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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)

Muhammad Sarwar

Pakistan Atomic Energy Commission, Nuclear Institute of Agriculture, Tando Jam- 70060, Sindh, Pakistan
Corresponding Author: Muhammad Sarwar

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ABSTRACT

Brassica crops are the most diversified and largest oilseeds produced by Pakistan and other countries of the world. Different species of aphids are the most devasting pests of Brassica campestris L., due to sucking of cell sap from leaves, stem, flowers and pods by both nymphs and adults insect. Study was conducted to examine resistance and susceptibility of eighteen B. campestris genotypes based on population density of aphids and grain yield under the same field environmental factors. The treatments were laid out in randomized complete block design in thrice replications. The trial was propagated as per the recommendations of agriculture and kept unsprayed. The most serious problematic insect pest at study site causing severe crop infestation was aphid Myzus persicae (Sulzer) (Homoptera: Aphididae) throughout the season. All genotypes had shown different levels of resistance and susceptibility to variable level of aphid infestation. High yielding genotypes were found comparatively more tolerant to aphids, whereas, severely damaged had given less produce. The genotypes NM-1, NM-2 and NM-3 were comparatively completely resistant with no population of aphids, showed the highest yield potential and did not differ significantly from one another. The genotypes DLJ-3, Chaliate and E-9 showed susceptible response and appeared comparatively the lowest yielding. Resistant genotypes can be grown as a component of an integrated pest management strategy for protecting the B. campestris crop from aphid infestation to reduce the use of expensive, toxic and environmentally damaging pesticides.

Keywords: *Aphids Management, Brassica campestris, Myzus persicae, Tolerance, Pest.*

INTRODUCTION

The land of Pakistan is an ideal location to produce high quality Brassica crops (Family: Brassicaceae of Order Papaverales) for oilseeds. The cooler local conditions in the winter season help to raise more difficult Brassica varieties and the warm spring allows for good harvesting conditions (Sarwar, 2009). Brassica crops include a family of agriculturally important species which are consumed in high quantities throughout the world. These crops are a good source of many health promoting and potentially protective phytochemicals including folic acid, phenolics, carotenoids, selenium, glucosinolates and vitamin C. Incorporating these potent plant based compounds in a daily food is a safe, effective and inexpensive way to guard against many of today's most common and lethal cancers of which nearly 30-40% are directly linked to improper diet and related factors (Kumar and Andy, 2012). The *Brassica campestris* L., is mostly a winter or spring annual plant that produces large amounts of biomass; stem erect, stout, much-branched; leaves petioled, alternate with a few bristly hairs, especially along the veins; flowers bright yellow, pedicellate, four-petaled; deep taproot and a fibrous near-surface root system; and seeds small, round, pale or dark, and smooth. Its cooked leaves are used as vegetable; the young leaves can also be added in little quantity to salads, and seeds contain a good source of edible oil. Its oil contains both high oil and protein contents, when the oil is crushed out, it leaves a high quality protein feed concentrate which is highly palatable to livestock (Sarwar et al., 2009; Sarwar, 2013 a; Sarwar, 2013 b). Albumins and globulins are the major seed proteins of *B. campestris*. The relative viscosities of both of these protein fractions increase with an increase in the protein concentration up to 0.6 percent. It is the minimum at pH 6 and high in acid and alkaline conditions. The presence of sodium lauryl sulfate and urea increase the viscosity. Sodium lauryl sulfate is effective at low concentrations (0.1-0.9 M) and urea at higher concentrations (1-9 M). The viscosity of the albumin fraction suffers more than globulin by these denaturing reagents (Amita and Dua, 1994). Brassica flowers have been observed to attract several species of natural enemies including lady beetles (Coccinellidae: Coleoptera), green lacewing *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), spider *Tibellus oblongus* (Walckenaer) (Araneae**:** Philodromidae) and syrphid fly *Syrphus balteaus* De Geer (Diptera: Syrphidae) as predators associated with aphid colonies. The most common parasite is *Aphidius* species (Hymenoptera: Aphidiidae) occurring in aphid populations. The natural enemies from these groups are important natural biological control agents in a number of agro-ecosystems, including *B. campestris* crop, which is important practical information to improve integrated pest management systems in these crops (Sarwar, 2013).

The aphids are the severely disparaging insect pests of brassica crops, both nymphs and adults suck sap from leaves, stem, flowers and pods ensuing in deprived pod formation and reduced oil content in seed under severe attack. The green peach aphid *Myzus persicae* (Sulzer) feeds on hundreds of host plants and is found throughout the world. Moreover, in addition to inflict damage to plants of field crops, *M. persicae* also infests many vegetables and ornamental plants, which allow high levels of survival of this pest. If young plants are infested with aphid and then such plants are transplanted into the field, fields grown plants are also inoculated with pest. Aphid *M. persicae* is typically present on the underside of the oldest leaves, but, commonly found on seedlings, young plants, and lower leaves of older plants (Sarwar et al., 2011). This aphid can attain very high densities on young plant tissue, causing water stress, wilting, and reducing growth rate of the plant. Prolonged aphid infestation can cause appreciable reduction in yield of root crops and foliage crops. Early season infestation is particularly damaging to crop, even if the aphids are subsequently removed (Petitt and Smilowitz, 1982). Contamination of harvestable plant material with aphids, or with aphid honeydew, also causes loss leading to contamination problems (McLeod, 1987). However, *M. persicae* aphid does not seem to produce the high volume of honeydew as observed with some other species of aphids. The major damage caused by green peach aphid is through transmission of plant viruses. Indeed, this aphid is considered to be the most important vector of plant viruses throughout the world. Nymphs and adults are equally capable of virus transmission (Namba and Sylvester, 1981), but adults by virtue of being so mobile, probably have greater opportunity for transmission. The use of host plant resistance has provided a successful and environmentally benign means of controlling damage from aphids in Brassica crops. The major Brassica pest aphid has developed resistance to certain pesticide chemicals which have been used against it (Sarwar and Sattar, 2013). Given as a priority, the preventing of the development and spread of insecticide resistance has long been recognized. The development of resistance management strategy has been worked effectively for controlling resistance outbreak in aphids along with other resistance management techniques which are being investigated. For formulating a suitable pest management strategy, constant monitoring of *M. persicae* pest on it hosts under field condition is crucial. Hence, the present study was taken up to know the population fluctuations of this pest on different *B. campestris* genotypes.

MATERIALS AND METHODS

Experimental locality and crop growing

These field experiments were conducted during winter season at the Experimental Farm of Nuclear Institute of Agriculture, Tandojam, Sindh, Pakistan (this town lies about 20 km away from Hyderabad along Hyderabad and Mirpurkhas Road locating at 25°25'60N, 68°31'60E, and Elevation 13 m). Eighteen *Brassica campestris* L., genotypes were examined for their resistance at natural infestation of aphids to manage the damage due to the pest. These genotypes were offered by Nuclear Institute of Food and Agriculture (NIFA), Peshawar, Pakistan. The experimental design was randomized complete block with three replications. Each experimental unit consisted of 3 lines of *B. campestris* sown, each line 2.5 meter long, 1 meter wide and spaced 30 cm (2.5 m^2 area per replicate). The seeds of all *B. campestris* germplasm were sown on first week of November in rows. After 3 weeks from sowing, all plants were thinned to one plant per spot. Fertilizer Nitrogen (N) in the form of ammonium sulphate @ 60 Kg/ ha was applied in two alike doses, first as a basal dose at sowing, and second 30 days after plant thinning. Phosphorus (P_2O_5) was applied @ 40 Kg/ ha in the form of calcium super phosphate as single dose by mixing in the top soil ahead of sowing. Potassium sulphate (K_2O) was added at the time of seed sowing @ 40 Kg/ ha as a basal dose. The usual cultural practices were followed for growing *B. campestris* plants to maintain uniform crop growing pattern.

Counting of aphid population

During the course of the trial, species of aphids were identified and assessed which were affecting and colonizing *B. campestris* to observe their comeback to plants. The degree of resistance to aphid population was determined by data recording from instigation of aphid just at once its first appearance noticed until to crop maturity. Five *B. campestris* plants were selected at random and aphid's sampling consisted of counting its density from whole plant from all the replicates of trial (5 plants per replication) and then estimation of the number of aphids per plant observed at weekly to fortnightly interval. The average population of pest per plant was calculated for each observation date from aphid population recorded from five randomly selected plants. The seasonal mean populations of aphid determined on leaves, stem and flowers were calculated. based on the whole study period.

Assessment of seed yield

The pressure of pest incidence on *B. campestris* crop yield was determined by comparing the yield of attacked and healthy plants. After 120 days from sowing the crop, it was at the ripeness stage and ready to harvest. At harvesting time, plants were cut with sickle and seeds taken from each replication threshed to estimate seed yield by weighing with balance. The mean seed yield was determined from all replications of each genotype and the yield per 2.5 m^2 area calculated was converted to mean yield kg/ hectare.

Statistical analysis of Data

The data recorded were converted to mean values to find the seasonal pest population estimation on per plant basis and the yield per 2.5 m^2 areas to analyze statistically. For computation, the data were subjected to statistical analysis by means of ANOVA and LSD test for the separation of means by implementing Statistix 8.1 software to assess the outcome of *B. campestris* genotypes due to aphid's density.

RESULTS AND DISCUSSION

Pest occurance

The most serious problematic insect pest at study site causing severe infestation was aphid *Myzus persicae* (Sulzer) (Homoptera: Aphididae) throughout the season. During last week of January, the individuals of aphid appeared on various *B. campestris* genotypes, and their population peaks reached at the end of February till mid of March. However, even in almost all the test cases the differences in period of peak aphid population were not more than two or three weeks under the identical environmental factors. The most suitable stage of plant for aphid population build up was seen to be the flowering stage. Peak population of this species reached at the same time on leaves and flowers. This might be due to the fact that at the end of February till mid of March, *B. campestris* genotypes, reached to the full flowering and pod formation stages attaining the peak onslaught of aphid population and infestation.

Aphid population

Data of Table 1, showed that aphid population levels recorded were the highest (15.33, 13.55 and 12.88 aphids/ plant) in the replicates where DLJ-3, Chaliate and E-9 had been grown and showed susceptible response to pest invasion. However, data revealed that plant replicates sown with genotypes NM-1, NM-2 and NM-3, showed the retarded pest incidence (0.00 aphids/ plant) and were comparatively completely resistant differing non-significantly from one another. Data showed that all genotypes had shown different level of resistance and susceptibility to different level of aphid infestation. High yielding genotypes were found to be more tolerant to aphids, whereas, severely damaged had given less produce.

Seed yield

Data taken in case of seed yield regarding different *B. campestris* genotypes are also presented in Table 1. The data showed that there were noticeable differences in seed yield levels in different *B. campestris* genotypes. The seed yield weight recorded was tremendously the highest (1283.3 gm/ 2.5 m^2) (5133.2 kg/ h) in the replicates where NM-1 was grown followed by NM-3 and NM-2 (1246.7 and 1200.0 gm/ 2.5 m^2 or 4986.8 and 4800.0 kg/ h, respectively). According to the data the lowest yields of 716.7, 740.0 and 780.0 gm/ 2.5 m^2 or 2866.8, 2960 and 3120 kg/ h, respectively, were obtained from the replicates where DLJ-3, Chaliate and E-9 were grown.

Table 1. Seasonal mean population numbers of aphid *M. persicae* and seed yield on different *B. campestris* L. genotypes

Genotypes	Aphids/ plant	Yield gm/ 2.5m²	Yield Kg/ Hectare
NM-1	0.00 l	1283.3 a	5133.2
NM-2	0.00 l	1200.0 bc	4800.0
NM-3	0.00 l	1246.7 ab	4986.8
NM-4	2.66 jk	1146.7 cde	4586.8
NM-5	4.00 ij	1133.3 cde	4533.2
NM-6	0.88 kl	1166.7 bcd	4666.8
NM-7	1.11 kl	1166.7 bcd	4666.8
NM-8	4.88 i	1133.3 cde	4533.2
NM-9	5.77 hi	1116.7 def	4466.8
NM-10	7.55 fgh	1083.3 efg	4333.2
NM-11	7.33 gh	1106.7 def	4426.8
NM-12	8.88 efg	1050.0 fg	4200.0
NIFA-Raya	10.22 de	940.0 hi	3760.0
Chaliate	13.55 ab	740.0 j	2960.0
DLJ-3	15.33 a	716.7 j	2866.8
95101/163	11.11 cd	923.3 i	3693.2
95102/51-5	9.33 def	1013.3 gh	4053.2
E-9	12.88 bc	780.0 j	3120.0
LSD Value	1.94	80.71	322.84

Means followed by the dissimilar alphabetical letters are statistically different according to least significant differences (LSD) test at 5% probability level

Data revealed that seed yield (kg ha^{-1}) was affected due to variable potential of test germplasm towards pest incidence. Highest seed yield was observed in those *B. campestris* genotypes where lesser aphid population levels were recorded. Data further showed that where tremendous pest incidence was recorded, clearly the reduced yield was observed. Thus, the rates of population change of the aphids and the extent of infestation on different Brassica crop seem to be presiding over by genetically diversified genotypes tested and genotypic characteristics of different germplasms. The over all effects of aphid during different growth period of *B. campestris* genotypes specified in the text might be due to reason that the resistant plants lost their resistance on flowering stage and became normally susceptible to aphid attack. With maturity, however, the *Brevicoryne brassicae* L. resistant plants became slightly resistant to *M. persicae.* Seasonal abundance of aphids on resistant plants was considerably variable and pest population could decline on the tolerant hosts being about one-eighth that on the susceptible plants. Resistance to *B. brassicae* attacks is resulted from a combination of host non-preference and antibiosis. Using clonal plant material obtained from cuttings, only half the numbers of immigrant alate aphids that settled to reproduce on the susceptible rape were to be found on the resistant rape. The reproduction rate of these alates was about 12% slower on the resistant plants than on the susceptibles and the young took about 13% longer time to mature. Antibiosis then shortened the reproductive life of the apterae by one-third, reduced their fecundity by nearly 50% and caused 40% mortality in their progeny (Dunn and Kempton, 2008). Further, different species of aphids are reported to have different growth pattern on different Brassica cultivators (Ronquist and Ahman,1990).

It is interesting to note that number of lesions per unit length of stem including the number and size of lesion on siliqua are found positively correlated criterion with most other components of resistance for evaluation of resistance in rapeseed-mustard. Further, higher content of chlorophyll of leaf and low frequency of open stomata were found associated with resistance of *B. alba* as against lower chlorophyll and higher frequency of open stomata in the most susceptible *B. campestris*. But in the case of *B. carinata*, besides higher content of gallic acid, synergic acid and vanillic acid, higher epicuticular wax content in the leaf area also played a role in guarding the infection against pest than the susceptible genotype. Studies further revealed that lower stomatal size, index and frequency, higher content of phenols, flavonoids, ascorbic acid, chlorophyll and sugars and lesser percent disease index are indices of resistance in cauliflower genotypes (Neelima et al., 2011). Resistance in Brassica reported in recent studies is in conformity with the earlier findings of related species/ varieties screened in field trials, so, the present results agree with Setokuchi (1983), Amjad (1999), Aslam et al., (2005), Amer et al., (2009) and Ahmad et al., (2013) where resistance presence in Brassica species or varieties of species have been reported under field conditions.

Consequently as a concluding point, most of the tested *B. campestris* genotypes were found infested with aphid pest and only three sowed tolerance, its mean only a few genotypes proved absolutely and completely free from aphid's infestation. The aphids appeared on the tested genotypes during late January or else at the beginning of February, following a peak density at the end of February and its population declined on first week or mid of March. The differences in holding aphid's population can be attributed due to variations in their diversified genetic make up and genotypic characteristics of different germplasms. The comparatively completely resistant genotypes NM-1, NM-2 and NM-3 without harboring population of aphids are ideally suggested to incorporate in breeding program to potentially decrease pest incidence at the field. This information would be used to develop a model for resistance management techniques for incorporating host plant resistance in the Brassica cropping system, with the aim to contribute to help the spread of host plant tolerance for pest control.

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