MORPHOLOGICAL TRAITS AND PHYTOCHEMICAL CONTENTS OF BRINJAL GERMPLASM AFFECT THE INCIDENCE AND INFESTATION OF APHID

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ABSTRACT

The study was conducted with BD-7320, BD-7328, BD-9952, BD-10154, BD-10158, BARI Begun-1, BARI Begun-4, BARI Begun-5, BARI Begun-6, BARI Begun-7, BARI Begun-8 and BARI Begun-9 germplasm lines of brinjal with a view to understanding the resistant behavior of plant morphological characteristics and phytochemical contents to aphid infestation. The experiment was conducted at Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh during September 2018 to March 2019. The abundance of aphid among the germplasm lines varied significantly, and was the lowest and statistically similar on BD-9952, BARI Begun-6 and BARI Begun-4. The abundance of aphid on BARI Begun-8 and BD-10158 showed significant positive correlation with plant height, branch/plant, leaf/plant and leaf area, but had significant negative association with abaxial and adaxial leaf trichomes, spine/stem and spine/leaf. The phytochemical content of leaf like moisture, total chlorophyll, proline, reducing sugar, total sugar and protein content had positive effect on the abundance of aphid, whereas pH and ash content of leaf had negative correlation. The infestation level of aphid varied significantly among twelve germplasm lines where BD-9952, BARI Begun- 6 and BARI Begun- 4 depicted statistically similar and the lowest infestation of aphid.

Keywords: *Solanum melongena,* morphological characters, phytochemicals, *Myzus persicae.*

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INTRODUCTION

Brinjal is the second important and commercially grown annual vegetable after potato. The best growing areas of brinjal in Bangladesh are Rajshahi, Sirajganj, Jamalpur, and Jashore (BBS 2016). The production of brinjal faces a great loss from season to season depending upon many reasons such as biotic factors like insect pests and pathogens, and abiotic factors like temperature, relative humidity and rainfall (Gangwar and Sachen 1981). Brinjal is subjected to attack by 140 species of insect pests from nursery stage till harvesting (Regupathy *et al.* 1997). Among the insect pests, aphid, *Myzus persicae* (Sulzer); jassid, *Amrasca biguttula biguttula* (Ishida); shoot and fruit borer, *Leucinodes orbonalis* (Guenee); whitefly, *Bemicia tabaci* (Genn.) are the most destructive.

Aphid is one of the most harmful threats to brinjal. The direct consequences of its infestation include production losses, decline in quality and increased agricultural risks (Miller 2009). The nymphs and adults of aphid suck cell sap from the leaves and tender shoots, and plants become weak, pale, stunted, and curling downward, which reduce the fruit size and yield as high as 25-40% (Ghosh 2004).

Host plant defense mechanisms are very significant considerations in integrated pest management (IPM) program against the chewing and sucking insects (Tsai and Wang 2001). Brinjal shows response to higher amount of nutrients with good plant growth and vigor, and by producing more leaves, branches and bigger size of leaves provide more food resources to the insects (Teja and Bradford 2000). It was found that insect population was negatively correlated with trichome density and greater number of spine on plant parts (Khan *et al*. 2015, Amin *et al*. 2017). The nutrient contents of crop varieties are responsible to cause variations in survival, growth, developmental time, reproduction and population dynamics of insects (Amjad & Peters 1992, Amin *et al*. 2011). Higher ash content and pH level, and lower amount of total sugar and reducing sugar were found in resistant germplasm of brinjal (Panda and Das 1975). Raju *et al.* (2007) discovered less protein content determined as total nitrogen content in leaf of moderately resistant cultivar.

The occurrence of insecticide resistance, pest resurgence, human health hazards and environmental pollution due to excessive use of insecticides is quite common in recent days (Costa *et al.* 2003). Wilde *et al.* (2001) reported that the extensive use of different groups of pesticides developed aphid resistance to them. Therefore, host plant resistance can replace this wide spectrum use of insecticides and be compatible

in IPM. Aphids ensure the suitability of a plant as host using both visual and chemical cues before landing on the plant (Pickett *et al.* 2007). So, the morphological traits and biochemical content of host plant can directly affect the abundance of aphid. Considering the above facts, the objectives of the study are to know the abundance and infestation of aphid on brinjal germplasm lines, and to assess the resistance of plant morphological characteristics and phytochemical contents against its attack.

MATERIALS AND METHODS

Study site and condition: The study was carried out with brinjal germplasm lines in the field and laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur. Bangladesh during September 2018 to March 2019. The area is located in the middle of Bangladesh at 25°25′ N and 89°5′ E with 34 m altitude above sea level (Amin *et al*. 2015).

Cultivation of brinjal: Twelve germplasms of brinjal were used as experimental material. Among the germplasm lines BARI Begun- 1, BARI Begun- 4, BARI Begun- 5, BARI Begun- 6, BARI Begun- 7, BARI Begun- 8 and BARI Begun- 9 were Bangladesh Agricultural Research Institute (BARI released varieties and rest five genotypes namely BD- 7320, BD- 7328, BD- 9952, BD- 10154 and BD-10158 were collected from Plant Genetic Resource Centre, BARI. Each germplasm was cultivated in 3.0 m × 3.0 m plot following randomized complete block design with three replications. The spacing between block to block and plot to plot was 1.0 m in both the cases. Seeds were sown on fifth October 2018 in seedbed and 30 days old seedlings were transplanted to the field on fourth November 2018. Fertilizers were applied according to the fertilizer recommendation guide **(**FRG 2018). All the intercultural operations except insect control were adopted whenever necessary.

Observation of plant morphological traits: Plant height of five plants from each germplasm was measured at full blooming stage from soil line to the apical leaf of main stem. The number of branch per plant, leaf per plant, spine per stem and spine per leaf was also counted at that period. Leaf areas of three healthy leaves from five selected plants of each germplasm were measured using a digital Leaf Area Measuring Machine (LI-3100C Area Meter). A stereo microscope (BOE3200, BOECO, Germany) and a manual counting machine were used to count the trichomes of both abaxial and adaxial surfaces of three healthy leaves from each of five selected plants of all the germplasms.

Estimation of phytochemical contents: Fresh leaves from each germplasm were used for biochemical analysis. For this purpose, 10 samples from each of the germplasms were collected. Moisture content in leaves was determined using oven dry method. Reducing sugar and total sugar contents in leaves were estimated following Bertrand's method (Kumar *et al.* 2011). The content of Chlorophyll (chlorophyll a and chlorophyll b) of leaf was estimated using the procedure explained by Gagoi and Basumatary (2018). The nitrogen content of the leaf was estimated using Micro Kjeldahl method (Maehre *et al.* 2018). Each of the values was then multiplied by 6.25 to get the percentage of protein. The ash content of leaf sample was estimated in wet basis using Muffle Furnace (Nielsen 2010). A digital pH meter was used to determine the pH of the samples (Sharma and Rao 2013). Proline content of leaf was determined with Colorimetric Assay (Abraham *et al.* 2010).

Data collection and analysis: To observe the incidence and infestation of aphid, field inspection was done weekly. For collecting data, five plants were randomly selected for each germplasm. Number of aphids prevailed on the top, middle and bottom leaves of the selected plants were recorded using hand lens. Number of healthy leaves and number of infested leaves of the selected plants were also counted and the infestation level was calculated in percentage. A one-way analysis of variance, followed by Tukey′s honestly significant difference (HSD) post hoc test, was used to determine the variations of the abundance and infestation of aphid on the tested germplasm lines. Pearson′s correlation coefficients were worked out between the incidence of aphid on different germplasms with plant morphological traits and the biochemical content of leaf. All the analyses were performed using IBM SPSS 20.0.

RESULTS AND DISCUSSION

The number of adult aphids on brinjal germplasm lines varied significantly ($F_{11, 192}$ = 3.7, $p < 0.001$). The lowest and statistically similar aphid population was observed on BD-9952, BARI Begun-6 and BARI Begun-4 (1.6 ± 0.3, 1.5 ± 0.3 and 1.9 ± 0.4 adults/ 3 leaves, respectively) (Fig. 1).

The tested germplasm lines varied significantly in their morphological parameters such as plant height, branch/plant, leaf/plant, leaf area, leaf trichome (abaxial and adaxial), spine/ stem and spine/leaf ($F_{11, 48}$= 50.4, $p < 0.001$, $F_{11, 48}$ = 13.5, $p < 0.001$, $F_{11, 48}$ = 55.7, $p < 0.001$, $F_{11, 48}$ = 9446.9, $p < 0.001$, $F_{11, 48}$ = 13.5, $p < 0.001$, $F_{11, 48}$ = 15.8, $p < 0.001$, $F_{11, 48}$ = 86.0, $p < 0.001$, $F_{11, 48}$ = 55.8, $p < 0.001$, respectively) (Table 1). The highest plant height was observed on BD-10154

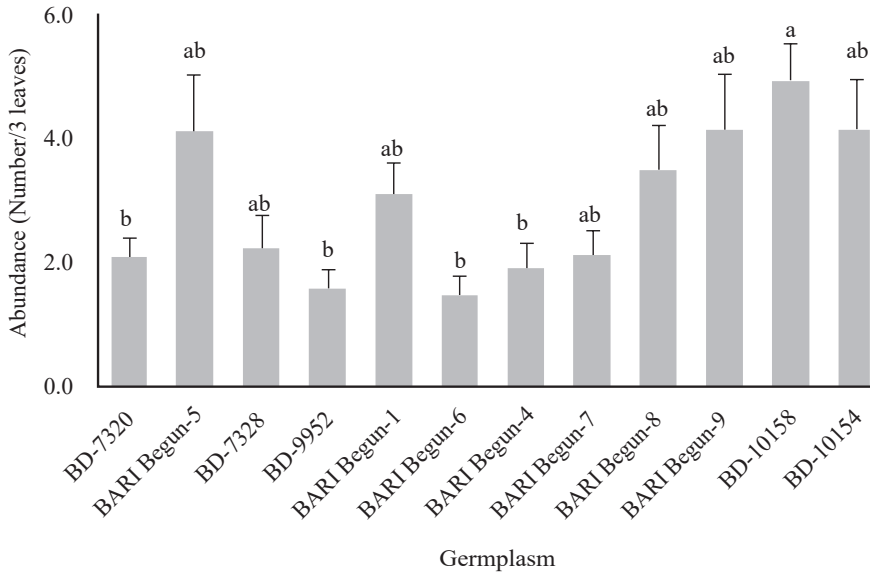

Fig. 1. Abundance (number/three leaves) of aphid on the brinjal germplasm lines during December 2018 to March 2019. Data expressed as mean ± SE. Bars with common letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05.

(104.6±4.2 cm), followed by BARI Begun-6 (97.0±2.1 cm). BARI Begun-4 had the highest number of branches per plant (16.8±1.7), followed by BD-9952 (15.2±1.6). BARI Begun-8 showed the highest number of leaf/plant (124.8±7.4), followed by BARI Begun-5 having 107.0±2.0 leaf/plant. The maximum leaf area was observed on BARI Begun-8 (169.5±0.4 cm^2), followed by BARI Begun-6 (149.7±0.6 cm^2). BARI Begun-6 and BARI Begun-4 revealed statistically similar and the highest number of leaf trichome on abaxial surface (2540.8±20.0/leaf and 2481.2±133.1/leaf, respectively), whereas BD-9952 showed the highest adaxial leaf trichome (1265.6±47.0/leaf). BD-7328 showed the highest number of spines per stem, followed by BARI Begun-6 (44.4±1.7 and 30.0±3.5, respectively). The number of spines per leaf was the highest on BD-7328, followed by BARI Begun-9 (22.4±0.8 and 18.8±2.1, respectively).

The relationship between the abundance of aphid and plant morphological characteristics such as plant height, branch/plant, leaf/plant, leaf area, abaxial and adxial leaf trichome, spine/stem and spine/leaf is shown in Table 2. The abundance of aphid on BARI Begun-7, BD-7320, BD-7328, BD-9952, BARI Begun-4, BARI Begun-8, BD-10158 and BD-10154 showed significant positive correlation with

Table 1. Comparisons of plant morphological characteristics (mean ± SE) among the brinjal germplasm lines

Germplasm	Plant height (cm)	Branch/plant	Leaf/plant	Leaf area (cm^2)	Trichome/leaf		Spine/stem	Spine/ leaf
					Abaxial	Adaxial		
BD-7320	67.8±2.1de	7.2±0.6ef	44.2±0.7f	47.1±0.3i	1708.0±186.1cd	805.0±103.3ef	2.0±0.3f	3.0±0.3ef
BARI Begun-5	52.4±1.1g	13.2±0.8ad	107.0±2.0ab	72.0±0.2e	1387.4±74.3d	632.8±34.8f	3.0±0.7eg	8.0±1.1d
BD-7328	70.2±3.1d	13.8±0.6ac	78.0±2.6cd	26.1±0.2k	1768.2±42.1cd	1170.2±62.4ab	44.4±1.7a	22.4±0.8a
BD-9952	55.8±2.3fg	15.2±1.6ab	104.0±5.9b	53.8±0.8h	2329.0±105.4ab	1265.6±47.0a	9.4±1.0de	4.0±0.7df
BARI Begun-1	71.6±2.7d	11.0±1.1be	103.4±4.5b	56.9±0.2g	1880.0±47.9bc	956.2±24.0be	9.0±0.7df	6.2±0.6df
BARI Begun-6	97.0±2.1ab	8.8±0.9df	57.2±3.0ef	149.7±0.6b	2540.8±20.0a	1071.8±23.8ad	30.0±3.5b	12.6±1.1c
BARI Begun-4	58.2±1.3eg	16.8±1.7a	92.8±3.6bc	33.5±0.6j	2481.2±133.1a	751.2±27.4ef	18.6±1.8c	2.0±0.3f
BARI Begun-7	83.6±2.1c	9.0±0.7df	65.2±2.2de	67.5±0.5f	1921.6±44.7bc	879.0±22.5ce	16.4±1.2c	5.4±0.6df
BARI Begun-8	89.4±3.1bc	10.4±1.0ce	124.8±7.4a	169.5±0.4a	1884.8±32.3bc	1043.0±33.6ad	2.6±0.5fg	6.4±0.6de
BARI Begun-9	57.2±1.8eg	7.2±0.6ef	50.2±2.1ef	98.8±0.4c	1537.6±132.0cd	1102.8±30.0ac	3.0±0.3eg	18.8±2.1ab
BD-10158	64.6±1.3df	7.4±0.5ef	47.6±2.1ef	51.7±0.4h	1913.2±122.5bc	851.8±69.3df	4.6±0.5eg	4.6±0.5df
BD-10154	104.6±4.2a	5.4±0.7f	60.8±2.5df	86.2±0.4d	1873.0±37.8bc	769.4±24.1ef	12.6±0.7cd	16.0±7.1bc

Means within a column followed by same letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05.

Table 2. Correlation between aphid abundance and morphological characteristics of the brinjal germplasm lines

Germplasm	Plant height (cm)	Branch/ plant	Leaf/plant	Leaf area	Leaf trichome		Spine/stem	Spine/ leaf
					Abaxial	Adaxial		
BD-7320	0.893*	0.942*	0.946*	0.954*	-0.960**	-0.802^{NS}	-0.930*	-0.930*
BARI Begun-5	0.856^{NS}	0.907*	0.850^{NS}	0.465^{NS}	-0.989**	-0.948*	-0.980**	-0.946*
BD-7328	0.922*	0.871^{NS}	0.560^{NS}	0.275^{NS}	-0.866^{NS}	-0.819^{NS}	-0.901*	-0.901*
BD-9952	0.932*	0.911*	0.816^{NS}	0.969**	-0.961**	-0.511^{NS}	-0.894*	-0.930*
BARI Begun-1	0.573^{NS}	0.469^{NS}	0.937*	0.569^{NS}	-0.920*	-0.737^{NS}	-0.945*	-0.96**
BARI Begun-6	0.764^{NS}	0.435^{NS}	0.930*	0.975*	-0.931*	-0.887*	-0.947*	-0.945*
BARI Begun-4	0.949*	0.958**	0.894*	0.869^{NS}	-0.937^{NS}	-0.831*	-0.912*	-0.930*
BARI Begun-7	0.987**	0.567^{NS}	0.890*	0.660^{NS}	-0.928*	-0.825^{NS}	-0.951*	-0.943*
BARI Begun-8	0.945*	0.966**	0.911*	0.963**	-0.983*	-0.965**	-0.921*	-0.908*
BARI Begun-9	0.697^{NS}	0.437^{NS}	0.960**	0.982**	-0.976**	-0.879*	-0.930*	-0.933*
BD-10158	0.947*	0.943*	0.945*	0.945*	-0.971**	-0.887*	-0.943*	-0.943*
BD-10154	0.913*	0.848^{NS}	0.960**	0.633^{NS}	-0.967**	-0.885*	-0.936*	-0.97**

NS = Non-significant, * = Significant, ** = highly significant

plant height. Among the germplasm lines, the number of branches per plant of BARI Begun-4, BARI Begun-8, BD-7320, BARI Begun-5, BD-9952 and BD-10158 showed significant positive effect on the abundance of aphid. The number of leaves per plant of BARI Begun-9, BD-10154, BD-7320, BARI Begun-1, BARI Begun-6, BARI Begun-7, BARI Begun-8 and BD-10158 depicted significant and positive correlation with aphid abundance. The leaf area of BD-9952, BARI Begun-8, BARI Begun-9, BD-7320, BARI Begun-6 and BD-10158 had significant and positive effect with aphid abundance. The number of abaxial leaf trichome on BD-7320, BARI Begun-5, BD-9952, BARI Begun-9, BD-10158, BD-10154, BARI Begun-1, BARI Begun-6, BARI Begun-7, and BARI begun-8 showed significant negative correlation with the abundance of aphid. The adaxial leaf trichome of BARI Begun-8, BARI Begun-5, BARI Begun-6, BARI Begun-4, BARI Begun-9, BD-10158 and BD-10154 showed significant negative correlation with aphid abundance. The number of spines per stem and leaf of all the germplasm lines showed significant negative correlation with aphid abundance. Khalid *et al.* (2009) reported that young

leaf contains relatively high amount of moisture and nitrogen than the mature leaf. As the young leaves mostly remain at the upper portion of plant, plant height thus affects the abundance of insect population. The results of current study supported the findings of Nasrin *et al.* (2020) who found higher abundance of white fly on the top branches compared to middle and lower branches of chili. The findings of current study are in accordance with that of Glas *et al.* (2012) who reported that trichome has a significant role in reducing the abundance and infestation of herbivorous insects and thus has a negative association with the insects. Khan *et al.* (2000) also reported that higher number of trichome resulted in less aphids on ash gourd. Amin *et al.* (2020) found that the morphological and biochemical contents of host plants as well as the exudates from trichome can alter the abundance, distribution and infestation of associated insects. The presence of trichome affects the movement and stylet insertion in plant, thus reduces the abundance of aphid.

The relationship between abundance of aphid and leaf biochemical content is shown in Table 3. The abundance of aphid onBD-7328, BARI Begun-1, BARI Begun-4, BARI Begun-9, BD-10154, BARI Begun-5, BARI Begun-6, BARI Begun-7, BARI Begun-8 and BD-10158 revealed significant positive correlation with the moisture content of leaf. Laichattiwar *et al.* (2018) found that the moisture content of brinjal leaf had positive correlation with the abundance of aphid. Among the germplasm pH content of BD-7320, BARI Begun-5, BD- 7328, BARI Begun- 9, BD-10158, and BD-10154; BARI Begun-1, BARI Begun-4, BARI Begun-6, BARI Begun-7 and BARI Begun-8 had significant negative effect on the abundance of aphid. Leaf ash content of the germplasm lines BD- 7320, BARI Begun- 5, BARI Begun- 4, BARI Begun- 9, BD- 10154, BD- 7328, BARI Begun- 1, BARI Begun-7, BARI Begun- 8, and BD- 10158 showed significant negative association with aphid abundance. Total chlorophyll BD-7320, BARI Begun-6, BARI Begun-7, and BARI Begun-9, BARI Begun-5, BD-7328, BD-9952, BARI Begun-1, BARI Begun-4, BARI Begun-8, BD- 10158, and BD-10154 depicted significant positive impact on aphid abundance. Abundance of aphid showed positive correlation with proline content of BD-7320, BARI Begun-5, BARI Begun- 6, BARI Begun-7, BARI Begun- 9, BD-7328, BARI Begun-1, BARI Begun-8, BD-10158, BD-10154. BD-7328, BARI Begun- 1, BARI Begun- 8, BD- 10158 and BD- 10154. Abundance of aphid showed positive correlation with reducing sugar of leaf of the tested germplasm. Among the germplasms, BD- 7320, BARI Begun- 5, BARI Begun- 1, BARI Begun- 9, BARI Begun- 6, BARI Begun- 7, BARI Begun- 8 and BD- 10154 showed significant correlation. The total sugar content of BD- 7320, BARI Begun-

Table 3. Correlation between aphid abundance and biochemical content of leaf of twelve brinjal germplasm lines

Germplasm	Moisture (%)	pH	Ash (%)	Total Chlorophyll	Proline	Reducing sugar	Total sugar	Protein (%)
BD-7320	0.841^{NS}	-0.971**	-0.980**	0.971**	0.971**	0.971**	0.971**	0.980**
BARI Begun-5	0.923*	-0.971**	-0.971**	0.923*	0.983**	0.971**	0.971**	0.973**
BD-7328	0.967**	-0.943**	-0.943*	0.943*	0.891*	0.871^{NS}	0.943*	0.891*
BD-9952	0.753^{NS}	-0.775^{NS}	-0.574^{NS}	0.930*	0.750^{NS}	0.813^{NS}	0.775^{NS}	0.894*
BARI Begun-1	0.963**	-0.943*	-0.943*	0.943*	0.891*	0.963**	0.963**	0.891*
BARI Begun-6	0.945*	-0.891*	-0.871^{NS}	0.963**	0.963**	0.891*	0.871^{NS}	0.945*
BARI Begun-4	0.971**	-0.923*	-0.980**	0.923*	0.721^{NS}	0.908*	0.923*	0.980**
BARI Begun-7	0.945*	-0.945*	-0.945*	0.963**	0.963**	0.945*	0.945*	0.945*
BARI Begun-8	0.908*	-0.908*	-0.908*	0.942*	0.942*	0.942*	0.908*	0.942*
BARI Begun-9	0.971**	-0.971**	-0.971**	0.980**	0.973**	0.971**	0.942*	0.931*
BD-10158	0.943*	-0.943**	-0.945*	0.891*	0.945*	0.871^{NS}	0.945*	0.895*
BD-10154	0.970**	-0.970**	-0.970**	0.908*	0.908*	0.908*	0.942*	0.970**

NS = Non-significant, * = Significant, ** = Highly significant

5, BARI Begun- 1, BD- 7328, BARI Begun- 4, BARI Begun- 7, BARI Begun- 8, BARI Begun- 9, BD- 10158, and BD- 10154 showed significant positive impact on aphid abundance. Abundance of aphid showed positive correlation with leaf protein (%) of the tested germplasm germplasm BD- 7320, BARI Begun- 5, BARI Begun- 4, BD- 10154 BD- 7328, BD- 9952, BARI Begun- 1, BARI Begun- 6, BARI Begun- 7, BARI Begun- 8, BARI Begun- 9 and BD- 10158. The results of current study are in agreement with Ahmed (1994) who found that high protein content of cucumber was responsible to make the plant susceptible to aphid infestation. Ghosh and Senapati (2001) reported that higher application of nitrogen fertilizer to brinjal caused high aphid infestation.

The leaf infestation level of aphid varied significantly among twelve germplasm lines ($F_{11, 192} = 3.2$, $p < 0.01$). The highest infestation level was recorded on BD-10158 (15.8 ± 1.0%). BD- 9952, BARI Begun- 6 and BARI Begun- 4 showed

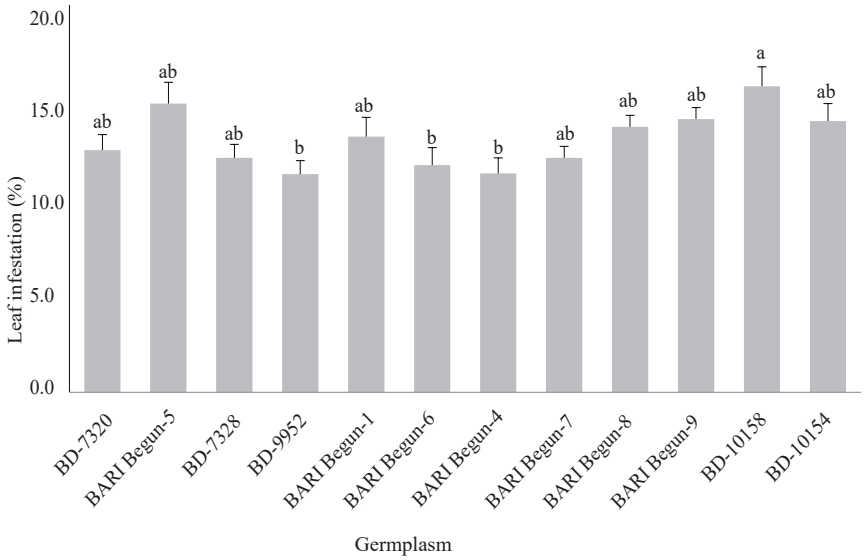

Fig. 2. Infestation level (%) of aphid on the leaves of the brinjal germplasm lines during December 2018 to March 2019. Data expressed as mean ± SE. Bars with common letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05.

statistically similar and the lowest infestation levels (11.3 ± 0.7, 11.7 ± 0.9 and 11.3 ± 0.8%, respectively) (Fig.2).

The findings of current study indicated that there were significant variations in the abundance and infestation of aphid on different germplasm lines of brinjal. The morphological traits and biochemical contents of brinjal leaf were found to be responsible to direct the aphid attack on them. The presence of higher number of leaves trichomes, and spines on stem and leaf reduced aphid populations, in addition, leaf pH and ash content negatively affected the abundance of aphid on the tested germplasms.

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