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Evaluation of *Brassica napus* germplasm for susceptibility status against Mustard Aphid (*Lipaphis erysimi* Kalt.)

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Abstract
Lipaphis erysimi (Mustard aphid) is widely distributed and causes considerable losses in terms of oil contents and yield in *Brassica* crops. Various strategies are being adopted to control its infestation. Breeding programs are enlisted as the most important dimension in enhancing crop yield which are based on the aim of increasing the oil content percentage and certification of less insect and disease susceptible cultivars which ultimately increase the yield. There is a dire need to ensure safety of the crop from losses caused by various insects and diseases. The present study was conducted to evaluate the cultivars for their mustard aphid susceptibility status and to determine the effect of temperature and relative humidity on the population buildup of mustard aphid. All tested cultivars were found less susceptible to mustard aphid. Insect population buildup showed positive correlation with temperature (0.752) and negative correlation with relative humidity (-0.850).

Keywords: Napus, Screening, Aphid, Mustard, Pakistan

1. Introduction
Edible mustard oil is a good source of energy which is extensively used in the preparation of food items, enhancing food palatability and flavor of the food. This oil is also used as hair oil, lubricant, a folk remedy for arthritis, foot ache, lumbago, and rheumatism [1]. The oil seed cake is also used as cattle feed and fertilizers [2].
Human population is increasing day by day throughout the world and so are the demands for edible oils as well as food are also increasing. Now, the emphasis on growing the oilseed crops is increasing day by day. The accessibility to improved varieties, adoptions of better crop production strategies and excellent market price made canola truly striking to growers leading to its speedy expansion [3]. In Pakistan, it is considered as a source of good income for the growers. The seed has oil as high as 46-48%. Whole seed meal has 43.6 percent protein. Rapeseed meal is an excellent feed for animals [4].
In the last few decades, a lot of research work has been done and many *Brassica napus* varieties have been certified and made available for cultivation over vast cropping area in order to enhance the productivity and to meet the ever-challenging environmental requirements. But, the major losses in production occur due to the mustard aphid (*Lipaphis erysimi*) infestation [5].
Aphids multiply very rapidly under favorable conditions on leaves, stems and inflorescence from where these pests suck the sap. They cause direct feeding damage to plant and transmit different viruses to a particular crop. Due to the attack of aphids on *Brassica*, infested pods and seeds remain stunted [6]. The yield loss due to aphid infestation was recorded from 35.4 to 91.3% [7] but the loss may be as high as 97% [8]. So, the breeding programs are continuously striving to develop the resistant or less susceptible varieties of *Brassica napus*. The aim of the present study was to evaluate the germplasm regarding their susceptibility/resistance status against mustard aphid.

2. Materials and Methods
2.1 Collection and Sowing of germplasm
This study was carried out in the farm area of Oilseeds Research Institute (ORI), Ayub

Agricultural Research Institute (AARI), Faisalabad, Pakistan in Rabi crop growing season 2017-18. Nine genotypes; RBN-13015, RBN-13016, RBN-13017, RBN-13022, KN-279, KN-294, 15CBN-006, 15CBN-010 and Faisal Canola (A certified cultivar), obtained from the Oilseeds Research Institute, Faisalabad were sown in the farm area of the same institute. Crop was sown in the first week of November 2017 with RCBD design. Row spacing was maintained at 45 cm and fertilizer input ratio was 90:85:60 NPK (kg/ha).

2.2 Data Recording

Data for mustard aphid were recorded on five randomly selected plants at their top 10 cm of central shoot. Data recording were started in the first week of February-2018 and continued up to mid-March-2018. Meteorological data were obtained from Meteorological Observatory, Plant Physiology Section, AARI.

2.3 Statistical Analysis

Data was analyzed, analysis of variance (ANOVA) was constructed and the Tuckey's HSD was performed for the differentiation of means among genotypes. Recorded data was correlated with the weather parameters (Temperature and Relative humidity) in order to evaluate the effect of weather conditions on the incidence of mustard aphid.

3. Results

Table 1: Analysis of Variance (ANOVA) for Source of resistance against mustard aphid on *Brassica napus*

Source	DF	SS	MS	F	P
Dates	5	101953	20390.7	30.34	0.0000*
Varieties	8	4968	621.1	0.92	0.4997
Dates*Varieties	40	23057	576.4	0.86	0.7040
Error	106	71232	672.0		
Total	161	204068			

* = Significant at $P < 0.05$

Analysis of variance (ANOVA) for mustard aphid population for the dates on which data were recorded is significant while for varieties and for the interaction between Dates and Varieties was non-significant.

Table 2: Tuckey HSD Pairwise comparison of mustard aphid for Dates

Dates	Mean
06-02-2018	1.756d
13-02-2018	5.741d
20-02-2018	9.393cd
27-02-2018	28.170bc
06-03-2018	73.659a
13-03-2018	41.111b

Mean population comparison of mustard aphid for the calendar dates represented a significant difference (Table 2). First data were recorded in the first week of February and it represented that the population of mustard aphid just started to be built up. Insect population continued to increase till the first week of the month of March-2018 but it started declining near the maturity stage of the crop and last data were recorded in the second week of month of March-2018.

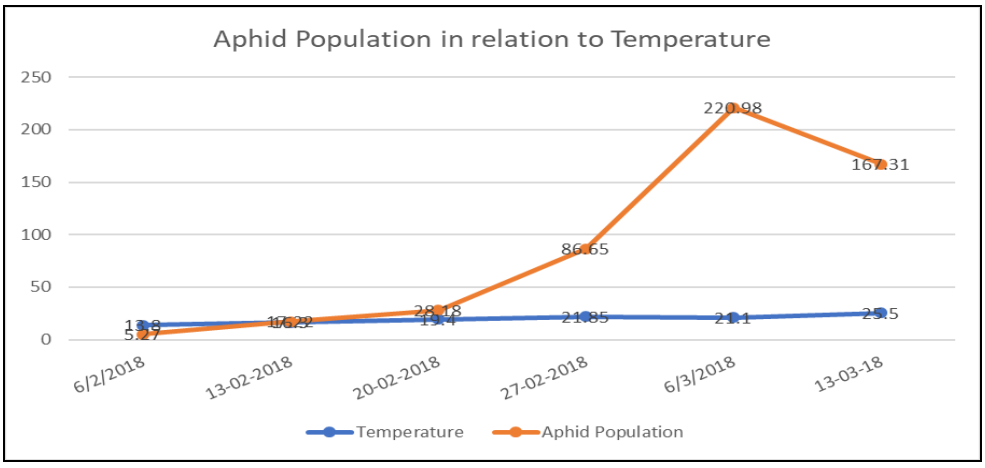

Fig 1: Mustard Aphid Population in relation to Temperature on Data Recording Calendar Date

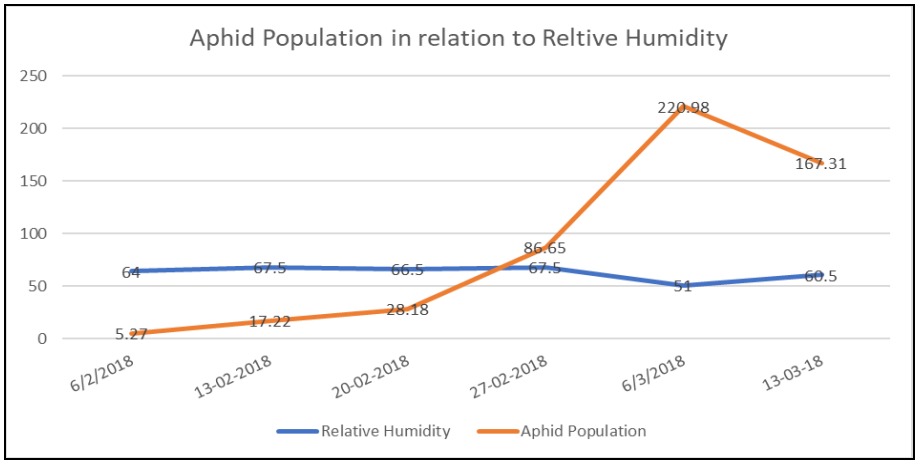

Fig 2: Mustard Aphid Population in relation to Relative Humidity on Data Recording Calendar Date

Fig. 1 represented that as the temperature increased, the insect population also increased as the temperature fluctuated and the positive correlation (0.752) was found among temperature and mustard aphid population. Fig. 2 showed that in case of Relative Humidity, the mustard aphid population exhibited negative correlation (-0.850).

Table 3: Tuckey HSD Pairwise comparison of mustard aphid for Varieties

Varieties	Mean
RBN-13015	37.756a
RBN-13016	25.722a
RBN-13017	30.122a
RBN-13022	30.700a
KN-279	20.822a
KN-294	20.600a
15CBN-006	26.056a
15CBN-010	28.356a
Faisal Canola	19.611a

Nine cultivars were evaluated for their susceptibility against mustard aphid but it is evident from Table 3 that statistically there is no significant difference among the tested germplasm. It is also concluded that the mustard aphid population remained below Economic Threshold Level (ETL) which is widely considered in the range of 50-60 aphids/upper 10 cm portion of the central twig of the plant. So, it can be inferred that all the tested germplasm was less susceptible to the mustard aphid infestation.

Table 4: Tuckey HSD Pairwise comparison of mustard aphid for Dates*Varieties

Varieties	Dates					
	06-02-2018	13-02-2018	20-02-2018	27-02-2018	06-03-2018	13-03-2018
RBN-13015	1.53d	7.53cd	15.73bcd	29.93abcd	96.60ab	75.20abcd
RBN-13016	1.73d	18.87bcd	27.60abcd	18.60bcd	66.13abcd	21.40bcd
RBN-13017	1.53d	5.40d	6.80cd	22.93abcd	93.47abc	50.60abcd
RBN-13022	1.60d	4.47d	12.47bcd	45.53abcd	51.13abcd	69.00abcd
KN-279	1.80d	3.40d	5.27d	27.67abcd	47.80abcd	39.00abcd
KN-294	1.40d	3.93d	4.67d	18.33bcd	73.20abcd	22.07bcd
15CBN-006	1.20d	2.53d	4.40d	16.13bcd	110.27a	21.80bcd
15CBN-010	1.87d	2.53d	4.47d	51.93abcd	60.40abcd	48.93abcd
Faisal Canola	3.13d	3.00d	3.13d	22.47abcd	63.93abcd	22.00bcd

It can be inferred from Table 4 that there is no significant difference in population count of mustard aphid when data were recorded in the first week of February-2018. In the second week of February-2018, RBN-13015 and RBN-13016 showed significant difference as compared to the other cultivars.

Data recorded in the third week of February-2018 revealed that there was a significant difference in insect population as compared to the data recorded in previous weeks and among cultivars namely, RBN-13015, RBN-13016, RBN-13017, RBN-13022. Moreover, five cultivars viz; KN-279, KN-294, 15CBN-006, 15CBN-010 and Faisal Canola did not differ significantly regarding the population but they showed a relatively different response as compared to the other four cultivars.

Data recorded in the last week of the month of February-2018 represented that the tested cultivars behaved in two different ways. RBN-13016, KN-294 and 15CBN-006 showed significant difference as compared to the other cultivars.

It has already been stated that mustard aphid population was at its peak in the first week of the month of March-2018. 15CBN-006 exhibited the maximum number of insect population followed by RBN-13015 and RBN-13017 respectively but these three cultivars also represented

significant difference among themselves. Other six cultivars namely RBN-13016, RBN-13022, KN-279, KN-294, 15CBN-010 and Faisal Canola also showed relatively greater number of mustard aphid population as compared to the data recorded on them in the previous four weeks.

Recorded data in the second week of March-2018 represented that there was no significant difference among RBN-13015, RBN-13017, RBN-13022, KN-279 and 15CBN-010. RBN-13016, KN-294, 15CBN-006 and Faisal Canola did not exhibit significant difference among them. But, from Table 4, it can be inferred that both these groups showed significant difference in incidence of mustard aphid population on the screened cultivars.

4. Discussion

Abiotic factors considerably affect the incidence of insect pests on crops and the situation was same in case of the mustard aphid infestation on *Brassica napus* cultivars. Positive correlation was found between insect population and temperature for the population buildup. Insect population was at maximum in the first week of the month of March-2018. Population of mustard aphid was at the lowest level in the first week of the month of February-2018 and it increased gradually until first week of March-2018 but it was declining when the data were recorded in the 2nd week of the month of March-2018. Average temperature in fourth week of February-2018 (21.85 ^{0}C) was much higher than the average temperature in the first week of March-2018 (21.1 ^{0}C). Mustard aphid population was building up in these weeks and it is evident from Table 2 and Fig. 1 that population was higher when the recorded temperature was considerably lower as compared to the former and subsequent weeks. It is also evident that the population started to decline when the temperature was increased in the second week of March-2018. By above recorded data, it can be inferred that mustard aphid population increased when the temperature was low and decreased when the temperature was relatively high. It has also been reported that mustard aphid population disappeared in the ninth standard week of the year [9]. Mustard aphid population has positive correlation with abiotic factors like temperature and rainfall [10].

Average Relative Humidity was comparatively lower in the first week of March-2018 (51%) as compared to four former and one subsequent week, when the Relative humidity was above 60%. Table 2 revealed that population was at maximum in the first week of March-2018 and when relative humidity was minimum. Fig. 2 also revealed that negative correlation (-0.850) exists between relative humidity and mustard aphid population. These findings contradict with the conclusion [11] that relative humidity had no effect on population of mustard aphid. Current findings reveal that there is significant impact of relative humidity on the insect population as relative humidity was minimum when the insect population was at its peak while this situation was inverse in case of higher humidity levels in other weeks.

5. Conclusion

This experiment concluded that entire evaluated germplasm of *Brassica napus* was less susceptible to mustard aphid (*Lipaphis erysimi*). Data recorded were also statistically evaluated and there was no significant difference among cultivars. Dates*cultivars interaction was developed and cultivars represented significant difference among themselves when evaluated on different data recording dates. It was also concluded that temperature exhibited positive correlation with population of insect pests and relative humidity showed negative correlation with the population of mustard aphid.

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