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Varietal resistance of pumpkin (*Cucurbita pepo* L.) Germplasms against Red Pumpkin Beetle *Aulacophora foveicollis* L. in Pothwar region

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Abstract

The present study was conducted for the evaluation of different pumpkin cultivars against Red Pumpkin Beetle *Aulacophora foveicollis* L. (Chrysomelidae: Coleoptera) at University Research Farm Koont, during 2016. The data regarding number of eggs, larvae and adult population on Bottle Gourd Lattu and Bottle Gourd varieties with 0.26 and 0.23 number of eggs per leaf while 0.31 and 0.22 larvae population per leaf and maximum population of adults with 0.26 and 0.18 per leaf were recorded respectively. The minimum population of eggs, larvae and adult were recorded on Round Gourd Hybrid-F1 with 0.08, 0.06 and 0.05 per leaf respectively. According to physico-morphic characters the length and girth of Bottle Gourd Lattu and Bottle Gourd varieties were maximum with (0.26 and 0.18 cm length of plant) and (20.97 and 20.67 mm girth of plant) and minimum vines length and girth with 0.18 cm length of plant and 20.72 mm girth of plant were recorded on Round Gourd Hybrid-F1. The leaf infestation of Bottle Gourd and Bottle Gourd Lattu were maximum with 33.33 and 33.21 percent respectively while minimum infestation was recorded on Round Gourd Hybrid-F1 i.e 24.25 percent. Flower infestation of Bottle Gourd and Bottle Gourd Lattu were higher with 22.81 and 22.76 percent and minimum on Round Gourd Hybrid-F1 with 14.83 percent. Maximum yield was observed on Round Gourd Hybrid-F1 with 17.11 kg while the Bottle Gourd Lattu and Bottle Gourd had low yield 10.58, 10.58 kg respectively.

Keywords: Pumpkin, red pumpkin beetle, physico-morphic and abiotic factors

1. Introduction

Pumpkin (*Cucurbita pepo* L.) belongs to the family Cucurbitaceae having about 118 genera and 825 species [1]. The cucurbita species are now cultivated throughout the world. It provides good source of energy to the people. According to latest research in Asia, India and China is the major producer of cucurbitaceous vegetable but worldwide Africa, North America, Europe, South America and Oceania with 58, 15, 11, 9, 3 and 0.8 percent share in the production of cucurbitaceous vegetable respectively [2]. The Pumpkin is an important vegetable crop that widely grown in tropical and subtropical region of the world [3]. There are other members such as musk melon, water melon, cucumbers and the gourds [4]. Among the vegetables, the cucurbits are more significant group due to extraordinary nutritive standards such as β -carotene, extended shelf-life and satisfactory deliciousness towards the users [5]. Pumpkin is best among the cucurbits and having the highest economic worth [6]. Pumpkin is a vegetable that fulfill the needs of healthy nourishment [7]. Pumpkin seeds are admirable cradle of protein and furthermore having the pharmacological properties such as antifungal, anti-diabetic and anti-inflammation characteristics [8]. The seeds extract has been used as an antidiabetic, antitumor, antibacterial, anticancer and antioxidant [9].

There are many insect pests which attack on cucurbits but Red Pumpkin Beetle (*Aulacophora foveicollis*) is the key pest that causes significant losses to the cucurbitaceous crops. Red pumpkin beetle has a polyphagous behavior. Cucurbit vines are largely damaged by feeding on the cotyledons which encompass great yield losses. It starts damage after the germination and reduces the plant growth due to destructive feeding. Both adults and larvae cause damage to the vegetable but the larval stage that live underground, are regarded as more destructive. Its active period starts from March till October. Its peak activity ranges from April to June and its activity falls from September. Increase or decrease in population is due to the deviations of food availability [10]. The prevalence of mature stage on many cucurbits has been described by numerous workers [11]. Red Pumpkin Beetle cause yield losses ranges from 30 to 100%.

Sometime losses are such severe that the crop needs resowing for 3 to 4 times [12]. It is the most dangerous pest of the cucurbitaceous vegetables. It is scattered over Asia, Australia, Europe and Africa [13]. It feeds on leaves by making asymmetrical dams and also damages the flowers [14].

Management of this pest using the insecticides causes several problems and adds the dangerous residues to the fruit. Chemicals are also fatal for beneficial insects and major source of polluting the environment. One of the effective and cheapest way to control an insect pest is the use of resistant cultivars against the red pumpkin beetle. The use of host plant resistance (HPR) for insect pest control is environmental friendly practice. It will play significant role in integrated pest management program.

Keeping in view positive and negative aspects of different control measures, the present study was conducted to evaluate different pumpkin cultivars against red pumpkin beetle. It will also help to increase the pumpkin yield and facilitate small farmers for growing of this important vegetable.

2. Materials and Methods

The experiment was conducted in a Randomized Complete Block Design (RCBD) to evaluate different cultivars of pumpkin along with four replications at University Research Farm Koont, during 2016.

2.1 Research Area

Rawalpindi region have different environmental conditions. Its winter season are cold and dry having average maximum temperature 24.4 °C and average minimum temperature 3.4 °C while its summer season vary are hot and rainy having average maximum and minimum temperature of 34.2 °C and 16.4 °C respectively. The different pumpkin cultivars were collected for field experiment as well as for the screening of pumpkin cultivars against red pumpkin beetle.

2.2 Screening of Pumpkin Cultivars

Sowing of different pumpkin cultivars were done using dip method. Land preparation was done using standard farm operations. The plot size was dimension 20 m×25 m. The distance from plant to plant and row to row was maintained as 45 cm and 75 cm respectively. Irrigation was done at 7 days and 10 days. Data regarding pest population of pumpkin were recorded on five different randomly selected plants from each replication starting from 40 days after sowing till the harvesting.

2.3 Egg Population

The number of eggs of red pumpkin beetle was observed in morning hours from five different randomly selected plants of each experimental unit. Three leaves from each plant were selected, i.e near the tip of the vine, at the middle of the vine and close to the point of organ. The eggs were counted carefully by using the magnifier lens and data was taken at weekly (7± 1 day) interval. The average was calculated by using the following formula:

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

2.4 Larval Population

The number of grubs of red pumpkin beetle was recorded on weekly (7± 1 day) interval from the five different randomly selected plants of each replication. The grubs were counted

from randomly selected upper, middle and lower portion of leaf of each selected plant. The average was calculated by using the following formula:

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

2.5 Adult Population

The number of adult beetles was observed from five different plants of each replication of each treatment and the data were recorded on weekly (7± 1 day) interval. The number of adults population were counted from randomly selected upper, middle and lower portion of leaf of each selected plant. The average was calculated as:

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

2.6 Correlations

Red Pumpkin Beetle larval and adult populations were correlated with environmental factors. The physico-morphic characteristics were also correlated with pests' population dynamics.

2.7 Statistical Analysis

The data regarding the population pattern of red pumpkin beetle *A. foveicollis* L. on different pumpkin cultivars and physico-morphic characters of various varieties were subjected to statistical analysis and means were compared with Duncan's Multiple Range test at 5% level of probability. Then, the data was processed for simple correlation.

3. Results and Discussion

3.1 Screening of Different Pumpkin Cultivars against Red Pumpkin Beetle

3.1.1 Eggs Population

The different pumpkin cultivars were evaluated to investigate the eggs population in 2016. The data regarding the beetle eggs population exposed that the Bottle Gourd Lattu and Bottle Gourd were the susceptible cultivar with 0.26 and 0.23 eggs per leaf and Round Gourd Hybrid-F1 was the comparative resistant cultivar with 0.08 per leaf. Gourd Long Hybrid-F1, pumpkin Hybrid-F1 and Pumpkin Desi Special were statistically similar to each-others with 0.13, 0.14 and 0.16 per leaf population respectively in the (Table No. 1). The present studies results that number of eggs of red pumpkin beetle were minimum on number of pumpkin cultivars which is not similar to the finding of [15, 16] which might be due to the environment factors in the research year.

3.1.2 Larval Population

The means of red pumpkin beetle larval population on all pumpkin cultivars were analyzed by DMR Test (0.05) and results showed the most number of grubs were recorded on Bottle Gourd Lattu and Bottle Gourd cultivars with 0.31 and 0.22 larvae per leaf and Round Gourd Hybrid-F1 was comparative resistant cultivar against *A. foveicollis* L. with 0.06 larvae per leaf which were followed by Gourd Long Hybrid-F1, Pumpkin Hybrid-F1 and Pumpkin Desi Special with an average of 0.12, 0.13 and 0.13 respectively in the (Table No. 1). The present studies results that densities of red pumpkin beetle were lower on number of pumpkin cultivars which is contradict to the finding of [17] which might be due to the abiotic factors in the research year.

3.1.3 Adult Population

The presence of adults of red pumpkin beetle on different pumpkin cultivars revealed that Round Gourd Hybrid-F1 was the comparatively resistant and significantly different from all other cultivars with 0.05 beetle adults per leaf. The highest beetle population was recorded on Bottle Gourd Lattu and Bottle Gourd which were the most susceptible cultivars with 0.26 and 0.18 adults per leaf. The adults per leaf were recorded on Gourd Long Hybrid-F1 and Pumpkin Hybrid-F1 with 0.13 and 0.12 adults per leaf in the (Table No. 1). According to [18] maximum adults population per leaf were recorded on Bottle Gourd cultivars i.e. BSS-687 and Arya (45.3) relatively moderate susceptible towards this beetle which are similar to the result of current study. The results of [19] are in reliable with those of present study in which Bitter Gourd cultivars i.e. Jaunpuri, Nirali were highly resistant while the Cucumber and Bottle Gourd germplasms revealed comparatively moderate susceptible to the red pumpkin beetle.

3.1.4 Leaf infestation of pumpkin cultivars

The means leaves infestation of red pumpkin beetle on all pumpkin cultivars were analyzed by DMR Test (0.05). The results revealed that Bottle Gourd and Bottle Gourd Lattu

cultivars were most infested than other varieties and significantly different from other cultivars. Pumpkin Hybrid-F1, Pumpkin Desi Special and Gourd Long Hybrid-F1 were statistically similar to each other 28.96, 28.39 and 28.1 percent respectively. Round Gourd Hybrid-F1 with 24.25 percent was least infested to red pumpkin beetle in the (Table No. 1). [20] Recorded heigh leaf infestation per leaf on Bottle Gourd cultivars relatively moderate susceptible to red pumpkin beetle which are similar to the result of current study.

3.1.5 Flower infestation of pumpkin cultivars

Data relating to flower infestation was measured and means of data regarding flower infestation was compared by DMR Test at 0.05 P value. The results showed that Round Gourd Hybrid-F1 with 14.83 percent was least infested and resistant against red pumpkin beetle. Bottle Gourd and Bottle Gourd Lattu with 22.81 and 22.76 percent were highly infested. Pumpkin Desi Special and Pumpkin Hybrid-F1 were statistically similar with 17.91 and 17.15 percent in the (Table No. 1). Similar results were reported by [20] who reported that flower infestation per leaf on Bottle Gourd cultivars were relatively moderate susceptible to red pumpkin beetle.

Table 1: Mean comparison data Number of Eggs, Larval, Adult population, Leaf and Flower infestation of *A. foveicollis* L. on different pumpkin cultivars per leaf during 2016.

Cultivars	Number of Eggs	Larval population	Adult Population	Leaf infestation	Flower infestation
Bottle Gourd Lattu	0.26 a	0.31	0.26	33.21 a	22.76 a
Bottle Gourd	0.23 a	0.22	0.18	33.33 a	22.81 a
Gourd Long Hybrid-F1	0.13 b	0.12	0.16	28.1 b	16.05 c
Pumpkin Hybrid-F1	0.14 b	0.13	0.12	28.96 b	17.15 b
Pumpkin Desi Special	0.16 b	0.15	0.13	28.39 b	17.91 b
Round Gourd Hybrid-F1	0.08 c	0.06	0.05	24.25 c	14.83 d
LSD	0.034	0.025	0.023	1.55	0.96
Analysis	F5, 239 = 1.000 $p < 0.4801$ ns	F5, 239 = 0.878 $p < 0.6887$ ns	F5, 239 = 0.955 $p < 0.5576$ ns	F5, 95 = 2.22 $p < 0.0131$ *	F5, 47 = 1.64 $p < 0.1747$ ns

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

3.2 Physico-morphic Characters on Different Pumpkin Cultivars During 2016

3.2.1 Height of pumpkin cultivars in (cm) after 40 days

The data related to the height of different pumpkin cultivars after 40 days was measured. The means data regarding plant height was compared by DMR Test at 0.05 P value. The Bottle Gourd Lattu was significantly different from all other cultivars with the mean height of 0.26 cm. The average height was recorded on Gourd Long Hybrid-F1 and Pumpkin Desi Special with 0.12 and 0.16 cm which were similar to each other. Maximum mean height was recorded on Round Gourd Hybrid-F1 with 0.18 cm in the (Table No. 2).

3.2.2 Height of pumpkin cultivars in (cm) after 70 days

The data regarding height of different cultivars of pumpkin after 70 days was calculated along with the Analysis of variance. It result was recorded that, the average plant height of different pumpkin cultivars were statistically similar to each other Pumpkin Desi Special with 91.1 cm followed by Gourd Long Hybrid-F1, Pumpkin Hybrid-F1, Bottle Gourd, Bottle Gourd Lattu with (87.75 cm, 87 cm, 86.57 cm and 82.27 cm) respectively in the (Table No. 2).

3.2.3 Height of pumpkin cultivars in (cm) after 100 days

The means data regarding plant height were compared by DMR Test at 0.05 P value. The results revealed that Round Gourd Hybrid-F1 was the most resistant and non-significantly

different from all other five cultivars with 104.62 cm followed by Gourd Long Hybrid-F1, Bottle Gourd Lattu, Bottle Gourd, Pumpkin Hybrid-F1 and Pumpkin Desi Special with 134.15, 133.5, 127.87 and 125.2 cm and 116.47 cm respectively in the (Table No. 2).

3.2.4 Plant Stem Girth of Pumpkin Cultivars in (mm) After 40 Days

Data relating to different pumpkin plant stem girth after 40 days were measured and their Analysis of variance was also calculated. The results showed that Pumpkin Desi Special with 22.02 mm and Gourd Long Hybrid-F1 with 21.97 mm were statistically similar with each other. And the Bottle Gourd Lattu, Round Gourd Hybrid-F1 and Bottle Gourd were also exposed similar to each other with 20.97, 20.72 and 20.67 mm respectively in the (Table No. 2).

3.2.5 Plant stem girth of pumpkin cultivars in (mm) after 70 days

The data regarding plant stem of different cultivars of pumpkin after 70 days were calculated along with the Analysis of variance. The result showed that the average stem girth of the pumpkin plants were statistically similar to each other Round Gourd Hybrid-F1 with 29.95 mm followed by Pumpkin Hybrid-F1, Bottle Gourd Lattu, Pumpkin Desi Special, Bottle Gourd and Gourd Long Hybrid-F1 cultivars with 29.95 mm, 29.87 mm, 29.72 mm, 29.12 mm and 28.05

mm respectively in the (Table No. 2).

3.2.6 Plant stem girth of pumpkin cultivars in (mm) after 100 days

The means of data regarding plant stem girth were compared by DMR Test at 0.05 P value. The results showed that Bottle Gourd Lattu and Bottle Gourd were the susceptible and significantly different from other cultivars with 51.37 mm and 50.7 mm. It was also showed from these results that, the average stem girth of the pumpkin plants were statistically similar to each other in the (Table No. 2).

3.2.7 Fruit length in (cm) at mature stage

The data regarding fruit length of different pumpkin cultivars at mature stage were calculated. Round Gourd Hybrid-F1 revealed that having more length and non-significantly different from all other five cultivars with 17.05 cm. It is evident that Bottle Gourd Lattu with (7.01 cm) and Bottle Gourd with (6.56 cm) cultivars were significantly similar to each other in the (Table No. 2).

3.2.8 Fruit girth in (mm) at mature stage

Data relating to different pumpkin fruits girth were measured and their Analysis of variance was also calculated. The results

showed that Round Gourd Hybrid-F1 with 26.99 had more fruit girth and resistant cultivar than other pumpkin fruits. Pumpkin Desi Special with 21.14 mm was statistically similar to Pumpkin Hybrid-F1 with 20.76 mm. The results also revealed that Bottle Gourd, Bottle Gourd Lattu and Gourd Long Hybrid-F1 cultivars were also statistically similar with each other 12.88 mm, 11.55 mm and 10.55 mm respectively in the (Table No. 2).

3.2.9 Yield in (kg) per plant of different pumpkin cultivars

The data regarding comparison of yield in kg of different pumpkin fruits were calculated. Analysis of variance and mean compared by DMR Test at (P=0.05) showed that the average yield comparison (kg) of different pumpkin fruits were statistically different to each other. The results revealed that the Round Gourd Hybrid-F1 fruits gave the highest yield 17.11 (kg) followed by Pumpkin Hybrid-F1, Pumpkin Desi Special, Gourd Long Hybrid-F1 with 14.06, 13.37 and 12.61 (kg). Least yield was observed in Bottle Gourd Lattu with 10.58 (kg) and Bottle Gourd with 10.58 (kg) in the (Table No. 2). The present research findings were different to the result of [21] who reported that Bottle Gourd cultivars yield 17.78 kg per plot.

Table 2: Mean values comparison of data regarding different Physico-morphic characters on pumpkin cultivars during 2016.

Cultivar	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	Fruit length in (cm)	Fruit girth in (mm)	Fruit yield (Kg) per plant
Bottle Gourd Lattu	0.26 a	82.27 a	133.5 a	20.97 ab	29.87 a	51.37 a	7.01 c	11.55 c	10.58 d
Bottle Gourd	0.18 b	86.57 a	127.87 ab	20.67 ab	29.12 a	48.2 a	6.56 c	12.88 c	10.58 d
Gourd Long Hybrid-F1	0.12 c	87.75 a	134.15 a	21.97 a	28.05 a	48.22 a	13.62 ab	10.55 c	12.61 c
Pumpkin Hybrid-F1	0.13 c	87 a	125.2 ab	19.95 b	29.95 a	47.8 a	12.30 b	20.76 b	14.06 b
Pumpkin Desi Special	0.16 b	91.1 a	116.47 bc	22.02 a	29.72 a	50.7 a	10.14 bc	21.14 b	13.37 bc
Round Gourd Hybrid-F1	0.18 d	79.75 a	104.62 c	20.72 ab	29.95 a	49.62 a	17.05 a	26.99 a	17.11 a
LSD	0.02	10.35	13.84	1.74	2.26	4.15	3.61	5.78	0.90
Analysis	F5, 23=57.34 p<0.0000***	F5,23=1.40 p<0.2777ns	F5, 23=6.07 p<0.0029**	F5,23=1.95 p<0.1446 ns	F5,23=0.99 p<0.4522 ns	F5,23=1.15 p<0.3743 ns	F5, 71=9.98 p<0.0000***	F5,71=10.44 p<0.0000***	F5,71=39.08p<0.0000***

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

3.3 Correlation of Red Pumpkin Beetle Population on Pumpkin Cultivars with Different Weather Factors

3.3.1 Correlation of Larval Population

The data regarding correlation between weather factors and *A. foveicollis* L. larval population of different pumpkin cultivars, Analysis of variance and mean was compared by DMR Test at (P=0.05) presented that maximum temperature showed negative and non-significant correlation between number of grubs on all the cultivars except Round Gourd Hybrid-F1 with 0.008 which showed positive correlation. Minimum temperature showed non-significant and negative correlation between number of grubs on all the cultivars except Gourd Long Hybrid-F1 and Round Gourd Hybrid-F1 with -0.26 and -0.39 which showed positive correlation in the (Table No. 3). Average temperature showed non-significant and negative correlation between number of grubs on all the cultivars except Bottle Gourd with 0.002 which showed positive correlation. Average relative humidity showed positive and non-significant correlation between number of grubs on three of cultivars and Bottle Gourd Lattu showed positive and highly significant correlation and Round Gourd Hybrid-F1

with -0.13 showed negative and non-significant correlation between number of grubs and average relative humidity in the (Table No. 3).

Average rainfall showed positive and non-significant correlation between number of grubs on two of cultivars and Bottle Gourd Lattu with 0.79 showed positive and highly significant correlation while Gourd Long Hybrid-F1 and Round Gourd Hybrid-F1 with -0.44 and -0.53 showed negative and non-significant correlation between number of grubs and average rainfall. These results were also the same as those reported by [22] who noted that relative humidity of 70% was optimal for the development and duration of various stages of the beetles (*A. foveicollis*) in the (Table No. 3).

3.3.2 Correlation of Adults Population

The data regarding correlation between weather factors and *A. foveicollis* L. adults population of different pumpkin cultivars, Analysis of variance and mean, compared by DMR Test at (P=0.05) showed that maximum temperature showed negative correlation on all the pumpkin cultivars. The minimum temperature, average temperature and relative humidity

revealed positive correlation on all the cultivars with the number of adults. The average rainfall showed negative correlation on the Round Gourd Hybrid-F1 (-0.11), Pumpkin Desi Special (-0.12) and Bottle Gourd Lattu (-0.09) and showed positive correlation on Bottle Gourd, Pumpkin Hybrid-F1 and Gourd Long Hybrid-F1 with the values 0.11, 0.47 and 0.44 respectively in the (Table No. 4). These results were in conformity with [23] who concluded that 19-37 °C and 30-82% Relative humidity was among the most favorable conditions for pest prevalence.

Table 3: Correlation of larval population of RPB on different pumpkin cultivars with different weather factors during 2016

Cultivars	Min. Temp. °C	Max. Temp. °C	Avg. Temp. °C	Avg. R. H. %	Avg. Rainfall (mm)
Bottle Gourd Lattu	0.58 ns	-0.68*	-0.08ns	0.84**	0.79**
Bottle Gourd	0.37 ns	-0.35ns	0.002 ns	0.39ns	0.20ns
Pumpkin Desi Special	0.07 ns	-0.13ns	-0.06ns	0.005ns	-0.06 ns
Pumpkin Hybrid-F1	0.46 ns	-0.48ns	-0.02 ns	0.43ns	0.14 ns
Gourd Long Hybrid-F1	-0.26 ns	-0.30ns	-0.50ns	0.05ns	-0.44 ns
Round Gourd Hybrid-F1	-0.39ns	0.008	-0.35ns	-0.13ns	-0.53ns

* = Significantly and

ns = Non Significantly at 0.05

Table 4: Correlation of Adults population of RPB on different pumpkin cultivars with different weather factors during 2016

Cultivars	Min. Temp. °C	Max. Temp. °C	Avg. Temp. °C	Avg. R. H. %	Avg. Rainfall (mm)
Bottle Gourd Lattu	0.40 ^{ns}	-0.18 ^{ns}	0.18 ^{ns}	0.33 ^{ns}	-0.09 ^{ns}
Bottle Gourd	0.39 ^{ns}	-0.031 ^{ns}	0.06 ^{ns}	0.38 ^{ns}	0.11 ^{ns}
Pumpkin Desi Special	0.61 ^{ns}	-0.09 ^{ns}	0.44 ^{ns}	0.29 ^{ns}	-0.12 ^{ns}
Pumpkin Hybrid-F1	0.64*	-0.49 ^{ns}	0.12 ^{ns}	0.71*	0.47 ^{ns}
Gourd Long Hybrid-F1	0.80**	-0.47 ^{ns}	0.28 ^{ns}	0.64*	0.44 ^{ns}
Round Gourd Hybrid-F1	0.31 ^{ns}	-0.03 ^{ns}	0.24 ns	0.21 ^{ns}	-0.11 ^{ns}

* = Significantly and

ns = Non Significantly at 0.05

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