Effect of IPM Component on the Infestation of Egg Plant Aphid *Aaphis gossypii* Glover (Homoptera: Aphidae) and Yield of Egg Plant *Solanum melongena* L.

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ABSTRACT

Impacts of planting dates and various other combinations of IPM components on *A. gossypii* Glover infestation and yields of egg plants of two BARI varieties, Nayantara and Kazla was studied in the field. The aphid infestation of both the varieties was very low (6.67-13.33 aphids / plant) and yield was higher (1.10-3.17 kg/plant) on the early planted crops. Aphid infestation on the successive late planting crops of both the varieties gradually increased. Yield of eggplant of both the varieties decreased gradually on mid and late planting plant. Lowest yield (1.07 kg/plant) for two said varieties was recorded in late planting plant.

Key words: IPM, *Aphis gossypii, Solanum melongena*

INTRODUCTION

Brinjal *(Solanum melongena* L.) is one of the most common and important vegetable sources in Bangladesh and occupy second highest place in terms of production following potato (BBS 2018). It is very rich in vitamins and minerals (Kumar *et al*. 2008). The production of this vegetable is seriously affected by two dozen insect pests of which brinjal aphid, *Aphis gossypii* Glover has been considered as major one (Gapud,1992). Both adults and nymphs of the aphid are found to suck sap from the ventral surface of the plant leaves which ultimately causes great damage to the plant and desired production of the crop is adversely affected (Alam,1969). Works on the integrated management of *A. gossypii* is almost nil til to day in Bangladesh. Therefore, an attempt has been made to investigate the effect of some components of IPM *viz*., planting time, variety, insecticides, botanicals, natural enemies, various indigenous materials like kerosinized ash were evaluated separately or in combination with one another on the population of *A. gossypii* and ultimately on yield of brinjal. The findings of this type of research may be helpful to formulate an ideal IPM strategy against a specific pest. These are the objectives of the present study.

MATERIALS AND METHODS

The experiment was carried out at Rajshahi University Campus during rabi 2004-2005. The entire research work was divided into following heads.

Preparation of seed bed

Seed beds were prepared by harrowing, followed by ploughing, cross ploughing and leveling since a sandy loam soil that is fertile, deep and well drained is ideal for egg plant. The size of each bed was 4m long and 1m wide. Cow dung @ 15ton, urea, TSP and MP @ 250, 150, 125 kg respectively per hectare were applied as recommended by Rashid (1993).

Seedling production and transplanting

Certified seeds of two BARI brinjal varieties, Nayantara and Kazla were collected from BARI, Joydebpur, Gazipur. Seeds of each variety were sown in three seedling beds at three different dates *viz*., 1st September (Early sowing), 16th September (Mid sowing) and 1st October (Late sowing). A seedling of forty day-old (3/4 leaf stage) from each bed were transplanted in the soil of experimental earthen tubs of 120 cm diameter and 40 cm deep. Transplanting were done during late afternoon in order to minimize the transplanting shock. Besides, immediately after transplanting soil surface of the tubs were irrigated sufficiently to establish a good root to soil contact. Eighteen tubs were prepared by the seedling of each variety and each sowing date respectively and divided them further into six blocks (T_1 –T_6) i.e. three tubs comprised as a block. Tubs were arranged in such a manner that spacing was maintained as 60 cm between plants and 1 meter between rows. In order to ensure green and healthy conditions of plants, fertilizers including cow dung and irrigation were applied into the soil of the tubs as and when necessary, throughout the investigation period.

Details of treatments

The experiment comprising six treatments including a control and treatments were done considering both the planting date and age of plant. Hence treatment schedule varied from block to block. Sprays operations were conducted when wind velocity was normal and dew drops dried up to avoid insecticidal drift. The gap in between first round and second round treatment were twenty days in each. Each block of the experiment of respective planting date was used for specific type of treatment.

Treatment block T_1 = Nimbicidine (0.03% EC Azadirachtin) @ 4ml/L water (1st round and 2nd round).

Treatment block T_2 = Nimbicidine (0.03% EC Azadirachtin) @ 4ml/L water (1st round) and Bankalmi leaf extract @1:10 W/V (2nd round).

Treatment block T_3 = Larvae of *C. transversalis* (1st round and 2nd round).

Treatment block T_4 = Larvae of *C. transversalis* (1st round) and Bankalmi leaf extract @1:10 W/V (2nd round).

Treatment block T_5 = Kerosinized ash (1st round) and Bankalmi leaf extract @1:10 W/V (2nd round).

Treatment block T_6 = Control, spray water only (1st round and 2nd round).

Nimbicidine (Insecticide)

Nimbicidine is only an organic phytobased insecticide in Bangladesh marked by ACI Crop Care widely used to control rice and vegetable pests. It is systemic in nature and derived from the extract of neem (*Azadirachta indica* Juss) and each liter of nimbicidine contains 0.03% EC

Azadirachtin. It is safe to beneficial and fits thereby excellent to IPM programs. The insecticide was diluted as 4ml: 1000ml @ 2 liter per hectare.

Bankalmi leaf extract (botanical)

Leaves of the plant Bankalmi, *Ipomoea* spp. (Family Convolvulaceae) collected from Rajshahi University Campus were air dried at room temperature (20-34^0 C) and then made into fine powder by a hand grinder. The leaf powder was dissolved in normal water at room temperature for 10 days. The proportion of plant material and water was 1:10 (w/v). The dissolved material was then passed through a fine mesh nylon cloth to separate the extract from the plant debris. The extracted water was then poured into the sprayer and sprayed in block T_2, T_4 and T_5 (Second round) of each experimental block.

Natural enemies release

Five third instar larvae of *C. transvresalis*, (Omker and Parvez, 2000) were released per plant in block T_3 (First round and second round) and T_4 of each field (First round only) with soft brush (0 size).

Kerosinized ash

Certain mineral oils are well known to reduce aphid colonization on plants and thus the transmission of virus diseases (Simons and Zitter, 1980). Accordingly, six tea-spoon of kerosene were mixed with 1 kg of wood ash and applied manually by throwing in block T_5 (First round) of each field.

The control block T_6 was also sprayed with water only at the time of treatment made on other blocks of experiment.

Counting of aphids

The brinjal plants of each block were checked regularly to observe the aphid infestation. Counts were taken after twenty days of each treatment. Altogether three types of leaf (young, mature and old) from each plant of all the blocks were considered for the counting of aphids. The plants observed once were not taken for subsequent observation. In case of thick colonies aphids were taken carefully on a white plastic plate from the infested leaves by means of a soft camel hair brush (0 size), counted and thereafter they were placed back to the same place of the plant.

Yield counting

The number of brinjal per plant from all the blocks was collected and their weight was recorded. Usually, the very immature and abnormal brinjal were not recorded.

Data recording and analysis

Data base upon both the number of aphids (Nymphs and adults) and crop yield per plant was averaged and plotted in Table 1&2 respectively. Percent increase in yield over control in various treatments are also shown in Table in 3. Mean data expressed in counting aphid density and crop yield was analyzed statistically by analysis of variance (ANOVA) to test the significance in difference among the treatments. Mean separation was done by Duncan's Multiple Range Test (DMRT) at 0.05 probability level. All statistical works were done with the help of Statistical Software, SPSS (Ver. 11.5).

Table 1. Number of brinjal aphid, *Aphis gossypii* Glover after two rounds of treatment.

Field based on planting date	Crop variety	Mean number of aphids with standard error (Mean± S.E) / plant											
		1st round treatment						2nd round treatment					
		T_1	T_2	T_3	T_4	T_5	T_6	T_1	T_2	T_3	T_4	T_5	T_6
A Early planting 01.09.2004	Nayantara	7.00± 0.58**b**	6.00± 0.00**b**	11.67± 2.40**ab**	5.33± 2.73**b**	8.33± 3.33**b**	20.00± 5.00**a**	6.00± 3.00**a**	6.00± 3.00**a**	6.00± 3.00**a**	6.00± 3.00**a**	6.00± 3.00**a**	6.00± 3.00**a**
	Kazla	6.67± 1.45**a**	6.67± 1.45**a**	6.67± 1.45**a**	6.67± 1.45**a**	6.67± 1.45**a**	6.67± 1.45**a**	18.33± 1.20**a**	18.33± 1.20**a**	18.33± 1.20**a**	18.33± 1.20**a**	18.33± 1.20**a**	18.33± 1.20**a**
B Mid planting 16.09.2004	Nayantara	22.33± 5.36**ab**	22.33± 5.36**ab**	22.33± 5.36**ab**	22.33± 5.36**ab**	22.33± 5.36**ab**	22.33± 5.36**ab**	27.50± 10.20**a**	27.50± 10.20**a**	27.50± 10.20**a**	27.50± 10.20**a**	27.50± 10.20**a**	27.50± 10.20**a**
	Kazla	20.00± 2.89**ab**	20.00± 2.89**ab**	20.00± 2.89**ab**	20.00± 2.89**ab**	20.00± 2.89**ab**	20.00± 2.89**ab**	30.00± 11.50**ab**	30.00± 11.50**ab**	30.00± 11.50**ab**	30.00± 11.50**ab**	30.00± 11.50**ab**	30.00± 11.50**ab**
C Late planting 01.10.2004	Nayantara	26.67± 1.67**ab**	26.67± 1.67**ab**	26.67± 1.67**ab**	26.67± 1.67**ab**	26.67± 1.67**ab**	26.67± 1.67**ab**	40.00± 5.77**ab**	40.00± 5.77**ab**	40.00± 5.77**ab**	40.00± 5.77**ab**	40.00± 5.77**ab**	40.00± 5.77**ab**
	Kazla	30.00± 2.89**ab**	30.00± 2.89**ab**	30.00± 2.89**ab**	30.00± 2.89**ab**	30.00± 2.89**ab**	30.00± 2.89**ab**	30.00± 11.50**a**	30.00± 11.50**a**	30.00± 11.50**a**	30.00± 11.50**a**	30.00± 11.50**a**	30.00± 11.50**a**

- All figures are mean of three replications
- Means having the same letters in a raw are not significantly different at 0.05 probability level by DMRT

Table 2. Yield (Mean ± S.E.) of brinjal (kg/plant) in terms of planting date, variety and treatments.

Date of sowing	Crop variety	Treatments					
		T_1	T_2	T_3	T_4	T_5	T_6
Early planting 01.09.2004	Nayantara	3.17±0.17**a**	3.00±0.00**a**	2.58±0.30**a**	2.50±0.02**a**	2.00±0.29**ab**	1.67±0.17**a**
	Kazla	2.10±0.06**c**	2.00±0.00**b**	1.75±0.14**bc**	1.42±0.22**b**	1.17±0.08**c**	1.10±0.10**a**
Mid planting 16.09.2004	Nayantara	2.97±0.03**a**	2.67±0.33**a**	2.50±0.00**a**	2.33±0.17**a**	2.17±0.17**a**	1.67±0.33**a**
	Kazla	2.00± 0.00**c**	1.77±0.12**b**	1.57±0.03**c**	1.37±0.03**b**	1.33±0.03**c**	1.07±0.12**a**
Late planting 01.10.2004	Nayantara	2.53±0.03**b**	2.17±0.17**b**	2.33±0.33**ab**	2.33±0.09**a**	2.07±0.07**ab**	1.63±0.32**a**
	Kazla	1.93±0.07**c**	1.90± 0.06**b**	1.70±0.06**c**	1.60±0.06**b**	1.60±0.06**c**	1.07±0.07**a**
		P=.000 F=43.818	P=.001 F=8.898	P=.008 F=5.349	P=.000 F=18.145	P=.001 F=8.207	P=.115 F=2.255

- All figures are mean of three replications
- Means having the same letters in a column are not significantly different at P<0.01 and P<0.001 probability level by DMRT

Figure1. Brinjal plants (Variety Naayantara)

Figure2. Brinjal plant lant (variety Kajla).

Table 3: Percentage of increase (%) in yield over control (T_6) in various treatments for BARI brinjal, Nayantara and Kazla.

Date of sowing	Crop variety	Treatments				
		T_1	T_2	T_3	T_4	T_5
Early planting 01.09.2004	Nayantara	89.82	79.64	54.49	49.7	19.76
	Kazla	90.91	81.82	59.09	29.09	6.36
Mid planting 16.09.2004	Nayantara	77.84	59.88	49.7	39.52	29.94
	Kazla	86.91	65.42	46.73	28.03	24.29
Late planting 01.10.2004	Nayantara	55.21	33.13	42.94	42.94	26.99
	Kazla	80.37	77.57	58.88	49.53	49.53

RESULTS

Nayantara brinjal is rounded in shape and its color is bright purple. On an average twenty to thirty brinjals were produced by a single plant and weight of each brinjal varies from 120 gm to 130 gm. First harvesting was done within eighty to eighty-five days of planting. The shape of Kazla brinjal on the other hand is moderately elongated and blackish purpled colored. Seventy to eighty brinjals produced per plant and weight of each brinjal varies from 55 gm to 60 gm. After sowing, ninety to ninety-five days are needed to produce brinjal by the variety Kazla. Effect of various treatments on the mean member of aphids per plant after twenty days of each treatment and finally on yield in two varieties under three sowing dates have been plotted in Table 1-2. Among all the treatments, highest aphid population and minimum yield per plant were recorded in controlled block (T_6) irrespective of varietal difference and planting date. However, two times insecticide spray provided better effect on aphid population reduction and consequently on

highest yield in early, mid and late sowing fields of two varieties compared to other treatments. Insecticide plus botanical treated block (T_2) stood in second position in aphid population reduction. Two times treatment by natural enemies (block T_3), one-time natural enemies plus one-time botanical treated block (block T_4) and one time kerosinised ash plus one-time botanical treated block (block T_5) reduced aphid numbers and produced significantly different yield in comparison to untreated (controlled) blocks.

In case of early planting fields of the variety Nayantara as shown in Table 2, highest yield of brinjal (3.17±0.17 kg/plant) was found in two times insecticide treated blocks (ET_1) and it was 89.82% increase in yield over control (Table-3). This was followed by 79.64%, 54.49%. 49.70% and 19.76% (table-3) in the blocks having treatment by one time insecticide plus one-time botanical treated block (ET_2), two times natural enemies treated block (ET_3), one-time natural enemies plus one-time botanical treated block (ET_4) and one time kerosinised ash plus one-time botanical treated block (ET_5) respectively. Similar trends of yield of brinjal may be noticed in mid and late planting blocks of the same variety.

On the other hand highest production (2.10±0.06 kg/plant) of Kazla brinjal was recorded from two times insecticide treated block of early planting block (ET_1) followed by one time insecticide plus one time botanical treated block (ET_2), two times natural enemies (ET_3), one time natural enemies plus one time botanical (ET_4) and one time kerosinised ash plus one time botanical (ET_5) respectively. Regarding yield the mid and late planting fields of the same variety also produced similar results (Table 2). Statistical analysis also revealed that yield of brinjal differed significantly ($P<0.01$ and $P<0.001$) within specific treatment blocks of early, mid and late sowing fields of both varieties (Table 2). Aphid population was comparatively higher in mid and late planting field than that of early planting.

Percent increase in yield over control in various treatments is also shown in Table 3. *A. gossypii* attack the lower surface of the leaves and its number was comparatively higher in matured leaves those received less sun light.

DISCUSSION

This study has demonstrated that aphid incidence and the associated yield affected variously because of various IPM treatments. Das (2001) carried out an experiment on IPM of aphid pest on eggplant but his experiment was confined within only two treatments *viz*., two sprays of recommended insecticide and one spray of insecticide plus one time release of natural enemies along with sowing date alteration. A significant ($p<0.001$) difference was observed between controlled and treated crops but no difference could be recognized between two sprays and one time release of natural enemies (Das, 2001). Veeravel and Jeganathan (2006) did an experiment with certain plant products *viz*., leaf extract of *Datura alba*, *Pongomia pinnata*, *Parthenium hysterophorus*, *Ipomea carnea*, flower extract of *Calotropis procera*, flesh extract of *Agave americana*, seed extract of *datura alba* and Neem oil against *A. gossypii* infesting brinjal (Var. LAR 5166) at experimental farm of Annamalai University, Tamil Nadu, India. The concentrations of above photochemical were as 1, 3, 1, 10, 5, 2.5, 1 and 1 percent respectively. They sprayed these photochemical three times at 15 days intervals. Among the treatments the neem oil gave the maximum mean percentage reduction of 47.87, 53.37 and 47.08 aphids and *C. procera* flower extract gave the least control of 19.49, 21.25 and 23.07 aphids in the first, second and third trails respectively. Butler *et al*.(1988) tested soybean and cotton seed oils against *A. gossypii* in green house condition and reported that foliar sprays of the oils reduced nymphal and adult populations remarkably. Fiume (1993) tested biological and integrated control methods against *A. gossypii* on peppers and obtained best results with integrated control which combined

chemical (Methomyl) and biological (*Verticililum spp*) methods which is in good agreement with the present findings. From the residual toxicity test of eight insecticides using *A. gossypii* on cotton, Nagia *et al*., (1989) revealed that Cypermethrin, Fenvalerate, Deltamethrin and Permethrin remained active for about 10 days and giving aphid mortality between 61-86%. Monocrotophos, Endosulphan, Chlorpyriphos and Methyl Paration were effective for 14,10,8 and 4 days giving insect mortality of 96.4%, 79.3%, 62.9% and 83.3% respectively. Semada *et al*.,(1993) have shown that *A. gossypii* attacked the lower surface of unfurled leaves, especially in lower regions of the plants and was present for 8 and 5 weeks with 62.7 and 30.3 aphids/ square inch on maize crops planted on May 15 and June 15 respectively. The reason for more aphids in matured leaves in the lower part of the plant is probably due to the favorable microclimate for an aphid not for its natural enemies (Coaker, 1987).

Water and nitrogenous compounds are relatively high in young leaves and decline with leaf maturation (Scriber, 1984). Monophagous and oligophagous herbivores often show a strong preference for the more nutritious younger tissues that are also high in toxins, whereas polyphagous herbivores demonstrate a strong preference for the less nutritious mature leaves (Evans,1984). Therefore, the highest population of *A. gossypii* on matured leaves might also be due to its polyphagous nature. Besides, the present observation was close to the observation of Raupp and Denno (1983) who reported that plant leaves under full sunlight are generally less attractive to aphids than those in shade though the nitrogen content may be higher. Webb (1994) did an experiment for the protection of squash from *A. gossypii* through various control measures and found that mineral oil in combination with Bifenthrin was very effective. Nagia *et. al.*(1994), suggested from their experiment , Dimethoate 30 EC and Oxydemeton methyl 25 EC may used either alone or in combination for the control of *A. gossypii* and *Myzus persicae* (Sulz.) when they occur simultaneously on potato. Jarande and Dethe (1994) carried out an experiment on brinjal sucking pests and showed that imidacloprid was highly effective in reducing the incidence of aphids, whiteflies and jassids on brinjal and increasing in seedling height and total leaf chlorophyll over those of untreated plants. However, results of the present study tend to agree with the results of previous studies conducted by Das (2001) who reported that population of *A. gossypii* was significantly ($p<0.05$) lower on the early sowing transplanted egg plants than those of mid and late planting plants. Finally, it could be concluded that in combination of appropriate planting time with minimum insecticide plus botanical or natural enemies release technique may be applied to control the population of *A. gossypii* in the field under economic threshold level and higher economic return.

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