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Chlorophyll Contents of Brinjal Plants Influencing the Resistance and Susceptibility to Brinjal Shoot and Fruit Borer, *Leucinodes orbonalis* Guenee

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Abstract: The highest chlorophyll 'a' content was recorded in the variety BLO 101 (0.74) and was found significantly different from other varieties/lines except BLO 114 and khotkhotia-1. The lowest amount of chlorophyll 'a' content was observed in the variety Nayankajal (0.43), which was also significantly different from that of other varieties/lines. The chlorophyll 'a' content was negatively correlated (-0.146) with brinjal shoot and fruit borer (BSFB) infestation. The highest chlorophyll 'b' content was recorded at 70 DAT. The amount of chlorophyll 'b' varied significantly among the varieties/lines at different ages. The lowest chlorophyll 'b' content was recorded at 40 DAT (0.26) and it was statistically identical with that of 100 DAT (0.30). The average highest amount of chlorophyll 'b' was estimated in the variety Dhohazari-1 (0.45), which was significantly different from that of other varieties/lines except BLO 45. The lowest amount of chlorophyll 'b' was obtained in the variety Laffa (0.25), which was significantly different from that of all other varieties/lines. The highest amount of total chlorophyll contents was estimated in the variety BLO 114 (1.109) which was significantly different from that of other varieties/lines. The average lowest amount of total chlorophyll was estimated in the variety Nayankajal (0.83) with the highest infestation.

Key word: Shoot borer, *Leucinodes orbonalis*, chlorophyll 'a', chlorophyll 'b', *Solanum melongena*

Introduction

In Bangladesh, Brinjal (*Solanum melongena* L.) is a popular vegetable grown throughout the year. It is the second most important vegetable crop after potato (Anonymous, 1996). A number of good varieties of brinjal are grown throughout Bangladesh. The brinjal shoot and fruit borer, *Leucinodes orbonalis* is one of the major pests of brinjal causing considerable damage every year.

The yield loss caused by this pest has been estimated up to 67% in Bangladesh (Islam and Karim, 1991) and up to 63% in Haryana, India (Dhankar *et al*., 1977). The damage by *L. orbonalis* starts soon after transplanting of seedling and continues till the last harvest of the fruits. In the early stage of crop growth, the newly hatched larvae bore into the petioles and midribs of large leaves and young tender shoots, and close the entry holes with their excreta and feed inside (Butani and Jotwani, 1984). Due to the larval activity within the shoot, the transmission mechanism of the plant sap is affected causing dropping and withering of the shoots (Alam and Sana, 1962).

At the later stage of plant growth, the larvae bore into the flower buds and also enter into the tender fruits, generally through the calyx without leaving any visible sign of infestation (Butani and Jotwani, 1984). At this stage of plant growth, the insect damages both shoots and fruits. Secondary infections by certain bacteria may cause further deterioration of the fruits (Islam and Karim, 1994). As a result, the brinjal becomes rotten which is unfit for human consumption.

Regarding chlorophyll contents for other insects, Pathak (1961) investigated the influence of leaf colour on the resistance of mustard varieties to *L. erysimi* (Kalt) and found that some varieties belonging to brown sarson group having light colour leaves were more susceptible to aphids than those having dark colour leaves. But Teotia and Lal (1970) found that light colour leaves of mustard plants increased the aphid tolerance than the dark colour leaves. Mazokhin-Porshnyakov (1969) reported that most of the aphids were attracted to the leaves reflecting within 500-600 nm range (yellow green colour).

Chloroplasts or chromatophores contain pigments, which convert the light energy into chemical energy during photosynthesis. There are three types of pigments in photosynthetic cells chlorophylls, carotenoids and phycobilins (Malik, 1980). Chlorophylls are the most important pigments which are active in photosynthesis. Natural chlorophyll consists of two components - chlorophyll 'a' ($C_{55}H_{72}O_5N_4Mg$) and chlorophyll 'b' ($C_{55}H_{70}O_6N_4Mg$). A number of different types of chlorophylls occur in the plant kingdom (Strain, 1944). Among these, chlorophyll 'a' is of universal occurrence being present, as far as is known, in all photosynthetic organisms except the green and purple bacteria. Chlorophyll 'b' is found in all higher plants and only in the green algae.

The combined chlorophyll of the leaves varies from 0.13 to 0.35%, chlorophyll 'a' is nearly always present, and about 2.0-2.5 times higher than chlorophyll 'b' (Malik, 1980). Both chlorophylls are optically active. Kabir *et al*. (1989) reported that the physical and chemical factors of mustard plant were responsible for aphid resistance and plants containing less chlorophyll and having soft and thin haired stems and leaves were highly infested by the aphid.

This experiment was, therefore, undertaken to find the interrelationship between brinjal shoot and fruit borer infestation and leaf chlorophyll content of brinjal plant affecting the borer infestation.

Materials and Methods

The experiment was conducted in Bangladesh Agricultural University (BAU), Mymensingh in Kharif season, 1997 for determination of chlorophyll in different varieties/lines of brinjal leaf. Twenty brinjal varieties/lines were grown in Bangladesh Agricultural University (BAU) farm. The experiment was laid out in RCBD with three replications. Seedlings were spaced at 80 X 60 cm^2 in a plot of 16 X 12 m^2. Fifteen tons of cowdung, 115 kg N_2, 72 kg P_2O_5 and 75 kg K_2O per hectare (Rashid, 1993) was applied in the individual plot. The entire amount of cowdung, TSP, half of urea and MP were applied as the basal. The remaining half of urea and MP was applied in two equal splits as top dressing at 21 days after transplanting and at flowering. Intercultural operations viz. weeding, spading, irrigation etc. were performed as and when necessary. Chemical control measures were not taken against insect pests.

Leaf chlorophyll was estimated from the third leaf counted from the top of a shoot. Ten leaves were randomly selected from 10 different plants in each entry in a replicate and leaf pigment was estimated and statistical analysis was done according to Gomez and Gomez (1984). At the same time, percentages of infestations were recorded and were graded from the mean percentages, following the method of Mukhopadhyay and Mandal (1994) for Brinjal shoot and fruit borer. Leaf pigment was estimated by the method of Yoshida *et al*. (1976), which was based on the following principles and method.

Principles: Measuring absorbencies of the chlorophyll solution at two wavelengths were selected by using following equations simultaneously.

$D_{663} = 82.04\ C_a + 9.27\ C_b$ (i)

$D_{645} = 16.75\ C_a + 45.6\ C_b$ (ii)

Where, D_{663} = Absorbance at 663 nm, D_{645} = Absorbance at 645 nm, C_a = Concentration of chlorophyll 'a' in g L^{-1}, C_b = Concentration of chlorophyll 'b' in g L^{-1}. The 82.04, 9.27, 16.75 and 45.6 are the specific absorption coefficients of chlorophyll 'a' and 'b' at the wavelengths of 663 and 645 nm, respectively. Solving the equations (i) and (ii), we have calculated C_a = (0.0127 D_{663} - 0.00269 D_{645}) and C_b = (0.0229 D_{645} - 0.000468 D_{663}).

Method: Chlorophyll contents were determined from the third leaf counted from the top to down of the main stems and the leaves were collected at 40, 70 and 100 days after transplantation. Leaves were cut into small pieces and 50 mg of such masses were placed into a mortar and crushed thoroughly with a pestle. About 10 ml of 80% acetone was added to allow the tissue to be thoroughly homogenized and centrifuged for 5 minutes at 4000 rpm and supernatant. The chlorophyll solution was taken in a cuvette and absorbance was recorded at 663 and 645 nm wavelength by spectrophotometer. Blank data were recorded with 80% acetone.

Chlorophyll 'a', 'b' and total contents were calculated by the following formulae (Yoshida *et al.*, 1976):

Chlorophyll 'a' = (12.7 X D_{663} - 2.69 X D_{645}) X 10/ (1000 X 0.05) mg/gfw

Chlorophyll 'b' = (22.9 X D_{645} - 4.68 X D_{663}) X 10/ (1000 X 0.05) mg/gfw

Total Chlorophyll = (20.2 X D_{645} + 8.02 X D_{663}) X 10/(1000 X 0.05) mg/gfw

Where, mg/gfw = Milligram per gram fresh weight.

Results and Discussion

Relationship between chlorophyll 'a' content and brinjal shoot and fruit borer infestation of different selected brinjal varieties/lines at different ages: Chlorophyll 'a' content of 3rd leaf of different brinjal varieties/lines varied significantly from 0.28 (Nayankajal) to 0.67 (BLO101), 0.43 (Nayankajal) to 0.69 (BLO101), 0.59 (Nayankajal) to 1.07 (BLO 114) at 40, 70 and 100 DAT, respectively (Fig. 1). Amount of chlorophyll 'a' also varied significantly with the age of brinjal plants with highest at 100 DAT (0.76) and lowest at 70 DAT (0.53), which was statistically similar to that of 40 DAT. The correlation coefficients of chlorophyll 'a' content of the 3rd leaf between 40 and 70 DAT (0.549), 40 and 100 DAT (0.583) were significant at 1 % level but between 70 and 100 DAT (0.306) was insignificant. Besides infestation patterns of BSFB were different at 40, 70 and 100 DAT (Fig. 4). On the basis of average value highest chlorophyll 'a' content was recorded in the variety BLO 101 (0.74) and was found significantly different from other varieties/lines except BLO 114 and khotkhotia-1 (Table 1). The lowest amount of chlorophyll 'a' content was observed in the variety Nayankajal (0.43), which was also significantly different from that of other varieties/lines. The chlorophyll 'a' content was negatively correlated (-0.146) with brinjal shoot and fruit borer (BSFB) infestation (Fig. 1) i.e., the varieties (BLO 101, Nayankajal, BLO 85, Khotkhotia-2, Borka and BLO 98) with light coloured leaves at 70 DAT were more susceptible to BSFB than those having darker coloured leaves at 100 DAT (Pathak, 1961; Mazokhin-Porshnyakov, 1969 and Kabir *et al.*, 1989) except some varieties (BLO 95, Islampuri) in which infestation increased with the increase in chlorophyll 'a' content (Fig. 1 and 4).

Relationship between chlorophyll 'b' content and brinjal shoot and fruit borer infestation on different selected brinjal varieties/lines at different ages: The amount of chlorophyll 'b' ranged from 0.20 (Islampuri) to 0.34 (Dhohazari-1) at 40 DAT, 0.28 (Laffa) to 0.51 (Dhohazari-2) at 70 DAT and 0.21 (Baromashi) to 0.52 (Dhohazari-1) at 100 DAT (Fig. 2). The highest chlorophyll 'b' content was recorded at 70 DAT. Amount of chlorophyll 'b' varied significantly among the varieties/lines at different ages. The lowest chlorophyll

Table 1: Leaf chlorophyll (mg/gfw) of 20 selected brinjal varieties/lines at different ages (BAU farm; Kharif, 1997)

Varieties/lines with accession no.	Mean chlorophyll (mg/gfw) contents of 40, 70 and 100 DAT			Percent infestation of BSFB*	Level of resistance
	Chlorophyll 'a'	Chlorophyll 'b'	Total Chlorophyll		
Baromashi	0.55ji	0.31c-e	0.86gh	14.75de	T
BLO 45	0.56h-j	0.43ab	0.99bc	23.13b-e	MT
BLO 85	0.65d-f	0.29c-f	0.93cf	31.69a-c	S
BLO 95	0.62e-g	0.27d-f	0.89fg	33.76ab	S
BLO 96	0.56h-j	0.30c-e	0.87gh	19.96c-e	MT
BLO 98	0.65c-e	0.31cd	0.96b-d	29.06bc	S
BLO 101	0.74a	0.27d-f	1.013b	22.37b-e	MT
BLO 114	0.71ab	0.40b	1.109a	28.65bc	S
Borka	0.64d-f	0.30c-e	0.95c-f	27.70b-d	S
Dhohazari-1 (BLO 81)	0.53j	0.45a	0.99bc	21.42b-e	MT
Dhohazari-2 (BLO 72)	0.55ij	0.40b	0.96b-e	22.79b-e	MT
Islampuri	0.59g-l	0.27d-f	0.87gh	23.26b-e	MT
Jhumki	0.54j	0.32c	0.86gh	13.77e	T
Khotkhotia-1 (BLO117)	0.71ab	0.27d-f	0.99bc	20.18c-e	MT
Khotkhotia-2 (BLO118)	0.64d-f	0.30c-e	0.95c-f	27.74b-d	S
Laffa	0.56c-e	0.25f	0.90ef	25.28b-e	MT
Nayankajal	0.43k	0.40b	0.83h	42.14a	HS
Sada ball	0.69bc	0.26ef	0.95b-f	19.78c-e	MT
Singnath (BLO 83)	0.60f-h	0.30c-e	0.91d-g	18.97c-e	MT
Uttara	0.68b-d	0.28c-f	0.97bc	18.71c-e	MT
SE	0.0100	0.0091	0.0178	2.6360	
CV%	4.52	9.01	4.74	37.55	

Within column means followed by same letter(s) did not differ significantly at $P<0.01$ by DMRT. DAT = Days after transplantation, HS = Highly susceptible, S = Susceptible, MT = Moderately tolerant and T = Tolerant

*BSFB = Brinjal shoot and fruit borer

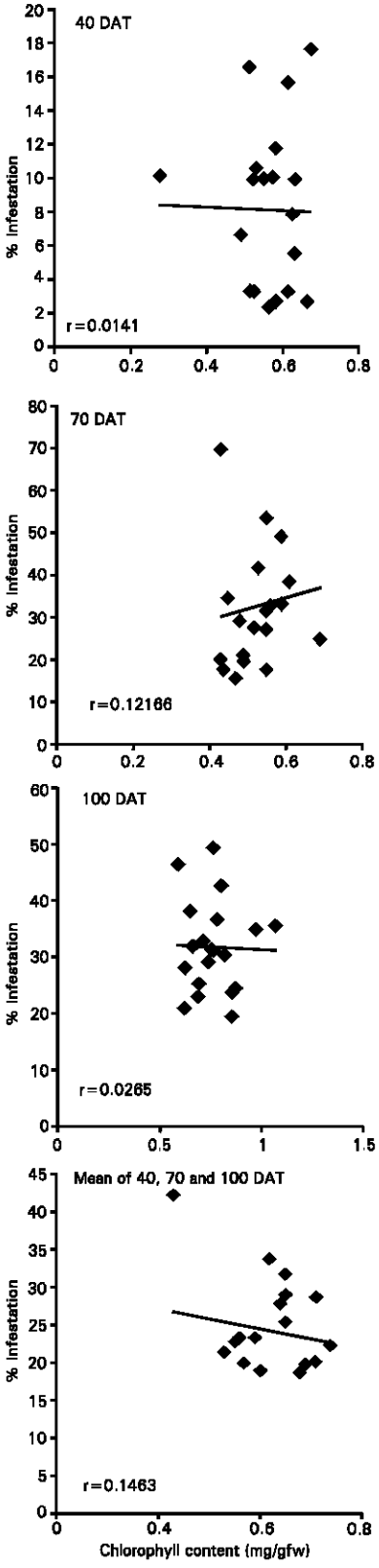

Fig. 1: Relationship between chlorophyll ' a ' content and brinjal shoot and fruit borer infestation at different DAT

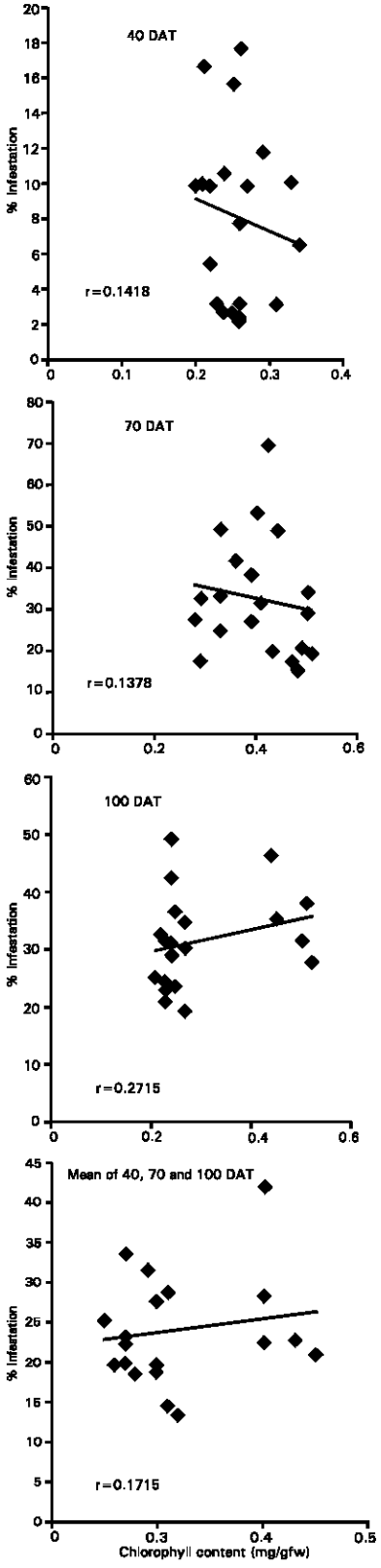

Fig. 2: Relationship between chlorophyll ' b' content and brinjal shoot and fruit borer infestation at different DAT

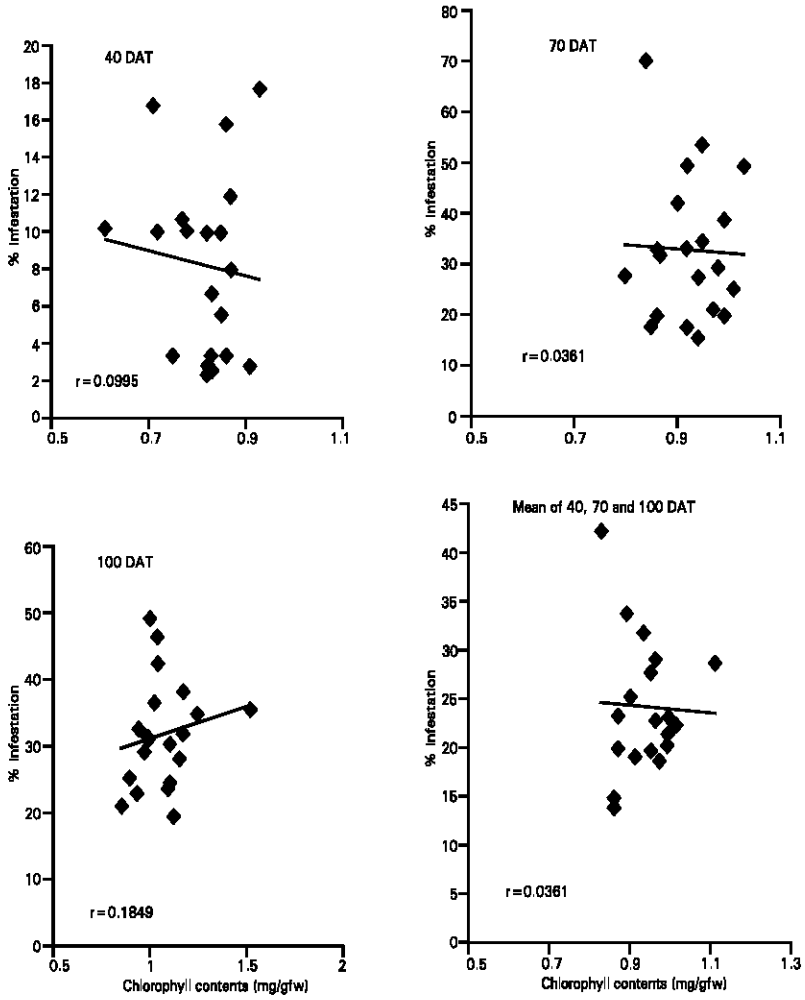

Fig. 3: Relationship between total chlorophyll contents and brinjal shoot and fruit borer infestation at different DAT

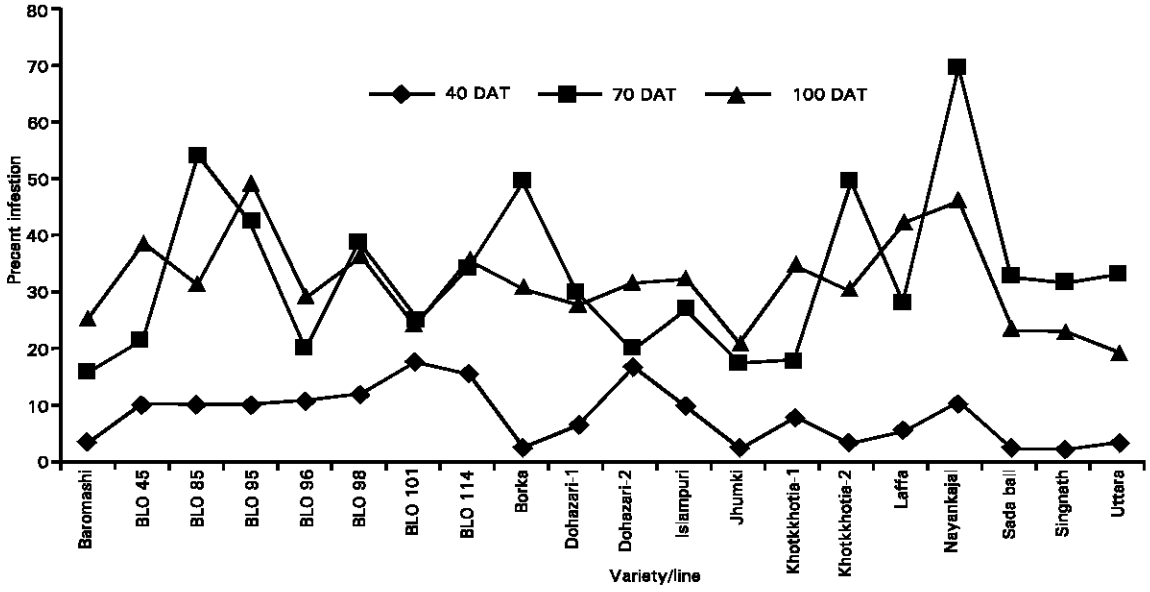

Fig. 4: Infestation pattern of brinjal shoot and fruit borer in twenty varieties/lines of brinjal at 40, 70 and 100 DAT

'b' content was recorded at 40 DAT (0.26) and it was statistically identical with that of 100 DAT (0.30). The average highest amount of chlorophyll 'b' was estimated in the variety Dhohazari-1 (0.45), which was significantly different from that of other varieties/lines except BLO 45 (Table 1). The lowest amount of chlorophyll 'b' was obtained in the variety Laffa (0.25), which was significantly different from that of all other varieties/lines. The correlation coefficients of chlorophyll 'b' content between 40 and 70 DAT (0.084), 40 and 100 DAT (0.409), 70 and 100 DAT (0.568) were non significant. Infestation patterns of BSFB in different brinjal varieties/lines at 40, 70 and 100 DAT are shown in Fig. 4. The chlorophyll 'b' content was positively correlated (0.171) with BSFB infestation (Fig. 2) i.e., infestation increased with the increase of chlorophyll 'b' (Table 1) (eg., in BLO 45 and Dhohazari-1) and decreased at a certain point in some varieties (eg., in BLO 85, Dhohazari-2 and Nayankajal) except some other varieties (eg., in Baromashi, BLO 95, BLO 96, Islampuri, Jhumki, Khotkhotia-1 and Laffa) which contradict the findings of Teotia and Lal (1970).

Relationship between total chlorophyll contents and brinjal shoot and fruit borer infestation on different selected brinjal varieties/lines at different ages: Total chlorophyll contents of different brinjal varieties/lines ranged from 0.61 (Nayankajal) to 0.93 (BLO 101) at 40 DAT, 0.80 (Laffa) to 1.03 (Borka) at 70 DAT and 0.85 (Jhumki) to 1.52 (BLO 114) at 100 DAT (Fig. 3). Chlorophyll contents varied significantly among the varieties/lines at different plant ages. Besides infestation pattern for BSFB varied among the varieties/lines at different plant ages (Fig. 4). Total chlorophyll content was positively correlated with the infestation of BSFB at 100 DAT (Fig. 3). The highest total chlorophyll contents were recorded at 100 DAT (1.07) and lowest at 40 DAT (0.81). The correlation coefficients of total chlorophyll content between 40 and 70 DAT (0.150), 40 and 100 DAT (0.274), and 70 and 100 DAT (0.04) were not significant. The average highest amount of total chlorophyll contents was estimated in the variety BLO 114 (1.109) which was significantly different from that of other varieties/lines. The average lowest amount of total chlorophyll was estimated in the variety Nayankajal (0.83) with highest infestation (Table 1), which supports the findings of Pathak (1961) and Kabir *et al.* (1989). This finding was significantly different from that of other varieties/lines except Baromashi, BLO 96, Islampuri and Jhumki.

Chlorophyll contents varied significantly among the varieties/lines. The maximum leaf chlorophyll 'a', leaf chlorophyll 'b' and brinjal shoot and fruit borer infestation were found in Dhohazari-1, BLO 114 and Nayankajal, respectively and these variables were minimum in Laffa, Nayankajal, and Jhumki (Table 1). The correlation coefficients between BSFB infestation and chlorophyll 'a', chlorophyll 'b' and total chlorophyll were -0.146, 0.171 and 0.036, respectively (Fig. 1-3). The light coloured leaves (due to less chlorophyll 'a') were more infested by BSFB compared with darker leaves of highest chlorophyll 'a' while degree of infestation of different varieties/lines increased with the increase of chlorophyll 'b' and total chlorophyll but declined at a certain point in some varieties/lines (Table 1). So, chlorophyll ('a' and 'b') contents of brinjal plant leaf has no clear-cut effect/ influence on the infestation of brinjal shoot and fruit borer.

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