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Evaluation of Different *Brassica* spp. Against Aphids, Under Multan Agro-Ecological Conditions

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ABSTRACT

Four species of *Brassica viz*,. *B. napus, B. juncea. B. compestris* and *B. rapa* were studied for their relative resistance/susceptibility against aphids, under field conditions for three consecutive crop seasons *i.e*., 2009-2010, 2010-2011 and 2011-2012. The data on the incidence of aphids were recorded at weekly interval. Host plant susceptibility indices were also calculated. *B. napus* was found to be susceptible showing maximum population of aphids *i.e*., 6.80 per 10-cm inflorescence whereas *B. compestris* showed comparatively resistant response with minimum population of aphids *i.e*., 0.43 per 10-cm inflorescence. The population of aphid was recorded to be the highest (12.83 per 10-cm inflorescence) on March 11 which showed non-significant difference with those of recorded on March 04 (12.52/10-cm inflorescence) Furthermore, the population of aphids remained present throughout the crop season starting from December 10 of each cropping period. The population of aphids was recorded to be higher on *B. napus* and *B. juncea* as compared to *B. compestris* and *B. rapa* on most of the dates of observation. Non-significant difference was found to exist among years regarding the population of aphids on *Brassica* species. The population of aphids showed significant difference among years for *B. napus* whereas *B. juncea*, *B. compestris* and *B. rapa* showed non-significant difference. The crop seasons 2009-2010, 2010-2011 and 2011-2012 did not show significant difference regarding the population of aphids at various dates of observation starting from December 03 to January 28 for each crop season. Significant difference was found to exist thereafter from February 04 to march 25 among crop seasons. The highest population was recorded to be 12.84 during 2009-2010 on March 11, 13.15 per 10-cm inflorescence on March 04 during 2010-2011 and 13.78 per 10-cm inflorescence on March during 2011-2012. The maximum HPSIs were recorded to be 51, 48, 55 and 51 percent in *B. napus* during 2009-2010, 2010-2011, 2011-2012 on cumulative basis, respectively and proved to be susceptible specie. The minimum HPSI was recorded to be 3, 5, 1 and 3 percent for *B. compestris* during the crop seasons as mentioned above, respectively and found to be comparatively resistant.

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AF designed and supervised the work. MJ executed the experiment work and wrote the article

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***Brassica* , aphids population, host plant resistance, abundance period**

INTRODUCTION

Rape and mustard oil seed crops are the most important sources of vegetable oil grown during the winter season. The area and production level of rape and mustard in Pakistan during 2002-03 were about 649 x 103 acres, 217 x 103 tons oil seeds and 69 x 103 tons oil (Anonymous, 2009). During the year 2008-09 total production of edible oil met 27.2% requirements of Pakistan, whereas remaining amount was imported by expending 84 billion rupees. Cotton and sunflower are major crops contributing to local oil production. Oilseed brassicas are the minor crops. Canola, *Brassica napus, Raya, Brassica juncea* and *Brassica carinata* are some important crops from this group (Anonymous, 2009).

Poor yield of crops is mainly attributed to its susceptibility to insect pests and host plant resistance can be manipulated against a variety of insects including aphids (Athar *et al*., 2011). There are different insect pests, which attack *Brassica* like aphids, white fly, painted bug, pea leaf miner and saw fly but aphids are the main pests which attack *Brassica* (Agarwal and Datta, 1999). They multiply very rapidly under favorable conditions on leaves, stems and inflorescence from where these pests suck the plant juices. Due to the attack of aphids, affected pods and seeds remain stinted (Devi *et al*., 2002). It has been observed that yield loss ranges from 30-35% by the attack of aphids on *Brassica* (Buntin and Raymer, 1994). It can go up to 70% by the attack of aphids on *Brassica* (Phadke, 1985; Prasad, 1992). Yield losses up to 70-80% are also reported by (Bedford and Henry, 1998) Rustamani *et al*. (1998). In Pakistan, winter oilseed *Brassica* crops are attacked by *Lipaphis erysimi* (Kalt.) and to a lesser extent by *Brevicoryne brassica* (L.) and *Myzus persicae* (Hamid

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and Ahmad, 1980). In Bangladesh and elsewhere Mustard aphid, *Lipaphis erysimi* is the most serious and destructive pest of mustard and a major limiting factor for successful cultivation of mustard seed production (Biswas and Das, 2000). Its population reaches its peak when the crop is about 70 days old. The feeding just prior to and during bloom, results in aborts flower buds, deformed developing pods and generally decreases vigor in plant growth resulting in yield losses of up to 40 percent in untreated fields (Agarwal and Bardhanroy, 1999). The age factor has prime importance for aphids, their mortality, reproduction and even writing ouputs are completely dependent on the age of aphid (Hol *et al*., 2016). In addition to this, they are known to be the vectors of various diseases (Kennedy *et al*., 1962) which can be only managed by effective control of aphids.

The estimation of the variation was concluded by Way and Murdie (1965) in host plant resistance of Brussels sprouts and concluded that waxy leaved varieties supported large aphids populations as compared to glossy leaved plants. Auclair (1969) reported that host selection by aphids was affected by the balance of (nutrients) chemicals. Dunn and Kempton (1971) reported that the increase in aphid population depends upon the rate of development, age, temperature and host plants in turn affect survival and fecundity of individual. Mathur *et al*. (1971) tested more than 70 varieties of002*Coriandrum sativum* L. against *Hydaphis coriandri* under natural conditions and found that there was little infestation of some of the test varieties, while there was severe attack on the other test varieties, due to their early flowering and seed maturation. The study by Dunn and Kempton (1972) reported that some of plants of Brussels sprouts were resistant to the aphid species. Further investigation showed that the most resistant of those from the first year of the work proved to be at least as resistant as any of the subsequently discovered. (Mathur *et al*.,1971). Dean (1973) studied the biology and economics of aphids reared on cereals and concluded that *Rhopalosiphum padi* increased faster on barley than on oats. MacCarter and Habeck (1973) explained that the susceptibility of a host plant could be reduced from the fecundity and longevity of aphids on diverse host plants. A variety of canola Bullbull-98 (*Brassica napus*) was susceptible against aphids where as variety Khanpur Raya (*Brassica juncea*) was resistant against this pest (Farooq and Tasawar, 2007). The incidence of aphids on brassica begins from November and continues till the harvesting stage (Zsuzsa and Adrien, 2003). Keeping in view the above facts, the present study was conducted with an aim to (i) find relative resistance against aphids in various *Brassica* species, (ii) to find the period of abundance of aphids, and (iii) to calculate the host plant susceptibility indices.

MATERIALS AND METHODS

The study was conducted on Host Plant Resistance against aphid on *Brassica* sp. in the experimental area of University College of Agriculture, Bahauddin Zakariya University Multan from 2009, 2010 to 2012-13. Four available brassica species *i.e.*, *B napus*, *B. rapa*, *B. juncea* and *B.compestris* were sown in the experimental area of Entomology Department, College of Agriculture, BZ University Multan for three consecutive seasons *viz*., 2009-2010, 2010-2011 and 2011-2012.

The randomized complete block design was followed with four replications. The plot size was kept at 5-m x 4-m for each season. Recommended cultural practices were adopted.

The data regarding population of aphids were recorded from 10-cm inflorescence of central shoot at weekly interval by randomly selecting 10 tillers from each plot (Supplementary Table I, II, III).

Host Plant Susceptibility Indices (HPSIs) based on aphid population at 10-cm inflorescence for all brassica species studied on each year during three consecutive seasons were determined by Excel Software through IBM compatible computer. The objective was to determine the level of susceptibility within brassica species. However the HPSI was also determined with the following formula followed by Ali (1991).

$$HPSI\ (\%) = \frac{B - A}{B} \times 100$$

Whereas A stand for aphid population on a single genotype and B stands for aphid population on all *Brassica* species, on total basis.

RESULTS AND DISCUSSION

The analysis of variance of the data reveals significant difference among dates of observation, genotypes of *Brassica* and in their all interactions in which Population of aphids per 10-cm inflorescence on different species of *Brassica* at various dates is observed (Table I). The variation was found to be non-significant among different years.

Table I shows that maximum population of aphid was recorded to be 6.86 per 10-cm inflorescence on *Brassica napus* and differed significantly from those of recorded on other *Brassica* species. The minimum population of aphid was observed to be 0.43 per 10-cm inflorescence on *Brassica compestris* and did not show significant difference with those of recorded on *B. rapa* (0.60/10-cm inflorescence). The specy of *B. juncea* possessed 5.47 aphids per 10-cm inflorescence and also differed significantly from those of recorded on other species of *Brassica*. From these results it

Table I. Population of aphids per 10-cm inflorescence on various species of *Brassica* during different crop seasons.

Years	Year X species of Brassica (LSD at 5% =0.48)				Average (ns) (E)
	***B. napus* (A)**	***B. Juncea* (B)**	***B. comperstris* (C)**	***B. rapa* (D)**	
2010	6.86 a	5.47 c	0.43 de	0.60 de	3.35
2011	6.32 b	5.38 c	0.68 de	0.78 de	3.29
2012	7.23 a	5.39 c	0.19 e	0.36 de	3.29

Figures in column ABCD showing similar letters are not significantly different by DMR Test at P=0.05; LSD, Least significant difference; NS, Non-significant.

Table II. Population of aphids per 10-cm inflorescence on different species of *Brassica* at various dates of observation.

Dates of observation	Species of Brassica (LSD at 5% = 1.15)				Average (LSD at 5%) =0.58 (E)
	***B. napus* (A)**	***B. Juncea* (B)**	***B.comperstris* (C)**	***B. rapa* (D)**	
December 03	0.000 m	0.000 m	0.000 m	0.001 m	0.000 g
December 10	0.008 m	0.017 m	0.084 m	0.083 m	0.048 g
December 17	0.083 m	0.167 m	0.000 m	0.000 m	0.063 g
December 24	0.008 m	0.084 m	0.000 m	0.000 m	0.023 g
December 31	0.000 m	0.083 m	0.083 m	0.000 m	0.042 g
January 07	0.042 m	0.075 m	0.033 m	0.092 m	0.060 g
January 14	0.108 m	0.075 m	0.083 m	0.092 m	0.090 g
January 21	0.108 m	0.108 m	0.050 m	0.092 m	0.090 g
January 28	0.175 lm	0.075 m	0.058 m	0.133 m	0.110 g
February 04	1.850 j	1.200 jklm	0.933 jklm	1.408 jklm	1.348 g
February 11	5.408 h	3.675 i	0.958 jklm	0.792 jklm	2.708 e
February 18	8.225 g	6.433 h	1.083 jklm	1.150 jklm	4.223 d
February 25	13.792 e	10.517 f	1.583 jkl	1.492 jklm	6.846 c
March 04	24.417 b	21.917 c	1.658 jk	2.092 j	12.521 a
March 11	26.650 a	22.325 c	0.342 klm	2.008 j	12.831 a
March 18	23.875 b	17.692 d	0.325 klm	0.317 klm	10.552 b
March 25	10.908 f	7.650 g	0.058 m	0.450 klm	4.767 d
Average (LSD at 5% = 0.28	6.80 a	5.42 b	0.43 c	0.60 c	

Column ABC and D showing similar letters are not significantly different by DMR Test at P=0.05. Figures sharing similar letters in column E at par statistically by DMR Test P=0.05. The figures in the last row showing similar letters are not significantly different by DMR Test at P = 0.05; LSD, Least significant different value.

Analysis of variance of the data regarding population of aphids per 10-cm inflorescence on different genotypes of *Brassica* spp. at various dates of observation on different years.

S.O.V.	D.F.	S.S.	M.S.	F. ratio
Years (Y)	2	0.74	0.371	2
Dates of observation (D)	16	16453.25	1028.328	16
Y X D	32	103.57	3.237	32
Varieties V)	3	6583.98	2194.659	3
Y X V	6	42.22	7.036	6
D X V	48	13926.16	290.128	48
Y X D X V	96	277.53	2.891	96
Error	609	1266.63	2.080	609

CV, 43.53%; *, Significant at P<0.05; **, Significant at P<0.01.

is concluded that *B. napus* was found to be comparatively susceptible whereas *B. compestris* appeared relatively resistant showing minimum population of aphids and was at par statistically with those of *B. rapa*. The present findings cannot be compared with those of Way and Murdie (1965), Dun and Kempton (1971), Dun and Kempton (1972), Mathur *et al*. (1971), Dean (1973), MacCarter and Habeck (1973) and (Caresche *et al*., 1974) because of differences in their materials and methods as well as ecological variations. The present findings are partially in conformity with those of Farooq and Tasawar (2007) who reported that *B. napus* was susceptible against aphids while B. juncea was resistant whereas in the present study *B. juncea* was categorized as moderately susceptible.

The results presented in Table II reveal that the population of aphid showed non-significant difference from December 03 to January 28, during all the crop seasons showing the population range of 0.00 to 0.34 per 10-cm inflorescence. A significant increasing trend was observed thereafter from February 11 to March 11. The maximum peak of the pest was recorded to be 12.83 per 10-cm inflorescence on March 11 and did not differ significantly from those found on March 04 with 12.52 aphids per 10-cm inflorescence. A significant decreasing trend was observed thereafter on March 18 to March 25 with 10.55 and 4.76 aphids per 10-cm inflorescence, respectively. From these results it is concluded that on average of three year's data that the observation recorded on March 04 and March 11 showed favorable period for the development of the pest under study.

Table III shows observations recorded from December 03 to January 28 in all the species of *Brassica* which did not show any significant difference among themselves. The population of aphid recorded on February 04 on *B. napus i.e.*, 1.85 per 10-cm inflorescence did not show significant difference with those of recorded on *B. rapa* from February 04 to March 11. Similar trend was also recorded in *B. compestris* from February 04 to March 04. Maximum population of aphid was recorded to be 26.65 per 10-cm inflorescence on *B. napus* at observation recorded on March 11 and differed significantly from those of recorded on all other species of *Brassica* at all the observations. In general *B. napus* showed higher population of aphids per 10-cm inflorescence almost at all the dates of observation as compared to all other species of *Brassica*. However, March 04 and March 11 showed higher population of aphid per 10-cm inflorescence in all the species of *Brassica* . The present findings are partially be compared with those of Zsuzsa and Adrien (2003) who reported that the incidence of aphids on *Brassica* begins from November and continue till harvesting but in the present study the variation in aphids appearance was different on *Brassica* species.

Table III. Population of aphids per 10-cm inflorescence on different crop season at various dates of observation.

Dates of observation	Average (LSD at 5% = 1.00)		
	2009-2010 (A)	2010-2011 (B)	2011-2012 (C)
December 03	0.001	0.000	0.000
December 10	0.001	0.125	0.019
December 17	0.000	0.188	0.000
December 24	0.001	0.063	0.006
December 31	0.000	0.125	0.000
January 07	0.063	0.50	0.069
January 14	0.100	0.031	0.138
January 21	0.075	0.050	0.144
January 28	0.106	0.063	0.163
February 04	1.300 n	1.544 n	1.200 no
February 11	3.244 kl	2.875 lm	2.006 mn
February 18	4.244 jk	3.894 jkl	4.531 ij
February 25	6.944 fg	6.069 gh	7.525 f
March 04	12.831 ab	13.156 a	11.575 ed
March 11	12.844 ab	11.869 bc	13.781 a
March 18	10.506 e	10.369 e	10.781 de
March 25	4.788 ij	5.462 hi	4.050 jk
Average (ns)	3.36	3.29	3.29

Means sharing similar letters in column AB and C are not significantly different by DMR Test at P=0.05; LSD, Least significant difference value; NS, Non-significant.

Table II shows population of aphids per 10-cm inflorescence on various species of *Brassica* during different crop seasons. In this data non-significant difference among years is being revealed. However, the population ranged from 3.29 to 3.35 per 10-cm inflorescence. Nothing could be drawn from these results due to non significant variation. Maximum population of aphid per 10-cm inflorescence *i.e.,* 7.23 was recorded during the crop season 2011-12 on *B. napus* and did not show significant difference with those of recorded during 2009-2010 crop season for the same specie *i.e.*, 6.86 per 10-cm inflorescence while these were differed significantly from those of recorded on all others species of *Brassica* during all the crop seasons. The variation in crop season was non-significant in *B. juncea* where the population of aphid ranged from minimum of 5.38 to maximum of 5.47 per 10-cm inflorescence during 2010-11 and 2009-10 crop seasons, respectively. The population recorded on *B*, *compestris* and *B. rapa* showed non- significant difference regarding population of aphids per 10-cm inflorescence during all the crop seasons. The population ranged from minimum of 0.19 to maximum

of 0.78 per 10-cm inflorescence. The conclusion drawn from these results that the population of aphid per 10-cm inflorescence was higher on *B. napus* during all the crop season followed by *B. juncea*. The population of aphids was lower on *B. compestris* and *B. rapa* during all the crop season.

The interactional response among dates of observation and crop seasons regarding aphid population per 10-cm inflorescence is given in Table III. The population of aphid remained non-significant from December 03 to January 28 in all the crop seasons. The population ranged from 0.00 to 0.50 per 10-cm inflorescence. During 2009-2010 crop season, the population recorded on February 04 was 1.30 per 10-cm inflorescence and did not show significant difference from those of recorded on crop seasons 2010-2011 and 2011-2012 with 1.54 and 1.20 aphids per 10-cm inflorescence, respectively. An increasing trend in population of aphids was recorded thereafter in all the crop seasons upto March 11 during 2009-10, upto March 04 during 2010-2011 and upto March 11 during 2011-2012 showing 12.84, 13.15 and 13.78 aphids per 10-cm inflorescence, respectively and did not show significant difference with one another. A decreasing trend was observed thereafter upto March 25 in all the crop seasons and showed almost non-significant difference in their respective dates of observation. From these results it is concluded that the population of aphids reached to a peak level of 12.84 per 10-cm inflorescence on March 11 during 2009-2010, 13.15 per 10-cm inflorescence on March 04 during 2010-2011 and 13.78 per 10-cm inflorescence on March 11 during 2011-2012. Furthermore, only one peak was observed during all the crop season.

HPSIs were determined based on population density of aphids per 10-cm inflorescence with the objective to find the comparative susceptibility within species of *Brassica* for the observations recorded during 2009-2010, 2010-2011, 2011-2012 and on cumulative basis.

The results relating to HPSIs based on population density of aphid on various species of *Brassica* during 2009-10 are given in Table IV. It is evident that *B. napus* was found to be the most susceptible showing 51% HPSI followed by *B. juncea* with 41% HPSI. The lowest HPSI was recorded to be 3% for *B. compestris* which was found to be comparatively resistant against the population of aphids. The HPSI was recorded to be 5% for *B. rapa* which was also found to be relatively resistant. From these results, it is concluded that *B. napus* was the most susceptible whereas *B. compestris* appeared as comparatively resistant.

The results pertaining HPSIs based on population density of aphids on various species of *Brassica* during 2010-2011 are presented in Table IV. It is evident that *B. napus* showed maximum HPSI i.e. 48 percent followed by *B. juncea* showing 41% HPSI. The minimum HPSI was recorded to be 5% for *B. compestris* whereas *B. rapa* showed 6% HPSI. It is eoncluded from these results that *B. napus* was found to be comparatively resistant followed by *B. juncea* whereas *B. compestris* was appeared as relatively resistant followed by *B. rapa*.

Table IV. HPSI regarding the population of aphids on various species of Brassica during different years.

Sr #	Name of species	HPSI values (year wise)			
		2009-2010	2010-2011	2011-2012	Average of three years
1	*B. napus*	51%	48%	55%	51%
2	*B. juncea*	41%	41%	41%	41%
3	*B. compestris*	3%	5%	1%	3%
4	*B. rapa*	5%	6%	3%	5%

The results regarding HPSIs based on the population of aphids on various species of brassica during 2011-2012 are shown in Table IV. The results reveal that the maximum HPSI was calculated to be 55% for *B. napus* followed by 41% for *B. juncea*. The minimum HPSI was recorded to be 1% for *B. compestris* whereas *B. rapa* showed 3% HPSI. From these results it is concluded that *B. napus* was found to be comparatively susceptible whereas *B. compestris* appeared as relatively resistant to attack of aphids. When wheat is in grain filling stage at that moment the infestation of Aphids provides critical information about nutrient contents and metabolite accumulation which is important to know about the resistance mechanism (Xu *et al*., 2016).

The results pertaining to HPSIs based on population density of aphids on various species of brassica for the average of 3 years are given in Table IV. It is clear from the results that *B. napus* showed maximum HPSI *i.e.,* 51% and found to be comparatively susceptible followed by *B. juncea* with 41% HPSI. The minimum HPSI was observed to be 3% for *B. campestris* whereas *B. rapa* showed 5% HPSI. From these results it is concluded that *B. campestris* was found to be comparatively resistant whereas *B. napus* appeared as relatively susceptible. Such variability in host plant resistance is analogous to what has earlier been observed in cotton (Zafar and Athar, 2013a, b). The Bemissal is proved to be the most vulnerable cultivar having maximum level of HPSI which is 18% (Ali, 2016).

CONCLUSION

In conclusion, host plant resistance greatly varied in Brassica species against aphid. Detailed understanding of molecular biological basis of such variability in resistance

should be explored to develop aphid resistance *Brassica* species

Supplementary material

There is supplementary material associated with this article. Access the material online at: https://dx.doi.org/10.17582/journal.pjz/20131220132444

Statement of conflict of interest

The authors declare there is no conflict of interest.

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