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A study on correlation between aphid density and loss in yield components of 12 *Brassica* Genotypes under screen house conditions

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Abstract
The present study on correlation between aphid's density and loss in yield components of 12 *Brassica* genotypes under screen house conditions was conducted at the Institute of Biotechnology and Genetic Engineering (IBGE), The University of Agriculture, Peshawar (UAP) during 2006-08. The results revealed that overall mean aphids density was significantly higher (138.9 aphids plant^{-1}) on Rainbow and lower (59.00 aphids plant-1) on T-16-401. The seed losses were significantly higher (57.88%) in Vangard and lower (23.24%) in T-16-401. Overall mean straw losses were significantly higher (46.36%) in Peela Raya and lower (20.35%) in Ganyou-5. The losses in plant height losses were significantly higher (38.78%) in Westar and lower (25.32%) in Peela Raya. There were recorded significantly higher (27.78%) branches losses in Crusher and lower (6.25%) in T-16-401. The losses in siliquae/main raceme were significantly higher (40.20%) in Oscar and lower (16.24%) in Westar. Overall mean losses in leaves were significantly higher (27.63%) in Legend and lower (7.21%) in Westar. Correlation between aphids density and straw losses (r = 0.412) and aphids density and leaves losses (r = 0.317) was non-significant; correlation between aphids density and siliquae/main raceme (r = 0.469) was positively significant; correlation between aphids density and seed yield loss (r = 0.520), aphids density and plant height loss (r = 0.752) and aphids density and branches loss (r = 0.593) was highly positively significant; whereas correlation between aphids density and straw yield (r = -0.443), aphids density and no. of branches (r = -0.402), aphids density and siliquae/main raceme (r = -0.090) and aphids density and no. of leaves (r = -0.280) was negatively non-significant; correlation between aphids density and seed yield (r = (-0.483) was negatively significant and aphids density and plant height (r = -0.712) was negatively highly significant. The present results might be helpful in using host plant resistance in an integrated pest management program against aphids in *Brassica* genotypes.

Keywords: Aphid density, *Brassica* genotypes, Losses in yield components.

1. Introduction
In Pakistan, winter oilseed *Brassica* crops are attacked by *Lipaphis erysimi* (Kalt.) and to a lesser extent by *Brevicoryne brassica* (L.) and *Myzus persicae* (Sulz.). Aphids are the most important insect pests, causing 70-80% yield losses [1, 2]. *Brassica* crop is attacked by a number of pests; amongst these aphids are more serious. The species of aphids, i.e. cabbage aphid, *Brevicoryne brassicae* L., turnip aphid, *Lipaphis erysimi* Kalt and green peach aphid *Myzus persicae* Sulz. are widely distributed economic pests of canola and brassica [3, 4, 5], which also vectors many several plant pathogens of worldwide occurrence and of great economic importance [6, 7].
Cabbage aphid is the most destructive to the members of Brassicaceae. Its attack, results in severe distortion of leaves and heavy losses to crops by forming large colonies on leaves, stems and inflorescence. Aphids infested plants show slow growth, which result in seed loss of 9-77%. Aphids also cause an 11% reduction is seed oil content [8]. In India aphids alone attribute 30-70% losses in rapeseed yield in different agro climatic conditions with an average loss of 52.2% [9]. Under favorable circumstances, aphid's populations increase very rapidly by making dense colonies on all parts of plants. The economic impact of aphid damage can be from 80% yield losses to complete crop failure, if attack comes at seedling stage [10]. In Pakistan, cabbage aphid and mustard aphid are important pests of *Brassica* [11]; Cabbage aphid causes 35-75% yield losses [12, 13]; 6% losses in oil contents [14].

Based on the above information, the present study aimed to determine relationship between aphids density, brassica yield and yield components in 12 *Brassica* genotypes under screen house conditions.

2. Materials and Methods

The present study was conducted under screen house conditions at the New Developmental Farm (NDF) of the University of Agriculture, Peshawar (UAP) during the cropping seasons of 2006-2008. Twelve *Brassica* genotypes were obtained from the Institute of Biotechnology and Genetic Engineering (IBGE), UAP and grown in the NDF of the UAP for the experiments.

To determine relative abundance of aphid's population on brassica, 12 *Brassica* genotypes were sown in plots measuring each 5x4 meters, having rows of 5 meters, with 75 cm row-to-row distance and 40-50cm plant-to-plant distance. Each genotype was sown in four rows. The experiment was replicated four times using Randomized Complete Block Design (RCBD). Standard agronomic practices were applied to the crop throughout the cropping season. The experiment was carried out for two consecutive growing seasons (2006-07 and 2007-08). During 2006 the crop was sown on October 21 and in 2007 on November 2.

During the months of February and March data on aphid's population was recorded at ten days interval from five randomly selected plants from each row each time of data collection. Number of aphids was recorded from 1st, 2nd and 3rd leaf from the top of each plant and number of aphids/5cm of panicle/shoot (inflorescence).

For determining losses by aphids, the 12 genotypes were infested at flower-bud initiation stage (coinciding with natural infestation) plants of each genotype in pots with 0, 5, 10 and 15 aphids/plant.

Aphid's population was recorded when the pest level was at its peak (March 24-28) from stem 5 cm (lower, middle and top-inflorescence), branches 5 cm (lower, middle and apical portion), and leaves (lower, middle and top).

Aphid's population and its effects on yield losses were determined. Yield data was recorded by threshing individual plant. Each treatment was replicated three times and the experiment was laid out in CRBD.

Percent yield losses were calculated from the yield data in infested (treatment) and un-infested (Control) plants by using the following formula [14]:

$$W = \frac{(M-Y) \times 100}{M}$$

Where:
W is the percent yield loss
M is attainable yield in Control
Y is yield in the treatment.

2.1. Aphid's Density and yield Components in 12 *Brassica* Genotypes

The number of aphids on plant and its effect on different yield components Plant height, Primary branches, siliquae/main raceme, Siliqua length, Seed/siliquae, 1000-grain weight and Yield/plant, were recorded at appropriate time.

a. Aphid Density: Data on aphid's population was recorded when the pest level was at its peak (March 24-28) from stem 5 cm (lower, middle and top), branches 5 cm (lower, middle and apical portion), and leaves (lower, middle and top).
b. Yield Plant^{-1}: Yield per plant was determined by threshing individual plant and weighing its seeds with electronic balance.
c. Straw Yield: Straw yield was taken by weighing the whole plant after threshing and removing the seeds.
d. Plant Height: When plants reached full blooming stage their height was measured in centimeters from the ground level to the tip of the plant with the help of a 1000 cm measuring rod.
e. Primary Branches: Primary branches, which arise from main stem of plant, from base to the top of the plant were counted and recorded.
f. Siliquae/main raceme: The number of siliquae were counted on the main raceme and recorded.
g. Leaves: Leaves of the plant were counted when aphids infestation was at peak (March 24-28).

3. Results and Discussion

3.1 Aphids Density

The results revealed that aphids density was significantly higher of 200.00 aphids plant^{-1} on Rainbow with artificial infestation of 15 aphids plant^{-1} and lower of 27.67 aphids plant^{-1} on Raya Anmol with artificial infestation of 5 aphids plant^{-1} (Table 1). Overall mean aphids density was significantly higher (138.9 aphids plant^{-1}) on Rainbow and lower (59.00 aphids plant^{-1}) on T-16-401.

The present results are comparable to that of some earlier researchers. In a study of various morphological and yield components on 12 genotypes it was found that the genotypes showed significant differences for all characters except insect attack. The hybrid Altex x PC-89 was susceptible to insect attack [15]. More populations of *L. erysimi* were observed on *B. campestris* and *B. juncea* than *B. napus*, *B. nigra*, *E. sativa* and *B. carinata* under greenhouse conditions [16].

3.2 Losses in Seed Yield

The losses in seed yield were significantly higher of 87.36% in Altex with artificial infestation of 15 aphids plant^{-1} and lower of 17.79% in Legend with artificial infestation of 5 aphids plant^{-1}. Overall mean losses were significantly higher (57.88%) in Vanguard and lower (23.24%) in T-16-401. Correlation among aphids and seed yield percent loss was significant (0.52) (Table 2).

Earlier researchers have recorded variable seed losses from different aphid densities, e.g. *Brassica juncea* seed yield losses of 0.95, 14.23, 14.23, 21.27 and 26.42 from 20, 40, 60, 80 and 100 aphids, respectively were recorded, which was highly significant negative correlation value (-0.97) for aphids and seed yield losses/plant [17]; Losses of 45.38, 48.06 and 48.27% in seeds/siliqua in *B. napus*, *B. juncea* and *B. carinata* from aphid's density of 70, 78.33 and 65.66 /plant, respectively were noted [18]; Aphid's infestations of 216.10 caused yield loss of 605 kg ha^{-1} in canola crop, which was a strong negative relationship between the mean number of aphids and yield in canola crop [19]; Cabbage aphids caused 85% yield loss in rape seed [20]; Reduction in seeds per pod and test weight of grains have been reported due to increase in *L. erysimi* on mustard (Malik & Deen, 1998) [21]. The earlier results are comparable

to the present one in which we found average losses of 2.76, 3.81 and 5.57% in seeds yield per plant from infestation of 5, 10 and 15 aphids plant^{-1} at flower-bud initiation stage in the same species, which was significant negative correlation of -0.48.

3.3 Straw Losses

The losses in straw yield were significantly higher of 77.36% in Altex with artificial infestation of 15 aphids plant^{-1} and lower of 10.29% in Ganyou-5 with artificial infestation of 5 aphids plant^{-1}. Overall mean straw losses were significantly higher (46.36%) in Peela Raya and lower (20.35%) in Ganyou-5. Correlation among aphids and Straw yield percent loss was non-significant (0.41) (Table 2).

3.4 Plant height losses

The losses in plant height were significantly higher of 58.17% in Westar with artificial infestation of 15 aphids plant^{-1} and lower of 12.66% in Peela Raya with artificial infestation of 5 aphids plant^{-1}. Overall mean plant height losses were significantly higher (38.78%) in Westar and lower (25.32%) in Peela Raya. Correlation among aphids and Plant Height percent loss was highly significant (0.75) (Table 2).

Some earlier researchers have reported variable losses in plant height with different infestations of aphid densities, e.g. losses in plant height of 2.12, 2.62, 3.05, 4.48 and 5.50% from 20, 40, 60, 80 and 100 aphids plant^{-1}, respectively [17]; 15.69, 12.51 and 31.13% plant height losses in *B. napus*, *B. juncea* and *B. carinata* from aphid's density of 70, 78.33 and 65.66 /plant, respectively [18]. Cabbage aphid reduced 35% plant growth in rape seed [20]. Plant height of 118.5 cm in Rainbow was resulted with 3.13 aphids/ leaf [21]; aphid injury reduced plant height and delayed plant development [22].

3.5 Branches Losses

The losses in branches in were significantly higher of 35.42% in Crusher with artificial infestation of 15 aphids plant^{-1} and lower of 4.08% in Legend with artificial infestation of 5 aphids plant^{-1}. Overall mean branches losses were significantly higher (27.78%) in Crusher and lower (6.25%) in T-16-401. Correlation among aphids and Branches percent loss was highly significant (0.59) (Table 2).

The present results showed mean number of branches losses of 7.69, 9.62, 13.46% with infestation of 5, 10 and 15 aphids, which is comparable to the results of some earlier studies, e.g. with aphid densities of 20, 40, 60, 80 and 100 plant-1 reduced number of branches in *Brassica juncea* with 19.67, 24.04, 28.34, 34.85 and 45.73%, respectively [17]. Cabbage aphid reduced 43% side branches in rape seed [20]; Aphid densities of 5000 and 7000 per 106 plants decreased the number of plant branch by 51.1% and 76.3%, respectively, which is highly significant negative correlation (-0.96) for aphids and branches number losses [23]. Cabbage aphid reduced 1.3 and 1.2% in number of branches in *Brassica napus* and *B. juncea*, respectively [24].

3.6 Losses in Siliquae main raceme

The losses in siliquae main raceme were significantly higher of 57.15% in Peela Raya with artificial infestation of 15 aphids plant^{-1} and lower of 6.32% in Raya Anmol with artificial infestation of 5 aphids plant^{-1}. Overall mean losses in siliquae main raceme were significantly higher (40.20%) in Oscar and lower (16.24%) in Westar. Correlation among aphids and siliquae mr^{-1} loss was significant (0.47) (Table 2).

Earlier researchers have reported variable number of losses in siliquae main raceme with different aphid densities, e.g. densities of 20, 40, 60, 80 and 100 aphids plant^{-1} caused losses in siliqua main raceme per plant^{-1} of 3.77, 5.39, 7.54, 12.60 and 13.68%, respectively, which was highly significant negative correlation value (-0.99) for aphids and branches number losses [17]; aphid densities of 70, 78.33 and 65.66 plant^{-1} resulted in 56.84, 64.14 and 78.68% losses in siliquae plant^{-1} in *B. napus*, *B. juncea* and *B. carinata*, respectively [18]; Decrease of 0.06% in siliqua main shoot^{-1} from *Lipaphis erysimi* on *Brassica juncea* cv. RLM-619 under field conditions [5]; Reduction of 47.5 and 4.5% in number of siliquae on main raceme was noted due to cabbage aphid in *Brassica napus* L. and *B. juncea*, respectively [24].

3.7 Losses in Leaves

The losses in leaves were significantly higher of 44.21% in Legend with artificial infestation of 15 aphids plant^{-1} and lower of 3.22% in T-16-401 with artificial infestation of 5 aphids plant^{-1}. Overall mean losses in leaves were significantly higher (27.63%) in Legend and lower (7.21%) in Westar. Correlation among aphids and Leaves percent loss was non significant (0.32) (Table 2).

The present results are comparable to that of some earlier researcher. In a study on 12 genotypes of rapeseed performance under various aphid densities, significant differences were observed for all characters, where hybrid Altex and Candle performed well for leaf area [15]; aphid densities of 5000 and 7000 per 106 plants decreased the leaf area by 69.5% and 71.3%, respectively [23].

4. Conclusion

None of the *Brassica* genotypes were resistant against the aphids infestation and losses. The aphids densities were positively and significantly correlated with losses in *Brassica* seed yield, siliquae/main raceme, plant height and branches, but were non-significant to losses in straw and leaves.

Table 1: Aphids and Percent Losses in Yield and Yield Components in 12 *Brassica* Genotypes (5, 10 and 15 aphids/plant) during 2006-08.

Brassica Species	Genotypes	Aphids Density /Plant	Seed Yield/Plant grams	Straw Yield	Plant Height (cm)	Branches	Siliquae/main raceme	Leaves
Brassica napus	Westar	70.00bc	19.01	11.80	19.39	5.41	13.68	5.41
		117.0a	34.34	17.67	38.78	8.11	17.09	6.49
		137.7cd	52.60	39.24	58.17	13.51	17.95	9.73
	Average	108.2b	35.32bcd	22.90ef	38.78a	9.01cd	16.24e	7.21d

B. napus	Ganyou-5	37.83ef	18.23	10.29	16.51	5.26	10.36	3.69
		62.67cd	24.96	16.08	33.03	10.53	18.92	12.28
		82.83 f	43.35	34.69	49.54	13.16	23.87	16.57
	Average	61.11e	28.85d	20.35f	33.03abcd	9.65cd	17.72e	10.85cd
B. napus	Rainbow	106.2a	25.14	11.57	17.40	10.53	14.35	6.29
		110.0ab	30.13	18.29	34.79	13.16	14.35	8.18
		200.7a	44.55	33.38	52.19	21.05	33.80	11.32
	Average	138.9a	33.27cd	21.08f	34.79abc	14.91b	20.83de	8.60d
B. napus	Oscar	49.33de	29.56	14.32	18.05	6.98	35.78	7.76
		108.0ab	55.80	24.54	36.09	11.63	38.24	9.48
		184.3ab	66.30	38.86	54.14	16.28	46.57	11.64
	Average	113.9ab	50.55ab	25.91def	36.09abc	11.63bc	40.20a	9.63d
B. napus	Vangard	74.33b	34.89	15.14	18.53	4.55	17.36	18.44
		97.00abc	62.88	32.96	37.06	11.36	18.75	20.74
		132.7cde	75.86	59.08	55.60	18.18	20.83	35.49
	Average	101.3bc	57.88a	35.73abcd	37.06ab	11.36bc	18.98e	24.89ab
B. napus	Crusher	68.50bc	43.51	18.95	16.11	22.92	21.74	4.24
		95.83abc	49.65	28.94	32.22	25.00	41.30	8.95
		142.0c	60.00	46.02	48.33	35.42	46.74	26.41
	Average	102.1bc	51.05a	31.30cdef	32.22abcd	27.78a	36.59ab	13.20cd

***Brassica* Species**	**Genotypes**	**Aphids Density /Plant**	**Seed Yield/ P grams**	**Straw Yield**	**Plant Height (cm)**	**Branches**	**Siliquae/main raceme**	**Leaves**
B. napus	Torch	59.33cd	44.93	28.50	36.27	11.11	27.97	9.62
		77.67bcd	50.92	39.56	18.14	5.56	20.76	7.69
		101.2def	54.58	46.17	54.41	13.89	33.47	14.10
	Average	79.39cde	50.14ab	38.08abc	36.27abc	10.19cd	27.40bcde	10.47cd
B. napus	Legend	69.67bc	17.79	24.72	16.53	4.08	26.15	15.48
		125.7a	24.95	29.22	33.07	8.16	29.23	23.21
		149.2 bc	56.03	47.99	49.61	16.33	38.46	44.21
	Average	114.8ab	32.92cd	33.98bcde	33.07abcd	9.52cd	31.28abcd	27.63a
B. napus	Altex	73.83b	17.87	18.28	13.63	6.52	23.40	5.23
		97.00abc	42.60	38.77	27.25	8.70	35.64	6.04
		101.5def	87.36	77.36	40.88	13.04	41.49	10.88
	Average	90.78bcd	49.28ab	44.80ab	27.25cd	9.42cd	33.51abc	7.38d
Average for *B. napus*		101.16	43.24	30.45	34.28	12.61	26.97	13.32
Brassica juncea	Raya Anmol	27.67f	24.01	19.71	16.19	7.69	6.32	10.83
		57.67d	48.02	42.44	32.38	9.62	12.63	17.23
		100.7 ef	62.35	57.19	48.57	13.46	45.79	26.10
	Average	62.00e	44.79abc	39.76abc	32.38abcd	10.26c	21.58cde	18.05bc
Brassica carinata	Peela Raya	30.17f	35.65	29.65	12.66	4.94	17.86	20.10
		63.50cd	45.96	43.02	25.32	7.41	40.48	23.53
		103.5def	68.61	66.42	37.97	19.75	57.14	35.29
		65.72de	50.07ab	46.36a	25.32d	10.70c	38.49ab	26.31a
Brassica campestris	T-16-401	37.33ef	18.07	13.20	14.57	4.17	10.99	3.22
		54.50d	22.14	21.72	29.13	6.25	28.57	4.83
		85.17 f	29.52	28.14	43.70	8.33	31.32	28.22
	Average	59.00e	23.24d	21.02f	29.13bcd	6.25d	23.63cde	12.09cd

Means within a column followed by similar letters are non-significant from each other using LSD

Table 2: Correlation Coefficient (r) of Aphids Density with Different Yield Components during 2006-8.

	Seed Yield (Average)	**Straw Yield (Average)**	**Plant Height (Average)**	**No. of Branches (Average)**	**Siliquae/main raceme (Average)**	**No. of Leaves (Average)**
Aphids Density	-0.483*	-0.443	-0.712**	-0.402	-0.090	-0.280
	Seed Yield % Loss	Straw % Loss	P Height % Loss	Branches % Loss	Siliqua mr^{-1} % Loss	Leaves % Loss
Aphids Density	0.520**	0.412	0.752**	0.593**	0.469*	0.317

** = significant at P<0.01); * = significant at P<0.05

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