International Journal of Economic Plants 2014, 1(1):015-021

Full Research Article

Study on the Anatomical Characteristics of Brinjal Varieties/Lines Influencing Brinjal Shoot and Fruit Borer Infestation

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Article History

Manuscript No. IJEP3
Received in 03.03.2014
Received in revised form 08.04.2014
Accepted in final form 02.05.2014

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Keywords

Brinjal, anatomy, fruit borer

Abstract

Anatomical characteristics of brinjal shoot and fruit of 5 resistance/susceptible brinjal varieties/lines viz. BL 099, BARI brinjal-6, BL 117, BL 072 , BARI brinjal -1 and wild *Solanum torvum* was studied at the experimental farm and Entomology laboratory of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during the period from September 2004 to April 2005 in a randomized block design with three replications. From the observation it seem that resistant brinjal varieties (BL 099, BARI brinjal-6, BL 117, BL 072 , and wild *Solanum torvum*) with thick cuticle, broad and thick collenchymataous area (8-9 layers), compact paranchyma cell, compact arrangement of vascular bundle and small pith area (1.67 mm) showed lower shoot infestation. Where as susceptible variety (BARI Brinjal-1) has thin cuticle and collenchymatous area (6-7 layers), loose pharanchyma cell, poorly develop vascular bundle and large pith area (3.47 mm). The thickness of pericarp and mesocarp were positively correlated (R^2=0.64, 0.38) with the degree of fruit damage.The percent of fruit infestation decreases with the increases in number of seed per gram flesh of brinjal fruit. The variety having compact seed ring (BL009 and wild *S.torvum* with closely arranged seeds in mesocarp showed less infestation while variety with less compact seed ring with distantly arranged seed (BARI Brinjal-1) suffered more fruit infestation.

1. Introduction

Brinjal (*Solanum melongena* L.) is one of the most popular and principal vegetable crops grown in Bangladesh and in other parts of the world. It is the second most important vegetable crops after potato in relation to its production and consumption.The major constraint of brinjal production is that the crop is attacked by 53 species of insect pests (Nayar et al. 1995). Among them, brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* (Guenee) is the most destructive pest of brinjal in Bangladesh (Alam 1969, Chattopadhyay 1987) and India (Tewari and Sandana 1990) and also a major pest in other countries of the world (Dhanker 1988). Yield loss caused by brinjal shoot and fruit borer pest has been estimated up to 67% in Bangladesh (Islam & 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, midribs of large leaves and young tender shoots. They 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 the 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.

Host plant characters including morphological or structural qualities interfere with insect behavior such as mating, ovipositing, feeding and food ingestion. Pubescence and tissue hardness limit insect mobility acting as structural barriers (Webster 1975). Various mechanical resistant factors in plants such as solidness of stem, thickness of tissues, anatomical adaptations, and protective structures affect the use of a plant

as a host by phytophagous insects like brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee, Pyralidae: Lepidopera). Resistance due to antixenosis or non-preference appears to have a anatomical basis. Non-preference of selected tolerant, moderately tolerant, susceptible cultivars has been attributed to anatomical characters. Compact vascular bundles in a thick layer, with lignified cells and less area of pith in the shoot provided some resistance to *L. orbonalis* (Panda et al. 1971, Chelliah and Srinivasan 1983). Similarly, hardness of fruit skin and flesh due to compact seed arrangement and tight calyx affects larval entry into fruits which provided some degree of resistance to brinjal shoot and fruit borer (Lall & Ahmad 1965). Ali et al. (1994) examined the anatomical characters of 28 brinjal varieties/lines, which indicated that fruits with compact mesocarp and pulp suffer lower infestation than those with loose mesocarp and pulp. Mishra et al. (1988) tested 24 brinjal varieties for resistant to *L. orbonalis* and found that leaf color and phyllotaxy are not related to pest resistance, but tightly arranged seeds in the mesocarp, thick fruit skin and closely packed vascular bundles in pulp are possible causes of resistance in some varieties. Panda et al. (1971) evaluated 19 brinjal varieties for resistant to *L. orbonalis* and ascertained that the resistant varieties (Thorn Pendy, Black Pendy, H-165 and H-407) possess heavily lignified sclerenchymatous layers and closely packed vascular bundles and seeds are packed tightly in the mesocarp. They also noticed that the thick pithy stem and loose calyx of the susceptible varieties facilitated larval entry. Studies on resistance/tolerance of brinjal varieties against L.orbonalis Gunee in relation to anatomical characters of shootr and fruit of eggplant are scanty.

Therefore, the present work has been undertaken with the following objectives:

to identify the anatomical characteristics of brinjal shoot and fruit responsible for resistance to BSFB and.

to study the effect of these anatomical characters of brinjal shoot and fruit on the BSFB and the brinjal plant itself.

2. Materials and Methods

The study was conducted with 5 brinjal varieties/lines viz., BL 099, BARI brinjal-6, BL 117, BL 072 , BARI brinjal-1 and wild *Solanum torvum* at the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur and the Laboratory of Entomology, Crop Botany Department of BSMRAU during the period from September 2004 to April 2005 in a randomized block design with three replications. The crop was grown following the recommended practices (Rashid et al. 1993) except application of insecticide. The individual plot size was 3×3 m. The seedling were transplanted at spacing of 1 m between lines and 60 cm between plants.

For the anatomical study of brinjal shoot internode in between 3rd and 4th leaves were collected and fixed and preserved in formalin aceto-alcohol (FAA) solution (Johansen,1940). Transverse sections of the stem were made from fixed materials by free hand sectioning, using ordinary razor blades. Sections were made through the region between 3rd and 4th leaf from the top. The uniform thin sections were selected,then it was stained in saffranin and mounted in 50% glycerine temporarily, which are more or less similar in size as compared to the following the general principle of Johansen (1940) . The slides were examined under microscope to study the variation of anatomical characteristics of resistant and susceptible brinjal varieties/lines. Digital slide califers was used for measuring diameter of the internode pith.

The anatomical character of brinjal fruit studied included thickness of pericarp and mesocarp, number of seed per gram flesh and arrangement of seed. During the harvesting period mature fruit of average size from each variety were cut horizontally and the thickness of pericarp and mesocarp were measured with a scale. The arrangement of seed ring were examined and divided into i) compact ii) medium compact iii) less compact and iv) highly compact types. For counting the number of seed gm^{-1}, flesh a fruit were cut into equal 4 sections longitudinally then separated seeds from one section and weighed seeds and flesh separately.

Percentage of insect infestation by number and weight being an important criterion for evaluating the performance of brinjal against *L. orbonalis*, the number and weight of infested and healthy brinjal fruits per plot were recorded at each harvest. Number of healthy and infested shoot also collected at every 7 days interval for the calculation of percent shoot infestation. All the data were analyzed statistically by using MSTAT-C software.

Linear regression analysis was also performed to explore the relationships between different anatomical parameter of brinjal shoot and fruit with shoot and fruit infestation by BSFB.

3. Results and Discussion

Anatomical characteristics of brinjal shoot of susceptible and resistance varieties/lines were studied and presented in Table 2.1 and plate 1-6.

Epidermis of top internode of susceptible variety , BARI brinjal-1 is single layer, small and large cell with thin walled and thin to moderately thick cuticle (Plate 1). There are 6-7 layer of thick collenchymatous cell beneath the epidermis. Paranchymatous cells are 7-9 layers and are larger in size. Vascular form a ring with various thickness and poorly developed, loosely packed (Plate-1), less luignified. Internode of moderately resistance varieties/line, BL072 and BL117

has single layer epidermis, uniform, thin walled cell with moderately thick to thick cuticle. There are 7-8 layer of collenchymatous cell which are very thick and 6-8 layers round, oval or polygonal paranchymatous cell. Vascular bundle are moderately developed, large, moderately compact (Plate 2, 3) and medium lignified. Internode of resistance varieties/ line BARI brinjal-6, BL099 and wild *S. torvum* has uniform, smaller, thick walled epidermis with thick cuticle. There are 8-9 layers thick collenchymatous cell with 5-7 layers round and oval paranchymatous cell. Vascular bundle well developed large compact and uniform (Plate-4,5,6).

Highest diameter of pith of brinjal shoot was recorded in BARI brinjal-1 (3.47 mm) which was statistically similar to BL-117 (3.03 mm) and BL072 (2.9 mm) and lowest pith diameter was recorded in BL099 (1.67 mm) which is similar to BARI brinjal-6 (1.83 mm) and *S. torvum* (1.73 mm) (Table 2.1) .A positive correlation (R^2=0.89)was observed between shoot pith area and percent shoot infestation (Figure 2.1)

The identification of anatomical features of brinjal shoot governing resistance can help in the development of a rapid screening technique. From the observations it seems that brinjal varieties with thick cuticle, broad and thick collenchymatous area, compact parenchyma cells and compact arrangement of vascular bundles with lignified cells and small pith area offer some degree of resistance to brinjal shoot and fruit borer (Table 2.1) where as susceptible varieties have thinner cuticle and collenchymatous area ,loose parenchyma cells and large pith, poorly develop vascular bundle are the characters responsible

Table 2.1: Anatomical characters of top inter-node of shoots of some selected resistant and susceptible varieties/lines of brinjal influencing brinjal shoot and fruit borer infestation during winter 2004

Variety/line	Diameter of top inter-node pith (mm)	Level of lignification of inter-node tissue	Arrangement of vascular bundle in top inter-node	shoot infestation (%)
BL-099(R)	1.67b	More lignified	Well developed, large, More compact and uniform vascular bundle	2.73c
BARI brinjal-6(R)	1.83b	Medium lignified	Well developed, large, Compact and uniform vascular bundle	3.82bc
BL-117(R)	3.03a	Medium lignified	Moderately develop, large, Medium compact	5.38ab
Bl-072(R)	2.90a	Medium lignified	Moderately develop, large, Medium compact vascular bundle	5.01ab
BARI brinjal-1(S)	3.47a	Less lignified	Poorly developed, smaller, Loosely packed vascular bundle	6.73a
Solanum torvum(R)	1.73b	Medium lignified	Well developed ,large, Compact vascular bundle	1.81c

R=Resistant S= Susceptible; Figures in the same column having the same letter(s) are not significantly different at 5% level using Least Significant Difference test (LSD) Values are means of three replications.

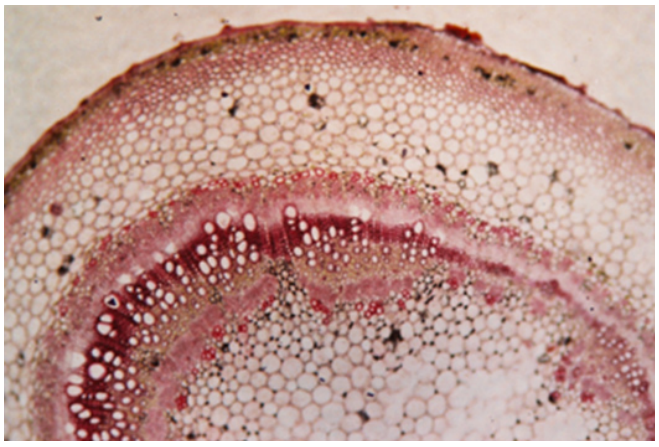

Plate 1: Transverse section of the shoot of BARI brinjal-1 showing single layer Epidermis, thin cuticle, 6-7 layers of collenchyma cells, vascular tissues forms a ring with various thickness, (c=cuticle, e=epidermis, ch=chlorenchyma cells,co=collenchyma cells, pc= parenchyma cells, pf= phloem fibre, xf=xylem fibre,[1=X38].

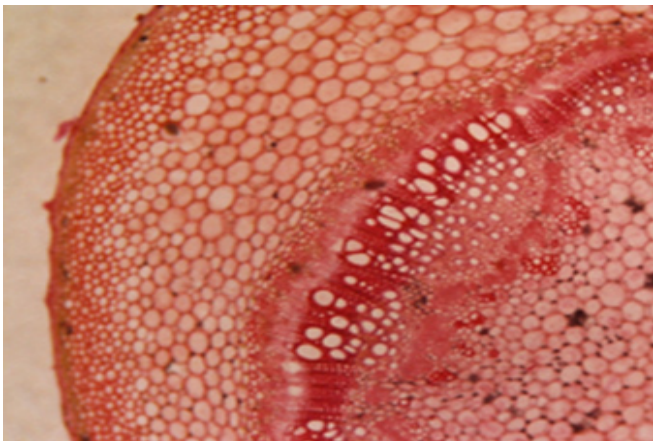

Plate 2: Transverse section of the shoot of BL 117 showing single layer epidermis with thin cuticle, vascular tissues forms a ring with various thickness, 7-8 layers of collenchyma cells, parenchyma cells less lignified fibres and vessels (t=trichome, c=cuticle, e=epidermis, co=collenchyma cells, pc=parenchyma cells, pf=phloem fibre, xf=xylem fibre,) [2=X38]

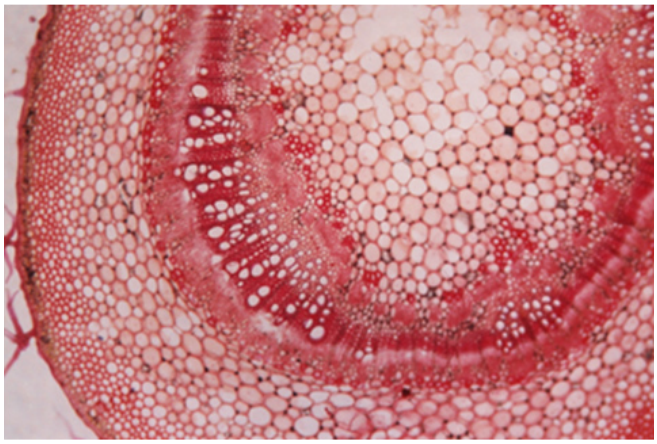

Plate 3: Transverse section of the shoot of BLO 72 showing epidermis with thin cuticle, prominent intercellular spaces in the cortical region with parenchyma cells, 7-8 layers of collenehyma cells and large pith area (t=trichome, c=cuticle, e=epidermis, co=collenchyma cells, pc=parenchyma cells, pf= phloem fibre, xf=xylem fibre,)[3=X38,].

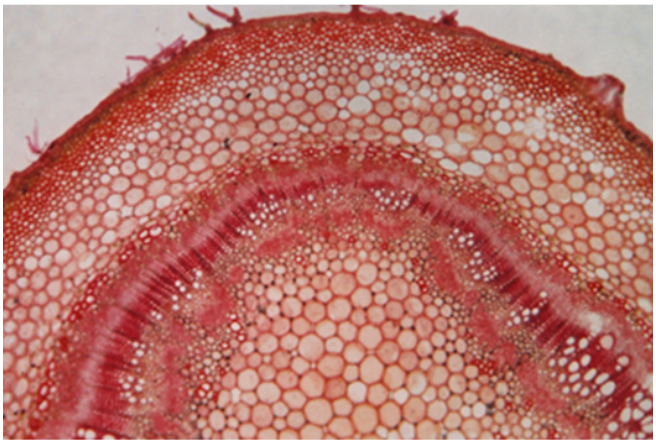

Plate 4: Transverse section of the shoot of BL099 showing single layer epidermis, thick cuticle, 8-9 layers of collenchyma cells, vascular tissues forms a ring with uniform thickness, phloem and xylem fibres are well developed and lignified (c=cuticle, e=epidermis, ch=chlorenchyma cells, co=collenchyma cells, pc=parenchyma cells, pf= phloem fibre, xf=xylem fibre,) [4=X38]

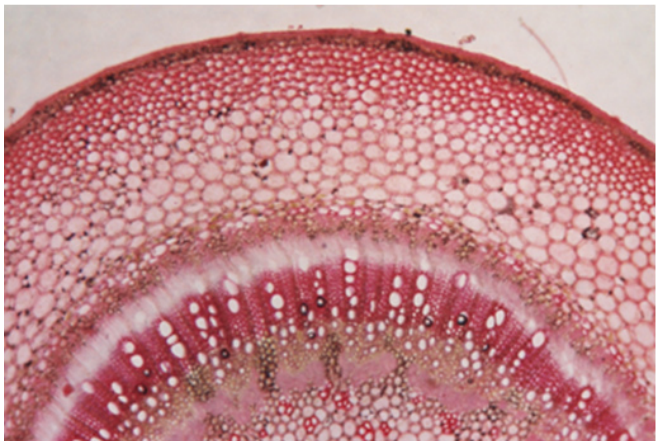

Plate 5: Transverse section of the shoot of BARI brinjal-6 showing single layer epidermis, 1-2 layers of chlorenchyma cells and 8-9 layers of collenchyma cells, vascular tissues forms a ring with uniform thickness, phloem and xylem fibres are well developed and lignified (c=cuticle, e=epidermis, ch=chlorenchyma cells, co=collenchyma cells, pc=parenchyma cells, pf= phloem fibre, xf=xylem fibre, [5=X38].

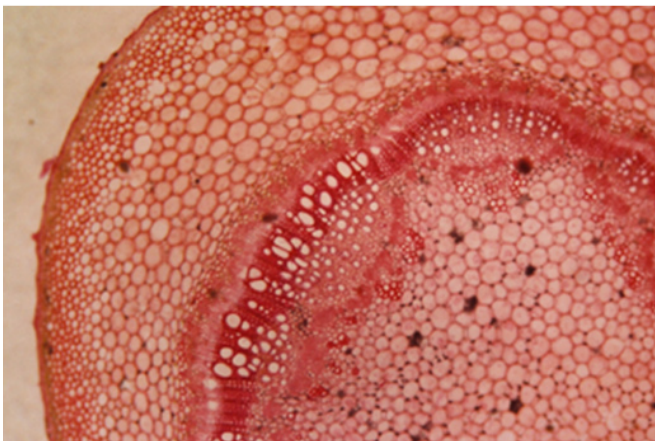

Plate 6: Transverse section of the shoot of *Solanum torvum* showing single layer epidermis, thick cuticle, 8-9 layers of collenchyma cells, vascular tissues forms a ring with uniform thickness, phloem and xylem fibres are well developed and lignified (c=cuticle, e=epidermis, ch=chlorenchyma cells, co=collenchyma cells, pc=parenchyma cells, pf= phloem fibre, xf=xylem fibre,) [6=X38]

for susceptibility. To support the result of the present study findings of some of the researchers need to be explained. Subbarathan (1982) reported that varieties with narrow shoot pith showed less shoot infestation. In conformity with present results Panda et al. (1974) also stated large pith area of shoot provided more food and space for the young larva, favoured its development and thus make a variety susceptible to borer. Ishaque and Chawdharay (1984) reported that resistant varieties had highly lignified scleranchymatous hypodermis and closely packed vascular bundle arranged in a ring acted as a barrier to BSFB larva. They further reported that the shoot of susceptible varieties had neither lignified scleranchymatous layer nor closely packed vascular bundle.

The effect of anatomical characteristics of brinjal fruit in different varieties/line have been studied and presented in Table 2.2

4. Thickness of pericarp and mesocarp

Highest thickness of pericarp of brinjal fruit was obtained in the varieties, BARI brinjal-1 (2.67 mm), BARI brinjal-6 (2.42 mm) and lowest in *S. torvum* (0.18 mm) (Table 2.2). The thickness of pericarp and mesocarp were positively correlated with the

degree of fruit damage (R^2=0.64 and 0.38, respectively) (Figure 2.1). *S. torvum*, BL 099 has less thicken pericarp (0.18 mm and 1.92 mm) and mesocarp (0.15 mm and 0.27 cm) faced lower infestation (13.33% and 21.92%) (Table 2.2). The variety BARI brinjal-1 have shorter mesocarp (0.87cm) but had highest fruit infestation (64.13%). On the other hand variety BARI brinjal-6, BL072 had wider pericarp (2.42 mm and 1.50 mm) and mesocarp (1.37 cm and 1.12 cm) and were experianced higher fruit infestation (39.16%, 35.32%). Simillar observation with respect of thickness of pericarp and mesocarp were also reported by Subbaratna (1982). However, Grewal and singh (1993) did not found any trend in degree of fruit damage and mesocarp thickness. Ali et al. (1994) also found that brinjal with compact mesocarp had low percent fruit infestation than those with loose mesocarp.

5. Number of seed per gram flash

The number of seed per gram flesh varied from 5 to 11. The variety/line BL117, *S. torvum* had minimum number (5.00 and 5.66) of seeds and BL099 and BL072 had the maximum (11). The number of seed per gram flash were negatively correlated to the percent of fruit infestation (R^2=0.25) (Figure 2.1). The result showed that the line BL 099 and wild *S.torvum* with highest number of seed had the lower percent of infested fruit (21.92%), (13.33%) and the variety BARI brinjal-1 with lower number of seed (8.00) had the highest infestation (64.13%). The percentage of fruit infestation decreases with the increase in number of seed per gram flash.The similar result was obtained by Grewal and Dilbagh (1995) and they opined that the higher number of seeds of brinjal acted as a mechanical barrier against the entry of fruit borer.

6. Arrangement of seeds

The variety having compact seed ring with closely arranged seeds in mesocarp showed less infestation (13.33%) while variety with less compact seed ring with distantly arranged seed suffered more fruit infestation(64.13%) (Table 2.2). The tight arrangement of seeds in the mesocarp might acted as a barrier against the entry of larvae inside the pulp. The important role of above physical character of mesocarp might

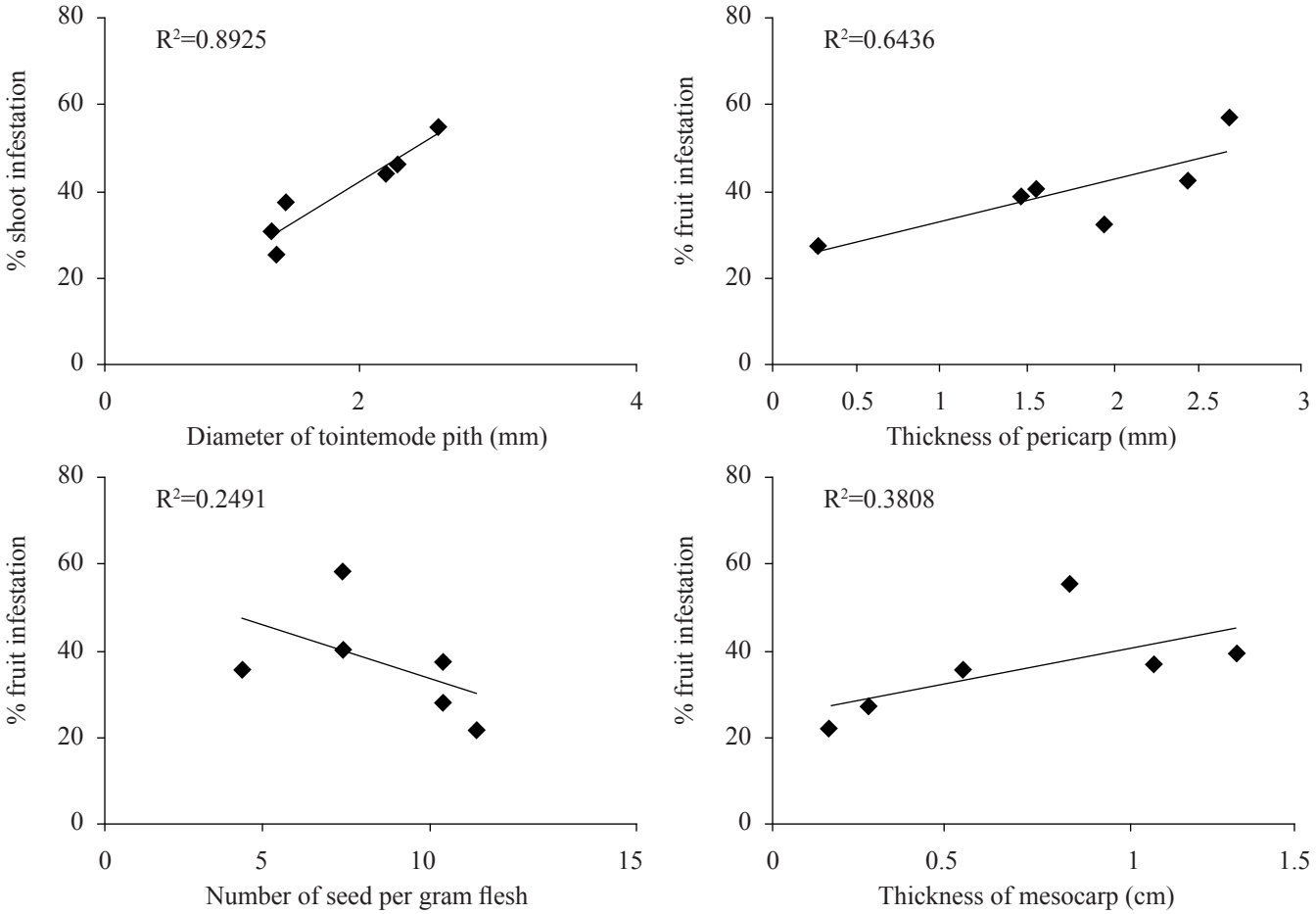

Figure 2.1: Relationship between, diameter of top internode pith, thickness of pericarp, thickness of mesocarp and number of seed/gram flesh with percent shoot infestation and fruit infestation of brinjal by brinjal shoot and fruit borer.

Table 2.2: Anatomical characters of seven days old brinjal fruits of some selected resistant and susceptible varieties/lines influencing brinjal shoot and fruit borer infestation during winter 2004

Variety/line	Thickness of pericarp (mm)	Thickness of mesocarp (cm)	Ratio of seed: flesh	No. of seed gm^{-1} flesh	Arrangement of seeds	Fruit infestation (%)
BL-099(R)	1.92ab	0.27e	1: 8.9	11.00a	Compact seed ring with closely arranged seeds	21.92cd
BARI brinjal-6(R)	2.42a	1.37a	1: 15.14	8.00b	Medium compact seed ring with distantly arranged seeds	39.19b
BL-117(R)	1.42b	0.55d	1: 37.95	5.00c	Medium compact seed ring with distantly arranged seeds	32.79bc
Bl-072(R)	1.50b	1.12b	1: 10.58	11.00a	Medium compact seed ring with distantly arranged seeds	35.32bc
BARI brinjal-1(S)	2.67a	0.87c	1: 20.81	8.00b	Less compact seed ring with distantly arranged seeds	64.13a
Solanum torvum(R)	0.18bc	0.15e	1: 1.62	12.00a	Highly compact seed ring with closely arranged seeds	13.33d

R=Resistant S= Susceptible; Figures in the same column having the same letter(s) are not significantly different at 5% level using Least Significant Difference test (LSD) Values are means of three replications.

impart resistance in brinjal fruits against BSFB have been reported (Panda et al.1971, Krishnaiah and Vizay 1975 and Lal et al.1976) earlier.

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