PERFORMANCE OF BRINJAL VARIETIES UNDER PEST EXCLUSION NET

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BY

BODRUN LAILA

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A Thesis Submitted to

The Department of Horticulture, Faculty of Agriculture

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In partial fulfillment of the requirements

for the degree

of

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APPROVED BY:

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CERTIFICATE

This is to certify that the thesis entitled ***"PERFORMANCE OF BRINJAL VARIETIES UNDER PEST EXCLUSION NET"*** *submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in HORTICULTURE****, embodies the result of a piece of bona fide research work carried out by****BODRUN LAILA,*** *Registration No.* ***10-03967*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated: June, 2017

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Author

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ABSTRACT

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period of November 2015 to April 2016. The experiment was laid out in split plot design with three replications. Three varieties of brinjal *viz.* Narsingdhi (V_1), Singnath (V_2) and Charki (V_3) were grown under different pest exclusion net (PEN) conditions *viz.* T_0 : Open field or control, T_1: 20 mesh PEN and T_2 : 40 mesh PEN. The treatments influenced significantly on most of the parameters. Among varieties, maximum gross yield (58.8 t/ha) and marketable yield (37.1 t/ha) were found in V_1 while minimum in V_2 . In case of PEN; gross yield (58.8 t/ha) and marketable yield (37.1 t/ha) were found maximum in T_2 whereas minimum in T_0. Again, 60.8% marketable yield was reduced in traditional cultivation (T_0) due to pest infestation. In combined effect, the highest marketable yield (51.3t/ha) was obtained from V_1T_2 and the lowest (17.7 t/ha) from V_1T_0. So, it can be concluded that 40 mesh pest exclusion net (T_2) could be regarded for getting the highest commercial brinjal yield in Bangladesh.

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ABBREVIATIONS AND ACCORONYMS

AEZ	=	Agro-ecological Zone
Agric.	=	Agricultural
ANOVA	=	Analysis of Variance
BARI	=	Bangladesh Agricultural Research Institute
BSFB	=	Brinjal Shoot and Fruit Borer
CV	=	Coefficient of Variance
DAT	=	Days after Transplanting
PEN	=	Pest Exclusion Net
et al.	=	And others
FAO	=	Food and Agriculture Organization of United Nations
Hort.	=	Horticulture
i.e.	=	That is
J.	=	Journal
LSD	=	Least Significance difference
mm	=	Millimeter
Res.	=	Research
SAU	=	Sher-e-Bangla Agricultural University
Sci.	=	Science
Technol.	=	Technology
Viz.	=	Namely

It is a fact that the remembrance of Allah brings peace in the heart. It is better to ponder over the verses to bring us even closer to Allah (swt).

DEDICATED TO-

My Honorable Supervisor & Guardian Professor

Dr. A.F.M. Jamal Uddin Sir

CHAPTER I

INTRODUCTION

Brinjalor Eggplant is an important crop of subtropics and tropics. The name brinjal is popular in Indian subcontinents is derived from Arabic and Sanskrit whereas the name eggplant has been derived from the shape of the fruit of some varieties , which are and resemble in shape to chicken eggs.It is also called Aubergine(French word) in Europe. In Bangladesh, it is one of the most common, popular and principal vegetable crops grown throughout the country except higher altitudes.It is a versatile crop adapted to different agro-climatic regions and can be grown throughout the year. It is a perennial but grown commercially as an annual crop. Anumber of cultivars are grown in Bangladesh, consumer preference being dependent upon fruit colour, size and shape.Brinjal is important constituent in daily food for poor masses in the country and is justified to call as 'poor man's crop'.

Brinjal (*Solanummelongena*L.) production is one of the most promising areas for horticultural expansion and development in many developing countries.Brinjal is a summer season crop and highly prone to the attack of insect-pests and diseases right from nursery stage till harvesting (Regupathy*et al*., 1997). Yield losses as high as 100% due to insect pest damage have been reported. Rich in nutrients, eggplant supplies vital vitamins, minerals, and dietary fiber to the human diet, especially in the rainy season, when other vegetables are in short supply for the rural and urban poor.Brinjal is one of the most important, inexpensive and popular vegetable crops grown in Bangladesh. As a densely populated area, the growth and production of brinjal is essential to the region and a primary source of income for poor farmers.

The crop is an important vegetable for both small and medium-scale growers with a potential for increasing income and creating employment. In many tropical countries, successful brinjal production is constrained by pest infestations that contribute to reduced fruit yield and quality. Common pests of brinjal in the tropics include Brinjal shoot and fruit borer (*Lucinodesorbonalis*Guen), Brinjal leaf roller (*Antobaolivacea* M.), Brinjal lace wing (*Urentius echinus* D. and *Urentiussentis* D.), Leafminers (*Lyriomyza*sp.), cotton bollworms (*Helicoverpaarmigera*Hubner), onion thrips(*Thripstabaci*Lindeman), mites (*Tetranychus*sp.), silverleaf flies

(*Bemisiatabaci*Gennadius), and aphids (*Aphis* sp.) Of these all, the brinjal shoot and fruit borer (*L. orbonalis*) is considered highly severe to damage the crop throughout the year. The yield loss due to the pest is to the extent of 70-92 per cent. The infested fruits become unfit for consumption due to loss of quality and lose their market value. The extent of damage can be 44% on shoots and 99.9 % on fruits (Panda, 1999, Kaur *et al.,*2004). Although a wide range of pesticides exists in the pest control industry, growing public awareness and concern for the adverse effects of these chemicals on human health, soil, and water resources demand that producers rethink their pest management options. Moreover, the development of resistance among most pests following repeated use of certain chemicals provides an opportunity to look for eco-friendly, safer, and sustainable methods of pest control.

However, high insect pest pressures are a barrier to the proliferation of the vegetable industry, including the organic market (Majumdar, 2010). In many parts of the world, nets or screens are commonly used in crop production for reducing excessive solar radiation, weather effects on produce, or to keep away insects. Net houses can be of variable height and width; some large net houses spread over hundreds of acres have been constructed in South Americaattempts to control eggplant pests currently entail excessive use of pesticides. Intensive pesticide use in eggplant increases the cost of production, making this vegetable expensive for poor consumers.Use of heavy doses of pesticide is a matter of concern for human health, environmental safety and economics of the crop (Hazra*et al.*, 2010). Pesticide misuse and residues pose serious risks to the health of growers, consumers, and the environment.Given its importance, scientists and farmers have teamed up to find both economically sustainable and environmentally friendly ways to tackle crop losses and increase farmers' incomes.

Net-house cultivation offers distinct advantages of earliness, higher productivity and quality particularly pesticide residue free produce, besides higher returns to growers. The trend of crop production under protected conditions is increasing due to high productivity and improved shelf life of fruits (Rai*et al*.,2004). In addition to leafy vegetables, tomato, eggplant, cabbage, cauliflower, broccoli, yard-long bean, and bitter gourd can also be grown successfully in net houses (Talekar*et al*., 2003). Net-houses act as a barrier between adult and larvae of the insect and inside grown plants; as a result crop is escaped from the pest attack. At the onset, identification of suitable varieties, poor fruit set, lanky growth, underutilized vertical space and optimum season of cultivation were the issues to tackle for net-house cultivation of brinjal. The supplementary pollination by tapping the main stem with stick at the time of dehiscence solved the problem the poor fruit setting; training of plants by maintaining two main stem tackled the issue of vertical space utilization and lanky growth; transplanting of seedlings in February, July and November made it possible to grow brinjal throughout the year under the net-house.

For several years, several research works and projects have been dedicated to the development of low-cost pest exclusion net affordable for smallholders to overcome agronomic constraints in vegetable crop production. Research has focused on the reduction of pest pressure, including insects, birds and weeds and on the mitigation of climatic hazards including excessive solar irradiation, rain and wind, using physical protection. The physical protection against crop pests provided by eco-friendly nets has been considered as a very promising solution to increase the yield and quality of vegetable production while reducing the use of chemical treatments (Weintraub,2009; Martin,2015). However, the results of protected cultivation in our country have been reported to be contrasted because of temperature and insects pest issues as well as limitations to the adoption of protected culture techniques by smallholders.

This research will make compare the performance and sustainability of using net to control the insect pests. The occasional pest outbreaks observed inside the net may have been initiated from insects emerging from the soil (e.g. grasshoppers), infested transplants (e.g.aphids), or small caterpillars crawling across the net (e.g., armyworms); these infestations were probably enhanced by the reduced action of natural enemies excluded by the sealed net house. This experiment will analyze the crucial benefit of using net for commercial brinjal production.

Objectives :

1. To evaluate the growth and yield performance of brinjal varieties under different pest exclusion net (PEN) conditions ;
2. To evaluate the performance of pest exclusion net (PEN) for crop protection without any pesticide application; and
3. To provide a suitable technology for producing safe and healthy brinjal with high yield potential for Bangladesh.

CHAPTER II
REVIEW OF LITERATURE

Brinjal (*Solanummelongena*) is one of the most important vegetable crop in Bangladesh as well as many countries of the world. Brinjal shoot and fruit borer (*Leucinodesorbonalis*) is the most destructive pest of brinjal. For controlling Brinjal shoot and fruit borer (BSFB) it is necessary to have a concept of the origin and distribution, pest status and host range, nature of damage, seasonal abundance, and bionomics of this pest. Farmers mainly control BSFB through use of different chemicals. But the concept of management of pest employing eco-friendly materials gained momentum as mankind became more safely about environment. Therefore, information available regarding pest management by avoiding harmful chemicals in brinjal and other vegetables are reviewed and presented in this section.

Brinjal is a summer season crop and highly prone to the attack of insect-pests and diseases right from nursery stage till harvesting (Regupathy*et al.,* 1997). Among the insects shoot and fruit borer, (*Leucinodesorbonalis*G.), fly, (*Bemiciatabaci*G.), leafhopper (*Amrascabiguttulabiguttula*I.), Epilachna beetle (*Henosepilachnavigintioctopunctata*F.). Of these all, the brinjal shoot and fruit borer (*L. orbonalis*) is considered highly severe to damage the crop throughout the year. The yield loss due to the pest is to the extent of 70-92 per cent. In early stage of the crop growth, larvae bores into the shoots resulting in drooping, withering and drying of the affected shoots. During the reproductive stage, tiny larva bores into the flower buds and a fruit, the bored hole is invariably plugged with excreta. The infested fruits become unfit for consumption due to loss of quality and lose their market value. The extent of damage can be 44% on shoots and 99.9 % on fruits (Panda, 1999 ; Kaur *et al.,* 2004). Although controlling the cryptic natured pest, 2 farmers use heavy doses of pesticides, which is a matter of concern for human health, environmental safety and economics of the crop (Hazra*et al.,* 2010).

High insect pest pressures are a barrier to the proliferation of the vegetable industry, including the organic market (Majumdar, 2010). Although a few alternative insecticides are available for the organic producers, effectiveness of insect exclusion using a net house has received limited or no attention in the United States (U.S.)

resulting in information gaps. In many parts of the world, nets or screens are commonly used in crop production for reducing excessive solar radiation, weather effects on produce, or to keep away insects. Net houses can be of variable height and width; some large net houses spread over hundreds of acres have been constructed in South America. Net houses or its variants also have been successfully used in some European and Southeast Asian countries for producing cabbage (Kiptoo*et al*., 2015) and egg plants (Kaur *et al*., 2004). In Africa, movable net houses made of mosquito nets (25-mesh) were effective as a physical barrier against the diamondback moth, cutworms, and loopers providing 66 to 97% control of moths and caterpillars (Kiptoo*et al*., 2015). Insect nets have also been tested in conjunction with hoop houses in the Germany with a great success (Mutwiwa and Tantau, 2008).In China, Feng-cheng*et al.* (2010) demonstrated 90% reduction in the occurrence of tomato yellow leaf curl virus due to the near elimination of flies using a 50-mesh net house. In the U.S., large arched net houses have been constructed in California and Florida on 70+ acres for bell pepper, tomato, chili, and citrus production; however, very little scientific evaluation of the technology has been completed and farmers have depended on vendor's recommendations for adopting the technology. Based on these past reports, the main goals of that preliminary net house study were to: 1. build the first net house dedicated to vegetable production in Alabama; 2. compare the insect exclusion efficiency (level of reduction of insect pests) of the net house. This is the first scientific study of a net house built exclusively for vegetable production in Alabama; trends reported herein need to be corroborated with further research.

Protective culture can be used as a strategy to ensure their production and their livelihood. However, the use of pesticides can no longer be considered as a solution to control insect pests because of the development of resistance (Martin, 2015; Carletto*et al*.,2010; Agboyi*et al.*, 2016) and because of their impacts on environment and human health (Wilson and Tisdell, 2001; De Bon *et al.*, 2014). Research has been underway for more than 10 years on the use of insect proof nets over vegetable crops as a generic protection to control insect pests while ensuring sufficient natural ventilation. Insect proof nets are believed to be a suitable solution to reduce the use of insecticides and to protect vegetable crops from the emergence of new devastating insect pests for which chemical treatments are not effective (Martin, 2015). Several studies on cabbage (*Brassica oleracea* L.) in Benin (Licciardi*et al*., 2007) and later in

Kenya (Kiptoo*et al.*, 2015; Muleke*et al.*, 2012,2014), on tomato (*Lycopersiconesculentum*Mill.) (Gogo*et al.*, 2014; Saidi*et al.*, 2013; Gogo*et al*., 2012), and on beans (*Phaseolus vulgaris* L.) in Kenya (Gogo*et al.*, 2014) have reported the advantage of using insect proof nets to exclude insect pests. Several studies have been dedicated to optimizing mesh size to ensure sufficient ventilation to limit heat load and efficient physical protection against insect pests (Saidi*et al.*, 2013). This task is not easy since the optimum size varies with the crop, the pressure from insect pests, and climatic conditions. The capacity of nets to exclude insect pests has been widely studied in net screens used for house ventilation (Bethke*et al.*,1994; Bethke and Paine, 1991). Results showed that there is no clear relationship between mesh size and the pest exclusion efficiency (Bethke and Pain, 1991). Berlinger*et al.* (2002) reported marked variations in fly penetration of the same screen in laboratory conditions.

Similarly contrasted results of field trials have been reported on the efficiency of nets to exclude insect pests. It is difficult to compare insect proof nets since several mesh features including size, geometry and blending, i.e. knitted or woven, influence their insect exclusion capacity (Bethke*et al*., 1994). Depending on the authors, mesh size is given either as the number of holes per inch or as the size of the hole, but this does not apply if the mesh is not square or is woven. In addition, the difference in nets efficiency could also be due to slipping of unevenly woven yarn. With certain exceptions, large pests (Lepidoptera, Diptera) are well controlled whereas small pests (Hemiptera, Thysanoptera, Mite) are not. In most field experiments, fruit worms were well controlled by a large mesh regardless of the crop and the mesh size tested (Kiptoo*et al*., 2015). Some bigger insect pests such as *Spodopteralittoralis* and *Tutaabsoluta* can also circumvent physical protection by laying their eggs on the nets and their very small prenatal larvae then pass through the mesh (Martin, 2015; Talekar*et al.,* 2003) Our overview of the literature indicates that nets, whatever their mesh size, cannot completely exclude small insects pests such as aphids, thrips, flies and mites, but they can reduce and delay infestation of the crop (Gogo*et al.*, 2014; Kaur *et al*., 2004).

Hossain *et al.* (2002) screened out twenty varieties and lines of brinjal to observe their resistance over to brinjal shoot and fruit borer *LeucinoidesorbonalisGuenee* infestation in the field conditions. The infestation varied significantly among the varieties/lines. The brinjal shoot and fruit borer infestation for different varieties/lines were found in the following order of intensity :Nayankajal> BLO95> BLO85 > BLO98 > BLO 114> khotkhotia-2 >Borka>Laffa>Islampuri . blo45 > Dhohazari-2 > BLO101 > Dhohazari-1 > Khotkhotia-1 > BLO96 >Sada ball > Singnath >Uttara>Baromashi>JHumki. Varietal resistance of brinjal against brinjal shoot and fruit borer indicated significant variations among different brinjal varieties/lines. Plant age had significant effect on the incidence of brinjal shoot and fruit borer. Highest percentage (32.89) of brinjal shoot and fruit borer infestation was observed at 70 DAT and lowest (5.18) was found at 40 DAT. Plant height at different ages varied significantly among the varieties. The highest plant height was recorded in the variety khotkhotia-1 which was significantly different from that of other varieties/lines.in respect of height , Baromashi was a short variety and the height of this variety significantly identical with that of the variety/line i.e. Nayankajal, BLO 45, BLO 95 and BLO 101.

Experiments on tomato in Kenya showed that nets with mesh size of 0.4 mm reduced aphid populations more efficiently than with a mesh size of 0.9 mm (Gogo*et al.*, 2014). Contradictory results were obtained on cabbage in Benin since similar nets promoted the development of aphids and the finest mesh size did not improve protection against insect pests (Simon *et al.*, 2014). Similarly, modeling approaches used by Holt *et al.* (2008) revealed that nets used on tomato crops without insecticide-treated strips can promote the development of flies. It is worth noting that the physical protection provided by insect proof nets is not specific. Use of covers on crops is therefore a suitable alternative to face changes in pest pressure related to the emergence of new insect pests. However the side effect of the lack of specificity of net exclusion concerns natural enemies. It is believed that nets can favor the development of some insect pests because of the exclusion of natural enemies and more favorable climatic conditions, including an increase in air moisture and shade. Results on cabbage in Benin suggested that removing nets during the day would favor natural predation and avoid bursts in populations of insect pests (Licciardi*et al.*, 2007; Simon *et al.*, 2014).

Ramesh and Arumugam (2010) conducted a field experiment in naturally ventilated gable shaped poly houses of side height 2.5m,centre height 4m, length 16 m and width 6 m established at Farming Systems Research Station Sadanandapuram. The field experiment on the performance evaluation of five leafy vegetables in naturally ventilated polyhouse in randomized block design during the rainy season (June-August, 2014) revealed coriander, palak and Amaranthus to establish and grow well with higher biomass production compared to lettuce and red Amaranthus. The modified microclimate influenced the incidence of pests and diseases and the latter affected the growth and performance of red Amaranthus and palakin the polyhouse. Reduced pigmentation was also observed in red Amaranthus. Relative yields in terms of Amaranthus proved palak to be most advantageous followed by coriander. In the polyhouse crop, significant variations in plant height were observed with taller plants being observed in Amaranthus varieties.

Medany*et al.* (2009) studied that black net house gave significantly the highest early yield, while net house gave significantly the highest plant height, number of leaves per plant, leaf area index and total yield compared to the other houses. In the winter season, the highest yield was obtained in the plastic house. The depreciated annual cost of covering nets was estimated to be half the cost of plastic covering. Ilic*et al.* (2012) evaluate the influence of different colored shade nets (photo selective) on the plant development, yield and quality of bell pepper (*Capsicum annuum*L.). Pepper was grown under four different coloured shade-nets (pearl, red, blue and black) with different relative shading (40% and 50%). Exposure to full sunlight was used as a control. Used colour-shade nets improved productivity by moderating climatic extremes. Depending on the year, the total fruit yields (t/ha) under the coloured shade nets were higher by 113 to 131%, relative to the open field.

According to Ilicand Milenković(2012), The concept of photo-selective netting using commercial cultivation practices was studied in a tomato (*Solanumlycopersicum*'Vedetta') summer cultivation in south Serbia (under high solar radiation 910 W m^{-2}, with a photosynthetic photon flux density of 1661 µmol m^{-2} s^{-1}, under four different coloured shade-nets (pearl, red, blue and black) with 40% relative shading. The aim of the study was to determine how different environmental control technologies (colouredshade-nets as screen house or plastic-house integrated with coloured shade-nets) could influence plant parameters, production and quality traits in tomato fruits cultivated in south Serbia (Balkan region). The leaf area index (LAI) ranged from 4.6 to 5.8 in open field and plastic tunnels plants (control) with maximum LAI values of 7.9-8.2 in net houses with red colour nets. Shade-grown leaves generally have higher total chlorophyll and carotenoids content than do control leaves. Pericarp thickness was significantly higher tomatoes grown under pearl (7.215.82 µm), red (7099.00 µm) and blue nets (6802.29 µm) compared to other treatments and to control (6202.48 µm). The highest concentration of lycopene was detected in tomatoes grown in plastic houses integrated with red colour nets (64.9 µg g^{-1} fresh weight). The plastic house and open field (control) tomato production had a taste index mean value of 1.09-1.10. This is significantly higher than the values determined for the treatments with different coloured shade-nets. These results show that red and pearl photo-selective nets create optimal growing conditions for the growth of the plant and produce fruits with thicker pericarp, the highest lycopene content, a satisfactory level of taste index and can be further implemented within protected cultivation practices.

Phookan*et al.* (1990) evaluated 29 genotypes of tomato (*Solanumlycopersicum*) against 8 different growth and yield attributing parameters under plastic house condition during summer season. 'Vaishali' tomato recorded the maximum yield (1.6 kg $plant^{-1}$) followed by 1.34 kg $plant^{-1}$ in the genotype Sutton gram prolific. Mean values of at the characters showed wide variations for the plant height (46.0 cm-95.00 cm), branch number (5.00-10.50), flower number (21.00-95.00), fruit number (2.67-70.00), fruit setting percentage (11.92-73.95), yield $plant^{-1}$ (0.210 kg -6.00 kg) and survival percentage (40-100).

Vegetable producers are consistently challenged by insect pest outbreaks. Physical barriers, e.g., row covers, are commonly used by producers for excluding insects from host plants. However, exclusion efficiency of a large net house for vegetable production has not been scientifically evaluated before in the United States. To fill this gap in information, a net house was constructed in Alabama for producing tomatoes and bell peppers. This net house was 150 feet (L), 48 feet (W), and 17 feet (H) constructed entirely of 50-mesh insect netting. Only double-doors provided access inside the net house for transplanting crops and routine maintenance. Insect pest activity was monitored in the net house as well as outside (untreated check plots) using pheromone traps. Plants were scouted directly to determine pest pressures. The net house significantly excluded moths of tomato fruitworm (*Helicoverpazea*) and beet armyworm (*Spodopteraexigua*) compared to the open field; exclusion efficiency was 82-100%. Direct scouting revealed armyworms (three species) and the tomato hornworm (*Manducaquinquemaculata*) caterpillar numbers reduced 98-100% under the net house. Leaffooted bugs (*Leptoglossus* sp.) were also undetectable on plants grown inside whereas open-field tomatoes were severely damaged by the insect. The net house also reduced number of pesticide applications by 90%. Major challenges of the net house crop production system included high humidity and temperature inside the unit which facilitated disease and aphid outbreak. Further studies are needed to resolve those issues and develop the net house technology for season extension. Implications of these finding for organic vegetable production are discussed in that experiment. (Majumdar and Powell, 2011)

Talekar*et al*. (2003) conducted an experiment by which it is evident that the net house vegetable production technology has numerous insect control advantages as well as disease control challenges that may be solved with continued research. Due to the high upfront cost of this technology, it is anticipated that organic and sustainable crop producers in high pest pressure areas of southeastern U.S. may be more willing to use the large net house after adjusting the technology to their situation. Further research is needed to screen heat-tolerant tomato, bell pepper, and other varieties that may be suitable for net house vegetable production. A trade-off can be expected between the use of a lighter fabric (i.e., 30- to 50-mesh with large holes to facilitate aeration) and insect control success, since small insects will be able to get through a lighter fabric.

Manipulation of microenvironments by means of photoselective nettings is widely used to improve the productivity and quality of high-value vegetables. The aim of this study was to investigate the effect of photoselective nettings on growth, productivity, and postharvest quality attributes of baby spinach. Baby spinach cv. Ohio was grown from seeds, and the trial was repeated. Plants were planted in an open field (control) and under closed nets, viz., black, pearl, yellow, and red nets. At harvest, baby spinach leaves were subjected to 4, 10, and 20 °C storage temperatures for 12 days. Crops grown under black nets and stored at 4 °C retained higher level of antioxidant activity (0.23 $g \cdot kg^{-1}$), whereas the least level of antioxidant activity was observed in baby spinach grown under red and yellow shade nets (0.01 $g \cdot kg^{-1}$). Similar trend was evident with flavonoid content where baby spinach leaves grown under black nets maintained high level of flavonoids at 4, 10, and 20 °C during storage period compared with other shade nets and the control. The study control showed a better potential in retaining antioxidant activity over red and yellow shade nets. Results showed that black shade nettings have the potential to reduce water loss, decay incidents, and maintain flavonoid content and antioxidant activity followed by pearl and yellow nets. (Mudau*et al.,* 2017)

Bergquist*et al.* (2007) conducted an experiment with Baby spinach (*Spinaciaoleracea* L.) grown under three types of shade netting (high transmittance, spectrum-altering, and low transmittance) to study the effect on the concentrations of vitamin C (ascorbic acid and dehydroascorbic acid), carotenoids, and chlorophyll and on the visual quality of the leaves. The spinach was sown in April and August and harvested at two growth stages. After harvest, leaves were stored in polypropylene bags at 2 and 10 °C. Shading significantly decreased the ascorbic acid concentration of April-sown spinach by 12–33%, but in the August-sown spinach, the response was inconsistent. Concentrations of total carotenoids and total chlorophylls were significantly higher under the nettings in many cases, especially under the spectrum-altering and low-transmittance nettings. Postharvest visual quality and postharvest persistence of the compounds analyzed were not greatly affected by shading. We conclude that these shade nettings are acceptable to use in baby spinach production when it comes to the studied aspects of internal and external quality of the produce.

Protecting vegetables with a screen in peri-urban areas of tropical countries could reduce or even prevent often indiscriminate insecticide applications by small-scale farmers. The advantages of such an approach are protection of human health by reducing insecticide sprays, reducing environmental pollution from insecticide residues and increasing effectiveness of crop protection. Tunnel screens are well adapted to farmers cultivating intensively on small plots. Two trials were conducted to test the ability of screened tunnels to protect *Brassica oleracea* crops. The first was carried out on-station and the second in partnership with three farmers in Cotonou, Benin, West Africa. Tunnel screens impregnated with deltamethrin were found to be particularly well adapted to protect young plants in seedling nurseries against infestations by the aphid*Lipaphiserysimi* (Kaltenbach). The number of diamondback moth*Plutellaxylostella* (Linnaeus) and borer*Hellulaundalis* (Fabricius) on cabbages protected with the tunnel screen was significantly lower than that of plots conventionally treated with insecticides. The tunnel screen was not efficient against the armyworm *Spodopteralittoralis* which laid eggs on the screen. After planting out, the use of a temporary screen from 1700 to 0900 h gave better control against pests than the use of a permanent screen possibly due to the impact of natural enemies during the day. The field trials showed that the protection of cabbage with a tunnel screen could be an economically viable method. The costs of pesticides are on average US$ 45 per 100 m^2 for one crop cycle compared with US$ 24 per 100 m^2 for tunnel screen material (assuming that this material can be used for 10 consecutive crop cycles). In addition, there are environmental benefits from a reduction of pesticide use. Farmers will have to cope with the initial investment for the screen material, which is, however, very cost-effective and locally available. Tunnel screens for vegetable protection can be easily combined with other integrated pest-management techniques. (Licciardi *et al.*, 2007)

Neave*et al.* (2011) conducted a research in Solomon island to evaluate the efficacy and financial feasibility of using exclusion row cover netting to exclude insect pests from cabbage crops as part of a management strategy. Two net materials, Evolution® Row Cover and MikroKlima® Grow Cover were compared with the local practice (where insects are picked by hand or no control), at three locations in the Solomon Islands. The use of Evolution® Row Cover and MikroKlima® Grow Cover resulted in 72% and 38% less pest damage compared to the local practice. There was little difference in size and weight of the heads harvested between treatments but there was an average increase of 40% in market price due to better quality heads grown under the MikroKlima® Grow Cover. Although the Evolution® Row Cover provided the better protection, it was less durable and more easily damaged than the MikroKlima® Grow Cover and needed regular repairs. Based on a predicted use of the MikroKlima® Grow Cover for six crop cycles and the nature of the market at the time, the net present value for the Mikroklima® net treatment in Busarata was SBD 1,387.68 From the results of this study, there is a justification, both from production and financial perspectives, for using insect exclusion netting on high value crops in Solomon Islands, particularly if a cheaper source of durable netting can be found.

Ishwarappa (2011) worked with a field experiment that was carried out at the department of horticulture, Hi-tech Horticulture Unit, Saidapur Farm, University of Agricultural Sciences Dharwad during 2009-10 to study the performance of tomato hybrids under shade house condition. Among the vegetative parameters STH-801 tomato recorded higher plant height (309.03 cm), maximum number of branches per plant (8.17) whereas, STH-801 hybrid recoded more number leaves (85.67/plant). Hybrid STH-901 recorded longer internodes (6.96 cm), higher leaf width (5.82 cm) and longer leaves (15.40 cm) and STH-39 recoded thick stem (1.78 cm). Plants trained under single stem recorded higher plant height (270.08 cm), stem girth (1.75 cm), number of branches per plant (7.78), intermodal length (6.75 cm), leaf length (15.10 cm), leaf area (77.06 cm2) compared to the plants trained with two stems. Number of leaves per plant (82.80) was found maximum in plants trained under double stem. Days to fifty per cent flowering, days taken from flowering to fruit development were not influenced by training. Among the hybrids, STH-801 recorded higher number of cluster per plant (12.15), number of fruit per cluster (7.75) and percent fruit set (93.17). STH-801 recorded the highest yield per plant (6.52 kg), yield per square meter (15.68 kg) and number of seeds per fruit (141.50). Whereas, STH-39 recorded the highest average fruit weight (115.50 g), average fruit diameter (6.30 cm) and average fruit volume (157.00 cc). Plants with double stem recorded increased yield per plant, yield per square meter (6.30, 15.36 kg respectively). Plants with single stem recorded highest average fruit weight, average fruit diameter, average fruit volume and number of seeds per fruit (105.50 g, 5.59 cm, 143 cc, 115 respectively). STH-801 tomato juice possessed higher amount of TSS and pH (5.47 0 B, 6.20 respectively). The study revealed that hybrid STH-801 performed best with yield of 6.52 kg per plant and STH-801 on double stem training system was superior of all the other treatment combinations.

Ahmad *et al*. (2009) twenty brinjal varieties/lines during October 2007 to May 2008 to identify shoot and leaf characteristics of brinjal plants for their susceptibility/resistance against brinjal shoot and fruit borer infestation. Borer infestation was influenced by different characters of plant shoot and leaf. Various parameters like plant height, stem diameter, number of branches and leaves plant^{-1}, third leaf length and width were recorded from different varieties used. The shoot infestation rate was found positively correlated with plant height (0.407), stem diameter (0.520), number of branches plant^{-1} (0.255), number of leaves plant^{-1} (0.478), third leaf length (0.373) and third leaf width (0.536). Considering all the recorded parameters, the infestation was found minimum on the variety katabegun WS (1.65%) followed by Marich begun S (1.74%).

Hossain *et al.* (2002) conducted to an experiment was designed to study the morphological and yield behavior of nine exotic and one local cultivar of tomato under Islamabad conditions. Significant difference in the parameter except days to maturity were observed which could be attributed to inherited differences among cultivars. Cultivar marmande (TMV) took significantly minimum time (65.0 day) to riped followed by S. marzano which ripened in 72.3 day. Cultivar polefemo ripened late (91.7 days) followed by marmande which took 88.7 days to tipen. Cultivars marmande TMV and marmande out yielded other cultivares with 64.29 t/ha, respectively while poor yield was obtained in S. marzano (14.90 t/ha)

Parvej*et al*. (2010) conducted an experiment was conducted in a covered polyhouse along with an open field (control) aside the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from December 2007 to April 2008 to compare the phenological development and production potentials of two tomato varieties *viz.* BARI Tomato-3 and Ratan under polyhouse and open field conditions. Photosynthetically active radiation inside the polyhouse was reduced by about 40% compared to the outside (i.e. open field) while air and soil temperatures were always remained higher. From December to February the mid day air temperature under polyhouse and open field varied from 31.8 to 39.1ºC and 23.3 to 31.1ºC, respectively indicating about 8ºC higher air temperature inside polyhouse and during that time the average air temperature inside polyhouse was about 28ºC which was optimum for the growth and development of tomato plants. Relative humidity had opposite trends with that of air temperature i.e. it was lower inside the polyhouse as compared to open field. The above microclimatic

variabilities inside polyhousefavoured the growth and development of tomato plant through increased plant height, number of branches/plant, rate of leaf area expansion and leaf area index over the plants grown in open field. Flowering, fruit setting and fruit maturity in polyhouse plants were advanced by about 3, 4 and 5 days, respectively compared to the crop raised in open field condition. Polyhoused plants had higher number of flower clusters/plant, flowers/cluster, flowers/plant, fruit clusters/plant, fruits/cluster and fruits/plant, and fruit length, fruit diameter, individual fruit weight, fruit weight/plant and fruit yield over open field condition. The fruit yield obtained from the polyhouse was 81 t/ha against 57 t/ha from the open field.
Pest exclusion net maintained permanently covered significantly reduced populations of BSFB, Leaf roller, jassids, mealy bugs, and leaf miners. PEN covers reduced insecticide sprays per crop cycle from 11 to 1 and improved marketable brinjal fruits by between 15.0-43.5% compared to the control and 2.1-27.3% compared to spraying with insecticides. Marketable fruit weight was higher by between 28.7-130.1% under PEN compared to the control and by 9.3-95.4% compared to spraying with insecticides. The highest brinjal marketable yields and net income on sales were obtained under the 0.9 mm pore diameter agronet maintained permanently covered which gave the highest cost benefit ratio of 1:17.1 in season one and 1:26.2 in season two. These results present permanent use of 0.9 mm pore diameter agronets as a viable technology in reducing insect pest infestation and cost of brinjal production. This is achieved through reduced pesticide use with a potential of contributing towards environmentally safe and profitable brinjal production by small-scale growers in Bangladesh.

Thangam and Thamburaj (2008) conduct to the study on effect of shade on growth, yield and quality of six varieties and fourteen hybrids in tomato was conducted under agro shade net (50 %) and in open field simultaneously during consecutive summer seasons. Observed higher fruit length (7.86 cm) in Rashmi under shade compared to open field conditions (7.23 cm).

Tika*et al.* (2011) carried out an experiment with plastic house technology and arrivals of hybrid varieties have increased the possibility of tomato cultivation in rainy season in high hills. An experiment was conducted to assess the performance of tomato varieties under plastic house for two consecutive years from 2009 to 2010 at National

Commercial Agriculture Research Program (NCARP), Pakhribas (1750m), Nepal. The experiment consisted of eight tomato varieties namely, All Rounder, Bishesh, Dalila, Manisha, Srijna, Suraksha, Trishul and US-04 laid out in a randomized complete block design with three replications. The varieties differed significantly for all observed traits. The highest marketable yield was recorded from All Rounder (86.6 t/ha) followed by Srijana (80.8 t/ha). Srijana took the shortest period for flowering and harvesting with an average of 37 and 77 days after transplanting respectively. This was also the tallest variety (268.7 cm) with more clusters (36.23) per plant. However, the highest average single fruit weight was recorded from Manisha (61.94g), and the largest fruit size in US-04 with a diameter of 5.78 cm. Based on yield parameter, the varieties All Rounder and Srijana are recommended for commercial cultivation under plastic house conditions.

Sima*et al*. (2011) evaluated six tomato hybrids in house for yield potential and quality reported significantly highest fruit length for Monroe F1 (53.50 mm) followed by Menhir F_1 (52.64 mm).

Olaniyiand Fagbayide(2010) conducted experiments on a sandy loam soil at the Teaching and Research farm of the Faculty of Agricultural Sciences, LadokeAkintola University of Technology (LAUTECH), Ogbomoso 13 (8°10N; 4°10E) between April and July, 2004 to evaluate the growth, fruit yield and quality of seven varieties of tomato in the Guinea Savannah zone of South West Nigeria. The varieties tested were, ‘DT97/162A(R)’, ‘DT97/215A’, ‘Tropical’, ‘Roma VF’, ‘UC82B’, ‘Ibadan local’ and ‘Ogbomoso local’. These were assigned randomly into three blocks each containing seven beds and fitted into randomized complete block design. Growth, yield, mineral content and quality attributes of tomato were assessed. The results showed that ‘DT97/162A(R)’ gave the highest height whereas ‘Ogbomoso local’ recorded the highest number of leaves at 6 weeks after transplanting. Higher fruit yield was recorded from ‘UC82B’, closely followed by ‘Ibadan’ and ‘Ogbomoso local’. Although, there is inconsistence in the results of the nutritional compositions of tomato fruits, the local varieties (‘Ogbomoso’ and ‘Ibadan Local’) closely followed by ‘UC82B’ recorded most of the nutritional values more than the other varieties. Therefore ‘UC82B’, ‘Ibadan’ and ‘Ogbomoso local’ in that descending order are better in terms of fruit yield and quality, and can be successfully grown in 'Ogbomoso', the Guinea Savannah zone of south west Nigeria.

Bibi*et al.* (2012) carried out an experiment about the mean fruit yields of tomato under partial shades and showed that plants in control (full sun) produced maximum fruit yield (24.6 t ha^{-1}) closely followed by partial shade from June(22.1tha^{-1}). Plants under partial shade from April produced minimum fruit yield (9.4 t ha^{-1}).

CHAPTER III

MATERIALS AND METHODS

A field experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh during the period from November, 2015 to April, 2016to observe the performance of brinjal varieties under pest exclusion net. This chapter contains a brief description of location of the experimental site, climatic condition and soil, materials used for the experiment, treatment and design of the experiment, production methodology, intercultural operations, data collection procedure and statistical and economic analysis etc. which are presented as follows:

3.1 Experimental site

The experiment was conducted at the experimental field of Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2015 to April, 2016 to find out the performance of different brinjal varieties under different pest exclusion net conditions. The location of the experimental site is $23^{o}74^{/}$N latitude and $90^{o}35^{/}$E longtitude and at an elevation of 8.2m from sea level (Anon., 1989).

3.2 Climatic Condition

Experimental site was located in the subtropical monsoon climatic zone, set aparted by heavy rainfall during the months from April to September (Kharif season) and scant of rainfall during the rest of the year (Rabi season). Also under the sub-tropical climatic, which is characterized by high temperature, high humidity, heavy precipitation with occasional gusty winds and relatively long in Kharif season (April-September) and plenty of sunshine with moderately low temperature, low humidity and short day period during Rabi season (October - March). Weather information regarding the atmospheric temperature, relative humidity, rainfall, sunshine hours and soil temperature prevailed at the experimental site during the entire period of investigation. (Appendix I)

3.3 Characteristics of soil

The experimental soil belongs to the Modhupur Tract under AEZ No. 28 (UNDP - FAO, 1988). The selected experimental plot was medium high land and the soil series was Tejgaon (UNDP -FAO, 1988). The characteristics of soil under experimental plot were analyzed in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka. The soil of the experimental field initially had a pH of 6.5.

3.4 Experimental materials

3.4.1 Planting materials

Narsingdhi, Singnath and Charki – Brinjal varieties were used for the present research work. The purity and germination percentage were leveled as above 80%. The genetically pure and physically healthy seeds were collected from Advanced Seed Research sand Biotech Center (ASRBC), ACI Limited and Olericulture Division, Horticultural Research Centre (HRC), BARI, Gazipur, Dhaka.

3.4.2 Construction of net house

Net house is a sealed structure made of synthetic fabric that is designed to keep insects away from host plants by physical exclusion. Net houses can be of variable height and width. For this study, two large net houses (60 ft x 20 ft) were constructed at the Horticulture Farm of Sher-e-Bangla Agricultural University. A 20-mesh and a 40-mesh fabric were selected to exclude all small and big insects, per reports by Fang-cheng, 2010 andMutwiwa and Tantau, 2008. The fabric can last 5-8 years under ideal conditions and is manufactured as long pieces that can be sewn together during construction. The fabric was stretched over irony poles giving the net house a sloped roof to allow smooth wind flow over the large structure (Plate 1) .The fabric was slowly pulled across the length of the structure to prevent air-traps underneath it that could destabilize the structure during construction.

3.5 Treatments of the experiment

The experiment was conducted to study the influence of different Pest Exclusion Net (PEN) conditions on growth and yield of different brinjal varieties. The experiment consisted of two factors as follows:

Factor A: Brinjal Varieties

Three Brinjal Varieties

1. Narsingdhi (V_1)
2. Singnath (V_2)
3. Charki (V_3)

Factor B: PEN Conditions

There were three different pest exclusion net conditions

1. Without PEN (T_0) : Plants grown without pest exclusion net (control) in open field
2. 20 mesh PEN (T_1) : Plants grown under 20 mesh pest exclusion net
3. 40 mesh PEN (T_2) : Plants grown under 40 mesh pest exclusion net

20 mesh pest exclusion net was used to prepare one net house and another net house was prepared with 40 mesh pest exclusion net. After the construction of pest exclusion net house and final land preparation, three blocks were assigned for three different brinjal varieties and replicated three times in each net house and open field.

The treatment combinations were:

V_1T_0, V_2T_0, V_3T_0, V_1T_1, V_2T_1, V_3T_1, V_1T_2, V_2T_2, V_3T_2

3.6 Design and layout of the experiment

The two factorial experiment was laid out in split plot design with three replications. A total of 27 plots were arranged in the experiment. (Fig. 1)

The whole experimental plots were divided into three blocks, each of which was then divided into three sub plots. 25 days old seedlings were transplanted in the bed. There were 8 plants accommodated in each plot.

3.6.1 Spacing and plot size

The size of each plot was 3 m x 1 m. The distance between two blocks and two plots were 0.5 m and 1 m respectively. Row to row distance was maintained 60 cm and plant to plant distance was 60 cm.

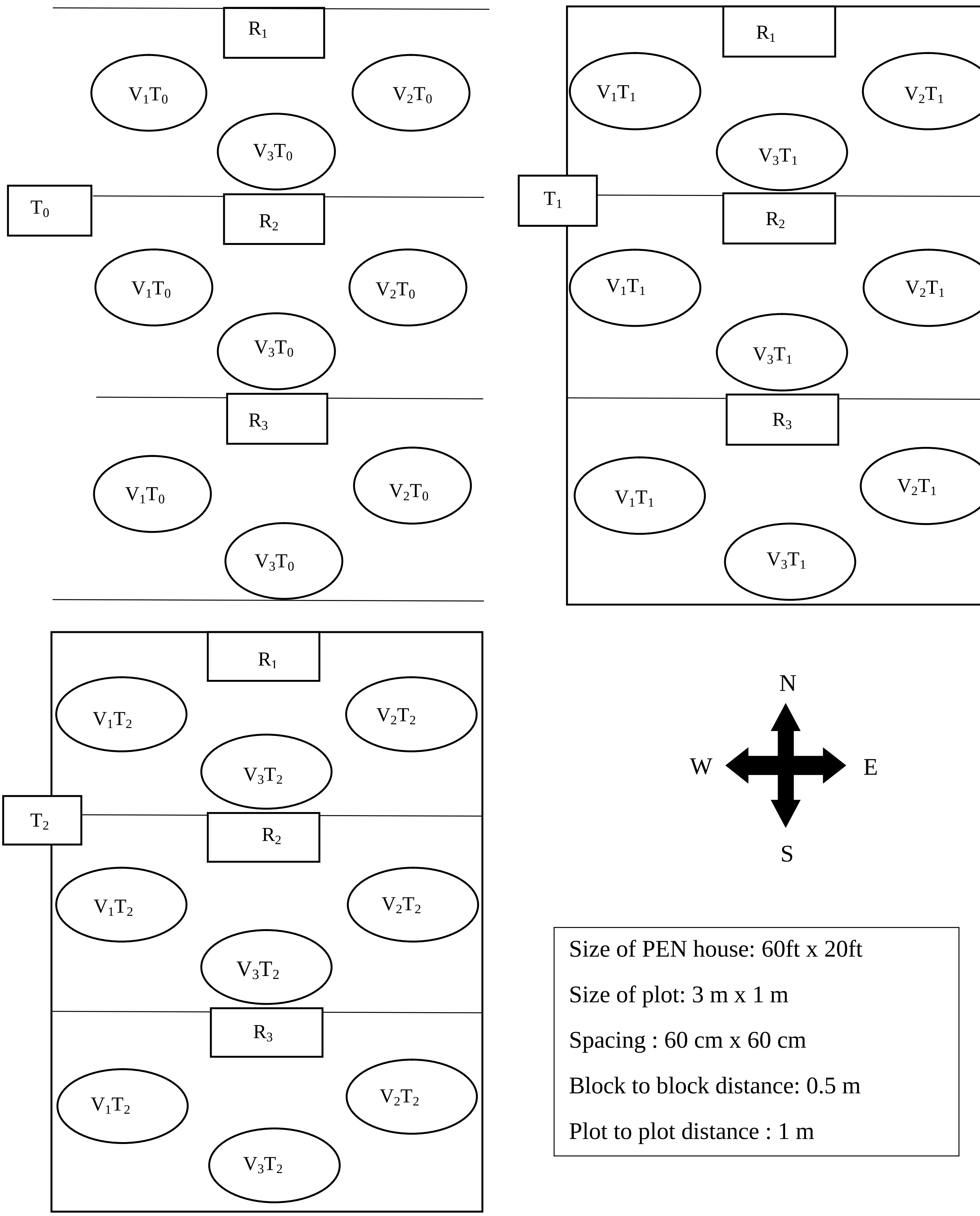


Fig. 1. Layout of the experiment

3.7 Production methodology

3.7.1 Seedbed preparation and raising of seedlings

The sowing was carried out on 1 November in the seedbed; before sowing seeds were soakedovernight. Seedlings of all varieties were raised in seedbeds in the Sher-e-Bangla Agricultural University. All care and precaution were taken to raise healthy seedlings. When the seedlings become 25 days old, those were transplanted in the main field.

3.7.2 Land preparation

The experimental plot was prepared by several ploughing and cross ploughing followed by laddering and harrowing with tractor and power tiller to bring about a good tilth. Weeds and other stubbles were removed carefully from the experimental plot and leveled properly.

3.7.3 Transplanting of seedlings

All seeds were germinated within 5 to 8 days after sowing. The seedlings were raised in the seedbed in usual way and seedlings were transplanted in the main field on 2 December, 2016. The transplanted seedlings were watered regularly to make a firm relation with roots and soil to stand along.

3.7.4 Manure and fertilizers application

Total cow dung and triple super phosphate (TSP) were applied in the field during final land preparation. Half urea and half murate of potash (MOP) were applied in the plot after three weeks of transplanting. Remaining urea and murate of potash (MOP) were applied after five weeks of transplanting. Dose of manure and fertilizers used in the study are showing in Table 1.

Table1. Doses of manures and fertilizers used in the study

SL No.	Fertilizers/Manures	Dose
		Quantity/ha*
1	Cow dung	10 -15 ton
2	Urea	375 Kg
3	TSP	150 Kg
4	MP	250 Kg
5	Gypsum	100kg

*Source: KrishiProjuktiHatboi, Part-1, Fifth Edition, BARI, Gazipur,1701, Bd.

3.8 Intercultural operations

After transplanting of seedlings, various intercultural operations such as irrigation, weeding and top dressing etc. were accomplished for better growth and development of the brinjal seedlings.

3.8.1 Gap filling

When the seedlings were established, the soil around the base of each seedling was pulverized. Very few seedlings were damaged after transplanting and the damaged seedlings were replaced by new healthy seedlings from the same stock. Excess plants were transplanted in border area at the same date of plants. Those seedlings were re-transplanted with a high mass of soil with roots to minimize transplanting stock.

3.8.2 Staking

When the plants were well established, staking was given to each plant by bamboo sticks to keep them erect.

3.8.3 Irrigation

Irrigation was given as when as necessary by observing the soil moisture condition. Irrigation was given throughout the growing period. The first irrigation was given 40 days after planting followed by irrigation 20 days after the first irrigation. Each fertilizing was followed by irrigation. Each plant was irrigated by a watering cane. Mulching was also done after each irrigation at appropriate time for breaking the soil crust.

3.8.4 Weeding

Weeding was done as when as necessary. It was done at every 15 days interval after planting followed upto peak flowering stage. As the land was covered by plant canopy by that time weeding was discontinued. Spading was done from time to time specially to break the soil crusts and keep the land weed free after each irrigation.

3.8.5 Harvesting

Harvesting continued for about one month because fruits of different lines matured progressively at different dates and over long time. Fruits were picked on the basis of horticultural maturity, size, color and age being determined for the purpose of consumption as the fruit grew rapidly and soon get beyond the marketable stage, frequent picking was done throughout the harvesting period.

3.9 Crop protection

No pesticides was applied in this experiment neither in open field nor in PEN houses. Only sticky traps were used for counting insect pests. This experiment was done to observe the findings of using pest exclusion net instead of pesticides for getting fresh, safe and organic brinjal.

3.10 Data collection

The plants in each entry were selected randomly and were tagged. These tagged plants were used for recording observations for the following characters.

3.10.1 Plant height

The plant height was measured from ground level to tip of the plant expressed in centimeters at different days after transplanting and mean was computed. (Plate 2a)

3.10.2 Number of leaves per plant

The number of leaves per plant was counted from the selected plants and their average was taken as the number of leaves per plant. It was recorded during different days after transplanting.

3.10.3 Leaf length

Leaf length was measured by centimeter scale. Mature leaf (from 4th node) were measured once at 60 days after transplanting and expressed in cm. Five mature leaves from each plant were measured and then average it after that mean was calculated.

3.10.4 Leaf width

Leaf width was measured by centimeter scale. Mature leaf (from 4th node) were measured once at 60 days after transplanting and expressed in centimeters. Five mature leaves from each plant were measured and then average it after that mean was calculated.

3.10.5 Chlorophyll content (%)

Leaf chlorophyll content was measured by using SPAD-502 plus (plate 2c). The chlorophyll was measured at 4 different portion of the leaf and then averaged for analysis. Chlorophyll content expressed in percentage.

3.10.6 Total number of branches per plant

The total number of branches arising from the main stem above the ground was recorded during experimental period.

3.10.7 Number of infested branches per plant

Branches were infested mainly by BSFB. They feed on the tender shoots. Soon after boring into the shoots and fruits, the larva seals the entry hole with excreta. The larva tunnels inside the shoot and feeds on the inner contents. It also fills the feeding tunnels with excreta. This results in wilting of young shoots, followed by drying and drop off, which slows plant growth. In addition, it produces new shoots, delaying crop maturity. The number of infested branches arising from the main stem above the ground was recorded during experimental period.

3.10.8 Number of healthy branches per plant

The number of healthy branches arising from the main stem above the ground was recorded during experimental period.

3.10.9 Branch infestation percentage

All the healthy and infested branches were counted from 5 randomly selected plants from each plot and examined. The healthy and infested branches were counted and the percent branch infestation was calculated using the following formula:

$$\% \text{ Branch infestation} = \frac{\text{Number of infested branch}}{\text{Number of total branch}} \text{ X } 100$$

3.10.10 Number of flowers per plant

Total number of flowers was counted from the tagged plants of each treatment and mean was computed.

3.10.11 Number of fruits per plant

Total number of fruits from different pickings during the cropping season was added and the appraisals were made for fruits per plant (Plate 2b).

3.10.12 Number of infested fruits per plant

The total number of infested fruits harvested from the five plants was counted and the average number of fruits per plant was calculated.

3.10.13 Fruit length

Length of five mature fruits at marketable stage was measured individually in centimeters from the base of calyx to tip of fruit using centimeter scale, when held vertically and the average was computed (Plate 2e).

3.10.14 Fruit diameter

Five mature fruits at marketable stage were used to measure the diameter of fruit in millimeter (mm) using Digital Caliper-515 (DC-515) at the widest point of the fruit. Average of five fruits diameter was expressed in millimeter (mm) (Plate 2f).

3.10.15 Single fruit weight

Fruit weight was measured by Electronic Precision Balance in gram (Plate 2d). Total fruit weight of each treatment was obtained by addition of weight of the total fruit number and average fruit weight was obtained from division of the total fruit weight by total number of fruit.

3.10.16 Gross yield per hectare

Gross yield per hectare was calculated from the total fruit yield obtained in each of the experimental unit and was expressed in tons per hectare.

3.10.17 Marketable Yield per hectare

Harvested fruits were categorized at each harvest as marketable and unmarketable on the basis of fruit borer infestation and other defective unmarketable fruits were weighed and their weight was subtracted from the total fruit weight. Then the marketable yield in kg/per plant was calculated. Marketable yield per hectare was calculated from the marketable yield obtained in each of the experimental unit and was expressed in tons per hectare.

3.10.18 Marketable yield reduction percentage

Yield reduction percentage was calculated by the difference between gross yield and marketable yield per hectare and was expressed in percentage. The gross yield (t) per hectare and total marketable yield (t) per hectare were computed and yield reduction (%) per hectare was calculated using the following formula:

$$\text{Marketable yield reduction \%} = \frac{\text{Gross yield (t/ha) - Marketable yield (t/ha)}}{\text{Gross yield (t/ha)}} \times 100$$

3.10.19 Pest population percentage

The numbers of insect pests at their respective injurious stage(s) were counted once every week from the sticky trap. Counting of insects was done early in the morning when most insects had low activity. Hand lenses were used for counting smaller pests like mites, thrips and aphids. During insect assessments, the opening of the PEN was minimal for treatments requiring a permanent protection. Total insects caught in

sticky trap and total pests caught in sticky trap were counted and then pest infestation percentage per plot was calculated through following formula:

$$\text{Pest population \%} = \frac{\text{Number of insect pests}}{\text{Number of total insects on sticky trap}} \times 100$$

3.11 Statistical analysis

The recorded data for different characters were analyzed statistically using MSTAT-C program to find out the significance of variation among the treatments. The analysis of variance (ANOVA) was performed by F-test, while the significance of difference between the pairs of treatment means were evaluated by the Duncan's Multiple Range Test (DMRT) test at 5% and 1% level of probability (Gomez and Gomez, 1984).

3.12 Economic analysis

The cost of production was analyzed in order to find out the most economic solution of different insect pests of brinjal without residual effect of pesticides. All input cost included the cost for lease of land and interests on running capital in computing the cost of production (Appendix IX, X). The interests were calculated @ 7% in simple rate. The market price of brinjal was considered for estimating the cost and return. Analyses were done according to the procedure of (Alam*et al.*, 1989). The benefit cost (BCR) was calculated as follows:

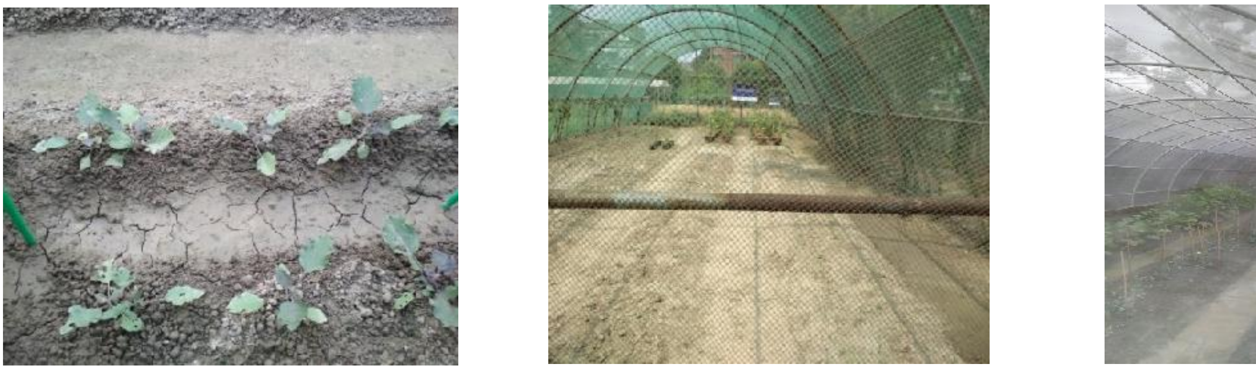
$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return per hectare (Tk)}}{\text{Total cost of production per hectare (Tk)}}$$

(a) **(b)**

(c)

Plate 1. Pictorial presentation of different brinjal varieties.

a.Narsingdhi (V_1); **b.** Singnath (V_2); **c.** Charki (V_3)



(a) **(b)**

(c)

Plate 2. Pictorial presentation of different PEN conditions.

a. Open Field (T_0); **b.** 20 mesh PEN house (T_1); **c.** 40 mesh PEN house (T_2)

(a) **(b)**

(c) **(d)**

(e) **(f)**

Plate 2. Pictorial presentation of data collection.

a. Measurement of plant height using meter scale in cm; **b.** Counting number of fruits per plant; **c.** Measurement of chlorophyll percentage using SPAD; **d.** Measurement of single fruit weight using electrical balance; **e.** Measurement of fruit length using centimeter scale; **f.** Measurement of fruit diameter using Digital Caliper-515 (DC-515) in millimeter (mm)

CHAPTER IV

RESULT AND DISCUSSION

The research work on 'Performance of brinjal varieties under pest-exclusion net' was undertaken in the Department of Horticulture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The experimental results on growth, yield and quality parameters recorded during the entire period of study are presented as follows:

4.1 Statistical analysis

4.1.1 Plant height

Plant height is one of the most important growth parameters in brinjal which is positively correlated with yield and the growing conditions significantly influenced this trait.

The difference in varieties for plant height was found significant. (Appendix II). Highly significant differences exist among different of varieties with regard to plant height at 35 days, 45 days, 55 days, 65 days and 75 days after transplanting. Tallest plant was found from V_2 (82.1 cm) whereas the shortest from V_3 (74.1cm) at 75 days after transplanting which is statistically similar with V_1 (75.4 cm) (Fig. 2). Olaniyiand Fagbayide(2010) also found that plant height varied due to the varietal differences. It was observed that the tallness, shortness and other morphological differences are varietal characteristics, which are controlled and expressed by certain genes (Fayaz*et al.*, 2007). Similar opinion was put forwarded by Hossain *et al.* (2002) in brinjal.

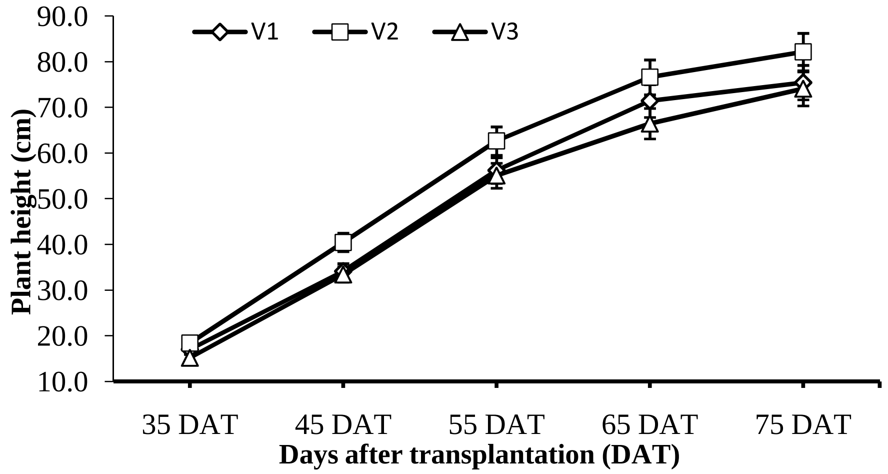


Fig. 2. Performance of different varieties on plant height at different days after transplanting of brinjal(Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety)

In case of different pest exclusion net conditions, significant variation in plant height was observed. (Appendix II). The tallest plant (81.1 cm) wasfound under 40 mesh pest exclusion net (T_2) and the shortest plant (72.9 cm) was found from open field condition (T_0) at 75 days after transplanting. (Fig. 3) Similar opinion was put forwarded by Ramesh and Arumugam (2010) in tomato. Plant height was highest under 75 % shade net house in both seasons compared to open field. This is due to enhanced photosynthesis and respiration due to the favorable micro-climatic conditions in the shade net house. (Nangare*et al.*, 2015). Phookan*et al.* (1990) found that plant height of tomato varied in summer under plastic house condition.

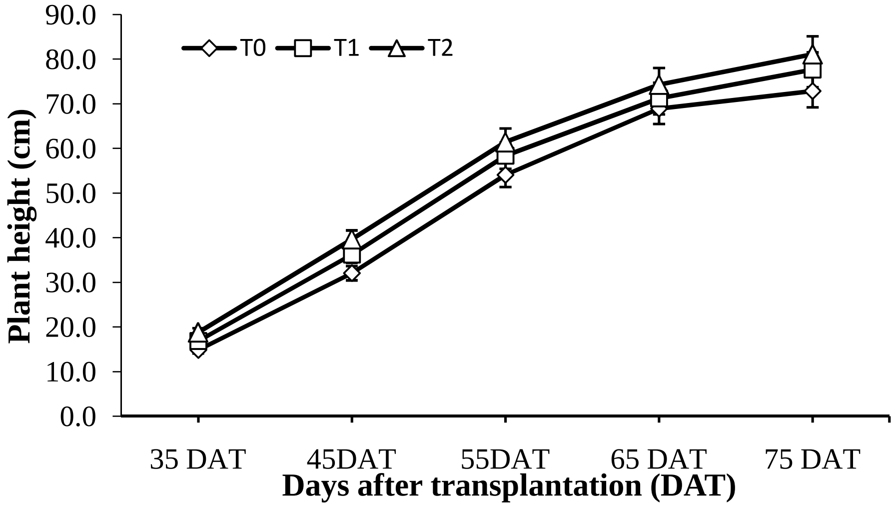


Fig. 3. Influence of different PEN conditions on plant height at differentdays after transplanting of brinjal(Here, T_0: Open field or control treatment; T_1: 20 mesh pest exclusion netting ; T_2: 40 mesh pest exclusion netting)

In case of combination treatment significant variation in plant height was observed which indicated the influence of growing condition on plant height of different varieties (Appendix II). Singnath variety produced tallest plant (86.7cm) under T_2 condition (V_2T_2) whereas shortest plant (69.1 cm) was found in V_3T_0 at 75 days after transplanting (Table 2). Singh (2013) also showed that plant under net house grow tall than the open field condition. More plant height inside the net house can be due to training of plants by retaining two main stems and shade effect under the net house. Ganesan (2001) revealed that Pusa Ruby attained maximum plant height (211 cm) under house conditions.

Table 2.Combined effect of varieties and PEN conditions on plant height at different days after transplanting of brinjal

Treatment combinations [X]	Plant height (cm) [Y]									
	35 DAT		45 DAT		55 DAT		65 DAT		75 DAT	
V_1T_0	15.2	e	31.9	e	53.2	f	69.6	de	71.2	f
V_1T_1	17.2	cd	34.1	d	56.1	e	71.2	d	76.0	de
V_1T_2	18.5	b	36.2	c	59.3	c	73.5	c	79.1	bc
V_2T_0	16.6	d	36.2	c	59.0	c	74.0	bc	78.3	cd
V_2T_1	18.4	b	40.5	b	62.7	b	75.5	b	81.4	b
V_2T_2	20.2	a	44.6	a	66.2	a	80.2	a	86.7	a
V_3T_0	12.7	f	28.0	f	50.0	g	63.2	g	69.1	f
V_3T_1	15.	e	34.0	d	56.3	de	66.9	f	75.5	e
V_3T_2	17.7	c	38.2	c	58.8	cd	69.3	e	77.6	cde
CV%	2.25		3.31		2.55		1.34		1.8	
$LSD_{0.05}$	0.65		2.06		2.55		1.66		2.41	

[X] Here, V_1: Narsingdhi variety; V_2: Singnath variety; V_3: Charki variety
T_0: Open field or control treatment; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting
[Y] In a column, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.2 Number of leaves per plant

Leaves are very important vegetative organs, as they are chiefly concerned with the physiological processes, photosynthesis and transpirations. Thus it influenced the growth of a plant very much and is positively correlated with the yield of a plant. The number of leaves per plant significantly varied among the brinjal varieties (Appendix III). Highly significant differences exist among different of varieties with regard to number of leaves at 35 DAT, 45 DAT, 55 DAT, 65 DAT and 75 days after transplanting. The maximum number of leaves (32.7) was found from V_2 and minimum (28.8) from V_1 at 75 days after transplanting (Fig. 4). Similar results had been reported by Ahmed *et al.*,1988. Hossain (2007) observed highly significant variation in respect of number of leaves per plant in Raton.

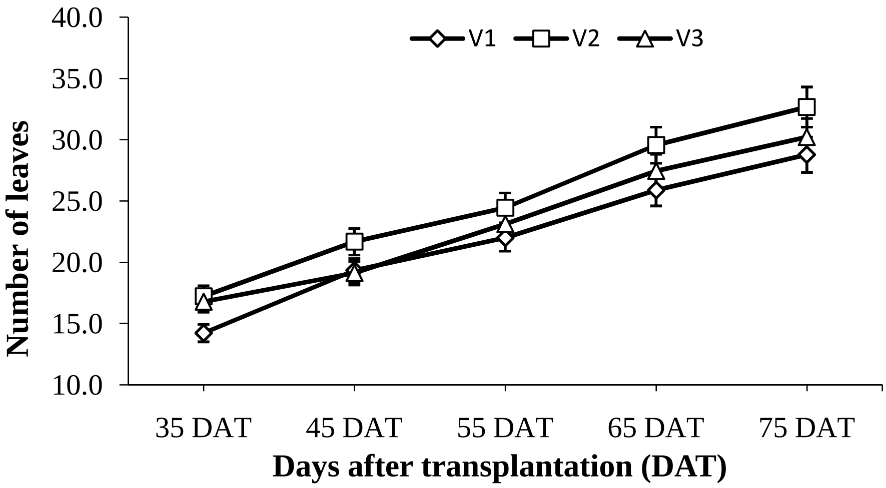


Fig. 4.Performance of different varieties on number of leaves per plant at different days of transplanting of brinjal(Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety)

In case of open field and different pest exclusion net conditions, significant variation in number of leaves was observed (Appendix III). The maximum number of leaves (33.1) was found from T_2 and minimum (27.8) from T_0 with 75 days after transplanting (Fig. 5). Nissim-Levi *et al*. (2008)found shade netting that increases light scattering but does not affect the light spectrum has been shown to increase branching, plant compactness, and the number of leaves per plant.

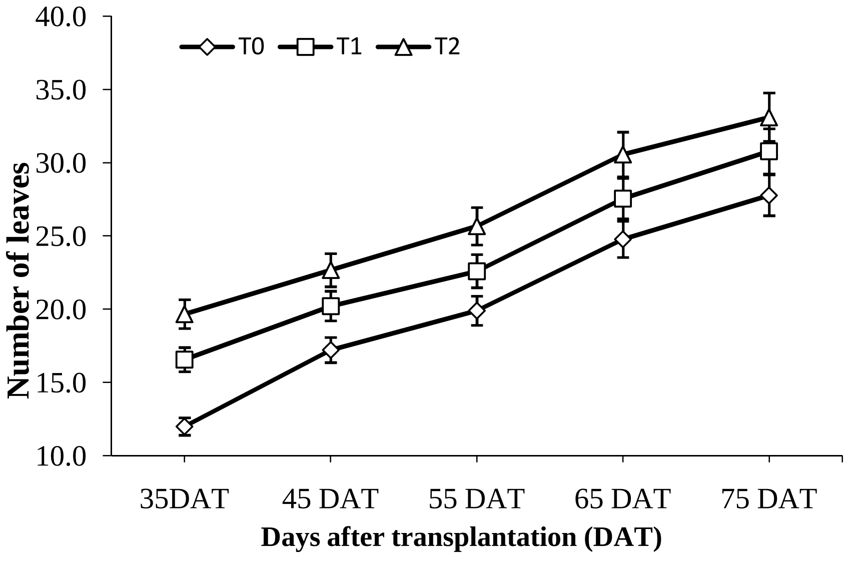


Fig. 5.Influence of PEN conditions on number of leaves per plant at different days after transplanting of brinjal(Here, T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting ; T_2: 40 mesh pest exclusion netting)

In case of combined effect significant variation was observed in the number of leaves per plant was observed (Appendix III). Singnath produced maximum number of leaves (37.0) under T_2 condition (V_2T_2) and minimum (26.7) from V_1T_0 with 75 days after transplanting. (Table 3).

Table 3.Combined effect of varieties and PEN conditions on number of leaves per plant at different days after transplanting of brinjal

	Number of leaves per plant[Y]									
Treatment combinations[X]	**35 DAT**		**45DAT**		**55 DAT**		**65 DAT**		**75 DAT**	
V_1T_0	10	e	17.3	de	20	de	23.3	d	26.7	e
V_1T_1	14.7	d	19.7	b-d	22.3	b-d	25.7	cd	29	cd
V_1T_2	18	bc	21	bc	23.7	bc	28.7	b	30. 7	bc
V_2T_0	13	d	18	c-e	21	b-e	25.7	cd	28.3	de
V_2T_1	17.3	c	21.7	b	24.3	b	29.3	b	32. 7	b
V_2T_2	21.3	a	25.3	a	28	a	33.7	a	37	a
V_3T_0	13	d	16.3	e	17.7	e	25.3	cd	28.3	de
V_3T_1	17.7	bc	19.3	b-e	20.3	c-e	27.7	bc	30.7	bc
V_3T_2	19.7	ab	21.7	b	22.3	b-d	29.3	b	31.7	b
CV%	8.15		9.18		8.92		5.98		4.1	
$LSD_{0.05}$	2.27		3.17		3.42		2.86		2.17	

[X]Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety
T_0: Open field or control treatment; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting
[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.3 Leaf length

Significant difference was found for leaf length with different brinjal varieties (Appendix IV). Among the varieties of brinjal V_2 (Singnath) gave the longest leaf (23.9 cm) while V_1 gave the shortest leaf (21.2 cm) length which is statistically dissimilar with V_3 (22.3 cm). (Table 4). Similar results was obtained by Ahmad *et al*. (2009)

Significant variation was observed on leaf length in case of different pest exclusion net conditions and open field condition (Appendix IV). Maximum leaf length (24.6 cm) was observed under T_2 condition and minimum leaf length (20.4 cm) was observed in T_0 (Table 5).

Significant variation was found for leaf length in case of combined effect (Appendix IV). Singnath produced longest leaf (25.7cm) under 40 mesh pest exclusion net (V_2T_2) and minimum leaf length (18.6 cm) was found in V_1T_0 (Table 6).

4.1.4 Leaf width

Significant difference was found for leaf width with different brinjal varieties (Appendix IV). Among the varieties of brinjal maximum leaf width (17.0 cm) found on Singnath (V_2) while minimum leaf width (15.5 cm) found on V_3 (Table 4). Ahmad *et al*. (2009) also reported that higher third leaf width might increase infestation because the more leaves and higher third leaf width may be favorable for egg lying of BSFB.

Significant variation was observed on leaf width in case of different pest exclusion net (Appendix IV). Maximum leaf width (17.9 cm) was observed under T_2 condition andminimum leaf width (14.4 cm) was observed in T_0 (Table 5).

The interaction between varieties and environment was also significant, which indicated that the influence of growing condition on leaf width of different brinjal varieties (Appendix IV). Maximum leaf width (18.6 cm) was found in singnath variety under T_2 condition (V_2T_2) which is statistically similar with V_1T_2 (18.3 cm) and minimum leaf width (13.8 cm) was found in V_3T_0 which is statistically similar with narsingdhi variety under open field condition (V_1T_0) (14 cm) (Table 6).

4.1.5 Chlorophyll content (%)

Chlorophyll influences the growth of a plant which is correlated with the yield. Chlorophyll (%) on leaves (SPAD reading) showed significant variation among the varieties (Appendix IV). The highest chlorophyll content (42.2%) observed from V_3 (Charki) whereas the lowest chlorophyllcontent (36.2%) observed from V_1 (Table 4). The variation in the chlorophyll content is an indication of the differences in the growth habit of the plant varieties as similarly found in cowpeas by Olotuah and Fadare (2012). Leaf chlorophyll content is often highly correlated with leaf N status, photosynthetic capacity and RuBP carboxylase activity (Evans,1998;Seemann*et al.*, 1987) a loss in chlorophyll coincides with development of grain filling.

Significant variation was observed in case of chlorophyll percentage of leaves under different PEN conditions (AppendixIV). Maximum chlorophyll percentage (40.3) was found under T_2 and minimum (37.8) was observed in open field (T_0) (Table5). Similar results were found by Bergquist*et al.* (2007) who showed that the concentrations of total carotenoids and total chlorophylls in baby spinach leaves were significantly higher under the nettings, especially under the spectrum-altering and low transmittance nettings. Chlorophyll content and photosynthetic capacity increased as the degree of shading was increased. (Ilic*et al.*, 2012)

In case of combination treatment significant variation was observed (Appendix IV). Maximum chlorophyll content of leaves (43.0%) was found in V_3T_2 and minimum chlorophyll content of leaves (34.5%) was found from narsingdhi variety in open field (V_1T_0) (Table 6).

Table 4. Performance of different varieties on leaf length, leaf width and chlorophyll content of brinjal[Y]

Treatments[X]	**leaf length(cm)**	**leaf width(cm)**	**Chlorophyll %**
V_1	21.2 c	16.2 b	36.2 c
V_2	23.9 a	17.0 a	39.2 b
V_3	22.3 b	15.5 c	42.2 a
CV%	2.1	1.35	1.15
$LSD_{0.05}$	0.47	0.22	0.45

[X]Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety
[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 5. Influence of different PEN conditions on leaf length, leaf width and chlorophyll content of brinjal[Y]

Treatments[X]	**leaf length(cm)**	**leaf width(cm)**	**Chlorophyll %**
T_0	20.4 c	14.4 c	37.8 c
T_1	22.5 b	16.4 b	39.4 b
T_2	24.6 a	17.9 a	40.3 a
CV%	2.11	1.35	1.15
$LSD_{0.05}$	0.47	0.21	0.45

[X]Here, T_0: Open field or control treatment; T_1: 20 meshpest exclusion netting; T_2: 40 mesh pest exclusion netting
[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 6.Combined effect of varieties and PEN conditions on leaf length, leaf width and chlorophyll content of brinjal^{Y}

Treatment combinations^{X}	leaf length(cm)	leaf width (cm)	Chlorophyll %
V_1T_0	18.6 e	14.0 f	34.5 f
V_1T_1	21.4 c	16.3 c	36.8 e
V_1T_2	23.7 b	18.3 a	37.5 de
V_2T_0	21.9 c	15.3 e	37.7 d
V_2T_1	24.3 b	17.2 b	39.2 c
V_2T_2	25.7 a	18.6 a	40.5 b
V_3T_0	20.6 d	13.8 f	41.2 b
V_3T_1	21.9 c	15.7 d	42.3 a
V_3T_2	24.4 b	17.1 b	43 a
CV%	2.1	1.35	1.15
$LSD_{0.05}$	0.81	0.38	0.78

^{X}Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety
T_0: Open field or control treatment; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting
^{Y}In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.6 Number of branches per plant

Significant difference among the varieties in the number of branches per plant was observed (Appendix V). The maximum number of branches per plant (24.7) was produced in V_2 whereas the minimum number ofbranches per plant (17.9) was produced in V_3. But infested branch number per plant is the highest (5.1) in V_3 which is statistically similar with V_2 (4.9)and V_1 (4.8). Maximum healthy branches (19.8) were found in V_2 and minimum (12.8) in V_3. Again, branch infestation percentage was highest (38.6) in V_3 and lowest (23.5) in V_2(Table 7). This is due to varietal characteristics.

In case of different pest exclusion net conditions, significant variation was observed in the number of branches per plant (Appendix V). Maximum number of branches per plant (25.7) was found in 40 mesh pest exclusion netting (T_2) and minimum number of branches per plant (13.8) was found in T_0 . But infested branch number per plant was highest (9.9) in T_0 and lowest (1.9) in T_2. Maximum healthy branches (23.8) were found in T_2 and lowest (3.8) in T_0. Again, branch infestation was maximum (76.4%) in $T_0$and minimum (7.4%) in T_2 (Table 8). Many researchers studied the effect of net house on vegetative parameters of plants and showed that increases vegetative growth and allows more light penetration and increases photosynthesis efficiency and improve vegetative growth of plants (Preece and Read, 2005).

In case of combined effect significant variation was observed in the number of branches per plant (Appendix V). Maximum number of branches per plant (29.7) was found in V_2T_2 and minimum number of branches per plant (10.9) was found in V_3T_0 (Table 9) But, in case of infested branch number per plant lowest (2.3) found in V_2T_2 while highest (21.6) found in narsingdhi variety in open field condition (V_1T_0). Maximum healthy branches (27.5) were found in V_2T_2 and minimum (1.2) in V_3T_0 which is statistically similar of V_1T_0 (1.4). Branch infestation percentage was maximum (88.7) in V_1T_0 which is statistically similar of V_3T_0 (88.9) and minimum (5.3) in V_1T_2 (Table 9).

Table 7. Performance of different varieties on number of branches per plant of brinjal

Treatments^X	Number of branches per plant ^{Y}			
	Total branches no.	**Healthy branches no.**	**Infested branches no.**	**Branch infestation%**
V_1	19.3 a	14.6 b	4.8 a	34.9 b
V_2	24.7 b	19.8 a	4.9 a	23.5 c
V_3	17.9 c	12.8 c	5.1 a	38.6 a
CV%	2.65	4.87	ns	10.22
$LSD_{0.05}$	0.55	0.77	ns	3.30

^{X}Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety

^{Y}In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 8.Influence of different PEN conditions on number of branches per plant of brinjal

Treatments^X	Number of branches per plant ^{Y}			
	Total branches no.	**Healthy branches no.**	**Infested branches no.**	**Branch infestation%**
T_0	13.7 c	3.8 c	9.9 a	76.4 a
T_1	22.5 b	19.6 b	2.9 b	13.2 b
T_2	25.7 a	23.8 a	1.9 c	7.4 c
CV%	2.65	4.87	8.17	10.22
$LSD_{0.05}$	0.55	0.77	0.40	3.30

^{X}Here, T_0: Open field or control treatment; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting

^{Y}In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 9.Combined effect of varieties and PEN conditions on number of branches per plant of brinjal

Number of branches per plant [Y]				
Treatment Combinations[X]	Total branches no.	Healthy branchesno.	Infested branches no.	Branch infestation%
V_1T_0	12.0 h	1.4 G	10.7 a	88.7 a
V_1T_1	21.5 e	19.2 D	2.3 d	10.7 de
V_1T_2	24.5 c	23.1 B	1.3 e	5.3 e
V_2T_0	18.3 g	8.8 F	9.5 b	51.7 b
V_2T_1	26.2 b	23.2 B	3.0 c	11.5 d
V_2T_2	29.7 a	27.5 A	2.1 d	7.1 de
V_3T_0	10.9 i	1.2 G	9.7 b	88.9 a
V_3T_1	19.9 f	16.5 E	3.5 c	17.3 c
V_3T_2	22.9 d	20.7 C	2.2 d	9.7 de
CV%	0.95	4.87	0.69	10.22
$LSD_{0.05}$	2.65	1.326	8.17	5.722

[X]Here, V_1: Narsingdhi variety; V_2 : Singnath variety ; V_3: Charki variety
T_0: Open field or control treatment; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting
[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.7 Number of flowers per plant

In case of different brinjal varieties the number of flower per plant varied significantly (Appendix VI). Maximum number of flower (57.0) was found in Narsingdhi (V_1) variety and minimum number of flower (22) was found in V_3 (Table 10). Similar results were reported by Sk. Rahul *et al.* (2017). Significant difference among the brinjal varieties in case of the number of flowers per plant.

In case of different pest exclusion netting, the number of flower per plant varied significantly (Appendix VI). Maximum number of flower (49.7) was found in T_2 condition and minimum number of flower (32.7) were found in control (T_0) treatment (Table 11).

In case of combination treatment the number of flowers per plant varied significantly (AppendixVI). Maximum number of flowers (73.3) was found in V_1T_2 treatment combination and minimum number of flowers (18.7) was found in V_3T_0 (Table 12).

4.1.8 Number of fruits per plant

In case of three different brinjal varieties, number of fruit/plant varied significantly (AppendixVI). Maximum number of fruits per plant (34.6) were found in Narsingdhi (V_1) variety and V_3 produced minimum number of fruits (9.6) (Table10). The genotypic differences for number of fruits per plant were also observed by Muniappan*et al.* (2010) and Islam and Uddin (2009) in brinjal.

In case of different pest exclusion net conditions the number of fruits per plant varied significantly (Appendix VI). Maximum number of fruits per plant (21.5) was found in T_2 netting and minimum number of fruits per plant (19.9) was found in T_0 (Table 11). The findings were supported by the study conducted by Singh *et al*. (2005) which revealed that Avinash-2 had potential of setting maximum fruits per plant (91.9) under net house conditions.

In case of combination treatment the number of fruits per plant varied significantly (Appendix VI). Maximum number of fruits per plant (35.6) was found in V_1T_1 and minimum number of fruit per plant (8.7) were found in V_3T_1 (Table 12).

4.1.9 Number of infested fruits per plant

Significant variation among the brinjal varieties in number of infested fruit per plant. (Appendix VI). Narsingdhi (V_1) produced maximum infested fruits (12.2) rather than and V_3 produced minimum infested fruits (4.6) among varieties (Table 10).

Significant difference was revealed on number of infested fruits per plant in case of open field and different netting conditions (Appendix VI). Maximum number of infested fruit (12.5) was found in T_0 whereas minimum number of infested fruit (3.9) was found in 20 mesh pest exclusion netting (T_2) (Table 11).

In case of combined effect of brinjal varieties and netting conditions, significant variation also found in number of infested fruit per plant (Appendix VI). Maximum number of infested fruit (21.6) was found in V_1T_0 and minimum number of infested fruit (2.3) was found in V_2T_2 (Table 12).

Table 10.Performance of different varieties on number of flowers, number of fruits and number of infested fruits per plant of brinjal

Treatments[X]	No. of flowers/plant[Y]	No. of fruits/plant[Y]	No. of infested fruits/ plant[Y]
V_1	57.0 a	34.6 a	12.0 a
V_2	41.4 b	18.2 b	5.0 b
V_3	22.0 c	9.6 c	5.0 c
CV%	2.88	8.49	9
$LSD_{0.05}$	1.16	1.76	1

[X]Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety

[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 11.Influence of different PEN conditions on number of flowers per plant, number of fruits per plant and number of infested fruits per plant of brinjal

Treatments[X]	No. of flowers/plant[Y]	No. of fruits/plant[Y]	No. of infested fruits/ plant[Y]
T_0	32.7 c	19.9 a	13.0 a
T_1	38.1 b	20.9 a	6.0 b
T_2	49.7 a	21.5 a	4.0 c
CV%	2.88	ns	9
$LSD_{0.05}$	1.16	ns	1

[X]Here, T_0: Open field or control treatment; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting

[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

(a)

(b)

(c)

(d)

(e)

(f)

Plate 3. Pictorial view of healthy and infested fruits of different brinjal varieties

a. Healthy fruit of V_1 (Narsingdhi); **d.** Infested fruit of V_1 (Narsingdhi);

b. Healthy fruit of V_2 (Singnath); **e.** Infested fruit of V_2 (Singnath);

c. Healthy fruit of V_3 (Charki); **f.** Infested fruit of V_3 (Charki)

Table 12. Combined effect of varieties and PEN conditions on number of flowers per plant, number of fruits per plant and number of infested fruits per plant of brinjal

Treatment combinations[X]	No. of flowers/plant[Y]	No. of fruits/plant[Y]	No. of infested fruits/ plant[Y]
V_1T_0	45.7 d	32.7 a	21.6 a
V_1T_1	52.1 b	35.5 a	9.7 b
V_1T_2	73.3 a	35.5 a	5.4 cd
V_2T_0	33.7 f	17.9 b	9.7 b
V_2T_1	42.3 e	18.3 b	4.2 de
V_2T_2	48.3 c	18.3 b	2.3 f
V_3T_0	18.7 h	9.3 c	6.3 c
V_3T_1	20 h	8.7 c	3.7 e
V_3T_2	27.3 g	10.7 c	3.9 e
CV%	2.88	8.49	9.3
$LSD_{0.05}$	2	3.056	1.19

[X]Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety
T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting ; T_2: 40 mesh pest exclusion netting
[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.10 Fruit length

Significant difference was revealed on fruit length with different brinjal varieties (Appendix VII). Among the varieties of brinjal V_2 (Singnath) gave the longest fruit (25.0 cm) while V_3(Charki) gave the shortest fruit (9.2 cm) length which is statistically dissimilar with V_1 (15.48 cm) (Table 13). This is may be due to variation of varietal characteristics. Hossain (2001), Singh and Sahu (1998) also reported varietal influence on the length of fruit.

Significant variation was found for fruit length in case of different pest exclusion net conditions and open field condition (Appendix VII). Maximum fruit length (18.2 cm) was observed under T_2 condition and minimum fruit length (14.9 cm) was observed in T_0. (Table 14). Thangam and Thamburaj (2008) also observed higher fruit length (7.8 cm) in Rashmi cherry tomato under shade compared to open field conditions (7.2 cm). Chapagain*et al.* (2011) reported largest fruit size in US-04 with a diameter of 5.7 cm.

Significant variation was found for fruit length in case of combined effect (Appendix VII). Maximum fruit length (26.8 cm) was found in V_2T_2 and minimum fruit length (8.2 cm) was found in V_3T_0 (Table 15). Sima*et al*. (2011) evaluated six tomato hybrids in house for yield potential and quality reported significantly highest fruit length for Monroe F_1 (53.50 mm) followed by Menhir F_1 (52.64 mm).

4.1.11 Fruit diameter

The difference in varieties for fruit diameter was found significant (Appendix VII). Where, maximum fruit diameter was recorded 74.7 mm in V_3 and the smallest diameter of fruit was 33.6mm in V_2 (Table 13). Muniappan*et al.* (2010) reported wide range of variability in case of fruit diameter.

The growing conditions *viz.*, net house and open field significantly influenced the fruit diameter in brinjal (Appendix VII). Where, maximum fruit diameter (56.4 mm) found in T_2 and minimum fruit diameter (48.7 mm) found in T_0 (Table 14).

The interaction between varieties and environment was also significant, which indicated that the influence of growing condition on fruit diameter of different brinjal varieties (Appendix VII). Comparison of varieties revealed that Charki variety (V_3) produced widest fruit (77.7 mm) under T_2 condition (V_3T_2) and minimum fruit diameter (27.4 mm) found in V_2T_0 (Table 15). Muniappan*et al* (2010) reported wide range of variability in case of fruit diameter. Among the eleven inbred lines of cherry tomatoes evaluated by Islam *et al*. (2012) maximum fruit width was noticed in CLN1555A (4.5 cm) while, the line CH155 had the minimum fruit width (2.05 cm).

4.1.12 Single fruit weight

Single fruit weight showed significant variation among the brinjal varieties (Appendix VII). Maximum individual fruit weight (244.8 g) was found in Charki (V_3) variety and minimum individual fruit weight (59.3 g) was found in V_1 (Table 13). Variation in single fruit weight was also observed by Glavinich*et al.* (1982), Gabal*et al.* (1985), Bhangu and Singh (1993), Mehraj*et al.* (2014) and Islam (2014).

In case of different pest exclusion netting the single fruit weight varied significantly (Appendix VII). Maximum individual fruitweight (134.7 g) was found in 40 mesh pest exclusion net condition (T_2) and minimum individual fruitweight (126.6 g) was found in T_0 (Table 14). These results are in line with the findings of Ishwarappa (2011) and Sima*et al*. (2011) in tomato under shade. Chaudhary *et al.* (1993) reported that tomato hybrid Carmello had the maximum average fruit weight (163.33g) under the plastic tunnel. In both seasons, growing tomato under agronet cover and companion planting with a row of basil in between adjacent rows of tomato produced heavier tomato fruits compared with the fruitsobtained from the control treatment which yielded the least weight. (Mutisya*et al.*, 2016).

In case of combination treatment the number of single fruit weight varied significantly (Appendix VII). Maximum individual fruitweight (252.3 g) was found in V_3T_2 and minimum(57.53g) was found in V_1T_0 (Table 15).

Table 13.Performance of different varieties on fruit length, fruit diameter and single fruit weight of brinjal

Treatments^X	Fruit length (cm)^Y	Fruit diameter (mm)^Y	Single fruit weight (g)^Y
V_1	15.5 b	50.4 b	59.3 c
V_2	25.1 a	33.6 c	87.6 b
V_3	9.2 c	74.7 a	245 a
CV%	1.16	1.2	0.73
$LSD_{0.05}$	0.19	0.64	0.96

*Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety

**In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 14.Influence of different PEN conditions on fruit length, fruit diameter and single fruit weight of brinjal

Treatments^X	fruit length (cm)^Y	fruit diameter (mm)^Y	Single fruit weight (g)^Y
T_0	14.9 c	48.7 c	127 c
T_1	16.6 b	53.7 b	131 b
T_2	18.2 a	56.4 a	135 a
CV%	1.16	1.2	0.73
$LSD_{0.05}$	0.19	0.64	0.96

^{X}Here, T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting ; T_2: 40 mesh pest exclusion netting

^{Y}In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 15.Combined effect of varieties and PEN conditions on fruit length, fruit diameter and single fruit weight of brinjal

Treatment combinations[X]	fruit length (cm)[Y]		Fruit diameter (mm)[Y]		Single fruit weight (g)[Y]	
V_1T_0	13.3	f	47.5	f	57.5	h
V_1T_1	15.3	e	50.4	e	59.1	h
V_1T_2	17.8	d	53.5	d	61.3	g
V_2T_0	23.2	c	27.4	i	85	f
V_2T_1	25.2	b	35.3	h	87.3	e
V_2T_2	26.8	a	38.1	g	90.5	d
V_3T_0	8.2	i	71.1	c	237.2	c
V_3T_1	9.2	h	75.3	b	244.9	b
V_3T_2	10.1	g	77.7	a	252.3	a
CV%	1.16		1.2		0.73	
$LSD_{0.05}$	0.33		1.1		1.66	

[X]Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety

T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting ; T_2: 40 mesh pest exclusion netting

[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.13 Gross Yield

Significant differences among the brinjal varieties respect to yield were observed(Appendix VIII). The highest fruit yield per hectare (58.9 t) was found from V_1. The lowest (44.3 t) was significantly obtained from V_2 (Fig. 6). This may be due to the inherent ability of the hybrids and their better response to controlled environment condition. Similar reports of better performance of hybrids due to genetic makeup have been reported by Singh *et al*. (2005), Parvej*et al*. (2010), Chapagain*et al.* (2011), Ishwarappa (2011), Bibi*et al.* (2012), Islam *et al*. (2012) and Singh *et al*. (2013) in tomato under shade net conditions and Prema*et al.* (2011), Aguirre and Cabrera (2012) and Razzak*et al.* (2013) in cherry tomato.

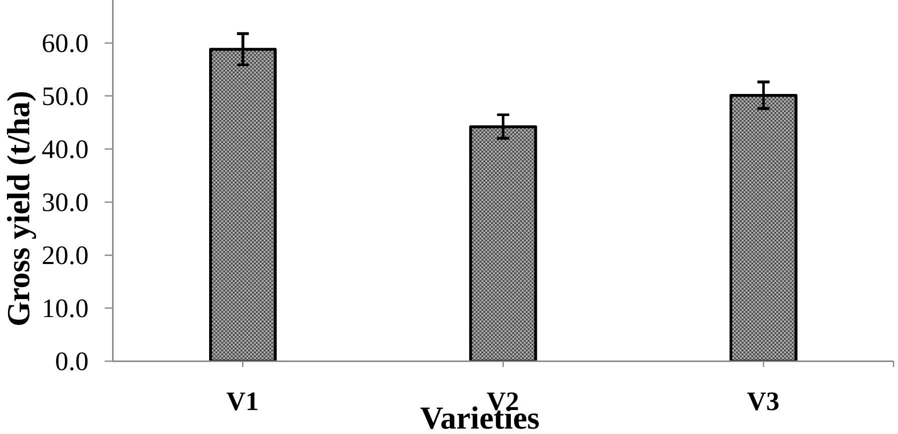


Fig. 6.Performance of different varieties on gross yield of brinjal

(Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety)

Different netting conditions showed significant variation in respect to brinjal fruit gross yield per hectare (t) (Appendix VIII). Maximum gross yield per hectare (52.9 t) was obtained fromT_2condition whereas minimum gross yield per hectare (49.4 t) was obtained from open field or control treatment (T_0) (Fig. 7).

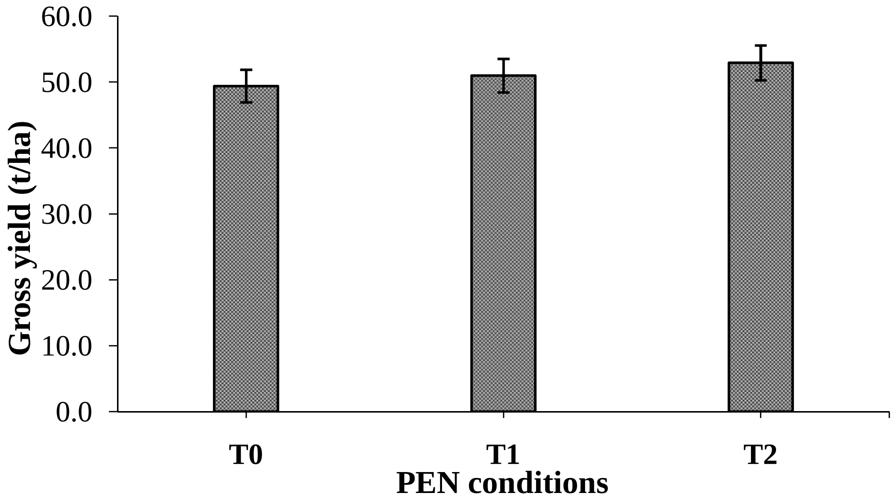


Fig. 7.Influence of different PEN conditions on gross yield of brinjal
(Here, T_0: Open field or control treatment; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting)

In case of combined effect of brinjal varieties and netting conditions, significant variation was found in fruit yield per hectare (t) (Appendix VIII). Maximum fruit gross yield per hectare (60.5 t) was obtained fromV_1T_2 whereas minimum fruit yield per hectare (42.4 t) was obtained from Singnath variety in open field (V_2T_0)(Table 16).

4.1.14 Marketable yield

Marketable yield is paramount parameter due to severe attack of shoot and fruit borer in brinjal. Significant variation was observed among the varieties of brinjal in respect to marketable yield (Appendix VIII). Among brinjal varieties maximum marketable yield per hectare (37.1 t) was found on Narsingdhi variety (V_1) and minimum marketable yield per hectare (31.4 t) was found from Singnath variety (V_2) (Fig. 8). Similarly, heterotic differences for marketable yield were reported by Singh *et al.* (1998).

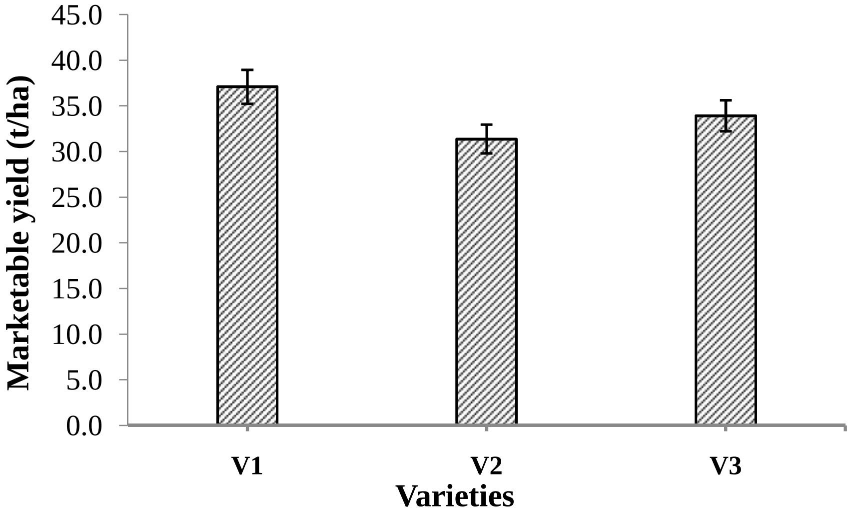


Fig. 8. Performance of different varieties on marketable yield of brinjal
(Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety)

Significant variation in marketable yield under different PEN conditions (Appendix VIII).Under net-house, maximum marketable fruit yield per hectare (46.4 t) was obtained from T_2 whereas, in open field (T_0) minimum marketable fruit yield per hectare (18.9 t) was obtained (Fig 9).

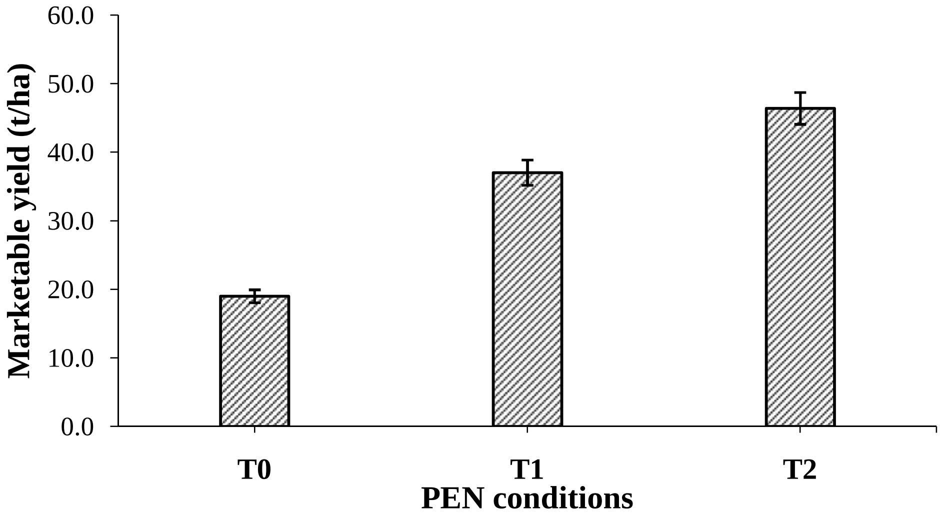


Fig. 9.Influence of different PEN conditions on marketable yield of brinjal
(Here, T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting ; T_2: 40 mesh pest exclusion netting)

It was found significantly different under both the netting conditions and of the different brinjal varieties (Appendix VIII). Maximum marketable fruit yield (51.4 t/ha) was produced by narsingdhi variety under T_2 condition (V_1T_2) and minimum marketable fruit yield (17.7 t/ha) was produced in V_1T_0 (Table 16)

Table 16.Combined effect of varieties and PEN conditions on gross yield per hectare and marketable yield per hectare of brinjal

Treatment combinations[X]	Gross yield t/ha[Y]	Marketable yield t/ha[Y]
V_1T_0	57.7 b	17.7 d
V_1T_1	58.4 b	42.2 b
V_1T_2	60.5 a	51.4 a
V_2T_0	42.4 h	19.5 d
V_2T_1	44.3 g	34.3 c
V_2T_2	46.1 f	40.4 b
V_3T_0	48.1 e	19.8 d
V_3T_1	50.2 d	34.6 c
V_3T_2	52.2 c	47.4 a
CV%	1.58	6.97
$LSD_{0.05}$	1.40	4.12

[X]Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety
T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting
[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.1.15 Marketable yield reduction percentage

Significant variation among brinjal varieties was found on marketableyield reduction percentage (Appendix VIII). Maximum marketable yield reduction (37.5%) was found in Narsingdhi variety (V_1) whereas minimum yield reduction per hectare (29.8%) was found in V_2 (Table 17).

Significant variation was found in marketable yield reduction percentage under different pest exclusion netting conditions (Appendix VIII). Maximum marketable yield reduction (60.8%) was found in open field (T_0) and minimum marketable yield reduction (12.3%) was found under T_2 (Table 18).

Significant variation was found in case of interaction between different brinjal varieties and different netting conditions on marketable yield reduction percentage (Appendix VIII). Maximum marketable yield reduction (69.4%) was found in

V_1T_0whereas minimum marketable yield reduction (9.2%) was found in V_3T_2which is statistically similar with V_2T_2(12.5%) (Table 19).

4.1.16 Pest population percentage

Significant variation among the brinjal varieties in population percentage per plot (Appendix VIII). Maximum population (23.4%) was found in V_2 and minimum population (21.5%) was found in V_3 variety (Table 17)

Significant difference was revealed on population percentage per plot in case of open field and different netting conditions. (Appendix VIII). Maximum population (42.1%) was found in T_0 whereas minimum population (7.8 %) was found in T_2. (Table 18) Preliminary data based on pheromone trap catches indicated activity of moths inside net houses to be 82-100% lower than in open field (Majumdar and Powell, 2010)

In case of combined effect of brinjal varieties and netting conditions, significant variation also found in case of population per plot (Appendix VIII). Maximum pest population (43.8%) was found in V_1T_0 which is statistically similar with V_2T_0 (44.8%) and minimum population (6.4%) was found in V_1T_2 (Table 19).

Table 17.Performance of different varieties on marketable yield reductionand pest population of brinal

Treatments^X	Marketable yield reduction (%)^Y		Pest population %^{Y}	
V_1	37.5	a	22.7	ab
V_2	29.8	b	23.4	a
V_3	33.1	ab	21.5	b
CV %	13.65		1.16	
$LSD_{0.05}$	4.57		5.13	

^{X}Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety

^{Y}In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 18.Influence of different PEN conditions on marketableyield reduction and pest population of brinjal

Treatments^X	Marketable yield reduction^Y		Pest population %^{Y}	
T_0	60.8	a	42.1	a
T_1	27.3	b	17.6	b

T_2	12.3 c	7.8 c
CV%	13.65	1.16
$LSD_{0.05}$	4.57	5.13

[X]Here, T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting
[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Table 19. Combined effect of varieties and PEN conditions on marketableyield reduction and pest population of brinjal

Treatment combinations[X]	Marketable yield reduction%	Pest population %
V_1T_0	69.4 a	43.8 a
V_1T_1	27.9 cd	17.8 cd
V_1T_2	15.1 ef	6.4 f
V_2T_0	54.1 b	44.8 a
V_2T_1	22.8 de	16.1 d
V_2T_2	12.5 f	9.3 e
V_3T_0	58.9 b	37.7 b
V_3T_1	31.2 c	19.1 c
V_3T_2	9.2 f	7.8 Ef
CV%	13.7	5.13
$LSD_{0.05}$	7.906	2.001

[X]Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety
T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting
[Y]In a coloumn, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2 Economic analysis

Input costs for land preparation, fertilizer, irrigation and manpower required for all the operations from seedling transplanting to harvesting of brinjal were recorded as per plot and converted into cost per hectare. Price of brinjal was considered as per market rate. The economic analysis is presented under the following headings –

4.2.1 Gross return

Thecombination of different brinjal varieties and PEN conditions showed different value in terms of gross return (Table 20). The highest gross return (Tk. 513800) was obtained from the treatment combination V_1T_2 and the lowest gross return (Tk. 176900) was obtained from V_1T_0 in first year and consecutive years.

4.2.2 Net return

In case of net return, different brinjal varieties and PEN conditions showed different levels of net return (Table 20). The highest net return (Tk. 346752.75) was found from V_1T_2 and the lowest net return (Tk. 30082.75) was obtained from the combination V_1T_0 for first year. From second year, the highest net return (Tk. 402997.75) was observed from V_1T_2 combination (Table 21).

4.2.3 Benefit cost ratio

In the combination of different brinjal varieties and PEN conditions, the highest benefit cost ratio (3.08) was noted from $V_1T_2$and the second highest benefit cost ratio (2.84) was estimated from the combination of V_3T_2. The lowest benefit cost ratio (1.21) was obtained from V_1T_0 in case of first year (Table 20). The highest benefit cost ratio (4.64) was noted from V_1T_2 and the lowest benefit cost ratio (1.33) was observed in case of V_1T_0 combination from second year (Table 21). Therefore, it is apparent that the combination of V_1T_2 was better than rest of the combination from economic point of view.

Table 20. Cost and return of brinjal grown under PEN for first year

Treatment combintions^X	Marketable yield (t/ha)	Gross return (Tk.)	Total cost of production (Tk.)	Net return (Tk.)	Benefit cost ratio (BCR)
V_1T_0	17.7	176900	146817.3	30082.75	1.21
V_1T_1	42.2	422200	164667.3	257532.75	2.56
V_1T_2	51.4	513800	167047.3	346752.75	3.08
V_2T_0	19.5	195200	146817.3	48382.75	1.33
V_2T_1	34.3	342700	164667.3	178032.75	2.08
V_2T_2	40.4	403500	167047.3	236452.75	2.42
V_3T_0	19.8	197700	146817.3	50882.75	1.35
V_3T_1	34.6	345800	164667.3	181132.75	2.10
V_3T_2	47.4	474400	167047.3	307352.75	2.84

^{X}Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety
T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting

Table 21. Cost and return of brinjal grown under PEN for second to fifth year(Approximate data calculation)

Treatment combintions[X]	Marketable yield (t/ha)	Gross return (Tk.)	Total cost of production (Tk.)	Net return (Tk.)	Benefit cost ratio (BCR)
V_1T_0	17.7	176900	132817.25	44082.75	1.33
V_1T_1	42.2	422200	110802.25	311397.75	3.81
V_1T_2	51.4	513800	110802.25	402997.75	4.64
V_2T_0	19.5	195200	132817.25	62382.75	1.47
V_2T_1	34.3	342700	110802.25	231897.75	3.09
V_2T_2	40.4	403500	110802.25	292697.75	3.64
V_3T_0	19.8	197700	132817.25	64882.75	1.49
V_3T_1	34.6	345800	110802.25	234997.75	3.12
V_3T_2	47.4	474400	110802.25	363597.75	4.28

[X]Here, V_1: Narsingdhi variety ; V_2 : Singnath variety ; V_3: Charki variety
T_0: Open field or control treatment ; T_1: 20 mesh pest exclusion netting; T_2: 40 mesh pest exclusion netting

CHAPTER V

SUMMARY AND CONCLUSION

5.1 Summary

A research was conducted in the Horticulture farm of Sher-e-Bangla Agricultural University for avoiding use and harmful effect of chemical pesticides on brinjal cultivation during the period of November, 2015 to April, 2016. Three brinjal varieties *viz.* V_1; Narsingdhi, V_2 ; Singnath and V_3 ; Charki were produced under three different PEN conditions (T_0 ;Open field , T_1 ; 20mesh PEN and T_2;40mesh PEN). This two factorial experiment was laid in Split Plot Design with three replications.

All the collected data to the relevant parameters were arranged accordingly and analyzed to evaluate the performance of brinjal varieties under pest exclusion net. The findings of the experiment are summarized in this segment.

Significant variations were observed in respect of varieties as well as pest exclusion net conditions in case of all parameters like as following -

The tallest plant was found from V_2 (82.1 cm) and from T_2 (81.1 cm) whereas the shortest from V_3 (74.1 cm) and from T_0 (72.9 cm) at 75 days after transplanting. In case of treatment combination, tallest plant (86.7 cm) was found in V_2T_2 as well as the shortest plant (69.1 cm) was found in V_3T_0 at 75 days after transplantation.

The maximum number of leaves (32.7) was found from V_2 and minimum (28.8) from V_1 at 75 DAT. The maximum number of leaves (33.1) was found from T_2 and minimum from T_0 (27.8) with 75 days after transplanting. In case of combined effect, maximum number of leaves (37) was found from V_2T_2 and minimum (26.7) from V_1T_0 with 75 DAT.

The longest leaf was found from V_2 (23.9 cm) and T_2 (24.6 cm) whereas the shortest from V_1 (21.2 cm) and T_0 (20.4cm). Combined effect showed maximum leaf length (25.7cm) in V_2T_2 and minimum (18.6cm) in V_1T_0.

Among the varieties of brinjal, maximum leaf width (17 cm) found on V_2 while minimum (15.5 cm) on V_3. In case of different PEN conditions, maximum leaf width (17.9 cm) was observed underT_2 and minimum (14.4 cm) inT_0. Combined effect gave maximum leaf width (18.6cm) in V_2T_2 and minimum (13.8cm) in V_1T_0.

The highest chlorophyll content (42.2%) observed from V_3 whereas the lowest (36.2%) from V_1. In case of PEN, maximum chlorophyll percentage (40.3) was found under T_2 and minimum (37.8) in T_0. In case of combination treatment, maximum chlorophyll percentage (43) was found in V_3T_2 and minimum (34.5) from V_1T_0.

Maximum branch number (24.7) and healthy branches (19.8) were produced in V_2 whereas minimum in $V_{3.}$ Under PEN, maximum branch number (25.7) and healthy branches (23.8) were found under T_2 and minimum in T_0. Combined effect showed maximum branch number (29.7) and healthy branches (27.5) in V_2T_2 and minimum in $V_1T_{0.}$ Again, infested branch number (5.1) and infestation (38.6%) were highest in $V_3$and lowest in V_1. In case of PEN conditions, highest infested branch number (9.9) and infestation (76.4%) in T_0 and lowest in T_2. In combined effect, highest infested branch number (10.7) and infestation (88.7%) were found from V_1T_0 and lowest from V_1T_2.

Maximum number of flowers (57) was found in V_1 and minimum (22) in V_3. Under PEN treatment, maximum number of flowers (49.7) was found in T_2 and minimum (32.7) in T_0. Combined effect of varieties and PEN, maximum number of flowers (73.3) was found in V_1T_2 and minimum (18.7) in V_3T_0.

Maximum number of fruits per plant (34.6) was found in V_1 and T_2 (21.5) whereas minimum (9.6) in V_3 and T_0 (19.9). In case of combination treatment, maximum number of fruits (35.6) was found in V_1T_1 and minimum (8.73) in V_3T_1.

Again, infested fruit number was maximum in V_1 (12.2) and minimum in $V_{3.}$ Under PEN, maximum number of infested fruits (12.5) was found in T_0 whereas minimum (3.9) in T_2. In case of combined effect, maximum number of infested fruit (21.6) was found in V_1T_0 and minimum (2.28) in V_2T_2.

Longest fruit (25 cm)was found in V_2 while the shortest fruit (9.2 cm) in $V_{3.}$ In case of PEN treatment, maximum fruit length (18.2 cm) was observed under T_2 and minimum (14.9 cm) in T_0. In combined effect, maximum fruit length (26.8cm) was found in V_2T_2 and minimum in V_3T_0.

Maximum fruit diameter was recorded in V_3(74.7mm) and T_2(56.4mm) and the smallest in V_2 (33.6mm) and T_0 (48.7mm).The combination between treatments indicated that maximum fruit diameter (77.7mm) was found from V_3T_2 and minimum (27.4 mm) from V_2T_0.

Maximum individual fruit weight (244.8g) was found in V_3 and minimum (59.3g) in V_1. In case of different PEN conditions, maximum individual fruitweight (134.7g) was found in T_2 and minimum (126.6g) in T_0. In case of combined effect, maximumindividual fruit weight (252.3g) was found in V_3T_2 and minimum (57.5g) in V_1T_0.

Significant variation was observed among the brinjal varieties in respect to yield per hectare. The highest gross yield (58.9 t/ha) was found from V_1 and the lowest (44.3t/ha) from V_2. In case of different PEN conditions, maximum gross yield per hectare (52.9 t/ha) was obtained from T_2 whereas minimum (49.4 t/ha) from T_0. In case of combined effect, maximum gross yield (60.5 t/ha) was obtained from V_1T_2 whereas minimum (42.42 t/ha) from V_2T_0.

Among brinjal varieties, maximum marketable yield (37.1 t/ha) was found on V_1 and minimum (31.4 t/ha) from V_2. Under PEN-house, highest marketable yield(46.4 t/ha) was obtained from T_2 whereas lowest in T_0(18.9 t/ha). In treatment combination, maximum marketable yield (51.4t/ha) was produced in V_1T_2 and minimum (17.7 t/ha) in V_1T_0.

Maximum marketable yield reduction percentage (37.5) was found in V_1 whereas minimum (29.8) was found in V_2. Under PEN house, maximum marketable yield reduction percentage (60.8) was found in T_0 and minimum (12.3) under T_2. Significant variation was found in case of combined effect of brinjal varieties and PEN conditions on yield reduction. Maximum marketable yield reduction (69.4%) was found in V_1T_0whereas minimum (9.2%) in V_3T_2.

Maximum pest population (23.4%) was found in $V_2$and minimum (21.5%) in V_3. In case of PEN, maximum pest population (42.1%) was found in T_0 whereas minimum (7.8%) in T_2. In case of combined effect, maximum pestpopulation (43.8%) was found in V_1T_0 and minimum infestation (6.4%) was found inV_1T_2.

From economic analysis, significant variation was observed in case of benefit cost ratio for first and consecutive years in respect of treatment combinations. Maximum BCR was found in V_1T_2 (3.08) whereas minimum in V_1T_0 (1.21) in first year and so on.

5.2 Conclusion

From the result and discussion it can be concluded that the brinjal varietiesgrown under pest exclusion net conditions (with and without) showed significant variation in the studied characteristics. As infested fruits have no market value, marketable yield will be reduced. This yield reduction can be minimized through using 40 mesh PEN instead of open field (T_0) cultivation without using pesticides. According to result, highest marketable yield was obtained from Narsingdhi variety under 40 mesh pest exclusion net conditions and other varieties also produced higher marketable yield under 40 mesh PEN conditions compared to open field condition. So, 40 mesh pest exclusion netting can be used to get chemical free, fresh and safe brinjal which is also economically viable for brinjal production in Bangladesh.

5.3 Suggesations

It is clear from the preceding discussion that the net house vegetable production system is not a 'silver bullet' solution to all pest problems. But, PEN house vegetable production provides many insect control advantages as well as disease management challenges which can be resolved with continued research.

CHAPTER VII
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APPENDICES

Appendix I. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period from November, 2015 to April, 2016

Month	*Air temperature (^oC)		*Relative humidity (%)	*Rainfall (mm) (total)
	Maximum	Minimum		
November,2015	25.82	16.04	78	0
December, 2015	22.4	13.5	74	0
January, 2016	24.5	12.4	68	0
February, 2016	27.1	16.7	67	30
March, 2016	31.4	19.6	54	11
April, 2016	33.7	21.3	58	20

*Monthly average,

*Source: Bangladesh Meteorological Department (Climate & weather division) Agargaon, Dhaka-1207

Appendix II. Analysis of variance on plant height at different days after transplantingof brinjal

Source of Variation	Degrees of freedom	Mean Square for plant height (cm)				
		35DAT	45DAT	55DAT	65DAT	75DAT
Factor A (brinjal varieties)	2	32.00*	140.55*	147.60*	156.30*	159.62*
Factor B (PEN)	2	32.28*	142.73*	145.84*	140.93*	160.67*
Interaction (A×B)	4	0.83*	4.75*	4.70*	4.44*	5.40*
Error	16	0.066	0.871	1.382	1.040	1.949

***: Significant at 0.05 level of probability**

Appendix III. Analysis of variance on the number of leaves at different days after transplantingof brinjal

Source of Variation	Degrees of freedom	Mean Square for Number of leaves				
		35DAT	45DAT	55DAT	65DAT	75DAT
Factor A (brinjal varieties)	2	23.60*	18.04*	42.48*	30.48*	34.78*
Factor B (PEN)	2	133.82*	66.93*	58.93*	75.15* `	64.33*
Interaction (A×B)	4	0.93 *	2.59*	2.32*	3.26*	6.44*
Error	16	1.718	3.384	3.912	2.731	1.569

***: Significant at 0.05 level of probability**

Appendix IV. Analysis of variance of the data of leaf length, leaf width and chlorophyll % of brinjal

Source of Variation	**Degrees of freedom**	**Mean Square of**		
		Leaf length	**Leaf Width**	**Chlorophyll %**
Factor A (brinjal varieties)	2	17.25*	4.93*	79.34*
Factor B (PEN)	2	40.33*	29.26*	15.09*
Interaction (A×B)	4	0.81*	0.21*	0.44*
Error	16	0.222	0.048	0.204

***: Significant at 0.05 level of probability**

Appendix V. Analysis of variance of the data on no. of branches/plant, healthy branches/plant, infested branches/plant and infestation % of brinjal

Source of Variation	Degrees of freedom	Mean Square of			
		Total Branches/ plant	Healthy branches/ plant	Infested branches/ plant	Infestation %
Factor A (brinjal varieties)	2	115.04*	120.56*	0.31*	562.34*
Factor B (PEN)	2	343.95*	1001.74*	173.68*	13201.38*
Interaction (A×B)	4	0.49*	2.93*	1.40*	433.45*
Error	16	0.300	0.587	0.162	10.927

***: Significant at 0.05 level of probability**

Appendix VI. Analysis of variance of the data on number of flowers / plant, number of fruits /plant, number of infested fruits /plant of brinjal

Source of Variation	**Degrees of freedom**	**Mean Square of**		
		No. of flowers/ plant	**No. of fruits / plant**	**No. of Infested fruits/ plant**
Factor A (Brinjal variety)	2	2772.65*	1455.54*	89865.92*
Factor B (PEN)	2	677.65*	5.34*	149.35*
Interaction (A×B)	4	89.82*	2.91*	28.39*
Error	16	1.335	3.117	0.916

***: Significant at 0.05 level of probability**

Appendix VII. Analysis of variance of the data on fruit length (cm), fruit diameter (mm), single fruit weight (g) of brinjal

Source of Variation	Degrees of freedom	Mean Square of		
		Fruit length (cm)	Fruit diameter (mm)	Single fruit weight (g)
Factor A (Brinjal varieties)	2	577.73*	3839.67*	89865.92*
Factor B(PEN)	2	24.67*	139.22*	149.35*
Interaction (A×B)	4	1.38*	6.50*	28.39*
Error	16	0.037	0.406	0.916

***: Significant at 0.05 level of probability**

Appendix VIII. Analysis of variance of the data ongross yield, marketableield, marketable yieldreduction and pest population of brinjal

Source of Variation	Degrees of freedom	Mean Square of			
		Gross yield/ha (ton)	Marketable yield/ha (ton)	Yieldredu ction (%)	Pest population %
Factor A (brinjal varieties)	2	484.67*	73.90*	134.42*	7.73*
Factor B (PEN)	2	28.10*	1745.15*	5563.70*	2813.19*
Interaction (A×B)	4	0.59*	42.35*	64.95*	24.82*
Error	16	0.655	5.668	20.865	1.337

***: Significant at 0.05 level of probability**

Appendix IX. Production cost of brinjal per hectare for first year (contd.)

1.Input Cost (Tk.)							
1.A Non Material cost (Tk.)							
Treatment combinations	**Seedbed & land preparation**	**PEN house preparation**	**Manure, Fertilizer &Pesticide application**	**Seed sowing**	**Inter cultural operation**	**Harvesting**	**Sub total 1(A)**
V_1T_0	6300	0	20100	3000	12000	4500	45900
V_1T_1	6300	3500	2100	3000	12000	4500	31400
V_1T_2	6300	3500	2100	3000	12000	4500	31400
V_2T_0	6300	0	20100	3000	12000	4500	45900
V_2T_1	6300	3500	2100	3000	12000	4500	31400

V_2T_2	6300	3500	2100	3000	12000	4500	31400
V_3T_0	6300	0	20100	3000	12000	4500	45900
V_3T_1	6300	3500	2100	3000	12000	4500	31400
V_3T_2	6300	3500	2100	3000	12000	4500	31400

Labour cost @ Tk. 300/day
V_1: Narsingdhi variety
V_2 : Singnath variety
V_3: Charki variety

Rent of machinery @ Tk. 300/day
T_0: Open field or control treatment
T_1: 20 mesh pest exclusion netting
T_2: 40 mesh pest exclusion netting

Appendix IX. Production cost of brinjal per hectare for first year (contd.)

1. Input Cost (Tk.)							
1.B Material cost (Tk.)							
Treatment combinations	**Seed (125 g/ha)**	**Net & other materials for PEN house**	**Manure & Fertilizers**	**Insecticides**	**Irrigation**	**Sub total 1(B)**	**Total Input cost 1(A)+1(B)**
V_1T_0	7500	0	56375	500	1000	65375	111275
V_1T_1	7500	30000	56375	0	1000	94875	126275
V_1T_2	7500	32000	56375	0	1000	96875	128275
V_2T_0	7500	0	56375	500	1000	65375	111275
V_2T_1	7500	30000	56375	0	1000	94875	126275
V_2T_2	7500	32000	56375	0	1000	96875	128275
V_3T_0	7500	0	56375	500	1000	65375	111275
V_3T_1	7500	30000	56375	0	1000	94875	126275
V_3T_2	7500	32000	56375	0	1000	96875	128275

Cowdung @ Tk. 2000/t
Urea @ Tk. 25/Kg
T.S.P. @ Tk. 30/Kg
M.P. @ Tk. 30/Kg
Gypsum @ Tk. 50/Kg

Brinjal seed @ Tk. 60/g

Appendix IX. Production cost of brinjal per hectare for first year

2.Overhead Cost (Tk.) and Total cost of production					
Treatment combinations	**Tax of land**	**Miscellaneous cost (5% of input cost)**	**Interest on running capital for 6 months (14% of total input cost)**	**Total overhead cost**	**Total cost of production 1+2 (Tk./ha)**
V_1T_0	400	5563.75	29578.5	35542.25	146817.3
V_1T_1	400	6313.75	31678.5	38392.25	164667.3
V_1T_2	400	6413.75	31958.5	38772.25	167047.3
V_2T_0	400	5563.75	29578.5	35542.25	146817.3
V_2T_1	400	6313.75	31678.5	38392.25	164667.3
V_2T_2	400	6413.75	31958.5	38772.25	167047.3
V_3T_0	400	5563.75	29578.5	35542.25	146817.3
V_3T_1	400	6313.75	31678.5	38392.25	164667.3

Appendix X. Production cost of brinjal per hectare for second to fifth year(Approximate)

1.Input Cost (Tk.)							
1.A Non Material cost (Tk.)							
Treatment combinations	**Seedbed & land preparation**	**PEN house preparation**	**Manure, Fertilizer &Pesticide application**	**Seed sowing**	**Inter cultural operation**	**Harvesting**	**Sub total 1(A)**
V_1T_0	6300	0	20100	3000	12000	4500	45900
V_1T_1	6300	0	2100	3000	12000	4500	27900
V_1T_2	6300	0	2100	3000	12000	4500	27900
V_2T_0	6300	0	20100	3000	12000	4500	45900
V_2T_1	6300	0	2100	3000	12000	4500	27900
V_2T_2	6300	0	2100	3000	12000	4500	27900

V_3T_0	6300	0	20100	3000	12000	4500	45900
V_3T_1	6300	0	2100	3000	12000	4500	27900
V_3T_2	6300	0	2100	3000	12000	4500	27900

Labour cost @ Tk. 300/day Rent of machinery @ Tk. 300/day

V_1: Narsingdhi variety T_0: Open field or control treatment
V_2 : Singnath variety T_1: 20 mesh pest exclusion netting
V_3: Charki varietyT_2:40 mesh pest exclusion netting

Appendix X. Production cost of brinjal per hectare for second to fifth year (contd.)

1. Input Cost (Tk.)							
1.B Material cost (Tk.)							
Treatment combinations	**Seed (125 g/ha)**	**Net for PEN house**	**Manure & Fertilizers**	**Insecticides**	**Irrigation**	**Sub total 1(B)**	**Total Input cost 1(A)+1(B)**
V_1T_0	7500	0	56375	500	1000	65375	98675
V_1T_1	7500	0	56375	0	1000	64875	91275
V_1T_2	7500	0	56375	0	1000	64875	91275
V_2T_0	7500	0	56375	500	1000	65375	98675
V_2T_1	7500	0	56375	0	1000	64875	91275
V_2T_2	7500	0	56375	0	1000	64875	91275
V_3T_0	7500	0	56375	500	1000	65375	98675
V_3T_1	7500	0	56375	0	1000	64875	91275
V_3T_2	7500	0	56375	0	1000	64875	91275

Cowdung @ Tk. 2000/t Brinjal seed @ Tk. 60/g
Urea @ Tk. 25/Kg
T.S.P. @ Tk. 30/Kg
M.P. @ Tk. 30/Kg Gypsum @ Tk. 50/Kg

Appendix X. Production cost of brinjal per hectare for second to fifth year

2.Overhead Cost (Tk.) and Total cost of production					
Treatment combinations	**Tax of land**	**Miscellaneous cost (5% of input cost)**	**Interest on running capital for 6 months (13% of total input cost)**	**Total overhead cost**	**Total cost of production 1+2 (Tk./ha)**
V_1T_0	400	5563.75	15578.5	21542.25	132817.3
V_1T_1	400	6313.75	12988.5	18027.25	110802.3
V_1T_2	400	6413.75	12988.5	18027.25	110802.3
V_2T_0	400	5563.75	15578.5	21542.25	132817.3
V_2T_1	400	6313.75	12988.5	18027.25	110802.3
V_2T_2	400	6413.75	12988.5	18027.25	110802.3
V_3T_0	400	5563.75	15578.5	21542.25	132817.3
V_3T_1	400	6313.75	12988.5	18027.25	110802.3
V_3T_2	400	6413.75	12988.5	18027.25	110802.3