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VARIETALS RESISTANCE AND SUSCEPTIBILITY IN MUSTARD (BRASSICA CAMPESTRIS L.) GENOTYPES AGAINST APHID MYZUS PERSICAE (SULZER) (HOMOPTERA: APHIDIDAE)

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The exploitation of resistant cultivars is an imperative, simple, practical and flexible way to cope with insect pests incidence. Thirty genotypes of mustard *(Brassica campestris L.)* were tested for their resistance and susceptibility to aphid *Myzus persicae* (Sulzer) exposed under natural field conditions. Data on pest tolerance of genotypes were judged by quantitative traits such as number of aphids on each infested plant and mean dry weight of seeds per genotype. Studies observed the discrepancy in overall rates of pest invasion and seed yield contained by trailed mustard genotypes. Agati sarson (P), S-9-S-97-100/45 and S-9-S-97-100/45 were the least damaged genotypes showing their moderate resistance. Amongst other genotypes, MM-I/01-5, MM-I285 and MM-I/01-6 were the most damaged showing oversensitive response. Although the majority of genotypes were found vulnerable to pest, Agati sarson (P) and S-9-S-97-100/45 due to their lowest hypersensitive response toward aphid contamination and increased pods yield could be used for the development of essential resistance in mustard plant. A marked mode of damage inflicted by aphid on the crop was noticed and the abiotic factors contributing variations in aphid infestation levels during both growing seasons were determined. Knowledge about the host plant resistance investigated can facilitate growers to choose the most appropriate cultivars as pest control strategy.

Keywords: APHID, Brassica, Resistance, Mustard, Myzus, Pest.

1. Introduction

The aphid *Myzus persicae* (Sulzer) develops well on Brassica species, particularly those that grow rapidly, such as mustard *Brassica campestris* L. It usually develops better on young, rapidly growing leaves than on mature leaves [1]. The *M. persicae* is outstanding in its distribution, in host plant range and as a pest which causes not only direct damage but is able to transfer over 100 virus diseases of plants on about thirty different families including many major crops such as Brassicas [2]. This aphid species is one of the most important groups of phytophagous insects because of their polyphenism, host alternation, heteroecious behavior and reproductive habits [3].

Many factors are involved in the widespread of aphid populations. Besides indiscriminate use of insecticides without regard for economic thresholds and development of resistance, there are many interactions that affect its population trends. Slosser et al. [4] concluded that an interaction between bioclimate and plant nutritional status stimulated initial population increases of aphid. Cole [5] monitored feeding behaviour of *M. persicae* electronically on a range of *Brassica* species, observations indicated that *M. persicae* did not generally accept or reject *Brassica* species due to the presence of phagostimulants, such as glucosinolates at the leaf surface or along the stylet pathway, unless the concentration is very high. The farmers solely depend on pesticides for the control of this insect pest. A population survey carried out using topical application of different insecticides indicated that different populations of *M. persicae* had developed resistance to certain chemicals and one mechanism of resistance was esterase-based resistance [6]. The future farming practices will likely be lesser dependant on agricultural chemicals and greater profits will be realized by reducing input costs. One vital element of sustainable farming is growing crops, which require minimum chemical inputs. Broad spectrum host plant resistance is now possible with crop breeding strategies. Still better understanding the mecha-nism of resistance for insect pests, will

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allow better deployment of technologies for different pests. In realizing this, one of the important stumbling blocks seems to be the evaluation of varietals resistance and susceptibility in mustard *B. campestris* genotypes against aphid *M. persicae*.

2. Materials and Methods

Field trials were carried out during the years 2004-2005 and 2005-2006 at the Nuclear Institute of Agriculture, Tandojam. The mustard (*Brassica campestris* L.) was grown on well prepared soil for 2 successive crop seasons on 02 December 2004 and 02 November 2005. Thirty mustard genotypes were tested for their resistance to aphid under field conditions. The genotypes selected for the experiment were included, Toria Selection-A (P), TSA-752/96, TSA-1005/95, S-9 (P), S-9-1005/95, S-9-1006/95, Agati Sarson (P), A-S-1004/96, A-S-1006/95, A-S-7517/96, A-S-10014/96, SMP-67, FSD-86028-3, FSD-850347, S-9-S-97-1.0E/20, S-9-S-97-1.0E/21, S-9-S-97-75/33, S-9-S-97-75/36, S-9-S-97-100/45, S-9-S-97-100/48, S-9-S-97-0.75+75/50, S-9-S-97-0.75+75/60, MM-I/01-3, MM-I/01-5, MM-I/01-6, MM-II/02-3, MM-VI/02-1, BM-T, MM-I285 and NIFA-Raya. The seeds of all the test genotypes were acquired from Plant Genetics Division of this Institute and Nuclear Institute of Food and Agriculture, Peshawar. The clean, pure, non-contaminated seeds with any other mustard genotypes and reasonably free of any unfamiliar substrates were used. Genotypes were direct seeded into four rows, plots for each genotype consisted of 2.5 m^2, planted at 30 cm row spacing and 9 cm plant to plant spacing, with 1 m bed buffer between the plots. Plots were arranged in a randomized complete block design with 3 replications. All the agronomic practices were accomplished according to the recommendations of Department of Agriculture. The investigational field was kept open for natural infestation of pests and no pest protecting trial or pest control measures were adopted against the insect invasion during the course of experiment. Nitrogen and phosphorus fertilizers were applied at recommended doses basally.

The varietal resistance and susceptibility of mustard in the test genotypes were determined by detecting aphids population and seed yield. The data on aphids population was acquired from first initiation of pest and prolonged till the invasion ended (from last week of January to second week of March). Aphid populations' developments were assessed by estimating the number of aphids/ plant on each sampling date. Each plant was sampled by visually examining all plant foliage and counting the number of alate (winged) and apterous (non-winged) aphids present. Infestation levels of aphids were estimated by randomly selecting 5 plants within each replicate, and all leaves in a plant were sampled, and particular attention was given to terminal growing points. Aphid population was monitored every 10 days interval and rated by average counts of aphid per plant sampled per replicate. All plots were hand-harvested from each replicate to estimate yield, and produce of each genotype combined to obtain total seed weight. Field studies were also carried to determine the effects of sowing time and the role of key abiotic factors regulating the field populations of aphid and consequences of aphid on yield of *B. campestris* for the duration of both growing seasons. Data on Meteorological observations during both the studies periods were obtained from Regional Agromet Center, and Drainage Research Center Campus, Tandojam. For each genotype, first calculated the aphid developmental rate and seed weight for each replicate; then data for mean values for each factor of three replicates estimated. For Statistical analysis of pest developmental rate and seed weight traits, data were analyzed with a simple one-way ANOVA to determine significant differences.

3. Results and Discussion

From the perusal of results, it appears that tendency of all *B. campestris* genotypes were varied in holding the numbers of aphids per plant and yield capability. Aphid populations varied greatly for both the years, all genotypes harbored the lower aphid population and higher yield performances at early season sown crop than higher aphid population and inferior yield at the late period of sowing.

3.1. Aphids mode of damage on mustard crop

The incidence of aphids attack on the plants of different mustard genotypes started on 2nd week of February. The aphid population increased gradually with the growth of plants. The aphid multiplication rate was slower during vegetative growth stage of crop; however, afterward a continuous increase in the mean population

Table 1. Average values for aphids population and grain yield of different mustard genotypes (*B. campestris*) during the years 2004-2005 and 2005-2006.

Name of Genotypes	Aphid population/ plant 2004-05 and 2005-06			Yield/ plot (2.5 m^2) (gm) 2004-05 and 2005-06		
	2004-05	2005-06	Pooled	2004-05	2005-06	Pooled
Toria Selection-A (P)	120.0 bcde	25.4 def	72.7 bcdefg	303.3 i	556.7 ghi	430.0 jk
TSA-752/96	193.3 abcd	32.6 cd	113.0 abcdef	240.0 k	543.3 hi	391.7 kl
TSA-1005/95	195.3 abc	28.7 cde	112.1 abcdef	221.6 kl	526.7 i	374.2 lm
S-9 (P)	114.0 bcde	10.4 jkl	62.2 bcdefg	330.0 ghi	803.3 cd	566.7 ef
S-9-1005/95	96.6 bcde	10.8 ijkl	53.7 cdefg	366.6 efgh	831.7 bc	599.2 cde
S-9-1006/95	77.0 def	16.7 fghijk	46.8 efg	403.3 bcde	746.7 de	575.0 ef
Agati Sarson (P)	50.6 e	5.80 l	28.2 g	463.3 a	1075. 0 a	769.2 a
A-S-1004/96	126.6 bcde	16.3 fghijk	71.4 bcdefg	296.6 ij	753.3 de	525.0 fgh
A-S-1006/95	77.0 def	19.75 efghij	48.3 efg	373.3 efg	740.0 de	556.7 efg
A-S-7517/96	73.0 e	24.0 defg	48.5 efg	435.0 abcd	703.3 ef	569.2 ef
A-S-10014/96	75.0 de	23.0 defgh	49.0 efg	400.0 bcde	721.7 de	560.8 efg
SMP-67	76.3 def	29.43 cde	52.8 defg	430.0 abcd	601.7 ghi	515.8 gh
FSD-86028-3	199.6 ab	25.9 def	112.8 abcdef	246.6 jk	731.7 de	489.2 hi
FSD-850347	73.0 e	24.4 defg	48.7 efg	436.6 abc	741.7 de	589.2 de
S-9-S-97-1.0E/20	116.0 bcde	20.4 efghi	68.2 bcdefg	320.0 hi	746.7 de	533.3 fgh
S-9-S-97-1.0E/21	110.0 bcde	24.8 def	67.4 bcdefg	340.0 fghi	736.7 de	538.3 fgh
S-9-S-97-75/33	92.0 bcde	32.9 cd	62.4 bcdefg	366.6 efgh	633.3 fg	500.0 hi
S-9-S-97-75/36	127.6 bcde	31.6 cd	79.6 bcdefg	296.6 ij	616.7 gh	456.7 ij
S-9-S-97-100/45	54.3 e	8.26 kl	31.3 g	446.6 ab	1030.0 a	738.3 ab
S-9-S-97-100/48	74.6 de	9.0 kl	41.8 fg	400.0 bcde	1013.0 a	706.7 b
S-9-S-97-0.75+75/50	74.6 de	14.9 ghijkl	44.8 efg	386.6 defg	900.0 b	643.3 c
S-9-S-97-0.75+75/60	76.6 def	13.85 hijkl	45.2 efg	383.3 def	881.7 b	632.5 cd
MM-I/01-3	202.0 ab	44.8 ab	123.4 abc	183.3 l	283.3 lm	233.3 n
MM-I/01-5	251.6 a	51.8 a	151.7 a	103.3 m	216.7 m	160.0 o
MM-I/01-6	208.6 ab	46.0 a	127.3 ab	113.3 m	241.7 lm	177.5 o
MM-II/02-3	203.6 ab	42.5 ab	123.1 abcd	180.0 l	283.3 lm	231.7 n
MM-VI/02-1	123.0 bcde	36.2 bc	79.6 bcdefg	301.6 i	393.3 j	347.5 lm
BM-T	111.3 bcde	30.6 cd	70.98 bcdefg	300.0 i	376.7 jk	338.3 m
MM-I285	205.3 ab	46.9 a	126.1 ab	123.3 m	233.3 lm	178.3 o
NIFA-Raya	198.6 ab	31.5 cd	115.1 abcde	200.0 kl	310.0 kl	255.0 n
LSD value	8.38	59.99	57.60	49.52	72.49	43.63

Each value is a mean of three replicates; mean sharing common letters within rows are non-significantly different at 0.05.

density was observed**.** Aphid crowding in crop year 2005 was fairly enormous as compared with prevalence recorded during 2006. Both alate (winged) and apterous (non-winged) aphids forms were recorded at study site. Alate aphids that flied into the crop from surrounding weeds conferred the colonies comprising of generally apterous aphids and created typically dense assemblage on plant. Aphids were analyzed sucking the sap from growing points of plants or found feeding on the undersides of leaves causing injury to plant resulting flower abortion and reduced pod setting. The pest also coated the plants with sticky honeydew that promoted the development of black sooty mould, in this manner failing the plants' capability to photosynthesis and usually reducing plant vigor and considerable yield losses. Additional line of investigation is designed on this aspect.

3.2. *Aphids population on mustard genotypes*

The aphid *M. persicae* was the most numerous pest species at the experimental site. Studies observed the discrepancy in overall rates of pest invasion; the results established (Table 1) that aphid development on all mustard genotypes was greatly elevated in the first year 2004-05 (50.6 - 251.6 / plant) than the lesser rate of invasion during the second year 2005-06 (5.80-51.8/ plant). For observations of both the years, although majority of genotypes were found vulnerable to pest, the lowest pooled aphid contamination was contained by Agati sarson (P), S-9-S-97-100/45 and S-9-S-97-100/48 (28.2, 31.3 and 41.8 individuals/ plant, respectively) due to their lowest hypersensitive response. Amongst other genotypes, MM-I/01-5, MM-I/01-6 and MM-I285 were the most damaged (151.7, 127.3 and 126.1 aphids/ plant, respectively) showing oversensitive response, and there were statistical differences. The studies revealed significant negative relationships among aphid population and mustard yield attribute.

3.3. *Effects of aphids on mustard yield*

Maximum grain yield of 1075.0 gm/ 2.5 m^2 was recorded in early grown mustard (first week of November 2005-06), which can be attributed owing to diminish pest incidence, and comparatively a lesser amount of grain yield 463.33 gm/ 2.5 m^2 was recorded when crop sown on first week of December 2004-05 due to intense aphid infestation. The maximum pooled grain yield of 769.2, 738.3 and 706.7 gm was recorded in genotypes Agati sarson (P), S-9-S-97-100/45 and S-9-S-97-100/48/ 2.5 m^2 areas, respectively, for the period of both growing seasons. The statistical analysis showed that means were significantly different between genotypes tested. Overall result showed a mean minimum grain output of 160.0, 177.5 and 178.3 gm observed for genotypes, MM-I/01-5, MM-I285 and MM-I/01-6, respectively and there were statistical differences.

3.4. *Meteorological observations at the experimental site*

Aphid populations varied greatly within both the years, on an average unusually heavy aphid population inflicting damage on mustard was observed during 2004-05. During this peak year of pest intensity, total rainfall was nominal, but the temperature remained around 12.1-27.9 ^{0}C that was higher than the average temperature prevailing in 2005-2006 (approximately 13.2-28.1 ^{0}C), whereas, the relative humidity was 67.2 and 75.2%, respectively. The low temperature associated with humidity might be the probable reason for the carry over of the aestivated pest. Similar observations were reported by Dhaliwal, et al. [7], that the incidence, growth and multiplication of aphid are largely influenced by meteorological parameters like temperature and relative humidity. The data analyzed that the years with low aphid attack were comparatively warmer than the years with high aphid attack. Thus, abiotic factors (temperature, relative humidity) contributed variation in aphid infestation levels during both growing seasons. The activity of aphid was the maximum in late sown crop (first week of December) when 50.6 to 251.6 aphid/ plant were recorded. It indicated that in early-sown crop (first week of November) aphid infestation remained low (5.80 to 51.8 aphid/ plant) as a result of its poor initial population and comparatively low temperature. On the other hand, increased temperature and relative humidity were responsible for adversely affecting the activity of aphid in the earlier sowing. In the same fashion, the maximum seed yield was recorded in earlier sowing than late sown mustard as a consequence of varying aphid incidence under field conditions. Equivalent to present study, the role of key abiotic factors regulating the field populations of aphid was studied by Prasad and Phadke [8] and Reza et al. [9], who observed variability in the incidence of aphid on different species of mustard crop. The aphid population was positively related with temperature but relative humidity had shown slight response on its intensity and without any significant response of little rainfall. None of the ecological parameters alone was responsible for rapid multiplication of the aphid. The possible effects of ecological parameters on the aphid population, however, require further study.

Crop year 2005-2006 was characterized by extremely low aphid infestations throughout the growing season. Crop year 2004-2005 was typified by tremendously enormous aphid appearance. Further, all genotypes gave the higher yield performances at early date (November) sown crop than inferior yield at the late date of sowing (December). Similar investigations were carried out [10-12] to determine the effect of sowing dates on mustard aphid population. The early sown crop escaped from aphid infestation, while, the crop sown on late season suffered the most as maximum aphids per plant were recorded. Another experiment on incidence of aphid and the time of sowing was conducted [13]. The early sown crop escaped the aphid attacks in all the growth stages of the crop and resulted higher yield. In late sown crop, high level of aphid infestation was found at flowering and pod initiation stages, which recorded lowest yield. Thus present studies revealed that early date of sowing was best to avoid aphid as compared with late date of sowing.

Present studies revealed that all the tested *Brassica* genotypes showed different response towards holding aphids infestation and seed yield, and these were categorized either susceptible or resistant under the field conditions. The infestation of aphid on genotypes revealed that there was an inter-genotypic variation in population of mustard aphid. Analogous research work on evaluation of genotypes belonging to *Brassica* species for their tolerance to aphid was undertaken [14, 15]. The surveillance revealed that aphid incidence started at flowering of crop, but infestation was higher from the pod formation to maturity stages. Both nymphs and adults showed distinct non-preference reactions to the resistant varieties for feeding, orientation and oviposition; or adverse influence on the nymphal survival, emergence and duration as well as on the longevity and fecundity of adult females occurred. The overall assessment in the present study indicated that resistance to aphid was shown by the combined influence of non-preference, antibiosis and tolerance. The resistant varieties had adverse cumulative effects on the population buildup of aphid, which in turn influenced the grain yield. The highly susceptible genotypes might have shown lack of the characters with respect to all the components of resistance, clearly indicating the break down of their resistance. Weibull and Melin [16] analysed cultivars of *Brassica* species differing in host-suitability to the aphid for their phloem sap content of free amino acids. One *B. campestris* cultivar (yellow sarson), on which the aphids were shown to grow more slowly, had less amino acid content than other *B. campestris* varieties. This might also be due to effects of certain compounds, namely allelochemicals and plant growth regulators that caused maximum inhibition on the emergence of aphid nymphal stages [17] or else attributable to biological effects of allelochemicals from Brassicaceae plant species on aphid [18].

4. Conclusions

To emphasize the role of the host plant tolerance, Agati sarson (P) and S-9-S-97-100/45 due to lowest hypersensitive response toward aphid contamination and increased pods yield could be used for the development of essential resistance in mustard. The early sowing crop under agroclimatic conditions of experimental site is recommended to protect the plant from aphid's invasions. Knowledge about the host plant resistance attained from current investigations can facilitate growers to choose the most appropriate cultivars in terms of pest control strategy.

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