



E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(1): 786-791
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Received: 17-11-2016
Accepted: 18-12-2016

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Screening of different brinjal (*Solanum melongena* L.) cultivars against hadda beetle (*Epilachna vigintioctopunctata* F.) in Pothwar region

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Abstract

The experiment was conducted to evaluate different brinjal cultivars against Hadda Beetle *Epilachna vigintioctopunctata* F. (Coccinellidae: Coleoptera) at University Research Farm Koont, during 2015. The maximum number of all three stages eggs, grubs and adults of *E. vigintioctopunctata* per leaf were observed to be 5.92, 1.35 and 0.75 respectively on the brinjal cultivar Round F1 Hybrid so considered as the most susceptible cultivar among the tested cultivars. While the least number of *E. vigintioctopunctata* eggs, grubs and adults per leaf were recorded to be 1.94, 0.45 and 0.41 respectively on the brinjal cultivar Blue Pearl therefore it was considered as the most resistant cultivar relatively. Average hair density on leaf lamina per cm² and hair density on mid-rib per cm showed a significant positive correlation with the grub population of *E. vigintioctopunctata* with r-value 0.94 and 0.92 respectively. The average plant height and number of primary branches had shown highly significant positive correlation with the grub population with r-value 0.96 and 0.98 respectively. The yield had shown significant negative correlation with grub population with r-value -0.98. The maximum average yield was observed 1.84 kg per plant on Blue Pearl which was significantly different from other cultivars. The average Relative Humidity (%) showed highly significant positive correlation with adult population while average Rainfall (mm) had shown non-significantly positive correlation. On average basis, temperature showed significant negative correlation with hadda beetle population on brinjal.

Keywords: Brinjal, hadda beetle, physico-morphic and abiotic factors

1. Introduction

Brinjal (*Solanum melongena* L.) is an important vegetable crop of tropical and subtropical region. It is also known as eggplant and aubergine, belonging to the family Solanaceae which contain 95 genera and over 2000 species [1]. It is the second most produced vegetable crop after potato and sweet potato [2]. It is originated in India and cultivated in the Subcontinent since last 4000 years [3]. The global area under its cultivation has been estimated about 1.85 million hectares with the annual production of about 32 million tons. The contribution of Subcontinent toward the world production of eggplant is almost 37% with an annual production of 10.50 million tons on an area of more than 0.678 million hectares [4]. It is a potential source of income for farmers and considered as cash crop for being cultivated on commercial as well as kitchen gardens. Brinjal fruit contains all the essential amino acids, minerals and vitamins [5]. It has properties of an antidote and antioxidant, and also reduces the swelling of the legs [6]. It is also advantageous for hypertensive and diabetes patients because of high potassium content [7]. Apart from the other uses, its dry shoots are a source of fuel in rural areas [8].

There are several factors which influence on the productivity of the brinjal crop. The losses caused by biotic factors are much dependent on abiotic factors [9]. The study revealed that *Epilachna vigintioctopunctata* has a significant positive correlation with maximum temperature, relative humidity and wind velocity and negatively correlated with rainfall [10]. It has been found that there are at least 26 insect species which effect on the brinjal production and cause serious losses. The most important includes Brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.), Hudda beetle (*Henosepilachna vigintioctopunctata* Fab.), leafhopper (*Amarasca devastans*), whitefly (*Bemisia tabaci* Genn.) and aphid (*Aphis gossypii* Glover.) which cause severe losses in brinjal [11].

Epilachna vigintioctopunctata is a serious pest of vegetables and can be easily identified by 14 or 28 spots on its dorsal side with 7 pronotal spots. Hadda beetle can cause serious damage to Cucurbitaceous and Solanaceous crops [12]. They are specialist feeders of various plant species of family Solanaceae but they vigorously start feeding within 5 minutes on tomato and brinjal and continually feeding to cause severe losses [13]. Both the damaging stages, adults and grubs feed on the epidermal layer of the leaves, reducing the photosynthetic area and cause serious defoliation [14]. The most damaging and voracious stages are 3rd and 4th instar grubs and may cause damage up to 80% in favorable conditions however it varies depending on the environmental conditions [15]. The adults confine their damage to the upper side while grubs usually on the lower side of the leaves [16].

Although different practices can be used for the management of hadda beetle population but mostly farmers prefer the use of chemicals which have bad effects on the environment leading to the serious hazardous effects on the human health. So we have to focus on more sustainable and environmentally friendly approaches for the management of these pests. Integrated pest management include different tactics for the management of these pest but the most effective and encouraging results were found in the host plant resistant mechanism. Keeping in view the importance of these facts, the present study was conducted to evaluate different brinjal cultivars against hadda beetle which will help the farmers to attain better yield production.

2. Materials and Methods

2.1 Research Area

The research was conducted at University Research Farm Koon, during 2015. Rawalpindi region has unique environmental conditions. The winter season is too cold having average maximum temperature and minimum temperature of 24.4 °C and 3.4 °C respectively while summer season are very hot having average maximum and minimum temperature of 34.2 °C and 16.4 °C respectively. The different brinjal cultivars were collected for the experiment to evaluate them against hadda beetle.

2.2 Screening of Brinjal Cultivars

The land was prepared with ploughing, laddering and fertilized with organic manure. The individual plot size was of 11.5 × 7 m. Plant-Plant and Row-Row distance was maintained at 60 and 75 cm, respectively in each experimental plot. The irrigation was done accordingly as necessary. The nursery was raised at green house of Horticulture Department, PMAS-AAUR. The seedlings of five different cultivars like Round F1 Hybrid, Short Purple, Pusa Purple Long, EP-273 and Blue Pearl were transplanted after 4 weeks of germination to the experimental plots. The data regarding pest population was recorded on five different randomly selected plants of each replication from 40 days after transplantation till the harvest of crop.

2.3 Number of Eggs

The number of eggs of *E. vigintioctopunctata* were counted in the morning hours from five randomly selected plants of each experimental unit and three leaves were selected further from each selected plant representing the upper, middle and lower portion of the plant. The eggs were counted carefully using magnifier lens and data were taken at weekly (7± 1 day) interval. The average was calculated by following formula:

$$\text{Average no. of eggs per leaf} = \frac{\text{Total no. of eggs counted}}{\text{Total no. of leaves observed}}$$

2.4 Number of Grubs

The number of grubs of *E. vigintioctopunctata* were recorded on weekly (7± 1 day) interval from five randomly selected plants of each replication. The number of grubs were counted from randomly selected upper, middle and lower leaf of each selected plant and average was calculated by following formula:

$$\text{Average no. of grubs per leaf} = \frac{\text{Total no. of grubs counted}}{\text{Total no. of leaves observed}}$$

2.5 Number of Adults

The number of adult beetles were also observed from five different plants of each replication of each treatment and data were collected at weekly (7± 1 day) interval. One leaf each from top, middle and lower portion of the selected plant were observed and average was calculated as:

$$\text{Average no. of adults per leaf} = \frac{\text{Total no. of adults counted}}{\text{Total no. of leaves observed}}$$

2.6 Physico- Morphic Characters

The physico-morphic characters viz: hair density on leaf lamina and mid-rib, stem girth, plant height, leaf area and number of primary branches of various brinjal cultivars were also recorded during the experiment to check their role in the resilience of above said cultivars.

2.7 Yield

Yield (kg/plant) of different brinjal cultivars were recorded in three different time of intervals and then subjected to correlate it with the extent of *E. vigintioctopunctata* population of various brinjal cultivars.

2.8 Statistical Analysis

The data regarding hadda beetle population on various brinjal cultivars and Physico- morphic characters of different cultivars were subjected to statistical analysis using the Co-Stat version 6.311 software package and means were compared with Duncan's Multiple Range test at 5% level of probability. Then, the data were processed for simple correlation.

3. Results and Discussion

3.1 Screening of Brinjal cultivars against Hadda Beetle

3.1.1 Eggs Population

The statistical analysis of variance and the means compared by DMR Test at (P=0.05) revealed that maximum number of eggs per leaf of hadda beetle were 5.92 on the cultivar Round F1 Hybrid which was significantly different from others brinjal cultivars and followed by Short Purple, Pusa Purple Long and EP-273 with 3.96, 3.89 and 3.82 respectively. The least number of eggs per leaf were 1.94 on Blue Pearl cultivars in (Table No. 1). The present findings are in contradictory with [17] who reported the fecundity of females was on brinjal (486) eggs.

3.1.2 Grubs Population

The data regarding grubs population has shown that most number of grubs per leaf were 1.35 on Round F1 Hybrid followed by Short Purple with 0.99 which were found. The Pusa Purple Long and EP-273 had 0.75 and 0.70 number of grubs respectively. The least number of grubs per leaf were 0.45 on Blue Pearl cultivar in (Table No. 1). The present findings are in agreement with those of [18,19] who recorded many host plants such as brinjal, tomato, tobacco, melon,

cucumber, gourds, pumpkin and potato have been attacked by *E. vigintioctopunctata*.

3.1.3 Adult Population

The data regarding number of adults per leaf of *E. vigintioctopunctata* revealed that most average number of adults per leaf were 0.75 on Round F1 Hybrid cultivar. The Pusa Purple Long and Short Purple had 0.65 and 0.60 number of adults respectively. The least number of adults per leaf were 0.41 on Blue Pearl followed by EP-273 with 0.47 number of adults in (Table No. 1).

Table 1: Mean comparison data regarding Number of Eggs, Grubs and Adults population of *E. vigintioctopunctata* on different brinjal cultivars per leaf during 2015.

Cultivars	Number of Eggs	Grub population	Adult Population
Round F1 Hybrid	5.92 a	1.35 a	0.75 a
Short Purple	3.96 b	0.99 b	0.60 b
Pusa Purple Long	3.89 b	0.75 c	0.65 b
EP-273	3.82 b	0.70 c	0.46 c
Blue Pearl	1.94 c	0.45 d	0.41 c
LSD	0.6558	0.203	0.0634
Analysis	F4, 199 = 1.912 p<0.0039**	F4, 199 = 2.35 p<0.000***	F4, 199 = 0.996 p<0.484 ns

Mean sharing similar letters are not significantly different by DMR Test at p=0.05

3.2 Physico-Morphic Characteristics of Different Brinjal Cultivars

3.2.1 Hairs density per cm² on leaf lamina of various brinjal cultivars

The data revealed that hairs density per cm² of leaf lamina on different brinjal cultivars were found significantly different from each other except the cultivar, Pusa Purple Long and Short Purple. The most average number of hairs with 538.27 per cm² on leaf lamina were recorded on Round F1 Hybrid which found significantly different from rest of the cultivars, followed by Pusa Purple Long and Short Purple with 497.44 and 492.84 hairs on leaf lamina per square centimeter respectively. The least number of hairs with 437.16/cm² on leaf lamina were found on Blue Pearl cultivar followed by 467/cm² on cultivar EP-273 in (Table No. 2).

3.2.2 Hairs density per cm on leaf mid-rib of various brinjal cultivars

The data revealed that maximum number of hairs on mid-rib were 185.44/cm on Round F1 Hybrid cultivar. The other cultivars Pusa Purple Long, Short Purple and EP-273 had shown 153.76, 145.76 and 122.77/cm number of hairs on mid rib respectively. The brinjal cultivar, Blue Pearl showed least number of hairs with (113.53/cm) on mid-rib in (Table No. 2).

3.2.3 Height of plants (cm) of different brinjal cultivars after 40 days of transplantation

The data revealed that maximum average height of plants after 40 days of transplantation were 43.55 cm of Round F1 Hybrid followed by Short Purple with 37.45 cm average height of plants. The EP-273, Pusa Purple Long and Blue Pearl had shown 32.45, 29.9 and 28.7cm average height of plants after 40 days of transplantation respectively. The least height of plants was found on Blue Pearl with 28.7 cm average height in (Table No. 2).

3.2.4 Height of plants (cm) of different brinjal cultivars after 70 days of transplantation

The data revealed that maximum average height of plants after 70 days of transplantation were 75.5 cm on Round F1 Hybrid followed by Pusa Purple Long and Short Purple with 68.65 and 67.55 cm average plant height respectively. The least average height of plants were found on Blue Pearl with 48.6 cm followed by EP-273 with 57.35 cm height of plants (Table No. 2).

3.2.5 Height of plants (cm) of different brinjal cultivars after 100 days of transplantation

The data revealed that maximum average height of plants after 100 days of transplantation were 121.5 cm on Round F1 Hybrid followed by Pusa Purple Long with 110.45 cm. The Short Purple, EP-273 and Blue Pearl had shown 105.75, 99.7 and 97.45 cm average height of plants respectively. The least average height was 97.45 cm on Blue Pearl plants in (Table No. 2).

3.2.6 Stem Girth (mm) of different brinjal cultivars after 40 days of transplantation

The data regarding stem girth of plants (mm) of different brinjal cultivars after 40 days of transplantation revealed that maximum stem girth were 44.80 mm on Pusa Purple Long followed by Round F1 Hybrid, Blue Pearl and Short Purple with 44.65, 40.17 and 39.08 mm average stem girth respectively. The lowest stem girth was 28.7 mm on EP-273 cultivar which found significantly different from other cultivars in (Table No. 2).

3.2.7 Stem Girth (mm) of different brinjal cultivars after 70 days of transplantation

The data had shown that maximum stem girth of plants after 70 days of transplantation were 57.86 mm average stem girth on Round F1 Hybrid followed by Pusa Purple Long and Short Purple with 56.33 and 54.32 mm respectively. The lowest stem girth were 45.32 mm on EP-273 cultivar followed by Blue Pearl with 47.33 mm stem girth in (Table No. 2).

3.2.8 Stem Girth (mm) of different brinjal cultivars after 100 days of transplantation

The data had shown that maximum stem girth of plants after 100 days of transplantation were 67.60 mm on Pusa Purple Long followed Round F1 Hybrid and Short Purple with 64.04 and 63.22 mm average stem girth respectively. The lowest stem girth were recorded on EP-273 cultivar with 54.85 mm followed by Blue Pearl with 56.25 mm stem girth in (Table No. 2).

3.2.9 Leaf Area in square centimeter of various brinjal cultivars

The data related leaf area in square centimeter had shown that maximum average leaf area was recorded 68.92 cm² on Blue Pearl followed by Short Purple with 63.44 cm² leaf area. The lowest leaf area were recorded 49.83 cm² on Round F1 Hybrid followed by 54.30 cm² and 54.62 cm² leaf area on EP-273 and Pusa Purple Long cultivars respectively. These results found very similar to those described by [20] who reported that cultivars with more leaf area showed least pest population (Table No. 2).

3.2.10 Number of primary branches of various brinjal cultivars

The most number of primary branches were recorded 6.5 on Round F1 Hybrid which were found significantly different

from other cultivars. The Short Purple and Pusa Purple Long had 5.5 and 4.95 number of primary branches respectively. The least number of primary branches were recorded 3.75 on Blue Pearl followed by 4.25 number of primary branches on EP-273 in (Table No. 2).

3.2.11 Comparison of Yield (Kg) per Plant of Various Brinjal Cultivars

The data regarding comparison of brinjal fruit yield (kg) per plant revealed that maximum average yield was observed 1.84 kg per plant on Blue Pearl which was significantly different from other cultivars. Alternatively, least yield 0.44 kg was observed on Round F1 Hybrid. Other brinjal cultivars viz; Pusa Purple Long, EP-273 and Short Purple gave 1.60, 1.43 and 1.20 kg of fruit yield respectively (TableNo.2).

3.3. Host Plant Susceptibility Indices

Host plant susceptibility indices were calculated on the basis of grub population of *E. vigintioctopunctata* on various brinjal cultivars during 2015. The results showed in the figure 3.1 revealed that maximum host plant susceptibility indices were recorded 31.91% on Round F1 Hybrid cultivar which found the most susceptible cultivar among the tested cultivars. The cultivar Short Purple with 23.40% found comparatively less susceptible. The least host plant susceptibility indices were calculated 10.55% on the Blue Pearl followed by 16.48% and 17.66% on EP-273 and Pusa Purple Long respectively which showed comparatively more resistance against hadda beetle grubs.

Table 2: Mean value comparison of data regarding Physico-morphic characters of brinjal cultivars during 2015.

Cultivars	Hairs density on leaf lamina per cm ²	Hairs density on mid-rib per cm	Plant Height (cm) after 40 days	Plant Height (cm) after 70 days	Plant Height (cm) after 100 days	Stem girth (mm) after 40 days	Stem girth (mm) after 70 days	Stem girth (mm) after 100 days	Leaf Area (cm ²)	Number of primary branches	Fruit yield (Kg) per plant
Round F1 Hybrid	538.27 a	185.44 a	43.55 a	75.50 a	121.55 a	44.65 a	57.86 a	64.04 a	49.83 c	6.5 a	0.44 e
Pusa Purple Long	497.44 b	153.76 b	29.90 b	68.65 ab	110.45 ab	44.80 a	56.33 a	67.60 a	54.62 c	4.95 bc	1.60 b
Short Purple	492.84 b	145.76 b	37.45 ab	67.55 ab	105.75 b	39.08 ab	54.32 a	63.22 a	63.44 b	5.5 b	1.20 d
EP-273	467.00 c	122.77 bc	32.45 b	57.35 bc	99.7 b	36.05 b	45.32 b	54.85 b	54.30 c	4.25 cd	1.43 c
Blue Pearl	437.16 d	113.53 c	28.7 b	48.6 c	97.45 b	40.17 ab	47.33 b	56.25 b	68.92 a	3.75 d	1.84 a
LSD	12.14	25.58	7.08	11.84	12.55	4.94	6.95	5.17	5.25	0.72	0.10
Analysis	F4, 19=91.11 p<0.000***	F4, 19=11.58 p<0.0004**	F4, 19=7.08 p<0.0036**	F4, 19=7.56 p<0.0028**	F4, 19=5.57 p<0.009**	F4, 19=5.57 p<0.009**	F4, 19=6.17 p<0.0064**	F4, 19=10.46 p<0.0007**	F4, 19=20.68 p<0.000***	F4, 19= 20.87 p<0.000***	F4,59=5.62 p<0.000***

Mean sharing similar letters are not significantly different by DMR Test at P=0.05

3.3.1 Host Plant Susceptibility Indices

Host plant susceptibility indices were calculated on the basis of grub population of *E. vigintioctopunctata* on various brinjal cultivars during 2015. The results showed in the figure 3.1 revealed that maximum host plant susceptibility indices were recorded 31.91% on Round F1 Hybrid cultivar which found the most susceptible cultivar among tested cultivars. The

cultivar Short Purple with 23.40% found comparatively less susceptible. The least host plant susceptibility indices were calculated 10.55% on Blue Pearl followed by 16.48% and 17.66% on EP-273 and Pusa Purple Long respectively which showed comparatively more resistance against hadda beetle grubs.

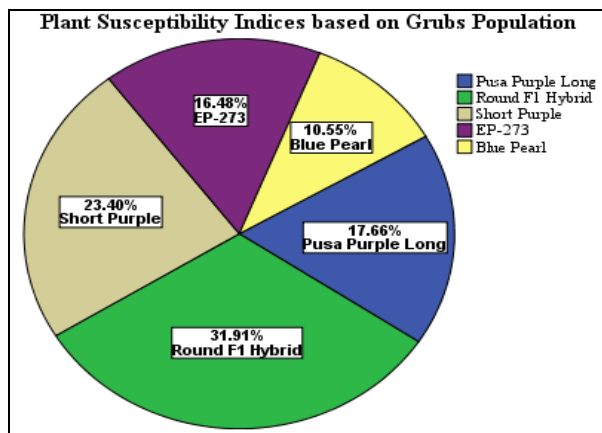


Fig 3.1: Host Plant Susceptibility Indices (%) based on Grubs population of hadda beetle on various brinjal cultivars.

3.4. Correlation of Hadda Beetle Population with Physico-Morphic Characters

3.4.1 Correlation between Hadda Beetle Grubs and Physico-morphic characters

The results given in the Table No.3 revealed that average hair density on leaf lamina per cm² and hair density on mid-rib per cm showed significant positive correlation with the grub population of *E. vigintioctopunctata* with r-value 0.94 and 0.92 respectively. The average plant height and number of primary branches had shown highly significant positive correlation with the grub population with r-value 0.96 and

0.98 respectively while stem girth had a non-significant positive impact on grubs population with r-value 0.69. Leaf area showed non-significant negative impact with r-value -0.64, while yield had highly significant negative correlation with grub population with r-value -0.98.

3.4.2 Correlation between Hadda Beetle adults and Physico-morphic characters

The results in the Table No.3 revealed that hair density on leaf lamina per cm², hair density on mid-rib per cm and plant height (cm) showed a significant positive correlation with the

adult population of *E. vigintioctopunctata* with r-value 0.98, 0.99 and 0.98 respectively. The average stem girth (mm) and number of primary branches had shown a significant positive correlation with the adult population with r-value 0.92 and 0.94 respectively whereas leaf area and yield had a non-significant negative impact on *E. vigintioctopunctata* adult population with r-value -0.69 and -0.80 respectively. These results found similar to those described by [20] who reported

that cultivars with more leaf area showed least pest population. The results found in conformity to those described by [21] who reported that number of primary branches had positive and significant correlation with pest population. These results were in conformity to those described by [22] who reported positive and highly significant correlation between plant height and brinjal infestation.

Table 3: Correlation between *E. vigintioctopunctata* population and Physico-morphic characters.

Physico-morphic Characters	Grub Population Correlation (r-value)	Adult Population Correlation (r-value)
Hairs density on leaf lamina	0.94*	0.98**
Hairs density on mid-rib	0.92*	0.99**
Plant height	0.96**	0.98**
Shoot/stem girth	0.69ns	0.92*
Leaf area	-0.64ns	-0.69ns
Primary branches	0.98**	0.94*
Yield	-0.98**	-0.80ns

3.5. Correlation of Hadda Beetle population with different weather factors during 2015.

3.5.1 Correlation of Hadda Beetle Grubs with different weather factors

The data regarding correlation of *E. vigintioctopunctata* grub population with different weather factors given in the Table No.4 revealed that minimum and average temperature (C°) had shown non-significant positive correlation with grubs population whereas significant positive correlation was found on Blue Pearl with r-value 0.70. The Maximum temperature (C°) and average rainfall had negative impact on the grub

population on all cultivars except Round F1 Hybrid and EP-273 with r-value 0.33 and 0.03 respectively. Average Relative Humidity (%) showed non-significantly positive correlation with grub population on all the cultivars except Round F1 Hybrid with -0.29. These results found very similar to the findings described by [23] who reported that hadda beetle grubs had significant negative correlation with maximum temperature and significant positive correlation with relative humidity. Average Rainfall (mm) had shown non-significantly negative correlation with grubs population.

Table 4: Correlation of Hadda Beetle Grubs population with different weather factors during 2015.

Cultivars	Minimum Temp. (°C)	Maximum Temp. (°C)	Average Temp.(°C)	Average R. H. (%)	Average Rainfall(mm)
Pusa Purple Long	0.57 ^{ns}	-0.16 ^{ns}	0.41 ^{ns}	0.29 ^{ns}	-0.44 ^{ns}
Round F1 Hybrid	0.03 ^{ns}	0.33 ^{ns}	0.45 ^{ns}	-0.29 ^{ns}	-0.55 ^{ns}
Short Purple	0.42 ^{ns}	-0.03 ^{ns}	0.41 ^{ns}	0.11 ^{ns}	-0.50 ^{ns}
EP-273	0.39 ^{ns}	0.03 ^{ns}	0.45 ^{ns}	0.07 ^{ns}	-0.54 ^{ns}
Blue Pearl	0.70*	-0.28 ^{ns}	0.40 ^{ns}	0.44 ^{ns}	-0.26 ^{ns}

* = Significant ** = Highly Significant ns = Non Significant at 0.05

3.5.2 Correlation of Hadda Beetle adults with different weather factors

The data regarding correlation of *E. vigintioctopunctata* adult population with different weather factors given in (Table No.5) revealed that minimum temperature (C°) and average relative humidity had positive and significant impact on the adult population on all cultivars Pusa Purple Long, Short Purple and EP-273 were non-significant impact of minimum temperature. Average rainfall showed positive but non-

significant correlation with adult population except Blue Pearl with 0.64. Maximum and average temperature (C°) had shown negative but non-significant correlation with adults population on all tested brinjal cultivars except Short Purple, Round Hybrid F1 and Pusa Purple Long which were negative but significant correlation with adult population. These results found very similar to those described by [24] who reported a negative correlation with temperature and positive correlation to all other abiotic factors.

Table 5: Correlation of Hadda Beetle Adults population with different weather factors during 2015.

Cultivars	Minimum Temp. (°C)	Maximum Temp. (°C)	Average Temp. (°C)	Average R. H. (%)	Average Rainfall (mm)
Pusa Purple Long	0.42 ^{ns}	-0.68*	-0.40 ^{ns}	0.67*	0.18 ^{ns}
Round Hybrid F1	0.64*	-0.76*	-0.27 ^{ns}	0.84**	0.38 ^{ns}
Short Purple	0.43 ^{ns}	-0.76*	-0.49 ^{ns}	0.72*	0.47 ^{ns}
EP-273	0.59 ^{ns}	-0.50 ^{ns}	-0.07 ^{ns}	0.67*	0.47 ^{ns}
Blue Pearl	0.76**	-0.50 ^{ns}	0.19 ^{ns}	0.71*	0.64*

* = Significant ** = Highly Significant ns = Non Significant at 0.05

3.6 Conclusion

The present study concluded that brinjal cultivar, Blue Pearl had shown the most resistance against the *E. vigintioctopunctata* Fabricius population and least number of eggs, larvae and adults were recorded on it. While the highest yield productions were also observed in the above mentioned cultivar and it may be recommended for cultivation in arid

regions to gain maximum fruit yield of brinjal.

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