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RELATIVE DEGREE OF SUSCEPTIBILITY AND RESISTANCE OF DIFFERENT *BRASSICA CAMPESTRIS* L. GENOTYPES AGAINST APHID *MYZUS PERSICAE*-A FIELD INVESTIGATION

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Field evaluation of twenty three *Brassica campestris* L. genotypes was conducted for aphid (Homoptera: Aphididae) resistance during 2008 crop season. The parameters used to assess tolerance of germplasm lines included pest population during growth season and grain yield at crop maturity. Aphids showed obvious preferences for all of the germplasm investigated; however, the evaluation for resistance to pest identified several genotypes with variable potential for tolerance and sensitivity. Estimated grain yield also varied significantly due to variable pest intensity noted, and seemed to be more appropriately dependent on the pest population conditions at the experimental site. Among the germplasm, the estimation obtained regarding both the parameters sorted out MM-II/02-3 and MM-I285 genotypes as most tolerant due to less pest infestation and damage. Peak infestations by aphid caused severe crop fatalities on S-9-S-97-0.75+75/55 and S-9-1006/95 genotypes, affecting the seed weight and resulting an immense reduction in grain produced. The degrees of aphids' population and infestation on different *Brassica* genotypes appeared to be governed by means of varietals characteristics of diverse germplasms. The result of resistance test conducted under field environment is an effective and consistent approach in the practical selection of crop lines resistant or partially resistant to pests for use in future breeding programs.

Keywords: Aphid, Pest population, Genotypes, Cultivars, *Brassica campestris*

1. Introduction

The mustard *Brassica campestris* L. (syn. *Brassica rapa*), Family Brassicaceae (Cruciferae), Order Papaverales, is grown for its oil and meal, and as a cover crop. However, as a result of intensive breeding for seed and oil quality traits, oilseeds now-a-days represent one of the most important sources of vegetable oil worldwide [1,2]. Generally, *Brassica* plants are known to play an important role in human nutrition due to their phytochemicals, such as vitamins, minerals, glucosinolates and phenolic compounds [3]. In particular, it has been shown that *Brassica* species potentially exert inhibitory activity against chronic diseases like cancer [4]. The *Brassica* plants are significant source of polyphenols which are biologically important active constituents of the human diet. Several studies have investigated the phenolic composition of members of the Brassicaceae family. Twenty-eight polyphenols (11 flavonoid derivatives and 17 hydroxycinnamic acid derivatives) were detected in different cultivars of *B. campestris*. sp. c*hinensis* var. *communis* [5-7]. Hence, *B. campestris* constitutes a significant grouping of oilseeds and adds considerably to edible oil requirements of the nation. Alongwith the different insect pests invading this crop, aphid, *Myzus persicae* (Sulzer) (Homoptera: Aphididae), is regarded as the severe pest and liable to rigorous yield losses. Sarwar et al. [8] observed aphid feedings through sucking by adults and nymphs resulting injury to leaves that wilt afterward and dry. Owing to profound attack by aphid on immature plants usually results in plant death. The heavy population of aphids possibly can destroy small plants shortly and their feeding may deform the leaves of older plants resulting leaf to curl. Phloem-feeding insects like *M. persicae* are among the most devastating pests worldwide. They not only cause damage by feeding from the phloem, thereby depleting the plant from photo-assimilates, but, also by vectoring viruses. Owing to genomic variation and high mutation rate, it is relatively easy for plant viruses to overcome the resistance of plants. For that reason, until now, it turns out to be a main way and attractive strategy to explore for resistance against the vector insect rather than for the resistance against every individual of virus [9].

Now-a-days emphasis is being focussed on sustainable pest solution that makes use of plant varieties having resistance to the insect in the environment. The present spread of aphids in

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oilseed mustard production areas and with a long history of cultivation of this crop, require great efforts to develop cultivars with total or at least partial resistance to this pest. The prospects to protect oilseeds production through crop resistance and tolerance are accurately exciting and scientists are constantly identifying host plant resistance as the highest research priority of pest management tool. The advantages and benefits of growing crops resistant to injurious insect pests are numerous and diverse. The resistance plants can provide an effectual and inexpensive technique for managing pests and can reduce pest populations to levels that are non-damaging to succeeding plants. They are environmentally well-suited and do not necessitate particular application of chemicals and also do not require an extra cost inputs. An extremely resistant plant permits slight or else no pest reproduction but a vulnerable plant supports plentiful reproduction. To some extent, reasonably resistant plants allow intermediary intensity of pest reproduction [10, 11]. Within less developed countries and in low-cash cropping systems, host plant resistance is almost certainly the principally practicable way out to pest troubles. For this purpose large numbers of plant lines and breeding progenies are needed to be screened for resistance. The objective of this work was to focus on three possible scenarios explaining screening of different *Brassica* genotypes for resistance towards aphid under field conditions, estimation of yield and transfer of knowledge gained to the oilseed industry.

2. Materials and Methods

2.1. Plant Material

In order to identify potential performance of *Brassica campestris* genotypes for generating enhanced varietals resistance to aphids, the experiment was conducted at Nuclear Institute of Agriculture, Tandojam, Sindh, Pakistan. In total, twenty three lines supplied by Nuclear Institute of Food and Agriculture (NIFA), Peshawar, Pakistan, were tested in this study. The crop was sown on first week of November 2008 and seeds were drilled in straight lines. When planted the seeds, seedbeds prepared were smooth, firm and packed to minimize soil interference with seedlings emergence. The crop was sown with the help of single row hand drill in rows 30 cm away from each other. The experiment was conducted in Randomized Complete Block Design (RCBD) cultivated in triplicate. As and when required, three irrigations were applied to the crop and weeds were controlled by hoeing operation. Overall, no insecticide was applied to control the sucking insects specially the aphids. The fertilizer nutrients were applied in the form of Urea, Triple Super Phosphate and Muriate of Potash. As per local farmers practice, the half amount of Urea (N), and total Phosphate (P_2O_5) and Potash (K_2O) were applied at the time of seed sowing. The rest of half quantity of Urea (N) was applied as side dressing after 30 days of crop sowing. While thinning, ten days after seed sowing, two seedlings were retained per spot, and single retained twenty days after sowing. The entire intercultural operations and agronomic practices accomplished were kept normal for all the replicates to have a good crop husbandry.

2.2. Data Collection

Evaluation of resistance response of germplasms was performed by including pest population during growth period and grain yield at crop maturity. When necessary, the crop was watched regularly for pest incidence after seedling thinning when plants became well established. The observations recorded on aphid incidence were started since the preliminary manifestation to ultimate absconding of the pest on crop. Five representative plants were selected randomly in each replicate of 2.5 m^2 area and marked for identification. These five plants were monitored at fortnightly breaks to collect data on pest population. Average pest population was calculated by dividing the total pest density with respected number of five plants. Afterward, the average pest population was computed on per plant basis.

The yield contributing character was taken at crop maturity from each replicate of plants. Immediately after crop harvest, pods comprising the seeds were collected from each genotype at experimental location and threshed manually. The seed yield from each replicate of a genotype was weighed separately in grams using an electric balance and added to get yield per genotype. The best *B. campestris* genotype was determined on the basis of entomological assessment of aphids' population per plant and agronomic characteristic yield per 2.5 m^2 of experimental unit to conclude the fact that infection with aphid resulted in reduced plant growth and produce.

2.3. Statistical Analyses of Data

Data obtained from the experiments on different parameters were statistically examined using Statistix 8.1 software package. The data obtained on the field screening and scorings of yield samples were analyzed statistically following analysis of variance technique. The differences among means of pest severity and corresponding yield values were tested using least significant difference (LSD) test and adjudged significant at P≤ 0.05.

3. Results and Discussion

3. 1. Pest Identification and Population

One aphid species, *Myzus persicae* was observed as one of the mainly devastating insect pests. Besides aphid, appearance of other insect pests on *B. campestris* was either nil or minor. For that reason, emphasis was laid to cope with the aphids only in the present experiment. During experimental year, initiation of aphid infestation was recorded in January. The aphid population peaked on all germplasm after sometimes in February at flowering and pod initiation stages, while declined in late March. There were large variations in response to aphid severity among the screened genotypes; resultantly very few genotypes exhibited significantly a higher resistance level than that of the relatively less susceptible. Particularly among the *Brassica* germplasm, few genotypes exhibited significantly moderately susceptible or moderately resistant levels with values of variable range.

Among the parameters estimated, the data obtained sorted out principally the MM-II/02-3, MM-I285, S-9-S-97-1.0E+100/65 and S-9-S-97-1.0E/21 genotypes as tolerant due to least pest infestation and damage (7.33, 11.00, 14.67 and 16.67 aphids population/ plant, respectively), and these values differed significantly. In contrast to the comparatively higher resistant *B. campestris* genomes, the infestations by aphid caused severe damage particularly on S-9-S-97-0.75+75/55, S-9-1006/95 and TSA-752/96 genotypes expressing 49.00, 43.33 and 42.00 aphids population/ plant, respectively, and these values were significantly higher than the most tolerant genomes. These differences were adjudged significant by least significance differences analyzed statistically. The left behind genotypes showed a broad range of resistance or susceptibility with values between 18.00 and 37.33 aphids population/ plant and differences were found significant (Table 1).

3.2. Seed Produce

Irrespective of genotypes, aphid had significant effects on seed yield from the beginning of crop growth to end of the crop maturity. As a result, seed yield varied significantly, higher seed yield was obtained in genotypes MM-II/02-3, MM-I285, S-9-S-97-1.0E/21, S-9-S-97-1.0E+100/65 and MM-I/01-3 contributing 1220.00, 1143.00, 1063.00, 1038.00 and 1030.00 gm yield per 2.5 m^2, respectively. Statistical analysis confirmed significantly the highest seed yield produced by genotypes S-9-S-97-0.75+75/55 and S-9-1006/95 followed by TSA-752/96 showing 450.00, 476.70 and 500.00 gm seeds per 2.5 m^2, respectively (Table 1). This might be the genetic character of susceptible or tolerant genotypes as well as pest population suggesting that larger pest density ultimately reduced the yield since the major portion of the plant nutrients might have been lost through de-sapping at flowering and pod formation stages. On the other hand, less pest intensity helped in better pods retention and development due to less amount of required nutrients provision to the aphids and increased food retention by plant.

In *B. campestris* genome, twenty three genotypes were screened for resistance to aphid, the majority of lines were susceptible to pest as aphid showed maximum preference for feeding, particularly on S-9-S-97-0.75+75/55, S-9-1006/95 and TSA-752/96 expressing poorer resistance to pest. Strong resistance to aphid was frequent in MM-II/02-3, MM-I285, S-9-S-97-1.0E/21, S-9-S-97-1.0E+100/65 and MM-I/01-3 genotypes due to least pest preference recorded, indicating an important genome origin in them. In order to effective utilization of the pest-resistant gene resources for pest-resistance breeding, and for further studies, an understanding of the genetic mechanism of the resistance in elite *Brassica* germplasm is compulsory. The probable rationales for this resistance are multiple. Initially, on the one hand this might be due to an uneven distribution of *Brassica* genome homogeneity governing the resistance response of the plant material tested in the study that may have played a role. The mentioned genotypes were genetically largely heterogeneous and showed a variable response to aphid infection to have a significant impact on mechanism of tolerance. Assuming the presence of some heterogeneity in this material, might explain its maximum part in the variability of test results. However, up till now, the degree of homogeneity or heterogeneity in the breeding lines is unfamiliar. Secondly, the plant developmental stage may play an additional role towards aphid vulnerability. Until today, information is available at which developmental stage plants in the field are preferably invaded by aphid. Up-to-date few field investigations have demonstrated that the aphids

Table 1. Assessment of aphid's severity and grain yield in *Brassica* genotypes used in the studies.

No.	Name of genotypes	Aphids population/ plant	Yield (gm per 2.5 m^2)
1	Toria Selection-A	22.50 efgh	923.30 de
2	TSA-752/96	42.00 bc	500.00 jk
3	TSA-1005/95	37.33 cd	513.30 j
4	S-9 (P)	34.50 d	576.70hi
5	S-9-1006/95	43.33 b	476.70 jk
6	Agati Sarson	23.33 efgh	916.70 de
7	A-S-1006/95	27.00 e	696.70 g
8	A-S-7517/96	19.67 ghij	946.70 d
9	S-9-S-97-1.0E/21	16.67 ij	1063.00 c
10	S-9-S-97-0.75+75/50	26.67 ef	636.70 gh
11	S-9-S-97-0.75+75/60	34.00 d	576.70 hi
12	MM-I/01-3	18.00 hij	1030.00 c
13	MM-I/01-5	32.67 d	580.00 h
14	MM-I/01-6	25.00 efg	640.00 gh
15	MM-II/02-3	7.33 l	1220.00 a
16	MM-VII/02-1	26.00 ef	626.70 h
17	BM-I	23.00 efgh	833.30 f
18	MM-I285	11.00 kl	1143.00 b
19	NIFA-Raya	36.67 d	516.70 ij
20	S-9-S-97-0.75+75/55	49.00 a	450.00 k
21	S-9-S-97-0.75+75/61	32.00 d	583.30 h
22	S-9-S-97-0.75+75/62	21.33 fghi	876.70 ef
23	S-9-S-97-1.0E+100/65	14.67 jk	1038.00 c
LSD Value		4.82	57.60

Values with different letters are different significantly from one another (P= 0.05)

spread on crop at different developmental stage of plants in the field. It had been determined that aphids arrived at crop at flowering and pod formation stages, which are variable on different germplasm investigated due to the implement of different potentially originated in tested genomes. These consistent results are almost certainly related to the reports of Sarwar et al. [11], and Sarwar [12], who observed that *Brassica* genomes, differed for flowering and crop maturity. A third point may be represented due to the role of all environmental situations found in the field. But, the influence of environmental conditions may be alleviated by the fact that resistance is expressed internally in the vascular system of plant and thus less influenced by external weather factors. This may explain why genotypes showing elevated resistance to the aphids also performed well in the field for yield. On the other hand, the highly advantageous circumstances of pest contamination found in the field might have uniform influence on resistance and yield traits on all genotypes which driven out to be variably resistant under field conditions. This interpretation on frequency of aphid is in consistency with the findings of earlier workers that proved the correlation coefficients between aphid population and abiotic parameters could not establish a clear cut trend in relationship of aphid population with environmental factors. Except for a few instances the abiotic parameters show a low order of association with aphid population [13, 14].

The resistance of Brassica to attack by aphids can also be investigated from a chemical standpoint where by the presence or absence of certain chemicals quantitatively may show to play an important part in the palatability or un-palatability of the plant. Parallel to this, variations were observed among the progenitor species of the *Brassica,* where a diverse array of wild and weedy crucifers was screened for their resistance to *Lipaphis erysimi* (Kaltenbach). The biochemical analysis suggested the possibility of high concentration of lectins to be associated with low aphid infestation in *B. fruticulosa* [15]. The amount and sugar concentration of nectar produced in genotypes may be variable, exhibiting a resistance level significantly higher in tolerant than that of the relatively susceptible germplasm. This result is in consistent with earlier findings where the amount and sugar concentration of nectar produced by cultivars of *B. campestris* and the cultivars of *B. napus* were determined. The flowers of both species produced more nectar, with a lower sugar concentration [16]. But this argue is contrary to what have seen on a previous test, where results suggested that the mechanism of resistance may be a mechanical blocking of the sieve element or stylets rather than a difference in the secondary plant chemistry of glucosinolates and phenolics [17]. These observations are in conformity with the fact that the efficiency of insect vector is affected by plant traits conferring resistance against the pest. For instance, mechanical barriers may interfere with the insect’s ability to reach the phloem and subsequently reduce the transmission of virus [9].

Finally, estimated yield losses based on pest intensity seemed more appropriate to the pest population conditions of the experiment. Seed yield and quality may be significantly altered by a number of factors and certain practices. The yield response might be due to the cumulative effects of the aphid density and genetic character of the genotypes to produce more seeds at the later stage of the crop that ultimately influenced seed yield. This observation is in conformity with the reports where the degree of infestation and the rates of population change of the aphids on different *Brassica* cultivars were found to be governed by varietals characteristics of different germplasm [13]. This statement is also compatible with earlier findings where significant reductions in the percentage of epicuticular wax, dry weight, sugar, amino acids levels were found with aphid feeding [18]. The findings advocate that aphid feeding possibly resulted nutrients deficiency in plant that may play a role in the defense mechanism of aphid infested foliages, thereby hindering their activity. Though the genetic basis of host plant resistance is poorly understood, it is of great value for understanding the evolution of insect pest resistance in natural plant populations and for increasing crop yields. Conceivably, with the exception of genotypes which had been characterized as less resistant to pest, the germplasm lines which performed extremely well for enhanced resistance levels in the field are effective and consistent sources for use in future breeding programs. Due to advent of genetic transformation procedures, it is now feasible to clone and insert genes into the crop plants to confer resistance to insect pests. A combination of integrated pest management tactics give hopes on host plant resistance that could provide durable source of resistance for contributing to a durable defense for aphid control.

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