filtered through double layered cheese cloths. Extracts were used immediately for spraying. First spray was done after 30 days of transplanting. The plant extracts were sprayed 3 times at 15 days interval. All exposed surface of the plants including leaves, buds, twigs, branches and fruits were sprayed. Control plots were sprayed with distilled water.

Data recorded on individual plant basis were taken from 10 randomly selected plants (5 healthy and 5 diseased) in each plot. Sampling was done at one stage of the plants. Virus infestation was examined carefully in the plants from top to bottom. The investigation of the experiment was made on percentage of infected plants $plot^{-1}$, percentage of leaf area infection, plant height, number of green fruits $plant^{-1}$, green fruit length, green fruit weight and yield $plant^{-1}$. Data were analyzed for ANOVA with the help of a computer package program of MSTAT. A two way ANOVA was made by F variance test. The pair comparisons were performed by Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984). Regression line was prepared using MS Excel.

RESULTS AND DISCUSSION

Incidence of *Okra mosaic virus*

There were significant effects of phytopesticides on the incidence of *Okra mosaic virus* indicated by infected plant $plot^{-1}$ and leaf area infection (Table 1). Results revealed the increasing trend of okra plant infection over time being control was highest in all aspect among the treatments (Fig. 1). Though all the phytopesticide applied plots showed more or less similar rate of infection at 25 Days After Sowing (DAS), but at the later stages karamja treated plot was found to be the least infected. During the whole growth stages of plants, garlic and neem extract showed almost similar performance against

Table 1: ANOVA for incidence of Okra mosaic virus on okra plant under different phytopesticidal treatments

Sources of variation	df	Mean sum of square: Infested plant $plot^{-1}$ 25 DAS	50 DAS	75 DAS	100 DAS	Leaf area infestation $plot^{-1}$ 25 DAS	50 DAS	75 DAS	100 DAS
Treatments	4	12.92**	261.4***	327.1***	955.3***	5.485**	38.37***	515.8*	1088***
Error	12	1.454	2.090	0.998	2.440	0.743	1.201	0.393	1.139

*: Significant at 5% level; **: Significant at 1% level; ***: Significant at 0.1% level

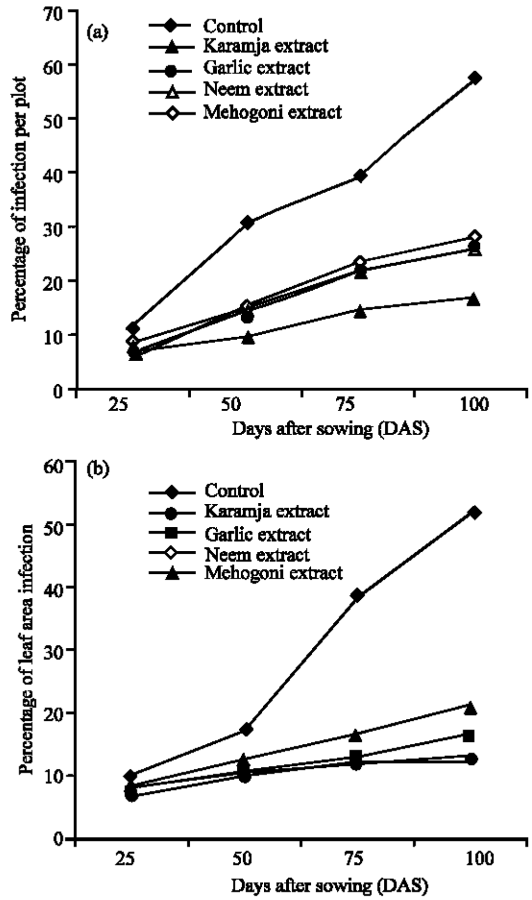

Fig. 1: Incidence (a: No. of plant basis, b: Leaf area basis) of *Okra mosaic virus* under different phytopesticidal treatments

OMV infection. While in control plot, infected plant was more than double at 50, 75 and 100 DAS, as compared to other treatments. It was found that number of infected plants increased rapidly in plots with no phytopesticide application and steadily in plots under phytopesticidal treatments.

It was shown that all the treatments exhibited more precisely the similar performance showing the leaf area infestation within the range of 5-8% at 25 DAS (Fig. 1). But, at later stages, there were a difference between the performances of different treatments. In case of phytopesticidal treatments, plants showed a steady rate of leaf area infestation. While for control treatments, it increased rapidly and got the peak of over 50% at 100 DAS starting from nearly 8% at 25 DAS. Karamja and neem extracts performed better by showing a trivial increase of leaf area infestation over time. The ranking was then moved to garlic and mehogoni extract respectively. In control treatment, the rate of leaf area infestation was three times more than that of karamja and neem at 75 DAS. Later it was extended to 5 times at 100 DAS. So, there might be a positive effect of plant extracts to be used as pesticidal agents and karamja and neem extract could be ranked top among the treatments used under study due to their diminishing effect of damaging caused by OMV. Lower rate of incidence of *Rice tungro virus* with the application of botanicals was also observed by Rajappan *et al*. (2000). Efficacy of *A. indica* in reducing virus infectivity was also reported (Tripathi and Tripathi, 1982).

Table 2: Effect of phytopesticides on the severity of okra mosaic virus for yield related traits of okra

	Plant height (cm)							
	25 DAS		50 DAS		75 DAS		100 DAS	
Treatments	Healthy	Infested	Healthy	Infested	Healthy	Infested	Healthy	Infested
Control	13.900^{a}	9.950^{b}	22.80^{c}	18.15^{d}	47.68^{c}	24.00^{e}	77.45^{d}	26.50^{e}
Neem extract	13.600^{a}	11.500^{a}	22.73^{c}	21.95^{bc}	50.95^{b}	33.13^{c}	80.38^{c}	45.20^{c}
Karamja extract	12.500^{a}	11.630^{a}	24.43^{bc}	22.47^{ab}	53.65^{a}	38.85^{a}	84.38^{a}	48.61^{a}
Mehogoni extract	13.000^{a}	11.780^{a}	26.33^{a}	20.83^{c}	51.90^{ab}	31.33^{d}	82.75^{ab}	43.55^{d}
Garlic extract	13.600^{a}	12.730^{a}	25.40^{ab}	23.83^{a}	50.83^{b}	35.98^{b}	82.08^{b}	47.13^{b}
LSD	1.567	1.337	1.767	1.502	1.971	1.766	1.899	1.663
	Green fruit length (cm)		Green fruit weight (g)		No. of fruits $plant^{-1}$		Yield (kg $plant^{-1}$)	
Treatments	Healthy	Infested	Healthy	Infested	Healthy	Infested	Healthy	Infested
Control	11.45^{c}	5.13^{c}	14.73^{c}	7.475^{c}	15.50^{c}	3.45^{c}	0.228^{b}	0.026^{d}
Neem extract	13.45^{b}	8.25^{b}	16.03^{b}	10.55^{b}	19.73^{a}	12.05^{ab}	0.307^{a}	0.127^{c}
Karamja extract	14.55^{a}	9.50^{a}	17.63^{a}	12.98^{a}	18.35^{a}	12.33^{a}	0.323^{a}	0.156^{a}
Mehogoni extract	13.58^{b}	8.08^{b}	16.10^{b}	10.85^{b}	16.30^{bc}	12.13^{ab}	0.244^{b}	0.130^{bc}
Garlic extract	14.55^{a}	8.65^{b}	17.55^{a}	11.08^{b}	16.95^{b}	11.83^{b}	0.297^{a}	0.132^{b}
LSD	0.8123	0.805	1.092	1.365	1.233	0.4247	0.04872	0.004872

Mean-values with the different superscript one significantly different

It was thus clear from the discussion that OMV affect okra plants drastically once infested and it continues it destruction if not taken under management. It can also be concluded that plant extracts can be used a good pesticide to keep the rate of infestation under control. Lower rate of plant infestation may be due to the effect of phytopesticides on the vectors of the virus or directly on OMV. It was recorded that some plant extract like neem extract have a number of properties useful for insect management (Schmutterer, 1990; Koul, 1992; Hiiesaar *et al*., 2000). Under the treatment of botanical leaf extract, reduced population of vector and less incidence of tungro virus in rice was also reported by Rajappan *et al*. (2000), which supports the result of present investigation. However, lower leaf area infestation indicates the presence of virus inhibitory action in the plant extracts, which was supported by the investigations of Baranwal and Verma (1997 and 1992) and Verma *et al*. (1995a and b). However, the efficacy of *A. indica* in reducing virus infectivity was also reported by Tripathi and Trypathi, 1982).

Effect on Plant Height

There was a significant influence of phytopesticides against okra mosaic virus for plant height at different growth stages (Table 2). It was revealed that virus infestation reduced plant height irrespective of growth stages. At 25 days after sowing, healthy plants of different treatments showed statistically similar performance. But, at the later stages i.e., 50, 75 and 100 DAS, there was significant difference among the healthy plants of different treatments. At 50 DAS, the tallest plants were observed under the phytopesticidal treatment of mehogoni extract followed by garlic extract. Neem extract, karamja extract and control treatments gave more or less similar heights at this stage. After 75 days of sowing, karamja treated plots produced tallest plants, though mehogoni extract showed almost same performance. At that stage, smallest plants were found in control plot. Similar trends were also found at 100 DAS (Table 2).

It was found that infested plants under the control treatment differed from other phytopesticidal treatments for plant height at all stages of growth (Table 2). Plants under control treatment, was found to be stunted due to the influence of virus. While, in other cases where okra plants were treated with plant extracts, better growth was exhibited. It is thus clear that there was a significant role of plant virus on growth habit of okra and simultaneously phytopesticides played a greater role against the OMV for the continuation of the growth of the plants.

Among the phytopesticides, karamja extract could be considered as the best treatment against OMV for plant height, as karamja treated plants were found to be tallest (11.63, 22.47, 38.85 and 48.61 cm at 25, 50, 75 and 100 DAS, respectively) in all stages. The garlic extract performed better at the earlier stages (12.73 cm at 25 DAS and 23.83 at 50 DAS), but at later stages its performance declined slightly (35.98 cm at 75 DAS and 47.13 at 100 DAS). Infested plants under no phytopesticidal action gave an average height of 9.95, 18.15, 24 and 26.5 cm at 25, 50, 75 and 100 DAS, respectively (Table 2).

Present study thus revealed that virus played a significant role in reducing plant height. On the other hand, phytopesticidal treatments ensured better height than control and was able to reduce the severity of the virus. This was supposed to be due to the reduction of virus incidence by the application of plant extracts and the presence of antiviral activity in the plant extract as observed by Baranwal and Verma (1992 and 1996).

Effect on Fruit Characters

There was a significant role of plant extracts on OMV for fruit characters of okra (Table 2). In all cases, shortest, lightest and lowest number of fruits was produced in plants under no phytopesticidal action.

Among the healthy plants, largest (14.55 cm) and heaviest fruit (17.63 and 17.55 g, respectively) were produced by plants treated with karamja and garlic extracts. Though *neem* extract exhibited best performance in fruit formation (19.73), but statistically similar performance was found in favour of karamja treatment (18.35). It was also revealed that phytopesticides took part in the enhancement of fruit biomass production. Fruits of OMV infested plants of the control plot appeared to be smallest (5.13 cm), lightest (7.475 g) than that of plant extract treated plants. Fruiting was drastically hampered in control plots. On an average only 3.45 number of fruits was produced in plants under no phytopesticidal treatments. While, phytopesticide treated infested plants produced nearly four times as many fruits as that in control plot. Among the plant extracts, karamja was best in all respect due to its role in the production of largest (9.5), heaviest (12.98 g) and maximum fruit formation (12.33) in the infested plant. It is to be added that statistically similar performance for number of fruits per plant was found in neem and mehogoni extracts (12.05 and 12.13, respectively) (Table 2).

It was thus clear that virus caused a severe effect on fruit formation, which was minimized by the application of phytopecticides.

Effect on Yield

It was observed that there was a significant difference among the treatments in both healthy and infested group of plants for yield (Table 2). Phytopesticide treated plants performed better than plants under control. In healthy plants, fruit yield ranged from 0.228 to 0.322 kg plant^{-1} and in OMV infested plant it was 0.026 to 0.156 kg plant^{-1}. In both groups, highest yield was observed in karamja treated plots and lowest in control plants. The difference between the yield of healthy and infested plants indicated that there was a negative influence of OMV on yield of okra. Vanlommel *et al*. (1996) revealed that OMV infestation causes a yield loss of 26%. However, in cowpea a complete loss of yield was also been observed (Kareem and Taiwo, 2007). It was investigated that OMV infested plants of control plots produced 0.026 kg fruit per plant, while neem, karamja, mehogoni and garlic extracts treated OMV infested plants produced 0.127, 0.156, 0.130 and 0.132 kg fruit per plant, respectively. Inference should thus be made that despite of the negative influence of OMV on fruit yield, plant extracts acted as vector or virus inhibiting agents by showing better performance in infested plants, which supports the result of Rajappan *et al*. (2000) in *Rice tungro virus*.

Therefore, it is to be concluded that under no phytopesticidal management virus incidence was highest causing a severe economic loss of yield and nutrition in okra plants. Besides, application of phytopesticides may be a mean of reducing OMV infestation and damage caused by it. The results also give importance on conducting similar works in future both in cellular and molecular levels to investigate the actual facts of the efficacy of phytopesticides against viral infection.

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