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Shoot and fruit borer, *Leucinodes orbonalis* incidence as influenced by total chlorophyll content in different brinjal varieties

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Abstract
The present study the biochemical on the basis of resistance against *Leucinodes orbonalis* infestation was conducted during the year 2013 and 2014. During the first year total chlorophyll content was maximum in leaves of CO-2 variety with 0.920 mg g^{-1} while, minimum total chlorophyll content was noticed in the varieties Swarna Prabha and Utkal Tarani with 0.786 mg g^{-1}. During second year also CO-2 variety recorded maximum total chlorophyll content with 0.922 mg g^{-1}. Whereas, minimum total chlorophyll content (0.790 mg g^{-1}) was recorded in Arka Keshav. From the present investigation it could be ascertained that the chlorophyll content was higher in leaves of susceptible brinjal variety CO-2 with shoot infestation of 20.25 % and 22.06 % as compared to resistant genotype Arka Keshav with 3.95 % and 4.65 % shoot infestation. A significantly positive correlation was observed during both the years between total chlorophyll content and shoot infestation that ascertained increase in chlorophyll content resulted in an increased shoot infestation.

Keywords: Brinjal varieties, Chlorophyll, *Leucinodes orbonalis,* Incidence, Infestation

1. Introduction
Brinjal (*Solanum melongena* L.) is one of the most popular and versatile crop adapted to different agroclimatic conditions which can be grown round the year especially in subtropics and tropics. A number of cultivars are grown in India which are suited to different regions, consumer preference being dependent upon fruit colour, size and shape. The major constraints in cultivation of brinjal is insect pest infestation which is a major bottleneck threat for its economic production [1]. Among all these insect pests, the most important and ubiquitous pest is the shoot and fruit borer *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) [2]. It is the most destructive and regular pest, causing considerable loss in crop yield and also responsible for deterioration of fruit quality which ultimately affect the market value of the fruits. At times, entire crops can be lost.

The female moths lay eggs on the underside of the leaves, on green stems, flower buds or the calyces of fruits. The young larvae of the pest bore into petioles, midribs of large leaves and tender shoots, causing dropping before the flowering which subsequently bore into the flowers buds and fruits. Since the larvae inhabit inside the shoots or fruits of the brinjal therefore management of this pest become difficult [3]. The pupal stage lasts for 6- 17 days. It is known to damage the shoots and fruits of brinjal in all stages (vegetative and reproductive) of its growth. Damaged fruits show circular holes often plugged with excreta and later becomes rotten which is unfit for human consumption. Exit holes are clearly visible in fruits but may not be obvious in shoots because of the hairiness of shoots. The yield loss due to this pest may vary from 70-92 per cent [4] and may cause 100% damage if no control measures are done [5].

Insecticides are widely used means of managing shoot and fruit borer in brinjal although the indiscriminate application has posed problems of high residues in fruits, destruction of natural enemies and development of resistance to different classes of insecticide [6] besides making eggplant fruit costly to consumers. With the growing realization of hazards and side ill effects connected with the indiscriminate use of pesticides, entomologists has developed an integrated pest management programme to maintain the pest population below those causing economic injury level. Hence, there is an urgent need to develop safe pest management strategies in pest control programmes of brinjal.

Resistant and tolerant cultivars form the basic component of Integrated Pest Management (IPM) over which other components are to be built up.

Host plant resistance strategy serves as an outstanding component when integrated with other approaches as it has several advantages over other control measures [7]. It is highly compatible with biological control agents and pesticides. Besides its effectiveness, selectivity against the pest and relatively long stability makes this tactic a cornerstone of IPM systems. Biochemical basis of resistance is one of the important aspects of host plant resistance. Some biochemical constituents may act as feeding stimuli for insects. Occurrence at lower concentration or total absence of such biochemical leads to non-preference, a form of insect resistance [8]. It is obvious in many cases that the biochemical factors are more important than morphological and physiological factors in conferring nonpreference and antibiosis. Among different biochemical factors present in the brinjal plants, chlorophyll content also plays a vital role in conferring resistance/ susceptibility to shoot and fruit borer [9]. The information regarding the relationship between *L.orbonalis* incidence and chlorophyll content are measure. Even a low level of resistance could be effective by way of reducing the survival of pests and favouring the activity of natural enemies to the extent of effective natural control. The present investigation was therefore undertaken to find the interrelationship between brinjal shoot infestation and leaf chlorophyll content of brinjal plants.

Materials and Methods

Field experiments were carried out at Vegetable Research Farm and laboratory experiments at the Department of Plant Physiology, Banaras Hindu University (BHU), Varanasi during Kharif seasons of 2013 and 2014 for assessing the influence of chlorophyll for resistance/susceptibility against shoot and fruit borer, *Leucinodes orbonalis* Guen. in different brinjal varieties. Field experiments were laid-out in randomized block design (RBD) with three replications. A total of 16 varieties (IVBL 9, JB 80, CO2, KS 329, ARKA SHREE, ARKA KESHAV, CHBR 2, DHBR 2, JBL-03-04, IVBL-10, SWARNA PRABHA, PUNJAB SADABAHAR, DBR-8, AZAD BRINJAL-3, RAJENDRA BAIGAN-2 and UTKAL TARANI) was procured from Indian Institute of Vegetable Research (IIVR), Varanasi. The seeds were treated with Captan to prevent soil-borne fungal diseases, and sown in nursery beds of size 7.2 X 1.2 m and 15 cm height for transplanting in the experiment field. Brinjal plants were transplanted in plot size of 3m X 3m on ridges and furrows made 75cm apart. The plant to plant distance was maintained at a 60 cm. A basal dose of 100 kg N, 70 kg P_2O_5, and 60 kg K_2O ha^{-1} was applied and top dressing with 40 kg N ha^{-1} was done at 50 days after transplanting. Irrigation and weeding operations were performed whenever necessary. The shoot infestation of eggplant against shoot and fruit borer was recorded as per cent infestation [10].

Whereas, the chlorophyll content of leaves for were analyzed at 45 DAT and 90 DAT respectively. Fresh leaves of each variety from each replication were taken from five selected plants with respect to the damage by shoot and fruit borer. Quantitative estimation of chlorophyll content (mg/g) were determined for all selected screened varieties and correlated with the shoot infestation of shoot and fruit borer, *L. orbonalis* recorded on respective varieties.

The chlorophyll estimation of leaves was done by the method of Arnon [11]. Leaves of shoot and fruit borer infested plants from all 16 varieties of brinjal were brought to the laboratory. The leaves were cleaned thoroughly with running tap water. Three replicates of each variety were having 500 mg of fresh weight of leaves were taken and homogenized with 80% acetone in a mortar and pestle. The macerate was then filtered with filter paper and the supernatant was collected. Maceration was done again with 80% acetone in a mortar and pestle. For maceration, 10ml of 80% acetone was used to finally obtained filtrant. Filtration was done again and the supernatant was collected. Final volume of supernatant was made up to 50 ml, by adding 80% acetone to it. Finally, O.D was taken at 645 nm and 663 nm, in which 80% acetone served as a blank.

The concentration of chlorophyll pigment was calculated using the following formula and was expressed in mg g^{-1} f.w. of leaf.

Total chlorophyll = [(20.2 X A645) – (8.02 X A663)] X 0.1.

Results and Discussion

The chlorophyll a+b content in leaves varied significantly across different varieties (Table 1) ranged from 0.786 to 0.920 mg g^{-1} fresh weight during Kharif 2013. Highest total chlorophyll content was recorded in CO-2 variety with 0.920 mg g^{-1} was followed by CHBR-2 (0.919 mg g^{-1} leaf), DBR-8 (0.914 mg g^{-1} leaf), DBR-8 (0.908 mg g^{-1} leaf), KS-329 (0.902 mg g^{-1} leaf), JB-80 (0.886 mg g^{-1} leaf), IVBL-9 (0.871 mg g^{-1} leaf) and JBL-03-04 (0.845 mg g^{-1} leaf) were at par with each other. Swarna Prabha and Utkal Tarani with 0.786 mg g^{-1} leaf was ranked as lowest among the total chlorophyll content were at par with Azad Brinjal-3 (0.788 mg g^{-1} leaf), Arka Keshav (0.794 mg g^{-1} leaf), Rajendra Baigan-2 (0.795 mg g^{-1} leaf), IVBL-10 (0.806 mg g^{-1} leaf), Arka Shree (0.825 mg g^{-1} g leaf) and DHBR-2 (0.835 mg g^{-1} leaf).

Among the varieties on the basis of shoot infestation during Kharif 2013 Arka Keshav recorded lowest mean per cent shoot infestation of 3.95 per plant which was statistically at par with Utkal Tarani (4.26% /plant). These two varieties were significantly differed in shoot infestation from Azad Brinjal-3 (9.30% /plant), Swarna Prabha (9.50% /plant), Rajendra Baigan-2 (9.60% /plant), IVBL-10 (10.28% /plant), Arka Shree (10.47% /plant) and DHBR-2 (10.97% /plant) who were found at par among themselves. The varieties like JBL-03-04 (15.49% /plant), IVBL-9 (17.48% /plant), KS-329 (18.14% /plant), JB-80 (18.34% /plant), DBR-8 (18.69% /plant) and CHBR-2 (19.56% /plant) recorded higher shoot infestation and were at par with each other in terms of per cent shoot infestation. The maximum shoot infestation per plant was recorded on variety CO-2 (20.25% /plant) followed by the variety Punjab Sadabahar (20.20% /plant). Total chlorophyll content present in leaves when correlated with a shoot infestation of *Leucinodes orbonalis* showed significant positive correlation (r = 0.944).

The total chlorophyll (a+b) content in leaves varied significantly among the treatments during the Kharif 2014 ranged from 0.790 to 0.922 mg g^{-1} fresh weight. CO-2 variety recorded highest total chlorophyll content 0.922 mg g^{-1} was followed by CHBR-2 (0.921 mg g^{-1} leaf), Punjab Sadabahar (0.919 mg g^{-1} leaf), IVBL-9 (0.860 mg g^{-1} leaf), KS-329 (0.860 mg g^{-1} leaf), and JB-80 (0.858 mg g^{-1} leaf) were at par with each other. Arka Keshav with 0.790 mg g^{-1} leaf was ranked as lowest among the total chlorophyll content was at par with Azad Brinjal-3 (0.794 mg g^{-1} leaf), Utkal Tarani (0.797 mg g^{-1} leaf), Swarna Prabha (0.798 mg g^{-1} leaf), Rajendra Baigan-2 (8.00 mg g^{-1} leaf), IVBL-10 (0.811 mg g^{-1}

leaf), Arka Shree (0.814 mg g^{-1} g leaf), DBR-8 (0.831 mg g^{-1} leaf), DHBR-2 (0.836 mg g^{-1} leaf) and JBL-03-04 (0.840 mg g^{-1} leaf).

Among the varieties on the basis of shoot infestation during second year Arka Keshav (Table 1) again recorded minimum overall mean percent shoot infestation of 4.65 per plant which was at par with Utkal Tarani (5.03% /plant). Utkal Tarani was followed by Swarna Prabha (8.17% /plant), Azad Brinjal-3 (9.48% /plant) and Arka Shree (10.75% /plant) and the percent shoot infestation was found to be statistically at par with each other followed by Rajendra Baigan-2 (10.84% /plant), IVBL-10 (11.43% /plant) and DHBR-2 (12.28% /plant). The varieties like JBL-03-04 (17.21% /plant), KS-329 (18.28% /plant), IVBL-9 (18.92% /plant) and JB-80 (19.13% /plant) were at par with each other recorded higher shoot infestation. CO-2 with 22.06 recorded maximum shoot infestation per plant which was followed by DBR-8 (21.71% /plant), Punjab Sadabahar (21.38% /plant) and CHBR-2 (20.89% /plant) and were having no significant difference among them. However, the significant positive correlation (r= 0.865) was found between chlorophyll content and per cent shoot damage.

From the present investigation, it is evident that chlorophyll content was higher in shoots of susceptible brinjal variety CO-2 as compared to resistant genotype Arka Keshav which are in support with previous workers like [12] and [9] who reported that the increased infestation of shoot and fruit borer with increase in the content of chlorophyll and also noted that the degree of infestation of different brinjal varieties increased with increase of chlorophyll content in plants. Contrary, [13] and [14] observed the average lowest amount of total chlorophyll content in susceptible variety Nayankajal which recorded the highest infestation. Whereas, [15] observed a correlation between chlorophyll content and brinjal shoot and fruit borer and found non-significant. The susceptible nature of CO2 might be due to the high level of the chlorophyll content which may be responsible for higher shoot infestation. High chlorophyll content which results in green colour seems to be the remote factor in attracting *L. orbonalis* which cause more shoot infestation. The presence of biochemical compounds like chlorophyll can be used as one of the criteria for effective and reliable selection to select resistance plants. Therefore, the results of the present study suggested that varieties having lower chlorophyll content in leaves could be utilized in the breeding programme for the development of brinjal shoot and fruit borer resistant varieties in brinjal.

Table 1: Chlorophyll content of brinjal leaves of selected varieties associated with infestation of *L. orbonalis* during *Kharif* 2013-2014.

Treatments	Chlorophyll a+b (mg/g FW) in 2013	Shoot Infestation (%) in 2013	Chlorophyll a+b (mg/g FW) in 2014	Shoot Infestation (%) in 2014
IVBL 9	0.871	17.48	0.860	18.92
JB 80	0.886	18.34	0.858	19.13
CO2	0.920	20.25	0.922	22.06
KS 329	0.902	18.14	0.860	18.28
Arka Shree	0.825	10.47	0.814	10.75
Arka Keshav	0.794	3.95	0.790	4.65
CHBR 2	0.919	19.56	0.921	20.89
DHBR 2	0.835	10.97	0.836	12.28
JBL-03-04	0.845	15.49	0.840	17.21
IVBL-10	0.806	10.28	0.811	11.43
Swarna Prabha	0.786	9.50	0.798	8.17
Punjab Sadabahar	0.914	20.20	0.919	21.38
DBR-8	0.908	18.69	0.831	21.71
Azad Brinjal-3	0.788	9.30	0.794	9.48
Rajendra Baigan-2	0.795	9.60	0.800	10.84
Utkal Tarani	0.786	4.26	0.797	5.03
C.D. ($P \leq 0.05$)	0.077	---	0.064	----
S.E.M. $\pm$	0.027	---	0.022	----
Correlation coefficient (r)	0.944^{**}	---	0.865^{**}	----

FW = Fresh weight.

Conclusion

During first year total chlorophyll content was maximum in leaves of CO-2 variety with 0.920 mg g^{-1}. Minimum total chlorophyll content was noticed in the varieties Swarna Prabha and Utkal Tarani with 0.786 mg g^{-1}. During second year CO-2 variety recorded maximum total chlorophyll content with 0.922 mg g^{-1}. While, minimum total chlorophyll content (0.790 mg g^{-1}) was recorded in Arka Keshav. The significantly positive correlation was observed during both the years between total chlorophyll content and shoot infestation that means increase in chlorophyll content resulted in increased shoot infestation. High chlorophyll content which results in green colour seems to be the remote factor in attracting insect pests which cause more pest infestation. From the present investigation the chlorophyll content was higher in shoots of susceptible brinjal variety CO-2 as compared to resistant genotype Arka Keshav.

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