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LOSSES IN YIELD AND YIELD COMPONENTS CAUSED BY APHIDS TO LATE SOWN *BRASSICA NAPUS* L., *BRASSICA JUNCEA* L. AND *BRASSICA CARRINATA* A. BRAUN AT MULTAN, PUNJAB (PAKISTAN)

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Abstract

Cabbage aphid, *Brevicoryne brassicae* L., and turnip aphid, *Lipahis eyrsimi* Kalt., are the regular insect pests of Brassica crops in Southern Punjab, Pakistan. Population development of and losses to yield and yield components due to these two aphid species were examined on late sown crops of *Brassica napus* L., *Brassica juncea* L., and *Brassica carinata* A. Braun under sprayed and unsprayed conditions during 2007-08 at Mulatn. Populations of both the species of aphids were statistically similar on three species of Brassica in unsprayed plots. Losses to yield, plant height, numbers of pods per plant, pod length, numbers of seeds per pod and pod weight were statistically similar across all the three species in untreated plots, those of thousand seeds weight was different . *B. napus, B. juncea* and *B. carinata* suffered 75.06, 77.25 and 81.86% losses from aphids in yield where insecticides were not applied. Pod weight, pods per plant and yield per ha., was significantly increased by application of insecticides for all the three species. Due to heavy losses in yield and yield components we recommend insecticide application for reducing losses due to aphids.

Introduction

During the year 2008-09 total production of edible oil met 27.2% requirements of Pakistan, whereas remaining amount was imported by expending 84 billion rupees. Cotton and sunflower are major crops contributing to local oil production. Oilseed brassicas are the minor crops. Canola, *Brassica napus* L., Raya, *Brassica juncea* L. and *Brassica carinata* A. Braun are some important crops from this group (Anon., 2009). These crops are sown for multiple purposes like fodder for animals, as vegetable and to produce oil for human consumption. Damage caused by insect pests is an important factor in reducing the yield of oilseed brassicas. Aphid, *Lipahis eyrsimi* Kalt., causes 10-90% losses in yield in India to these crops depending upon severity of damage and crop stage (Rana, 2005). Losses due to *Brevicoryne brassicae* L., and *L. eyrsimi* reach to 70-80% in Pakistan to different oilseed brassicas. During the years of sporadic attack and severe infestation there may be no grain formation at all (Rustamani *et al.*, 1988; Khattak *et al.*, 2002).

B. brassicae L., and *L. eyrsimi* are severe pests of *B. napus* and *B. juncea* in Mlutan. Several methods are used to mange aphids to reduce damage to oilseed brassicas. Host plant resistance and biological control methods are environment friendly. Unfortunately available cultivars of *B. napus* and *B. juncea* lack sufficient plant resistance to avoid damage by aphids (Amer *et al.*, 2009; Aslam *et al.*, 2009).

Natural enemies like *Chrysoperla* Spp. and lady bird beetles, *Coccinella septempunctata* (L.) appear at the later stage of crop when most of the damage has been caused by aphids brassicas in Multan. Moreover, populations of these two natural enemies are too low to reduce numbers of aphids (Aslam and Razaq, 2007). *L. eyrsimi* has been reported to prefer *B. campestris* and *B. juncea* than *B. napus, Brassica nigra, Eruca sativa* and *B. carinata* in India (Rana, 2005). *Sinapis alba* L., and *B. napus* are susceptible to *B. brassicae* and *L. eyrsimi* than *B. juncea* in USA. Moreover, variable losses were observed in yield and yield components and insecticides proved to be effective in reducing losses to yield in these species of Brassica (Brown *et al*., 1999). As oilseed Brassica are considered minor crops and conventional farmers do not apply control measures to manage insect pests because they are not familiar with losses. To date no study reported preference of aphids, losses in yield and yield components due to damage of aphids and effect of insecticides application to late sown *B. napus*, *B. juncea* and *B. carrinata* at Multan. Present study reports losses in yield and yield components to *B. napus*, *B. juncea* and *B. carrinata* and also proves how insecticide application can be effective in reducing the damage to these crops.

Material and Methods

The research was carried out under irrigated conditions during crop season 2007-2008 at the Experimental Farm of the University College of Agriculture, Bahuddin Zakariya University, Multan in Southern Punjab, Pakistan. These areas are arid and receive mean annual rainfall of about 125mm. The winter season extends from November to February. There is short spring during March. The study site had silt loamy soil (Amer *et al*., 2009). Each of three species, i.e. *B. juncea, B. carrinata* and *B. napus*, was sown in three replicates in a Randomized Complete Block Design. Seeds of all the three species were sown with hand drill in a plot having three rows with row to row distance of 0.5 m and plot to plot distance was 1.5 m. Each row was 5.0 m long. Plant to plant distance was 10.0 cm. The sowing was done on December 5, 2007, whereas recommended planting time is15th October to 15th November in this region (http://www.parc.gov.pk/rapeseed.html). After germination, all the cultural practices were performed through out the growing season uniformly in the all plots. Aphids were allowed to develop on two rows whereas one row was kept free from aphids by spraying imidacloprid (Confidor 20SL, Bayer Crop Science, Karachi) at a recommended field rate. Application of the imidacloprid was done with a hand operated knapsack sprayer at a pressure of 3 bars using a hollow cone nozzle. Insecticide was needed to apply for three times to keep crop free from aphids. There were negligible number of aphids on treated lines of each pot. During application of insecticide rows of each plot were covered with plastic sheet so that insecticide may not affect aphids present on plants of remaining rows due to drift.

Per plant aphid population was recorded at weekly intervals from the initiation of aphid attack till maturity of crop i.e., three plants from each out of non-sprayed rows from each plot. For this purpose top 10 cm of the central shoot inflorescence was beaten gently six times with a 15 cm long stick of pencil thickness. Dislodged aphids were collected on a piece of white sheet and counted.

At the end of the season, plant height (cm), number of pods per plant, number of seeds per pod, mean weight of pod, length of pod (cm) and weight of 1000 seeds were recorded from six plants selected randomly from sprayed as well unsprayed rows in each treatment.

Yield was taken from the respective plots of each species by harvesting one meter from a row of each plot and converted to kg per hectare. Loss in the yield of unsprayed plots was compared to the yield of sprayed plots and percent loss was calculated for each species using the following formulae:

Loss in yield = sprayed plots yield −unsprayed plots yield (1)

Yield loss (%) =yield loss/sprayed yield ×100 (2)

Losses in other plant characters were also determined by same formulae given above by substituting yield with appropriate character of plant. These formulae have been employed by Jarvie and Shanahan (2009) to determine in losses in yield in sprayed and unsprayed plots of soybean.

Data on mean population of aphids per plant only from unsprayed plots were analyzed by analysis of variance (ANOVA) to compare Brassica species for harbouring aphids. Data on yield and all the yield components were analyzed by analysis of variance as a separate experiment for sprayed as well as unsprayed plots. Differences in means for yield and all the yield components were calculated by LSD method among the species in sprayed and unsprayed plots, respectively. Differences between yield and each yield components for sprayed and unsprayed plots were determined by t-test. (Steel and Torrie, 1980).

Results and Discussion

Populations of both the species were statistically non-significantly different among *B. napus, B. juncea* and *B. carrinata* on all sampling dates (Table 1). As might be expected from statistically similar densities of aphids on all the species of Brassica, there were non-significant differences in plant height, numbers of pods per plant, pod length, numbers of seeds per pod, pod weight and yield per ha. in untreated plots. However, 1000 seeds weight of all the species was statistically different (Table 2).

Minimum plant height was recorded for *B. napus* as compared to that of *B. juncea* and *B. carrinata* in sprayed plots. Pod length, pod weight, and yield per ha., of *B. juncea*, *B. napus* and *B. carrinata* was statistically similar where insecticides were applied. Application of insecticides significantly affected numbers of pods per plant of three species of Brassica. The highest numbers of pods were observed in *B. carrinata*. Highest numbers of seeds per pod were observed in *B. napus* where insecticides were applied whereas statistically similar numbers of seeds per pod were observed in *B. juncea* and *B. carrinata*. Thousand seed weight of all the species was statistically different in insecticide treated plots (Table 2).

Application of insecticides significantly increased plant height of *B. carrinatua* among three species of Brassica, as t-value was significant between mean plant height of sprayed and unsprayed plots. Similar results were obtained for number of seeds per pod for *B. napus*. Pod length, pods per plant and yield per ha. was significantly increased by application of insecticides for all the three species. However, insecticides did not affect pod length and thousand seed weight of *B. juncea*, *B. napus* and *B. carrinata* as t-value was non-significant between sprayed and unsprayed plants for these plant characters (Table 2).

Table 1. Mean population of *Lipaphis erysimi (L.e.)* and *Brevicoryne brassicae (B.b.)* per top 10 cm inflorescence of *B. napus*, *B. juncea* and *B. carrinata* at Multan during 2008.

Species	Sampling Dates							
	01st March		08th March		15th March		22nd March	
	L.e.	*B.b.*	*L.e.*	*B.b.*	*L.e.*	*B.b.*	*L.e.*	*B.b.*
Brassica napus	28.66 n.s.	45.5 n.s.	41.33 n.s.	59.3 n.s.	48.66 n.s.	91.66 n.s.	41.33 n.s.	70.00 n.s.
Brassica juncea	23.00	38.33	28.66	64.67	36.00	98.33	31.33	78.33
Brassica carrinata	21.66	31.67	39.00	58.66	51.33	85.33	41.66	65.66

n.s.= Non-significantly different

Table 2. Plant height, pods per plant, number of seeds per pod, pod length, pod weight, thousand seed weight and yield per ha., of, *B. napus B. juncea* and *B. carrinata* in sprayed and unsprayed plots at Multan during 2008.

		B. napus	*B.juncea*	*B.carrinata*	LSD-value
Plant height (cm)	Sprayed	76.48±4.9B	96.94±2.4 A	98.35±2.4 A	13.32*
	Unsprayed	64.48±2.9	84.81±3.4	67.73±2.8	24.26 NS
	t-value	2.63 NS	1.28 NS	07.81*	
Pods per plant	Sprayed	34.09±3.5 C	55.53±6.7 B	93.00±10.16A	20.65*
	Unsprayed	14.71±1.7	19.91±3.7	19.81±1.8	5.87NS
	t-value	3.68*	6.87*	8.51*	
Seeds per Pod	Sprayed	18.31±0.68 A	11.38±0.33 B	13.03±0.26 B	05.08*
	Unsprayed	10.00±0.74	05.91±.60	06.74±.61	4.15 NS
	t-value	04.35*	2.60 NS	2.50 NS	
Pod length (cm)	Sprayed	5.13±0.18	4.03±0.08	4.08±0.09	1.42 NS
	Unsprayed	3.78±0.14	3.07±0.09	3.86±0.14	2.67 NS
	t-value	1.4 NS	2.03 NS	0.33 NS	
Pod weight (gm)	Sprayed	0.45±0.01	0.41±0.01	0.39±0.01	0.15NS
	Unsprayed	0.25±0.02	0.15±0.01	0.22±0.01	0.11NS
	t-value	6.72*	4.03*	8.08*	
Thousand seeds weight (gm)	Sprayed	4.56± 0.81AB	5.75±0.88A	2.97±0.73 B	1.98*
	Unsprayed	2.30±0.28AB	3.47±0.57A	1.45±0.27 B	1.29*
	t-value	2.53 NS	2.16 NS	1.93 NS	
Yield/ha (kg)	Sprayed	1270.64±133.76	1633.32±296.44	1580.88±211.52	38.76NS
	Unsprayed	316.88±22.66	371.54±15.54	286.66±64.42	7.52NS
	t-value	4.31*	4.24*	9.52*	

NS = Non-significant, * = Significant t-value and LSD-value at p>0.05. Mean ± SE (df=2); Figures in rows followed by the same letter are not significantly different (p>0.05), LSD test, Non-significant t-test value indicates that means in each column are not significantly different.

Table 3. Percent loss in yield and yield components of *B. napus*, *B. juncea* and *B. carrinata* at Multan during 2008.

Brassica species	Yield and yield components						
	Plant height	Pods per plant	Seed per Pod.	Pod length	Pod weight	Thousand seeds weight	Yield (kg/ha)
B. napus	15.69	56.84	45.38	26.31	44.44	49.56	75.06
B. juncea	12.51	64.14	48.06	23.82	63.41	39.65	77.25
B. carrinata	31.13	78.69	48.27	5.39	43.58	51.17	81.86

More populations of *L. eyrsimi* were observed on *B. campestris* and *B. juncea* than *B. napus, B. nigra, E. sativa* and *B. carinata* in the field and under greenhouse conditions in India (Rana, 2005). *S. alba* and *B. napus* have been reported to be more susceptible to *B. brassicae* and *L. eyrsimi* than *B. juncea* in Pacific Northwest region of USA on late sown crops. Due to different preference of Brassica species by aphids, losses in yield and yield components were also variable in late sown Brassica species. *S. alba* produced higher yield than *B. juncea*, *B. napus* and *B.rapa* in two year research on late sown crops in USA (Brown *et al*., 1999). In present research all three species presented similar response towards populations of both the aphid species. The differences may be due to variation in germ plasm and environmental conditions. However, results of present study partially agree with the previous research reported from India and USA, i.e., there were no differences in all the species of Brassica for preference by aphids rather some species were better hosts than other in both the studies. Yield and yield components except thousand grain weight were also statistically similar in our research due to similar populations by aphids on all Brassica species where insecticides were not applied.

Application of insecticides on mustard influenced plant height, branches per plant, pods per plant, pod length, seeds per pod and seed yield significantly as compared to control in Bangladesh (Shah *et al*., 2008). Reduction in plant height, pods per plant, seeds per pod and test weight of grains have been reported due to increase in *L. eyrsimi* in India on mustard (Malik & Deen, 1998). Significant increase in pods per plant and seed yield was observed in insecticides treated plots as compared to untreated plots on late sown *S. alba B. juncea*, *B. napus* and *B. rapa* in USA (Brown *et al*., 1999). Similar results have been observed in our studies as pod weight, pods per plant and yield per ha was significantly increased by application of insecticides for all the three species. Application of insecticides significantly increased plant height of *B. carrinata* and seeds per pod of *B. napus* among three species of Brassica, as t-value were significant between mean plant height of sprayed and unsprayed plots.

Losses in yield were too high as *B. carinata* sustained 81.86% losses followed by *B. juncea* (77.25%) and *B. napus* (75.06%). Highest losses (56.84 to 78.29%) were observed in number of pods per plant among the yield components. Yield components like pods per plant, seeds per pod and thousand seed weight have been reported to be correlated positively with yield in *B. napus*. Numbers of pods per plant, thousand seed weight and number of seeds per pod have shown a considerable direct positive effect on seed yield (Ali *et al*., 2003; Tunçtürk & Iftçi, 2007). Losses in these three yield components were 39.65-78.69% in the present research.

Heavy losses to late sown crops are due to prolonged feeding of aphids on Brassica crops. Higher aphid infestations on late sown crops have been reported in Brassica crops from India. A delayed sowing provides better coincidence of the growth stage of plants having tender shoots and ultimately mustard aphids colonize the crop at an earlier growth stage. The availability of such favourable conditions affects the longevity of the period of aphid injury to Brassica that consequently causes reduction in the yield (Singh *et al*., 1984; Chattopadhyay *et al*., 2005).

There are too heavy losses to late sown Brassica crops as these are more vulnerable and susceptible to aphids. Application of insecticides is only option to reduce the losses by aphids as available cultivars of *B. napus* and *B. juncea* lack plant resistance and natural enemies appear too late and their populations are insufficient to reduce aphid damage (Aslam & Razaq, 2007; Aslam *et al.*, 2009; Amer *et al*., 2009). However, appropriate time of application of insecticides is still to be determined as economic threshold level (ETL) has not been yet worked out.

Response of yield to insecticide application was similar statistically for three species and insecticide application increased the yield of each species significantly. Therefore, farmers can sow any of the species among *B. juncea*, *B. napus* and *B. carrinatua* but *B. napus* will be the better choice as this species is economically more important.

References

Ali, N., F. Javidfar, J.Y. Elmira and M.Y. Mirza, 2003. Relationship among yield components and selection criteria for yield improvement in winter rapeseed (*Brassica napus* L.) *Pak. J. Bot.*, 35: 167-174.

Amer, M., M. Aslam, M. Razaq and M. Afzal. 2009**.** Lack of plant resistance against aphids, as indicated by their seasonal abundance in canola, *Brassica napus* (L.) in Southern Punjab, Pakistan. *Pak. J. Bot.*, 41:1043-1051.

Anonymous. 2009. *Economic Survey of Pakistan.* Govt. of Pakistan Economic Advisor Wing, Finance Division, Islamabad (Pakistan).

Aslam, M. and M. Razaq 2007. Arthropod fauna of *Brassica napus and Bbrassica juncea* from Southern Punjab (Pakistan). *J Agri. Urban Entomol.,* 24: 49-50.

Aslam, M., M. Razaq, M. Amer, F. Ahmad and Y.H. Mirza. 2009. Lack of plant resistance in Raya, *Brassica juncea* (L.) varieties against two aphid species in Southern Punjab, *Pak. J. Zool*., 41: 463-468.

Brown, J., J.P. McCaffrey, B.L. Harmon, J.B. Davis, A.P. Brown and D.A. Erickson. 1999. Effect of late season insect infestation on yield, yield components and oil quality of *Brassica napus, B. rapa, B. juncea* and *Sinapis alba* in the Pacific Northwest region of the United States. *J. Agr. Sci.,* 132: 281-288.

Chattopadhyay, C., R. Agrawal, A. Kumar, Y.P. Singh, S.K. Roy, S.A. Khan, L.M. Bhar, N.V.K. Chakravarthy, A. Srivastava, B.S. Patel, B. Srivastava, C.P. Singh and S.C. Mehta. 2005. Forecasting of *Lipaphis erysimi* on oilseed Brassicas in India—a case study. *Crop Prot.,* 24: 1042-1053.

Jarvie, J.A. and P.E. Shanahan. 2009. Assessing tolerance to soybean rust in selected genotypes. *Field Crops Research,* 114: 419-425.

Khattak, S.U., M. Hameed, A.U. Khan, A. Zeb and A. Farid. 2002. Pesticidal control of rapeseed aphid, *Brevicoryne brassicae* L. *Pak. J. Zool.,* 34: 222-228.

Malik, Y.P. and B. Deen. 1998. Impact of aphid (*Lipahis eyrsimi*) intensity on plant growth and seed characters of Indian mustard. *Indian J. Ent*., 24: 286-287.

Rana, J. S., 2005. Performance of *Lipaphis erysimi* (Homoptera: Aphididae) on different *Brassica* species in a tropical environment. *J. Pest Sci.,* 78: 155-160.

Rustamani, M.A., U.F. Qamikhani, G.H. Munshi and A.B. Chutto. 1988. Efficacy of different insecticides against mustard aphid, *Brevicoryne brassicae* L. *Sarhad. J. Agri.,* 4: 659-664.

Shah, M.M.R., A.K.M. Maula, M.N.A. Siddquie, M.A.A. Mamun and M.S. Islam. 2008. Effect of insecticides on the growth parameters, yield and oil content of mustard. *Int. J. Sustain. Crop Prod*., 3: 11-15.

Singh, H., H.R. Rohilla, V.K. Kalra and T.P. Yadava. 1984. Response of Brassica cultivars sown on different dates to attack of mustard aphid *Lipaphis erysimi* (Kalt.). *J. Oilseeds Res*., 1: 49-56.

Steel, R.G.D. and J.H. Torrie. 1980. *Principles and Procedures of Statistics: A Biometrical Approach.* New York, McGraw-Hill, pp. 633.

Tunçtürk, M. and V. Çiftçi. 2007. Relationships between yield and some yield components in rapeseed (*Brassica napus* ssp. *oleifera* L.*)* cultivars by using correlation and path analysis *Pak. J. Bot*., 39: 81-84.

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