Science Letters ISSN 2345-5463 – An International Triannually Journal

Research article
2019 | Volume 7 | Issue 2 | Pages 52-58

Open Access

Abundance of Aphids on Various Canola Genotypes and Role of Abiotic Factors in its Population Fluctuation

Waseem Akbar, Muhammad Usman Asif*, Raza Muhammad, Muhammad Hamayoon Khan, Moula Bux

Plant Protection Division, Nuclear Institute of Agriculture, Tandojam-70060, Sindh, Pakistan

ARTICLE INFO

Received
April 18, 2019
Accepted
June 30, 2019
Published
August 15, 2019

***Corresponding Author**
Muhammad Usman Asif
E-mail
uakhan1987@hotmail.com

Keywords
Aphid screening
Canola genotypes
Yield
Abiotic factors
Correlation

How to Cite
Akbar W, Asif MU, Muhammad R, Khan AH, Bux M. Abundance of aphids on various canola genotypes and role of abiotic factors in its population fluctuation. Sci Lett 2019; 7(2):52-58

Abstract

Brassica crops are the most diversified and largest oilseeds produced in the world. Different species of aphids are the most destructive pests of these crops due to sucking of cell sap from leaves, stem, flowers and pods limiting the crop yields. A field experiment was conducted to determine the relative tolerance of 28 canola genotypes against aphids and the effect of different abiotic factors on the aphid incidence from late January to late March at fortnightly intervals. Data inferred that all the evaluated genotypes had varying degree of tolerance to aphids and none of them was found completely immune. The abundance of aphids on different sampling dates and seasonal means differed significantly among the tested genotypes. The lowest aphid population per plant was observed on genotype NR-18 (11.11), whereas the highest on genotype NR-11 (89.22). For grain yield, genotype NR-18 gave the maximum productivity (3028.57 kg/ha) and NR-11 yielded the least (1409.11 kg/ha). Furthermore, highest aphid population (95.60 per plant) was recorded during the mid of March. The abundance of aphids showed non-significant association with mean temperature, humidity and sunshine. Our result suggests that tolerant genotypes can be grown as a component of an integrated pest management strategy for protecting the crop from aphid infestation and to reduce the use of expensive, toxic and environmentally damaging pesticides.

Introduction

Canola (*Brassica napus* L.), recognized as sweet mustard, is a genetic variation of rapeseed [1]. It is considered as a promising oilseed crop in the world, characterized by high protein (23-25%) and oil content (40-45%) in seed and highly nutritive feed for animals and poultry birds. Its oil possesses the minimum quantity of saturated fats, with unique fatty acid composition and higher quantity of essential fatty acids (Omega-3) whose consumption is primarily linked with a lower chance of heart diseases and also with low blood cholesterol levels [2]. It has also been assessed as a substitute for different products, related to petroleum industry like engine oil and fuel [2, 3].

In Pakistan, rapeseed and mustard were introduced by Pakistan Agricultural Research Council during 1980-81 and is now ranked the 2nd most vital origin of edible oil after cottonseed [4, 5]. Pakistan has been chronically and constantly deficient in edible oil production and accomplishes its domestic needs through imports. During 2016-17, the entire availability of edible oils stood at 3.623 million tons, of which 0.431 million tons (12%) acquired from local sources and the remaining 3.19 million tons (88%) through imports. During this period, 2.5 billion US$ was expended as the edible oil import bill [6]. About 74% of the yield potential has yet not been achieved in rapeseed and mustard [7]. Several biotic and abiotic stresses, including, diseases, insect pests, frost and drought, and lack of appropriate resistant varieties have been characterized as the major factors responsible for lower yield [8, 9]. The major constraint to increasing production is the damage caused by the aphids (*Brevicoryne brassicae* L.), both nymphal and adult stages suck the cell sap from stem, pods, leaves and flowers, consequently leading to reduced pod formation and poor oil seed content under situations of severe attack [10-12]. Infestation of aphids causes inhibition of growth and development, lessening seed oil content (11%) and tremendous yield losses ranging from 9-77% [13]. Green peach aphid, turnip aphid and the cabbage aphid are the most abundant and broadly distributed aphid species, which attack rapeseed and mustard [4].

One of the most vital methods to overwhelm the pest problem is the resistant variety development through different breeding procedures [14]. It is not only compatible with other methods of control but also environmentally safe and cost-effective [15] than chemical control [16]. In integrated pest management programs, the host plant resistance is used very effectively. It protects the crop from injury by mechanisms of tolerance, non-preference and antibiosis which occur in many varieties of *Brassica* and affects the time of development, survival and reproduction rate of insects [17-19].

Apparently, an ideal way for the management of aphid menace would be the use of resistant varieties. A lot of efforts have been made for the improvement of canola varieties to enhance the quality, production and tolerance against aphids. In this regard, new varieties have been developed and also evaluated in various areas of Pakistan. The newly evolved varieties are superior in quality, vigor and oil contents [8]. Keeping in view the significance of crop and pest, the present study was initiated to compare the relative resistance of different canola genotypes against aphids and to determine the role of abiotic factors in its population fluctuation for using it as a foundation in future research studies and in integrated pest management programs on aphid.

Materials and Methods

Experimental area and canola genotypes

The trial was carried out in the research area of the Nuclear Institute of Agriculture (NIA), Tandojam, Sindh, Pakistan during the crop season 2015-16. The study area is located at latitude and longitude of 25.25º and 68.33º, respectively. Seeds of 28 canola genotypes, *viz.* NR-1, NR-2, NR-3, NR-4, NR-5, NR-6, NR-7, NR-8, NR-9, NR-10, NR-11, NR-12, NR-13, NR-14, NR-15, NR-16, NR-17, NR-18, NR-19, NR-20, Dunkeld, Shiralee, Durre-NIFA, Ac-elect, Concorde, Hyola-43, Hyola-401 and Hyola- 405 were obtained from Pulses and Oilseed section of Plant Breeding and Genetics Division of NIA, Tandojam.

Planting method and crop management

Seeds of canola varieties were sown in rows on November 2015 using hand drill method. Plot size was 3.5 m^2, whereas plot to plot distance was 90 cm. Each plot consisted of three rows with a row-to-row distance of 30 cm and plant-to-plant distance of 10 cm. The trial was laid out under RCBD (Randomized Complete Block Design) with three replicates. The recommended agronomic practices were performed in all the plots uniformly during the whole growing season. The basal dose rate of NPK fertilizers at the rate of 90-60-00 kg ha^{-1} was applied in the form of urea and di-ammonium phosphate, respectively.

Data collection

To investigate the comparative tolerance, the population of aphids was recorded at fortnightly intervals from late January to late March on 30-01-2016, 14-02-2016, 28-02-2016, 15-03-2016 and 29-03-2016. Five randomly selected plants were observed for aphids in each replicate by recording the number of aphids from the leaves, stem and inflorescence and presented as aphids per plant. Seed yield from each plot within the radius of 3.5 m^2 was recorded after the crop was harvested and presented as yield per hectare.

Statistical analysis

The data were analyzed by ANOVA and means were compared through the LSD test at 0.05% [20]. To determine regression and correlation analysis of aphid population with abiotic factors, meteorological data [temperature (°C), relative humidity (%) and sunshine hours] were collected daily from Regional Agromet Center, Tandojam, Sindh. Daily data were then pooled in fortnightly mean values. The statistical analysis was performed using Statistica, V. 10.0. Statsoft, Inc. Tulsa, Okla.

Results and Discussion

Incidence of aphids

The population of aphids on different dates of sampling was found to be significantly different among all the tested genotypes of canola (Fig. 1). On 28th February, the number of aphids per plant ranged from 6.66 on NR-4 and NR-18 to 32.66 on NR-11 while on 15th March, the population ranged from 24.00 on NR-18 to 187.33 on NR-11. On 29th March, the lowest aphid population of 2.66 was observed on NR-4 and NR-18 while the highest of 47.66 was observed on NR-11. On the contrary, Aslam et al. [21] and Amer et al. [22] reported the non-significant difference of aphid population on different sampling dates between the tested genotypes of canola. The dissimilarity in the results may be due to the differences in the tested genotypes and also the ecological conditions.

The activity period of aphids was observed during the last week of February to the last week of March on all the tested genotypes. Generally, the maximum number of aphids was observed on the 14th March followed by 29th March and 28th February while no population (zero aphids per plant) was recorded during the sampling dates of 30th January and 14th February. During the 4th week of March decline in the aphid population was observed and at the beginning of April, it disappeared from the experimental area (Fig. 2). Aslam et al. [23] and Aslam et al. [21] also recorded a maximum population of aphids on March 13th and 15th during the years 1999 and 2003. Similarly, Sarwar [24] reported 2nd week of February up to the 2nd week of March as the peak activity period of aphids.

Effect of abiotic factors on aphid population

The population of aphids was found to be positively correlated with the mean temperature and negative-

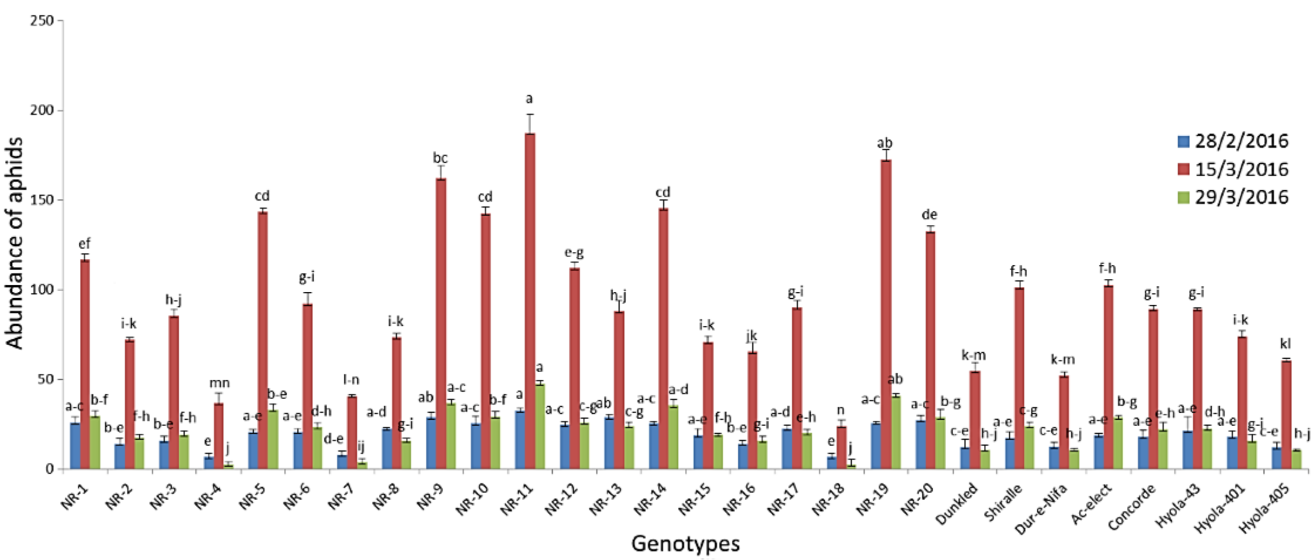

Fig. 1 Mean population of aphids per plant of canola genotypes on different sampling dates during 2016.

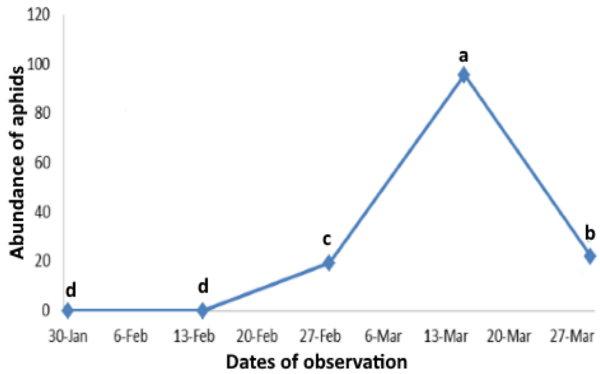

Fig. 2 Mean abundance of aphid population on different sampling dates during 2016.

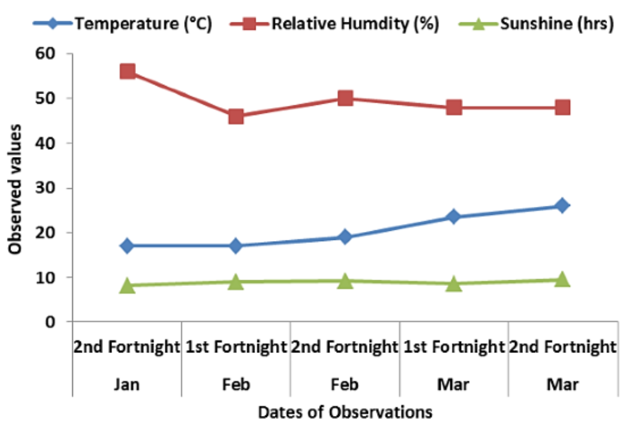

Fig. 3 Mean temperature (°C), relative humidity (%) and sunshine (hrs) during the observation of the aphid population from January to March.

-ly correlated with relative humidity and sunshine; however, these correlations were nonsignificant statistically (Table 1; Fig. 3). Different researchers reported different results regarding the association of aphid population with temperature, relative humidity and sunshine. Laskar et al. [25] reported a positive correlation between temperature and aphid population. Abbas et al. [26] found a positive correlation of temperature with the aphid population, while the negative correlation with relative humidity and rainfall. The abiotic factors such as sunshine and relative humidity exhibited a negative correlation with the multiplication of aphids [27]. Bishnoi et al. [28] and Ansari et al. [29] also reported similar results. On the other hand, Singh et al. [30] observed a positive association of sunlight and relative humidity with aphid population, whereas the negative association with wind speed and rainfall. Gami et al. [31] documented a negative correlation between temperature and aphid population.

Plant resistance against aphids

The seasonal mean of aphid population was also found to be significantly different on all the genotypes of canola (Table 2). None of the genotypes was found to be completely immune to the aphid attack. However, all the tested genotypes showed varying degree of susceptibility to aphids. The minimum seasonal mean population of aphids per plant was recorded on the genotype NR-18 (11.11) followed by NR-4 (15.33) and NR-7 (17.44), while maximum mean was observed on NR-11 (89.22) followed by NR-19 (79.77) and NR-9 (75.77). Our results are in accordance with that of Aslam et al. [21] and Marghub et al. [32] who documented that all the evaluated genotypes were susceptible and none of them was found free from the infestation of aphids. Significant difference of aphid population on different varieties of *Brassica* was reported by Niaz et al. [33], Amjad et al. [34], Aheer et al. [35], Kumar and Sharma [16], Sarwar et al. [36], Solangi et al. [37], Aslam et al. [1], Mamun et al. [38], Abbas et al. [39] and Sarwar [24]. Paula et al. [40] observed that net increase in population and reproduction rate of *B. brassicae* was high on susceptible than resistant Kale varieties. Khattak and Hamed [41] reported that the crop susceptibility to insect pests attack depends upon various factors including ecological, abiotic and biotic factors. The most vital amongst these could be the genetic potential of the crop, insect pests and the prevailing environmental conditions.

Table 1 Correlation analysis between aphid population and abiotic factors during 2016.

Parameter	Correlation coefficients	R^2-value	*P*-value
Temperature (°C)	0.5959	0.3551	0.288
Humidity (%)	-0.2968	0.0881	0.627
Sunshine (hrs)	-0.0675	0.0046	0.914

Effect of aphids on canola yield

The varying levels of aphid population significantly affected the yield of different canola genotypes. The maximum yield of 1060 g/3.5m^2 (3028.57 kg/ha) was recorded from genotype NR-18 followed by NR-4 and NR-7 with the yields of 1013.3 g/3.5m^2 (2895.14 kg/ha) and 960.0 per plot (2742.85 kg/ha), respectively. The lowest yield of 550.0 g/3.5m^2 (1571.42 kg/ha) was recorded from genotype NR-19 followed by NR-9 and NR-5 with the yields of 573.3 g/3.5m^2 (1638 kg/ha) and 583.3 g/3.5m^2 (1666.57 kg/ha), respectively (Table 2). It is evident from the results that the genotype NR-18 was found

Table 2 Seasonal means of aphid population and yield of canola genotypes.

Genotypes	Aphids/plant	Yield g/3.5m^2	Yield kg/ha
NR-1	57.44 e	690.0 h	1971.42 h
NR-2	34.55 kl	833.3 d	2380.85 d
NR-3	40.22 ij	760.0 ef	2171.42 ef
NR-4	15.33 op	1013.3 a	2895.14 a
NR-5	65.66 cd	583.3 i	1666.57 i
NR-6	45.33 ghi	723.3 fgh	2066.57 fgh
NR-7	17.44 o	960.0 b	2742.85 b
NR-8	37.33 jk	910.0 c	2600.00 c
NR-9	75.77 b	573.3 i	1638.00 i
NR-10	65.77 cd	586.7 i	1676.28 i
NR-11	89.22 a	493.3 j	1409.42 j
NR-12	54.22 ef	716.7 fgh	2047.71 fgh
NR-13	46.88 gh	726.7 fgh	2076.28 fgh
NR-14	68.66 c	583.3 i	1666.57 i
NR-15	36.33 jkl	826.7 d	2362.00 d
NR-16	31.77 lm	916.7 bc	2619.14 bc
NR-17	44.22 hi	756.7 ef	2162.00 ef
NR-18	11.11 p	1060 a	3028.57a
NR-19	79.77 b	550.0 i	1571.42 i
NR-20	62.88 d	686.7 h	1962.00 h
Dunkled	25.88 n	926.7 bc	2647.71 bc
Shiralle	47.55 gh	723.3 fgh	2066.57 fgh
Durre-NIFA	25.11 n	953.3 bc	2723.71 bc
Ac-elect	50.00 fg	706.7 gh	2019.14 gh
Concorde	43.11 hi	750.0 efg	2142.8 efg
Hyola-43	44.44 hi	753.3 efg	2152.28 efg
Hyola-401	36.00 jkl	793.3 de	2266.57 de
Hyola-405	27.77 mn	916.7 bc	2619.14 bc

*Means that do not share a letter in columns are significantly different.

to be highly tolerant for holding a minimum population of aphids and superior in grain yield as compared to other genotypes. NR-11 was found to be the most susceptible genotype against aphids during the whole growing season and also inferior in yield. In general, these results are in agreement with the findings of previous studies, *i.e*., Alipieva and Nankova [42], Sarwar et al. [36], Mamun et al. [38], Ahmed et al. [14] and Sarwar [24] who have documented significant interactions between crop yield and population of aphids.

Conclusions

The genotypes NR-18 and NR-4 harbored the minimum population of aphids during most of the growing season and were found highly tolerant with enhanced yield. These genotypes can be included in future breeding programs for resistance enhancement and also in integrated pest management programs for the control of pest to avoid yield losses.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

[1] Aslam M, Razaq M, Shahzad A. Comparative resistance of different canola (*Brassica napus* L.) varieties against turnip aphid (*Lipaphis erysimi* Kalt.). Pak J Zool 2007; 39:311-314.

[2] Barth CA. Rapeseed for human nutrition–present knowledge and future options. Proceedings of the 12th International Rapeseed Congress 26–30 March. Sustainable Development in Cruciferous Oilseed Crops Production, Wuhan, China; 2007, p. 3–5.

[3] Demirel N. Determination of *Heteroptera* species on canola plants in Hatay province of Turkey. Afr J Agric Res 2009; 4:1226–1233.

[4] Rehman KA, Munir M, Yousaf A. Rape and Mustard in Pakistan. PARC Islamabad; 1987, pp. 101.

[5] Syed TS, Makorami A, Abro GH. Resistance of different canola varieties against aphid, *Lipaphis erysimi* K alt. Proc Pakistan Congr Zool 1999; 19: 45–49.

[6] GOP. Pakistan economic Survey 2017-18. Ministry of Finance, Government of Pakistan; 2018, p. 13-32.

[7] Amjad M. Oilseeds crops of Pakistan. Status paper plant Sciences division, Pakistan Agricultural Research Council Islamabad, 2014, p. 5-7.

[8] Swati ZA. Genetic improvement of *Brassica* oilseed by integrated use of conventional and molecular biological approaches. Inst. of Biotech. and Genetic Engg. The

Univ. of Agric. Peshawar, Pakistan. Project Final Compl. Rep. of ALP Project; 2005, pp. 33.

[9] USDA. Crop Production Tables. Rapeseed area, yield, and production (Table 15), 2011; http://ffas.usda.gov/wap/circular /2007/07-02/tables.html

[10] Sarwar M, Sattar M. Varietals variability of winter rapes (*Brassica napus* L.) for their susceptibility to green aphid, *Myzus persicae* (Sulzer)(Homoptera: Aphididae). Pak J Zool 2013; 45:883-888.

[11] Akbar W, Asif MU, Muhammad R, Tofique M. Bio-efficacy of different plant extracts against mustard aphid (*Lipaphis erysimi*) on canola. Pak J Entomol 2016; 31:189-196.

[12] Akbar W, Asif MU, Ismail M, Bux M, Memon RM. Management of aphids on canola (*Brassica napus* L.) through cultural practices. Pak Entomol 2017; 39:27-31.

[13] Kelm M, Gadomski H, Pruszynski S. Occurrence and harmfulness of the cabbage aphid, *Brevicoryne brassicae* (L.) on winter rape. In: XXXV Scientific Meeting of Institute of plant protection; 1995, pp. 101-103.

[14] Ahmed N, Ahmad S, Junaid M, Mehmood N. Population trend of aphid (*Lipaphis erysimi* Kalt.) on canola (*Brassica* spp.) cultivar in Peshawar. Pak Entomol 2013; 35:135-138.

[15] Maurya PR. Entomological problems of oil seed crops and extension strategy. Venus Publishing House, New Delhi, India; 2019, pp. 68.

[16] Kumar A, Sharma SD. Relative susceptibility of mustard germplasm entries against *Lipaphis erysimi* Kaltenbach. Ind J Agric Res 1999; 33:23–27.

[17] Amjad M, Peters DC. Survival, development, and reproduction of turnip aphids (Homoptera: Aphididae) on oilseed brassica. J Econ Ent 1992; 85:2003-2007.

[18] Ellis PR, Farrel JA. Resistance to cabbage aphid (*Brevicoryne brassicae*) in six Brassica accessions in New Zealand. NZ J Crop Hort Sci 1995; 23:25-29.

[19] Ellis PR, Ramsey AD, Singh R, Pink DAC. Wild Brassica species as sources of resistance to *Brevicoryne brassicae* and *Alerodes proletella*. Bull OILB/SROP 1996; 19:1-7.

[20] Steel RGD, Torrie JH. Principles and procedures of statistics. McGraw Hill Book Co., Inc., New York; 1984, pp. 232-251.

[21] Aslam M, Razaq M, Shahzad A. Comparison of different canola (*Brassica napus* L.) varieties for resistance against cabbage aphid (*Brevicoryne brassicae* L.). Int J Agric Biol 2005; 7:781-782.

[22] Amer M, Aslam M, Razaq M, Afzal M. Lack of plant resistance against aphids, as indicated by their seasonal abundance in canola (*Brassica napus* L.) in southern Punjab, Pakistan. Pak J Bot 2009; 41:1043-1051.

[23] Aslam M, Ahmad M, Islama Z, Anjum S. Population of aphid, *Lipaphis erysimi* (Kali) on canola (*Brassica napus*). Sci Tech Dev 2002; 21:41-42.

[24] Sarwar M. Study on differences in some new mustard *Brassica campestris* l. genotypes for having resistance and susceptibility feedback infected with aphid *Myzus persicae* (Sulzer) (Homoptera: Aphididae). Global J Sci Res 2013; 1:80-84.

[25] Laskar N, Mandal J, Ghosh SK. Effect of temperature on the incidence of mustard aphid, *Lipaphis* on broccoli both in open and covered conditions in the Hills of Darjeeling. Environ Ecol 2004; 22:342-344.

[26] Abbas Q, Ahmad I, Shahid MA, Akhtar MF, Hussain M, Akram M, Raza A, Sharif T. Role of climatic factors on population fluctuation of aphids (*Brevicoryne brassicae*, *Myzus persicae* and *Lipaphis erysimi*) on canola (*Brassica napus*) in Punjab, Pakistan. Pak J Nutri 2014; 13:705-709.

[27] Ali A, Rizvi PQ. Influence of abiotic and biotic factors on the population dynamics of mustard aphid, *Lipaphis erysimi* (kalt.) on indian mustard, *Brassica juncea* with respect to sowing dates. Acad J Plant Sci 2012; 5:123-127.

[28] Bishnoi, OP, Singh H, Singh R. Incidence and multiplication of mustard aphid (*Lipaphis erysimi*) in relation to meteorological variables. Ind J Agri Sci 1992; 62: 710-712.

[29] Ansari MS, Hussain B, Qazi NA. Influence of abiotic environment on the population dynamics of mustard aphid, *Lipaphis erysimi* (Kalt.) on *Brassica* germplasm. J Biol Sci 2007; 7: 993-996.

[30] Singh SS, Lal MN. Seasonal incidence of mustard aphid *Lipaphis erysimi* on mustard crop. J Entomol Res 1999; 23:165-167.

[31] Gami LM, Bapodra JG, Rathod RR. Population dynamics of mustard aphid [*Lipaphis erysimi* (Kaltenbach)] in relation to weather parameters. Ind J Pl Prot, 2002; 30:202-204.

[32] Marghub A, Muhammad A, Muhammad R, MuhammadA. Lack of plant resistance against aphids, as indicated by their seasonal abundance in canola, (*Brassica napus* L.) in southern Punjab, Pakistan. Pak J Bot 2009; 41:1043-1051.

[33] Niaz T, Aheer GM, Jalali SMI, Ashraf M, Ali A. Relative response of Brassica varieties / advanced lines against cabbage aphid, *Brevicoryne brassicae* (Linn.) (Aphididae: Homoptera). J Agric Res 1996; 34:55–58.

[34] Amjad, M, Islam N, Kakakhe SA. Turnip Aphid, *Lipaphis erysimi* Kalt. (Homoptera: Aphididae) Biology, instrinsic rate of increase and dev. threshold temperature on oilseed *Brassica*. Pak J Biol Sci 1999; 2:599-602.

[35] Aheer GM, Malik NA, Ahmad J, Razaq A. Screening of Brassica varieties / advanced lines against aphid attack. J Agric Res 1999; 37:195–200

[36] Sarwar M, Ahmad N, Bux M, Ali A, Tofique M. Response of various brassica genotypes against aphids infestation under natural conditions. Pak J Zool 2004; 36:69-74.

[37] Solangi BK, Muzaffar AT, Imtiaz AN. Preference of *Lipaphis erysimi* (Kalt.) to different canola varieties. Sarhad J Agric 2007; 23: 701-704.

[38] Mamun MSA, Ali MH, Ferdous MM, Rahman MA, Hossain MA. Assessment of several mustard varieties resistance to mustard aphid, *Lipaphis erysimi* (Kalt.). J Soil Nature 2010; 4:34-38.

[39] Abbas Q, Arif M, Ashfaq M, Sayyad H Khan M. Comparison of canola (*Brassica napus* l.) genotypes grown under different farming systems for resistance against aphid species, *Brevicoryne brassicae* (l.),

Myzus persicae (sulzer) and *Lipaphis erysimi* kalt. (Homoptera: Aphididae). Pak Entomol 2012; 34:145-150.

[40] Paula SV, Picanco MC, Koga FH, Moraes JC. Resistance of seven clones of kale to *Brevicoryne brassicae* (L.) (Homoptera: Aphididae). Anais Soc Entomol Brasil, 1995; 24:99–104.

[41] Khattak SU, Hamed M. Effect of different dates of sowing of rapeseed on aphid (*Brevicoryne brassicae* L.) infestation. Proc Pak Cong Zool 1993; 13:249–254.

[42] Alipieva M, Nankova T. The resistance of *Brassica oleracea* var. *capitata* L. to *Brevicoryne brassicae* L. Crucif. News 1996; 18:100-101.