Research Article

Effects of Aphid Infestation on Yield and Yield Parameters of *Brassica juncea* Crop

Umair Faheem[1*], Madiha Mobeen Khan[2], Qurban Ali[3], Muhammad Jamil[4], Wajiha Anum[2], Mashal Rehman[2], Imran Akhtar[2], Mussurrat Hussain[1], Qaisar Abbas[1], Ghayour Ahmad[5] and Abrar Ahmad[6]

[1]Entomological Research Sub Station, Multan, Punjab, Pakistan; [2]Regional Agricultural Research Institute, Bahawalpur, Punjab, Pakistan; [3]Entomological Research Institute, Multan, Punjab, Pakistan; [4]Cotton Research Station, Vehari, Punjab, Pakistan; [5]Cotton Research Institute, Multan, Punjab, Pakistan; [6]Vegetable Research Sub Station, Multan, Punjab, Pakistan.

Abstract | Pakistan had to devour huge money on the import of edible oil. Aphids are the most notorious insect pests of Brassica crops in Pakistan and throughout the world as well. Host plant resistance is one of the most useful tools for the management of aphids in Brassica crop. This trial was executed at the farm of Regional Agricultural Research Institute, Bahawalpur to report the impact of aphid damage on yield and yield parameters on *Brassica juncea*. Five varieties/strains i.e. BRJ-9070, BRJ-9072, BRJ-1004, BRJ-1104 and KP Raya were grown in two sets with Randomized Complete Block Design (RCBD) and there were three replications. No pesticides used on untreated block and natural populations of aphids were allowed to develop to estimate losses while and aphid population was recorded every 10 days intervals, while the treated blocks were kept free from aphids by the use of carbosulfan @ 400 ml/acre. At crop maturity, crop parameters like plant height (cm), number of silique per plant, yield loss in unsprayed blocks was compared to the yield of pesticide sprayed blocks. The yield components and yield in the insecticide free plots were much lower than that of insecticide sprayed plots which were kept aphid free. Maximum percentage reduction (14%) in plant height was observed on BRJ-9072, the silique per plant loss percentage was maximum on KP-raya (36.97%), whereas maximum percentage loss of yield per hectare (70.77%) was observed on BRJ-1104. Application of insecticide would still be required for the control of aphids as the current varieties lack complete or sufficient resistance against them.

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***Correspondence** | Umair Faheem, Entomological Research Sub Station, Multan, Punjab, Pakistan; **Email:** umair4548952@gmail.com
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Introduction

Brassica spp. family Cruciferae has a prime position as a resource of edible oil for humans (Mandal *et al.*, 2012). In Pakistan, the most abundant species of Brasicae comprise *Brassica campestris* L., *B. juncea* L. and *B. napus* L. (Khan and Begum, 2005). It occupies an area of 2,22,000 hectares with 4,88,000 tons of production (Anonymous, 2021).

The injury done by insect pests is a limiting factor for successful brassica cultivation (Rana, 2005). Aphid is a main insect pest of brassica crop (Razaq *et al.*, 2011). Three species of aphids attack Brassica such as *Lipaphiserysimi* (Kalt.), *Brevicoryne brassica* (L.) and *Myzus persicae* (Sulz.) (Hamid and Ahmad, 1980; Rustamani *et al.*, 1998). In Southern Punjab, Pakistan *L.erysimi* and *B.brassicae* are the most vicious insect pests of Brassica crop (Hussain *et al.*, 2015). Both *L. erysimi* and *B. brassicae* L. can cause 70-80% damage in oilseed brassicas. In case of heavy damage and sporadic attack, there might be no grains in pod in the produce (Rustamani *et al.*, 1988; Khattak *et al.*, 2002). *B. brassicae* and *L. erysimi* are also reported to decrease photosynthetic factors and photosynthetic activity in brassica (Hussain *et al.*, 2014; Razaq *et al.*, 2014). They also affect the yield and yield parameters (Hussain *et al.*, 2015).

Several control techniques are employed to control aphids. Although, biological control technique and host plant resistance is eco-friendly. The existing strains of *B. campestris* L., *B. napus* and *B. juncea* are deficient in plant resistance to withstand injury caused by aphids (Amer *et al.*, 2009; Aslam *et al.*, 2009). The biological control insects are inadequate to manage the population of aphids in Brassica. The growers have to rely on use of selective chemicals (Aslam and Razaq, 2007; Hainan *et al.*, 2007). Insecticides are being used successfully for inhibiting the losses caused by aphids on Brassica (Brown *et al.*, 1999).

Recently, Ahmed *et al.* (2013), and Razaq *et al.* (2011) compared the resistance of Brassica crop against aphids at different locations (Peshawar and Multan) of Pakistan. Aphid arrival, maximum and minimum population of aphid on Brassica crop on different strains were also studied (Ahmad *et al.*, 2013; Ali *et al.*, 2019; Razaq *et al.*, 2014). Effect of aphid population on yield and yield components i.e. plant length, pods per plant, pod weight, grains per pod, thousand seed weight and yield per hectare and pod length on different strains were also studied (Ahmad *et al.*, 2013; Razaq *et al.*, 2011). Imidachloprid 20SL @ 80ml/acre also significantly reduce aphid population on Brassica (Hussain *et al.*, 2015; Razaq *et al.*, 2011, 2014).

So far no study is done on the evaluation of yield losses and its parameters due to attack of aphid and the impact of insecticide (carbosulfan) spray to late sown *B. juncea* at Bahawalpur, Punjab conditions. For late sowing the latest available strains of Brassica, were used. This experiment was performed to report the consequence of aphid infestation on yield and yield parameters on insecticides treated and untreated plots.

Materials and Methods

Location

The research experiment was performed during the cropping season, 2017-2018 at the research farms of Regional Agricultural Research Institute, Bahawalpur, Pakistan.

Varieties/strains

Five varieties/strains namely BRJ-9070, BRJ-9072, BRJ-1004, BRJ-1104 and KP Raya were sown at late planting time of 15 November, 2019. This was done in order to maximize the aphid population build up.

Planting geometry

Randomized complete block design (RCBD) was used and there was three replications and plot size of 15×5 feet for each entry. 1.5 feet was row to row spacing. Two sets of five raya varieties/strains were sown.

Agronomic practices

At the time of sowing 75 kg of nitrogen per ha and 60 kg of phosphorous per ha were applied. After thirty days of emergence of crop thinning was carried out and harvesting was done at crop maturity.

Data collection of aphid population

Aphids were allowed to develop on untreated blocks and aphid population was observed from 10 randomly selected plants after 10 days of interval from the inflorescence of 10 cm length, while the treated blocks were kept free from aphids by using carbosulfan@400 ml/acre at the time of appearance of pest till the maturity of crop. A total of two sprays of carbosulfan@400 ml/acre were applied during the season.

Yield and other parameters

From each plot yield was measured by harvesting 1 meter square from a row of each plot and converted to kg/ha. Yields of unsprayed plots and sprayed plots were compared and percentage loss was evaluated for each variety using the following formulae:

Yield loss = yield in sprayed plots – yield in unsprayed plots … (1)

Loss in yield (%) =loss in yield/yield in sprayed plots ×100 … (2)

(Jarvie and Shanahan, 2009; Razaq *et al*., 2011).

Similar formula was applied to calculate loss in silique per plant and plant height.

Plant height (cm) and number of silique per plant were observed from 05 plants randomly selected from sprayed and unsprayed rows in each treatment at the end of the season.

Statistical analysis

Number of aphids and yield characteristics were analyzed by analysis of variance (ANOVA) through computer software Statistix 8.1. Differences among the treatments were determined by Least Significant Difference (LSD) test.

Results and Discussion

Effect of time on aphid population

The aphid population began to increase at the end of February with gradual increase till the 18th of March. After that a gradual decline in aphid population was observed (Table 1).

Ahmad *et al*. (2013) found that during 2006-2008 at Peshawar, Khayber Pakhtunkhwa, Pakistan aphids per plant on twelve brassica varieties/strains were highest during the mid-week of January. Meanwhile, Razaq *et al*. (2014) studied that maximum aphid infestation was on mid of February at Multan, Punjab, Pakistan on the strains Can Raya and Con-I, while the highest infestation on Con-II and Westar was observed on start of March.

The population of aphid was found started to build up in all strains of Brassica during mid of November, 2013. The maximum infestation of six aphids/ leaf was observed at first week of December and in contrast the lowest infestation of 1.1 aphids/ leaf was noted during 2nd week of November (Ali *et al*., 2019).

Effect of varieties/strains on aphid population

The population data of aphid showed significant differences on all the varieties/lines. Maximum population of aphid was observed on Khanpur-raya (33.55 aphids/10cm of inflorescence). Followed by BRJ-1104 (31.22 aphids/10cm of inflorescence) and BRJ-1004 (30.75 aphids/10cm of inflorescence). Minimum population was found in the end of February on BRJ-9072 and BRJ-9070 (14.76 and 15.54/10cm of inflorescence, respectively) (Table 1), this was in paralell with the conclusions of Mamun *et al*. (2010) and Ahmad *et al*. (2013) that aphid damage showed tendency from flowering, reached at its peak at pod formation, and then tended to decrease in all varieties.

Effect of insecticide application

The yield and yield parameters are found to be statistically non-significant with all the advanced lines/strains. However, the difference between yields attributes of sprayed and unsprayed plots were highly significant. On the insect free plots, Plant height as high as 170cm was obtained on the KP-raya and BRJ-1004, maximum number of silique per plants (348 cm) was obtained on KP-raya, maximum yield per hectare (1203 kg/ha) was also obtained on BRJ-1104 (Table 2). On the unsprayed plots, maximum plant height (150cm) was obtained on BRJ-1004, maximum silique per plant (222) on KP-Raya and maximum yield (360 kg/ha) was obtained on BRJ-1004 (Table 2). The results were in conformity with

Table 1: *Mean population of aphid per top 10 cm inflorescence on different varieties of B. juncea at Bahawalpur during, 2018-19.*

Var/Lines	Sampling dates				
	28-Feb	8-Mar	18-Mar	28-Mar	Mean
BRJ-9070	15.56±2.62	20.67±1.24	35.34±2.71	30.67±3.81	25.56 d
BRJ-9072	14.76± 2.65	23.98± 1.75	38.67±2.14	34.34±2.34	27.94 c
BRJ-1004	16.67± 2.96	27.34± 1.71	41.65±2.15	37.34±2.14	30.75 bc
BRJ-1104	20.44± 2.17	27. 34±1.68	41.24±2.37	35.86±2.73	31.22 b
KP-RAYA	20.67±1.92	28.34± 2.36	44.83±3.13	40.34±2.17	33.55 a
Mean	17.62 d	25.53 c	40.35 a	35.71 b	
LSD value	5.32				2.13

Table 2: *Plant height, Silique per plant and yield per ha. of B. juncea varieties in sprayed and unsprayed plots at Bahawalpur during 2018-19.*

		BRJ-9070	BRJ-9072	BRJ-1004	BRJ-1104	KP-RAYA	LSD value
Plant height (cm)	Sprayed	163±2.64 abc	165±2.89 ab	170±2.76 a	170±2.83 a	170±3.07 a	4.87
	Unsprayed	147±2.86 d	141±3.08 d	150±2.32 bcd	147±3.08 cd	149±2.74 bcd	
Silique/ plant	Sprayed	269±8.07 b	266±6.23 b	264±7.67b	330 ± 7.32a	348±7.56 a	17.19
	Unsprayed	169±8.35 d	168±7.93 d	168±7.84d	208 ± 7.78cd	222±7.95bc	
Yield (Kg/ha)	Sprayed	1272±22.37a	1190±21.49a	1201±21.92a	1203± 23.29a	1155±22.19a	47.89
	Unsprayed	351±21.74 b	357±21.92 b	360±22.19 b	351±21.49 b	346±21.49 b	

(Malik and Deen, 1998; Brown *et al*., 1999; Ali *et al*., 2003; Tunçtürk and Iftçi, 2007; Shah *et al*., 2008; Razaq *et al*., 2011, 2014; Ahmad *et al*., 2013; Hussain *et al*., 2015). The yield and yield parameters are found to be statistically non-significant with all the advanced lines/strains. However, the difference between yields attributes of sprayed and unsprayed plots were highly significant.

Percentage reduction in yield and yield parameters

On the insecticide free plots the yield components and yield were much lower than that of insecticide sprayed plots which were kept aphid free. Maximum percentage reduction (14%) in plant height was observed on BRJ-9072, the silique per plant loss percentage was maximum on BRJ-9072 (37.10%), whereas maximum percentage loss of yield per hectare (70.77%) was observed on BRJ-1104 (Table 3). Results are in conformity with (Aslam and Razaq, 2007; Amer *et al*., 2009; Aslam *et al*., 2009; Razaq *et al*., 2011; Hussain *et al*., 2015). However, findings were different from that of Hussain *et al*. (2015) in terms of yield loss percentage as he reports 40-50% losses in the yield. The results were also different from Patel *et al*. (2004) as he reports 80.0 to 97.6% yield loss in *B. juncea* without insect pest management. This may be due to difference in materials and methods.

Table 3: *Percent loss in yield and yield components of B. juncea lines/varieties at Bahawalpur during 2018-19.*

S. No.	Line/variety	Plant height	silique per plant	Yield
1	BRJ-9070	10.19	37.05	69.99
2	BRJ-9072	14.9	37.10	69.99
3	BRJ-1004	11.92	36.37	70.00
4	BRJ-1104	12.70	36.97	70.77
5	KP-RAYA	12.70	36.21	70.00

Conclusions and Recommendations

It can be concluded that the application of insecticide is only feasible selection so far to minimize losses caused by aphid on Brassica crop. As the available cultivars lack plant resistance and biocontrol agents appear too late in the season to reduce aphid damage effectively. The lower aphid population caused increase plant height, silique per plants and yield per hectare and vice versa.

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Novelty Statement

Research work focused on how populations of aphids affect the Brassica crop.

Author's Contribution

UF: Manuscript writing, data analysis and conducted experiment.
MMK: Written part of manuscript, data analysis and conducted experiment.
QA and MJ: Proof reading and conducted experiment.
WA MR, IA, MH, QA, GA and AA: Conducted experiment.

Conflict of interest

The authors have declared no conflict of interest.

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