VARIETAL PERFORMANCE OF CHILLI AGAINST MAJOR SUCKING PESTS

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CERTIFICATE

This is to certify that the thesis entitled **'Varietal Performance of Chilli Against Major Sucking Pests'** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of Master of Science in Entomology, embodies the result of a piece of *bonafide* research work carried out by **Md. Emdadul Haque Sarkar**, Registration number: **09-03516** 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 duly been acknowledged.

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DEDICATED

TO

MY BELOVED PARENTS

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ABSTRACT

The study was conducted at the research farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from May to August 2014 to study the host preferences of sucking pest on different varieties of chillies. The study comprised with eight varieties of the chilli varieties which are- BARI-I, BARI-II, Bindu, Balujuri, Augnikonna, Black Lady, Jhal Morich and Surjamukhi. Data was recorded on number of sucking pests/plant at early, mid and late growing stage, fruiting status in terms of healthy, infested fruits and infestation level in number and weight basis, yield contributing characters and yield. Aphid, jassid, white fly, mite and mealy bug were found in all growing stage. The lowest number of aphids/plant was recorded from BARI II and the highest number from Black Lady. At entire fruiting stage, the highest number of healthy fruits/plant (46.40) was recorded from BARI II, while the lowest number (39.20) from Jhal Morich. The lowest number of infested fruits/plant (1.80) was recorded from BARI II, whereas the highest number (3.27) from Black Lady. The lowest fruit infestation/plant (3.74%) was recorded from BARI II, whereas the highest (7.16%) from Black Lady. At entire fruiting stage, the highest weight of healthy fruits/plant (378.52 g) was recorded from BARI II, whereas the lowest weight (283.97 g) from Surjamukhi. The lowest weight of infested fruits/plant (16.29 g) was recorded from BARI II, whereas the highest weight (28.45 g) from Black Lady. The lowest fruit infestation/plant (4.24%) was recorded from BARI II, whereas the highest (8.55%) from Black Lady. The longest plant (95.28 cm) was found from BARI I, while the shortest plant (81.04 cm) from Jhal Morich. The maximum number of fruits/plant (51.73) was recorded from BARI II, while the minimum number (43.07) from Jhal Morich. The highest weight of individual fruit (8.12 g) was found from BARI II, while the lowest (7.15 g) from Augnikonna. The highest fruit yield (17.50 t/ha) was found from BARI II and the lowest (13.07 t/ha) from Jhal Morich.

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CHAPTER I

INTRODUCTION

Chili (*Capsicum annuum* L.) belongs to the family Solanaceae is a spice crop and also used as vegetable which was widely cultivated throughout the world (Dias *et al*., 2013; Wahyuni *et al*., 2013). It is originated from South and Central America. Chili, of the genus *Capsicum*, has more than 25 species with four cultivars groups that are: *chinense* group (West Indies chili), *frutescens* group (bird chili), *annuum* group (hot chili) and sweet pepper group (Nsabiyera *et al*., 2013). Throughout the world, chili is generally consumed either in fresh, dried or in powder (El-Ghoraba *et al*., 2013).

Although chilli is grown as a cash crop in all parts of Bangladesh but its commercial production is largely concentrated in the district of Bogra, Rangpur, Comilla, Noakhali, Faridpur, Chittagong and Mymensingh (Mustafiz, 1999). In Bangladesh 434,757 acres land is under its cultivation and total production of green chilli was approximately 1549,474 metric tonnes (BBS, 2014). Chilli is rich in proteins, lipids, carbohydrates, fibres, mineral salts (Ca, P, Fe) and in vitamins A, D_3, E, C, K, B_2 and B_{12} (El-Ghoraba *et al*., 2013). The fruits are an excellent source of health-related phytochemical compounds, such as ascorbic acid (vitamin C), carotenoids (provitamin A), tocopherols (vitamin E), flavonoids, and capsaicinoids that are very important in preventing chronic diseases such as cancer, asthma, coughs, sore throats, toothache, diabetes and cardiovascular diseases (El-Ghoraba *et al*., 2013; Wahyuni *et al*., 2013). Moreover, the consumption of fresh fruits facilitates starchy food digestion in human body (Bhattacharya *et al*., 2010). Generally, it has antioxidant, anti-mutagenesis, hypocholesterolemic and immunosuppressive properties (El-Ghoraba *et al*., 2013) and also inhibits bacterial growth and platelet agglomeration (Wahyuni *et al*., 2013).

At global level, chili is one of the spices that generate huge revenues for producers and therefore contributes to poverty alleviation and improvement of women's social status (Karungi *et al*., 2013). Despite its economic, food and medicinal importance, chili remains in many countries a neglected crop that is rarely of national priority in terms of agricultural development (FAO, 2010). Therefore, its cultivation is still traditional and is facing many biotic (Pests, diseases), and abiotic (drought, high soil moisture, salinity, soil poverty, etc.) stresses that cause severe yield losses (Khan *et al*., 2009; Segnou *et al*., 2013; Zhani *et al*., 2013). In Bangladesh the yield of chilli is very low (1.44 t/ha) and such low yield however is not an indication of low yielding potentially of this crop, but the fact of that the low yield may be attributed to such biotic and abiotic factors. Among the different constraints that lower chilli productivity, the pest complex that attacks chilli at different crop stages is important.

Chilli is susceptible to insect attack from seedling to fruiting stage. All parts of the plant including leaves, stems, flowers and fruits are subjected to attack (HDRA, 2000). About 51 species of insects and 2 species of mites belonging to 27 families under 9 orders along with snail and two species of millipedes are known to damage chilli crop both in the nursery and main field. Among these pests' aphids, fruit borers, thrips, mites are of serious in nature (Muthukrishnan *et al*., 1990, Shahjahan and Ahmed, 1993). The major sucking insects that attack chilli are mites (*Polyphagotarsonemus latus* Banks), thrips (*Scirtothrips dorsalis* Hood) and aphid (*Myzus persicae* Sulzer and *Aphis gossypii* Glover) (Jayewar *et al*., 2003). These sucking pests cause both qualitative and quantitative losses in chilli in the field. The yield losses range from 50-90% due to insects pests of chilly (Nelson and Natrajan, 1994 and Kumar, 1995). The yield loss due to chilli thrips and mites is estimated to be tune of 50% (Ahmed *et al*., 1987; Kandasamy *et al*., 1990). An overall reduction in the yield of chilli due to arthropod pests was upto 77 per cent and the joint infestation of thrips and mites caused losses upto 34 per cent (HDRA, 2000). The infestation of thrips was initiated in the fourth week of July and remained continue upto fourth week of November.

Due to variation in the agro climatic conditions of different regions insects show varying trends in their incidence also in nature and extent of damage to the crop

(Bourland *et al*., 2003). Due to monoculture of chilli in major growing areas, the pests build up is so extreme that farmers have to resort different control measures. In developing countries, mainly insecticides are used to control insect pests known as the most important chili enemies (Segnou *et al*., 2013). However, insecticides are generally very costly for the majority of resource poor small-scale producers (Segnou *et al*., 2013) and their utilisation has negative impacts on human health and on the environment (Devine and Furlong, 2007). In that context and for many other factors such as drought, salinity and high moisture content, biological control through use of resistant or adapted varieties is recommended (Houimli *et al*., 2008; Truong *et al*., 2013). Such varieties can be developed or simply searched for within the existing environmental diversity. In both cases, a good knowledge of the existing varietal diversity and of the agronomic performances is necessary (Ajjapplavara, 2009; Melendez *et al*., 2009; Nsabiyera *et al*., 2013). Moreover, better orientation of improvement programs also calls for mastering production constraints and farmers' varietal preference criteria (Dansi *et al*., 2010; Zhang *et al*., 2012).

In Bangladesh, very few research works have been done mainly on approaches for the assessment of variety preference of sucking pests of chillies, their incidence level and so that the yield of chilli. Considering the above condition, the present piece of research work has been undertaken with fulfilling the following objectives-

i. To evaluate the potentiality of different varieties of chilli against sucking pests;

ii. To assess the damage of different chilli varieties while attacked by sucking pests.

CHAPTER II

REVIEW OF LITERATURE

Chilli is one of the important spices crop in Bangladesh and as well as many countries of the world although the crop has conventional less attention by the researchers on various aspects because normally it grows without or minimum care or management practices. There are many insects pests of chilli among them aphids, jassid, white fly, fruit borers, thrips, mites, mealy bug etc. are of serious is considered as the damaging one and has profound effect on chilli production in Bangladesh. Among them aphid, jassid, white fly, mite and mealy bug are the major sucking pests of chilli. Variety/genotypes play an important role in improving yield through creating varietal resistance against insect pests. But research works related to varieties on chilli in relation to create insect pest defense mechanisms are limited in Bangladesh as well as the World. The research work so far done in Bangladesh and else where is not adequate and conclusive. Nevertheless, some of the important and informative works and research findings related so far been done at home and abroad have been reviewed in this chapter under the following headings-

2.1 Sucking pests of chilli

2.1.1 Aphids

There are six species of aphids that damage crops. These species include *Rhopalosiphum padi, Schizaphis graminurn, Sitobion avenae, Metopoliphiurn dirhodum, R. Maidis* and *Diuraphis noxia.* Two of those species commonly known as Russian Aphid (*Diuraphis noxia*) and Bird Cherry-Oat Aphid (*Rhopalosiphum padi*) are considered notorious for their direct and indirect losses.

Aphid is known to be a sporadic insect causing significant yield losses by spreading out from its origin. The centre of origin for aphid is considered to be the central Asian mountains of Caucasus and Tian Shan. The specie could now be found in Asia, South Africa, Western United States, Central and Southern Europe and Middle East. The economic impact of aphid include direct and indirect losses that have been estimated to be $893 million in Western United States during 1987 to 1993 (Morrison and Peairs, 1998) whereas 37% yield losses in winter have been reported in Canadian Prairies. Direct losses have also been assessed as an increased input cost due to insecticides and indirect losses include reduced yield due to aphid infestation.

Climatic conditions and temperature in particular, plays a significant role in population dynamics of the aphids. A warmer temperature can potentially accelerate the aphid's growth both in terms of number and size, yet, the extreme temperatures can possibly reduce the survival and spread of Aphids. Aphid is known to be present in its three different morphological types: immature wingless females, mature wingless females and mature winged females. Winged mature females or adults spread the population and infection to the surrounding host plants whereas the wingless types or apterous cause damage by curling and sucking the young leaves. Heavily infested plants may typically look prostrated and/or stunted with yellow or whitish streaks on leaves. These streaks, basically, are formed due to the saliva injected by the aphid (Morrison and Peairs, 1998). The most obvious symptoms due to heavy infestations can be reduced leaf area, loss in dry weight index, and poor cholorophyll concentration. Plant growth losses could be attributed mainly due to reduced photosynthetic activity to plants aphid infestation. The photochemical activities of the plants were reportedly inhibited by the aphid feeding from leaves and disruption in electron transport chain. Spikes can have bleached appearance with their awns tightly held in curled flag leaf. Yield losses can greatly vary due to infestation at different growth stages, duration of infestation and climatic conditions (wind patterns and temperature). A number of biotypes for aphid have been reported to be present throughout the cereal production areas of the world. These biotypes are classified due to significant genetic differences among them.

A number of strategies have been deployed to mitigate aphid. Among these strategies, the host plant resistance has been the most effective and economic method to induce antixenosis, antibiosis and/or tolerance against aphid. Its host plant resistance is well known to be qualitative in nature, and about nine resistance genes have been documented so far. A number of alternate methods to control this pest has been suggested and practiced that include cultural, biological and chemical control methods. Cultural control strategies involved eradication of volunteer and alternate host plants is generally recommended. Another strategy is grazing the volunteer plants which significantly reduce the aphid infestation (Walker and Peairs, 1998). Adjusting planting dates to de-synchronize the insect population dynamics and favourable environmental conditions of any particular area can also help to control aphid. The enhanced fertigation of infested field, and biological control of aphid is also possible with 29 different species of insects and 6 fungus species, of the predator insects, 4 different species of wasps have become adopted to United States. Besides these cultural practices, chemical control method is also widely practiced with equivocal cost efficiency.

2.1.1.1 Life cycle

Most aphids reproduce a sexually throughout most or all of the year with adult females giving birth to live offspring often as many as 12 per day without mating. Young aphids are called nymphs. They molt, shedding their skin about four times before becoming adults. There is no pupal stage. Some species produce sexual forms that mate and produce eggs in fall or winter, providing a more hardy stage to survive harsh weather and the absence of foliage on deciduous plants. In some cases, aphids lay these eggs on an alternative host, usually a perennial plant, for winter survival. When the weather is warm, many species of aphids can develop from newborn nymph to reproducing adult in seven to eight days. Because each adult aphid can produce up to 80 offspring in a matter of a week, aphid populations can increase with great speed in our climatic condition (Flint, 1998).

2.1.1.2 Nature of damage

Low to moderate numbers of leaf-feeding aphids aren't usually damaging in gardens or on trees. However, large populations can turn leaves yellow and stunt shoots; aphids can also produce large quantities of a sticky exudates known as honeydew, which often turns black with the growth of a sooty mold fungus. Some aphid species inject a toxin into plants, which causes leaves to curl and further distorts growth. A few species cause gall formations (Cannon, 2008).

Squash, cucumber, pumpkin, melon, bean, potato, lettuce, beet, chard, and bok choy are crops that often have aphid-transmitted viruses associated with them. The viruses mottle, yellow, or curl leaves and stunt plant growth. Although losses can be great, they are difficult to prevent by controlling aphids, because infection occurs even when aphid numbers are very low; it takes only a few minutes for the aphid to transmit the virus, while it takes a much longer time to kill the aphid with an insecticide.

2.1.2 Jassid

Jassid is a serious sucking pests of chilli. The female adult insect lays a number egg singly on leaf. Eggs are oviposited into veins and leaf petioles of the plant (Chaudhary *et al.*, 1980). The wingless nymphs feed on the plant while passing through several nymphal stages and later emerge as winged adults. Life cycles are completed in three to four weeks. Nymphs and adults generally feed on the underside of the leaf, sucking out the juice and injecting toxic saliva into the cells causing hopper burn. Infested plants are unthrifty and lack vigor and young plants may be stunted (Chhabra *et al*., 1981).

2.1.3 White fly

The whiteflies cause damage to plant by three means, (i) large population of nymphs and adults suck sap directly from plant greatly reduce yield, (ii) heavy colonization of *B. tabaci* can cause serious damage to crops due to honeydew excreted by all stages, particularly the late nymphal instars which encourages growth of “sooty mould” that affect yield both in quantity and quality and (iii) they reduce crop yield through transmission of viral diseases from crop to crop (Kajita and Alam, 1996).

The adult of whitefly is soft and pale yellow, change to white within few hours due to deposition of wax on the body and wings (Haider, 1996). Eggs are laid indiscriminately almost always on the under surface of the young leaves. The whitefly, *B. tabaci* is an important pest worldwide for many vegetable crops as well as chilli. The whiteflies are very small, fragile and active insects, jump from plant to plant with very slight disturbance and because of this there is great difficulty in handling them for management.

Brown and Bird (1992) have pointed out the increased prevalence as well as expanded distribution of whitefly borne viruses during the last decade and resulting devastating impact on crop growth and yield. Yield loss range from 20-100%, depending on the crop, season, vector prevalence and other factors during the growing season.

The whitefly acts as a mechanical vector of many viral diseases for different vegetable crops (Butani and Jotwani, 1984). Young plant may even die in case of severe infestation. The pest is active during the dry season and its activity decreases with the on set of rains. As a result of their feeding the affected parts become yellowish, the leaves become wrinkle, and curl downwards and eventually fallen off. This happens mainly due to viral infection.

The adult whitefly is a tiny soft bodied and pale yellow, change to white within a few hours due to deposition of wax on the body and wings (Haider *et al*., 1996). Eggs are laid indiscriminately almost always on the under surface of the young leaves (Hirano *et al*., 1993). The nymphs are pale, translucent white, oval, with convex dorsum and flat elongated ventral side. The whitefly adults and nymphs feed on the plant sap from the underside of the leaves. They secrete honeydew, which later helps the growth of sooty mould fungus thus reducing the photosynthetic area. The infested plants became weakened due to sucking of the plant sap from the leaves and also due to the reduction of photosynthesis of the infested plant parts (Naresh and Nene, 1980). The infested plant parts become yellowish, the leaves become wrinkle, curl downwards and eventually they fallen off. This happens mainly due to viral infection where the whitefly acts as a mechanical vector of many viral diseases.

2.1.4 Mealy bug

Another major sucking pest of chilli plant is mealybug. Mealybugs (Homoptera: Pseudococcidae) are cottony in appearance, small oval, soft-bodied sucking insects. Adult mealybugs are found on leaves, stems and roots and are covered with white mealy wax, which makes them difficult to eradicate. They form colonies on stems and leaves developing into dense, waxy, white masses. They suck a large amount of sap from leaves and stems with the help of piercing/sucking mouth parts, depriving plants of essential nutrients. The excess sap is excreted as honeydew which attracts ants and develops sooty mould inhibiting the plant's ability to manufacture food. Mealybugs are white to pink in colour and measure 3-4 mm in length. Mealybugs eggs as well as crawlers are pink in colour. The crawlers measure 0.3 mm in length. Immature females and newly matured females are greyish-pink which are dusted with mealy white wax. Adult females are 2.5-4.0 mm long, soft-bodied, elongate oval and slightly flattened. Males have one pair of very simple wings, long antennae and white wax filaments projecting posteriorly with no mouthparts (Tanwar *et al*., 2007).

2.1.4.1 Mode of transport of mealy bug

Non-infected plants can be infected from infected plants as juvenile mealybugs can crawl from an infected plant to another plant. Small 'crawlers' are readily transported by wind, rain, birds, ants, clothing and vehicle and may settle in cracks and crevices, usually on new plants. The wax, which sticks to each egg, also facilitates passive transport by equipment's, animals or people. The female mealybug is not active and unable to fly. In fact, humans are great friends helping in transport of mealybugs. As the infested plant back the colonies of mealybugs migrate from shoot tips to twigs, branches and finally down the trunk. Long distance movement is most probable through carrying infested planting material and fresh fruit and vegetables across the country or even from one end of a farm to the other. Ants, attracted by the honeydew, have been seen carrying mealybugs from plant to plant (Tanwar *et al*., 2007).

2.1.4.2 Nature of Damage

Infested growing points become stunted and swollen which may vary depending upon the susceptibility of host species. Heavy clustering of mealybugs can be seen under leaf surface giving the appearance of a thick mat with waxy secretion. They excrete copious amount of honey dew that attracts ants and help in development of black sooty mould which inhibits the plants ability to manufacture food. Both nymphs and adults suck the sap from leaves causing withering and yellowing of leaves (Tanwar *et al*., 2007). Heavy infestation can cause defoliation and even death of the plant. Mealybugs also affect the development of flowers and stems.

2.1.5 Mite

Mites, along with ticks, are small arthropods belonging to the subclass Acari and the class Arachnida. The scientific discipline devoted to the study of ticks and mites is called acarology (Nyle and Weli, 2009).

Mites are among the most diverse and successful of all the invertebrate groups. They have exploited an incredible array of habitats, and because of their small size (most are microscopic), go largely unnoticed. Many live freely in the soil or water, but there are also a large number of species that live as parasites on plants, animals, and some that feed on mold. It is estimated that 48,200 species of mites have been described (Halliday *et al*., 2000).

Mites occupy a wide range of ecological niches. For example, Oribatid mites are important decomposers and occur in many habitats. They eat a wide variety of material including living and dead plant; some are even predatory, though no species of Oribatida mite are parasites (Arroyo *et al*., 2013).

2.2 Varietal performances of chilli on insect pests control

Dispersion of a new invasive thrips species in the United States, chilli thrips *Scirtothrips dorsalis* Hood, was studied by Kumar *et al*. (2014) on three plant hosts, i.e., cotton (*Gossypium hirsutum* L.), peanut (*Arachis hypogeal* L.) and pepper (*Capsicum annum* L.) in the greenhouse and under field conditions in Homestead, Florida. In the vertical distribution study, a strong negative relationship was observed between thrips density and height, with the significantly highest mean number of larvae and adults reported on host plants placed at the lowest height (45.7 cm) above ground. The study of horizontal distribution showed that S. dorsalis has weak dispersal potential and aggregates in open areas. During the entire six week study period, thrips were found to move a maximum of 12 m from their reservoir population. During two years of study, a high abundance of thrips population was observed during May-October with the highest mean count during July and August in both years. Flight activity of adults was highest between 10:00and16:00 EST, during peak solar radiation (~337-653 w/m^2). Results from these studies will help growers and extension personnel predict farm-scale distribution of *S. dorsalis* and efficiently monitor the pest for management before they become a serious problem for the vegetable and ornamental industry in the United States.

In order to document its diversity and identify the best performing varieties which could meet producers' and consumers' needs, surveys were conducted by (Orobiyi *et al*., 2013) in thirty-one villages randomly selected in southern Benin. Ten production constraints of agronomic nature were identified among which the most important were attacks of insects on fruits, viral infection, early fall of the plant's organs (leaves, flowers, fruits) and anthracnose. The number of varieties identified varies from 3 to 8 (5 on average) per village and from 1 to 7 (2 on average) per household. The distribution and extent analysis revealed that out of 5 varieties on average cultivated per village, only two are cultivated by many households and on large areas. The average rate of varietal diversity loss is 23.53% per village. Farmers' varietal preference criteria (17 in total) identified and prioritized were essentially agronomical characters (86.89% of the responses) and the most important were related to the post-harvest storage aptitude of the fruits, the productivity and the seed germination capacity. A participatory evaluation of the varieties has led to identification of the best performing ones per trait of economic importance. Throughout surveyed sites, 197 accessions of farmer-named landraces were collected and their agro-morphological characterization is recommended for clarification of synonymies and breeding purposes.

A field experiment was conducted by (Datta and Chakraborty, 2013) with fifty one chilli (*Capsicum annuum* L.) genotypes to study the growth, yield, quality characters, white fly and yellow mite incidence during Rabi season. Significantly the highest number of fruits per plant was recorded in genotype CA-29 (168.23) and it was lowest in genotype CA-2 (52.30) and it was statistically at par with genotypes CA-15 (56.09) and CA-43 (56.20). Like number of fruits per plant, the significantly highest fresh yield was recorded in CA-29 (14.58 t/ha). Higher fruit yield was also recorded in genotype CA-47 (13.35 t/ha) and CA-48 (13.18 t/ha). Ascorbic acid content in red ripe fruit varied from 75.89 to 167.21 mg/100 g fresh. Genotype CA-45 was almost free from white fly incidence and lower incidence was also recorded in genotype CA-43 (0.40/plant) followed by CA-23 (0.50/plant) and CA-21 (8.10/plant) was found most susceptible to white fly incidence. Among the different genotypes, CA-22, CA-24, CA-25, CA-27 and CA-30 were free from mite infestation where as CA-13 (13.60/leaf) was most susceptible to yellow mite incidence.

Mansour *et al*. (2013) carried out the study estimated the population abundance of *B. tabaci* on chilli, *Capsicum annuum* MC 11 alone, MC 11 planted with brinjal, *Solanum melongena* MT e1, tomato, *Lycopersicum esculentum* MT 1 or okra, *Abelmoschus esculentus* MK BE1 and MC 11 planted with a combination of all the other crops under glasshouse conditions. WF adults, egg and nymph samples were obtained every 4 days from the underside of the leaf (abaxial) on the upper, middle and lower strata of the plant for one month. The total mean numbers of WF adults, eggs and nymphs were significantly higher ($p<0.05$) on chilli in the monoculture experiment than on chilli in multiple crops experiment with okra, tomato and brinjal. Results also showed that the population of WF adults and eggs were significantly higher in the upper stratum than in the middle and lower plant strata. Interestingly, the number of nymphs was higher in the middle stratum than in the other strata in all treatments. This phenomenon indicated that mixed crops can lower pest populations and indirectly reduce virus disease incidence.

Incidence of thrips on different chilli entries was studied by Girish *et al*. (2012) in the field during 2008 on 23 entries evaluated for thrips infestation. Mean population of thrips ranged from 0.13 to 1.48 thrips/leaf and the corressponding damage score was zero (11 entries) to a maximum of 3.6 (Byadgi kaddi i.e. more than 50 per cent of leaves showing curling symptom). The per cent leaf curling ranged from 0 to 84 in highly susceptible entry Byadgi kaddi. Entries CA6, BVC 47, KNG 1 and CA 12 recorded less number of thrips per leaf, with no curling symptoms and were designated as promising and resistance to thrips infestation.

CHAPTER III
MATERIALS AND METHODS

The study was conducted to study the varietal performance of chilli against major sucking pests. The materials and methods were used for conducting the study has been presented in this chapter. It includes a short description of the study location, climate and soil conditions of the study area, materials used for the study, design of the study, data collection and data analysis procedure.

3.1 Description of the study location

3.1.1 Study period

The study was conducted during the period from May to August 2014.

3.1.2 Description of the study area site

The study was conducted at the research farm of Sher-e-Bangla Agricultural University (SAU), Dhaka. It was located in 24.09^0N latitude and 90.26^0E longitudes. The altitude of the location was 8 m above from the sea level as per the Bangladesh Metrological Department, Agargaon, Dhaka-1207.

3.1.3 Climatic conditions

The climate of the study area is subtropical, characterized by three distinct seasons, the monsoon from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October. The monthly average temperature, humidity and rainfall during the crop growing period were collected from Weather Yard, Bangladesh Meteorological Department, and presented in Appendix I. During the study period the maximum temperature (36.2^0C) was recorded from August, 2014 and the minimum temperature (23.2^0C) in the month of June, 2014. Highest relative humidity (83%) in the month of July, 2014 and the highest rainfall (563 mm) was recorded in the month of July 2014 and the highest sunshine hour (6.8) was recorded in the month of May, 2014.

3.1.4 Characteristics of soil

The soil of the study area belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ- 28) and the general soil type is Shallow Red Brown Terrace soil. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before the initiation of the study. The collected soil was air-dried, grind and passed through 2 mm sieve and analyzed at Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka for some important physical and chemical properties. The results have been presented in Appendix II.

3.2 Details of the study

3.2.1 Planting materials

Eight (8) varieties of chilli were used as the test crop of this study. The seeds of these chilli varieties were collected from Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur and Siddique bazar, Dhaka.

3.2.2 Treatments of the study

The study comprised with eight varieties and each variety considered as treatment. The name of the chilli varieties and treatments presented below:

Chilli varieties	Treatments
BARI-I	V_1
BARI-II	V_2
Bindu	V_3
Balujuri	V_4
Augnikonna	V_5
Black Lady	V_6
Jhal Morich	V_7
Surjamukhi	V_8

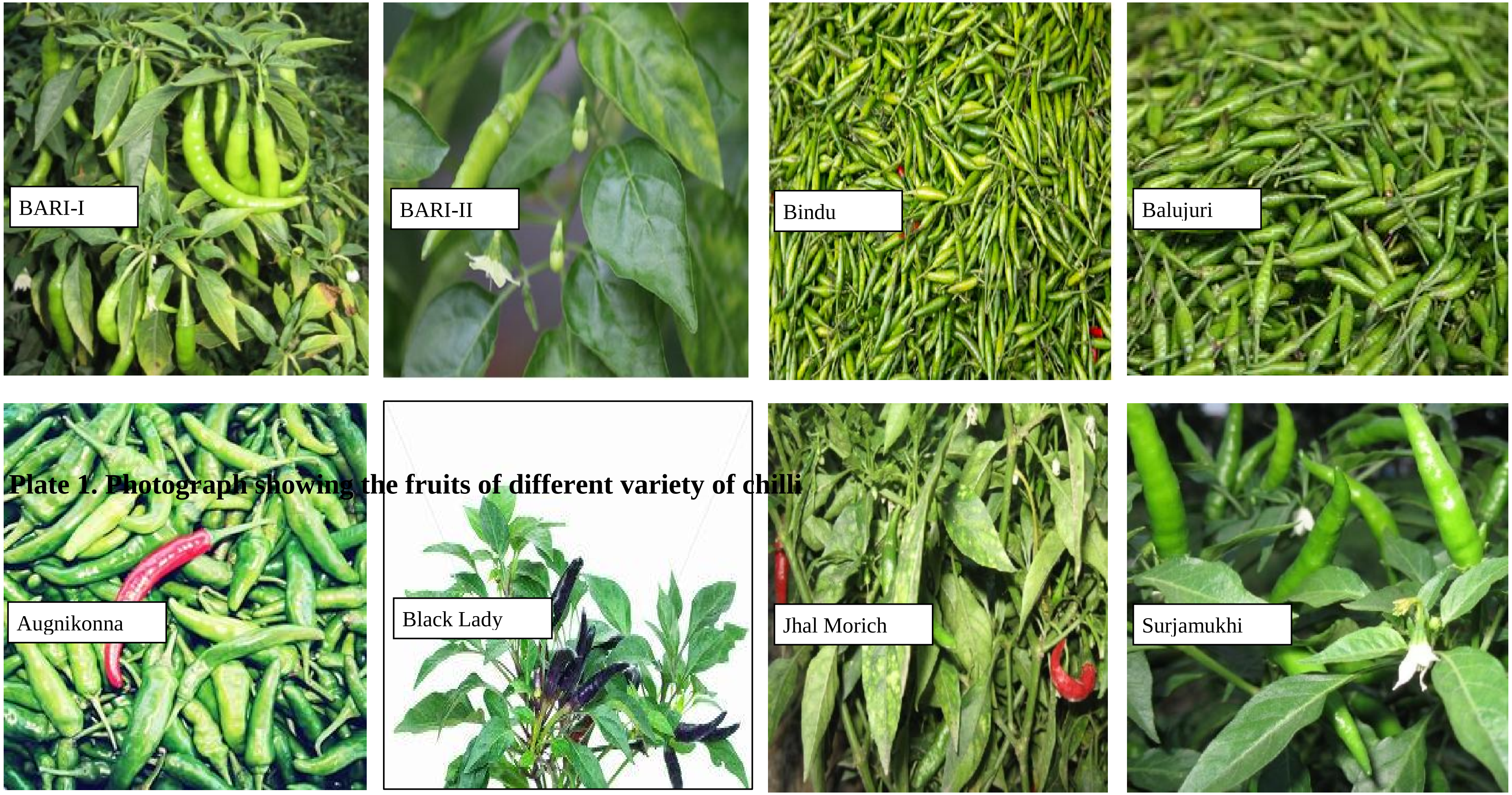


Plate 1. Photograph showing the fruits of different variety of chilli

3.2.3 Design and layout of the study

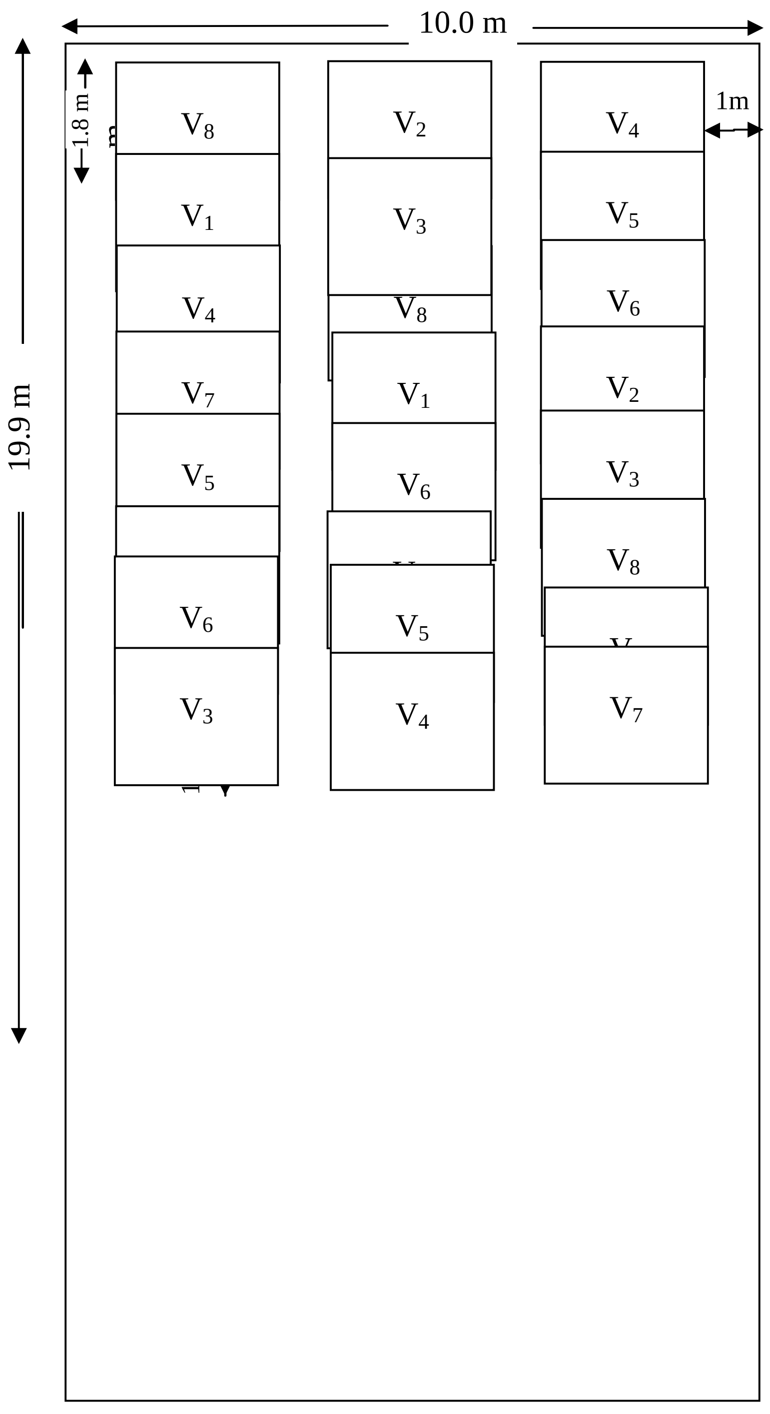
The study was laid out in Randomized Complete Block Design (RCBD) with three replications. The total area of the study plot was 199.0 m^2 with length 19.9 m and width 10.0 m. The total area was divided into three equal blocks. Each block was divided into 8 plots where 8 treatments combination were allotted at random. There were 24 unit plots and the size of each plot was 2.0 m × 1.8 m. The distance between blocks and plots was 1.0 m and 1.0 m, respectively. The layout of the study shown in Figure 1.

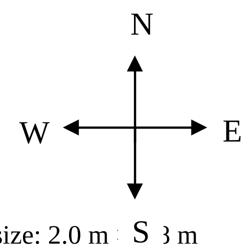
3.2.4 Raising of seedlings

Chilli seedlings were raised in seed beds of 3.0 m × 1.0 m size. The soil was well prepared and converted into loose friable and dried for seedbed. All weeds and stubbles were removed and well rotten cowdung was mixed with the soil. In each seed bed seeds were sown on 12th May 2014. After sowing, seeds were covered with light soil. Heptachlor 40 WP was applied @ 4 kg ha^{-1}, around each seedbed as precautionary measure against ants and worm. The emergence of the seedlings took place with 5 to 6 days after sowing. For healthy and uniform seedlings seed beds were watering when necessary and cleaned by removing weeds when emerged.

3.2.5 Land preparation

The plot selected for conducting the study was opened in the 1st week of June 2014 with a power tiller, and left exposed to the sun for a week. After one week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain until good tilth. Weeds and stubbles were removed, and finally obtained a desirable tilth of soil was obtained for transplanting chilli seedlings. The study plot was partitioned into unit blocks and blocks into unit plots in accordance with the design mentioned in Figure 1. Cowdung and chemical fertilizers as indicated below in 3.2.6 were mixed with the soil of each unit plot.





Plot size: 2.0 m × 1.8 m

Plot spacing: 50 cm

Between replication: 1.0 m

Treatments

- V_1: BARI-I
- V_2: BARI-II
- V_3: Bindu
- V_4: Balujuri
- V_5: Augnikonna
- V_6: Black Lady
- V_7: Jhal Morich
- V_8: Surjamukhi

3.2.6 Application of manure and fertilizers

Well decomposed cowdung (10 t/ha) was applied at the time of final land preparation. The sources of fertilizers used for N, P, K, S and Zn were urea (210 kg/ha), TSP (300 kg/ha), MoP (200 kg/ha), Gypsum (110 kg/ha) and Znic sulphate (15 kg/ha), respectively (Rashid, 1993). The entire amounts of TSP, MoP were applied during final land preparation. Only urea was applied in two equal installments at 30 and 60 Days after transplanting (DAT).

3.2.7 Transplanting of seedlings

Healthy and uniform size of chilli seedlings were uprooted separately from the seed bed and were transplanted in the study plots in the afternoon of 15th June, 2014 with maintaining 60 cm distance from row to row and 40 cm from plant to plant. This allowed an accommodation of 15 plants in each plot. The seed bed was watered before uprooting the seedlings from the seed bed so as to minimize damage to the roots. Seedlings were also planted around the border area of the study plots for gap filling.

3.2.8 Intercultural operations

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

3.2.8.1 Irrigation and drainage

Over-head irrigation was provided with a watering can to the plots as per necessary. Excess water from the plot was effectively drained out at the time of heavy rain.

3.2.8.2 Weeding

Weeding was done to keep the plots clean and easy aeration of soil which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully as per necessary.

3.2.8.3 Top dressing

Urea and MP was used as top-dressed as mentioned in Table 1. The fertilizers were applied on both sides of plant rows and mixed well with the soil. Earthing up operation was done immediately after top-dressing with fertilizer.

Plate 2. Photograph showing the experimental plots of chilli

3.3 Crop sampling and data collection

Five plants from each treatment were randomly marked inside the central row of each plot with the help of sample card.

3.4 Monitoring and data collection

The chilli plants of different treatment were closely examined at regular intervals commencing from transplanting to harvest. The following data were collected during the course of the study-

- Number of different sucking pests at different growing stages of chilli
- Number and weight of healthy fruits at different growing stages of chilli

- Number and weight of infested fruits at different growing stages of chilli
- Percent fruit infestation in number and weight basis at different growing stages of chilli
- Plant height at harvest (cm)
- Number of branches/plant at harvest
- Days to harvest
- Fruit length (cm)
- Fruit diameter (mm)
- Number of fruits/plant
- Individual fruit weight (g)
- Fruits yield per hectare (ton)

3.4.1 Monitoring of insect pests

The chilli plants were closely examined at regular intervals commencing from early, mid and late growing stage. Insects from 5 plants were recorded at weekly intervals in central rows at early, mid and late growing stage and converted per plant. The insect population was collected by a needle brush in a petridish. The entire period was divided into early, mid and late growing stage and the incidence of insect pests in chilli was measured.

3.4.2 Determination of fruit infestation in number

All the healthy and infested fruits were counted from 5 randomly selected plants from middle rows of each plot and examined. The collected data were divided into early, mid and late fruiting stage. The healthy and infested fruits were counted and the percent fruit damage was calculated using the following formula:

$$\text{Fruit infestation (\%)} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

3.4.3 Determination of fruit infestation in weight

All the healthy and infested fruits were weighted from 5 randomly selected plants from middle rows of each plot and examined. The collected data were divided into early, mid and late fruiting stage. The healthy and infested fruits were weighted and the percent fruit infestation was calculated using the following formula:

$$\text{Fruit infestation (\%)} = \frac{\text{Weight of infested fruit}}{\text{Total weight of fruit}} \times 100$$

3.5 Harvest and post harvest operations

Harvesting of fruit was done when the fruits attained marketable sized**.** The optimum marketable sized fruits were collected by hand picking from each plot and yield was converted into t/ha.

3.6 Procedure of data collection

3.6.1 Plant height at harvest

The plant heights of 5 randomly selected plants were measured with a meter scale from the ground level to the top of the plants and the mean height was expressed in centimeter (cm). Data were recorded from the inner rows plant of each plot during harvesting period.

3.6.2 Number of branches per plant at harvest

The total number of branches arisen from the stem of a plant was counted as the number of branches per plant at harvest.

3.6.3 Days to harvest

Difference between the dates of transplanting to the date of harvesting of fruits of fruit of a plot was counted. Days to harvest were calculated by deducting days of transplanting to the date of harvest.

3.6.4 Fruit length

The length of individual fruit was measured in one side to another side of fruit from five selected fruits with a meter scale and average of individual fruit length recorded and expressed in centimeter (cm).

3.6.5 Fruit diameter

The diameter of individual fruit was measured in several directions with a slide calipers and the average of all directions was finally recorded and expressed in millimeter (mm).

3.6.6 Number of fruits/plant

The number of fruits per plant was counted after harvesting of fruits and recorded per plant basis.

3.6.7 Individual fruit weight

Healthy fruits were collected from the ten randomly selected plants and were weighted by a digital electronic balance. The weight was expressed in gram (g).

3.6.8 Fruits yield per hectare

Fruits per plot were converted into hectare and the weight of fruits per hectare was calculated and expressed in ton.

3.7 Statistical analyses

The data on different parameters of chilli were statistically analyzed to find out the significant differences in relation to the performances of different chilli variety. The mean values of all the characters were calculated and analyses of variance were performed by the ‘F’ (variance ratio) test. The significance of the differences among the mean values of treatment in respect of different parameters was estimated by the Duncan’s Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The study was conducted to study the varietal performance of chilli against major sucking pests. Data was recorded on number of sucking pests/plant at early, mid and late growing stage, fruiting status in terms of healthy, infested fruits and infestation level in number and weight basis at early, mid and late fruiting stage and also yield contributing characters and yield of different varieties of chilli. The analysis of variance (ANOVA) of the data on different parameters has been presented in Appendix III-X. The results have been presented with the help of different Table, Graphs and possible interpretations given under the following headings and sub-headings:

4.1 Host preferences of sucking pests

4.1.1 At early growing stage

Number of aphid, jassid, white fly, mealy bug and mite/plant showed statistically significant variations due to different varieties of chilli at early growing stage (Appendix III).

Aphid

The lowest number of aphids/plant (5.27) was recorded from V_2 (BARI-II) which was statistically similar (5.87) to V_1 (BARI-I) and followed (6.13, 6.40 and 6.53, respectively) by V_4 (Balujuri), V_3 (Bindu) and V_5 (Augnikonna) and they were statistically similar (Table 1), while the highest number (8.67) was found from V_6 (Black Lady) which was followed (7.47 and 7.27, respectively) by V_8 (Surjamukhi) and V_7 (Jhal Morich) and they were statistically similar.

Jassid

The lowest number of jassid/plant (3.07) was observed from V_2 which was statistically similar (3.47) to V_1 and followed (3.87) by V_4, whereas the highest number (6.53) was recorded from V_6 which was followed (5.40 and 5.87, respectively) by V_8 and V_7 and they were statistically similar (Table 1).

Table 1. Varietal performance of chilli against the sucking pests/plant at early growing stage

Treatments	Number of insect pests/plant				
	Aphid	Jassid	White fly	Mealy bug	Mite
V_1	5.87 cd	3.47 de	1.60 f	1.20 d	1.60 e
V_2	5.27 d	3.07 e	1.47 f	1.00 d	1.00 f
V_3	6.40 c	4.47 c	2.27 de	1.20 d	2.27 cd
V_4	6.13 c	3.87 d	1.87 ef	1.00 d	2.20 d
V_5	6.53 c	4.53 c	2.67 cd	1.80 c	2.67 bc
V_6	8.67 a	6.53 a	4.13 a	3.27 a	3.40 a
V_7	7.27 b	5.40 b	3.00 bc	2.07 bc	2.87 b
V_8	7.47 b	5.87 b	3.47 b	2.40 b	3.07 ab
$LSD_{(0.05)}$	0.624	0.508	0.167	0.531	0.429
Level of significance	0.01	0.01	0.01	0.01	0.01
CV(%)	5.32	6.23	11.33	8.34	10.30

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 selected plants per treatment

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

V_1: BARI-I V_2: BARI-II V_3: Bindu V_4: Balujuri

V_5: Augnikonna V_6: Black Lady V_7: Jhal Morich V_8: Surjamukhi

Plate 3. Infested chilli leaves (Jhal Morich) by Whitefly

Plate 4. Infested chilli leaves (BARI-II) by Mealy bug

White fly

The lowest number of white fly/plant (1.47) was found from V_2 which was statistically similar (1.60 and 1.87, respectively) to V_1 and V_4 and followed (2.27 and 2.67, respectively) by V_3 andV_5, whereas the highest number of white fly/plant (4.13) was observed from V_6 which was followed (3.47 and 3.00, respectively) by V_8 and V_7 and they were statistically similar (Table 1).

Mealy bug

The lowest number of mealy bug/plant (1.00) was found from V_2 and V_4 which was statistically similar (1.20) to V_1 and V_3 and followed (1.80) by V_5, whereas the highest number (3.27) was obtained from V_6 which was followed (2.40 and 2.07, respectively) by V_8 and V_7 and they were statistically similar (Table 1).

Mite

The lowest number of mite/plant (1.00) was observed from V_2 which was followed (1.60) by V_1, while the highest number (3.40) was recorded from V_6 which was statistically similar (3.07) to V_8 and followed (2.87 and 2.67, respectively) by V_7 and V_5 and they were statistically similar (Table 1).

4.1.2 At mid growing stage

Statistically significant variations were recorded in terms of number of aphid, jassid, white fly, mite and mealy bug/plant for different varieties of chilli at mid growing stage (Appendix IV).

Aphid

The lowest number of aphids/plant (6.40) was found from V_2 which was statistically similar (6.80) to V_1 and followed (7.60 and 7.80, respectively) by V_3 and V_5 and they were statistically similar, while the highest number of aphids/plant (9.33) was recorded from V_6 which was followed (8.67 and 8.20, respectively) by V_8 and V_7 and they were statistically similar (Table 2).

Jassid

The lowest number of jassid/plant (4.27) was observed from V_2 which was followed (5.07, 5.27 and 5.60, respectively) by V_1, V_4 and V_3 and they were statistically similar. On the other hand, the highest number of jassid/plant (8.27) was found from V_6 which was followed (7.07 and 6.53, respectively) by V_8 and V_7 and they were statistically similar (Table 2).

Table 2. Varietal performance of chilli against the sucking pests/plant at mid growing stage

Treatments	Number of insect pests/plant				
	Aphid	Jassid	White fly	Mealy bug	Mite
V_1	6.80 ef	5.07 e	2.47 ef	1.20 f	2.40 e
V_2	6.40 f	4.27 f	2.27 f	1.07 f	1.80 f
V_3	7.60 cd	5.60 de	3.07 d	2.40 d	3.00 d
V_4	7.27 de	5.27 e	2.80 de	1.87 e	2.40 e
V_5	7.80 cd	6.07 cd	3. 20 cd	3.00 c	3.40 cd
V_6	9.33 a	8.27 a	5.20 a	4.87 a	5.40 a
V_7	8.20 bc	6.53 bc	3.60 bc	3.13 bc	3.80 bc
V_8	8.67 b	7.07 b	4.07 b	3.60 b	4.20 b
$LSD_{(0.05)}$	0.596	0.614	0.480	0.531	0.522
Level of significance	0.01	0.01	0.01	0.01	0.01
CV(%)	4.39	5.83	8.19	6.55	9.05

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 selected plants per treatment

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

V_1: BARI-I V_2: BARI-II V_3: Bindu V_4: Balujuri

V_5: Augnikonna V_6: Black Lady V_7: Jhal Morich V_8: Surjamukhi

White fly

The lowest number of white fly/plant (2.27) was obtained from V_2 which was statistically similar (2.47) to V_1 and followed (2.80, 3.07 and 3.20, respectively) by V_4, V_3 and V_5 and they were statistically similar, while the highest number of white fly/plant (5.20) was recorded from V_6 which was followed (4.07 and 3.60, respectively) by V_8 and V_7 and they were statistically similar (Table 2).

Mealy bug

The lowest number of mealy bug/plant (1.07) was found from V_2 which was statistically similar (1.20) to V_1 and followed (2.40) by V_3. On the other hand, the highest number of mealy bug/plant (4.87) was recorded from V_6 which was followed (3.60 and 3.13, respectively) by V_8 and V_7 and they were statistically similar (Table 2).

Mite

The lowest number of mite/plant (1.80) was recorded from V_2 which was followed (2.40) by V_1 and V_4, while the highest number of mite/plant (5.40) was observed from V_6 which was followed (4.20 and 3.80, respectively) by V_8 and V_7 and they were statistically similar (Table 2).

4.1.3 At late growing stage

Different varieties of chilli at late growing stage varied significantly in terms of number of aphid, jassid, white fly, mite and mealy bug/plant under the present trial (Appendix V). In consideration of aphid, at late growing stage, the lowest number of aphids/plant (4.20) was observed from V_2 which was followed (4.67 and 5.07, respectively) by V_1 and V_4 and they were statistically similar, while the highest number of aphids/plant (6.80) was recorded from V_6 which was followed (6.00 and 5.87, respectively) by V_8 and V_7 and they were statistically similar (Table 3).

Table 3. Varietal performance of chilli against the sucking pests/plant at late growing stage

Treatments	Number of insect pests/plant				
	Aphid	Jassid	White fly	Mealy bug	Mite
V_1	4.67 d	3.20 d	1.80 ef	1.27 d	1.13 e
V_2	4.20 e	3.00 d	1.40 f	0.00 e	1.00 e
V_3	5.20 c	3.93 c	2.40 cd	1.53 d	2.07 c
V_4	5.07 cd	3.80 c	2.00 de	1.33 d	1.60 d
V_5	5. 40 c	4.20 c	2.80 bc	2.13 c	2.20 c
V_6	6.80 a	6.27 a	3.73 a	3.80 a	3.20 a
V_7	5.87 b	4.87 b	3.07 b	3.07 b	2.40 bc
V_8	6.00 b	5.00 b	3.33 ab	3.20 b	2.80 ab
$LSD_{(0.05)}$	0.467	0.450	0.545	0.425	0.422
Level of significance	0.01	0.01	0.01	0.01	0.01
CV(%)	4.92	5.94	12.13	7.75	11.76

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 selected plants per treatment

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

V_1: BARI-I V_2: BARI-II V_3: Bindu V_4: Balujuri

V_5: Augnikonna V_6: Black Lady V_7: Jhal Morich V_8: Surjamukhi

Jassid

The lowest number of jassid/plant (3.00) was recorded from V_2 which was statistically similar (3.20) to V_1 and followed (3.80, 3.93 and 4.20, respectively) by V_4, V_3 and V_5 and they were statistically similar, while the highest number (6.27) from V_6 which was followed (5.00 and 4.87, respectively) by V_8 and V_7 and they were statistically similar (Table 3).

White fly

The lowest number of white fly/plant (1.40) was found from V_2 which was statistically similar (1.80) to V_1 and followed (2.00 and 2.40, respectively) by V_4 and V_3 and they were statistically similar. On the other hand, the highest number of white fly/plant (3.73) from V_6 which was statistically similar (3.33) to V_8 and closely followed (3.07 and 2.80, respectively) by V_7 and V_5 and they were statistically similar (Table 3).

Mealy bug

No mealy bug/plant was found from V_2 which was followed (1.27, 1.33 and 1.53, respectively) by V_1, V_4 and V_3 and they were statistically similar, whereas the highest number (3.80) was recorded from V_6 which was followed (3.20 and 3.07, respectively) by V_8 and V_7 and they were statistically similar (Table 3).

Mite

The lowest number of mite/plant (1.00) was recorded from V_2 which was statistically similar (1.13) to V_1 and closely followed (1.60) by V_4, while the highest number of mite/plant (3.20) was observed from V_6 which was statistically similar (2.80) to V_8 and followed (2.40) by V_7 (Table 3).

Chilli is susceptible to insect attack from seedling to fruiting stage (HDRA, 2000). Datta and Chakraborty (2013) reported that Genotype CA-45 was almost free from white fly incidence and lower incidence was also recorded in genotype CA-43 (0.40/plant) and CA-21 (8.10/plant) was found most susceptible to white fly incidence. Among the different genotypes, CA-22, CA-24, CA-25, CA-27 and CA-30 were free from mite infestation where as CA-13 (13.60/leaf) was most susceptible to mite incidence.

4.2 Fruit bearing status in number and weight basis

4.2.1 At early fruiting stage

Number of healthy, infested fruits and per cent fruit infestation in number basis showed significant differences at early fruiting stage due to different varieties of chilli (Appendix VI). At early fruiting stage, the highest number of healthy fruits/plant (13.40) was recorded from V_2 which was statistically similar (12.87 and 12.33, respectively) to V_1 and V_3 and followed (11.80) by V_4, while the lowest number (11.33) from V_7 which was statistically similar (10.53, 10.80 and 11.40, respectively) by V_8, V_5 and V_6. The lowest number of infested fruits/plant (0.40) was recorded from V_1 and V_2 which was statistically similar (0.47) to V_4, whereas the highest number (0.67) was observed from V_6 which was statistically similar (0.60 and 0.53, respectively) by V_3, V_5, V_7 and V_8. The lowest fruit infestation/plant (2.90%) was recorded from V_1 which was statistically similar (3.02% and 3.80%, respectively) to V_1 and V_4, whereas the highest fruit infestation/plant (5.50%) was observed from V_6 which was statistically similar (4.92%, 4.82%, 4.69% and 4.65%, respectively) by V_7, V_8, V_5 and V_3 (Table 4).

Weight of healthy, infested fruits and per cent fruit infestation in weight basis varied significantly at early fruiting stage due to different varieties of chilli (Appendix VI). At early fruiting stage, the highest weight of healthy fruits/plant (83.24 g) was recorded from V_2 which was statistically similar (79.39 g and 75.67 g) to V_1 and V_3 and followed (70.38 g) by V_4, whereas the lowest weight (56.76 g) from V_8 which was statistically similar (57.01 g and 60.73 g, respectively) to V_7 and V_5. The lowest weight of infested fruits/plant (2.62 g) was recorded from V_1 which was statistically similar (2.98 g) to V_1 and followed (3.52 g) by V_8, whereas the highest weight (4.58 g) from V_6 which was statistically similar (3.95 g, 3.89 g and 3.79 g, respectively) by V_3, V_5, V_7 and V_4. The lowest fruit infestation/plant (3.05%) was recorded from V_1 which was statistically similar (3.63%) by V_1 and followed (4.98% and 5.11%, respectively) by V_3 and V_4, whereas the highest fruit infestation/plant (6.51%) from V_6 which was statistically similar (6.39% and 6.12%, respectively) by V_7 and V_5 (Table 4).

Table 4. Number and weight of fruits and % infestation at early fruiting stage of chilli

Treatments	No. of fruits/plant		% infestation	Weight of fruits/plant (g)		Infestation (%)
	Healthy	Infested		Healthy	Infested	
V_1	12.87 ab	0.40 c	3.02 c	79.39 ab	2.98 cd	3.63 c
V_2	13.40 a	0.40 c	2.90 c	83.24 a	2.62 d	3.05 c
V_3	12.33 abc	0.60 ab	4.65 ab	75.67 abc	3.95 ab	4.98 b
V_4	11.80 bcd	0.47 bc	3.80 bc	70.38 bcd	3.79 ab	5.11 b
V_5	10.80 de	0.53 abc	4.69 ab	60.73 de	3.95 ab	6.12 ab
V_6	11.40 cde	0.67 a	5.50 a	66.49 cde	4.58 a	6.51 a
V_7	10.33 e	0.53 abc	4.92 ab	57.01 e	3.89 ab	6.39 a
V_8	10.53 e	0.53 abc	4.82 ab	56.76 e	3.52 bc	5.88 ab
$LSD_{(0.05)}$	1.144	0.166	1.329	11.70	0.761	1.091
Level of significance	0.01	0.05	0.01	0.01	0.01	0.01
CV(%)	5.60	17.92	17.70	9.73	11.89	11.97

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 selected plants per treatment

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

V_1: BARI-I V_2: BARI-II V_3: Bindu V_4: Balujuri

V_5: Augnikonna V_6: Black Lady V_7: Jhal Morich V_8: Surjamukhi

4.2.2 At mid fruiting stage

At mid fruiting stage due to different varieties of chilli varied significantly in terms of number of healthy, infested fruits and per cent fruit infestation in number basis (Appendix VII). At mid fruiting stage, the highest number of healthy fruits/plant (18.93) was recorded from V_1 which was statistically similar (18.73, 18.40, 17.93, 17.60 and 17.53, respectively) to V_2, V_3, V_4, V_5 and V_6, while the lowest number of healthy fruits/plant (16.67) was observed from V_8 which was statistically similar (17.00) to V_7. The lowest number of infested fruits/plant (0.67) was recorded from V_2 which was closely followed (0.87) by V_1, whereas the highest number of infested fruits/plant (1.27) was observed from V_6 which was statistically similar (1.13 and 1.07, respectively) by V_3, V_5, V_7 and V_8. The lowest fruit infestation/plant (3.43%) was recorded from V_2 which was statistically similar (4.38%) to V_1, whereas the highest fruit infestation/plant (6.73%) was observed from V_6 which was statistically similar (6.37%, 6.25%, 6.08% and 5.80%, respectively) by V_8, V_7, V_5 and V_3 (Table 5).

Statistically significant variation was recorded in terms of weight of healthy, infested fruits and per cent fruit infestation in weight basis at mid fruiting stage due to different varieties of chilli (Appendix VII). At mid fruiting stage, the highest weight of healthy fruits/plant (154.67 g) was recorded from V_2 which was statistically similar (152.41 g, 144.80 g and 138.19 g) to V_1, V_3 and V_4, whereas the lowest weight (121.50 g) was observed from V_8 which was statistically similar (125.60 g, 131.88 g and 132.84 g, respectively) by V_7, V_6 and V_5. The lowest weight of infested fruits/plant (5.56 g) was recorded from V_2 which was followed (7.22 g) by V_1, whereas the highest weight of infested fruits/plant (10.62 g) was observed from V_6 which was statistically similar (9.62 g and 9.30 g, respectively) by V_7 and V_4. The lowest fruit infestation/plant (3.47%) was recorded from V_2 which was statistically similar (4.55%) by V_1 and followed (5.68%) by V_3, whereas the highest fruit infestation/plant (7.45%) was observed from V_6 which was statistically similar (7.18%, 6.72%, 6.30% and 6.20%, respectively) by V_7, V_8, V_4 and V_5 (Table 5).

Table 5. Number and weight of fruits and % infestation at mid fruiting stage of chilli

Treatments	No. of fruits/plant		% infestation	Weight of fruits/plant (g)		% infestation
	Healthy	Infested		Healthy	Infested	
V_1	18.93 a	0.87 b	4.38 c	152.41 ab	7.22 c	4.55 cd
V_2	18.73 a	0.67 c	3.43 c	154.67 a	5.56 d	3.47 d
V_3	18.40 ab	1.13 a	5.80 ab	144.80 abc	8.70 bc	5.68 bc
V_4	17.93 abc	1.07 a	5.61 b	138.19 abcd	9.30 ab	6.30 ab
V_5	17.60 abc	1.13 a	6.08 ab	132.84 bcd	8.74 bc	6.20 ab
V_6	17.53 abc	1.27 a	6.73 a	131.88 cd	10.62 a	7.45 a
V_7	17.00 bc	1.13 a	6.25 ab	125.60 cd	9.62 ab	7.18 ab
V_8	16.67 c	1.13 a	6.37 ab	121.50 d	8.67 bc	6.72 ab
$LSD_{(0.05)}$	1.390	0.192	1.009	18.63	1.564	1.383
Level of significance	0.05	0.01	0.01	0.01	0.01	0.01
CV(%)	4.45	10.60	10.33	7.72	10.44	13.29

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 selected plants per treatment

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

V_1: BARI-I V_2: BARI-II V_3: Bindu V_4: Balujuri

V_5: Augnikonna V_6: Black Lady V_7: Jhal Morich V_8: Surjamukhi

4.2.3 At late fruiting stage

At late fruiting stage due to different varieties of chilli varied significantly in terms of number of healthy, infested fruits and per cent fruit infestation in number basis (Appendix VIII). At late fruiting stage, the highest number of healthy fruits/plant (14.27) was recorded from V_2 which was statistically similar (13.93, 13.60, 13.40 and 13.20, respectively) to V_1, V_3, V_6 and V_4, while the lowest number of healthy fruits/plant (11.87) was observed from V_7 which was statistically similar (12.07) to V_8. The lowest number of infested fruits/plant (0.73) was recorded from V_2 which was statistically similar (0.93) to V_1, whereas the highest number of infested fruits/plant (1.33) was observed from V_6 which was statistically similar (1.27 and 1.13, respectively) by V_5 and V_8. The lowest fruit infestation/plant (4.90%) was recorded from V_2 which was closely followed (6.27%, 7.28% and 7.46%, respectively) by V_1, V_3 and V_4, whereas the highest fruit infestation/plant (9.05%) was observed from V_6 which was statistically similar (8.87%, 8.59% and 8.24%, respectively) to V_5, V_8 and V_7 (Table 6).

Statistically significant variation was recorded in terms of weight of healthy, infested fruits and per cent fruit infestation in weight basis at late fruiting stage due to different varieties of chilli (Appendix VIII). At late fruiting stage, the highest weight of healthy fruits/plant (140.60 g) was recorded from V_2 which was statistically similar (134.78 g) to V_1, whereas the lowest weight of healthy fruits/plant (104.00 g) was observed from V_7 which was statistically similar (105.71 g) by V_8 and closely followed (121.54 g, 124.85 g and 125.08 g, respectively) by V_5, V_6 and V_4. The lowest weight of infested fruits/plant (8.11 g) was recorded from V_2 which was followed (9.22 g) by V_1, whereas the highest weight of infested fruits/plant (13.26 g) was observed from V_6 which was followed (11.97 g) by V_5. The lowest fruit infestation/plant (5.45%) was recorded from V_2 which was followed (6.40%) by V_1, whereas the highest fruit infestation/plant (9.61%) was observed from V_6 which was statistically similar (9.32%, 9.14% and 9.00%, respectively) to V_8, V_7 and V_5 (Table 6).

Table 6. Number and weight of fruits and % infestation at late fruiting stage of chilli

Treatments	No. of fruits/plant		% infestation	Weight of fruits/plant (g)		% infestation
	Healthy)	Infested		Healthy	Infested	
V_1	13.93 ab	0.93 cd	6.27 c	134.78 ab	9.22 d	6.40 c
V_2	14.27 a	0.73 d	4.90 d	140.60 a	8.11 e	5.45 d
V_3	13.60 ab	1.07 bc	7.28 bc	129.49 bc	10.52 c	7.51 b
V_4	13.20 ab	1.07 bc	7.46 bc	125.08 c	10.68 c	7.87 b
V_5	13.00 bc	1.27 ab	8.87 a	121.54 c	11.97 b	9.00 a
V_6	13.40 ab	1.33 a	9.05 a	124.85 c	13.26 a	9.61 a
V_7	11.87 d	1.07 bc	8.24 ab	104.00 d	10.47 c	9.14 a
V_8	12.07 cd	1.13 abc	8.59 ab	105.71 d	10.86 c	9.32 a
$LSD_{(0.05)}$	1.078	0.215	1.232	7.570	0.808	0.827
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	4.67	11.21	9.28	3.51	4.34	5.87

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 selected plants per treatment

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

V_1: BARI-I V_2: BARI-II V_3: Bindu V_4: Balujuri

V_5: Augnikonna V_6: Black Lady V_7: Jhal Morich V_8: Surjamukhi

4.2.4 At entire fruiting stage

At entire fruiting stage due to different varieties of chilli varied significantly in terms of number of healthy, infested fruits and per cent fruit infestation in number basis (Appendix IX). At entire fruiting stage, the highest number of healthy fruits/plant (46.40) was recorded from V_2 which was statistically similar (45.73 and 44.33, respectively) to V_1 and V_3, while the lowest number of healthy fruits/plant (39.20) was observed from V_7 which was statistically similar (39.27 and 41.40, respectively) to V_8 and V_5. The lowest number of infested fruits/plant (1.80) was recorded from V_2 which was followed (2.20) by V_1, whereas the highest number of infested fruits/plant (3.27) was observed from V_6 which was followed (2.93, 2.80 and 2.73, respectively) by V_5, V_3, V_8 and V_7. The lowest fruit infestation/plant (3.74%) was recorded from V_2 which was closely followed (4.59%) by V_1, whereas the highest fruit infestation/plant (7.16%) was observed from V_6 which was closely followed (6.65%, 6.62% and 6.51%, respectively) by V_8, V_5 and V_7 and they were statistically similar (Table 7).

Statistically significant variation was recorded in terms of weight of healthy, infested fruits and per cent fruit infestation in weight basis at entire fruiting stage due to different varieties of chilli (Appendix IX). At entire fruiting stage, the highest weight of healthy fruits/plant (378.52 g) was recorded from V_2 which was statistically similar (366.58 g) to V_1, whereas the lowest weight of healthy fruits/plant (283.97 g) was observed from V_8 which was statistically similar (286.62 g) by V_7 and closely followed (315.11 g and 323.22 g, respectively) by V_5 and V_6. The lowest weight of infested fruits/plant (16.29 g) was recorded from V_2 which was followed (19.43 g) by V_1, whereas the highest weight of infested fruits/plant (28.45 g) was observed from V_6 which was followed (24.66 g, 23.97 g, 23.77 g, 23.17 g and 23.04 g, respectively) by V_5, V_7, V_4, V_3 and V_8 and they were statistically similar. The lowest fruit infestation/plant (4.24%) was recorded from V_2 which was followed (5.22%) by V_1, whereas the highest fruit infestation/plant (8.55%) was observed from V_6 which was statistically similar (8.13%, 7.90% and 7.62%, respectively) to V_7, V_8 and V_5 (Table 7).

Table 7. Number and weight of fruits and % infestation in the entire fruiting stage of chilli

Treatments	No. of fruits/plant		% infestation	Weight of fruits/plant (g)		% infestation
	Healthy	Infested		Healthy	Infested	
V_1	45.73 a	2.20 d	4.59 d	366.58 ab	19.43 c	5.22 d
V_2	46.40 a	1.80 e	3.74 e	378.52 a	16.29 d	4.24 e
V_3	44.33 ab	2.80 bc	5.94 c	349.96 bc	23.17 b	6.48 c
V_4	42.93 bc	2.60 c	5.71 c	333.66 cd	23.77 b	6.96 bc
V_5	41.40 cd	2.93 b	6.62 b	315.11 d	24.66 b	7.62 ab
V_6	42.33 bc	3.27 a	7.16 a	323.22 cd	28.45 a	8.55 a
V_7	39.20 d	2.73 bc	6.51 b	286.62 e	23.97 b	8.13 a
V_8	39.27 d	2.80 bc	6.65 b	283.97 e	23.04 b	7.90 a
$LSD_{(0.05)}$	2.607	0.293	0.463	26.23	1.719	0.870
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	3.49	6.37	4.51	4.54	4.30	7.22

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 selected plants per treatment

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

V_1: BARI-I V_2: BARI-II V_3: Bindu V_4: Balujuri

V_5: Augnikonna V_6: Black Lady V_7: Jhal Morich V_8: Surjamukhi

From the findings it is revealed that chilly variety BARI-II produced the highest number of healthy fruits/plant and have the lowest fruit infestation whereas black leady have the highest fruit infestation in number and weight basis by the sucking pests of chillies. Sucking pests cause both qualitative and quantitative losses in chilli in the field. The yield losses range from 50-90% due to insects pests of chilli (Nelson and Natrajan, 1994 and Kumar, 1995). The yield loss due to chilli thrips and mites is estimated to be tune of 50% (Ahmed *et al*., 1987; Kandasamy *et al*., 1990). An overall reduction in the yield of chilli due to arthropod pests was upto 77 per cent and the joint infestation of thrips and mites caused losses upto 34 per cent (HDRA, 2000).

4.3 Yield contributing characters and yield of chilli

Statistically significant variation was recorded for different yield contributing characters and yield of chilli due to different varieties (Appendix X).

4.3.1 Plant height at harvest

The longest plant (95.28 cm) was found from V_1 which was statistically similar (92.32 cm and 91.05 cm, respectively) to V_2 and V_3, while the shortest plant (81.04 cm) was recorded from V_7 which was statistically similar (82.11 cm, 84.10 cm, 85.25 cm and 85.57 cm, respectively) to V_8, V_5, V_6 and V_4 (Table 8). Kumar *et al*. (2014) reported a strong negative relationship was observed between thrips density and height, with the significantly highest mean number of larvae and adults reported on host plants placed at the lowest height (45.7 cm) above ground.

4.3.2 Number of branches/plant at harvest

The maximum number of branches/plant (8.60) was found from V_1 which was statistically similar (8.20 and 7.93, respectively) to V_2 and V_3, whereas the minimum number of branches/plant (7.27) was obtained from V_8 which was statistically similar (7.40, 7.47, 7.53 and 7.67, respectively) to V_7, V_6, V_5 and V_4 (Table 8).

Table 8. Yield contributing characters and yield of Chilli during harvesting

Treatments	Plant height (cm)	Number of branches/plant	Days to harvest	Fruit diameter (mm)	Individual fruit weight (g)	Yield (t/ha)
V_1	95.28 a	8.60 a	86.80 cd	7.28 a	7.98 ab	16.18 ab
V_2	92.32 ab	8.20 ab	85.13 d	7.44 a	8.12 a	17.50 a
V_3	91.05 abc	7.93 abc	87.87 cd	7.18 a	7.80 abc	15.11 bc
V_4	85.57 bcd	7.67 bc	89.20 cd	6.92 ab	7.68 abc	14.28 bc
V_5	84.10 bcd	7.53 bc	90.40 bcd	6.84 ab	7.15 c	13.13 c
V_6	85.25 bcd	7.47 bc	92.27 abc	6.94 ab	7.50 abc	13.87 c
V_7	81.04 d	7.40 bc	95.87 ab	6.32 b	7.28 bc	13.07 c
V_8	82.11 cd	7.27 c	97.43 a	6.35 b	7.26 c	13.15 c
$LSD_{(0.05)}$	8.478	0.820	6.147	0.581	0.641	1.956
Level of significance	0.05	0.05	0.01	0.01	0.05	0.01
CV(%)	5.56	6.04	4.87	4.80	4.82	7.69

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 selected plants per treatment

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

V_1: BARI-I V_2: BARI-II V_3: Bindu V_4: Balujuri

V_5: Augnikonna V_6: Black Lady V_7: Jhal Morich V_8: Surjamukhi

Plate 5: Photograph showing the vigorous plant of chilli with flower and fruits. A: BARI I; B: Surjamukhi

4.3.3 Days to harvest

It was observed that the minimum days to harvest (85.13) was found from V_2 which was statistically similar (86.80, 87.87, 89.20 and 90.40, respectively) to V_1, V_3, V_4 and V_5, while the maximum days to harvest (97.43) was recorded from V_8 which was statistically similar (95.87 and 92.27, respectively) to V_7 and V_6 (Table 8).

4.3.4 Fruit length

The longest fruit (8.38 cm) was observed from V_2 which was statistically similar (7.72 cm) to V_1, while the shortest fruit (5.58 cm) was recorded from V_3 which was statistically similar (5.98 cm, 6.25 cm, 6.38 cm and 6.92 cm, respectively) to V_4, V_5, V_6, V_7 and V_8 (Figure 2). Datta and Chakraborty (2013) reported significantly the longest fruit in genotype CA-29 (8.05 cm) and it was shortest in genotype CA-2 (5.67 cm) and it was statistically at par with genotypes CA-15 (6.02 cm) and CA-43 (6.17 cm).

4.3.5 Fruit diameter

Data revealed that the highest fruit diameter (7.44 mm) was found from V_2 which was statistically similar (7.28 mm and 7.18 mm, 6.92 mm, 6.84 mm and 6.94 mm, respectively) to V_1, V_3, V_4, V_5 and V_6, whereas the lowest fruit diameter (6.32 mm) was recorded from V_7 which was statistically similar (6.35 mm) to V_8 (Table 8).

4.3.6 Number of fruits/plant

The maximum number of fruits/plant (51.73) was recorded from V_2 which was statistically similar (48.67) to V_1, while the minimum number (43.07) was recorded from V_7 which was statistically similar (43.40, 44.07, 44.40, 44.53 and 46.47, respectively) to V_8, V_5, V_6, V_4 and V_3 (Figure 3). Datta and Chakraborty (2013) reported significantly the highest number of fruits per plant was recorded in genotype CA-29 (168.23) and it was lowest in genotype CA-2 (52.30) and it was statistically at par with genotypes CA-15 (56.09) and CA-43 (56.20).

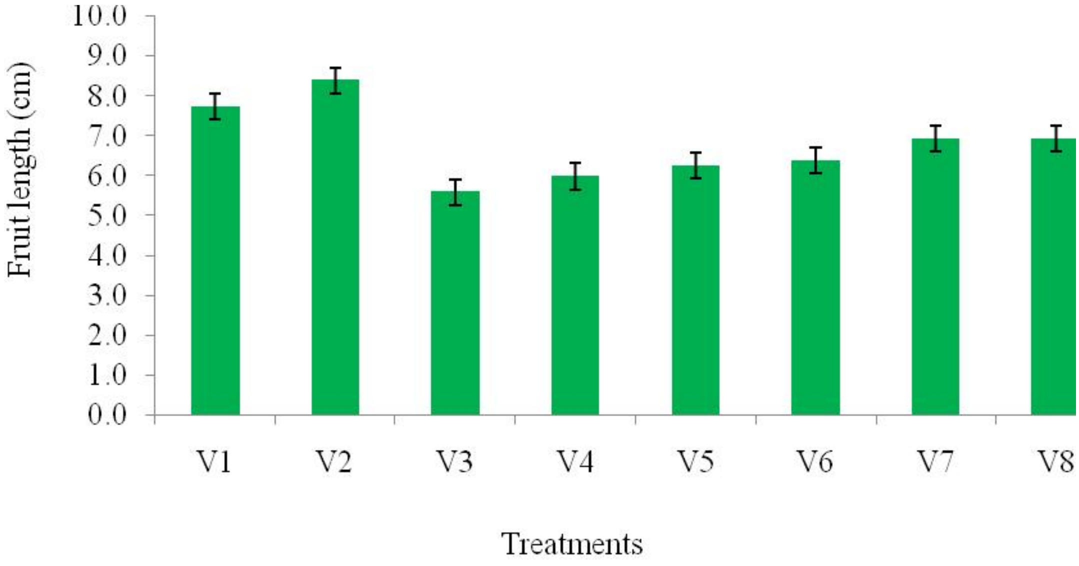


Figure 2. Effect of different variety on fruit length of chilli.
($LSD_{0.05}$ = 1.292)

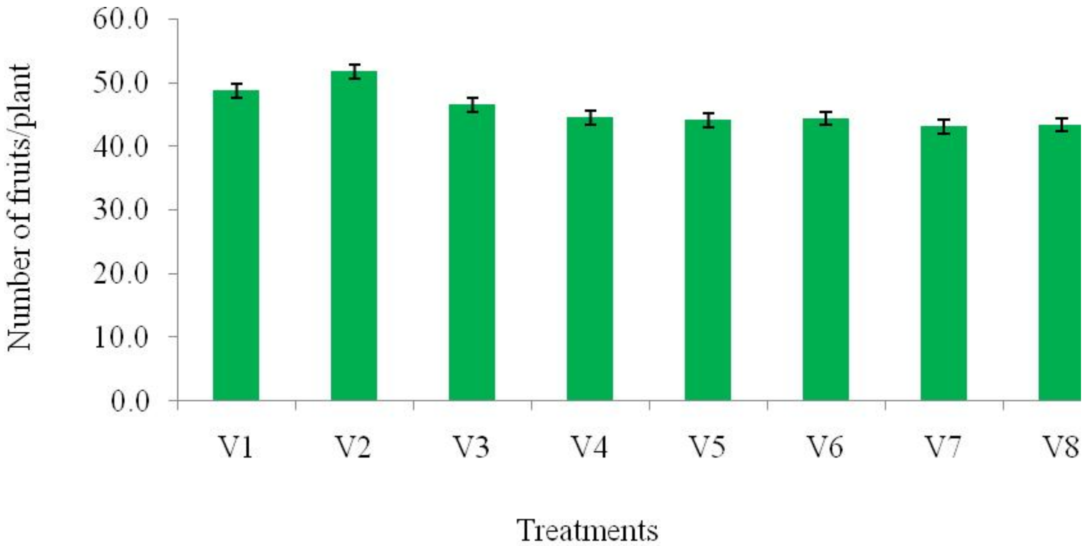


Figure 3. Effect of different variety on number of fruits/plant of chilli.
($LSD_{0.05}$ = 3.813)

V_1: BARI-I	V_2: BARI-II	V_3: Bindu	V_4: Balujuri
V_5: Augnikonna	V_6: Black Lady	V_7: Jhal Morich	V_8: Surjamukhi

4.3.7 Individual fruit weight

Data revealed that the highest weight of individual fruit (8.12 g) was found from V_2 which was statistically similar (7.98 g, 7.80 g, 7.68 g and 7.50 g, respectively) to V_1, V_3, V_4 and V_6, while the lowest weight of individual fruit (7.15 g) was recorded from V_5 which was statistically similar (7.26 g and 7.28 g, respectively) to V_8 and V_7 (Table 8).

4.3.8 Fruit yield

The highest fruit yield (17.50 t/ha) was found from V_2 which was statistically similar (16.18 t/ha) to V_1 and followed (15.11 t/ha and 14.28 t/ha, respectively) V_3 and V_4. On the other hand, the lowest fruit yield (13.07 t/ha) was recorded from V_7 which was statistically similar (13.13 t/ha, 13.15 t/ha and 13.87 t/ha, respectively) to V_5, V_8 and V_6 (Table 8). Datta and Chakraborty (2013) reported significantly highest fresh yield in CA-29 (14.58 t/ha) and higher fruit yield was also recorded in genotype CA-47 (13.35 t/ha) and CA-48 (13.18 t/ha).

CHAPTER V

SUMMARY AND CONCLUSION

The study was conducted at the research farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from May to August 2014 to study the varietal performance of chilli against major sucking pests. The name of the chilli varieties are-V_1: BARI-I, V_2: BARI-II, V_3: Bindu, V_4: Balujuri, V_5: Augnikonna, V_6: Black Lady, V_7: Jhal Morich and V_8: Surjamukhi. Data was recorded on number of sucking pests/plant at early, mid and late growing stage, fruiting status in terms of healthy, infested fruits and infestation level in number and weight basis at early, mid and late fruiting stage and also yield contributing characters and yield of different varieties of chilli and significant variation was observed for different variety.

In case of aphid, data from at early growing stage, the lowest number of aphids/plant (5.27) was recorded from V_2 and the highest number of aphids/plant (8.67) was found from V_6. For Jassid, at early growing stage, the lowest number of jassid/plant (3.07) was observed from V_2, whereas the highest number of jassid/plant (6.53) was recorded from V_6. In consideration of white fly, at early growing stage, the lowest number of white fly/plant (1.47) was found from V_2, whereas the highest number of white fly/plant (4.13) was observed from V_6. For mealy bug, at early growing stage, the lowest number of mealy bug/plant (1.00) was found from V_2 and V_4, whereas the highest number of mealy bug/plant (3.27) was obtained from V_6. In case of mite, at early growing stage, the lowest number of mite/plant (1.00) was observed from V_2, while the highest number of mite/plant (3.40) was recorded from V_6.

For aphid, at mid growing stage, the lowest number of aphids/plant (6.40) was found from V_2, while the highest number of aphids/plant (9.33) was recorded from V_6. In consideration of Jassid, at mid growing stage, the lowest number of jassid/plant (4.27) was observed from V_2 and the highest number of jassid/plant (8.27) was found from V_6. For white fly, at mid growing stage, the lowest number of white fly/plant (2.27) was obtained from V_2, while the highest number of white fly/plant (5.20) was recorded from V_6. In case of mealy bug, at mid growing stage, the lowest number of mealy bug/plant (1.07) was found from V_2 and the highest number of mealy bug/plant (4.87) was recorded from V_6. In consideration of mite, at mid growing stage, the lowest number of mite/plant (1.80) was recorded from V_2, while the highest number of mite/plant (5.40) was observed from V_6.

In consideration of aphid, at late growing stage, the lowest number of aphids/plant (4.20) was observed from V_2, while the highest number of aphids/plant (6.80) was recorded from V_6. For Jassid, at late growing stage, the lowest number of jassid/plant (3.00) was recorded from V_2, while the highest number (6.27) from V_6. In case of white fly, at late growing stage, the lowest number of white fly/plant (1.40) was found from V_2 and the highest number of white fly/plant (3.73) from V_6. In case of mealy bug, at late growing stage, no mealy bug/plant was found from V_2, whereas the highest number of mealy bug/plant (3.80) was recorded from V_6. In consideration of mite, at late growing stage, the lowest number of mite/plant (1.00) was recorded from V_2, while the highest number of mite/plant (3.20) was observed from V_6.

At early fruiting stage, the highest number of healthy fruits/plant (13.40) was recorded from V_2, while the lowest number (11.33) from V_7. The lowest number of infested fruits/plant (0.40) was recorded from V_1 and V_2, whereas the highest number (0.67) was observed from V_6. The lowest fruit infestation/plant (2.90%) was recorded from V_1, whereas the highest fruit infestation/plant (5.50%) was observed from V_6. At early fruiting stage, the highest weight of healthy fruits/plant (83.24 g) was recorded from V_2, whereas the lowest weight (56.76 g) from V_8. The lowest weight of infested fruits/plant (2.62 g) was recorded from V_1, whereas the highest weight (4.58 g) from V_6. The lowest fruit infestation/plant (3.05%) was recorded from V_1, whereas the highest fruit infestation/plant (6.51%) from V_6.

At mid fruiting stage, the highest number of healthy fruits/plant (18.93) was recorded from V_1, while the lowest number of healthy fruits/plant (16.67) was observed from V_8. The lowest number of infested fruits/plant (0.67) was recorded from V_2, whereas the highest number of infested fruits/plant (1.27) was observed from V_6. The lowest fruit infestation/plant (3.43%) was recorded from V_2, whereas the highest fruit infestation/plant (6.73%) was observed from V_6. At mid fruiting stage, the highest weight of healthy fruits/plant (154.67 g) was recorded from V_2, whereas the lowest weight (121.50 g) was observed from V_8. The lowest weight of infested fruits/plant (5.56 g) was recorded from V_2, whereas the highest weight of infested fruits/plant (10.62 g) was observed from V_6. The lowest fruit infestation/plant (3.47%) was recorded from V_2, whereas the highest fruit infestation/plant (7.45%) was observed from V_6.

At late fruiting stage, the highest number of healthy fruits/plant (14.27) was recorded from V_2, while the lowest number of healthy fruits/plant (11.87) was observed from V_7. The lowest number of infested fruits/plant (0.73) was recorded from V_2, whereas the highest number of infested fruits/plant (1.33) was observed from V_6. The lowest fruit infestation/plant (4.90%) was recorded from V_2, whereas the highest fruit infestation/plant (9.05%) was observed from V_6. At late fruiting stage, the highest weight of healthy fruits/plant (140.60 g) was recorded from V_2, whereas the lowest weight of healthy fruits/plant (104.00 g) was observed from V_7. The lowest weight of infested fruits/plant (8.11 g) was recorded from V_2, whereas the highest weight of infested fruits/plant (13.26 g) was observed from V_6. The lowest fruit infestation/plant (5.45%) was recorded from V_2, whereas the highest fruit infestation/plant (9.61%) from V_6.

At entire fruiting stage, the highest number of healthy fruits/plant (46.40) was recorded from V_2, while the lowest number of healthy fruits/plant (39.20) was observed from V_7. The lowest number of infested fruits/plant (1.80) was recorded from V_2, whereas the highest number of infested fruits/plant (3.27) was observed from V_6. The lowest fruit infestation/plant (3.74%) was recorded from V_2, whereas the highest fruit infestation/plant (7.16%) was observed from V_6. At entire fruiting stage, the highest weight of healthy fruits/plant (378.52 g) was recorded from V_2, whereas the lowest weight of healthy fruits/plant (283.97 g) was observed from V_8. The lowest weight of infested fruits/plant (16.29 g) was recorded from V_2, whereas the highest weight of infested fruits/plant (28.45 g) was observed from V_6. The lowest fruit infestation/plant (4.24%) was recorded from V_2, whereas the highest fruit infestation/plant (8.55%) from V_6.

The longest plant (95.28 cm) was found from V_1, while the shortest plant (81.04 cm) was recorded from V_7. The maximum number of branches/plant (8.60) was found from V_1, whereas the minimum number of branches/plant (7.27) was obtained from V_8. The minimum days to harvest (85.13) was found from V_2, while the maximum days to harvest (97.43) was recorded from V_8. The longest fruit (8.38 cm) was observed from V_2, while the shortest fruit (5.58 cm) was recorded from V_3. The highest fruit diameter (7.44 mm) was found from V_2, whereas the lowest fruit diameter (6.32 mm) was recorded from V_7. The maximum number of fruits/plant (51.73) was recorded from V_2, while the minimum number (43.07) was recorded from V_7. The highest weight of individual fruit (8.12 g) was found from V_2, while the lowest weight of individual fruit (7.15 g) was recorded from V_5. The highest fruit yield (17.50 t/ha) was found from V_2 and the lowest fruit yield (13.07 t/ha) was recorded from V_7.

REFERENCE

Ahmad, M.U. (1987). A survey on the edible species of the genus *Psidium*. Prentice Hall, New Jersey, USA. pp. 113-120.

Ajjapplavara, P.S. (2009). Genetic diversity in chilli (*Capsicum annuum* L.). The *Asian J. of Hort.* **4**(1): 29-31.

Arroyo, J., Keith, A.M., Schmidt, O., and Bolger, T. (2013). "Mite abundance and richness in an Irish survey of soil biodiversith with comments on some newly recorded species". *Intl. Nat. J.* **33**: 19-27.

BBS. (2014). Year Book of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Govt. of the Peoples Republic of Bangladesh, Dhaka. p. 156.

Bhattacharya, A., Chattopadhyay, A., Mazumdar, D., Chakravarty, A., and Pal, S. (2010). Antioxidant Constituents and Enzyme Activities in Chilli Peppers . *Intl. J. Veg. Sci*. **16**: 201 – 211.

Bourland, F.M., Hornback, J.M. and Calhun, S.D. (2003). A rating system for leaf pubescence of cotton. *J. Cotton Sci*. **7**: 8-15.

Brown, R.P. and Bird, T.T. (1992). Prevalence and expanded distribution of whitefly borne viruses. *Bull. Inst. Trop. Agri. Kyushu Univ*. **7**: 85-91.

Butane, D.K. and Jotwanil, M.G. (1984). Insects is Vegetables. Periodical Expert Book Agercy, Delhi. 356p.

Cannon, R.J.C., Matthews, L., Collins, D.W., Agallou, E., Bartlett, P.W., Walters, K.F.A., Macleod, A., Slawson, D.D. and Gaunt, A. (2008). Eradication of an invasive alien pest, Thrips palmi. *Crop Protect.* **26**(8): 1303-1314.

Chaudhary, J.P., Yadav, L.S. Poonia, R.S. and Rastogi, K.B. (1980). Some observation on field populations of *Empoasca kerri* Pruthi, a jasid pest on mungbean crop in Haryana. *Haryana Agric, Univ. J. Res*. **10**(2): 250-252.

Chhabra, K.S. Brar, J.S. and Kooner, B. (1981). Jassid species on recorded on greengram, blackgram and redgram in the Punjab. *Pulse Crops Newsl.* **1**: 65.

Dansi, A., Adoukonou-Sagbadja, H. and Vodouhe, R. (2010). Diversity, conservation and related wild species of Fonio millet (*Digitaria spp.*) in the northwest of Benin. Genet. Resour. *Crop Evol*. **57**: 827-839.

Datta, S. and Chakraborty, G. (2013). Studies on influence of genotypic diversity on yield, quality and incidence of white fly and yellow mite in *Capsicum annuum* L. *J. Appl. Natural Sci*. **5**(2): 350-356

Devine, G.J. and Furlong, M.J. (2007). Insecticide use: Contexts and ecological consequences. *Agric. Human Values.* **24**(3): 281-306.

Dias, G.B., Gomes, V.M., Moraes, T.M., Zottich, U.P., Rabelo, G.R., Carvalho, A.O., Moulin, M., Gonçalves, L.S., Rodrigues, R. and Da Cunha, M. (2013). Characterization of Capsicum species using anatomical and molecular data. Genet Mol Res. (Online first)

El-Ghoraba, A.H., Javedb, Q., Anjumb, F.M., Hamedc, S.F., Shaabana, H.A. (2013). Pakistani Bell Pepper: Chemical Compositions and its Antioxidant Activity. *Intl. J. Food Propt.* **16**(1):18-32.

FAO. (2010). FAOSTAT Database. Food and Agriculture Organization, Roma, Italy. Available online at URL: www.fao.org

Flint, M.L. (1998). Pests of the Garden and Small Farm: A Grower's Guide to Using Less Pesticide, 2nd ed. Oakland: Univ. Calif. Agric. Nat. Res. Publ. 3332. fungicides for the control of fungi of root. *Pakistan J. Agril. Sci. Ind. Res*. **29**(6): 435-8.

Girish, R., Srinivasa, N., Mutthuraju, G.P. and Shruthi, H.R. (2012). Field evaluation of chilli (*Capsicum annuum* L.) entries for infestation by thrips, Scirtothrips dorsalis Hood. *Uttar Pradesh J. Zoology*. **32**(3): 297-301.

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for Agricultural Research. Second Edition. A Wiley Interscience Publications Jhon Wiley and Sons, New York, Chichester, Torento, Singapore. p. 680.

Haider, M.Z. (1996). Effectiveness of some IPM packages for the management of viruse-disseminating whitefly on tomato. M. S. Thesis in Entomology. IPSA. Salna, Gazipur, Bangladesh. pp. 1-65.

Halliday, R.B., Connor, B.M.O. and Baker, A.S. (2000). "Global Diversity of Mites". In Peter H. Raven & Tania Williams. Nature and human society: the quest for a sustainable world : proceedings of the 1997 Forum on Biodiversity. National Academies. p. 192–212.

HDRA (The Organic Organization). (2000). Tropical Advisory Service. Ryton Organic Gardens Coventry, CV8 3LG, UK. June, 2000.

Hirano, K. Budiyanto, E and Winarni, S. (1993). Biological characteristics and forecasting outbreaks of the whitefly *Bemisia tabaci,* a vector of virus diseases in soybean fields. Food and Fertilizer Technology Center. Technical Bulletin. No. 135.

Houimli, S.I.M., Denden, M. and Salem, B.E. (2008). Induction of salt tolerance in pepper (*Capsicum annuum*) by 24-epibrassinolide. *EurAsia J. Bio Sci*. **2**: 83-90.

Jayewar, N.E., Mundha, D.R., Wadnerkar, D.W., Zanwar, P.R. and Narwade, B.P. (2003). Evaluation of acetamiprid 20SP against sucking pests of chilli. *Pestology*. **27**: 17-20.

Kajita, H. and Alam, M.Z. (1996). Whiteflies on guava and vegetables in Bangladesh and their Aphelinid parasitoids. *Appl. Entomol. Zool*. **31**(1): 159-162.

Kandasamy, C., Mohansundaram, M. and Karuppachamy, P. (1990). Evaluation of insecticides for the control of thrips. Scirtothrips dorsalis Hood in Chillies (*Capsium annum* L.). *Madras Agric. J*. **77**: 169-172.

Karungi, J., Obua, T., Kyamanywa, S., Mortensen, C.N. and Erbaugh, M. (2013). Seedling protection and field practices for management of insect vectors and viral diseases of hot pepper (*Capsicum chinense* Jacq.) in Uganda. *Intl. J. Pest Manage*. **10**(8): 74-81.

Khan, H.A., Ayub, C.M., Pervez, M.A., Bilal, R.M., Shahid, M.A., Ziaf, K. (2009). Effect of seed priming with NaCl on salinity tolerance of hot pepper (*Capsicum annum* L.) at seedling stage. *Environ. Exp. Bot*. **60**: 77- 85.

Kumar, N.K.K. (1995). Yield loss in chilli and sweet paper due to scirtothrips dorsalis Hood (Thysanoptera: Thripidae). *Pest Manag. Hort. Ecosystems*. **1**(2): 61-69.

Kumar, V., Kakkar, G., Seal, D.R., McKenzie, C.L., Colee, J. and Osborne, L.S. (2014). Temporal and spatial distribution of an invasive thrips species Scirtothrips dorsalis (Thysanoptera: Thripidae). *Crop Prot*. **55**: 80-90.

Mansour, S.A.A., Mohamad-Roff, M.N., Khalid, A.S., Ismail, A. and Idris, A.G. (2013). Population abundance of whitefly, Bemisia tabaci (Genn.), on chilli and other vegetable crops under glasshouse conditions. *J. Trop. Agric. Food Sci*. **41**(1): 149-157.

Melendez, A.A., Morrell, P.L., Roose, M.L., Kim, S.C. (2009). Genetic diversity and structure in semiwild and domesticated Chiles (*Capsicum annuum;* Solanaceae) from Mexico. *American J. Botany*. **96**(6): 1190–1202.

Morrison, Y. and Peairs, K. (1998). The economic impact of aphid include direct and indirect losses. *Indian J. Agric. Sci*. **50**: 620-623.

Mustafiz, R. (1999). Epidemic in chilli field in North Bengal. The Daily Janakantha, December, 22. 12p.

Muthukrishnan, C.R., Thangaraj, T. and Chatterjee, R. (1990). Chilli and capsicul *In*: Vegetable crops in India (1st ed.), T. K. Bose and Som, M. G. (ed.), Naya Prokash, Calcutta-6. p. 343-384.

Naresh, J.S. and Nene, Y.L. (1980). Host range, host preference for oviposition and development and the dispersal of *Bemisia tabaci* (Genn). A vector of several plant viruses. *Indian J. Agric. Sci*. **50**: 620-623.

Nelson, S. J. and Natarajan, S. (1994). Efficacy of moult inhibitiors and NVP on chilli fruit borer. *South Indian Hort*. **42**(4): 281-282.

Nsabiyera, V., Logose, M., Ochwo-Ssemakula, M., Sseruwagi, P., Gibson, P., Ojiewo, C.O. (2013). Morphological Characterization of Local and Exotic Hot Pepper (*Capsicum annuum*) Collections in Uganda. *Bioremed. Biodiv. Bioavail.* **7**(1): 22-32

Nyle, C.B. and Weil, R.R. (2009). Elements of the Nature and Properties of Soils (3rd Edition). Prentice Hall. ISBN 9780135014332.

Orobiyi, A., Dansi, A, Assogba, P., Loko, L.Y., Dansi, M., Vodouhe R., Akouegninou, A. and Sanni, A. (2013). Chili (*Capsicum annuum* L.) in southern Benin: production constraints, varietal diversity, preference criteria and participatory evaluation. *Intl. Res. J. Agril. Sci. Soil Sci*. **3**(4): 107-120.

Rashid, M. (1993). Studies on the extent of damage in different seasons, lift cycle and control of spiraling whitefly, *Aleurodicus disperses Russel* of guava. M.S. Thesis, Department of Entomology, Bangladesh Agricultural University, Mymensingh. 107p.

Segnou J, Amougou A, Youmbi E, Njoya J. 2013. Effect of Chemical Treatments on Pests and Diseases of Pepper (*Capsicum annuum* L.). *Greener J. Agril. Sci*. **3**(1): 12-20

Shahjahan, M. and Ahmed, K.U. (1993). Homestead vegetable production: Training manual (in Balgla). On farm research division, Bangladesh Agril. Res. Inst. Joydebpur, Gazipur. 235. P.

Tanwar, R.K., Jeyakumar, P. and Monga, D. (2007). Mealybugs and their management. NCIPM. New Delhi- 110012.

Truong, H.T.H., Kim, J.H., Cho, M.C., Chae, S.Y., Lee, H.E. (2013). Identification and development of molecular markers linked to Phytophthora root rot resistance in pepper (*Capsicum annuum* L.). *European J. Plant Pathol*. **135**(2): 289-297.

Wahyuni, Y., Ballester, A.R., Sudarmonowati, E., Bino, R.J., Bovy, A.G. (2013). Secondary Metabolites of Capsicum Species and Their Importance in the Human Diet. *J. Nat. Prod*., 10: 1021-1028.

Walker, P. and Peairs, M.K. (1998). Management of aphid infestation in plant. *Indian J. Agric. Sci*. **50**: 133-139.

Zhang, Y., Sun, J., Li, S.H. and Shu, S. and Guo, S.R. (2012). Application of vinegar residue substrate in nursery and cultivation of tomato. *Acta Hort*. **1037**: 1093-1101.

Zhani, K., Hermans, N., Ahmad, R., Hannachi, C. (2013). Evaluation of salt tolerance (NaCl) in tunisian chili pepper (*Capsicum frutescens* L.) on Growth, Mineral Analysis and Solutes Synthesis. *J. Stress Physiol. Biochem*. **9**(1): 209-228.

Plate 1. Photograph showing the fruits of different variety of chilli

Ptate 3: Photograph showing the vigorous plant of chilli with flower and fruits

Ptate 4: Infested chilli leaves (Jhal Morich) by Whitefly

Ptate 5: Infested chilli leaves (BARI-II) by Mealy bug

Ptate 6: Mite Infested chilli leaves

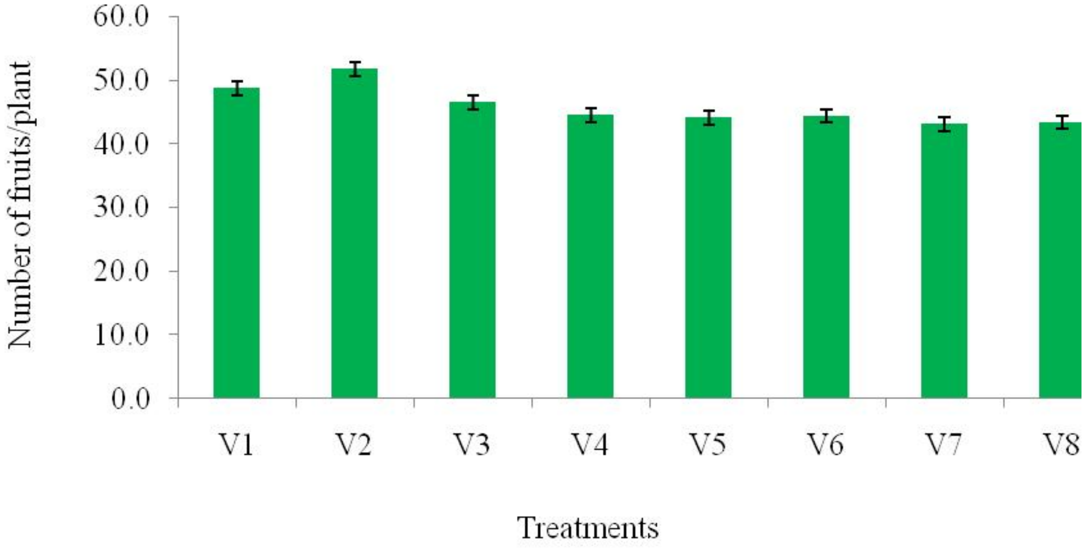


Figure 3. Effect of different variety on number of fruits/plant of chilli. ($LSD_{0.05}$ = 3.813)

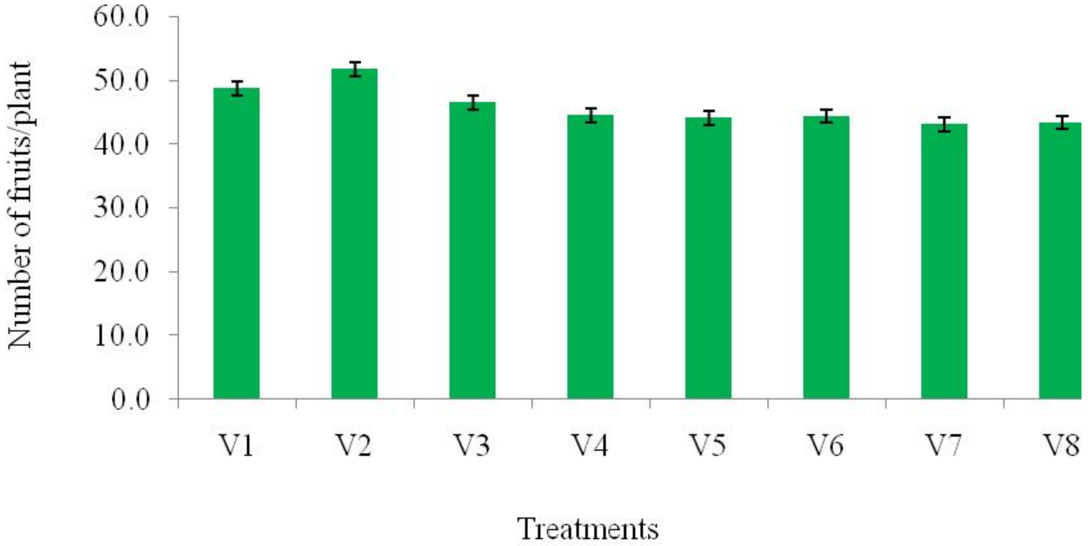


Figure 3. Effect of different variety on number of fruits/plant of chilli. ($LSD_{0.05}$ = 3.813)

APPENDICES

Appendix I. Monthly record of air temperature, relative humidity, rainfall, and sunshine (average) of the experimental site during the period from May to August 2014

Month (2014)	Air temperature (^{0}c)		Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
	Maximum	Minimum			
May	35.2	25.7	72	194	6.8
June	35.7	23.2	78	312	6.4
July	36.0	24.6	83	563	6.1
August	36.2	23.6	81	319	6.0

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka–1212*

Appendix II. Characteristics of the soil of experimental field analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the soil of experimental field

Morphological features	Characteristics
Location	Agronomy field, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% Clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00

Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: SRDI, Khamarbari, Farmgate, Dhaka

Appendix III. Analysis of variance of the data on varietal performance of chilli against the sucking pests/plant at early growing stage

Source of variation	Degrees of freedom	Mean square				
		Number of insect pests/plant				
		Aphid	Jassid	White fly	Mealy bug	Mite
Replication	2	0.125	0.065	0.052	0.022	0.032
Chilli variety (A)	7	3.413**	4.353**	2.651**	2.564**	1.881**
Error	14	0.127	0.084	0.084	0.092	0.060

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on varietal performance of chilli against the sucking pests/plant at mid growing stage

Source of variation	Degrees of freedom	Mean square				
		Number of insect pests/plant				
		Aphid	Jassid	White fly	Mealy bug	Mite
Replication	2	0.027	0.112	0.052	0.007	0.015
Chilli variety (A)	7	2.800**	4.772**	2.724**	4.910**	4.046**
Error	14	0.116	0.123	0.075	0.092	0.089

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on varietal performance of chilli against the sucking pests/plant at late growing stage

Source of variation	Degrees of freedom	Mean square				
		Number of insect pests/plant				
		Aphid	Jassid	White fly	Mealy bug	Mite
Replication	2	0.065	0.027	0.002	0.012	0.020
Chilli variety (A)	7	2.000**	3.416**	1.950**	3.564**	1.790**

Error	14	0.071	0.065	0.097	0.059	0.058

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on number and weight of fruits and % infestation at early fruiting stage of chilli

Source of variation	Degrees of freedom	Mean square					
		No. of fruits/plant		% infestation	Weight of fruits/plant (g)		infe
		Healthy	Infested		Healthy	Infested	
Replication	2	0.502	0.007	0.229	16.216	0.040	
Chilli variety (A)	7	3.767**	0.026*	2.661**	310.603**	1.136**	
Error	14	0.427	0.009	0.576	44.651	0.189	

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on number and weight of fruits and % infestation at mid fruiting stage of chilli

Source of variation	Degrees of freedom	Mean square				
		No. of fruits/plant		% infestation	Weight of fruits/plant (g)	
		Healthy	Infested		Healthy	Infested
Replication	2	0.015	0.020	0.477	25.875	0.431
Chilli variety (A)	7	1.950*	0.110**	3.748**	437.728**	7.172**
Error	14	0.630	0.012	0.332	113.195	0.798

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on number and weight of fruits and % infestation at late fruiting stage of chilli

Source of variation	Degrees of freedom	Mean square				
		No. of fruits/plant		% infestation	Weight of fruits/plant (g)	
		Healthy	Infested		Healthy	Infested
Replication	2	0.002	0.005	0.256	67.465	0.003
Chilli variety (A)	7	2.130**	0.105**	6.120**	497.148**	7.340**
Error	14	0.379	0.015	0.495	18.688	0.213

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix IX. Analysis of variance of the data on number and weight of fruits and % infestation in the entire fruiting stage of chilli

Source of variation	Degrees of freedom	Mean square				
		No. of fruits/plant		Infestation (%)	Weight of fruits/plant (g)	
		Healthy	Infested		Healthy	Infested
Replication	2	0.665	0.082	0.267	217.086	0.556
Chilli variety (A)	7	22.061**	0.617**	4.060**	3588.007**	39.302**
Error	14	2.217	0.028	0.070	224.332	0.963

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix X. Analysis of variance of the data on yield contributing characters and yield of Chilli during harvesting

Source of variation	Degrees of freedom	Mean square							
		Plant height (cm)	Number of branches/plant	Days to harvest	Fruit length (cm)	Fruit diameter (mm)	Number of fruits/plant	Individual fruit weight (g)	Yield (t/ha)
Replication	2	0.537	0.050	0.753	0.087	0.003	3.487	0.002	0.435
Chilli variety (A)	7	79.830*	0.621*	56.144**	2.567**	0.500**	27.285**	0.382*	7.876**
Error	14	23.439	0.219	12.323	0.544	0.110	4.742	0.134	1.248

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability