Host Plant Resistance of Eggplant, *Solanum inelongena* L. to the Leafhopper, *Amrasca biguttula* (Ishida), *and* the Eggplant Borer, *Leucinodes orbonalis* Guenee

[Resistance Screening of Farmers' and Commercial Varieties of Eggplant Against the Cotton Leafhopper, *Amrasca biguttula* (Ishida)]

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Abstract

Leafhopper infestation in the field followed the same pattern as that observed during the 1998 dry season trial. Adult and nymph populations peaked at 60 days after transplanting (DAT). More leafhoppers infested the 5[6] leaf from the growing tip. Based on over-all counts, the varieties Jackpot and Bulakena were most preferred by both adults and nymphs; variety IPB GS 1 was least preferred.

Overall damage rating showed that the variety SRO2 had the least yellowing and cupping symptoms. Among the varieties tested, Bulakena and Jackpot were susceptible at 60 DAT. Dumaguete Long Purple and Abar were the tallest varieties at vegetative and reproductive stages, respectively. Abar had the longest leaf while IPB GS1, the smallest. Both varieties were tolerant but whether these plant characters can affect leafhopper preference has not been established. Variety SRO2 had the highest number of trichomes per 40 sq. mm while Abar had the longest trichomes. This suggests that the dense trichomes in SRO2 could have deterred leafhopper feeding and oviposition. IPB GS1 yielded the healthiest fruits. The yield of Jackpot and Dumaguete Long Purple was comparable to 1PB GS1. Bulakena had the lowest number of healthy fruits.

Damaged fruits due to borer infestation were counted and expressed as percentage of the total number of healthy and damaged fruits. During the four harvest periods, Abar had the highest percentage of damaged fruits while IPB GS1 had the lowest percent infestation. SRO2 was resistant to leafhopper at vegetative and reproductive stages while Abar was tolerant to leafhopper until the last harvesting period. Jackpot was tolerant and yielded high despite the high leaf yellowing rating. Bulakena was the most susceptible variety showing distinct leaf cupping before the yellowing symptoms of leafhopper damage.

Objectives

(1) To screen and confirm the reaction of selected commercial and farmers' eggplant varieties for resistance or susceptibility to the cotton leafhopper.
(2) To determine the impact of leafhoppers on the yield of eggplant.
(3) To select the varieties that have resistance or tolerance to this pest and determine the mechanism of plant resistance to the pests in the genotypes identified.

IPM Constraints

(1) Lack of available sources of resistance to the cotton leafhopper for improving the resistance of improved varieties.
(2) No available resistant germplasm sources of eggplant against the eggplant borer.

Research Methods

General Screening

Seven selected varieties of eggplant were sown in seedbeds. After 2-3 weeks, the seedlings were pricked on plastic trays and maintained inside the greenhouse. After a month (seedlings reaching 10-15 cm length), they were planted in 4m x 5m field plots with four replications in RCBD at PhilRice Central Experimental Station during the 1999 dry season (January) and maintained following standard cultural management practices for eggplant production. Two eggplant entries are farmers' varieties (SRO 2 and Abar), the four entries came from different private seed companies (Jackpot, Bulakena, Long Violet), while IPB GS 1 is an

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improved line (genetic stock) developed at the Institute of Plant Breeding, which has increased resistance against the leafhopper.

Leafhopper populations and leaf damage were monitored for each variety at 30 days after transplanting (DAT) and every two weeks thereafter until 135 DAT. Leafhopper damage was recorded using a 1-9 rating scale on yellowing and cupping, based on the 4th and 5th fully expanded leaf. Other insect pests such as thrips, mites, aphids and natural enemies were also counted.

Morphological and horticultural features were measured from 45 to 105 DAT. Trichome density and length were measured at 45, 90, and 105 DAT. Dried leaf samples of each variety were taken to the Analytical Laboratory of the Institute of Plant Breeding for proximate analysis and other specific chemical tests including analysis of fat, sugar and amino acid content.

Fruit yields were determined weekly for each variety. Fruits infested with the eggplant borer (damaged fruits) and healthy (undamaged) fruits were counted and weighed.

Results

Leaf hopper populations

Leafhopper infestation levels in the field followed the same trend as that observed during the 1998 dry season trial. Adult leafhoppers counted on the 4th and 5th leaves started to increase at 45 DAT, peaked at 60 DAT and declined from 75 DAT and thereafter as the plants matured. Two-month old plants (60 DAT) were consistently susceptible to leafhopper under field conditions. Generally, more leafhoppers were present on the 4th and 5th leaves of Jackpot than on other varieties. Nymph populations peaked at 60 DAT, declined at 75 DAT and increased again at 90 DAT and thereafter. More nymphs preferred to aggregate on the 5th leaf from the top, especially on Jackpot and Long Violet. The least number of nymphs and adults were observed in the 4th and 5th leaf samples of SRO2.

Other Insect/Arthropod Pests and Natural Enemies

Thrips were found sinificantly abundant from 30 to 75 DAT on both 4th and 5th leaves, and declined thereafter (data not shown). Aphids were also found attacking the different eggplant varieties at early vegetative stage but numbers did not differ among varieties. Red spider mites became abundant from 45 DAT and decreased after 75 DAT on both leaves. The spider populations did not differ significantly among the eggplant varieties. Mirid bugs were also present at the early reproductive stages and coccinellids were observed between 120 and 135 DAT. However, they did not differ significantly in their numbers among the eggplant varieties.

Damage Response

Yellowing was more pronounced on the 5th leaf compared to the 4th especially towards the later part of the sampling periods. This was expected as the leafhoppers on the 4th leaf were fewer and physiologically younger than on the 5th. Jackpot showed the highest mean yellowing rating from 60 DAT onwards while IPB GS 1 showed the lowest mean yellowing rating throughout all rating periods except at 90 DAT, when both SRO2 and Abar had the least leaf yellowing. On the other hand, SR02 variety showed a relatively low cupping mean rating of 1.08 and 1.78 at 105 DAT and 120 DAT, respectively, compared with Jackpots' 4.35 at 60 DAT, which had the highest rating among all varieties up to the last rating period. Bulakena was the second most susceptible variety and showed distinct leaf cupping. IPB GS 1 and Abar variety were least susceptible between 105 and 120 DAT.

Morphological/Horticultural Characteristics

The tallest variety was IPB GS1 during the vegetative stage (45 DAT) and Abar during the reproductive and fruiting stages. Long Violet was the shortest at 75 DAT and SRO2 at 105 DAT. Abar variety was the largest in both 4th and 5th leaves in all sampling dates. Dumaguete Long Purple had the second largest leaves. IPB GS 1 had the smallest leaf area on the 4th leaf from 90 to 105 DAT.

Trichome characters

To confirm the antixenotic and tolerance mechanisms of field resistance demonstrated by some eggplant varieties, trichome characters were measured. All eggplant varieties had the dendritic or arboriform type of trichomes. Results showed that SRO2 had the highest number of trichomes per 40 sq. mm in all three sampling dates. This probably suggests that the trichome density in SRO2 could be the resistance factor that deters leafhopper feeding and oviposition on both 4th and 5th leaves of eggplant. Longer trichomes were observed on Abar from Nueva Ecija, followed by Dumaguete Long Purple in all sampling periods. Tolerance of Abar to leafhopper infestation could be due to longer trichomes of this eggplant variety. IPB GS 1 had the shortest trichomes at 45 and 105 DAT and Jackpot at 90 DAT. Trichome characters in IPB GS 1 probably do not confer tolerance or resistance mechanism as trichome density and length were lowest in this variety in all three sampling dates. The result shows that trichome characters can serve as resistance factors in some eggplant varieties and probably a combination of trichomes and chemical factors on the surface of the leaves in other eggplants.

Yields of Healthy Fruits

The yields of several eggplant varieties differed significantly from one another at various sampling periods. As in the previous season, IPB GS 1 yielded the healthiest fruits at 75

and 82 DAT. Jackpot and Dumaguete Long Purple yielded high at 89 DAT which was comparable to the yield of IPB GS 1 in terms of the number and weight of fruits. Bulakena, SRO2 and Abar yielded low in terms of the mean number of healthy fruits in all harvesting periods. The mean number of borer damaged fruits was highest on DLP followed by Abar and Jackpot, starting from 95 DAT harvesting. Bulakeiia and SRO2 had the lowest number of borer-damaged fruits in all sampling periods. The weights of healthy fruits were highest for Jackpot followed by IPB GS1 starting from 85 DAT up to 105 DAT.

Chemical Analyses

Proximate analyses of dried leaf samples of the different eggplant varieties collected at 60 DAT is shown in Table 1. The percent protein differed significantly among the eggplant varieties, with SRO2 having the highest amount. It is possible that these protein compounds are secondary metabolites that are considered defense substances in plants against herbivory. The pigments (also known as flavonoids) may have been present in the trichomes of some of these varieties such as IPB GS1. The biochemical basis of leafhopper resistance among the different eggplant varieties will be an interesting topic to pursue.

Table 1. Proximate analysis of farmers' and commercial varieties of eggplant for resistance to the leafhopper, *Amrasca biguttula* Ishida.

Treatment	% Crude Fat	% Protein	% Ash	% Crude Fi	% TFS	% Starch
Jackpot	16.99	24.20	9.98	23.10	14.00	28.40
DLP	17.01	24.18	9.98	24.57	12.13	29.37
Abar	17.13	27.50	9.70	25.73	12.73	32.58
SR02	16.34	30.83	11.03	26.06	14.30	28.89
Bulakefla	16.11	26.50	9.34	27.06	14.76	27.03
L Violet	15.71	39.75	10.08	25.24	13.56	30.99
IPB GS 1	16.60	27.78	10.01	22.29	13.11	29.83

Samples taken at 60 DAT; for analysis - 2 samples per replicate, three replications in the three inner 5m rows.

Relationship of damage rating leafhopper population and plant characters

A significantly positive correlation was obtained between leaf yellowing and mean weight of fruit yield, while no significant relationship was observed with the mean number of fruits (Table 2). When the leafhopper populations were correlated with damage rating, a highly positive significant correlation was observed using the leaf yellowing rating (Table 3). No significant correlation was observed between leafhopper population and plant characters, with the exception of leafhopper damage rating and trichome density (Table 4). Over-all, based on these results, the leafhopper population, leafhopper damage rating, fruit yield and trichome density are potential parameters for resistance evaluation which can be reliable indicators for selecting eggplant varieties with tolerance or resistance against a pest.

Table 2. Relationships of damage rating, leafhopper population and plant characters with the mean number and weight of healthy fruits. PhilRice-CES, Maligaya, Munoz, Nueva Ecija Philippines, 1999 dry season.

Parameters	Correlation (R)	
	No. of Fruits	Weight (kg)
Damage Rating		
Leaf Yellowing	0.272	0.766
Leaf Cupping	-0.044	0.499
Leaffolder population		
Nymph	0.054	0.519
Adult	0.129	0.587
Plant Characters		
No. of trichomes	-0.531	-0.378
Length of trichomes	-0.519	-0.289
Leaf Area	-0.287	-0.191
Leaf Length	-0.383	-0.217
Leaf Width	0.039	-0.102
Plant Height	0.200	0.174

Table 3. Relationship of damage rating and plant characters with the mean number of nymph and adult leafhoppers, PhilRice-CES, Maligaya, Munoz, Nueva Ecija, Philippines, 1999 DS.

Parameters	Correlation Coefficient (R)	
	Nymph	Adult
Damage Rating		
Leaf Yellowing	0.733	0.603
Leaf Cupping	0.573	0.263
Plant Characters		
No. of trichomes	-0.399	-0.268
Length of trichomes	0.289	0.479
Leaf Area	0.194	0.509
Leaf Length	0.106	0.441
Leaf Width	0.476	0.383
Plant Height	0.113	0.464

Table 4. Relationship between damage rate and plant characters. PhilRice-CES, Maligaya, Munoz, Nueva Ecija, Philippines, 1999 dry season.

Parameters	Correlation Coefficient (R)	
	Leaf Yellowing	Leaf Cupping
Plant Characters		
No. of trichomes	-0.71	-0.480
Length of trichomes	-0.163	0.029
Leaf Area	-0.296	-0.272
Leaf Length	-0.274	-0.312
Leaf Width	-0.053	0.133
Plant Height	-0.131	-0.346

Impact

Some morphological characters such as trichome density and length influenced Field preferences of adults and nymph leafhoppers among the different varieties of eggplant initially. The farmers' variety SRO2, from the Ilocos region, was densely covered with the arboriform or dendritic trichomes which initially inhibited leafhopper feeding and oviposition, as shown by the lowest number of nymphs and adult population counts all throughout the sampling periods. On the other hand, IPB GS1, an improved resistant/tolerant line from the Institute of Plant Breeding, was not densely covered by these arboriform trichomes but showed resistance or tolerance to leafhopper damage. Proximate analyses did not show any significant findings except for percent proteins. A closer look at the chemical nature of the leaf undersurface might reveal that this variety has increased resistant chemical substances, which possibly prevented the leafhoppers from feeding and oviposition. For resistance evaluation purposes, correlation studies showed that leafhopper counts, leafhopper damage rating, fruit yield and trichome density are good and reliable parameters. Jackpot, a commercial variety, is considered tolerant because it yields high in spite of the higher leafhopper damage at vegetative stage. The use of resistant or tolerant eggplant varieties is a promising alternative to reduce crop loss, increase fanner income and reduce pesticide use as shown by the differential varietal responses of several eggplant varieties against the leafhopper.

Networking Activities

- Lecture materials and posters as part of the Training Manual prepared by the IPM-CRSP group during Farmer's Forum and Trainers Training.
- Live Exhibits of the cotton leafhopper and the eggplant borer and their damage to eggplant. Presented during the Farmer's Forum.
- E. Rajotte traveled to PhilRice in October 1998 to evaluate research results and participate in planning for Year 7 experiments. N. S. Talekar also participated in these discussions in October 1998.

Publications and Presentations

M. Caasi-Lit, V. P. Gapud, B. A. Santiago, C. V. Pile, G. E. Balagot, N. S. Talekar and E. Rajotte. "Major insect pests of eggplant, *Solanum melongena* L., and their natural enemies". Poster paper during the Annual Scientific Meeting of the Pest Management Council of the Philippines, May 6, 1999, PhilRice, Maligaya, Munoz, Nueva Ecija.

M. Caasi=Lit, V. P. Gapud, B. A. Santiago, C. V. Pile, G. E. Balagot, N. S. Talekar and E. Rajotte. "Resistance screening of farmers' and commercial varieties of eggplant against the leafhopper, *Amrasca biguttula* (Ishida). Poster paper presented during the Farmer's Forum "Presentation of IPM CRSP Research/Technologies in Collaboration with NOGROCOMA Farmer Members". July 30, 1999, PhilRice, Maligaya, Munoz, Nueva Ecija.

Training Output

Pest Management of Eggplant/ Tomato Insect Pests during the Trainers Training, September 29-30, 1999, PhilRice, Maligaya, Munoz, Nueva Ecija.

Highlight

Several farmers' and commercial varieties of eggplant were resistant or tolerant to the leafhopper. The farmer's variety SRO2 has dense trichomes that prevented leafhoppers from feeding and oviposition. IPB GS 1, an improved line, has few trichomes but is resistant to leafhopper and yields high. The use of these varieties significantly cut production costs as no pesticide inputs were added. This was coupled with the abundance of natural enemies, which helped reduce and manage leafhopper and borer populations below damaging levels.

Movement of Arthropod Predators

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Abstract

The objective of the project is to quantify movements of predators between habitats in rice-onion cropping systems. Our hypothesis is that generalist predators can be found in rice-onion systems that play a role in maintaining control of insect pests. Habitats adjacent to the rice-onion system serve as reservoirs of generalist predators of insect pests. We have monitored arthropod predator activity-density and directional movement between habitats in the fallow and rice-onion system at four different farms in the province of Nueva Ecija and at one location at IRRI. We are assessing species density and composition in the field edge and at increasing distance from the field edge. This serves as a control of the catches in the pitfall traps. At the location at IRRI the spatial distribution within a whole field has been followed over two cropping seasons. In all localities the flora composition in the bunds have also been assessed. Directional pitfall traps placed in the bunds serve to assess the movement of walking predators. Sticky boards and window traps serve to assess the movement of flying predators. We are currently analyzing the temporal patterns of the movements in and out of the fields from diurnal samplings in the 1998-99 dry season. Preliminary results show a clear effect of crop age as well as farm operation upon the catches in the pitfall traps. There are trends of movement of *Pardosa pseudoannulata* females with young into the field early in the season, a trend that is later reversed. Farm operations affect movements of spiders, carabids and ants, as well as predator activity-density in the bunds. The importance of bunds as a refuge is stressed by the fact that walking generalist predators predominate during the early crop stages. A walking predator such as *P. pseudoannulata* needs favorable conditions for survival near the field to provide good biological control. Later flying predators, as the ballooning spider *Atypena formosana* arrive. Flying predators may be less dependent on refuges close to the field. The spiders *A. formosana* and *P. pseudoannulata* have been selected for more detailed study based on their early occurrence and high abundance in the pitfall traps and/or in the field. *P. pseudoannulata* is the most common spider caught in the pitfall traps, and occurs very early in the season and thus is an important early predator. Shortly after (2 weeks), *A. formosana* is also found in the field. It does enter the field walking (as seen from our pitfall traps), but entry by ballooning is much more important based on our window-trap and sticky trap catches. Functional response and density dependent predation were assessed for *A. fonnosana.* Results indicate a type two response, as well as a very high predation leveL Development time and fecundity of *A. formosana* on different diets were negatively affected by a pure diet of brown planthopper or green leafhopper as compared to a more varied diet.

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