SCREENING OF SOME BRINJAL HYBRIDS AND VARIETIES AGAINST BRINJAL SHOOT AND FRUIT BORER

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SCREENING OF SOME BRINJAL HYBRIDS AND VARIETIES AGAINST BRINJAL SHOOT AND FRUIT BORER

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CERTIFICATE

This is to certify that thesis entitled "**SCREENING OF SOME BRINJAL HYBRIDS AND VARIETIES AGAINST BRINJAL SHOOT AND FRUIT BORER"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) in ENTOMOLOGY,** embodies the result of a piece of bona fide research work carried out by **ASHRAFUL ISLAM**, Registration no. **08-02834** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: July, 2014
Dhaka, Bangladesh

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ABSTRACT

An experiment was conducted in the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, from mid-November, 2013 to May, 2014 to study varietal performance of brinjal against brinjal shoot and fruit (*Leucinodes orbonalis* Guinee.). The varieties are BARI brinjal 1, BARI hybrid brinjal 3, BARI brinjal 3, BARI hybrid brinjal 4, BARI brinjal 5, BARI brinjal 6, BARI brinjal 7, BARI brinjal 8, BARI brinjal 9, BARI brinjal 10 .The experiment was laid out in single factor Randomized Complete Block Design (RCBD) with three replications. The data were recorded on shoot infestation; fruit infestation by number and weight at vegetative, early, mid and late fruiting stages; plant and yield related attributes as well as yield of brinjal. Among all varieties, V_6 (BARI brinjal 6) showed best performance against brinjal shoot and fruit borer and reduced the highest percent of shoot infestation, fruit infestation by number and weight in early, mid and late stages (1.18, 3.54 and 2.74%, respectively) throughout the growing period of brinjal. Besides, BARI hybrid brinjal 3 showed best performance in case of single fruit weight, fruit number per plant and yield throughout the growing period of brinjal. In case of yield, BARI hybrid brinjal gave highest production. On the other hand, BARI brinjal 7 showed lowest performance in case of shoot infestation, infestation and fruit infestation by number and by weight, thrichome hair density and thorn on stem and leaves. It was revealed from the experiments, V_6 (BARI brinjal 6) showed best result and V_7 (BARI brinjal 7) showed least performance in case of shoot infestation, fruit infestation by number and weight in early, mid and late stages, number of fruits per plant and single fruit weight and yield. Brinjal yield was increased due to increases of number of branches per plant, number of leaf per plant and plant height.

CHAPTER I

INTRODUCTION

Brinjal *(Solanum melongena* L.) is the most important vegetable grown extensively in Bangladesh both kitchen and commercial gardens in Rabi and Kharif seasons. In Bangladesh, Brinjal is the second most important vegetable crop after Tomato in relation to its total production (Anonymous, 1996). Brinjal covers an area of 11, 5424 ha, which is about 15.75% of total vegetable area of this country and its production is about 3, 41,262 tons during the year 2009-10 (BBS, 2012). Brinjal (*S. melongena* L.), European name is eggplant also known as aubergine, guinea squash and garden egg. Brinjal is belongs to the family Solanaceae, is rich in calcium, phosphorus, sulphur, chloride and vitamins A and C.

Various factors are responsible for low yield of Brinjal in Bangladesh and out of which attack of different pests is one of the most important one. Brinjal is attacked by 53 species of insect pests (Nayer *et al*., 1995). Out of them, 8 species are considered as major pests causing serious damages to the crop and the remaining ones including one species of mite are considered as minor pest as they generally cause little damage (Bishwas *et al*., 1992). The insect pests cause enormous losses to brinjal in every season and every year.

A horde of insect pests attack this crop due to cultivation throughout the year, out of which brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee, Pyralidae: Lepidoptera) is the most serious (Sardana *et al.*, 2004). The genus *Leucinodes* includes three species *L. orbonalis* Guenee, *Leucinodes diaphana* Hampson, *Leucinodes apicalis* Hampson (Alam *et al*,. 1964). It caused 31-86% fruit damage in Bangladesh (Alam *et al.*, 2003), 37-63% in India (Dhankar, 1988) and 50-70% in Pakistan (Saeed and Khan, 1997). The management practices of the pest are limited to frequent spray of different chemical insecticides (Alam *et al.*, 2006; Singh and Singh 2003). Farmers of Bangladesh (Alam *et al.*, 2003) as well as India (George *et al.*, 2002) usually spray insecticides every day or every alternate day to combat this obnoxious pest. The indiscriminate use of insecticides may result in a series of problems related to both loss of their effectiveness in the long run and certain externalities such as pollution and health hazards (FAO, 2003). Pesticide use amounted to 38.8 % of the total cost of production in brinjal (Alam *et al*., 2006).

In order to reduce the pesticidal load in the environment and to be abreast with sustainability, emphasis has been done on the performance of different brinjal varieties. Vegetables are protective food rich in vitamins and minerals which are essential for

maintaining good health. Increased production and consumption of vegetables could alleviate the malnutrition and improve nutritional standard of our people.

Despite the importance of Brinjal and severity of brinjal shoot and fruit borer (BSFB) problem, the management practices to combat BSFB are still limited to frequent sprays of toxic chemicals and pesticides (Kabir *et al*., 1996). For vegetable in general, Sabur and Mollah (2000) observed an increase in use of pesticides by farmers in combatting pests throughout Bangladesh. According to Pesticide Association of Bangladesh (1999), pesticide use of growing brinjal was 1.41 kg/ha in Bangladesh, whereas for vegetables overall it was 1.12 kg, while it was only 0.20 kg in rice, Meanwhile, inappropriate pesticides, incorrect timing of application and improper doses all have resulted in high pesticides costs with little or no appreciable reduction in target pest populations. Farmers choose pesticides because they are readily available, highly promoted, inexpensive, easy to apply and quick acting. The increasing use of synthetic insecticides has led to a number of problems such as development of resistance to insecticides, high insecticide residues in market produce, resurgence of increased infestation by some insect species due to the destruction of natural predators and parasitoids, changing pest status of mites and other minor insect pests, ecological imbalance and danger to health of the pesticide applicator and consumers.

So, it is very important to develop alternative approaches to control the pest. Cultural practices, including crop hygiene (fallow, crop rotation, ploughing, removing crop residues, and planting time), use of resistant varieties etc. are different ways to manage the pest efficiently, to promote the activities of natural enemies, to reduce the threat from potential insect pests. In Bangladesh, research activities have been started since last seventies to control the pest effectively.

It’s been reported that morphological and physiological characters of host plants inhibits the growth and development of Brinjal shoot and fruit borer. The plant with thin shoots, prickles on stem and leaves, narrow pith and compact vascular system are reportedly resistant to Brinjal shoot and fruit borer (Chelliah and Sreenivashan, 1983; Mallik *et al*., 1986; Ali *et al*., 1994).

In Bangladesh, very few research findings have been so far reported on the host plant resistant of BSFB. Although, the use of resistant varieties in vegetable pest management programs are being considered as economic and safe in comparison to chemical control. To minimize the use of chemical insecticides and problems arising due to their frequent use, it is very much essential to focus on plant’s default mechanism to defend different pest attacks specially Brinjal shoot and fruit borer. In order to reduce the pesticidal load in the environment and to be abreast with

sustainability, emphasis has been done on the performance of different brinjal varieties. Considering the above facts view in mind, the experiment has been undertaken with the following objectives:

- To assess the infestation level of brinjal shoot and fruit borer (BSFB) among different brinjal varieties.
- To assess the yield attributes and yield performance of different brinjal varieties against BSFB.
- To evaluate the morphological traits of different brinjal varieties for resistance against BSFB.

CHAPTER II

REVIEW OF LITERATURE

Brinjal or eggplant or aubergine is one of the most common, popular and principal vegetable crops grown in Bangladesh. It is grown across Bangladesh round the year. Various factors are responsible for low yield of Brinjal in Bangladesh and out of which attack of different pests is one of the most important one. Amongst them, Brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) is the most important insect pest occurring every year throughout Bangladesh. Brinjal shoot and fruit borer (*L. orbonalis* Guenee) is one of the most destructive pest in Bangladesh (Alam, 1969) and India (Tewari and Sandana, 1990) and also a major pest in the other countries of the world (Dhankar, 1988). It is a native of India and extensively grown in all the South Asian countries. Brinjal is a warm season crop requires continuous long warm weather during growth and fruit maturation. The optimum growing temperature is 22-30^{0}C and growth stops at temperature below 17^{0}C (Yamaguchi, 1983). Brinjal is self-pollinated annual crop. Its cultivation helps to improve human nutrition and income generation.

Brinjal shoot and fruit borer is a phytophagous insect and belongs to the order Lepidoptera and family Pyralidae. This pest is active throughout the year at places having moderate climate but its activity adversely affected by severe cold. This pest is not common in temperate region. This pest can also infest potato and other Solanaceous crop and wild species of Solanum (Karim, 1994). It can causes damage to shoots from 12-16 percent and fruits from 20-60 percent in a cropping season (Alam, 1970; Maureal *et al.,* 1982). It is very active during rainy and summer seasons and often causes more than 90% damage (Ali *et al.*, 1980; Kalloo, 1988). The yield loss has been estimated up to 86% (Ali *et al.*, 1980) and 67% (Islam and Karim, 1991) in Bangladesh and up to 95% (Naresh *et al*., 1986) and 63% (Dhankar *et al*., 1977) in Hariyana, India.

To control this notorious pest, only two approaches are being used in Bangladesh. One approach advocates clean cultivation with hand picking of eggs, infested shoots and fruits. The other approach is to apply insecticides at an interval of 10-15 days. Use of resistant variety is another method of pest management. Varietal resistance and tolerance acts as preventive method of bio-control. This technique can be used against the Brinjal shoot and fruit borer to keep its population below economic injury level (EIL).

Oval, thin and elongated fruits of Brinjal plants are also resistant to Brinjal shoot and

fruit borer (Metho and Lal, 1981; Yein and Rathaia, 1984; Malik *et al*., 1986; Mishra *et al*., 1988; Ali, 1994). Purple and greenish color fruits are also reported to be resistant to Brinjal shoot and fruit borer (Metho and Lal, 1981; Yeith and Rathaia, 1984; Issaque and Chaudhari, 1984; Singh *et al.*, 1986; Ali, 1994). Small and hard calyxes, thick and hard fruit skin resist the larval entry into the fruit (Malik *et al*., 1986; Mishra *et al*., 1988). Fruits with tight mesocarp, compact and hard pulps are also reported to provide resistant to Brinjal shoot and fruit borer (Mishra *et al*., 1988; Ali *et al*., 1994). Low percentage of moisture, nitrogen and high phosphorus content are also found to be resistant to Brinjal shoot and fruit borer (Panda, 1999).

Resistance, tolerance or susceptibility of Brinjal plants to Brinjal shoot and fruit borer involve a great cause and effect relationship between the insects response to the plant and in turn, the plant's reactions to the insect pest. These responses are behavioral like orientation, feeding, oviposition and physiological, such as metabolic utilization of ingested food, growth, survival, egg production and hatching. The capacity of a plant to cause the interruption of any account for its resistance to Brinjal shoot and fruit borer infestation.

An effort has been attempted to present a brief review of research in relation to Varietal performance of Brinjal against Brinjal shoot and fruit borer. Brinjal, *(Solanum melongena* L.) is the most important vegetable grown extensively in Bangladesh. A horde of insect pests attack this crop due to cultivation throughout the year, out of which brinjal shoot and fruit borer (*L. orbonalis* Guenee, Pyralidae: Lepidoptera) is most serious (Sardana *et al.*, 2004). Brinjal shoot and fruit borer are reviewed in this chapter. In Bangladesh limited work of varital performance of brinjal has been done. A brief review of the literature available in Bangladesh and elsewhere related to varietal performance of Brinjal against Brinjal shoot and fruit borer is discussed below:

2.1 General review of brinjal shoot and fruit borer

2.1.1 Nomenclature

Brinjal shoot and fruit borer (BSFB) was first described as *Leucinodes orbonalis* by Guenee in 1854. It was designated as the type species of the genus by Walker in 1859. There are no known synonyms of *L. orbonalis* but several other species of Leucinodes orbonalis have been described. The genus includes three species, *L. orbonalis* Guenee, *L. diphana* Hampson, *L. apicalis* Hampson (*Alam et al*., 1964).

Taxonomic position

Phylum: Arthropoda

Sub-phylum: Mandibulata

Class: Insecta

Order: Lepidoptera

Family: Pyralidae

Genus: *Leucinodes*

Species: *Leucinodes orbonalis*

2.1.2 Host range

Shoot and fruit borer is the most destructive pest of Brinjal (Alam and Sana, 1962; Alam, 1969; Butani and Jotwani, 1984; Nair, 1986 and Chattapaddhaya, 1987). It was also found attack on shoots and fruits of tomato (Das and Patnaik, 1970), Potato (*Solanum tuberosum* L.), Green peas (*Pisum sativum* L) and *Solanum torvum* Swartz (Hill, 1987). Other wild species of Solanum are also attacked by the pest (Karim, 1994). Isahaque and Chaudhury (1983) reported *Solanum nigrum*, *S. indicum*, *S. torvum*, *S. myriacanthum* and potato as alternate host plants of BSFB in Assam.

Das and Patnayek (1970) studied that *Leucinodes orbonalis* Guenee, a serious pest of Brinjal (*Solanum melongina*), was also observed to bore into shoots and fruits of Tomato in Bhuboneshwar, India. The insect was found to be able to complete its development on tomato and also on the weed *S. nigrum* but moths that had been reared on the latter were smaller and laid fewer eggs than those reared on tomato or Brinjal.

2.1.2 Distribution of brinjal shoot and fruit borer

L. orbonalis is native to India but occurs in the Indian Sub-continent (Andaman Island, India, Bangladesh, Nepal, Srilanka and Pakistan), Far East Asia (Hong Kong, China, Taiwan and Japan), Africa (Burundi, Cameroon, Congo, Ethiopia, Ghana, Kenya, Lesotho, Malawi, South Africa etc.), (Veenakumari *et al*., 1995). Brinjals are severely attacked by Brinjal shoot and fruit borer in the tropics but not in the temperate regions (Yamaguchi, 1983).

2.1.3 Biology of brinjal shoot and fruit borer

Brinjal shoot and fruit borer is a holometabolous insect. So, it has four stages to complete its life cycle viz. egg, larva, pupa and adult.

Egg: Adult female insects lay eggs on the foliage. The number of eggs laid by an average female varies from 80-253. Oviposit ion takes place during the night and eggs are laid singly on the lower surface of the young leaves, green stems, flower buds or calyces of fruits. Eggs are flattened, elliptical and 0.5 mm in diameter. They are creamy-white soon after they lay, but changes to red after some time of hatching. Eggs hatch in 3 to 6 days.

Larva: Soon after hatching from eggs, young caterpillars search for and bore into tender shoots near the growing point, into flower buds, or into the fruits. Caterpillars prefer fruits over other plant parts. Larvae go through at least five instars (Awal, 1976) and there are reports of existence of six larval instars. Larval period lasts 12-15 days in summer and up to 22 days in winter. Sandanayake and Edirisinghe (1992) studied the larval distribution of mature brinjal in Srilanka. They found first instars in flower buds and flowers, second instars in all susceptible plant parts, third and fourth instars in shoots and fruits, and fifth instars mostly in fruits. Larval feeding in fruit and shoot is responsible for the damage to Brinjal crop. A full grown larva measures 18 to 23 mm in length.

Pupa: Mature larvae come out of their feeding tunnels and pupate in through silken cocoons among the fallen leaves and other plants debris on the soil surface near the Brinjal plants. The color and texture of the cocoon matches the surroundings making it difficult to detect. Some studies indicate the presence of cocoons at soil depths of 1 to 3 cm. The pupal period lasts 6 to 17 days depend upon the temperatures.

Adult: Moths come out of pupal cocoons at night. Young adults are generally found on the lower surfaces following emergence. BSFB females are slightly bigger than males. The abdomen of the female moth are tends to be pointed and curls upwards. Where, the male moth possesses a blunt abdomen. The moth is white but has pale brown or black spots on dorsum of thorax and abdomen. Wings are white with a margin. The forewings are ornamented with a number of black, pale and light brown spots. The moth measures 20 to 22 mm across the spread of wings. Longevity of adults was 1.5 to 2.4 days for males and 2.0 to 3.9 for females. The pre-oviposition and oviposition periods were 1.2 to 2.1 and 1.4 to 2.9 respectively (Mehto *et al*., 1983).

2.1.5 Seasonal abundance

The seasonal history of Brinjal shoot and fruit borer varies considerably due to different climatic conditions throughout the year. Hibernation does not take place and the insects are found active in summer months, especially in rainy season. Shoot and fruit borer is

very injurious to Brinjal during the rainy and summer seasons. The fruit infestation may even reach above 60% during the rainy seasons in Bangladesh and more than 90% in India (Kalloo, 1988). It is revealed from a study that population of *L. orbonalis* began to increase from the first week of July and peaked (50 larvae per 2 sq.m) during the third week of August. The population of this pest was positively correlated with average temperature, mean relative humidity and total rainfall (Shukla, 1989). Brinjal shoot and fruit borer are less active during February- April (Alam, 1969). During winter months, different stages of this pest last for longer periods and overlapping generations were observed.

2.1.6 Nature of damage

The damage caused by *L. orbonalis* starts soon after transplanting of seedling and continuous tills the harvest of the fruits. After hatching, the caterpillar begins to search for soft and tender shoots to bore. It is active from the beginning of its life. In young plants, the larvae bore into the petioles and mid ribs of large leaves and young shoots. After entering into host the larvae close the entry holes with their excreta and feed inside (Butani and Jotwani, 1984) by its mandibles. The infested shoots drop off due to disruption of vascular system and ultimate wither (Alam and Sana, 1962) and the borer continuous boring the stem until it incase itself.

At a later stage of plant growth, when the bud flowers come out the larvae at first bore generally through the calyx and later into the flower bud and the fruits without leaving any visible sign of infestation and feed inside (Butani and Jotwani, 1984). The infested flowering buds dry and shed. Infested fruits show exit holes along with excreta. The caterpillar rests in a cell of fruit. The affected fruit, when cut open is sometimes found rotting with full of dark excreta. Moulds grow therein and thus make the fruit unfit for human consumption and marketing. The full-grown larvae came out through the hole of infested fruits and drop on the ground for pupation in the soil or plant debris. The infestation of fruits is more than that of the shoots (Alam and Sana, 1962).

2.1.7 Varietal preferences against brinjal shoot and fruit borer

Panda (1999) conducted a field experiment on 174 brinjal cultivars for resistance to *L. orbonalis* at Bhuboneshwar, India. None of the Brinjal entries was immune to larval attack of shoots and fruits. The mean performance of shoot infestation varied from 1.61 to 44.11% and fruit damage varied from 8.5 to 100%, Maximum shoot damage was recorded at 75 days after transplanting (DAT) and 99-114 DAT in susceptible and

resistant cultivars respectively. Thus early fruiting varieties are more liable to fruit attack by *L. orbonalis*.

Sharma *et al.* (1998) studied 8 cultivars of Brinjal for their response to *L. orbonalis* and found that none of the cultivars were absolutely tolerant to the pest. The cultivars pusa purple cluster, Pusa krantiu and BR-112 were graded as tolerant and Muktakeshi, Pusa purple round, Arkakushmakar, Neelam Round, and Pusa purple long were graded as moderately tolerant for shoot infestation. However, based upon fruit infestationon number of weight basis, the cultivars Arkakushmakar and Pusa Purple cluster were ranked as tolerant. But Muktakeshi and BR-112 were susceptible and Pusa Kranti, Pusa Purple long, Pusa purple Round and Neelam Round were highly susceptible.

Begum and Mannan (1997) carried out a field trial during 1996-97 with 24 brinjal varieties cultivars against brinjal shoot and fruit borer and also showed that cultivar jhumki-1 was more tolerant than others against Brinjal shoot and fruit borer but higher yield was obtained from Muktakeshi.

Kumar and Sadashiva (1996) confirled resistance of Solanum macrocarpon to *L. orbonalis* while incidence of *L. orbonalis* on cultivated Brinjal varities was 10-50%. Less than 1% of S. macrocarpon fruits were damaged by *L. orbonalis*. Resistance can be incorporated by crossing *S. macrocarpon* with cultivated species of Brinjal.

Gangopadhyay *et al.* (1996) tested 27 germplasms and two wild species of Brinjal for resistance against Leucinoides orbonalis. The cultivars Arka kusumkumar, Nishchintapur, Brinjal long green, Altapati, Arka shirish, Manipur, Makra and Chikon long were relatively resistant to the pest, whereas Green Brinjal round, Shupal, Gourkaj-1, Brinjal No:3, and light purple Round were highly susceptible. Physical characters of the germplasms indicated that resistance is not conferred by any single character like spiness, shape and size of fruits arrangement of seeds.

Srinivash and Peter (1995) obsereved that among 18 brinjal cultivars, Arka ksuhsumkumar, Arka Shirish and Neelam were significantly less infested by *L. orbonalis* than early long fellow and Nagpur round.

Patel *et al.* (1995) conducted a field experiment on 28 varieties of Brinjal for resistance to insect pests. Of these, Pusa purple long, pusa purple cluster, pusa kranti, S-71-5, 39-9, S-71, S-21-4-22 and Arka kusumkumar were comparatively resistant to *L. orbonalis.*

Grewal and Dilbagh (1995) carried out a field study in 1987-88 at Ludhiana, Punjab, India on 12 Brinjal cultivars which were exposed to *Leucinodes orbonalis*. Infestation of fruit by the pest varied from 27 to 61%. CV SM 17-4, pusa purple cluster and Brinjal Green long were least susceptible to the pest, have narrow pericarp, long peripheral seed ring and less seedless area.

Begum (1995) carried out a field trial at Regional Agricultural Research Station (RARS), Jamalpur, during Rabi season of 1994-95 with 24 brinjal varieties/cultivars to find out their tolerance to Brinjal shoot and fruit borer. Among the tested varities/ cultivars, Jhumki-1 showed higher tolerance against the pest than others. The highest yield was obtained from Islampuri-1, although it had medium level of infestation (34% by number abd 45% by weight). Higher percent infestation was found in Nayankajal (39%).

Mukhopadhyay and Mandal (1994) evaluated the relative degree of resistance of 41 cultivars of Brinjal to *L. orbobalis* and also graded on the basis of mean percentage of Brinjal shoot and fruit borer infestation into tolerant (<15%), moderately tolerant (16-25%) susceptible (26-40%) and highly susceptible (>40%). They found that no cultivars were resistant to the pest but Nishchindipur local; Mukhtajhuri, Shyamla Dhepa, Benagas Dhepa, Kalo Dhepa and Banaras long purple were tolerant. Twenty-eight varieties of Brinjal were screened for resistance to insect pests. Of these, Pusa purple long, Pusa purple cluster, Junagadh long, Pusa kranti, S-71-5, 39-9, S-21-4-22 and Arka kusumkumar, Arka sirish and Neelam were significantly less infested.

Miah and Begum (1993) worked with eight Brinjal varities/ cultivars to find out their tolerance against Brinjal shoot and fruit borer and showed that Jhumki and Shingnath were more tolerant but yield was lower. Comparatively higher yields were obtained from Khotkhotia, Shingnath and Lalital with lower infestation.

Miah (1992) carried out a field trial during Rabi season, 1991-92, with eight Brinjal varieties/ cultivars to Brinjal shoot and fruit borer. Among the varieties, the Jhumki and Shingnath were found more tolerant with higher yield. Among the eight varieties, the infestation was lower in the early stage of plant and increased gradually upto fruiting stage and then decreased again.

Darekar *et al.* (1991) observed nine Brinjal varieties which were screened for resistance to Brinjal shoot and fruit borer under field conditions and reported that PBR129-5 and Arka kusumkumar were resistant to fruit borer.

Das and Singh (1990) tested the susceptibility of nine Brinjal cultivars to *L. orbonalis* in the filed during Kharif season in 1985. None of the cultivars was free from the attack of *L. orbonalis* Pusa purple cluster was the least susceptible variety with 18.76% fruit being attacked. The cultivar Muktakeshi has the highest mean number of holes per fruit.

Kalloo (1988) screened a large number of cultivated varieties of Brinjal and related wild species of Solanum against Brinjal shoot and fruit borer under natural and green house conditions. He did not find a single cultivated variety resistant against pest. However, minimum incidence was recorded in PPC-2 and Aushey but resistance was found in the wild species of *S. khasianum.*

Raju *et al*. (1987) worked on the 8 varieties of eggplant (*S. melongena*) for resistance to the spotted leaf beetle (Epilachna viginiopunctata) and Brinjal shoot and fruit borer (*L. orbonalis*). Punjab checkmate and SM-195 showed moderate resistance. Low amounts of N, K and Zn and high amount P, Ca, Mg, Fe, Mn, Cu, total carbohydrates and Phenols of the Brinjal fruits were implicated with the moderate resistance to fruit borer.

Tewari and Moorthy (1985) evaluated 26 brinjal varieties for resistance to *L. orbonalis* under field condition and showed that the varieties SM17-4, PBR 129-5 and Musk Brinjal were the most resistant and Punjab Chamkila, Black Beauty, Arka Sheel and Pusa Purple Round were the most susceptible.

Ahmed *et al*. (1985) tested 36 local and 30 exotic Brinjal cultivars to find out the susceptibility of cultivars against *L. orbonalis* and observed that none of the cultivar was free from attack of the pest. They also observed that the local cultivars were less susceptible as compare to exotic ones. Shingnath long, Rajshahi-3 and Rajshahi-5 were the least susceptible cultivars, whereas Black long, Black beauty, Islampuri, Rangpur-1, Kurume Naga Nasu, V13E, Pro and Hayakawa-2 were found highly susceptible to Brinjal shoot and fruit borer attack.

Yein and Rathanaiah (1984) observed that among 13 promising cultivars of Brinjals, Pusa purple cluster and Azad kranti were least susceptible to *L. orbonalis* and Pusa purple cluster, Long, green and Annamalia were moderately resistant.

Kabir *et al*. (1984) screened 12 brinjal varieties for resistance to *L. orbonalis* in Bangladesh and they observed that the degree of resistance varied significantly. The variety Shingnath had the lowest rate of shoot infestation and also gave the highest

yield, while Muktokeshi and Baromasi had the highest rate of infestation and gave lowest yield.

Baksha and Ali (1982) tested 13 brinjal varieties and found that none of the varieties were resistant to *L. orbonalis*. They also reported that Baromashi, Jhumki, Indian and Bogra special were moderately tolerant to shoot infestation and Nayankajol, Shingnath, Japani, Jhumki, Indian baromasi were similarly tolerant to fruit infestation. Tolerant to both shoot and fruit infestation was highest in Jhumki, Indian and Baromasi.

Response of different aubergine cultivars against Brinjal shoot and fruit borer (*L. orbonalis* Guenee) was evaluated at National Agricultural Research Centre, Islamabad during 2007-08 and 2008-09 (Javed *et al*.) The results reflected different levels of infestation in all cultivars by the pest. Cultivar Neelam showed maximum fruit infestation (58.60 and 48.09) followed by Black long (47.93 and 33.31%), while minimum was observed in Nirala with 24.75 and 21.57% fruit infestation during 2007-08 and 2008-09, repectivley. Similarly, Shoot infestation was found maximum in Naeelam (43.15 and 33.75%) followed by Kanha- shoot infestation was found to be least attacked by pest showing 19.27 and 15.81% shoot infestation during 2007-08 and 2008-09, repectively.

The correlation of different morphological plant characters with fruit infestation indicated very strong and negative correlation between fruit infestation and leaf trichomes, stem thickness and stem hair density. A negatively significant correlation was found between fruit infestation and plant height (r = -0.716), crown hair density (r = -0.672) while the correlation of leaf hair density (r = -0.623), and leaf area (r = -0.613), was also significant and negative but not so strong. There was positive correlation with number of primary branches/plant with r-value 0.661 and 0.319, respectively.

Mehto and Lall (1981) determined the relative susceptibility of several cultivars of Brinjal to infestation of Brinjal shoot and fruit borer, *L. orbonalis*. The minimum infestation of shoots (7.70%) and fruits (6.77%) was observed in the variety long purple which was more resistant to the pest than the other cultivars.

Ali *et al.* (1980) made a brief observation on the incidence of shoot and fruit borer on 12 cultivars of Brinjal. They observed that the cultivars Baromashi showed no shoot and fruit infestation. Lowest percentage of fruit infestation (25%) occurred in Shingnath and highest (86%) in Jhumki.

Panda *et al*. (1971) tested 19 brinjal varieties against *L. orbonalis* under field condition and reported that Thorn pendy, Black pendy, H-165 and H-407 were highly resistant to borer attack.

Some antibiosis and antixenosis basis of host plant resistance inhibits the growth and development of Brinjal shoot and fruit borer. In antibiosis type of resistance, plants and fruits having silica or low sugar or protein content affect the larval growth and development of this pest (Isahaque and Chaudhuri, 1984).

Ali *et al.* (1994) examined the anatomical characters of 28 brinjal varieties/ line to find out the resistant and tolerant verities. They showed that entries bearing fruits with compact mesocarp and pulp.

Hossain *et al.* (2002) observed that resistance or susceptible of Brinjal verities/ lines to shoot and fruit borer seems to be related with some anatomical characters. Varities / Lines having thick cuticle, broad and thick collenchymatous area (hypodermis), compactparenchyma cells in the cortical tissue. Small area in the cortical tissues, more vascular bundles with narrower spaces in the interfacicular region, and compact arrangements of vascular tissue with lignifice cellas and small pith were the main characterisitics of resistant or tolerant varieties. On the other hand, thinner cuticule and cholenchymatous area (hypodermis), loose paranchyma cells in the cortical region, larger spaces between vascular bundles i.e., interfasicular region and large pith, less number of trichomes, soft perenchymatous cells in the interfasicular region, might be responsible for the susceptibility to Brinjal; shoot and fruit borer.

Hossain *et al.* (2002a) carried out an experiment on the chlorophyll contents of Brinjal leaf and its relation to the resistance and susceptibility to Brinjal shoot and fruit borer, *L. orbonalis.* They observed that lowest amount of chlorophyll a and chlorophyll b present in the variety Nayan kajal and Laffa whereas the highest amount of chlorophyll a and chlorophyll b present in the variety BLO 101 and BLO 81 respectively. They also observed that the amount of chlorophyll b content was positively correlated with Brinjal shoot and fruit borer infestation.

Panda (1999) screened 174 brinjal cultivars for resistance to *L. orbonalis* in the field at Bhubaneswar, India. The attack of *L. orbonalis* in fruit was also restricted by low percentage of moisture, nitrogen and potassium and high phosphorus content.

Bajaj *et al.* (1989) conducted field trials during 1978 to 1983 and observed that the incidence of the pyralid, *L. orbonalis* was lower on the Brinjal cultivar SM-17-4 than

on Punjab Camkila. A laboratory analysis revealed higher levels of Glycoalkaloids and peroxidase and Polyphenol oxidase activity in fruits from resistant cultivars SM-17-4 than in those from susceptible cultivars.

Mishra *et al.* (1988) tested 24 brinjal varieties for resistance to *L. orbonalis* and showed that leaf colour and phyllotaxy were not related to pest resistance, but tightly arranged seeds in the mesocarp, thick fruit skin and closely packed vascular bundles in pulp were possible causes of resistance in long fruited varieties. However, 2 long-fruited varieties (S-5 and PPL) were susceptible despite having these characteristics.

Panda *et al*. (1971) evaluated 19 brinjal varieties for resistance to Brinjal shoot and fruit borer, *L. orbonalis* and ascertained that in resistant varieties (Thorn Pendy, Black Pendy, H-165 and H-407) the shoots were characterized by heavily lignified schlerenchymatous layer and closely packed vascular bundles. The seeds of the fruit were packed tightly in the mesocarp of the resistant varieties whereas those were loosely arranged in susceptible ones. They also found that larval entry was facilitated by the thick pithy stem and loose calyx of the susceptible varieties.

Lall and Ahmad (1965) observed that compact vascular bundles in a thick layer with lignified cells and less area of pith in the shoot provided resistance to *L. orbonalis.* Similarly, hardness of fruit skin and flesh due to compact seed arrangement and tight calyx to hinder initial larval entry into fruits (contribute to the non-preference for cultivars) which provided some degree of resistance to Brinjal shoot and fruit borer.

Prodhan et al. (2009) evaluated moisture content of brinjal shoot and fruit of twenty different varieties/lines was estimated to find out the relationship between the infestation rate of brinjal shoot and fruit borer, *L. orbonalis* Guenee and the moisture content of brinjal shoot and fruit. The highest level of shoot moisture (91.97%) and fruit moisture (95.89%) Were recorded in the line BLO 72 and the lowest level of shoot moisture (81.65%) and Fruit moisture (89.88%) in the variety Brinjal. Brinjal shoot infestation was found to be positively correlated with shoot moisture (0.701) and fruit infestation was also positively correlated with fruit moisture (0.695).

Mote (1981) carried out a field studies to screen 32 varieties of Brinjal for resistance to *L. orbonalis* and reported that the varieties NImbkar green, Arka kisumkumar, S.M. 213, Mukta keshi, Pusa kranti, A.C. 3698, S.M.2, Long green, Mysore, A-61 and Kalyanpur T-2 were rated as resistant in the basis of percentage of infested fruits.

Chaudhury *et al.* (1995) worked with 17 genotypes of Brinjal and reported that none of them was resistant to any of the Brinjal pests.

Gowda *et al*. (1990) crossed Solanum melongena, GKVK, Composite-2 and P12 (susceptible) with S. macrocarpon which possesses resistance to *L. orbonalis*. They found that the $F_{1,}$ hybrids were resistant to *L. orbonalis*.

Khorsheduzzaman *et al.* (1997) suggested that intercropping of coriander with brinjal reduced the infestation of Brinjal shoot and fruit borer. 1R Mehto and Lal (1981) determined the relative susceptibility of several cultivars of Brinjal to infestation by *L. orbonalis*. The minimum infestation of shoots (7.70%) and fruit (6.77%) was observed in the variety long purple, which was more resistant to the pest than the other cultivars.

Dilbagh *et al.* (1991) studied the morphological characters and the incidence of *L. orbonalis* in Brinjal. Out of 150 lines tested SM-17-4, PBR129-5 and Punjab Barsati were the most resistant and Punjab Chamkila was the least resistant to damage by the Pyralid.

Jyani *et al*. (1995) showed that Brinjal varieties of Chaklasi, Doli-5 and Pusa purple cluster were resistant to Brinjal shoot and fruit borer and Jassid. They also studied the correlationship between pest incidence and morphological characters of the Brinjal plants. The Brinjal varieties having dark color fruits showed negative correlation (r =0.80) and were found resistant to *L. orbonalis*.

Malik *et al.* (1986) suggested that lines bearing thin fruits with short, small calyx and thin shoots were tolerant to *L. orbonalis*. They also showed that co efficient of variation were high for calyx diameter, fruit diameter with percentage of fruit infestation.

Misra *et al.* (1990) observed that the population density of *Tetranychus cinnabarinus* on the Brinjal plants was negatively correlated with the density of leaf hairs.

The dense pubescence of the leaves of the cultivars Elokeshi, Giant Banaras, Black Beauty and H-165 made of unsuitable for the adult moth to deposit their eggs and the young larvae after hatching cannot bore easily (Panda and Das, 1974).

Patil and Ajri (1993) screened 17 varieties of Brinjal for resistance to *L. orbonalis*. PBR-129-5, ARU-2-C and PBR-91-1 were less susceptible and the biophysical characters (Shoot thickness, Calyx girth, Pedicel length, Number of holes per infested fruits etc.) showed positive correlation with susceptibility.

Prodhan (1969) reported that long narrow fruited Brinjal varieties were observed to be less infested than those with spherical fruits. Sharma et al. (1985) evaluated 39 *S. melongena* genotypes (July planting) and analyzed for total yield/plant. Plant height and fruit length contributed to yield, although their correlations were not consistent. Infested fruit yield/plant was correlated with the percentage of infested fruit yield and fruit diameter. They observed that round fruits were most susceptible to borer attack. Path analysis showed that infested fruit yield was directly affected by total yield and indirectly by fruit diameter. Total yield was directly affected by fruit number.

Sinha (1983) reported that yield was positively correlated with fruits/plants, plant height and branches/plants at all phenotypic and genotypic level. Path analysis indicated that fruits/plants and fruit length and circumference ratio had the maximum effect on yield.

Grew; and Dilbagh (1995) carried out a field study in 1987-88 at Ludhiana, Punjab, India on 121 aubergine cultivers which were exposed to *L. orbonalis*. Infestation of the fruit by the pest varied from 27-61%. The cv. SM 17-4, Pusa purple cluster and Brijal Green long, which were least susceptible to the pest, have narrow pericarp, long peripheral seed ring and less seedless area.

Srinivasan and Basheer (1961) mentioned that the possible causes for the least susceptibility in the lines of Coimbatore and H-158 seemed to be the toughness of the skin and the pulp of the fruits.

Yadav *et al*. (2003) conducted varietal screening of Brinjal shoot and fruit borer (*L. orbonalis* Guen.). Ten aubergine cultivars were screened for their resistance against the shoot and fruit borer (*L. orbonalis*). All of the cultivars screened were susceptible to the pest.

Kumar *et al*. (2002) conducted an experiment during the kharif season to investigate the varietal preference of *L. orbonalis* on aubergine. Twelve aubergine cultivars were used. A weekly record of *L. orbonalis* on each cultivar throughout the season was maintained by calculating the percentage of infested fruits on the basis of damaged and total fruit number at each picking.

Jai *et al.* (2002) conducted an experiment to study the seasonal incidence of shoot and fruit borer (*L. orbonalis* Guen.) on eggplant (*Solanum melongena* L.) in Rajasthan during 1999 and 2000. The seasonal incidence of *L. orbonalis* on aubergine cv. Pusa Purple Round was studied. The infestation of shoot and fruit borer started from fourth

week of August and reached to its peak in the last week of October, peaked in the fourth week of October and continued up to second week of December. Significant positive correlation was observed between fruit borer infestation and maximum temperature, while minimum temperature had no effect. The relative humidity had no effect. The relative humidity had no effect on fruit infestation during 1999 but showed significant positive correlation in the year 2000.

Sridhar *et al*. (2001) evaluated Brinjal (*Solanum* spp.) germplasm against shoot and fruit borer, *L. orbonalis* Guen. Fifty four Brinjal (aubergine) germplasm, including five wild species and some F_1 crosses were screened for resistance to *L. orbonalis*, during 1999-2000, under field conditions in Bhubaneswar, Orissa, India. None of the cultivated or wild species of Brinjal was found resistant to this pest. Three wild species, i.e. *S. khasianum*, *S. viarum* and *S. incanum*, were found to be tolerant from fruit infestation (0.5-10.0%). Among the cultivated lines, CHB-103, 187 and 259 were identified as fairly tolerant. Among the Brinjal groups, it was observed that in genotypes with relatively long fruits and tightly arranged seeds, the attack of *L. orbonalis* was less.

Singh and Singh (2001) screened 20 brinjal (*S. melongena* L.) cultivars against shoot and fruit borer (*L. orbonalis* Guen.) in a field experiment during the kharif season of 1994 and 1995, Meghalaya, India. None of the cultivars was resistance to the pest, but three, five and eight cultivars were highly tolerant, tolerant and moderately tolerant, respectively. Eleven and two cultivars were susceptible and highly susceptible. Cultivar Kuchia (HRS-4) was the most tolerant cultivar, followed by Pithoria and Lata Begun.

Thirteen *Solanum* spp. genotypes and 30 F_1 crosses of *S. melongena* were evaluated for resistance to *L. orbonalis* during February – October, 2000 under field conditions in Palampur, Himachal Pradesh, India. Arka Keshva was found resistant to the pest. Four genotypes and 11 F_1 crosses were also found resistant to fruit infestation, recording 2.75-10.00% fruit damage. Six lines, Pusa Anupam, Punjab Barsati, SM 6-7, SM-141, CHES-243 and DBL V-4, with 17 F_1 crosses were identified as fairly resistant. It was observed that attack of *L. orbonalis* was comparatively less fruits with tightly arranged seeds in the mesocarp (Anonymous, 2000).

CHAPTER III

MATERIALS AND METHODS

The present study of varietal performance of brinjal against brinjal shoot and fruit borer was carried out using 10 varieties of brinjal including two hybrids in the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during Mid-November, 2013 to May, 2014. The materials and methods adopted in the study are discussed under the following sub-headings:

3.1. Experimental site and duration

The research work was carried out at the experimental field of Entomology Department of Sher-e- Bangla Agricultural University, Dhaka during the period from mid October, 2013 to May, 2014 for the varietal performance of Brinjal against Brinjal shoot and fruit borer. The soil of the experimental site was well drained and moderate high. The soil of the experimental plots belonged to the agro ecological zone Madhupur Tract (AEZ-28).

3.2 Climate

The climate of the experimental site is sub-tropical characterized by moderate rainfall during April to May and sporadic during the rest of the year. During November to February, the temperature was less than the other months of the year and starts increasing after mid- march. The detail record of monthly total rainfalls, temperature, and humidity during the period of experiment were noted from the Bangladesh Meteorological Department (climate division), Agargaon, Dhaka.

3.3 Design of the experiment

The experiment was conducted in randomized complete block design (RCBD) with three replications.

3.4 Land preparation and layout

The experimental land was first opened with a country plough. Ploughed soil was then brought into desirable final tilt by four operations of ploughing followed by laddering. The stubbles of the crops and uprooted weeds were removed from the field and the land was properly leveled. The field layout was done on accordance to the design, immediately after land preparation. The good tilth main field was then divided into three main blocks considering 1 m block to block distance. Each block was sub-divided

into 10 sub-plots for 10 brinjal varieties considering 4 m x 1.5 m plot size and 0.5 m plot to plot distance. The plots were then raised by 10 cm from the soil surface keeping the drain around the plots.

Plate 1: The main field and transplanting of the seedling in the field

3.5 Manures, fertilizer and their methods of application

The experimental plots were fertilized at the rate of 15ton/ha, 250 kg/ha and 125 kg/ha, 5 kg/ha, 5 kg/ha of Cow dung, Urea, Triple Super Phosphate (TSP), Murate of Potash (MP), Gypsum and Boric Acid, respectively. The entire amounts of cow dung were applied at first land preparation. TSP, half of Urea and MP were applied at the time of final land preparation. The remaining half of the Urea and MP were applied at two equal installments as top dressing. The first top dressing was done 21 days after transplanting and second at the flowering stage of Brinjal. Entire amount of Boric acid and Gypsum was applied as basal dose during final land preparation.

3.6 Brinjal varieties used in the study

Ten (10) brinjal varieties developed and released by Bangladesh Agricultural Research Institute were cultivated in the experimental field to evaluate their performance against brinjal shoot and fruit borer. Each of the variety was treated as an individual treatment. The names of the 10 brinjal varieties cultivated in the field and their source of collection are given below:

Treatment	Name of variety	Source
T_1	BARI Brinjal 1	BARI*
T_2	BARI hybrid Brinjal 3	BARI
T_3	BARI Brinjal 3	BARI
T_4	BARI hybrid Brinjal 4	BARI
T_5	BARI Brinjal 5	BARI
T_6	BARI Brinjal 6	BARI
T_7	BARI Brinjal 7	BARI

Treatment	Name of variety	Source
T_8	BARI Brinjal 8	BARI
T_9	BARI Brinjal 9	BARI
T_{10}	BARI Brinjal 10	BARI

*BARI= Bangladesh Agricultural Research Institute

3.7 Collection and sowing of brinjal seeds

The seeds of 10 brinjal varieties developed by Bangladesh Agricultural Research Institute (BARI) were collected from the BARI, Joydebpur, Gazipur. Before sowing, seeds were pre-soaked for 24 hrs to ensure germination. The seeds of all brinjal varieties were sown separately in the seed bed on mid October, 2013. The intensive care and all necessary intercultural operations including irrigation, weeding, thinning etc were done in proper time to obtain healthy seedlings.

Plate 2: Brinjal seeds sown in the seed trays

3.8 Seedling transplanting

One month old seedlings of different brinjal varieties were transplanted in the well prepared pits of unit plots assigned for each variety according to the design and layout of the experiment.

The necessary intercultural operations including irrigation, weeding, top dressing of nitrogen fertilizer, tagging, etc were done in proper time. The seedling trays were watered before uprooting the seedling from the tray so as to minimize root damage. Healthy and uniform sized seedling of 30 days old were taken separately from the tray and transplanted in the experimental plots in the afternoon, maintaining a spacing of 75 cm between the rows and 60 cm between the plants. The seedlings were watered after transplanting and continued for several days for their establishment in the field. Excess seedlings were also planted around the border of the experimental plots for future gap feeling.

Plate 3: Seven days old seedlings in the seed tray

Plate 4: Growing seedling in the main field of experiment

3.9 Data collection

3.9.1 Infestation level

Infestation caused by brinjal shoot and fruit borer was monitored during both vegetative and reproductive stages of the brinjal plants. Five plants per plot were selected randomly and tagged. Infested shoots and fruits were counted and recorded at 7 days intervals after observing the bores and excreta in both vegetative and reproductive stage of the plants. The data were recorded on the following parameters throughout the growing period of the crops:

Number of infested shoot per plant: Number of infested shoot per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average number of infested shoot per plant was calculated.

Number of total shoots per plant: The total number of shoots per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average number of shoots per plant was calculated.

Number of infested fruits per plant: Number of infested fruits per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average number of infested fruits per plant was calculated.

Number of total fruits per plant: The total number of fruits per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average number of fruits per plant was calculated.

Weight of infested fruits per plant: Weight of infested fruits per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average weight of infested fruits per plant was calculated.

Weight of total fruits per plant: Weight of total fruits per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average weight of total fruits per plant was calculated.

Infestation intensity: Number of bore per 10 randomly selected infested fruits per plot for each of 10 varieties was recorded to determine the infestation intensity of fruits.

3.9.2 Yield attributes and yield

Number of branch/ 5 selected plants/ plot: Number of total branches per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average number of total leaves per plant was calculated.

Number of leaves/ 5 selected plants/ plot: Number of total leaves per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average number of total leaves per plant was calculated.

Number of fruits/ 5 selected plants/ plot: Number of total fruits per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average number of total fruits per plant was calculated.

Single fruit weight/ 5 selected plants/ plot: Weight of total fruits per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average weight of total fruits per plant was calculated.

Length of fruit/ 5 selected plants/ plot: Length of total fruits per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average length of total fruits per plant was calculated.

Girth of fruit/ 5 selected plants/ plot: Girth of total fruits per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average girth of total fruits per plant was calculated.

Weight of fruit/ 5 selected plants/ plot: Weight of total fruits per 5 tagged plants per plot was recorded for each of 10 brinjal varieties at 7 days interval and the average weight of total fruits per plant was calculated.

3.9.3 Data calculation

The percent infestation of the shoot and fruit on the basis of recorded data were calculated with the following procedure:

Shoot infestation: The percent shoot infestation was calculated using the number of infested shoots and total number of shoots recorded in the study as follows:

$$\% \text{ infestation of shoot} = \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \times 100$$

Fruit infestation: The percent fruit infestation by number and weight was calculated using the number and weight of infested shoots and total number and weight of shoots, respectively recorded in the study as follows:

$$\% \text{ infestation of fruit by number} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

$$\% \text{ infestation of fruit by weight} = \frac{\text{Weight of infested fruit}}{\text{Weight of total fruits}} \times 100$$

$$\% \text{ reduction of fruit length} = \frac{\text{(Mean length of healthy fruits) - (Mean length of infested fruits)}}{\text{Mean length of healthy fruits}} \times 100$$

$$\% \text{ reduction of fruit girth} = \frac{\text{(Mean girth of healthy fruits) - (Mean girth of infested fruits)}}{\text{Mean girth of healthy fruits}} \times 100$$

3.10. Determination of resistance factor

Leaf thorn density: Number of leaf thorns on fully opened top 3 leaves per 3 selected plants per plot was observed through visual inspection and recorded for each of 10 brinjal varieties at 7 days interval.

Stem thorns density: Number of thorns on top 10 cm of stem per 3 selected plants per plot was observed through visual inspection and recorded for each of 10 brinjal varieties at 7 days interval.

Leaf trichome hair density: Number of trichome hairs per 1 cm^2 of fully opened top 3 leaves per 3 selected plants per plot was observed through stereo microscope and recorded for each of 10 brinajal varieties at 7 days interval.

Leaf moisture content: The moisture content of fully opened top 3 leaves per 3 selected plants per plot was measured using oven in the laboratory under the Department of Agronomy, SAU. For this purpose, the fresh leaves collected from the field were weighed and recorded for each of 10 brinjal varieties. Then the leaves were dried in the oven at 70^oC temperature for 24 hours and the weight of dried leaves was measured for each variety and replication. Finally, the amount of moisture removed from the leaves and percent leaf moisture content was calculated using the following formula:

$$\% \text{ leaf moisture content} = \frac{\text{(Weight of fresh leaves) - (Weight of oven dried leaves)}}{}$$

---------- x 100

Weight of fresh leaves

Plate 5: Experimental plot at SAU farm

Plate 6: BARI Brinjal 1 (Uttara)

Plate 7: BARI hybrid Brinjal 3 (F_1) (Tarapuri)

Plate 8: BARI Brinjal 3

Plate 9: BARI hybrid Brinjal 4 (F_1)

Plate 10 : BARI Brinjal 5 (Nayantara)

Plate 11: BARI Brinjal 6

Plate 12: BARI Brinjal 7

Plate 13: BARI brinjal 8

Plate 14: BARI Brinjal 9

Plate 15: BARI Brinjal 10

Plate 16: Adult Brinjal shoot and fruit borer

Plate 17: Brinjal shoot and fruit borer (larvae)

Plate 18: Damaging symptom of Brinjal shoot and fruit borer

Plate 19: Shoot infestation


Plate 20: Fruit infestation

Plate 21: Thorn on Leaf

Plate 22: Thorn on stem

Plate 23: Trichome hairs distributed on leaf surface

3.11 Data analysis

The data recorded from the field on different parameters were analyzed using the MSTAT-C computer package to determine the level of significance among 10 brinjal varieties. The means for different brinjal varieties were separated through test of significance using Duncan's Multiple Range Test (DMRT). The possible correlations were done for different parameters. The necessary graphs were also made using MS Excel Office package.

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted in the experimental field of Sher-e-Bangla Agricultural University, Dhaka during Rabi season from October 2013 to May 2014 to evaluate varietal performance of ten brinjal varieties against brinjal shoot and fruit borer (*Leucinodes orbonalis*) in relation to level of infestation, yield attributes and fruit yield. The results of the study have been presented in this section with justified interpretations and discussion as follows:

4. Infestation level

4.1. Shoot infestation

The significant variations were observed among different brinjal varieties in terms of percent shoot infestation at vegetative, early fruiting, mid fruiting and late fruiting stages of eggplants in the field against brinjal shoot and fruit borer (Table 1). In case of vegetative stage of eggplants, the highest shoot infestation (4.653%) was recorded in V_7 (BARI brinjal 7), which was statistically different from all other varieties followed by V_8 (BARI brinjal 8), V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) those contributed 3.99%, 3.65% and 3.47% shoot infestation, respectively. On the other hand, the lowest shoot infestation (1.08%) was recorded in V_6 (BARI brinjal 6), which was statistically different from all other varieties followed by V_2 (BARI brinjal F_1), V_5 (BARI brinjal 5), V_3 (BARI brinjal 3), V_4 (BARI brinjal 4) and V_1 (BARI brinjal 1) those manifested 2.43%, 2.58%, 2.73%, 2.85% and 3.17% shoot infestation, respectively. More or less similar trends of results were recorded in terms of percent shoot infestation at early, mid, and late fruiting stages of eggplants, where the highest shoot infestations were recorded in V_7 (BARI brinjal 7) followed by BARI brinjal 8 (V_8). Conversely the lowest shoot infestations were observed V_6 (BARI brinjal 6) followed by V_2 (BARI brinjal F_1). In case of increasing growth stages of the eggplants, the percent shoot infestation was increased with the increase of the ages of the plants, where minimum shoot infestation was recorded at vegetative stage for all brinjal varieties and maximum shoot infestation at late fruiting stage. As a result, the order of shoot infestation for all varieties of brinjal is late fruiting stage > mid fruiting stage > early fruiting stage > vegetative stage.

Considering the mean shoot infestation, the highest shoot infestation (5.50%) was recorded in V_7 (BARI brinjal 7), which was statistically similar (5.04%) with V_8 (BARI brinjal 8), but statistically different from all other varieties followed by V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) those contributed 4.48%, and 3.86% shoot

infestation, respectively. On the other hand, the lowest shoot infestation (1.18%) was recorded in V_6 (BARI brinjal 6), which was statistically different from all other varieties followed by V_2 (BARI brinjal F_1), V_5 (BARI brinjal 5/Nayantara), V_3 (BARI brinjal 3), V_4 (BARI brinjal 4) and V_1 (BARI brinjal 1/Uttara) those manifested 2.69%, 2.95%, 3.12%, 3.37% and 3.57% shoot infestation, respectively.

Table 1. Shoot infestation caused by brinjal shoot and fruit borer in different brinjal varieties

Variety	% shoot infestation				
	Vegetative stage	Early fruiting stage	Mid fruiting stage	Late fruiting stage	Mean infestation
V_1	3.17 de	3.43 d	3.76 cd	3.90 cd	3.57 cd
V_2	2.43 g	2.56 g	2.74 e	3.05 e	2.69 f
V_3	2.73 fg	3.00 ef	3.29 cde	3.45 cde	3.12 def
V_4	2.85 ef	3.38 de	3.55 cde	3.70 cde	3.37 cde
V_5	2.58 fg	2.77 fg	3.09 de	3.35 de	2.95 ef
V_6	1.08 h	1.15 h	1.20 f	1.28 f	1.18 g
V_7	4.65 a	4.75 a	6.16 a	6.42 a	5.50 a
V_8	3.99 b	4.17 b	5.86 a	6.18 a	5.04 a
V_9	3.65 bc	3.89 bc	5.01 b	5.38 b	4.48 b
V_{10}	3.47 cd	3.64 cd	4.07 c	4.26 c	3.86 c
CV (%)	7.28	7.32	11.49	10.97	8.76
$LSD_{(0.05)}$	0.3836	0.4095	0.7633	0.7710	0.5370

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2= BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

From the above findings it was revealed that V_7 (BARI brinjal 7) and V_8 (BARI brinjal 8) performed as the most suitable brinjal varieties in terms of percent shoot infestation (5.50% and 5.04%, respectively), whereas the V_6 (BARI brinjal 6) performed as the least suitable varieties in terms of shoot infestation (1.18%) due to attack of brinjal shoot and fruit borer. As a result, the order of trends of least preferable brinjal varieties in terms of percent shoot infestation is V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1 (BARI brinjal 1/Uttara) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7). About similar results were also reported by several researchers. Panda (1999) reported in their findings that shoot infestation varied from 1.61 to 44.11%.

4.2. Fruit infestation

The significant variations were observed among different brinjal varieties in terms of percent fruit infestation by number and weight at early fruiting, mid fruiting and late fruiting stages of eggplants in the field against brinjal shoot and fruit borer (Table 2 and 3).

4.2.1 Fruit infestation by number

In case of early fruiting stage of eggplants, the highest fruit infestation by number (26.90%) was recorded in V_7 (BARI brinjal 7), which was statistically different from all other varieties followed by V_8 (BARI brinjal 8), V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) those contributed 24.58 %, 23.32 % and 23.06% fruit infestation by number, respectively. On the other hand, the lowest fruit infestation by number (1.31 %) was recorded in V_6 (BARI brinjal 6), which was statistically different from all other varieties followed by V_2 (BARI brinjal F_1), V_5 (BARI brinjal 5), V_3 (BARI brinjal 3), V_4 (BARI brinjal 4) and V_1 (BARI brinjal 1) those manifested 8.25%, 8.62%, 9.06%, 12.46% and 18.43% fruit infestation by number, respectively. More or less similar trends of results were also recorded in terms of percent fruit infestation by number at mid and late fruiting stages of eggplants, where the highest fruit infestations by number were recorded in V_7 (BARI brinjal 7) followed by BARI brinjal 8 (V_8). Conversely the lowest fruit infestations by number were observed V_6 (BARI brinjal 6) followed by V_2 (BARI brinjal F_1). In case of increasing growth stages of the eggplants, the percent fruit infestation by number was increased with the increase of the plant age, where minimum shoot infestation was recorded at early fruiting stage for all brinjal varieties and maximum fruit infestation by number at late fruiting stage. As a result, considering the growth stages of the eggplants, the order of trends of fruit infestation by number for all varieties of brinjal is late fruiting stage > mid fruiting stage > early fruiting stage.

Considering the mean fruit infestation by number, the highest fruit infestation by number (27.45%) was recorded in V_7 (BARI brinjal 7), which was statistically significant than all other varieties followed by V_8 (BARI brinjal 8), V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) those contributed 25.91%, 25.08% and 24.52% fruit infestation by number, respectively. On the other hand, the lowest fruit infestation by number (3.54%) was recorded in V_6 (BARI brinjal 6), which was statistically different from all other varieties followed by V_2 (BARI hybrid brinjal), V_5 (BARI brinjal 5), V_3 (BARI brinjal 3), V_4 (BARI brinjal 4) and V_1 (BARI brinjal 1) those manifested 9.93%, 10.20%, 12.65%, 16.44% and 19.70% fruit infestation by number, respectively.

Table 2. Fruit infestation by number due to brinjal shoot and fruit borer attack in different brinjal varieties

Treatment	% fruit infestation by number

	Early fruiting stage	Mid fruiting stage	Late fruiting stage	Mean infestation
V_1	18.43 d	20.06 e	20.61 d	19.70 e
V_2	8.25 g	9.13 h	12.41 g	9.93 i
V_3	9.06 f	12.65 g	16.23 f	12.65 g
V_4	12.46 e	18.37 f	18.51 e	16.44 f
V_5	8.62 fg	9.37 h	12.61 g	10.20 h
V_6	1.31 h	3.13 i	6.16 h	3.54 j
V_7	26.90 a	27.07 a	28.37 a	27.45 a
V_8	24.58 b	26.33 b	26.82 b	25.91 b
V_9	23.32 c	25.62 c	26.30 b	25.08 c
V_{10}	23.06 c	24.95 d	25.56 c	24.52 d
CV (%)	1.91	1.20	1.77	0.59
$LSD_{(0.05)}$	0.5089	0.3639	0.5893	0.1799

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2= BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

From the above findings it was revealed that V_7 (BARI brinjal 7) and V_8 (BARI brinjal 8) performed as the most suitable brinjal varieties in terms of percent fruit infestation by number (27.45% and 25.91%, respectively), whereas the V_6 (BARI brinjal 6) performed as the least suitable varieties in terms of fruit infestation by number (3.54%) due to attack of brinjal shoot and fruit borer. As a result, the order of trends of least preferable brinjal varieties in terms of percent fruit infestation by number is V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1 (BARI brinjal 1) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7).

4.2.2 Fruit infestation by weight

The significant variations were observed among different brinjal varieties in terms of percent fruit infestation by weight at early fruiting, mid fruiting and late fruiting stages of eggplants in the field against brinjal shoot and fruit borer (Table 3). In case of early fruiting stage of eggplants, the highest fruit infestation by weight (27.68%) was recorded in V_7 (BARI brinjal 7), which was statistically different from all other varieties followed by V_8 (BARI brinjal 8), V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) those contributed 26.49%, 26.10% and 25.76% fruit infestation by weight, respectively. On the other hand, the lowest fruit infestation by weight (1.357%) was recorded in V_6 (BARI brinjal 6), which was statistically different from all other

varieties followed by V_2 (BARI brinjal F_1), V_5 (BARI brinjal 5), V_3 (BARI brinjal 3), V_4 (BARI brinjal 4) and V_1 (BARI brinjal 1) those manifested 12.75%, 13.15%, 14.05%, 15.19% and 19.14% fruit infestation by weight, respectively. More or less similar trends of results were recorded in terms of percent fruit infestation by weight at mid and late fruiting stages of eggplants, where the highest fruit infestations by weight were recorded in V_7 (BARI brinjal 7) followed by V_8 (BARI brinjal 8). Conversely, the lowest fruit infestations by weight were observed in V_6 (BARI brinjal 6) followed by V_2 (BARI brinjal F_1). In case of increasing growth stages of the eggplants, the percent fruit infestation by weight was increased with the increase of the ages of the plants, where minimum shoot infestation was recorded at early fruiting stage for all brinjal varieties and maximum fruit infestation by weight at late fruiting stage. As a result, considering the growth stages of eggplants, the order of trends of fruit infestation by weight for all varieties of brinjal is late fruiting stage > mid fruiting stage > early fruiting stage .

Considering the mean fruit infestation by weight, the highest fruit infestation by weight (28.10%) was recorded in V_7 (BARI brinjal 7), which was statistically significant than all other varieties followed by V_8 (BARI brinjal 8), V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) those contributed 27.11%, 26.68% and 26.19% fruit infestation by weight, respectively. On the other hand, the lowest fruit infestation by weight (2.74%) was recorded in V_6 (BARI brinjal 6), which was statistically different from all other varieties followed by V_2 (BARI hybrid brinjal), V_5 (BARI brinjal 5), V_3 (BARI brinjal 3), V_4 (BARI brinjal 4) and V_1 (BARI brinjal 1) those manifested 13.37%, 14.09%, 15.63%, 16.96% and 21.04% fruit infestation by weight, respectively.

Table 3 Fruit infestation by weight due to brinjal shoot and fruit borer attack in different brinjal varieties

Treatment	% fruit infestation by weight			
	Early fruiting stage	Mid fruiting stage	Late fruiting stage	Mean infestation
V_1	19.14 c	21.71 d	22.26 d	21.04 d
V_2	12.75 f	13.16 h	14.21 h	13.37 h
V_3	14.05 e	14.59 f	18.24 f	15.63 f
V_4	15.19 d	16.43 e	19.27 e	16.96 e
V_5	13.15 f	13.78 g	15.35 g	14.09 g
V_6	1.36 g	2.24 i	4.63 i	2.740 i
V_7	27.68 a	27.87 a	28.74 a	28.10 a
V_8	26.49 b	26.98 b	27.86 b	27.11 b
V_9	26.10 b	26.53 b	27.41 bc	26.68 bc
V_{10}	25.76 b	25.96 c	26.85 c	26.19 c
CV (%)	2.29	1.75	2.46	1.97
$LSD_{(0.05)}$	0.7135	0.5689	0.8645	0.6487

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2= BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

From the above findings it was revealed that V_7 (BARI brinjal 7) and V_8 (BARI brinjal 8) performed as the most suitable brinjal varieties in terms of percent fruit infestation by weight (28.10% and 27.11%, respectively), whereas the V_6 (BARI brinjal 6) performed as the least suitable varieties in terms of fruit infestation by weight (2.74%) due to attack of brinjal shoot and fruit borer. As a result, the order of trends of least preferable brinjal varieties in terms of percent fruit infestation by weight is V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1 (BARI brinjal 1) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7).

4.2.3 Infestation intensity

The effects of different brinjal varieties on the infestation intensity expressed in terms of fruits having number of bore per fruits corresponding to any of 3 scales such as scale 1 comprised with 1-2 bores/fruit and designated as low infestation intensity; scale 2 comprised with 3-4 bores/fruit and designated as moderate infestation intensity; while the scale 3 comprised with more than 5 bores/fruit and designated as high infestation intensity have been presented in Table 4.

In case of scale 1 infestation intensity, the highest frequency of low infestation intensity fruits (8 per10 fruits) was observed in V_6, which was statistically different from all other varieties followed by V_2, V_3 and V_4, whereas the minimum frequency of low infestation intensity fruits was observed in V_7 (2.35 per 10 fruits) followed by V_8, V_9 and V_{10}.

In case of scale 2 infestation intensity, the highest frequency of moderate infestation intensity fruits (3.87 per10 fruits) was observed in V_7, which was statistically different from all other varieties followed by V_8, V_9, V_{10} and V_1, while the minimum frequency of moderate infestation intensity fruits was observed in V_6 (1.80 per 10 fruits) followed by V_2, V_5, V_3 and V_4. More or less similar trend of the frequency of infestation intensity fruits was also observed in case of scale 3, where the highest frequency of high infestation intensity fruits (4.40 per10 fruits) was observed in V_7, which was statistically different from all other varieties followed by V_8, V_9, V_{10} and V_1, while the minimum frequency of high infestation intensity fruits was observed in V_6 (1.17 per 10 fruits) followed by V_2, V_5, V_3 and V_4.

Table 4 Fruit infestation intensity (no. of bore/fruit) caused by brinjal shoot and fruit borer in different brinjal varities

Treatment	Infestation intensity (number of bores/ fruit)

	Scale 1 (1-2 bores/fruit)	Scale 2 (3-4 bores/fruit)	Scale 3 (>5 bores/fruit)
V_1	3.79 f	3.12 d	2.98 e
V_2	6.98 b	1.84 h	1.49 i
V_3	6.03 d	2.37 f	2.26 g
V_4	5.35 e	2.52 e	2.74 f
V_5	6.25 c	1.91 g	1.87 h
V_6	8.02 a	1.80 h	1.17 j
V_7	2.35 j	3.87 a	4.40 a
V_8	2.69 i	3.85 b	3.51 b
V_9	3.06 h	3.61 c	3.22 c
V_{10}	3.38 g	3.160 d	3.12 d
CV (%)	2.33	1.12	0.74
$LSD_{0.05}$	0.1879	0.05425	0.07671

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2= BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

Considering the comparison among three scales of infestation intensity for all brinjal varieties, the highest frequency of low infestation intensity (scale 1) fruits was observed in least preferred brinjal varieties by BSFB such as V_6 followed by V_2, V_5, V_3 and V_4. On the other hand, the lowest frequency of low infestation intensity (scale 1) was observed in most preferred brinjal varieties by BSFB such as V_7 followed by V_8, V_9, V_{10} and V_1. Conversely, the highest frequency of high infestation intensity (scale 3) fruits was observed in most preferred brinjal varieties by BSFB such as V_7 followed by V_8, V_9, V_{10} and V_1. On the other hand, the lowest frequency of low infestation intensity (scale 3) was observed in most preferred brinjal varieties by BSFB such as V_6 followed by V_2, V_5, V_3 and V_4.

From these findings it was revealed that the due to infestation caused by BSFB, the least preferred (resistant) brinjal varieties such as V_6 (BARI brinjal 6) manifested low infestation intensity (scale 1) on fruits and the most preferred (susceptible) brinjal varieties such as V_7 (BARI brinjal 7) evident high infestation intensity (scale 3) on fruits.

4.3 Yield attributes

The significant variations were observed among different brinjal varieties in terms of plant related yield attributes such as number of branch per plant and number of leaves per plant as well as fruit related yield attributes such as number of fruits per plant, fruit length, fruit girth, single fruit weight throughout the growing period of eggplants in the field (Table 5 and 6).

4.3.1 Plant related yield attributes

The significant variations were observed among different brinjal varieties in terms of number of branch per plant and number of leaves per plant throughout the growing period of eggplants in the field (Table 5).

Number of branch per plant

The highest number of branch per plant (69.46) was observed V_7 (BARI brinjal 7), which was significantly different from all other varieties followed by V_8 (BARI brinjal 8), V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) which contributed 65.34, 56.67 and 51.84 branch per plant, respectively. On the other hand, the lowest number of branch per plant (34.29) was observed in V_6 (BARI brinjal 6) which was significantly different from all other varieties followed by V_2, V_5 and V_3 which contributed 39.79, 42.67 and 48.30 branch per plant, respectively.

Number of leaf per plant

In terms of leaf number per plant, the highest number of leaves per plant (412.8) was observed in V_7 (BARI brinjal 7), which was significantly different from all other varieties followed by V_8 (BARI brinjal 8), V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) which contributed 402.5, 392.6 and 353.9 leaf per plant, respectively. On the other hand, lowest number of leaves per plant (178.4) was observed in V_6 (BARI brinjal 6) which was significant from all other varieties followed by V_2, V_5 and V_3 which contributed 240.1, 244.9 and 284.4 leaf per plant, respectively.

Table 5 Number of branch and leaf per plant in different brinjal varieties

Treatment	Plant related yield attributes	
	Branch (No./plant)	Leaf (No./plant)
V_1	52.71 d	341.2 e
V_2	39.79 g	240.1 h
V_3	48.30 e	284.4 f
V_4	48.67 e	340.3 e
V_5	42.67 f	244.9 g
V_6	34.29 h	178.4 i
V_7	69.46 a	412.8 a
V_8	65.34 b	402.5 b
V_9	56.67 c	392.6 c
V_{10}	51.84 d	353.9 d
CV (%)	2.86	3.227
$LSD_{0.05}$	2.502	0.59

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2=

BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

From these findings it was revealed that the brinjal variety V_7 mostly preferred by BSFB produced the highest number of branch and leaf per plant, while the least preferred brinjal variety V_6 produced the lowest number of branch and leaf per plant. Earlier, it was observed that variety V_6 (BARI brinjal 6) which possessed lowest number of infestation in terms shoot infestation, fruit infestation by number and weight produced the lowest number of branch and leaves per plant. It was also inferred from these findings that the bushy and shady varieties of brinjal manifested by higher number of branches and leaves much preferred by the brinjal shoot and fruit borer for infestation on shoots and fruits. About similar results were also reported by several researchers. Amin *et al.,* (2014) reported in their findings that the lowest number of leaves and branch per plant the lowest is the infestation by brinjal shoot and fruit borer.

4.3.2 Fruit related yield attributes

The significant variations were observed among different brinjal varieties in terms of fruit related yield attributes such as number of fruits per plant, fruit length, fruit girth, single fruit weight throughout the growing period of eggplants in the field (Table 6).

Number of fruits/plant

Table 6 depicted that different fruits/plant was greatly influenced by the effect of brinjal shoot and fruit borer. Results revealed that highest number of fruits per plant (6.05) was observed in V_2 (BARI hybrid brinjal 3) which was significantly different from all other varieties followed by V_5 (BARI brinjal 5/Nayantara) which was close to V_3 (BARI brinjal 3) which contributed 5.70 and 5.38 fruits per plant, respectively. Similarly, the lowest number of fruits per plant (0.76) has been observed in V_{10} (BARI brinjal 10) which was significantly different from all other variety, followed by V_9 (BARI brinjal 9 and BARI brinjal 8) that contributed 1.42 and 1.54 fruits per plant, respectively. As a result, in case of number of fruits per plant was found the following trend V_2 (BARI hybrid brinjal 3)> V_5 (BARI brinjal 5/ Nayantara)> V_3 (BARI brinjal 3)> V_4 (BARI hybrid brinjal 4)> V_6 (BARI brinjal 6) > V_1 (BARI brinjal 1/Uttara) > V_7 (BARI brinjal 7) > V_8 (BARI brinjal 8) > V_9 (BARI brinjal 9) > V_{10} (BARI brinjal 10).

Fruit length

The result obtained from Table 6 showed that Single fruit length had different influence in terms of different varieties. The highest single fruit length (35.61cm) has been reported in case of V_1 (BARI brinjal 7) which was statistically similar (35.23cm) to V_9 (BARI brinjal 9). Both are insignificantly different from V_8 (BARI brinjal 8) that was

statistically similar to V_4 (BARI hybrid brinjal 4) that contributed 33.36 cm and 33.34 cm, respectively. The lowest single fruit length was reported 5.99cm by V_6 (BARI brinjal 6) which was significantly different from all other varieties followed by V_1 (BARI brinjal 1) 14.78cm which was insignificantly different from V_2 (BARI brinjal 2) that contributed 22.88cm. As a result, in case of fruit length (cm), it was found the following trend V_7 (BARI brinjal 7)> V_9 (BARI brinjal 9)> V_8 (BARI brinjal 8)> V_4 (BARI hybrid brinjal 4)> V_3 (BARI brinjal 3) > V_5 (BARI brinjal 5) > V_{10} (BARI brinjal 10) > V_2 (BARI hybrid brinjal 2) > V_1 (BARI brinjal 1) > V_6 (BARI brinjal 6).

Fruit girth

The result obtained from Table 6 showed that Single fruit girth had different influence in terms of different varieties. The highest fruit girth has been reported (38.18cm) in case of V_8 (BARI brinjal 8) which was insignificantly different (35.23cm) to V_9 (BARI brinjal 9). Both are insignificantly different from V_8 (BARI brinjal 8) that was statistically similar to V_4 (BARI hybrid brinjal 4) that contributed 33.36cm and 33.34cm respectively. The lowest single fruit girth was reported 5.99cm by V_6 (BARI brinjal 6) which was significantly different from all other varieties followed by V_7 (BARI brinjal 7) 14.78cm which was insignificantly different from V_2 (BARI brinjal 2) that contributed 22.88cm. So, in case of single fruit girth (cm), it was found the following trend V_8 (BARI hybrid brinjal 8)> V_9 (BARI brinjal 9)> V_1 (BARI brinjal 1)> V_5 (BARI brinjal 5)> V_2 (BARI hybrid brinjal 3) > V_3 (BARI brinjal 3) > V_{10} (BARI brinjal 10) > V_4 (BARI hybrid brinjal 4) > V_6 (BARI brinjal 6) > V_7 (BARI brinjal 7).

Single fruit weight

In case of single fruit weight the highest result observed 323.5g by V_6 (BARI brinjal 6) which is significantly different from all other varieties followed by V_5 (BARI brinjal 5/ Nayantara) that contributed 225.5g and V_3 (BARI brinjal 3) 180.6g which is statistically similar to V_4 (BARI hybrid brinjal) which contributed 165.7g. On the other hand lowest single fruit weight observed (34.40g) in V_{10} (BARI brinjal 10) which is significantly different from all other brinjal varieties followed by V_9 (BARI brinjal 9), V_8 (BARI brinjal 8) and V_7 (BARI brinjal 7) which contributed 74.17g, 75.20g and 95.07g respectively. So, in case of single fruit weight (g), it was found the following trend V_2 (BARI hybrid brinjal 3)> V_5 (BARI brinjal 5)> V_3 (BARI brinjal 3)> V_4 (BARI hybrid brinjal 4)> V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7) > V_6 (BARI brinjal 6) > V_1 (BARI brinjal 1) > V_{10} (BARI brinjal 10).

Table 6. Fruit related yield attributes in different brinjal varieties

Treatment	Fruit related yield attributes			
	No. of fruits/plant	Single fruit length (cm)	Fruit girth (cm)	Single fruit weight (g)
V_1	2.05 e	14.78 d	31.05 b	105.5 d
V_2	6.05 a	22.88 cd	26.57 b	323.5 a
V_3	5.38 b	28.50 bc	20.62 c	180.6 c
V_4	4.36 c	33.34 ab	4.53 d	165.7 c
V_5	5.70 ab	27.69 bc	28.56 b	225.5 b
V_6	3.56 d	5.990 e	4.40 d	108.5 d
V_7	1.94 ef	35.61 a	24.57 de	95.07 d
V_8	1.54 fg	33.36 ab	38.18 a	75.20 d
V_9	1.42 g	35.23 a	34.54 ab	74.17 d
V_{10}	0.76 h	26.68bc	17.76 c	34.40 e
CV (%)	8.50	12.58	12.51	13.08
$LSD_{0.05}$	0.4791	5.697	4.951	31.16

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2= BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

4.4 Yield

Significant variations were observed among the varieties in terms of fruit yield of brinjal. In case of fruit yield (kg/plot), the highest yield (21.85 kg/plot) was recorded in V_2 (BARI hybrid brinjal 3), which was statistically similar to V5 (BARI brinjal 5) that contributed (17.19 kg/plot) followed by V_3 (BARI brinjal 3) and V_4 (BARI hybrid brinjal 4). On the other hand, the lowest yield (2.78kg/plot) was recorded in V_{10} which was statistically similar with V_8 and V_9 which was 3.28g and 3.07g respectively. More or less similar trend was observed in case of yield of fruits in ton per hectare where the highest yield was recorded in V_2 (36.41ton/ha) and lowest yield was recorded in V_{10} (4.64ton/ha). As a result, the order of results in terms of increasing the yield of okra yield over control is V_2> V_5> V_3> V_4> V_6> V_1> V_7> V_8> V_9> V_{10}.

Table 7. Fruit yield in different varieties of brinjal

Treatment	Fruit yield	
	Yield (kg/plot)	Yield (ton/ha)
V_1	5.39 ef	8.98 ef
V_2	21.85 a	36.41 a
V_3	12.94 c	21.57 c
V_4	7.60 d	12.68 d
V_5	17.19 a	28.65 a
V_6	6.23 e	10.39 e
V_7	4.94 f	8.24 f
V_8	3.28 g	5.46 g
V_9	3.07 g	5.12 g
V_{10}	2.78 g	4.64 g
CV (%)	7.27	7.29
$LSD_{(0.05)}$	0.9824	1.642

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2= BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

4.5 Evaluation of factors affecting varietal preference

The factors affecting the varietal preference of brinjal were evaluated against brinjal shoot and fruit borer. Considering the purpose, the moisture content of leaves, trichome hair density on leaves, thorn density on leaves and stems were observed and recorded. The significant variations were observed among different brinjal varieties in terms of the above mentioned factors of the eggplants (Table 8, 9 and 10).

4.5.1. Moisture content of leaves

The significant variations were observed among different brinjal varieties in terms of moisture content of leaves at vegetative, early fruiting and late fruiting stages of eggplants in the field against brinjal shoot and fruit borer (Table 8). In case of vegetative stage of eggplants, the highest moisture content of leaves (87.34%) was recorded in V_7 (BARI brinjal 7), which was statistically similar with V_8 (BARI brinjal 8), V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) those contributed 87.05%, 86.76% and 86.27% moisture, respectively, but different from other varieties. On the other hand, the lowest moisture content of leaves (83.94%) was recorded in V_6 (BARI brinjal 6), which was statistically similar with V_2 (BARI brinjal F_1), V_5 (BARI brinjal 5), V_3 (BARI brinjal 3), V_4 (BARI brinjal 4) and V_1 (BARI brinjal 1) those manifested 84.76%, 84.98%, 85.20%, 85.43% and 85.73% moisture, respectively. More or less similar trends of results were recorded in terms of percent moisture content of leaves at early, and late fruiting stages of eggplants. As a result, the order of trends of shoot infestation for all varieties of brinjal is early fruiting stage > vegetative stage > late fruiting stage.

Considering the mean percent moisture content of leaves, the highest percent moisture content of leaves (87.75%) was recorded in V_7 (BARI brinjal 7), which was statistically similar with V_8 (BARI brinjal 8) followed by V_9 (BARI brinjal 9) and V_{10} (BARI brinjal 10) those contributed 87.45%, and 86.99% and 86.50% moisture, respectively, but different from other varieties. On the other hand, the lowest moisture content (83.66%) was recorded in V_6 (BARI brinjal 6), which was statistically similar with V_2 (BARI brinjal F_1) followed by V_5 (BARI brinjal 5/Nayantara), V_3 (BARI brinjal 3), V_4 (BARI brinjal 4) and V_1 (BARI brinjal 1/Uttara) those manifested 84.66%, 85.31%, 85.74%, 85.96% and 86.10% moisture, respectively.

Considering the comparison among the growth ages the eggplants, the moisture content of leaves was increased at early fruiting stage from that of vegetative stage of eggplants, but drastically decreased at older stage (late fruiting stage) of the eggplants.

Table 8. Moisture contents of leaves during different growing stage of plants in different varieties

Treatment	Leaf moisture content (%)			
	Vegetative stage	Early fruiting stage	Late fruiting stage	Mean
V_1	85.73 abcde	96.84 abcd	75.73 cd	86.10 cd
V_2	84.76 de	95.50 d	73.72 ef	84.66 ef
V_3	85.20 cde	96.56 bcd	75.45 cd	85.74 de
V_4	85.43 bcde	96.79 abcd	75.66 cd	85.96 cd
V_5	84.98 cde	96.20 cd	74.76 de	85.31 de
V_6	83.94 e	94.07 e	72.97 f	83.66 f
V_7	87.34 a	98.06 a	77.84 a	87.75 a
V_8	87.05 ab	97.63 ab	77.67 a	87.45 ab
V_9	86.76 abc	97.39 abc	77.02 ab	86.99 abc
V_{10}	86.27 abcd	97.06 abc	76.18 bc	86.50 bcd
CV (%)	1.12	0.75	0.83	0.73
$LSD_{(0.05)}$	1.644	1.246	1.075	1.081

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2= BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

From the above findings it was revealed that V_7 (BARI brinjal 7) and V_8 (BARI brinjal 8) performed as the most suitable brinjal varieties in terms of percent moisture content of leaves (87.75% and 87.45%, respectively), whereas the V_6 (BARI brinjal 6) performed as the least suitable varieties in terms of shoot infestation (83.66%) due to attack of brinjal shoot and fruit borer. As a result, the of least preferable brinjal varieties in terms of percent moisture content was V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1

(BARI brinjal 1) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7).

4.6 Trichome hair density

The significant variations were observed among different brinjal varieties in terms of Trichome hair density of leaves per cm^2 at fully opened top first, third, fifth and seventh leaf of eggplants in the field (Table 9). In terms of top first leaf, the highest trichome hair per cm^2 has been recorded in V_6 (BARI brinjal 6) which is significantly different from all other varieties followed by V_2 (BARI hybrid brinjal 3) 23.74cm^2 which is insignificantly different from V_5 (BARI brinjal 5/ Nayantara) 22.45 cm^2. On the other hand, the lowest number of trichome per cm^2 on leaf was observed (8.76cm^2) in V_7 (BARI brinjal 7) was statistically similar with V_8 (BARI brinjal 8) and V_9 (BARI brinjal 9) followed by V_{10} (BARI brinjal 10) and V_1 (BARI brinjal 1) that were manifested 10.07cm^2, 11.56 $cm^{2,}$ 13.33 cm^2 and 13.96 cm^2 respectively. More or less similar results were recorded in terms of number of trichome hair density per cm^2 at top third leaf, top fifth leaf and top seventh leaf where the highest number of trichome hair density per cm^2 was recorded in terms of V_6 (BARI brinjal 6) and lowest number of trichome hair density per cm^2 was recorded in terms of V_7 (BARI brinjal 7). Trichome hair density gradually decreased with the age and lower position of leaves. Thus less trichome hair density was observed in top seventh leaves of plant. As a result, the order of trends of number of trichome per cm^2 for all varieties of brinjal was top first leaf > top third leaf > top fifth leaf> Top seventh leaf.

Considering the mean number of trichome hair density per cm^2, the highest number of trichome per cm^2 was observed in BARI brinjal 6 (V_6) 30.44 cm^2 which is significantly different from all other brinjal varieties followed by V_2 (BARI hybrid brinjal 3) and V_5 (BARI brinjal 5/ Nayantara). Both manifested 23.82 cm^2 and 19.84 cm^2 respectively. On the other hand, the lowest trichome density per cm^2 was recorded (8.35 cm^2) in terms of V_7 (BARI brinjal 7) which was statistically similar to V_8 (BARI brinjal 8) that manifested 8.65 cm^2 and 9.13 cm^2 trichome hair density respectively.

Table 9. Leaf Trichome density at various canopy strata of plants in different varieties

Treatment	Trichome hair density (no./cm^2)				
	Top first leaf	Top third leaf	Top fifth leaf	Top seventh leaf	Mean
V_1	13.96 d	12.67 ef	11.56 f	11.59 e	12.44 f
V_2	23.74 b	27.22 b	24.44 b	19.89 b	23.82 b
V_3	21.70 c	19.59 d	19.26 d	13.78 c	18.59 d

V_4	21.19 c	13.93 e	14.70 e	12.96 d	15.70 e
V_5	22.45 bc	22.71 c	20.07 c	14.11 c	19.84 c
V_6	36.30 a	33.34 a	29.04 a	23.07 a	30.44 a
V_7	8.76 f	9.93 g	7.96 j	6.74 g	8.35 h
V_8	10.07 ef	11.04 fg	8.37 i	7.04 g	9.13 h
V_9	11.56 e	12.30 efg	10.22 h	9.04 f	10.78 g
V_{10}	13.33 d	12.48 efg	10.63 g	9.41 f	11.46 g
CV (%)	4.77	8.06	1.11	2.15	3.19
LSD $_{(0.05)}$	1.497	2.424	0.2971	0.4698	0.8797

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2= BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

From the above findings it was revealed that V_7 (BARI brinjal 7) and V_8 (BARI brinjal 8) performed as the least suitable brinjal varieties in terms of trichome hair density per cm^2 (8.65 cm^2 and 9.13 cm^2 respectively), whereas the V_6 (BARI brinjal 6) performed as the most suitable varieties in terms of trichome hair density per cm^2 (30.44). As a result, the order of trends of the most preferable brinjal varieties in terms of trichome hair density per cm^2 is V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1 (BARI brinjal 1) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7).

4.7 Thorn density

Significant variation was found in terms of thorn density number per top fully open first leaf. The highest number of thorn density per top fully open first leaf was recorded 4.44 in V_6 (BARI brinjal 6) which is significantly different from all other brinjal varieties followed by V_2 (BARI hybrid brinjal 3) which was insignificantly different with V_3 (BARI brinjal 3), contributed 1.00 and 0.8533 respectively. On the other hand least number of thorn per top fully opened leaf was recorded (0.1467) in V_7 (BARI brinjal 7) which was statistically similar to V_8 (BARI brinjal 8) and V_9 (BARI brinjal 9), manifested 0.1833 and 0.22 respectively followed by, V_{10} (BARI brinjal 10) (0.37).

More or less similar trend was found in case of thorn density number per 10cm of apical stem of brinjal plant. The highest number of thorn density per 10 cm of apical stem was recorded (6.183) in V_6 (BARI brinjal 6) which was significantly different from all other varieties of brinjal followed by V_3 (BARI brinjal 3) and V_4 (BARI hubrid brinjal 4) that manifested 5.147 and 4.037 respectively. On the similar trend the least number of thorn per 10 cm of apical stem was recorded (2.483) in terms of V_7 (BARI

brinjal 7) which was statistically similar to V_8 (BARI brinjal 8) and V_9 (BARI brinjal 9) that manifested 2.593 and 2.780 respectively

Table 10. Leaf and stem thorns in different brinjal varieties

Treatment	Thorn density (No./leaf or stem)	
	Top first leaf	Stem (10 cm apical part)
V_1	0.59 cd	3.33 d
V_2	1.00 b	6.11 a
V_3	0.85 bc	5.15 b
V_4	0.63 cd	4.04 c
V_5	0.89bc	1.45 f
V_6	4.44 a	6.18 a
V_7	0.15 e	2.48 e
V_8	0.18e	2.59 e
V_9	0.22 e	2.78 e
V_{10}	0.37 de	2.93 de
CV (%)	17.25	7.29
$LSD_{(0.05)}$	0.2766	0.4635

[In columns, each mean is the average of three replicates and the same letter with means indicate the statistically similar with each other at 5% level of significance with DMRT. V_1= BARI* brinjal 1, V_2= BARI brinjal 3 (F_1), V_3= BARI brinjal 3, V_4= BARI brinjal 4 (F_1), V_5= BARI brinjal 5, V_6= BARI brinjal 6, V_7= BARI brinjal 7, V_8= BARI brinjal 8, V_9= BARI brinjal 9, V_{10}= BARI brinjal 10]

From the above findings, it was revealed that, V_6 (BARI brinjal 6) possessed the highest number of thorn density per top fully open first leaf and per 10 cm of apical stem (4.443 and 6.183) respectively while the least amount of thorn density per top fully open first leaf and per 10 cm of apical stem was recorded in terms of V_7 (BARI brinjal 7) (0.1467 and 2.483) respectively.

4.8 Relationship between number of fruits and shoot infestation

Correlation study was done to establish a relationship between percent shoot infestation and number of fruit. From the study it was revealed that significant correlation existed between the characters (Figure-1). The regression equation y= -0.4809x +4.81 gave a good fit to the data and value of the co-efficient of determination (R^2 = 0.2622). From this it can be concluded that the number of fruit was decreased with the increase of percent shoot infestation.

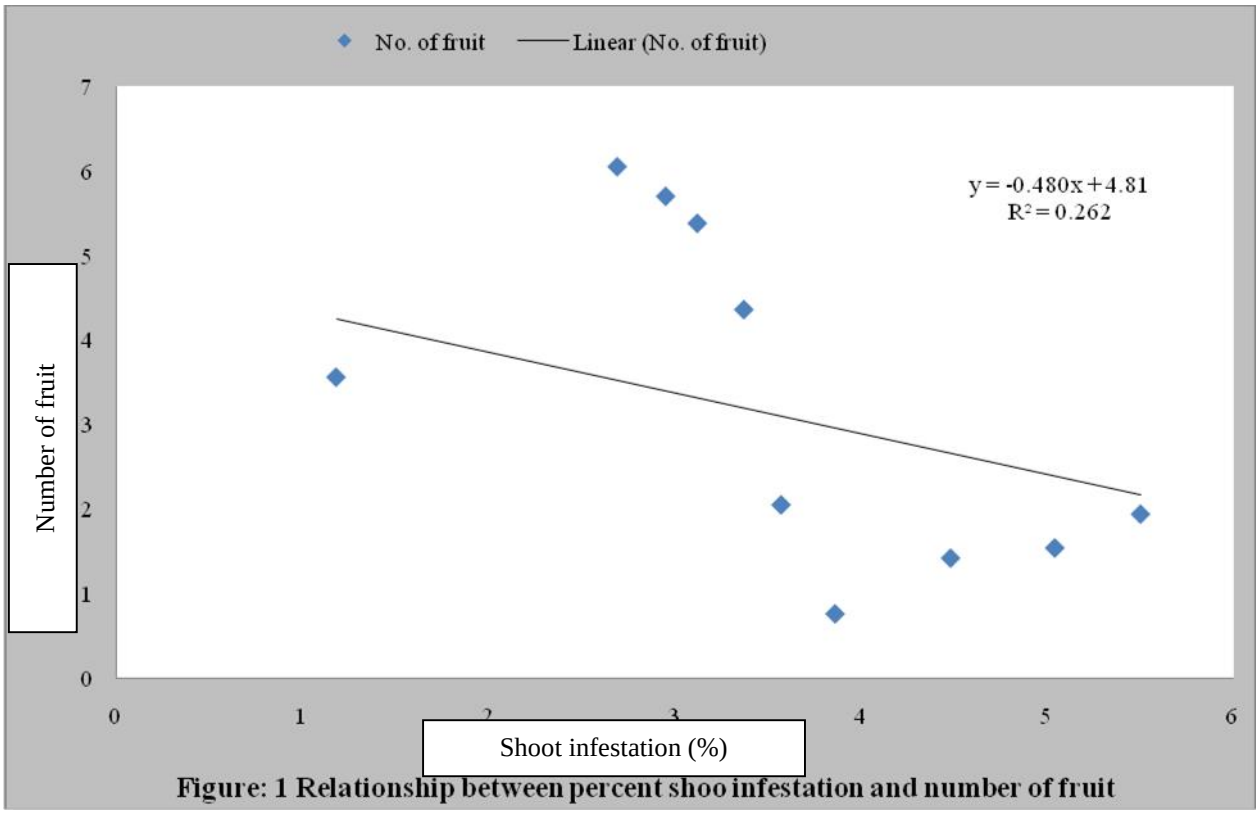

Figure: 1 Relationship between percent shoo infestation and number of fruit

4.9 Relationship between fruit infestation and number of fruit

Correlation study was done to establish a relationship between percent fruit infestation by number and number of fruit. From the study it was revealed that significant correlation existed between the characters (Figure-2). The regression equation y= -1.223x +28.33 gave a good fit to the data and value of the co-efficient of determination ($R^{2 =}$ -21.5). From this it can be concluded that the number of fruit was decreased with the increase of number of percent fruit infestation by number.

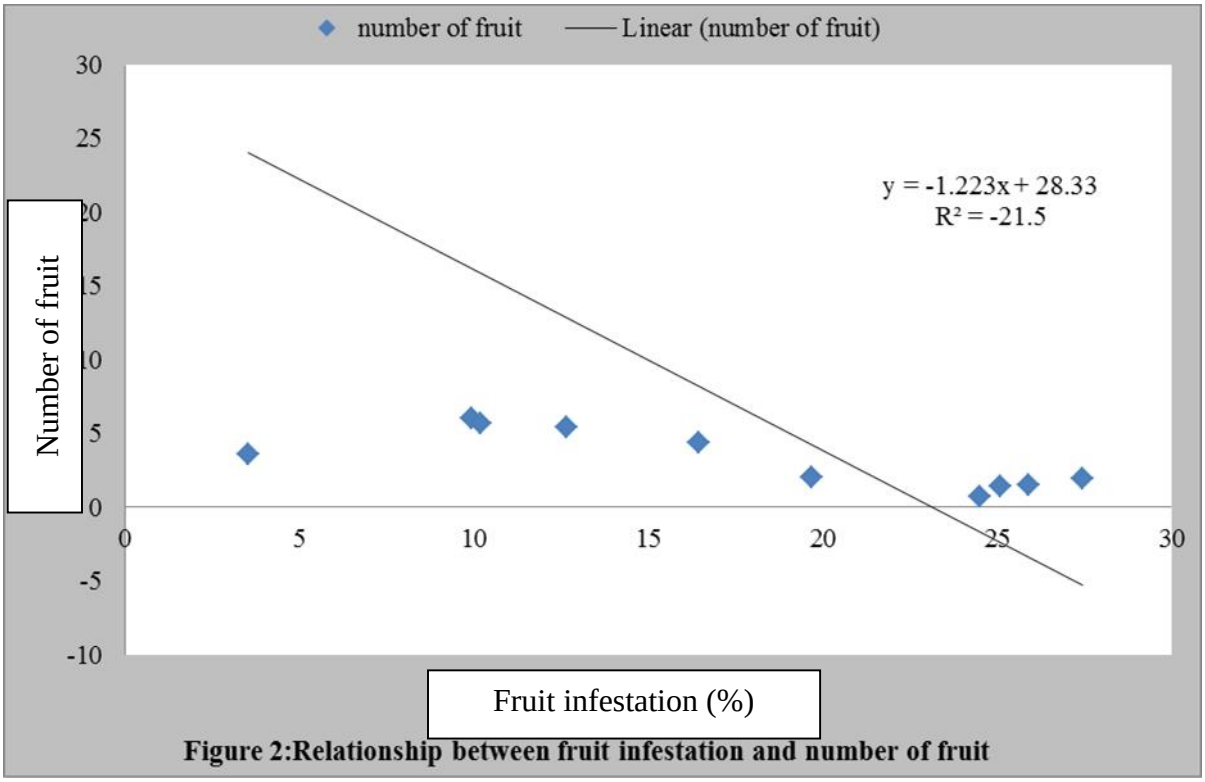

Figure 2:Relationship between fruit infestation and number of fruit

4.10 Relationship between leaf moisture content and shoot infestation

Correlation study was done to establish a relationship between moisture percent and percent shoot infestation. From the study it was revealed that significant positive correlation existed between the characters (Figure-3). The regression equation y= 1x - 82.44 gave a good fit to the data and value of the co-efficient of determination (R^2 = 0.9731). From this it can be concluded that the percent shoot infestation was increased with the increase of moisture percentage. Prodhan et. Al., (2009) observed similar result Brinjal shoot infestation was found to be positively correlated with shoot moisture (0.701).

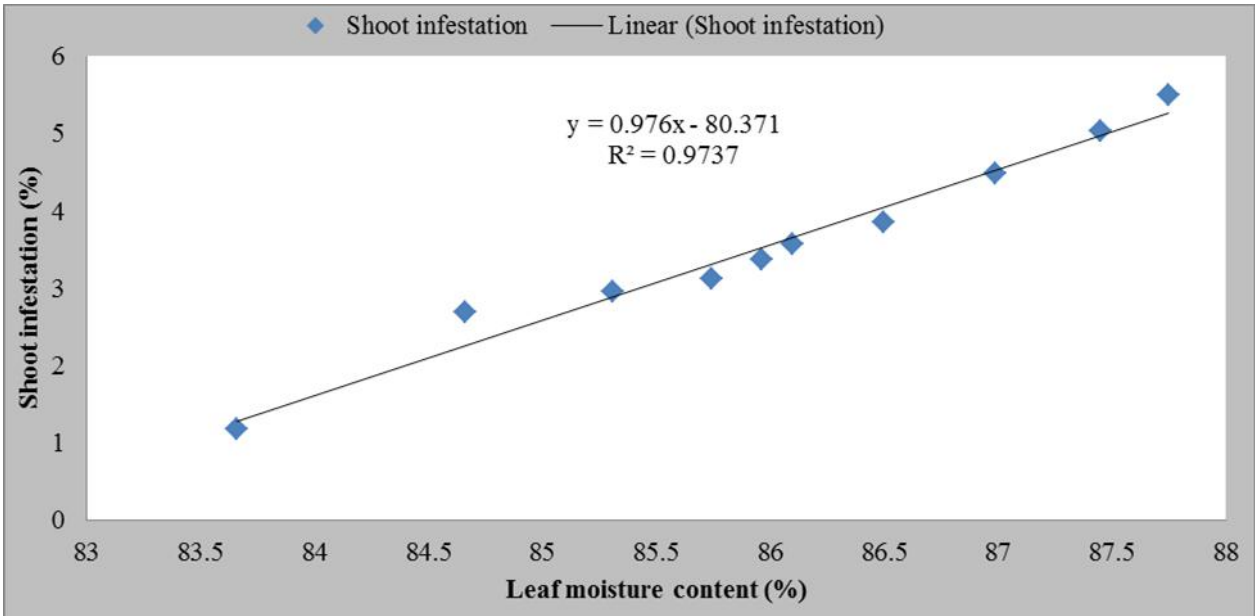

Figure 3: Relationship between leaf moisture content and shoot infestation

4.11 Relationship between trichome hair density and shoot infestation

Correlation study was done to establish a relationship between trichome hair density and percent shoot infestation. From the study it was revealed that significant negative correlation existed between the characters (Figure-4). The regression equation y= -1.7158x +35.54 gave a good fit to the data and value of the co-efficient of determination (R^2 = -92.13). From this it can be concluded that the percent shoot infestation was decreased with the increase of trichome hair density. Hossain *et al.* (2002) observed similar result that resistance or susceptible of Brinjal verities/ lines to shoot and fruit borer seems to be related with some anatomical characters like trichome hair density. Shoot infestation is negatively correlated with trichome hair density.

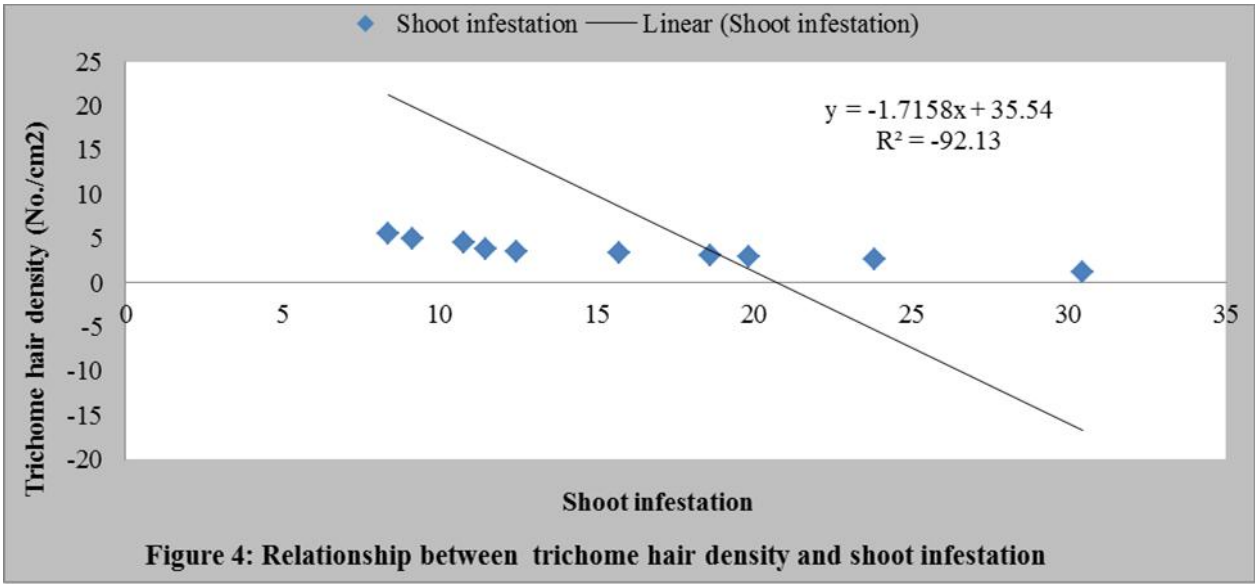

Figure 4: Relationship between trichome hair density and shoot infestation

4.12 Relationship between trichome hair density and fruit infestation by number

Correlation study was done to establish a relationship between trichome hair density and percent fruit infestation by number. From the study it was revealed that significant negative correlation existed between the characters (Figure-5). The regression equation y= -0.8713x +30.81 gave a good fit to the data and value of the co-efficient of determination (R^2 = 0.8892). From this it can be concluded that the percent fruit infestation by number was decreased with the increase of trichome hair density. Hossain *et al.* (2002) observed similar result that resistance or susceptible of Brinjal verities/ lines to shoot and fruit borer seems to be related with some anatomical characters like trichome hair density. Shoot infestation and fruit infestation is negatively correlated with trichome hair density.

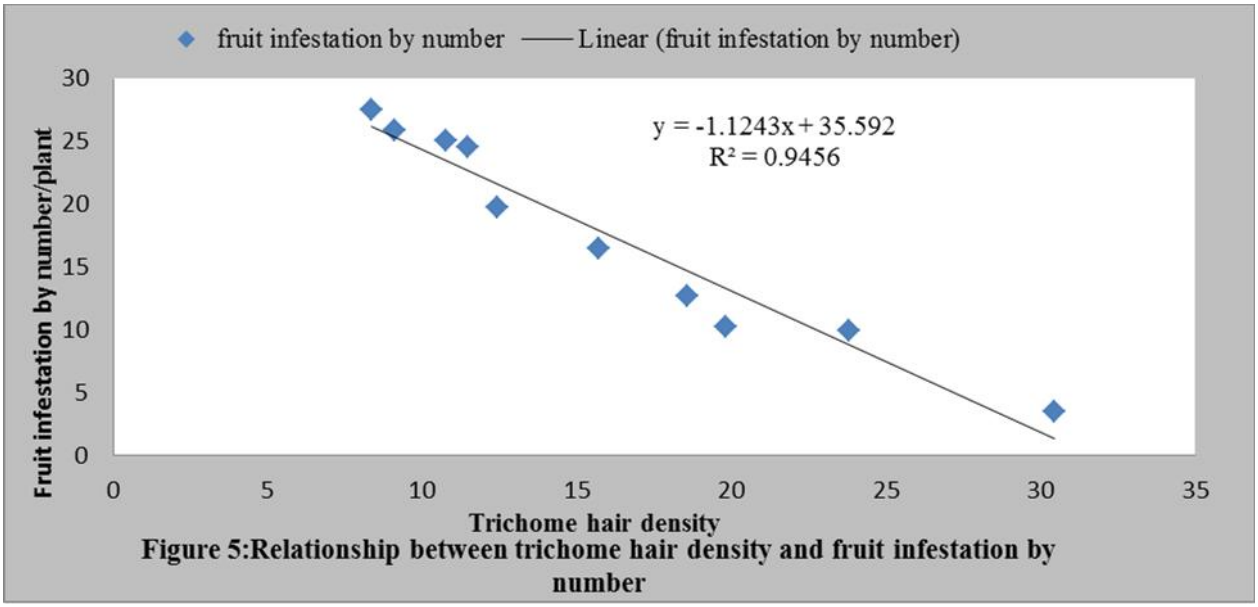

Figure 5:Relationship between trichome hair density and fruit infestation by number

4.15 Relationship between thorn on stem and shoot infestation

Correlation study was done to establish a relationship between number of thorn on 10 cm of apical stem and percent shoot infestation. From the study it was revealed that

significant negative correlation existed between the characters (Figure-8). The regression equation y= -0.8432x +6.9 gave a good fit to the data and value of the co-efficient of determination ($R^{2 =}$ 0.2728). From this it can be concluded that the percent shoot infestation was decreased with the increase of number of thorn on 10 cm of apical stem.

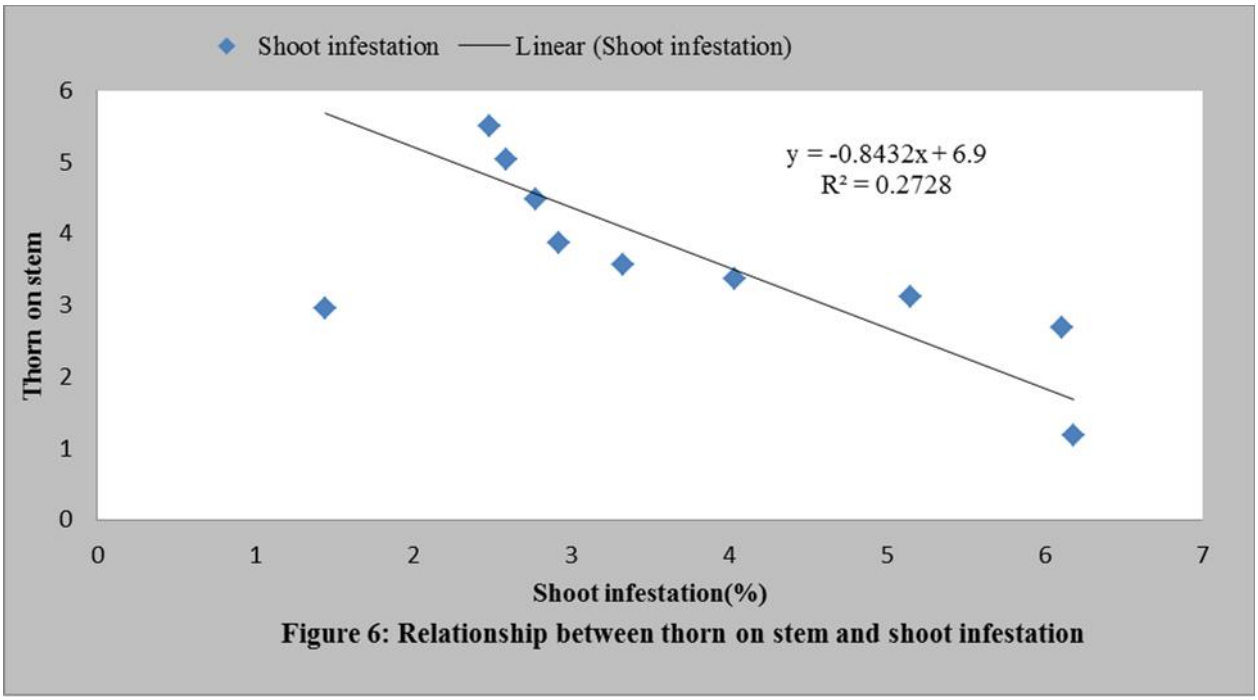

Figure 6: Relationship between thorn on stem and shoot infestation

CHAPTER V

SUMMARY AND CONCLUSION

The research work was carried out at the experimental field of Entomology Department of Sher-e- Bangla Agricultural University, Dhaka during the period from Mid-November, 2013 to May, 2014 for the varietal performance of Brinjal against Brinjal shoot and fruit borer. The study of varietal performance of Brinjal against Brinjal shoot and fruit borer was carried out using 10 varieties of BARI Brinjal. The varieties were BARI brinjal 1, BARI hybrid brinjal 3, BARI brinjal 3, BARI hybrid brinjal 4, BARI brinjal 5, BARI brinjal 6, BARI brinjal 7, BARI brinjal 8, BARI brinjal 9, BARI brinjal 10.

SUMMARY

Considering the efficiency of different brinjal varieties against brinjal shoot and fruit borer on different parameters, the findings and results have been summarized below:

In terms of percent shoot infestation throughout the growing period of brinjal, BARI brinjal 6 (V_6) showed the best performance against brinjal shoot and fruit borer as 1.18% shoot infestation recorded and the highest percentage of shoot infestation was observed (5.5%) in case of BARI brinjal 7 (V_7). That means, BARI brinjal 7 is the most suitable variety for shoot infestation by brinjal shoot and fruit borer and BARI brinjal 6 (V_6) is the least suitable variety for shoot infestation. As a result, the order of trends of least preferable brinjal varieties in terms of percent shoot infestation is V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1 (BARI brinjal 1) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7).

In terms of percent fruit infestation by number throughout the growing period brinjal, BARI brinjal 7 (V_7) showed highest infestation percentage (27.45%) by brinjal shoot and fruit borer and the lowest fruit infestation by number by brinjal shoot and fruit borer was observed in terms of BARI brinjal 6 (3.537%) throughout the growing period of brinjal. As a result, the order of trends of least preferable brinjal varieties in terms of percent fruit infestation by number is V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1 (BARI brinjal 1) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7).

In terms of percent fruit infestation by weight throughout the growing period of brinjal against brinjal shoot and fruit borer, the highest percent of infestation was recorded (28.17%) in terms of BARI brinjal 7 (V_7). On the other hand, the lowest percent fruit infestation by weight was observed (2.74%) in BARI brinjal 6 (V_6) throughout the growing period of brinjal on the field. As a result, the order of least preferable brinjal varieties in terms of percent fruit infestation by weight is V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1 (BARI brinjal 1) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7).

In terms of infestation intensity number per 10 fruit, the highest bore number per fruit was belonged to in scale 2 comprised with 3-4 bores/fruit, on the other hand scale 1 comprised of 1-2 bores/ fruit was observed the lowest infestation throughout the growing period of brinjal on the field.

In terms of branch per plant the highest number was observed (69.46) in case of V_7 (Bari brinjal 7). On the other hand, lowest number of branch per plant was observed in case of (34.29) V6 (Bari brinjal 6).

In terms of leaf number per plant, the highest number of leaves per plant was observed (412.8) in case of V_7 (Bari brinjal 7). On the other hand, lowest number of leaves per plant was observed in case of (178.4) V6 (Bari brinjal 6).

In terms of number of fruits per plant, results revealed that highest number of fruits per plant was observed (6.05) in terms of V_2 (Bari hybrid brinjal 3). Similarly the lowest number of fruits per plant has been observed (0.76) in V_{10} (BARI brinjal 10) So, in case of number of fruits per plant we found the following trend V_2 (BARI hybrid brinjal 3)> V_5 (BARI brinjal 5)> V_3 (BARI brinjal 3)> V_4 (BARI hybrid brinjal 4)> V_6 (BARI brinjal 6) > V_1 (BARI brinjal 1) > V_7 (BARI brinjal 7) > V_8 (BARI brinjal 8) > V_9 (BARI brinjal 9) > V_{10} (BARI brinjal 10).

In terms of single fruit length (cm) the highest single fruit length has been reported (35.61cm) in case of V_7 (BARI brinjal 7). The lowest single fruit length was reported 5.990cm by V_6 (BARI brinjal 6). So, in case of single fruit length (cm) we found the following trend V_7 (BARI brinjal 7)> V_9 (BARI brinjal 9)> V_8 (BARI brinjal 8)> V_4 (BARI hybrid brinjal 4)> V_3 (BARI brinjal 3) > V_5 (BARI brinjal 5) > V_{10} (BARI brinjal 10) > V_2 (BARI hybrid brinjal 2) > V_7 (BARI brinjal 1) > V_6 (BARI brinjal 6).

In terms of single fruit girth the highest data has been reported (38.18cm) in case of V_8 (BARI brinjal 8) and the lowest single fruit girth was reported 5.99cm by V_6 (BARI

brinjal 6) throughout the growing period of brinjal. So, in case of single fruit girth (cm) we found the following trend V_8 (BARI hybrid brinjal 8)> V_9 (BARI brinjal 9)> V_1 (BARI brinjal 1)> V_5 (BARI brinjal 5)> V_2 (BARI hybrid brinjal 3) > V_3 (BARI brinjal 3) > V_{10} (BARI brinjal 10) > V_4 (BARI hybrid brinjal 4) > V_6 (BARI brinjal 6) > V_7 (BARI brinjal 7).

In terms of single fruit weight the highest result observed 323.5g by V_6 (BARI brinjal 6). On the other hand lowest single fruit weight observed (34.40g) in V_{10} (BARI brinjal 10) throughout the growing period of brinjal. So, in case of single fruit weight (g) we found the following trend V_2 (BARI hybrid brinjal 3)> V_5 (BARI brinjal 5)> V_3 (BARI brinjal 3)> V_4 (BARI hybrid brinjal 4)> V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7) > V_6 (BARI brinjal 6) > V_1 (BARI brinjal 1) > V_{10} (BARI brinjal 10).

In terms of moisture content of leaves, the highest data (87.75%) was recorded in V_7 (BARI brinjal 7), and the lowest moisture percent (83.66%) was recorded in V_6 (BARI brinjal 6). As a result, the order of trends of least preferable brinjal varieties in terms of percent moisture content was V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5/Nayantara) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1 (BARI brinjal 1/Uttara) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7).

In terms of trichome hair density, the highest number of trichome per cm^2 was observed in BARI brinjal 6 (V_6) 30.44 cm^2. On the other hand, the lowest trichome density per cm^2 was recorded (8.35 cm^2) in terms of V_7 (BARI brinjal 7). As a result, the order of trends of the most preferable brinjal varieties in terms of trichome hair density per cm^2 is V_6 (BARI brinjal 6) > V_2 (BARI brinjal F_1) > V_5 (BARI brinjal 5) > V_3 (BARI brinjal 3) > V_4 (BARI brinjal 4) > V_1 (BARI brinjal 1) > V_{10} (BARI brinjal 10) > V_9 (BARI brinjal 9) > V_8 (BARI brinjal 8) > V_7 (BARI brinjal 7).

Thorn density, in terms of number per top fully opened first leaf, the highest number of thorn density per top fully open first leaf was recorded 4.443 in V_6 (BARI brinjal 6). On the other hand least number of thorns per top fully opened leaf was recorded (0.1467) in V_7 (BARI brinjal 7). Similarly, the highest number of thorn density per 10 cm of apical stem was recorded (6.183) in V_6 (BARI brinjal 6) and the least number of thorn per 10 cm of apical stem was recorded (2.483) in terms of V_7 (BARI brinjal 7).

CONCLUSION

Considering the findings of the research the following conclusions have been done:

- BARI brinjal 6 showed best performances against brinjal shoot and fruit borer in terms of the lowest percent shoot infestation, percent fruit infestation by number, percent fruit infestation by weight, infestation intensity.
- BARI brinjal 6 showed best resistant mechanisms against brinjal shoot and fruit borer with the highest number of trichome hair density, the lowest percentage of moisture content on leaves, thorn density on leaves and stems, less number of leaves and branches.
- In terms of yield, BARI hybrid brinjal 3 showed best result as it also showed the highest number of fruits per plant and the highest single fruit weight.
- On the other hand, BARI brinjal 7 showed poor performance as it showed the highest percent of shoot infestation, fruit infestation by number, highest percent of fruit infestation by weight, poor yield, lowest number of trichome hair density, thorn on apical stem and leaves and the highest percentage of moisture content on leaves.

RECOMMENDATIONS

Considering the findings of the study the following recommendations can be drawn:

- In the context of total yield production, BARI hybrid brinjal 3 can be recommended as a suitable variety to cultivate. But resistant mechanisms are not up to the expectations.
- In the context of resistant mechanisms and morphological characters, BARI brinjal 6 is the most appropriate variety but yield is comparatively poor than other varieties.
- More brinjal varieties should be included in further elaborative research for finding out the resistant mechanism for controlling brinjal shoot and fruit borer.

CHAPTER VI

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ABBREVIATIONS AND ACRONYMS

AEZ	:	Agro-Ecological Zone
et al.	:	And associates
BBS	:	Bangladesh Bureau of Statistics
cm	:	Centimeter
CV	:	Coefficient of variation
DAT	:	Days After Transplanting
DMRT	:	Duncan's Multiple Range Test
^{o}C	:	Degree Celsius
d.f	:	Degrees of freedom
etc.	:	Et cetera
g	:	Gram
ha	:	Hectare
J.	:	Journal
Kg	:	Kilogram
LSD	:	Least Significant Difference
L	:	Liter
m	:	Meter
MS	:	Mean sum of square
SP	:	Soluble Powder
MP	:	Murate of Potash
no.	:	Number
%	:	Percentage
SAU	:	Sher-e-Bangla Agricultural University
m^2	:	Square meter
t	:	Ton
TSP	:	Triple Super Phosphate