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Host Plant and Treatment Influence on Population of Sugarcane Leafhopper in Tropical Field Conditions

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ABSTRACT

The management of sugarcane leafhopper was carried out on different sugarcane varieties with different control measures during 2014-2015 and 2015-2016 with various control methods, like, cultural, biological, chemical, were applied singly and in their possible combinations, such as, biological + cultural, biological + chemical, cultural + chemical and cultural + biological + chemical control with the objective to keep the pest population below the economic threshold level and to find the most economical and effective method of control, for use instead of traditional approaches.

Key words: Biological, Cultural, *Pyrilla perpusilla*, Sugarcane, Sustainable management

INTRODUCTION

Sugarcane is an important cash crop of agriculture and GDP respectively. Sugarcane leafhopper, *Pyrilla perpusilla* Wlk. (Lophopidae: Homoptera), is the most destructive pest of the sugarcane. The nymphs and adults feed by sucking the cell-sap from the leaves of sugarcane and other secondary host plants, that extensively affects the yield (Kumar and Yadav, 2006).

Pyrilla perpusilla causes direct and indirect losses and the attacked leaves become pale and wither later on. The feeding by pest causes poor growth of sets which also creates difficulty in milling of effected canes (Kumarasinghe and Wratten, 1996). The infestation during the early growth period of cane, affects the yield adversely, whereas the late infestation from September onwards, mostly affects the sucrose contents (Puri and Siddharth, 2001). These losses, in sugarcane, can only be minimized with a proper protection of the cane-crop from insect pests, with a scientifically designed IPM Program, throughout the year. Pesticides are applied as and when needed, in combination with cultural practices, resistant varieties as well as with an introduction and conservation of the natural enemies. Pesticides will continue to play an important role in the IPM Program.

The Integrated Pest Management (IPM), is the most, desirable approach, which intends to integrate more than one possible control measures to keep the insect pests below an economic threshold level. Hence, the problem necessitates the establishment of an IPM strategy in which ideal factors are to be considered. Eco-friendly pest-control in sugarcane by using IPM techniques like cultural, mechanical, resistant varieties and bio-control agents for the management of sugarcane pyrilla were recommended by various authors (Singh, *et al.*, 2001; Verma, *et al.*, 2002). Varieties with a hard mid-rib, erect and narrow leaves, are less preferred by the top-borer and *Pyrilla*. Biological control of *Pyrilla* has been reported as major achievement in Haryana, India (Madan, 2001). *Epiricania melanoleuca* (Fletcher) is a potential ecto-parasitoid, which successfully controls the sugarcane leaf hopper, *P. perpusilla* through field colonization. (Rajak, 2007; Gangwar, *et al.*, 2008).

During the study regarding the efficacy of different control measures, against pyrilla in a ratoon crop, minimum pest population (0.45 and 0.28 individuals/leaf) was found where cocoons of *Epiricania melanoleuca* were placed followed by the treatment with Furadan 3G @12 kg/acre (0.85 and 0.67 individuals/leaf) as against check (3.75 and 4.05 individuals/leaf), Rana, *et al.* (2002). Chemical control was found to be more effective method as compared to the biological control for the management of *P. perpusilla* in sugarcane (Wasim, 2007). As for as cultural practices are concerned the trash-burning or mulching, has no effect on the pest populations, because the development from nymphs to the adults, takes place on the living plant parts (Brar, *et al.*,1983). However, trash mulching, alone, gave 100% eggs parasitization, by the ecto-parasite (Mohyuddin and Qureshi, 1999, 2000). The de-trashing not only reduces the pest menace like pyrilla, white flies, mealybugs, inter node-borer but also improves the aeration and yield in sugarcane (Kathiresan, 2004).

The present study was designed to focus on the integration of various control methods, like cultural, biological & chemical, to find out the most effective & economical combination for an IPM strategy of *P. perpusilla* and for recommendation to the farmers.

METHODS AND MATERIALS

SCREENING OF THE VARIETIES:

Studies were carried out to screen out the material for the final investigations. Experiments were laid out in a Randomized Complete Block Design (RCBD), in the Kamla Rai College, Gopalganj. The crop was sown in a North-West direction, for each experiment. The sets, consisting of two buds, of each variety, were placed together, side by side, longitudinally.

PRELIMINARY SCREENING DURING 2015:

The objective of this study was to screen out the resistant and susceptible varieties, on the basis of pyrilla-population, for the final investigations. Six commercial varieties and advanced lines of the sugarcane were sown on February 15, 2014. The experiment was repeated thrice, with a plot size of 13m×3.05m and a row to row distance of 0.76m, in a randomized complete block design. No plant protection measures were applied to treat the optimum conditions, for the pest attack. All the recommended agronomic practices, were applied, during the experiment

Ten leaves were selected, randomly, from each plot, to check the population density of test insect, per leaf. Observations were taken, on weekly basis. Three genotypes, each showing resistant, susceptible and intermediate response were selected for further experiments. There were nine genotypes, in total, to be selected.

FINAL SCREENING DURING 2016:

Nine genotypes of sugarcane, basis on-density per leaf, were selected from the preliminary trials, during 2015, for a further study. These were, sown on Feb 20, 2014, in three repeats. The size of plot was kept as 13m x 4.58 m and a row to row distance was kept to be 0.76 m. There were five rows, in each plot, for each variety. The data, regarding the pyrilla-population, were recorded. The data on the Morphological, physical and chemical plant-factors were studied from other four rows and correlated with the insect pest population.

DATA COLLECTION

The data, regarding the Pyrilla-population, per leaf, were recorded, randomly, throughout the season, consistently, at an interval of 7 ± 2 days starting from May, 2014 to 2015.

HOST-PLANT SUSCEPTIBILITY INDICES (HPSIS):

Plant-susceptibility indices, based on the adult/ nymph population of Pyrilla, on different selected genotype of sugarcane, were determined, using an IBM compatible computer,

with a Microsoft chart package. However, HPSI may be calculated by the following formula-

$$\text{HPSI (\%)} = 100 \frac{B - A}{B} \times 100$$

Where;

A= Adult/nymph population, in an individual genotype of Sugarcane, and

B= Adult/nymph population, in all genotype of Sugarcane.

MANAGEMENT OF THE SUGARCANE PYRILLA

The study was conducted in sugarcane fields at different sites at Gopalganj District from February 2014 to October 2015. The most resistant, variety CO 0238, was selected from screening trials and used for a further study. Management of sugarcane pyrilla, was carried out, with different control measures, individually, and in their possible combinations, as under-

T1 = Cultural Control (I) Fortnightly hoeing and destruction of weeds, to remove alternate host-plants. (II) Detrashing of older leaves, twice, during the season. (III) Trash mulching, at the time of sowing.

T2 = Biological Control (I) Placing of cocoons of *Epiricania melanoleuca* @ 2500 cocoons, per ha. Monthly observations were made for biological fields at different sites of Gopalganj during 2014 and 2015.

T3 = Chemical Control (I) Application of Carbofuron @ 35 Kg, per ha. Starting from one month, after sowing, and coupled with the earthing-up.

T4 = Biological control + Cultural Control;

T5 = Biological Control + Chemical Control;

T6 = Cultural + Chemical Control;

T7 = Cultural + Chemical Control + Biological Control; and

T8 = Control.

The crop was sown on Feb 20, 2014 in an RCBD, with three replications. The size of the plot was kept as 13m × 4.5 m, with a row to row distance of 0.76 m. There were five rows, in each plot. The data, regarding the Pyrilla-population, per leaf, were recorded, fortnightly (15±2 days). Treatments means, were compared by a DMR test, at P=0.05. The whole analysis was performed, using IBM compatible computer, with an M stat package.

RESULTS AND OBSERVATIONS

VARIETAL DIFFERENCES:

The mean comparison of the data, regarding the population of *P. perpusilla*, per leaf, on various selected genotypes of sugarcane revealed that the genotype CoC 671, possessed maximum population of *P. perpusilla* and appeared to be comparatively susceptible, with a population of 17.24 pests per leaf, which differed significantly from those observed in all other genotypes. The minimum population of the pest was recorded to be 4.84, per leaf, on Co 238. The varietal difference for pest incidence was shown in Table 1.

Table 1: Pyrilla population per leaf on various sugarcane genotypes under field conditions

Sugarcane Variety	Mean of Pyrilla Population	Type of Resistance
CO 0238	4.03	Resistant
COP 2061	4.56	Resistant
COP 112	6.90	Intermediate
CO 79158	7.30	Intermediate
COC 671	12.01	Susceptible
BO 138	12.37	Susceptible

Furthermore, it was also observed that all the genotypes, showed a similar trend, in response to the population of *P. perpusilla*, as that observed during 2015, in the preliminary screening trials.

ABUNDANCE PERIOD OF THE PEST:

The comparison of means for the data, regarding the population of *P. perpusilla* per leaf, at various dates of observation on sugarcane, during 2014 (Table 2) revealed that the minimum population of the pest was recorded to be 1.07, per leaf, on May 12 and this population, increased to a significant level upto 1.84, per leaf, on June 02. The chemical constituents are shown in Table 3.

Table 2: A comparison of means regarding physico-morphic characters in various selected genotypes of sugarcane

Genotype	Leaf width (cm)	Leaf length (cm)	Hair density (cm ²)	Cane length (meter)	Cane dia (cm)
CO 0238	3.80	151	30.80	2.37	2.47
COP 2061	3.92	142	30.27	2.64	2.50
COP 112	4.43	128	21.57	2.58	2.49
CO 79158	4.58	131	19.03	3.46	2.68
COC 671	5.72	143	5.10	2.89	2.49
BO 138	6.16	138	6.13	2.90	2.45

Table 3: A comparison of means for the data regarding chemical characters in various selected genotypes of the sugarcane

Geno type	N	P	Min	Ca	Mg	Fat	CHO	Pol	Brix	CCS	Fiber
CO 0238	1.89	.211	6.75	.14	.44	2.19	48.96	19.05	22.33	13.22	14.77
COP2061	1.86	.211	6.69	.15	.46	2.18	48.74	19.47	20.89	12.70	14.77
COP 112	2.09	.185	6.68	.16	.153	2.16	51.12	18.63	21.62	12.62	13.83
CO79158	2.19	.168	6.70	.15	.165	2.18	53.68	18.46	21.34	12.97	11.92
COC 671	2.23	.169	6.67	.15	.152	2.19	53.78	18.65	20.69	12.97	12.18
BO 138	2.27	.170	NS	.15	.160	NS	0.90	0.40	0.51	0.31	00.18

The population of the pest, was decreased down to 1.61, per leaf, on June 09 and an increasing trend, was again observed, on the subsequent dates of observation upto 31.02, per leaf, on August 25. From these results, it was concluded that the month of August, was the most favorable for the development of the pest.

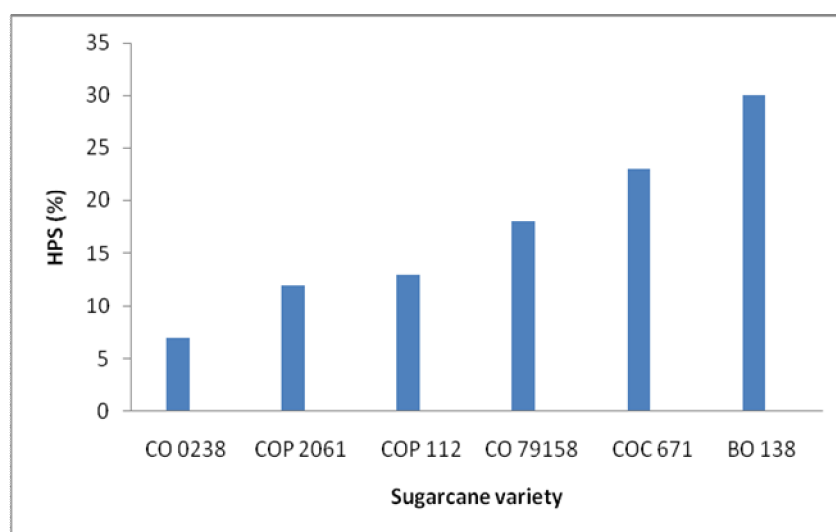


Fig. 1: HPS (%) value of different sugarcane genotypes during 2014-2015

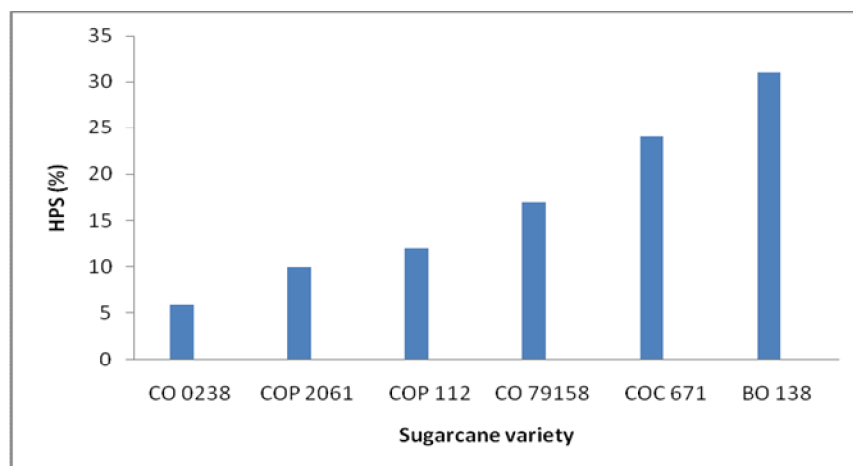


Fig. 2: HPS (%) value of different sugarcane genotypes during 2015-2016

Host-Plant Susceptibility Indices (HPSIs):

The results, pertaining to the HPSIs, during 2014 and 2015 and on an average basis, in various selected genotypes of sugarcane, are presented in Figs. 7 to 8, respectively.

The objective of this study was to determine the level of resistance/susceptibility, within the test material, in percentages. The results during 2014-2015 (Fig. 1) revealed that the genotypes COP 2061 and CO 0238 appeared, as comparatively resistant genotypes, each showed 5.00 percent HPSI; whereas COC 671 and had a maximum HPSI, i.e. 18.00 percent and appeared to be comparatively susceptible to the pest.

The results presented in Figure 2, showed a similar trend, with minor variations, as that observed, during 2014-2015. However, COP 2061 and CO 0238 showed 5.00 percent HPSI and appeared comparatively resistant; whereas, COC 671 had a maximum HPSI i.e., 19.00 percent and was found to be comparatively susceptible.

Integrated Pest Management:

Various control methods, such as, cultural control (fortnightly hoeing, de-trashing of older leaves two times, trash mulching), biological control (placing of cocoons of *Epiricania melanoleuca* 2500 cocoons per ha, four times in the season from June 15 to September 15), chemical control (carbofuron @ 35 kg/ha starting from one month after sowing and coupled with earthing up), were applied, singly, and in their possible integrations, viz., biological + cultural control, biological + chemical control, cultural + chemical control and cultural + chemical + biological control on the resistant genotype (CO 0238) obtained from screening trials, with the objective to minimize the pest attack and find the most economic and effective method for control, by determining the cost benefit ratio. The results are presented, as under:

Treatment Effects on the Population of *P. perpusilla*:

The analysis of variance for the same is shown in Table 4 and Table 5, which revealed significant differences ($P < 0.01$), among the dates of observation, various control methods and in their various interactional combinations.

Table 4: The correlation coefficient values between *Pyrilla perpusilla* and Physico-morphic plant characters

Physico-morphic plant characters	r-value
Leaf area	0.644**
Leaf length	0.187
Leaf spine density	-0.978**
Cane length	0.428*
Cane diameter	-0.166

Table 5: The correlation coefficient values between *Pyrilla perpusilla* and Physico-morphic plant characters

Chemical plant Characters	r-value
Nitrogen	0.944**
Potassium	-0.908**
Total minerals	-0.016
Calcium	-0.037
Magnesium	-0.727**
Fat	-0.198
CHO	0.976**
POL	-0.726**
Brix	-0.207
CCS	0.396*
Fibre	-0.949**

The application of biological + cultural + chemical control, in integration, resulted in a minimum population of *P. perpusilla*, and it did not differ, significantly, from other treatments, where cultural + chemical and biological + chemical control, were applied in combination each, showing 0.42/leaf population of *P. perpusilla*. The maximum population of the pest was recorded to be 3.65/leaf, in those treatments, where cultural methods were practiced and it differed significantly from those observed in all other treatments (Table 6).

Table 6: Comparison regarding *Pyrilla* populations on resistant variety of the sugarcane with various control methods

Control Measures	Average
T1= Cultural control	3.65
T2= Biological control	0.99
T3= Cultural + Biological control	0.64
T4= Biological + Cultural control	0.53
T5= Biological + Chemical control	0.42
T6= Cultural+Chemical control	0.42
T7= Cultural+Chemical+Biological control	0.32
T8=Control	7.59

The biological and chemical control methods, when applied, singly, resulted in 0.99 and 0.64/leaf population of the *P. perpusilla*, which differed significantly with each other. The latter mentioned figures, showed a non-significant variation with those where biological and cultural control methods were integrated, together and resulted in 0.53/leaf population of the pest. From these results, it was observed that the plots, where cultural+chemical + biological methods, were integrated, together, proved to be the best treatment, for the control of the pest.

DISCUSSIONS

HOST-PLANT RESISTANCE:

All the genotypes under study differed significantly, from one another, regarding the population of *P. perpusilla*, per leaf, during both the study years. The genotypes CO 0238 and COP 2061 were found to be comparatively resistant; whereas BO 138 and COC 671 were relatively susceptible, with a minimum population range of 4.03 to 4.30 insects per leaf and 13.01 to 13.67, per leaf, respectively. The host-plant susceptibility indices revealed that CO 0238 and COP 2061 had the lowest HPSIs i.e., 5% each; whereas, BO 138 and COC 671, showed 18% HPSI, and were categorized as resistant and susceptible genotypes, respectively.

The present findings are however, in line, but cannot be compared with those of Kishore *et al.* (2002) and Shrivastava *et al.* (2003), who studied the response of various genotypes of sugarcane for resistance/susceptibility, other than those studied in the present study.

PHYSIO-MORPHIC AND CHEMICAL PLANT-RESISTANCE AGAINST *P. PERPUSILLA*:

All the physico-morphic and chemical plant-characters showed a significant difference among genotypes except total minerals and fat contents. Amongst various physio-morphic plant-characters, leaf-width ($P < 0.01$) and cane-length ($P < 0.05$), with r -values 0.644 and 0.425, respectively showed a significant and positive correlation with the pest population; whereas, the leaf spine density, had a negative and significant correlation ($P < 0.01$) with the pest density. Cane-diameter and leaf-length exerted a non-significant correlation with the pest population. The present findings are in conformity with those of Kumarasinghe *et al.* (2001) who stated that spine-density is the most important character for anti-biotic resistance, against the *P. perpusilla*. Similarly, Kumarasinghe and Jepson, (2003), who reported that oviposition preference was affected by the leaf-spine density. The present findings can partially be compared with those of Deepak *et al.* (1999) who reported that cane-diameter and canelength showed a non significant correlation with the leaf-hopper population; but, in the present studies cane-diameter showed a non-significant; while, cane-length showed a significant and positive correlation with the pest-population.

In the present study, amongst the chemical plant characters, nitrogen, magnesium and CHO showed a highly significant and positive correlation with the pest-population; whereas, phosphorus, zinc, POL and fiber contents exerted a negative and significant correlation ($P < 0.01$) with the pest-population. Copper-contents also showed a negative and significant correlation ($P < 0.05$); while the CCS exerted a positive and significant correlation ($P < 0.05$) with the pest-density. Total minerals, calcium, fat and brix contents showed a non-significant correlation and a negative response with the pest-population. The present findings are in partial agreement, with those of Deepak *et al.* (1999), who reported the effect of canediameter, cane-height, brix and CCS to be non-significant with the *P. perpusilla* population. The present findings cannot be compared with those of Kumarasinghe and Wratten (1998) due to the differences in their materials and methods.

INTEGRATED PEST MANAGEMENT:

Various control methods, like, cultural (fortnightly hoeing from June 15 to September 15, 2015, de-trashing of older leaves two times, once in June and second in first week of August and trash mulching at the time of sowing), biological (release of cocoons of *Epiricania melanoleuca* @ 2500 cocoons/ha four times from June 15 to September 15) and chemical (carbofuron @ 35 kg/ha starting one month after sowing and coupled with earthing up), were studied, singly, and in their possible interactions, viz., biological+cultural, biological + chemical, cultural + chemical and cultural + chemical + biological) on selected resistant genotype of sugarcane.

The results revealed a significant difference, among the treatments regarding the population of *P. perpusilla*. The application of cultural + chemical + biological control, resulted in a minimum population of the pest, i.e., 0.32/leaf followed by the cultural+chemical and biological + chemical applications, each showing a pest population of 0.42/leaf. Maximum population of the pest, was recorded to be 3.65/leaf, in the application of cultural methods, which, also, showed significant reduction in the population of the pest against the control (7.59/leaf). The application of biological control singly, and in combination with cultural practices, resulted in an intermediate trend, in the population reduction. Keeping in view the results of cost-benefit ratio, the application of biological control was found to be the most benefited to the farmers. The present findings are in conformity with the findings of Madan (2001), who reported that the biological control of Pyrilla is the major achievement. Similarly, Rajak (2007) and Gangwar *et al.* (2008), controlled *P. perpusilla* population with the ecto-parasitoid. Pawar *et al.* (2002), also, reported that *E. melanoleuca*, played a major role in controlling the

pyrilla-population. In the present study, the application of cultural methods, viz., fortnightly hoeing + de-trashing of older leaves + trash mulching, showed a significant control of the pest and resulted in a population of 3.65 *P. perpusilla* per leaf as against 7.59 in control.

The present findings cannot be compared with single treatment effect as application of chemicals (Tripathi and Katiyar, 1998 and Tripathi, 2004); mulching for parasitization (Mohyuddin and Qureshi, 2000); cultural method of Brar *et al.* (1983) and also use of ectoparasitoid+chemicals presented by Rana *et al.* (2002) and Wasim (2007). Kathiresan (2004) reported that de-trashing can improve the cane yield and quality.

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