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Effect of Aphid Infestation on Photosynthesis, Growth and Yield of *Brassica carinata* A. Braun

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Abstract.- *Brevicoryne brassicae* L. and *Lipahis eyrsimi* K. are the important insect pests of *Brassica* crops in Southern Punjab, Pakistan. To evaluate their damage to *Brassica carinata* A. Braun, the photosynthesis, yield and yield parameters of two varieties under three levels of aphid infestation were measured. Low aphid infestation significantly increased photosynthetic factors except for transpiration rate. Similarly lower aphid populations increased plant and pod length, pods per plant, grains per pod, pod weight, thousand seed weight and yield per hectare. In aphid protected treatment, UCD *carinata* yielded 1520 kg/ha. and *B. carinata* yielded 1291 kg/ha. The interaction of variety and insecticide was non significant among the photosynthetic factors but significant for yield/ ha. Losses in yield due to aphids observed in high and moderate infestations (one spray of immidacloprid) were 41.57, 50.18 and 16.29, 22.49 %, respectively. The single application of insecticide was not able to return all yield losses due to aphids but it helped to recover more than 28 % losses.

Key words: *Brassica carinata*, aphids, infestation, photosynthesis rate, *Brevicoryne brassicae, Lipaphis erysimi.*

INTRODUCTION

The oilseed crops of the family Cruciferae, are economically important crops of the world. The importance of oilseed crops can be visualized from the fact that during 2008-09, the total production of edible oil met only 27.2% requirements of Pakistan, and remaining quantity worth of 84 billion rupees was imported (Anonymous, 2009). Oilseed brassicas such as *Brassica napus* L. *B. juncea* L. and *B. carinata* A. Braun possess the status of minor crops in Pakistan and are grown for multiple purposes like fodders, vegetables and edible oils. Damage caused by insect pests is an important factor in reducing the yield of oilseed brassicas. Aphid, *Lipaphis erysimi* Kalt. can reduce 10-90% yield of *Brassica* in India (Rana, 2005). *Brevicoryne brassicae* L. and *L. erysimi* can cause 70-80% losses of different oilseed brassicas in Pakistan. In the years of severe infestation there may be no grains in pod at harvest (Khattak *et al.*, 2002). These species are the major pests of brassicas in Multan (Razaq *et al.*, 2011).

Besides reducing yield, aphids like *Aphis gossypii* G. affect photosynthetic processes of cotton, *Gossypium hirsutum* L. (Shannag *et al.*, 1998). *Brevicoryne brassicae* L. and *L. erysimi* also hamper photosynthetic process in different oilseed brassicas (Razaq *et al*., 2014; Hussain *et al.*, 2014). Under the feeding pressure of Russian wheat aphid, *Diuraphis noxia* (Mordvilko) severe reduction in yield components and grain yield (average reduction 56%) was observed in susceptible cultivars of wheat (Dhaliwal and Arora, 1994). The natural enemies are not sufficient to control the populations of aphids in *Brassica*, so the alternative is the use of selective chemicals (Hainan *et al.*, 2007; Aslam and Razaq, 2007). The over use of chemicals has resulted in the pollution of environment, losses to the farmers due to increase in cost of production and ecosystem instability. So, the best option is to adopt the IPM practices. The paradigm of IPM is minimizing application of insecticides. There are no published reports on the effect of aphid damage on the yield and photosynthesis of *B. carinata*. In this study we have evaluated the effect of *B. brassicae* and *L. erysimi* on yield and photosynthetic losses of *B. carinata*. Furthermore, since there are no guidelines for applying pesticides, we tested single application of imidacloprid on flowering stage of *B. carinata* with no aphids attack and untreated control to determine if the yield losses can be avoided due

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to aphids. We also included available varieties in the experiment to determine relative tolerance towards aphids and their subsequent impact on yield and photosynthesis.

MATERIALS AND METHODS

Conduction of research trial

The experiments were conducted during the growing season of the brassica crop during 2011-2012 in the Exprimental Farms of Bahauddin Zakariya University, Multan. The mean annual rainfall in this area was 125mm (Razaq *et al.,* 2012).

Application of treatments

Varieties of *B. carinata* (local or peela raya) and UCD *carinata* developed by Oilseed Program, National Agricultural Research Centre, Islamabad, Pakistan) of were sown on 5th November 2011 by hand poring method in Randomized Complete Block Design (RCBD) with three replicates in rows. Rows and plants were 30 cm and 9 cm apart, respectively. The distance between replications was 90 cm. All cultural practices were adopted according to the requirement of the crop. To determine the effect of aphids on yield and photosynthesis each treatment was subdivided into three parts each having two lines. One part of each treatment was kept aphid free, for this purpose three sprays (20th, 28th February and 6th March 2012) of imidacloprid (Confidor 20 SL, Bayer Crop Science @ 625 ml/ ha.) were done with knapsack sprayer. Second and third sub treatments comprised one spray of imidacloprid at the flowering stage and no spray (untreated control). Adjacent rows of sub treatments were protected from the drift by spreading plastic sheet during application.

Sampling of aphids

For the estimation of aphid population, six plants were randomly chosen from every treatment and their inflorescences were gently beaten with 15 cm long thick lead pencil to dislodge the aphids, which were collected on thin white plastic sheet and counted. Data were collected every week from the beginning of colonization of aphids i.e. 29th February to the maturity of crop (17th March 2012), when the aphid numbers declined and the crop was fully ripened. Harvesting was done on 26th March 2012.

Measurement of photosynthetic parameters

The photosynthetic rate (A), transpiration rate (E) and internal CO_2 (Ci) were measured with a battery operated instrument IRGA (Infrared gas analyzer, Analytical Development Company, Hoddeson, England). Measurements were taken during day time from two randomly selected plants from infested and protected plots, respectively. From every plant two top surfaced lush green leaves were taken and their upper surfaces were placed on the sensor of the machine till the stable readings. Water use efficiency (Wue) was calculated by dividing the photosynthetic rate with the transpiration rate.

Yield, yield attributes and losses

Yield and its attributes such as plant height (cm), pod length (cm), number of pods per plant, number of grains per pod, pod weight (g) and thousand seed weight (g) were recorded by randomly selecting six plants from every treatment. Yield was calculated by harvesting one meter square and converted them into yield per hectare (kg) (Ali *et al.,* 2003).

Percent losses in yield in unsprayed and one-sprayed-plots were calculated by the following formulae (Razaq *et al.,* 2011).

$$\text{Percent Yield Loss} = \frac{\text{Yield with no aphid stress} - \text{Yield with aphid stress}}{\text{Yield with no aphid stress}} \times 100$$

Statistical analysis

Number of aphids (*L. erysimi* and *B. brevicoryne*), photosynthetic parameters and yield attributes were analyzed by analysis of variance (ANOVA) using Statistics computer software 8.1 (Anonymous, 2005). Differences among the treatments were determined by Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

Brevicoryne brassicae L. and *L. erysimi* were observed feeding on the varieties of *B. carinata* throughout the growing season. They appeared on

Table I.- Mean aphid population (n=18) on 10 cm inflorescence of aphid infested (Unsprayed) and aphid protected / one spray at flowering stages) plots on varieties of *B. carinata* in Multan during 2012.

Treatments	Sampling dates					
	29-02-2012		10-03-2012		17-03-2012	
	B.b	***L.e***	***B.b***	***L.e***	***B.b***	***L.e***
Aphid infested plots						
B. carinata (peela raya)	7.50±3.72	7.63±1.28	58.46±16.7	18.60±2.10	85.61±5.38	24.60±4.97
UCD *carinata*	8.40±1.73	11.16±3.37	39.27±20.08	16.23±5.23	102.60±6.55	27.40±6.59
D.F	(1, 2)	(1, 2)	(1, 2)	(1, 2)	(1, 2)	(1, 2)
F-value	0.03ns	0.57ns	1.37ns	0.57ns	3.61ns	0.40ns
P-value	0.88	0.52	0.36	0.53	0.20	0.59
Aphid protected plots (one spray at flowering stage)						
B. carinata (peela raya)	0.73±0.23	0.76±0.26	4.37±0.96B	3.30±0.86B	42.60±0.73	26.41±3.83
UCD *carinata*	1.34±0.43	1.36±0.45	20.03±3.81A	20.23±3.72A	43.21±2.93	30.2±2.37
DF	(1,2)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2)
F-value	2.53	3.48	23.19	38.21	0.46	0.00
P-value	0.20	0.20	0.04	0.03	0.57	1.00
LSD value	ns	ns	13.99	11.8	Ns	Ns

B.b, Brevicoryne brassicae; *L.e, Liphaphis erysimi*.
ns denotes the non significance at 5 % level of significance. Means with different letters are significant at 5% level of significance.

Table II.- Effect of aphid infestation on photosynthetic parameters of two *B. carinata* varieties.

Photosynthetic parameters	Varieties	No aphid stress	Moderate aphid stress	High aphid stress
Photosynthetic rate (A)	*B. carinata* (peela raya)	24.40±2.90A	23.51±2.60A	9.81±2.91C
	UCD *carinata*	22.82±1.74A	20.60±1.32A	12.43±1.73B
Transpiration (E)	*B. carinata*(peela raya)	3.42±0.67	3.42±0.60	2.97±0.72
	UCD *carinata*	3.48±0.17	3.34±0.36	2.86±0.38
Internal CO_2 (ci)	*B. carinata*(peela raya)	413.03±8.90A	391.50±11.82AB	368.71±11.17B
	UCD *carinata*	391.15±6.04AB	388±6.33AB	373.30±6.04B
Water use efficiency (Wue)	*B. carinata*(peela raya)	7.55±1.35A	7.20±1.11A	3.63±1.32B
	UCD *carinata*	6.52±0.26A	6.22±0.35A	4.62±1.13B

Different letters in the table represents the significance difference at the 5 % level of significance based upon LSD test.

the varieties of *B. carinata* on 29th February 2012 and their population gradually increased and became maximum on 17th March 2012 in aphid infested treatment. The population (n=18) of both the aphid species did not differ significantly between the varieties (P> 0.05) (Table I). Plots once sprayed with imidacloprid at peak flowering stage having massive colonies escaped from the heavy pest attack initially due to reduction in noxious aphids (Table I).

Application of three sprays and one spray significantly increased the photosynthetic parameters except for the transpiration which was statistically not different. The interaction of varieties and insecticides was non significant (Table II). Insecticide treatment increased the yield and all its attributes significantly ($p<0.05$). The interaction of variety and insecticide was significant in yield per hectare (Fig. 1).

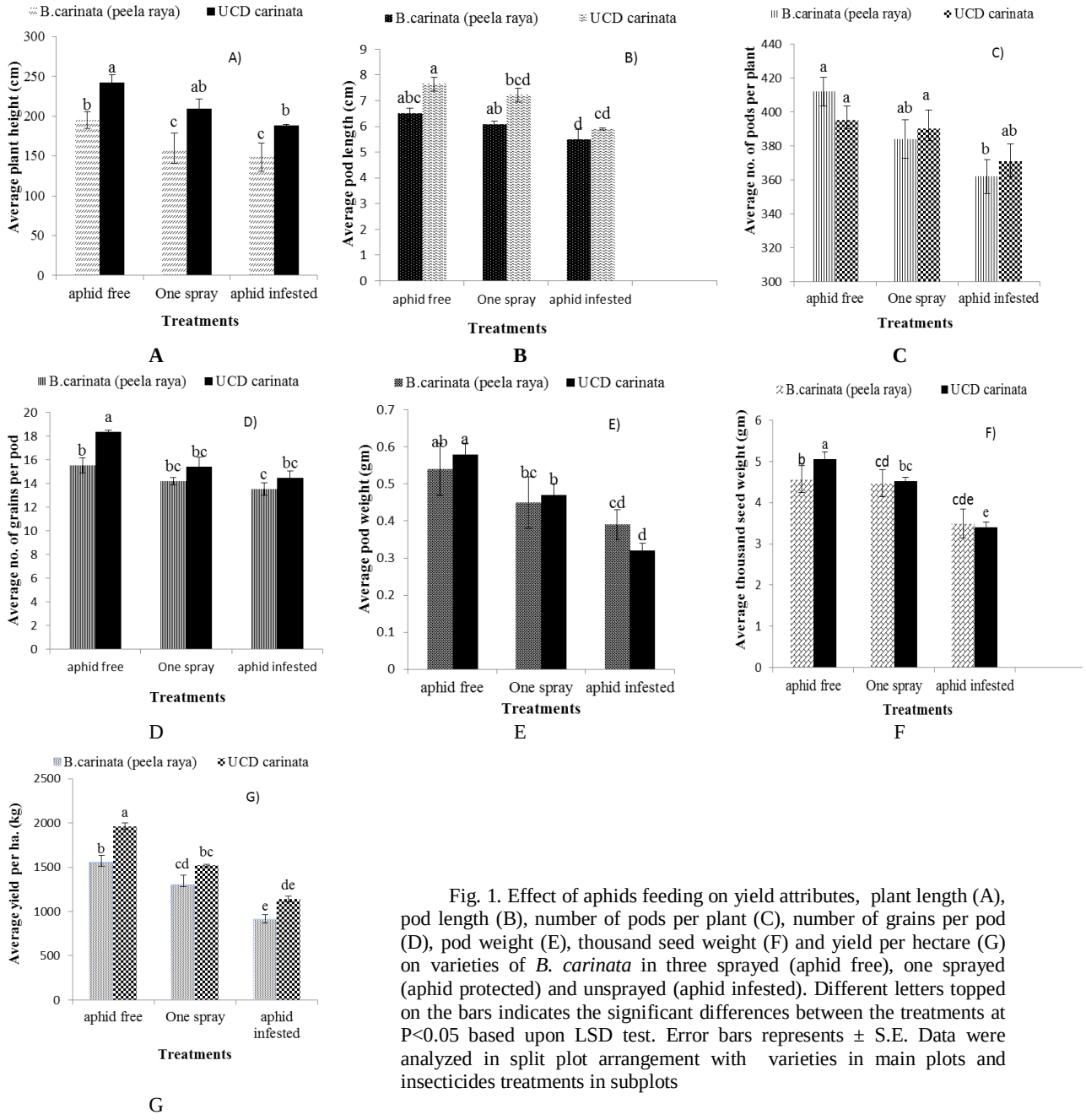

Fig. 1. Effect of aphids feeding on yield attributes, plant length (A), pod length (B), number of pods per plant (C), number of grains per pod (D), pod weight (E), thousand seed weight (F) and yield per hectare (G) on varieties of *B. carinata* in three sprayed (aphid free), one sprayed (aphid protected) and unsprayed (aphid infested). Different letters topped on the bars indicates the significant differences between the treatments at $P<0.05$ based upon LSD test. Error bars represents ± S.E. Data were analyzed in split plot arrangement with varieties in main plots and insecticides treatments in subplots

Brevicoryne brassicae and *L. erysimi* have been recorded as major insect pests on *B. napus*, *B. juncea* and *B. campestris* in the Southern Punjab (Pakistan) (Aslam and Razaq, 2007; Razaq *et al*., 2011). This is the first report of about the status of insect pests of *B. carinata* from this region. *L. erysimi* was found more noxious to *B. juncea* and *B. napus* and less damaging to *B. carinata* both in field as well as in the green house (Rana, 2005). *Brevicoryne brassicae* has been reported to damage several species of *Brassica* crops in USA (Brown *et al*., 1999). Our results do not agree with those of Sarwar *et al.* (2004) who reported that density of aphids on different *B. napus* varieties was

statistically different. This might be due to the difference of plant species and environment where crop was grown.

Infestation of aphids reduced the photosynthetic parameters except transpiration rate. In recent research infestation of *B. brassicae* and L. *erysimi* reduced photosynthetic rate of *B. napus* compared to noninfested plants but did not affect transpiration rate (Razaq *et al.*, 2014). Sucking insect pests like *Nilaparvata lugens* of rice (Watanabe and Kitagawa, 2000) and *Bemisia argentifolli* of cotton (Lin *et al.*, 1999) have been observed to cause reduction in photosynthesis in their infested hosts. *Diuraphis noxia* has been reported not to affect transpiration rate in wheat plants (Macedo *et al.*, 2009). Hawkins *et al.* (2006) found that all aphid-infested plants had more net CO_2 exchange rates in the light than their respective controls.

Aphids reduced yield by 41.57, 50.18 and 16.29, 22.49% in unsprayed and one spray treatments of both the varieties, respectively. Our study proved that single application of insecticide at the peak flowering stage is helpful to recover more than 28 % losses. Interaction between varieties and insecticide applications was significant. UCD *carinata* was more tolerant to aphid damage as its yield was more in all the treatments. The *B. carinata* was sown late in our experiments. Late sown *Brassica* are more prone to aphids and ultimately severe reduction occurs in yield even without aphids and environment (Turhan *et al.*, 2010; Razaq *et al.*, 2011). Aphid infestation reduced the yield and fertile head density, total kernel weight and seed weight on winter wheat (Royer *et al.*, 2005).

CONCLUSIONS

The findings of present study reveal that that aphid infestation caused 40-50% losses in the yield of *B. carnata.* However, single application of imidacloprid recovered 28 % yield losses. Growers are not familiar with losses due to aphids in these crops as being minor in importance. Among the both varieties UCD *carinata* proved to be high yielding with less damage than the *B. carinata* (local or peela raya).

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