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Cotton Leafhopper in the Philippines: A Review

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The cotton leafhopper, *Amrasca biguttula* Ishida is one of the serious pests of cotton in the Philippines. Heavy infestation of cotton leafhopper on cotton impairs growth, and reduces number of bolls and seedcotton yield from 40 to 100 percent. Information available about this cotton pest in the Philippines is reviewed in this paper. Its taxonomy, distribution, life history, ecology, phenology and control measures are discussed.

Keywords: taxonomy, life history, ecology, phenology, control measures

The cotton leafhopper, *Amrasca biguttula* Ishida, is one of the major insect pests of cotton in the Philippines (Gabriel, 1975). It attacks the cotton plant by sucking the sap on the lower surface of leaves, between veins. The damage of the insect is popularly known as hopper burn of the leaves causing mechanical injury, loss of sap and injection of toxic saliva in plant tissues. Leaves become yellow, then deformed and curled, and in severe infestation, turn brick red or brown and dry up.

As early as 1935, the cotton leafhopper has been a limiting factor in profitable cotton production (Otanes and Butac, 1938). Heavy infestation of cotton leafhopper impairs growth, and reduces number of bolls and seedcotton yield from 40 to 100 percent (Pascua, 1989). Cotton attacked by cotton leafhopper at the seedling stage could not recover (Cendana and Baltazar, 1947).

Taxonomy and Distribution

The cotton leafhopper, Genus *Empoasca,* has 27 species attacking cotton throughout the world (Hargreaves, 1948). Its identity has created much confusion since it was named in 1912 by Shiraki (Merino, 1936). Other synonyms include *Chlorita bimaculata* Matsumura 1917; *C. biguttula* Ishida, 1913; *Empoasca flavescens* Fabricus; *E. devastans* Distant 1918; *E. depunctata* Schumacher, 1915; *E. nigropunctata* Merino, 1936. The first Philippine species of Typhlocybinae, *Empoasca flavescens* (Fabricus) was recorded in cotton and eggplant (Woodworth, 1921 and 1922) and also reported by succeeding workers like Otanes and Butac (1938 and 1939) and Merino (1936). Capco (1957) used *Empoasca biguttula* (Matsumura) and later by Baltazar (1968). Gabriel (1975) adopted the change and implied that *E. flavescens* was *E. biguttula*. The generic name was changed from *Empoasca* to *Amrasca* (Kapoor and Sori, 1972) and the latter is presently being adopted.

Amrasca biguttula belongs to order Hemiptera, suborder Homoptera, family Ciccadelidae and the subfamily Typhlobinae. It is small, slender, possesses four apical cells in the forewings and has one or more rows of spines on the hind tibiae. It is found everywhere in the Philippines, being a pest of different major crops.

Life History and Other Features

Cotton leafhopper undergoes simple metamorphosis. Nymphs are wingless while adults are winged although both live in the same habitat. The principal changes during their growth are only in size, body proportion and development of ocelli. Their wings develop externally

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and both stages have compound eyes (Borror et al., 1971). Cendana and Baltazar (1947), Obien (1985) and Embuido (1985) studied the developmental stage of cotton leafhopper and slight variations were observed (Table 1).

Table 1. Developmental period of cotton leafhopper.

Stage	Developmental Period (days)		
	Baltazar & Cendana (1947)	Obien (1985)	Embuido (1985)
Egg			6-10
Nymph	13-15	11-17	8-11
Adult	3-19	13-15	10-15

Schmutterer (1978) described the features of the cotton leafhopper during its developmental stages namely:

Egg It is banana shaped, whitish to bluish-white and about 0.5 mm long, 0.1 mm wide

Nymph It has five nymphal instars. First four nymphal instars are similar to the last instar but smaller

Last nymphal instar It is about 2.0 to 2.4 mm long and 0.5 to 0.6 mm wide. Its body shape is similar to that of an adult but smaller in size and without developed wings. The color is greenish to yellowish.

Adult Its body is 2.5 to 3.0 mm long, yellowish to yellowish-green in color. The forewings are shiny and with a conspicuous dark spot on the posterior half. The tibiae of the hind legs are equipped with numerous strong setae.

Ecology

The adult cotton leafhopper stays in the plant anytime of the day and is very active at mid-morning to search for convenient feeding and oviposition sites. Both adult and nymph are located mostly at fully expanded young leaves of the upper one-third of the cotton plant.

The female lays its eggs singly about 20 to 600 eggs in petioles, main vein of the leaf and even in the young stem but prefers young leaves. After hatching, the active and destructive nymph starts sucking the plant sap usually at the lower surface of the leaf, with as many as 34 nymphs staying in a single leaf.

The nymph stays at the undersurface of the leaf where it was previously laid, seldom transfering to other leaves. It stays here for feeding and protection until adult stage. In few situations, it crawls to the petiole but goes back to the undersurface of the leaf before reaching the stem.

Both nymph and adult feed on the undersurface of the leaves, causing mechanical injury and loss of sap. This is manifested by the discoloration and yellowing of the leaves starting at the edges extending into the tissues between the veins and later hopper burned. The hopper burn caused by the cotton leafhopper feeding is explained in two theories. The cotton leafhopper injects toxin into the tissues and the toxin reacts with the tissues causing the hopper burn, or the injury interferes with the translocation of food materials and water due to physical plugging of the xylem and destruction of the phloem (De Long, 1971). The edges of the damaged leaf turn pale green, then yellow and finally brick red or brown. The color changes are accompanied by severe wrinkling and curling of the leaf. In severe infestation, the whole leaf gradually dries up and drops.

Aside from feeding and protection, both nymph and adult prefer to stay at the lower surface of the leaf where 75 to 100 percent of the stomata are located and transpiration occurs. This microenvironment favors the cotton leafhopper because of the cool environment. However, when high density of cotton leafhopper occurs at the underside of the leaf, some also stay and feed at the upper side.

The cotton leafhopper attacks all the developmental stages of the cotton plant (Parducho, 1976) but the seedling stage is the most susceptible. It prefers two to four week-old seedlings for feeding (Cadapan and Magtibay, 1978; IPB-Fiber Crop Breeding, 1980; Bergonia, 1983) where it generally multiplies faster (Bergonia, 1983).

Amrasca biguttula can be reared in the laboratory using fresh succulent okra pods. The adult can survive for 10 to 15 days (Adordionisio, 1979). Aside from cotton, *Amrasca biguttula* also attacks okra, eggplant, peanut, cucurbits, potato, tomato, corn, mulberry, raddish, legumes and pepper.

Phenology

The cotton leafhopper occurs throughout the cropping season and is abundant usually at the seedling stage. Its occurrence is influenced by the plant growth stages rather than environmental factors (Obien, 1985). It is predominant in cotton planted in September, October, November and December (Orlido, 1985).

Control Measures

Use of resistant variety

The use of resistant cotton variety is the most economical, practical and effective control for cotton leafhopper because it is a built-in character of the variety. This method eliminates the application of insecticides for cotton leafhopper, thus, preserving the natural enemies. This also allows for the population build-up of natural enemies that could help in the natural control of insect pests in the later stage of the crop (Pascua, 1989).

Since 1982, 562 cotton cultivars/lines had been evaluated for cotton leafhopper resistance: 38 highly resistant, 88 resistant, 122 intermediate resistance, 67

susceptible and 142 highly susceptible (Adalla, 1982; Pascua, 1989; Pascua and Adalla (1990a); Pascua and Punio, 1989; Pascua, 1990; 1991; 1992; 1993; 1994 and 1995; Pascua and Franco, 1998; Pascua et al. 1999, Pascua and Damo, 2002). However, only two resistant varieties, CRDI-1 and Navkar 5, are recommended for commercial planting.

Hairiness is an important factor in cotton leafhopper resistance. The hairs or trichomes serve as physical obstruction to the leafhopper stylets in penetrating the leaf tissues. Resistant cotton varieties possess at least 100 trichomes per cm^2 and 0.6 mm in length (Hasse et al., 1986). Other characters such as moisture content (Afzal and Ghani, 1953), nitrogen and protein content (Chakraborty and Sanhi, 1972) and gossypol content (Bottger et al., 1964; Lukefahr et al., 1966) are also correlated with leafhopper resistance. Cotton varieties containing less moisture and possessing leathery appearance are less preferred by cotton leafhoppers (Afzal and Ghani, 1953).

In several studies, feeding and ovipositional antixenosis, antibiosis and tolerance were observed as mechanism of cotton leafhopper resistance. Studies by Pascua and Adalla, (1990a) show that low leafhopper population on resistant varieties indicates feeding antixenosis, while low nymphal emergence is ovipositional antixenosis. Also, in studies conducted by Pascua and Adalla, (1990b) and Pascua (1990) and Adordionisio (1979), antibiosis is operating as mechanism of resistance. Cotton leafhoppers reared in resistant cultivars such as Ferguson Liza, ISA 205, Ala 894(65) and EC 1579 have lower survival rate, eggs laid, mean generation time and net replacement rate, shorter adult longevity, and longer developmental period than those in susceptible variety Delta Pine 16 (Table 2 and 3). This indicates that cotton leafhoppers reared in resistant varieties have low rate of population increase, subsequently, a decrease of population in next generations. The number of cotton leafhoppers in the cultivar is a function of combined effects of ovipositional and feeding antixenosis, and antibiotic effects influencing the insect population build-up (Pascua, 1989). In tolerance mechanism, resistant cultivars have higher damage threshold level than the susceptible variety, Delta Pine 16 (Pascua, 1989, 1990, 1991).

Cultural Control

Some cultural management practices can aggravate the infestation of the cotton leafhopper. Cotton plants spaced closer at 75 mm x 25 mm have earlier cotton leafhopper population build-up than those spaced wider at 75 mm x40 mm (Campos and Orlido, 1978). The closer spacing could create a suitable microenvironment for insect population built-up. However, Ugare (1985) noted that different plant densities did not affect cotton leafhopper populations. The difference of results could be attributed to the cotton varieties used in the experiments.

Plants fertilized with higher nitrogen level (220 kg N ha^{-1}) have significantly higher cotton leafhopper population than the recommended rate (75 to 100 kg N ha^{-1}) (Ugare, 1985; Cimafranca, 1993 and Damo, 1994). Therefore, cotton should only be supplied with the recommended fertilizer.

Biological Control

Spiders belonging to Thomisidae, Argiopidae and Tetragnathidae families (Obien, 1987; Parducho, 1976); coccinelid beetles (Campos and Orlido, 1978) like *Micraspis crocea, Menochilus sexmaculatus* and *Cyrtorhinus lividipennis*; nabid bugs and green lacewings (Parducho, 1976) were identified as predators of cotton leafhopper.

Spiders are the most voracious predator of cotton leafhoppers, attacking both the nymphs and adults

Table 2. Reactions of cotton leafhopper on five cotton cultivars (Pascua and Adalla, 1990a).

Cultivar	Nymphs/leaf	First instar to adult (days)	Adult longevity (days)	Rate of population increase	Mean generation time
Ferguson Liza	0.60	15.33	17.50	0.0035	21.67
Deltapine 16	1.83	10.83	26.13	0.109	20.40
ISA 205	0.43	14.83	19.53	0.014	25.72
ALA (65)	0.10	16.17	15.80	0.063	21.00
UPL-C2	0.97	212.33	20.23	0.047	22.64

Table 3. Reactions of cotton leafhopper on two cotton cultivars (Adordionisio, 1979)

Cultivar	Parameter			
	survival rate (%)	devt period (days)	female adult longevity (days)	eggs laid/plant
Deltapine 16	83.00	15.50	12.42	8.10
EC 1597	54.00	21.40	7.20	4.70

(Cendana and Baltazar, 1947). Coccinelid predators are ineffective because they can only kill 1.3 to 2.6 nymphs per day or prey mortality ranges from 7.3 to 13 percent (Campos and Orlido, 1978). The conservation of these natural enemies should receive attention by using insecticides only when necessary. A fungus, *Cephalosporium sp*., attacks the nymphs and adults during the rainy months (Cendana and Baltazar, 1947).

Insect Pest Surveillance System and Chemical Control

Prior to insecticide application, the crop should be surveyed for cotton leafhopper using the critical pest level (CPL). In using the CPL, at least 10 of the 20 sample plants have cotton leafhopper and leafhopper burn up to the upper third leaf. When the CPL is reached, the crop should be sprayed with the recommended insecticides (CODA, 2002).

Recommended pest management for cotton leafhopper

The CODA (2002) recommends the following pest management components for cotton leafhopper:

1. use cotton varieties CRDI-1 and Navkar 5 which are a resistant to cotton leafhopper and eliminate the application of insecticides during the early stage of the crop to preserve natural enemies;
2. fertilize cotton plants with the recommended levels to avoid excessive and luxuriant plant growth on which pests can proliferate;
3. monitor the pest weekly;
4. spray the recommended synthetic insecticide when the *H. armigera* population reaches the critical pest level;

This pest management package of technology is very effective in reducing the damage of cotton leafhopper and resulted in high yield of seedcotton. The technology requires minimal or no insecticide because using cotton leafhopper resistant variety can be a sole control to this pest. This allows for the preservation and population build-up of natural enemies that could help in the natural control of cotton leafhopper and other insect pests in the early and later stages of the cotton crop thus, lowering the burden of insect control. This technology not only lowers production inputs but also preserves the biodiversity of the ecosystem, prevents environmental pollution and health hazards to farmers.

Research Status

The identification of a resistant cultivar/line and the incorporation of a leaf hopper resistant gene into high yielding cotton varieties are the main thrusts of cotton breeding program in the Philippines. Hence, evaluation of cultivars introduced from other countries and lines developed by the Cotton Development Administration is a continuous undertaking. Identified cultivars/lines are used as parent materials for hybridization work to come up with high yielding and cotton leafhopper resistant varieties.

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