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Screening of *Brassica* genotypes against mustard aphid under northern Indian Shivalik hill conditions

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ABSTRACT

Oilseed Brassica plays the important role in Indian agriculture in relation to oil production. The major insects in Brassicas are *Lipaphis erysimi*, *Bagrada hilaris*, *Athalia lugens proxima* (Klug), *Chromatomyia horticola* Goureau, *Pieris rapae*, *Bagrada cruciferarum* Kirkaldy are of practical importance. Out of these, the *Lipaphis erysimi* (Kalt.) [mustard aphid], a part of family Aphididae with order Hemiptera leads to great yield losses in rapeseed-mustard. To overcome this problem, the easiest solution is to grow resistant and tolerant varieties. The screening is done on the basis of aphid infestation index scale for categorization of the genotypes into resistance and tolerance. Experiments were carried out at the experimental farm of Division of Plant Breeding and Genetics, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during *rabi* of 2017–18 and 2018–19 to evaluate mustard germplasm against *Lipaphis erysimi* and selecting the resistant genotypes of Brassica for its cultivation and expansion purposes. A total of fifteen cultivars were evaluated based on population buildup of mustard aphid and infestation index. The genotypes RSPN-28, CNH-11-13, RL-1359, HNS-1101, GSC-101, CNH-11-2 and HNS-1102 were found moderately resistant during the *rabi* 2017–2018 and during *rabi* 2018–2019, due to weather conditions only two genotypes CNH-13-2 and RSPN-29 were found moderately resistant and susceptible against aphid infestation.

Introduction

Brassica belongs to tribe Brassicaceae (El-Esawi, 2016) is the important genus consisting of 238 genera and 3709 species (Poveda *et al.*, 2020) varied in respect of morphological as well as in genetical ways (Illardi *et al.*, 2020). They are known to be vegetable, fodder, oil, green manure as well as spice plants (Witzel *et al.*, 2021). This genus has 6 interrelated species. Out of six, three are diploid species namely, *Brassica nigra* (2n=16), *Brassica oleracea* (2n=18) and *Brassica rapa* (2n=20) and three are amphidiploid species namely, *Brassica carinata* (2n=34), *Brassica juncea* (2n=36) and *Brassica napus* (2n=38) (Sanlier *et al.*, 2018). The 'U' triangle defines the relationship among *Brassica*

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species (Zhang *et al.*, 2022). The allopolyploid *Brassica napus* ($2n = 4x = 38$, AACC) is the third most (Javed *et al.*, 2022) desirable oil crop in world comes after maize and oil palm obtained from interspecific hybridization between two species such as *Brassica rapa* having $2n= 2x= 20$, AA and *Brassica oleracea* having $2n = 2x = 18$, CC (Lu *et al.*, 2019).

For oilseed brassica, India holds the second-place area wise and third place production wise in world and rapeseed-mustard produces 72.37 million tonnes from a stretch of 33.64 m ha (Anonymous, 2021). In India, Rapeseed-mustard is cultivated over an area of 6.23 m ha with production of 9.33 mt and productivity of 15 q/ha during 2018–19 (Anonymous, 2020). Each part of rapeseed such as seeds, flower, leaves, stem and root are useful for cosmetics, food, remedies and has other industrial applications. Especially the most useful part is the seed part because of its application for oil and protein source (Raboanatahiry *et al.*, 2021).

The oil taken out from *Brassica napus* L. is high in quality wise (Hyder *et al.*, 2021) and rich in terms of fatty acid profiling (Tiwari *et al.,* 2021). It is, therefore, subjected to various biotic as well as abiotic stresses, which brings down its productivity remarkably (Mahapatra *et al.*, 2022). Keeping in view the growing demands of oils, every attempt is being put together for increasing the crop yield by adopting the modern agricultural practices, namely, utilization of high yielding varieties, heavy manuring and proper irrigation but these collaborated efforts are in vain if crop is not sheltered from the disastrous effect of insect-pests. The damage due to insect pest is one among the various major biotic factors leads to low productivity (Das *et al.*, 2022). There are > 3 dozens of insect-pests are to be known in India in case of rapeseed mustard crop (Bakhetia and Sekhon, 1989) and among them the most disastrous is mustard aphid which however, solely prove as one of the limiting factors in the mustard production (Kumar *et al.*, 2022).

Mustard aphid is a sucking pest and is the most destructive pest of brassica causing over 50 % yield loss (Fenning *et al.*, 2020) by excessive phloem sap diversion (Duhlian *et al.*, 2020). Especially, in case of rapeseed-mustard, it has occurred as the most atrocious insect-pest in the regions such as tropical and subtropical including India (Koramutla *et al.*, 2016). This pest brings damage to plants by covering the entire flower bud, shoot and pod surface (Raj *et al.*, 2017) at various stages such as vegetative, flowering, and also in pod formation stage (Taghizadeh, 2019). Commonly, sucking pest relatively become severe from the seedling stage. At time of heavy infestation, it causes the crop yield reduction to a large extent (Prasad and Ashwini, 2021). These aphids quantitatively and qualitatively affect plant production and processing through sap sucking, toxin injection and transmission of viruses from the Luteoviridae family, leading to leaf curling, shriveling and yellowing (Fidelis *et al.*, 2018). The attack is extreme in those areas where the cloudy days are more in numbers throughout the pest activity period. In boosting the mustard aphid multiplication, environment makes the major contribution and out of these environmental parameters, rainfall, temperature and relative humidity have the major effect on the mustard aphid's survival and its multiplication (Kumar *et al.*, 2000). Therefore, in present investigation, fifteen genotypes of *Brassica napus* were screened to detect the early tolerant varieties.

Material and Methods

Fifteen genotypes of *Brassica napus* mentioned (Table 1) were seeded at the experimental farm of Department of Plant Breeding and Genetics, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during the year 2017-18 and 2018-2019 with latitude 32°40 N and longitude 78°48 E. The experiment was remained for the causing the infestation of insects naturally and prevalence of aphid attack and for assuring their normal population growth, no insecticide was being used in contrary to the insect pests during the time. The first recording of mustard aphid was done after 50 days of sowing and subsequent data related to aphid population was taken on weekly basis, beginning from first incidence of pest and pursued up to the infestation come to an end (from February first week to March first week). Data of the aphid population was taken from randomly selected five plants in every replication on scale given by Bakhetia and Sandhu (Table 2). The observation of aphid population on each plant was done from 10 cm last shoot. By observing the aphids in every replication visually, population counts were being made on per plant basis by observing the number of aphids on different part of plant such as stem, leaves and inflorescence. Mean values was then calculated from the collected data to make the aphid population estimation based on per plant basis.

Aphid index was calculated by the following formula:

$$\textbf{Aphid Infestation Index} = \frac{0\times a+1\times b+2\times c+3\times d+4\times e+5\times f}{a+b+c+d+e+f}$$

Where a, b, c, d, e and f are the frequencies of the plants come under each grade from 0–5.

All the genotypes were categorized into different groups based on the aphid infestation index as mentioned in the table 3.

Table 1: List of Genotypes

SN	Genotypes	SN	Genotypes
1.	RSPN-29	9.	CNH-11-2
2.	RSPN-28	10.	GSC-6
3.	DGS-1	11.	EC552608
4.	RSPN-25	12.	CNH-13-2
5.	CNH-11-7	13.	HNS-1102
6.	CNH-11-13	14.	RL-1359
7.	GSL-1	15.	HNS-1101
8.	GSC-101		

Table 2: Screening of genotypes for aphid resistance by using the method of Bakhetia and Sandhu (1973)

Score	Injury symptoms
0	Free from aphid infestation.
1	Normal growth, no yellowing or curling of leaves, a few aphids without injury symptoms, flowering and pod setting almost normal.
2	Average growth, flowering and pod setting; curling and yellowing of few leaves.
3	Curling and yellowing of some branches, below average growth, poor flowering, with very little pod setting.
4	Very poor growth, heavy curling of leaves, stunting of plants, A little or no flowering and pod formation.
5	Heavy aphid colonies, severe stunting of plants, curling and yellowing of almost all leaves. No flowering and pod formation. Plants full of aphids.

Table 3: Categorization of genotypes on the basis of aphid infestation index:

Aphid Infestation Index	Designation
Up to 1.0	Highly resistant
1.1-2.0	Resistant
2.1-3.0	Moderately Resistant
Above 3	Susceptible

Results and Discussion

One of the most limiting factors in the rapeseed and mustard productivity is the losses brings by *Lipaphi serysimi* Kalt (mustard aphid) covering an extent of nearly 93% (Gupta *et al*., 2003). At times of the heavy infestation of *Lipaphis erysimi* causes the seed yield loss and reduction in oil content in mustard plants (Naga *et al*., 2022). The temperature is a crucial factor which affects directly the insect development, its reproduction and its survival. As the individual insect's behavior differs with climate change (increase in temperature), the prediction of the influence of global warming on insect plant interaction occur for enlarging the herbivore pressure intensity on plants (Dhaliwal, 2002).The aphid infestation index ranged from 2.4 to 3.3 during the year 2017–2018 (Table 4). None of the genotypes was found to be resistant against aphids. However, few genotypes viz., RSPN-29, RSPN-28, CNH-11-13, RL-1359, HNS-1101, GSC-101, CNH-11-2, HNS-1102 were found moderately resistant to aphids in the year 2017-18. The observations recorded during the year 2018-2019, only two genotypes namely, RSPN-29 and CNH-13-2 showed susceptible and moderately resistant reaction to aphid respectively and no aphid infestation was found on rest of the genotypes under study (Table 5).Favorable prevailing temperature as well as the relative humidity leads to the population buildup and aphid development and in turn, increase the aphid population. The prevalence of the *L. erysimi*, its growth and its multiplication are mainly affected by meteorological parameters such as temperature rainfall, relative humidity. During *rabi* 2017-2018, crop was sown on 20th and 30th October. The low temperature (10.2 to 19.6°C) and high relative humidity (56 to 88.2%) at vegetative as well as siliqua formation stages, favored aphid multiplication. During *rabi* 2018–2019, population

Table 4: Screening of Aphids based on Aphid Infestation Index.

Year	2017–2018	2018–2019
RSPN-29	2.6	4.25
RSPN-28	2.7	No infestation observed
DGS-1	3.2	No infestation observed
RSPN-25	3.3	No infestation observed
CNH 11-7	2.5	No infestation observed
CNH 11-13	2.4	No infestation observed
CNH 13-2	3.1	2.65
EC552608	3.2	No infestation observed
GSC-6	3.2	No infestation observed
RL1359	2.7	No infestation observed
HNS-1101	2.7	No infestation observed
GSC-101	3.0	No infestation observed
CNH 11-2	2.7	No infestation observed
GSL-1	3.2	No infestation observed
HNS-1102	2.6	No infestation observed

dynamics of *L. erysimi* was observed on mustard from 18th November 2018 to 19th April 2019. During this period the temperature fluctuated from 10.1 to 25.6 °C with relative humidity 63% on November 18th 2018. This increase of temperature and decrease in relative humidity continued till Feb 2019. At 19th March 2019 (siliqua formation stage), the temperature fluctuated between 5.2 to 17.4 with relative humidity 78% and on 19th April 2019, the

Table 5: Categorization of genotypes based on Aphid Infestation Index

Year	2017–2018	2018–2019
Highly Resistant	None of the genotypes	All these genotypes escaped aphid infestation
Resistant	None of the genotypes	None of the genotypes
Moderately Resistant	RSPN-29, RSPN-28, CNH-11-7, CNH-11-13, RL-1359, HNS-1101, GSC-101, CNH-11-2, HNS-1102	CNH-13-2
Susceptible	DGS-1, RSPN-25, CNH-13-2, EC552608, GSC-6,	RSPN-29

temperature ranged between 8.1 to 19.5with relative humidity 42.4% Therefore, this leads to declining of aphids during *rabi* 2018–2019. Hence, at vegetative stage the high temperature (25.6 to 26.6°C) and low relative humidity (52 to 63) and at siliqua formation, low temperature (17.4 to19.5°C) and high relative humidity (78 to 87%) might have helped these cultivars to break out from the severe attack of aphid and results in the development of healthy crops. Only two genotypes CNH-13-2 and RSPN-29 showed the aphid infestation (Table 5). These results are similar with Srivastava *et al.*, 1995, Prasad, 2003 and Ali *et al.*, 2011. By the results of the present study, identification of resistant as well as tolerant varieties to mustard aphid can be done by screening the rapeseed-mustard and can be used for the future endeavors.

Mustard aphid poses a serious threat to mustard cultivation and is a devastating pest of Brassica. There are over more than 200 different aphids type which are trouble-making for farmers and cause trouble by feeding on crops and also by infecting the plants with various diseases as well as viruses. Aphids can make colonies on the underside of leaves and also on growing tips. Aphid grow so fast that if get proper food supply, develops wings and fly and infects other plants. So the eco-friendly way for controlling the aphid infestation in Brassica is the application of resistance cultivars. Therefore, the screening of Brassica genotypes is the important aspect for finding the resistant and susceptible cultivars. The present study made by author are in conformity with the Jat *et al.*, 2007 and Yadav *et al.*, 2017 in which 240 mustard accessions were screened and 16 out of them were found resistant and 88 were found moderately resistant and remaining 102 were found susceptible and 39 were highly susceptible. Another study done by Chaudhary and Patel, 2016 revealed that three varieties namely, NRCM 120, NRCM 353 and Rayad 9602 found to be highly resistant with lowest aphid infestation index and one variety found resistant namely, Vardan and four varieties (GM-2, HYOLA-401, GM-3 and GM-1) found to be susceptible and highly susceptible. Other studies given by Pawar *et al.*, 2009 and Sanwar *et al.*, 2013 are also in support of the present study.

Conclusion

The mustard aphid leads to 97% yield losses in rapeseed- mustard. Pesticides application is not effective and deleterious as far the insecticide resistance is concerned. Germplasm screening is done to analyze the best germplasm for the development of tolerant or resistant varieties and for developing integrated pest management (IPM) program in oleiferous brassica crops, a good knowledge of insect pest and its interactions with plants is an important requirement. And for growers, the utilization of host plant resistance is the most useful, desirable, economical and practical method, with the assumption to be an efficient control element in IPM (insect pest management).

Conflict of interest

The authors declare that they have no conflict of interest.

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