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*Research article/Araştırma makalesi*

# Categorization of selected canola *Brassica napus* L. varieties/ lines for tolerance to natural infestation of aphid *Myzus persicae* (Sulzer)

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**Abstract**

Thirty canola *Brassica napus* L. varieties/ genotypes were field examined for their resistance at natural infestation of aphid to manage the damage due to the insect pests. Data based on aphid incidence and grain yield were recorded to evaluate performance of test material. The results showed that all genotypes in field conditions, exhibited high to low different levels of resistance against field infestation of aphid *Myzus persicae* (Sulzer) (Homoptera: Aphididae) and produced variable yield after infestation by insect pest. The varieties/ genotypes *viz.*, Rainbow and CON-I showed resistance reaction to pest invasion and gave amplified productivity. These varieties/ genotypes should be popularized in aphid endemic areas and can be used in varietals resistance breeding program. Nevertheless, the varieties/ genotypes Oscar, CAN-9-1 and RM-015/1-1 were highly susceptible to pest and failed to give augmented productivity. These results demonstrate the expression of resistance gene in the genome of tolerant varieties/ genotypes, Rainbow and CON-I which can provide season-long protection from the natural infestation of insects to diminish crop yield losses.

**Key words:** Canola, *Brassica napus*, *Myzus persicae*, aphids, tolerance, management

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## 1. Introduction

The *Brassica* and others intimately interrelated cruciferous crops are extensively cultivated all over the world as vegetable crops for human consumption, as condiments and spices for improved flavor of human diets, and as fodder crops for livestock feeding. Conversely, the largest cultivation of these crops is for edible vegetable oil production. Canola *Brassica napus* L. (Brassicaceae or Mustard family) could be considered as one of the most important oilseed crops in the world. The term “canola” has been coined to describe cultivars that meet specific requirements for erucic acid in the extracted seed oil (less than 2% erucic acid as a percentage of total fatty acids) and aliphatic glucosinolate content in the residual meal (less than 30 mmol of aliphatic glucosinolates/ g). At this time, certain cultivars of *B. napus* have been developed with both low-erucic and low glucosinolate (double low or canola) quality, and these are now widely grown commercially (Downey and Rimmer, 1993). Along with several restraining reasons accountable for lesser yield of rape *B. napus*, severe infestation of aphids, the stage of the crop being attacked, non-availability of good quality seed, and variability of weather are very critical.

Focal restraints to the decreased relative performance of canola for productivity and oil yield are owing to that the crop is constrained by a major problems including insect pests injury. Several aphids (Homoptera: Aphididae) species may attack this crop, however, *Myzus persicae* (Sulzer) is one of the key factors, ensuing decline in canola productivity. It feeds by means of sucking, needle-like mouthparts to take out plant sap. The presence of aphids in huge figures and their feeding may result a lessening of plant vitality as well as growth, in addition to leaf wrinkling, condensed pods and seeds numbers, along with eventually poor crop yield. The harshness of injure differs broadly and is based upon pest pressure and other changeable factors present under field conditions. It is imperative to keep in mind that aphid injure on the plant is intensified by other stressors, and hassled plant consecutively is a further encouraging host for development of pest, ensuing into inflated reproductive aphid rates. The honeydews created as a waste product by aphid through sap sucking; further encourage a gray, sooty mold growth over the surface of leaf, resulting decrease in photosynthetic capability of plant (Sarwar, 2009; 2011; Sarwar and Sattar, 2013).

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Aphid infestations can occur at two stages of the canola crop cycle; during the autumn/ winter establishment phase, and again during spring when crops are flowering and podding. Early infestations can lead to establishment failure or stress and the risk of virus transmission. Spring infestations often have a higher impact in combination with moisture stress, as high aphid populations appear more evident in dry seasons (Jenkins *et al.,* 2011). Due to their enormous reproductive potential and the damage that they cause, aphids are one of the most difficult insects to manage, so, remarkable immediate action may be necessary. Aphids can be controlled by using the systemic insecticides, but, these are usually not entirely specific in their action, and can affect plants and animals health. There is a critical need to explore and exploit naturally occurring tactics for combating harmful agricultural and public health insect pests. Of the useful and most common methods, host plant resistance is a significant and far the best for raising of crops that have the capacity to remain free from insect pests and environmental factors which play their parts to bring infection in plants (Sarwar *et al.,* 2011 a; b). The best management practice for the control of aphids is to screen out the available germplasm against it to estimate yield losses induced by this constraint; so that future losses could be avoided by cultivation of susceptible varieties suffering huge yield decline. The objective of this study was to evaluate the performance of *B. napus* varieties/ genotypes against aphid intensity to manage yield losses.

## 2. Materials and methods

### *2.1. Experimental location and crop culture*

These field experiments were conducted during winter season at the Experimental Farm of Nuclear Institute of Agriculture, Tandojam, Sindh, Pakistan (a 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). Thirty canola *Brassica napus* L. varieties/ genotypes were field examined for their resistance at natural infestation of aphids to manage the damage due to the pest. These genotypes were provided 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. napus* sown, each line 2.5 meter in length, 1 meter in width and 30 cm spaced out (2.5 $m^2$ area). The seeds of all *B. napus* germplasm were sown on first week of November in rows. After 3 weeks from sowing, *B. napus* plants were thinned to one plant per spot. Fertilizer Nitrogen (N) in the form of ammonium sulphate @ 60 Kg/ ha was applied in two identical doses, first as a basal dose at sowing, and second 30 days after plant thinning. Phosphorus ($P_2O_5$) in the form of calcium super phosphate was applied @ 40 Kg/ ha as single dose by mixing in the top soil ahead of sowing. Potassium sulphate ($K_2O$) was added @ 40 Kg/ ha as a basal dose at the time of seed sowing. The customary cultural practices were followed for growing *B. napus* plants to maintain uniform crop stand.

### *2.2. Counting of aphid populace*

During the course of the trial, species of aphids were identified and assessed which were affecting and colonizing *B. napus* to observe their response to plants. The degree of resistance to aphid population was determined by data recording at biweekly intervals from instigation of aphid just at once its assail first noted uptill to crop ripeness. Five *B. napus* plants were selected at random and sampling consisted of aphids' counts from whole-plant from the replicates of entire field (5 plants per replication) and then estimation of the number of aphids per plant. The average population of pest per plant was calculated for each observation date from aphid population recorded from five plants selected at random. The seasonal average populace of aphid was determined by dividing the entirety numerals of aphids surmised by the number of sampling dates for the duration of the whole study period.

### *2.3. Estimation of seed yield*

The influence of pest incidence severities on crop yield was determined by comparing the yield of attacked and healthy plants. After 120 days from sowing the crop, it was at the maturity stage and ready to reap. At harvesting time, plants were cut with sickle and seeds taken from each replication 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.

The data were subjected to statistical analysis by means of ANOVA and LSD test by implementing Statistix 8.1 software to appraise the upshot of *B. napus* varieties/ genotypes on aphid intensity.

## 3. Results

The data of the varietals tolerance throughout the crop season are presented in Table 1. The combined analysis of variance for the data of the whole season revealed that there were significant variations in the number of aphids per plant and seed yield per experimental unit.

*3.1. Aphid species identification and incidence*

One of the most important, abundant and conspicuous insect species found in crop samplings was sap feeding aphid *M. persicae* causing development of unpleasant sooty mould due to sugary honeydews it excretes on the leaves and flowers. The most noteworthy finding was that from the edge of the field, the severe infestations were often easily visible, but, later on in the season, infested patches appeared in field. On the younger plants, aphids were clustered near the base of the plant and on the upper sides of the leaves, but, on older plants, also found inside the leaf whorls of plant. The infestation started during flowering, and pod setting and filling stages and the damage symptoms included curled or yellowed leaves, and stunted plant.

*3.2. Aphid populace*

The statistical analysis showed highly significant differences in susceptibility levels of different *B. napus* varieties/ genotypes used in the experiment (Table 1). Comparison of mean values through Least Significant Differences Test at 0.01 level of probability enunciated that genotype Oscar proved to be the most susceptible with 87.55 aphids severity per plant followed by CAN-9-1 and RM-015/1-1 with 84.89 and 83.00 pest severity, respectively. On the other hand, the next lowest significant value of aphid severity (69.33/ plant) was achieved from CAN-5-4, which decreased compared to all other test genotypes. The genotypes Rainbow and CON-I, however, proved comparatively resistant showing 21.66 and 27.88 aphid severities per plant, respectively. Comparisons of mean values of remainder genotypes in Table 1 revealed that pest severity ranged from 33.33 to 67.77 aphids/ plant observed in the experiment.

Table 1. Mean seasonal population numbers of aphid *M. persicae* and seed yield in different *B. napus* varieties/ genotypes

| S. No. | Name of genotypes | Aphids population/ plant | Yield (gm per 2.5 $m^2$) |
|---|---|---|---|
| 1. | Waster | 66.67 bc | 610.00 jkl |
| 2. | CON-I | 27.88 mn | 940.00 a |
| 3. | CON-II | 55.00 def | 686.70 efghi |
| 4. | CON-III | 61.78 cd | 666.70 ghi |
| 5. | Abasin-95 | 45.11 hi | 710.00 efg |
| 6. | Dunkled | 35.77 jkl | 830.00 b |
| 7. | Rainbow | 21.66 n | 953.30 a |
| 8. | Shiralee | 55.22 def | 683.30 fghi |
| 9. | Hyola-42 | 37.11 jkl | 736.70 de |
| 10. | Hyola-308 | 41.77 hijk | 773.30 cd |
| 11. | Oscar | 87.55 a | 500.00 n |
| 12. | Rain-RN-1 | 33.33 lm | 843.30 b |
| 13. | Rain-RN-2 | 64.44 bc | 673.30 ghi |
| 14. | Rain-RN-3 | 34.67 klm | 816.70 bc |
| 15. | Rain-RN-4 | 34.78 klm | 826.70 b |
| 16. | Rain-RN-5 | 42.44 hij | 776.70 cd |
| 17. | Rain-RN-6 | 35.33 jkl | 836.70 b |
| 18. | Rain-RN-7 | 56.00 def | 683.30 fghi |
| 19. | Rain-RN-8 | 47.77 gh | 776.70 cd |
| 20. | RM-975/4-10 | 67.22 bc | 596.70 klm |
| 21. | RM-975/4-8 | 48.88 fgh | 730.00 def |
| 22. | RM-975/4-2 | 67.77 bc | 650.00 hij |
| 23. | RM-975/4-7 | 38.22 ijkl | 800.00 bc |
| 24. | RM-975/11-1 | 54.11 efg | 693.30 efgh |
| 25. | RM-971/5-1 | 56.89 de | 693.30 efgh |
| 26. | RM-015/1-1 | 83.00 a | 573.30 lm |
| 27. | RM-975/2-4 | 52.66 efg | 696.70 efgh |
| 28. | CAN-5-4 | 69.33 b | 636.70 ijk |
| 29. | CAN-9-1 | 84.89 a | 550.00 m |
| 30. | Abasin-10 | 66.33 bc | 673.30 ghi |
| LSD Value | | 6.50 | 44.58 |

Means followed by the identical alphabetical letters are not statistically different according to least significant differences (LSD) test at 5% probability level.

*3.3. Seed yield*

Analysis of variance further depicted highly significant differences among *B. napus* plants of different genotypes for grain weight (Table 1). Appraisal of mean season values indicated that maximum reduction in grain weight was observed in case of Oscar with 500.00 gm yield per 2.5 $m^2$. The mean value of grain weight losses pertaining to CAN-9-1 and RM-015/1-1 showed 573.30 and 550.00 gm per 2.5 $m^2$, respectively, wherein, maximum weight losses were also observed due to pest severity. Results confirmed the highest seed yields of 953.30 and 940.00 gm per 2.5 $m^2$ produced by Rainbow and CON-I, respectively, wherein, significantly exceeded value were achieved compared to the remainder genotypes despite of pest severity. On the other hand, the higher values of seed yield 843.30, 830.00, 836.70 and 826.70 gm per 2.5 $m^2$ were also achieved from Rain-RN-1, Dunkled, Rain-RN-6 and Rain-RN-4, respectively, and these germplasm were at significant increasing trend compared to all other remainder genotypes. Data revealed a limit of 816.70- 596.70 gm per 2.5 $m^2$ seed yield produced by plants of what's left genotypes throughout growing season.

## 4. Conclusions

The overall performance of *B. napus* varieties/ genotypes presented in the trail indicated that Rainbow and CON-I, exhibited minimum reduction of kernels weight inspite of the fact that a reasonable numbers of aphid severity was observed. Results have proved high yielding potential of both selections even under pest stress during growing season. Nevertheless, the genotypes Oscar, CAN-9-1 and RM-015/1-1 were highly susceptible to pest and failed to give augmented productivity. The present study clearly displayed that those lines on which pest density was maximum exhibited maximum yield losses and the lines which showed less aphid abundance suffered less yield losses. The tolerance and susceptibility of this crop to insect pests are based on numerous factors together with biotic, abiotic and ecological aspects. The most imperative among these could be the prevailing environment, insect species involved and the genetic potential of crop. The differentiations in the present results could be due to differences in the genetic make up of test varieties/ material and aphid incidence, since the ecological conditions for the study period were uniform and normal.

Resistance to *M. persicae*. attack in *B. napus* rape was result of combination of host non-preference by pest and antibiosis in plant. Using sampling methodology on plant material obtained, the numbers of immigrant alate aphids that settled to reproduce on the susceptible canola were higer than found on the resistant rape. The reproduction rates of these alates aphids were slower on the resistant plants than on the susceptible. The antibiosis in *B. napus* plants then shortened the reproductive life of the apterae aphids, reduced their fecundity and caused mortality in their progeny. The over-all effects of the host non-preference and antibiosis were considerable and under field conditions could result in the population decline on the resistant plants than on the susceptible. Similar results were detected by Caroline *et al.,* (2002) showing thst host plant quality is a key determinant of the fecundity of herbivorous insects. Components of host plant quality such as defensive metabolites, directly affect potential and achieved herbivorus fecundity. The responses of insect herbivores to changes in host plant quality vary within and between feeding guilds. Host plant quality also affects insect reproductive strategies; like egg size and quality, the allocation of resources to eggs, and the choice of oviposition sites may all be influenced by plant quality.

These results are in a same trend as it is currently accepted that under drought conditions, host plant sieve elements will become more concentrated; hence increases in available amino acid concentrations will potentially benefit aphids. In addition, drought induced changes in the plant host may make the host less palatable to aphid herbivore, for instance changes in sugar/ pH gradients may result in aphids facing difficulty in locating the phloem (Larsson, 1989; Bethke *et al.*, 1998). Plants developed different mechanisms to reduce insect attack, including specific responses that activate different metabolic pathways which considerably alter their chemical and physical aspects. On the other hand, insects developed several strategies to overcome plant defense barriers, allowing them to feed, grow and reproduce on their host plants (Marcia and Marcio, 2002). Similar results were recorded in other literature in support of this hypothesis that in order to reduce insect attack, plants developed different defense mechanisms including chemical and physical barriers such as the induction of defensive proteins (Haruta *et al.,* 2001), secondary metabolites (Baldwin, 2001) and trichome density (Fordyce and Agrawal, 2001). In parallel, insects developed strategies to overcome plant barriers such as detoxification of toxic compounds (Scott and Wen, 2001), avoidance mechanisms (Zangerl, 1990) and sequestration of poison (Nishida, 200). These results are in a good line with those reported by previous findings where it is reported that yield losses were less in resistant varieties than the susceptible varieties. These results might be due to the increasing yield attributes of test plants such as stimulating effect of metabolic activity, and cell division and expansion leading to higher resistance.

Plant resistance in Rainbow and CON-I, to pest infection was a hereditary property and the genes are passed from generation to generation which transmit resistance or susceptibility. By using the method of plant breeding for resistance, it is feasible to raise crops devoid of acquiring damage by a potential plant pest to avoid the expenditures compulsory to purchase the pesticides and manual labor needed for their field applications. Undoubtedly in nature there are wild species of *Brassica* and other consistent cruciferous crops which have moved out in the course of natural selection and therefore comprise the potential to survive the pressure of numerous pests. But, along with resistance to pest that is an exclusive source to continue existence of such crops, other capabilities such as to give good yield of grain, should also be considered. By the way, while breeding plant for resistance, the genetic philosophy should be considered. In this regard, the plant yielding valuable foodstuffs, if is sensitive to pest, it should be given the resistance characteristic from otherwise substandard plant. By keeping in view the above results, it is evident that there is a dire need to avoid growing of susceptible varieties. In addition, plant breeder ought to be encouraged to monitor aphids' circumstances through Entomologist to evolve resistant varieties to ensure sustainable food security of a nation.

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