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SUGARCANE WOOLLY APHID, *CERATOVACUNA LANIGERA* - AN INVASIVE PEST OF SUGARCANE AND ITS MANAGEMENT IN BANGLADESH

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Abstract

Study was conducted in homestead garden of Patuakhali Science and Technology University (PSTU) campus, Patuakhali during the period from November 2016 to October 2017. Results revealed that the length and width of the apterous adult female was 1.76 mm and 1.06 mm, respectively while the length and width of the alate adult was 2.09 mm and 6.4 mm, respectively. The nymphal stage varies from 15.8 (minimum) days to 32 (maximum) days of apterous, whereas of alate form the period is little longer, up to 40 days. The maximum population density of woolly aphid was observed in vegetative stage (47.12/2.5 sq.cm.) and the lowest population density was recorded in seedling stage (7.23/2.5 sq.cm.). The highest percent leaf area occupied by sugarcane woolly aphid was observed at vegetative stage (58.13%/leaf) and the lowest percent leaf area occupied by sugarcane woolly aphid was recorded in seedling stage (27.14%/leaf). No significant difference was found among leaves treated with 4 insecticidal treatments. But the lowest number (0.33 aphid/sq. cm) of woolly aphid per square cm area was found in leaf treated with Biotap plus extra 95EC @ 0.2 g/L of water followed by T4 (0.67 aphid/sq. cm) where Fija 70WG @ 0.074 g/L of water was sprayed. The highest number of woolly aphid was observed in untreated control treatment (41.33 woolly aphid/sq. cm). The highest percent reduction (99.20%) of woolly aphid over control was found in leaves treated with Biotap plus extra 95EC @ 0.2 g/L of water. Likewise, the percent reduction of leaf area occupied by woolly aphid was recorded maximum (99.41%) in leaves treated with Biotap plus extra 95EC @ 0.2 g/L of water while minimum percent (98.20%) was in leaves treated with Voliam flexi 300SC @ 0.5 ml/L of water. Application of Biotap plus extra 95EC @ 0.2 g/L of water could be the best treatment for the management of sugarcane woolly aphid.

Key words: sugarcane, woolly aphid, damage, incidence, insecticide.

Introduction

Sugarcane, *Saccharum officinarum* is an important cash crop of Bangladesh and it is the main source of processed sugar. It plays pivotal role in both agricultural and industrial economy of the country. Greater attention is given only in improving the sugar cane yield and not much in managing the cane trash. Sugarcane yield is markedly influenced by

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many factors like soil fertility, climate, variety, and cultural practices, prevalence of pests and diseases as well as environmental stress (Kumar and Pal, 2019). Among them, insect pests are known to cause considerable yield loss in sugarcane yield as well as sugar content. As sugarcane is a long duration crop of 10-18 months and therefore is liable to be attacked by a number of insect pests and diseases (Kumar and Pal, 2019). In sugarcane ecosystem the pests are classified into three categories *viz.*, internode bores, sucking pests and soil inhabiting pests. Internode borers like *Chilo infuscatellus* Snell (early shoot borer), *Scirpophaga excerptalis* Walker (top shoot borer), *Chilo sacchariphagus indicus* Kapur (internode stem borer), sucking pests are *Ceratovacuna lanigera* Zehnter (woollyaphid), *Pyrilla perpusilla* Walker (sugarcane leaf hopper), *Saccharicoccus sacchari* Cockerel (mealy bug), *Melanaspis glomeratus* Green (scale) and soil inhabiting pests like *Odontotermes obesus* Rhamb (termite) and *Holotrichia serrata* Fabricus (root grub) are the important pests of sugarcane in Indian situations (Vasantharaj and Ramamurthy, 2011). According to an estimate, sugarcane production declines by 20.0 and 19.0% by insect pests and diseases, respectively. Among the various factors, incidence of insect pests plays a vital role for low productivity and sugar recovery. About 103 insects were associated with sugarcane crop (Patil *et al*., 2007). Economical loss in sugarcane has been estimated to be 20 % in cane yield and 15 % in sugar recovery due to the ravages of the insect pests (Patil *et al*., 2011). Among different insect pests of sugarcane, sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner (Hemiptera: Aphididae), is one of the most destructive insect pests of sugarcane (Patil *et al*., 2007). It is a major leaf pest of sugarcane. The species is currently distributed in India, Nepal, Bangladesh, east and south-east Asia, Fiji and the Solomon Islands (Joshi and Viraktamath, 2004). It affects both the yield and quality of sugarcane in China. In India it has been reported from both tropical (Maharashtra, Karnataka, Gujrat, Andhra Pradesh and Tamilnadu) and subtropical belts (Assam, Nagaland, Tripura, Uttranchal, westen Uttar Pradesh and Haryana). Woolly aphid earlier was known to be minor pest in India has now assumed the status of economic pest after its severe outbreak in Maharashra during July 2002. The sugarcane woolly aphid bears huge content of white coloured woolly coating around it. Developed colonies looked like a white woolen mass and that is why this aphid is referred to as woolly aphid. It is often mistaken for a mealybug. Adult and nymphs of the sugarcane woolly aphid gather on the underside of leaves and suck the sap from the leaves (Girija 2012). The pests feed voraciously and convert excess sugar into honeydew. They produce honeydew that covers the entire upper surface of the leaf which causes the growth of sooty mold (Girija, 2012). This interrupts the plant's ability to photosynthesise and so results in a weaker plant with a reduced yield (Girija, 2015). The sugarcane plants wilt and gradually dry up from the tip downwards due to continuous

infestation and sap sucking from the leaves. This eventually leads to the reduction of the length, girth, and weight of the sugarcane, as well as the quality, yield, and sugar content (Patil *et al.*, 2011, Mukunthan *et al*., 2008). Management of agro-ecosystem which discourages the pest build-up like balanced use of fertilizers, avoiding excess irrigation, proper drainage, inter cropping and planting of least susceptible/resistant varieties (Joshi and Viraktmath, 2004). Use of less hazardous insecticides such as Metasystox 20 EC or endosulfan 35 EC @ 0.05% spray at 15-20 days interval where natural enemies are prevalent (Joshi and Viraktmath, 2004). No research report on incidence, damage severity and control of sugarcane woolly aphid is available in Bangladesh. Therefore, the present study has been undertaken to know the incidence pattern and damage of woolly aphid, and also to find out suitable chemical insecticide for controlling this pest.

Materials and Methods

Study was conducted in homestead garden of Patuakhali Science and Technology University (PSTU) campus, Patuakhali during the period from November 2016 to October 2017. The measurement of different stages of woolly aphid was performed by using stereo zoom trinocular microscope. The incidence and damage by woolly aphid on sugarcane leaves were observed from seedling to reproductive stages. Observations on the population of woolly aphid were recorded on 2.5 square cm area of sugarcane leaf in three randomly selected leaves per plant. The percentage of leaf area occupied by woolly aphid was measured on eye estimation. In case of control, there were five treatments viz., T_1 = Voliam flexi 300SC @ 0.5 ml/L of water, T_2 = Bioneem plus 1EC @ 1 ml/L of water, T_3 = Biotap plus extra 95EC @ 0.2 g/L of water, T_4 = Fija 70 WG @ 0.074 g/L of water and T_5= Untreated control. In this case, three leaves from each plant were used as three treatment replications for the application of each treatment. Data were also recorded on number of woolly aphid and leaf area occupied by woolly aphid. The percent reduction of woolly aphid and leaf area was calculated by following formula:

$$\% \text{ reduction over control} = \frac{\text{Control-treatment}}{\text{Control}} \times 100$$

Statistical analysis: Data were analyzed statistically following the analysis of variance (ANOVA) using WASP 1.0 software program. Means were separated by CD (critical difference) values.

Results and Discussion

Biology and characteristics of sugarcane woolly aphid

Different life stages of sugarcane woolly aphid is illustrated in Plate 1**.** Alate females produced first instar nymphs which were relatively active, had long and elliptical bodies. They were pale greenish white in colour. But apterous females produced first instar nymphs which were pale yellowish white in colour, had elongated ovoid bodies (0.75 mm length and 0.38 mm width). The dorsum was gradually covered by a white powdery secretion due to the development of nymph. Developed colonies looked like a white woollen mass, hence this aphid is referred to as woolly aphid (Table 1).

The length and width of the apterous adult female was 1.76 mm and 1.06 mm, respectively with broad, very soft, laterally depressed body which was densely covered by white, cotton like secretions. Its 5^{th} and 6^{th} segments of abdomen had circular cornicles through which it secretes waxy substance (Table 1).

Likewise, the length and width of the alate adult was 2.09 mm and 6.4 mm, respectively with expended wings. The head was black with enlarged brick red eyes (Table 1). The antennae had two thick basal segment and a flagellum composed of four segments. The legs had two tarsal segments with paired claws. The fore wing was very large and had 3 oblique veins emerging from subcostal vein. The hind wing was small with 2 oblique veins. Depending upon the temperature and relative humidity the nymphal stage varies from 15.8 - 16.5 (minimum) days to 23 - 32 (maximum) days of apterous, whereas of alate form the period is little longer, up to 40 days (Table 1).

Table 1. Characteristics of sugarcane woolly aphid.

Stages of woolly aphid	Size (mm)		Colour
	Length	Width	
Nymph	0.75 ± 0.2	0.38 ± 0.1	Pale greenish white
Apterous adult female	1.76 ± 0.6	1.06 ± 0.3	White
Alate adult	2.09 ± 0.5	6.4 ± 0.7	Head is black with brick red eyes
	Duration (Day)		
	Minimum	Maximum	
Apterous nymphal stage	15.8 - 16.5	23 - 32	
Alate nymphal stage		35-40	

Apterous females reproduced parthenogenetically giving birth directly to nymphs (Joshi and Viraktamath, 2004). In Woolly aphid thaleotoky type of parthenothenesis reproduction occurs where they reproduce viviparously. Immediately after ovulation, ova starts to develop within a viviparous reproducing female indicating that an embryo can exist inside another larger and mature embryo. These mode of reproduction provide an exceedingly rapid turnover of generations.

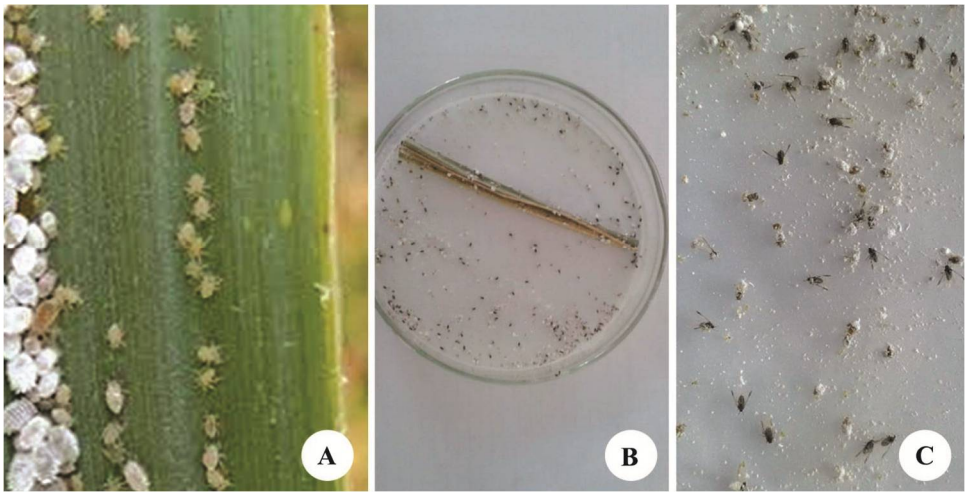

Plate 1. Different life stages (A- Nymphs, B-Adults, C-Adults in enlarged form) of sugarcane woolly aphid.

Incidence of sugarcane woolly aphid

Mean number of sugarcane woolly aphid per 2.5 square cm area in different growth stages of cane is presented in Fig. 1 and Plate 2. The maximum population density of woolly aphid was observed in vegetative stage (47.12/2.5 sq.cm.) which was followed by early vegetative stage (22.34/2.5 sq.cm.). The lowest population density was recorded in seedling stage (7.23/2.5 sq.cm.) and was followed by reproductive stage (12.68/2.5 sq. cm.), respectively.

Generally, the incidence of woolly aphid, scales and natural enemies was not appeared during seedling stage of crop since it requires cold climate and high relative humidity (80-95) and moderate temperature (19 to 30^0C). The colonies started developing in November and December and then gradually increased during winter, with phenomenal increase during summer. Measurements of the colony increased with decrease in

temperature from December to February. The pest population starts increasing in February and reaches its peak in April-June and decreases subsequently due to rains. The population peaked between the second half of April and the second half of June. Heavy precipitation coupled with high temperatures was the factors causing decline in the aphid population. The results are in conformity with Patil *et al*., (2003) who reported that the average population of sugarcane woolly aphid was 5.3 per 5 cm^2 leaf area during the month of July with corresponding leaf infestation being 42.11 per cent. Ghorpade *et al*., (2006) reported that the activity of sugarcane woolly aphid was started in the month of September and reached peak in the month of December. Thakur (2007) reported that apterous forms of *C. lanigera* showed maximum activity from mid October, 2003 to end of January, 2004 and their population vanished in May, 2004 and the late forms were appeared in first fortnight of July, 2003 and remained active till March, 2004 but the activity of predator, *D. aphidivora* was maximum (2.67/leaf/plant) in second fortnight of February, 2004. The incidence of Sugarcane Woolly Aphids was found sever in the months of September, October and November, 2011, but later on with increase in maximum temperature and decrease in relative humidity in the month of December, the population of woolly aphids declined (Mane *et al*., 2016).

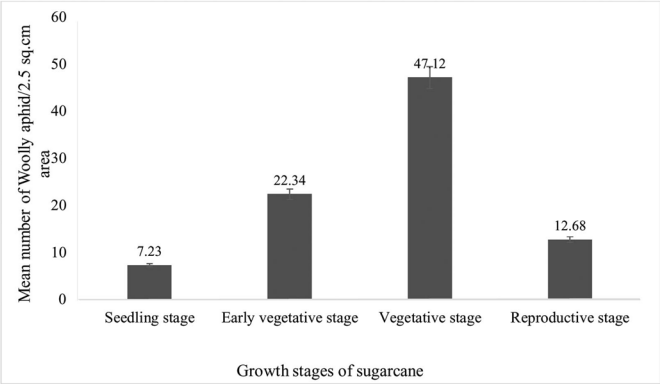

Fig. 1. Mean number of sugarcane woolly aphid at different growth stages of cane

The aphid emerged before sunset and continued to emerge until early morning (Arakaki, 1989). This probably helped aphids to escape desiccation due to high day temperatures. The incidence of this pest starts immediately after rainy season and becomes severe during summer and when there are prolonged dry spells coupled with high relative humidity. Therefore, more population density of woolly aphid, scales and natural enemies

was gradually increased during vegetative stage (Shruthi *et al*., 2018). While, incidence of sucking pests: pyrilla, derbid plant hopper, woolly aphid and mite were recorded as 0.92 per leaf, 4.2 per plant, 7.17 per leaf and 11.25%, respectively. Similar trend was also observed during 2018-19.

The incidence of stem borer, wooly aphid, pyrilla, grasshopper and mite occurs in July to February. The average incidence ranged from 1.86 to3.51 woolly aphids per leaf during 2017-18. During 2018-19, its average incidence ranged from 1.77 to 4.96 per leaf and the maximum incidence of 12.27 wooly aphids per leaf at village Salmara. The incidence started from August and continued up to February and reached the maximum during October till December. Rabindra *et al.* (2002) reported that serious infestation by the sugarcane woolly aphid, *C. lanigera*, on the leaves of 4 to 9 month old sugarcane plants was observed in Kolhapur and Pune districts of Maharashtra in September-October 2002.

The pest is transmitted by wind as well as by the transportation of sett and cane from an affected field to other areas. The pest survives on the ratoon crop as well as on hosts like grasses and banana during the off season. Rao *et al*., (2009) made roving survey in sugarcane fields both in planted and ratoon crops revealed that, among various and insect and non-insect pests, early shoot borer, internode borer, scale insect and mealybugs were considered as key pests, while whitefly, pyrilla, woolly aphid, red mite, yellow mite, white grub, termites and grasshoppers as localized pests and they also opined that, the suitable surveillance periods for different sugarcane pests i.e. March to May for early shoot borer, mealybugs and red mite, june to august for grasshopper, internode borer and yellow mite and June to October for grasshoppers, root grub, scale insect, termites, whitefly and woolly aphid.

Plate 2. Incidence pattern of sugarcane woolly aphid (cottony growth of woolly aphid on sugarcane leaf)

Damage severity by sugarcane woolly aphid

The average percentage of leaf area occupied by sugarcane woolly aphid at different growth stages of cane is presented in Fig. 2 and Plate 3. The highest percent leaf area occupied by sugarcane woolly aphid was observed at vegetative stage (58.13%/leaf) which was followed by early vegetative stage (43.41%/leaf). The lowest percent leaf area occupied by sugarcane woolly aphid was recorded in seedling stage (27.14%/leaf) and was followed by reproductive stage (36.32%/leaf) respectively.

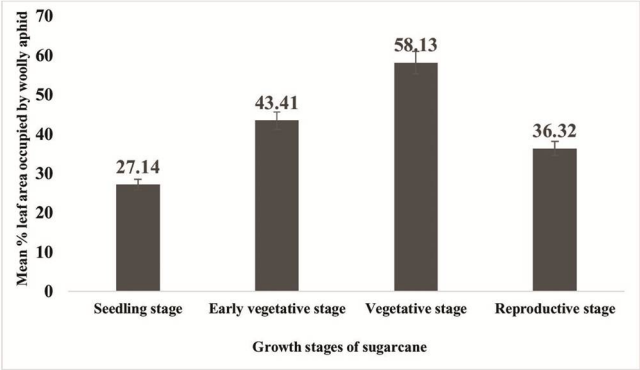

Fig. 2. Percentage of leaf area occupied by woolly aphid at different growth stages of sugarcane.

Plate 3. Damage severity of sugarcane woolly aphid.

The findings of the present study are supported by several authors who stated that both nymphs and adults of woolly aphid suck the cell sap from lower surface of leaves. They suck the sap from phloem by inserting their stylets through the stomata of the plants

leaves. Cell-sap concentration was a major factor in inducing susceptibility in different cane varieties (Yamazaki and Arikado, 1939). Mature leaves were more prone to aphid attack compared to young leaves (Uichanko, 1928). Takano (1937) observed that narrow and erect leaves were affected to a great extent while Patil (2002) found that soft, broad and drooping leaves were more suitable for aphid build-up. They excrete huge amount of honey dew on the leaves which provide a sticky coating on leaves that favours black sooty mould (*Capnodium* sp.) develops making the leaves look all black. The white powder on the ground and leaves confirms the presence of the aphids. If uncontrolled, it spreads very quickly and can cause yield losses of up to 20% (Girija, 2012). Due to the thick coating of sooty mould process of photosynthesis is significantly hampered in severely infested plants, thereby, considerable reduction in cane yield (25%) and sucrose content (26.71%), whereas, during the early growth period plants may die (Patil *et al*., 2011; Mukunthan *et al*., 2008). From above results it can be concluded that, occurrence of woolly aphid decreased during reproductive stage. Because cane become hard and sap is not available for survival of sucking pests so reduced during reproductive stage.

Management of sugarcane woolly aphid

The effect of selected insecticides on sugarcane woolly aphid at vegetative stage is presented in Table 2 and Plate 4. The lowest number (0.33 aphid/sq. cm) of woolly aphid per square cm area was found in leaf treated with Biotap plus extra 95EC @ 0.2 g/L of water followed by T_4 (0.67 aphid/sq. cm) where Fija 70 WG @ 0.074 g/L of water was sprayed. However, no significant difference was found among the treated leaves. The highest number of woolly aphid was observed in untreated control treatment (41.33 woolly aphid/sq. cm). The highest percent reduction (99.20%) of woolly aphid over control was found in leaves treated with Biotap plus extra 95EC @ 0.2 g/L of water followed by T_4 (98.38%) while the lowest percent reduction (96.78%) of woolly aphid over control was found in leaves treated with Voliam flexi 300SC @ 0.5 ml/L of water followed by T_2 (97.58%) where Bioneem plus 1EC @ 1 ml/L of water was sprayed. In case of percent leaf area occupied by woolly aphid, similar trend was also observed

where the lowest percent leaf area occupied (0.33 %) by woolly aphid was recorded in leaves sprayed with Biotap plus extra 95EC @ 0.2 g/L of water and the highest percent leaf area occupied (55.67%) by woolly aphid was recorded in leaves without spraying (T_5).

Table 2. Effect of selected synthetic insecticides on sugarcane woolly aphid at vegetative stage

Treatment	No woolly aphid/2.5 sq cm area	% reduction over control	Leaf area occupied by woolly aphid (%)	% reduction of leaf area occupied by woolly aphid over control
T_1 = Voliam flexi 300SC @ 0.5 ml/L of water	1.33b	96.78	1.00b	98.20
T_2 = Bioneem plus 1EC @ 1 ml/L of water	1.00b	97.58	0.67b	98.80
T_3 = Biotap plus extra 95EC @ 0.2 g/L of water	0.33b	99.20	0.33b	99.41
T_4= Fija 70 WG @ 0.074 g/L of water	0.67b	98.38	0.67b	98.80
T_5= Untreated control	41.33a	-	55.67a	-
CD (1%)	2.20		3.24	
CV (%)	13.08		14.76	

Values are average of three replications.

Plate 4. Leaves of sugarcane treated with selected insecticides (4 treatments).

The percent reduction of leaf area occupied by woolly aphid was recorded maximum (99.41%) in leaves treated with Biotap plus extra 95EC @ 0.2 g/L of water while minimum percent (98.20%) was in leaves treated with Voliam flexi 300SC @ 0.5 ml/L of water. The percent reduction of woolly aphid population ranged from 96.58 to 99.20% and leaf area reduction ranged from 98.20 to 99.41%, respectively. These results are in conformity with Patil *et al.* (2004) and Shankar and Shitole (2004) who found that soil application of phorate 10G @ 2.5 and 3.0 kg a.i./ha reduced the aphid population to the tune of 90 per cent.

Conclusions

The length and width of alate adult was higher compared to apterous adult female. The maximum population density and the highest percent leaf area occupied of woolly aphid was observed at vegetative stage than those of seedling and reproductive stages. The highest percent reduction of woolly aphid and its damage was recorded in leaves treated with Bitap extra plus 95EC @ 0.2 g/L of water at vegetative stage.

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