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Response of Different Cultivars of Groundnut, *Aarachis hypogaea* L. (Fabaceae: Fabales) to Aphids, *Aphis craccivora* K. (Aphididae: Homoptera) in Interaction With Local Weather Factors

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Abstract.- Field trials were conducted in randomized completed block design with three replications for the screening of five cultivars of groundnut (BARD-92, 699, 479, BARI-2000 and Golden) against aphid (*Aphis craccivora).* It was observed that BARD-699 cultivar showed comparatively high resistance with minimum aphid population (4.60 per leaf) and leaf infestation (22%) at 110 days after treatment (DAS).Whereas, the cultivar BARD-479 was found to be highly susceptible with maximum aphid population (8.50 per leaf) and leaf infestation (55%) at 110 DAS. The peak population of *A. craccivora* was recorded 110 DAS (May-June). The order of cultivar resistance against aphid population and leaf infestation during the whole crop duration was BARD 699 < BARD 92 < Golden < BARI 2000 < BARD 479. Aphid showed significantly positive correlation with maximum temperature for BARD-92 and for negative correlation BARI-2000 cultivars. Minimum temperature however showed significant positive correlation with aphid for BARD-92, Golden, and BARD-699 cultivars. Aphid had significant positive correlation with relative humidity for BARD-479 and Golden cultivars. Whereas, rainfall had negative correlation with aphids on BARD-479, BARI-2000, BARD-92 and BARD-699 cultivars. Consequently, based on the aphid density and leaf injuries on plant, BARD-699 was more resistant and BRD-479 highly susceptible cultivar.

Keywords: *Aphis craccivora*, groundnut cultivars.

INTRODUCTION

Groundnut is one of important essential oil seed crops that plays a significant role in the economy of agricultural crops of different parts of world (Bhatti and Soomro, 1996; Nwokolo, 1996; Wiess, 2000; Narda *et al.,* 2003; FAO, 2006). It is a source of highly nutritious contents such as 50% edible oil, 25% proteins and 10-25% carbohydrates (Christensen *et al*., 2004; Shah *et al*., 2012). It is a dietary source of vitamin E, Ca, phosphorus, Mg, Fe, Zn, riboflavin, thiamine and K. This crop is also used as animal diet in the form of fodder, seeds, straw and hay (Smith, 2002).

Groundnut is sown in different rainfed areas of Pakistan (Chakwal, Attock, Jhelum, Rawalpindi, Karak, Swabi and Sahngar) on an area of 252928 acres with an average yield of 114700 tonnes and 1121 kg per hectare (Ahmed and Rahim, 2007; Khan *et al.,* 2009; Naeem-ud-din *et al.,* 2009). Per acre yield of groundnut is still low because of low rains, low inputs by the farmer with unprecedented environmental conditions and unavailability of high yielding varieties. Groundnut is basically a stifling plant and needs a lengthy and hot growing period with optimum rainfall (500 mm) and optimum temperature of 25 to 30ºC (Weiss, 2000). A well-drained sandy loam soils (pH 6.0-6.5) best thrives for groundnut and light soil support as simple pegs diffusion, their growth and harvesting (Basu and Ghosh, 1995).

Groundnut is under threat of a wide range of insect pests that cause moderate to severe damage. The major insect pests of groundnut in ecological conditions of Asian region including Pakistan are termites, aphids (*Aphis craccivora* K.) and red hairy caterpillar (*Amsacta albistriga* Wlk*)* (Sheirdil *et al.,* 2012). Among them, aphid, *Aphis craccivora* Koch (Aphididae: Homoptera) is one of the most destructive brownish gray polyphagous sucking insect pests but showed distinct preference to legumes and oil seed crops including groundnut (David and Ramamurthy, 2011). Aphids not only cause the loss of yield but also serve as the vector of

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diseases. Around 30 parasites and 42 predators of different aphid species have been identified in Pakistan (Waterhous, 1998; Irshad, 2001). However, the efficiency of these natural enemies mainly dependents on nature of insects pests and the prevailing cropping system. Aphids infest at all stages of crops growth when conditions are suitable and play a prominent role in reducing the crop yield. Both nymphs and adults suck the cell sap in groups on leaves, shoots and reproductive parts. It causes malformations, stunting and even drying up of the plant parts. It feeds on phloem sap and is a potential vector of many diseases such as groundnut rosette virus, peanut virus and peanut stripe virus in Africa and Asia (Padgham *et al*., 1990).

Development of aphid resistant host plant is considered as an effective, economic and sustainable method for management of aphid (*A. cracivora)* and the viruses (Padgham *et al.*, 1990; Dogimont *et al.*, 2010). The evaluation of cultivars may therefore, lead to the identification of aphid-resistant groundnut genotypes. Keeping in view the drastic attack of aphid (*Aphis craccivora* K) on groundnut, the present study was designed with an objective to evaluate the comparative response of different groundnut cultivar against aphid in relation to abiotic weather factors.

MATERIALS AND METHODS

The study was conducted at University Research Farm of PMAS Arid Agriculture University, Rawalpindi. Five varieties of groundnut (BARD-479, BARD-699, BARD-92, BARI-2000 and Golden) were sown in randomized complete block design (RCBD) with three replications during February, 2012. The seeds were collected from National Agriculture Research Centre, Islamabad and Barani Agriculture Research Institute, Chakwal. Each plot size was 3×5 m^2. Each plot comprised 5 rows of 3 m each. The spacing between the rows and plants were kept at 70cm and 20cm, respectively, in each plot. Cultivars were sown by choosing normal cultural practices for groundnut. Weeding was also carried out manually. Crop remained natural without any kind of spray during the season to avoid any effect on aphid population density.

Data collection

The data were recorded by visual observation at weekly interval after four weeks of emergence of the plants *i.e.* 33 days after sowing (DAS) to the late stage of the cropping season. Percentage infestation was recorded by observing five randomly selected plants per plot and then nine randomly selected leaves from each plant. Three leaves from upper part, 3 from middle and 3 from lower part of plant were observed. Percentage infestation was calculated according to the following formula;

$$\% \text{ infestation} = \frac{\text{No. of infested leaves}}{\text{Total no. of observed leaves}} \times 100$$

To determine the aphid density, the total number of aphids per leaf was also observed. Five plants from each replication were randomly selected and one leaf from upper part, one leaf from middle and one leaf from lower part of each plant was observed.

The meteorological data were obtained from Barani Agriculture Research Institute, Chakwal. The data of environmental factors like temperature, relative humidity and rainfall were correlated with population and infestation of the *A. craccivora*.

Statistical analysis

The data was statistically analyzed by using MSTAC-C software program (and mean values were compared by using least significant difference (LSD) test at a level of 0.05 percent (Steel *et al.*, 1997; Nadeem *et al.*, 2010),

RESULTS AND DISCUSSION

Aphid population trend on different groundnut cultivars

Highly significant variation was observed in aphid population among different groundnut cultivars. The observations were taken every week until day 124 after sowing (Table (I). BARD 699 cultivar was comparatively resistant among all five tested cultivars with minimum mean aphid population while, the BARD 479 cultivar was highly susceptible with maximum mean aphid population throughout the duration of the crop. The order of resistance of groundnut cultivars against aphid population was BARD699 < BARD 92 < Golden < BARI 2000 < BARD 479 respectively. It

Table I.- Comparison of average aphid population at various intervals on groundnut cultivars.

Cultivars	Mean aphid population													
	33 DAS	40 DAS	47 DAS	54 DAS	61 DAS	68 DAS	75 DAS	82 DAS	89 DAS	96 DAS	103 DAS	110 DAS	117 DAS	124 DAS
BARD 479	0.65 a	0.72 a	0.70 a	0.77 a	0.99 a	1.60 a	3.32 a	5.12 a	6.03 a	6.93 a	7.80 a	**8.50 a**	5.03 a	3.23 a
BARI 2000	0.46 b	0.70 a	0.58 b	0.73 ab	0.84 b	1.08 b	2.76 b	4.68 b	4.66 b	6.66 b	7.50 b	8.26 a	4.76 b	2.90 b
Golden	0.38 c	0.60 ab	0.51 b	0.62 bc	0.75 b	1.00 b	2.38 c	4.26 c	4.26 b	6.16 c	6.90 c	7.63 b	4.30 c	2.50 c
BARD 92	0.32 d	0.45 bc	0.38 c	0.54 c	0.73 b	0.97 b	2.30 c	4.18 d	3.20 c	6.03 d	6.66 d	7.62 b	4.16 d	2.36 d
BARD 699	0.22 e	0.29 c	0.20 d	0.37 d	0.59 c	0.86 b	1.14 d	1.92 e	2.63 d	3.53 e	4.46 e	**4.60 c**	3.26 e	1.46 e
LSD (α =0.05)	2.306	2.306	2.306	2.306	0.13	0.22	0.28	2.306	0.05	0.05	0.05	0.25	0.09	0.09

Means sharing the same letters in each column are statistically non-significant at P>0.05. DAS: days after sowing.

Analysis of variance

SoV	df	Mean sum of squares (MS)													
		33 DAS	40 DAS	47 DAS	54 DAS	61 DAS	68 DAS	75 DAS	82 DAS	89 DAS	96 DAS	103 DAS	110 DAS	117 DAS	124 DAS
Replication	2	0.00748	0.00945	0.00053	0.00050	0.01571	0.07441	0.00340	0.42361	0.39267	0.34257	0.39267	0.18467	0.1626	0.2206
Cultivar	4	0.06547***	0.09651***	0.10900***	0.07788***	0.06288***	0.24764***	1.57652***	3.79600***	4.61900***	3.51900***	5.15500***	3.94433***	1.3806***	1.3373***
Error	8	0.00014	0.00766	0.00226	0.00409	0.00510	0.01480	0.00476	0.00400	0.00100	0.00100	0.00100	0.01883	0.0026	0.0023
Total	14														
CV		13.35	15.77	9.97	10.52	9.12	11.01	16.45	18.12	2.09	1.09	1.47	1.84	1.20	1.94

The asterisk indicates the significance level (* = Significant at P ≤ 0.05 ** = highly significant P ≤ 0.01, *** = highly significant P ≤ 0.001, ns = non significant). DAS: days after sowing

was observed that aphid population increased gradually with the passage of days after sowing (33-110 DAS). The highest aphid population was recorded at 110 DAS. These observations are in agreement with the findings of Nandagopal *et al*. (2004). Peak aphid population was recorded on BARD 479 (8.50 aphids per leaf) as compared to BARD 699 that showed comparatively minimum aphid population (4.60 aphids per leaf) at 110 DAS.The aphid population started to decline during the last two weeks (117 and 124 DAS) due to increase in temperature. These findings are in agreement with those of Singh *et al*. (2007) who showed negative effect between aphid population and temperature but are in contrast with those of Shivanna *et al*. (2011) and Tomar (2010) who observed positive relationship between them. It was also observed that rainfall in the later cropping season had negative effect on the aphid population which is in line with the study of Rao *et al*. (1991).

Leaf infestation by aphid on different groundnut cultivars

Table II shows percentage leaf infestation by aphid a five groundnut cultivars. It was observed that BARD 699 cultivar was comparatively resistant among all five tested cultivars with minimum percentage of leaf infestation while, BARD 479 cultivar was highly susceptible with maximum leaf infestation throughout the duration of the crop. The order of resistance against percentage leaf infestation by aphid was BARD699 < BARD 92 < Golden < BARI 2000 < BARD 479 respectively. The trend of leaf infestation percentage was gradually increasing with the passage of days after sowing after sowing (33-124 DAS) and was maximum (55%) in last three weeks (110, 117 and 124 DAS) on the BARD 479 cultivar. Whereas, minimum leaf infestation percentage (22%) was observed on BARD 699 cultivar at 110-124 DAS. Whereas, minimum leaf infestation percentage (22%) was observed on BARD 699 cultivar in last two weeks. The data regarding highest aphid infestation is comparable with findings of previous studies (Nandagopal *et al*., 2004; Singh *et al*., 2007: Tomar, 2010) who reported the aphid infestation on other groundnut cultivars. Thus, crop cultivar can significantly influence the insurgence of the insect population (Javed *et al*., 2013).

Temperature and leaf infestation by aphid

The results indicated that maximum temperature has negative but significant correlation with leaf infestation on cultivar BARI-2000 (r = -0.79). The negative correlation between temperature and leaf infestation is in agreement with the previous studies (Singh *et al*., 2007; Prasad *et al*., 2008; Kandakoor *et al*., 2012). Maximum temperature has also significant positive correlation (Table III) with leaf infestation by aphid on cultivar BARD 92 (r = 0.82). Surprisingly, these opposite findings are also supported by previous studies (Nandagopal *et al*., 2004; Tomar, 2010; Shivanna *et al*., 2011) who also reported significant positive effect of maximum temperature on aphid leaf infestation (Table III).

Moreover, our results indicated that minimum temperature has significant positive correlation with leaf infestation on cultivar BARD 92, Golden and BARD-699 (r = 0.86, 0.87, 0.88), respectively (Table III). These findings are in agreement with the outcomes of previous studies (Tomar, 2010; Kandakoor *et al*., 2012) who reported positive correlation between aphid infestation and minimum temperature. However, these findings are contradictory with those of Singh *et al*. (2007) and Prasad *et al*. (2008) who reported negative correlation between minimum temperature and aphid leaf infestation. The cultivars, BARI-2000 and BARD 479 show positive but non-significant correlation with high temperature (Table III).

In addition, average temperature has positive significant correlation with leaf infestation on cultivars BARD-92,0 Golden and BARD-699 (r = 0.02, 0.01 and 0.02) respectively. Whereas, negative but significant correlation (r = -0.05) with average temperature was observed on BARI-2000 cultivar (Table III).

Relative humidity (%) and leaf infestation by aphid

Relative humidity and leaf infestation has positive and significant correlation on cultivars; BARD-479 and Golden (r = 0.80 and 0.78), respectively. This finding was in conformity with previous studies stating the positive correlation between relative humidity and aphid infestation

Table II.- Comparison of average percentage leaf infestation at various intervals on groundnut cultivar.

Cultivars	Percentage aphid leaf infestation													
	33 DAS	40 DAS	47 DAS	54 DAS	61 DAS	68 DAS	75 DAS	82 DAS	89 DAS	96 DAS	103 DAS	110 DAS	117 DAS	124 DAS
BARD 479	12.33 a	18.00 a	17.00 a	21.33 a	23.00 a	26.33 a	31.00 a	33.00 a	38.00 a	43.00 a	48.00 a	**55.00 a**	55.00 a	55.00 a
BARI 2000	9.00 b	13.00 b	12.00 b	15.00 b	19.00 b	22.00 b	24.00 b	22.00 b	31.00 b	35.00 b	40.00 b	45.00 b	44.00 b	44.00 b
Golden	5.00 c	9.00 c	9.00 c	10.00 c	16.00 bc	17.00 c	19.00 c	21.00 b	25.00 c	31.00 c	35.00 bc	39.00 c	38.00 c	38.00 c
BARD 92	2.67 d	6.00 d	5.00 d	6.33 d	13.00 c	15.00 cd	18.00 d	19.00 c	24.00 d	27.00 d	31.00 c	34.00 d	33.00 d	33.00 d
BARD 699	1.33 d	3.00 e	3.00 e	5.00 d	8.66 d	11.00 d	12.00 e	12.00 d	16.00 e	17.00 e	20.00 d	**22.00 e**	22.00 e	22.00 e
LSD (α =0.05)	1.91	1.52	1.26	1.52	2.306	2.306	2.306	2.306	2.306	1.40	2.306	1.40	1.46	1.33

Means sharing the same letters in each column are statistically non-significant (P>0.05). DAT: days after sowing

Analysis of variance

SoV	df	Mean sum of squares (MS)													
		33 DAS	40 DAS	47 DAS	54 DAS	61 DAS	68 DAS	75 DAS	82 DAS	89 DAS	96 DAS	103 DAS	110 DAS	117 DAS	124 DAS
Replication	2	0.00009	0.00114	0.00062	0.00101	3.4667	17.067	0.00128	0.00961	0.00121	0.00168	13.400	0.00168	0.00206	0.00200
Cultivar	4	0.00622***	0.01014***	0.00936***	0.01351***	90.5667***	108.067***	0.01521***	0.03590***	0.01175***	0.02784***	326.100***	0.04545***	0.04539***	0.04593***
Error	8	0.00010	0.00007	0.00005	0.00007	4.4667	4.567	0.00003	0.00023	0.0017	0.00006	13.150	0.00006	0.00006	0.00005
Total	14														
CV		16.76	8.23	7.29	6.99	13.26	11.70	12.63	19.11	15.27	2.42	10.42	1.90	2.08	1.84

The asterisk indicates the significance level (* = Significant at P ≤ 0.05 ** = highly significant P ≤ 0.01, *** = highly significant P ≤ 0.001 ns = non significant). DAS: days after sowing.

(Jayanthi *et al*., 1993; Tomar, 2010). There was non-significant but positive correlation on the cultivar BARI-2000 and BARD-699 or non-significant but negative correlation between relative humidity and leaf infestation on the cultivar BARD-92 (Table III). These are partially in agreement with the findings about negative but significant correlation between relative humidity and aphid infestation (Singh *et al*., 2007; Prasad *et al*., 2008).

Table III.- Correlation of leaf infestation by *Aphis craccivora* (Koch) with abiotic factors on different groundnut cultivars

Cultivars	Temperature (C°)			RH. (%)	Rainfall (mm)
	Max.	Mini.	Mean		
BARD-479	0.82^{ns}	0.88^{ns}	-0.03^{ns}	0.80^{*}	-0.70^{*}
BARI-2000	-0.79^{*}	0.87^{ns}	-0.05^{*}	0.80^{ns}	-0.70^{*}
Golden	-0.82^{ns}	0.87^{*}	0.01^{*}	0.78^{*}	-0.74^{ns}
BARD-92	0.82^{*}	0.86^{*}	0.02^{*}	-0.76^{ns}	-0.74^{*}
BARD-699	-0.84^{ns}	0.88^{*}	0.02^{*}	0.78^{ns}	-0.73^{*}

The asterisk indicates the significance level (*, Significant at P≤0.05 **, highly significant P ≤ 0.01; ***, highly significant P≤0.001 ns = non significant).

Rainfall (mm) and aphid leaf infestation

The cultivars BARD-479, BARI-2000, BARD-92 and BARD-699 showed negative but significant correlation between Rainfall and leaf infestation with (r) values -0.70, -0.70, -0.74 and -0.73 respectively. These results were in accordance with the previous studies about negative correlation between aphid infestation and rainfall (Rao *et al*., 1991; Gibbons *et al*., 2007; Prasad *et al*., 2008; Kandakoor *et al*., 2012). The cultivar Golden showed negative but non-significant correlation (Table III) between aphid and precipitation. Same trend is reported in a separate studies of aphid on transgenic cotton (Shivanna *et al*., 2011).

CONCLUSIONS

It is concluded that BARD-699 cultivar exhibited comparatively high resistance while BARD-479 showed highly susceptibility to aphids. The other cultivars (BARI 2000, Golden and BARD 92) were moderate resistant cultivar. The maximum population of aphid was recorded on 110 DAS on different groundnut cultivars. Similarly, leaf infestation was maximum in the last three weeks 110-124 DAS. The abiotic factors (temperature, relative humidity and rainfall) also found to be affecting the aphid population throughout the duration of the crop.

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