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A study on aphids density, yield and yield components of 12 *brassica* genotypes under screen house conditions

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Abstract

The present study on aphid's density, yield and 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 12 genotypes belonged to four *Brassica* genera viz. *Brassica napus*, *B. juncea*, *B. campestris* and *B. carinata*. The results revealed that overall mean aphid density was highest (138.9 aphids plant⁻¹) on Rainbow and lowest (59.00 aphids plant⁻¹) on T-16-401. Overall mean seed yield was significantly higher (4.33 g plant⁻¹) of Ganyou-5 and lowest (1.79 g plant⁻¹) of Oscar. Overall mean straw yield was significantly higher (18.63 g plant⁻¹) for Westar and lower (12.56 g plant⁻¹) for Peela Raya. Overall mean plant height was significantly higher (153.4 cm plant⁻¹) for Peela Raya and lower (82.10 cm plant⁻¹) for Westar. Overall mean number of branches were significantly higher (12.05 plant⁻¹) in Peela Raya and lower (5.39 plant⁻¹) each in Rainbow and Torch. Overall mean siliquae number was significantly higher (32.67 plant⁻¹) in Westar and lower (8.61 plant⁻¹) in Peela Raya. Overall mean number of leaves were significantly higher (38.28 leaves plant⁻¹) in Altex and lower (21.83 leaves plant⁻¹) in Legend. The present results might be helpful in using host plant resistance in an integrated pest management program against *B. brassicae* in *Brassica* genotypes.

Keywords: *Brassica* genotypes, Aphid density, Brassica yield, Yield components.

1. Introduction

1.1 Importance of Aphids on Brassica crop

In Pakistan, winter oilseed *Brassica* crops are attacked by *Lipaphis erysimi* (Kalt.) and to a lesser extent by *Brevicoryne brassicae* (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 abundant and widely distributed^[3]. *Brevicoryne brassicae* L. and turnip aphid *Lipaphis erysimi* Kalt. are the most devastating pests of Canola^[4].

Three aphid species associated with *Brassica* oilseeds are: *Lipaphis erysimi*, *Myzus persicae* and *Brevicoryne brassicae*. Among these, the cabbage aphid (*B. brassicae*) is most predominant on cabbage; cauliflower, rape and turnip rape throughout the European and American countries^[5]. The green peach aphid or potato aphid (*M. persicae*) is a well-known vector of several plant pathogens of worldwide occurrence and of great economic importance. It is of minor significance to cruciferous oilseeds. The mustard aphid (*L. erysimi*) though a cosmopolitan is of major economic consequences to *Brassica* crops in the Indian sub-continent^[6, 7]. Colonies of these aphids are found on both lower and upper leaf surfaces and in leaf folds of developing heads, on leaf stalks, and on leaf axles. They are occasionally found at the soil level. Aphids feed by sucking sap from their hosts. Infested seedlings may become stunted and distorted. Continued feeding on mature plants causes wilting, yellowing and stunting of the plants.

1.2. Losses due to Aphids in Brassica Genotypes

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 11% reduction in 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] and 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

2.1 Field Layout

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 40-50 cm 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/5 cm of panicle/shoot (inflorescence).

2.2 Losses due to Aphid in 12 *Brassica* Genotypes

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.

2.3 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 racem, Siliqua length, Seed/siliqua, 1000-grain weight and Yield/plant, were recorded at appropriate time.

- 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).
- Yield Plant⁻¹: Yield per plant was determined by threshing individual plant and weighing its seeds with electronic balance.
- Straw Yield: Straw yield was taken by weighing the whole plant after threshing and removing the seeds.
- 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.
- Primary Branches: Primary branches, which arise from main stem of plant, from base to the top of the plant were counted and recorded.
- Siliquae main racem⁻¹: The number of siliquae were counted on the main raceme and recorded.
- Leaves: Leaves of the plant were counted when aphids infestation was at peak (March 24-28).

3. Results and Discussion

3.1 Aphid Density

The aphids density in the control was nil on all the *Brassica* genotypes (Table 1). Among aphid infested 12 genotypes highest mean aphids density was recorded on Rainbow (200.7 aphids plant⁻¹) with artificial infestation of 15 aphids plant⁻¹ and lowest on Raya Anmol (27.67 aphids plant⁻¹) with artificial infestation of 5 aphids plant⁻¹. Overall mean aphid density was highest (138.9 aphids plant⁻¹) on Rainbow and lowest (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 lodging and 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* in the field and under greenhouse conditions in India [16].

3.2 Seed Yield

Seed yield was significantly higher in control than the aphid infested plants of all the *Brassica* genotypes, where it was highest of 7.33 g plant⁻¹ of Raya Anmol and lowest of 3.62 g

plant⁻¹ in Oscar (Table 1). Among the aphid infested plants, seed yield was significantly higher (5.57 g plant⁻¹) of Raya Anmol with artificial infestation of 5 aphids plant⁻¹ and lowest (0.70 g plant⁻¹) of Altex with artificial infestation of 15 aphids plant with artificial infestation of 5 aphids/plant. Overall mean seed yield was significantly higher (4.33 g plant⁻¹) of Ganyou-5 and lowest (1.79 g plant⁻¹) of Oscar.

The present results are comparable to that of some earlier researchers. In a study on various aphids' densities and their effect on seed yield per plant in *Brassica juncea* L. at 25 days old crop infested with different loads of aphids, which accounts for 0.95, 14.23, 14.23, 21.27 and 26.42% losses from 20, 40, 60, 80 and 100 aphids, respectively [17]; Losses of 45.38, 48.06 and 48.27% losses in seeds/siliquae in *B. napus*, *B. juncea* and *B. carinata* from aphid's density of 70, 78.33 and 65.66 /plant, respectively [18]. Relationship between the number of aphids and yield in canola crop was found. With the increase of aphid population the yield decreased and that an aphid's infestations of 216.10 caused a yield loss of 605 kg ha⁻¹. Strong negative relationship between the mean number of aphids and yield in canola crop was found [19]. Cabbage aphids caused 85% yield loss in rape seed [20].

3.3 Straw Yield

Straw yield was significantly higher in control than all the aphid infested plant in all the 12 genotypes, where it was highest of 27.96 g plant⁻¹ for Altex and lowest of 12.56 g plant⁻¹ for Peela Raya. Among the aphid infested genotypes, straw yield was significantly higher (25.90 g plant⁻¹) for Vanguard with artificial infestation of 5 aphids plant⁻¹ and lowest (6.33 g plant⁻¹) for Altex with artificial infestation of 15 aphids plant⁻¹. Overall mean straw yield was significantly higher of 18.63 g plant⁻¹ for Westar and lowest of 12.56 g plant⁻¹ for Peela Raya.

3.4 Plant Height (cm)

Plant height was significantly higher in control than the aphid infested plants of all the *Brassica* genotypes, where it was highest of 205.4 cm plant⁻¹ for Peela Raya and lowest of 134.1 cm plant⁻¹ for Westar (Table 1). Among the aphid infested plants, plant height was significantly higher (179.4 cm plant⁻¹) for Peela Raya with artificial infestation of 5 aphids plant⁻¹ and lower (56.10 cm plant⁻¹) of Westar with artificial infestation of 15 aphids plant⁻¹. Overall mean plant height was significantly higher of 153.4 cm plant⁻¹ for Peela Raya and lowest of 82.10 cm plant⁻¹ for Westar.

Some earlier researchers have reported variable losses in plant height with different infestations of aphid densities, e.g. with different loads of aphids, which accounts for 2.12, 2.62, 3.05, 4.48 and 5.50% losses in plant height from 20, 40, 60, 80 and 100 aphids, 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/Plant

Number of branches was significantly higher in control than in the aphid infested plants of all the genotypes, where it was significantly higher with 13.50 plant⁻¹ in Peela Raya and lower with 6.00 plant⁻¹ in Torch (Table 1). Among the aphid infested plants mean number of branches were significantly higher (12.83 plant⁻¹) in Peela Raya with artificial infestation of 5 aphids/plant and lower (5.00 plant⁻¹) in Rainbow with artificial infestation of 15 aphids/plant. Overall mean number of branches were significantly higher of 12.05 branches plant in Peela Raya and lower of 5.39 branches/plant each in Rainbow and Torch.

Various aphids' densities resulted in branches losses in *Brassica juncea* L. at 25 days old crop infested with different loads of aphids, which accounted for 19.67, 24.04, 28.34, 34.85 and 45.73% losses from 20, 40, 60, 80 and 100 aphids, respectively [17]. Cabbage aphid reduced 43% side branches in rape seed [20].

3.6 Siliquae/main raceme

Siliquae/main raceme was significantly higher in control than all the aphid infested plants of the 12 *Brassica* genotypes, where it was significantly higher of 43.33 plant⁻¹ in Legend and lower of 14.00 plant⁻¹ in Peela Raya (Table 1). Among the aphid infested plants siliquae/main raceme was significantly higher (33.67 plant⁻¹) in Westar with artificial infestation of 5 aphids plant⁻¹ and lower (6.00 plant⁻¹) in Peela Raya with artificial infestation of 15 aphids plant⁻¹. Overall mean siliquae/main raceme was significantly higher of 32.67 plant⁻¹ in Westar and lower of 8.61 plant⁻¹ in Peela Raya.

Various aphids' densities and their effect on siliqua per plant losses in *Brassica juncea* L. at 25 days old crop infested with different loads of aphids. This accounted for 3.77, 5.39, 7.54, 12.60 and 13.68% losses from 20, 40, 60, 80 and 100 aphids, respectively [17]. Losses of 56.84, 64.14 and 78.68% siliquae/plant in *B. napus*, *B. juncea* and *B. carinata* from aphids density of 70, 78.33 and 65.66 /plant, respectively, were recorded [18].

3.7 Leaves/Plant

The number of leaves was significantly higher in control than the aphid infested plants of all the 12 *Brassica* genotypes, where it was significantly higher with 41.33 plant⁻¹ in control of each in Altex and T-16-401 (Table 1). Among the aphid infested plants mean number of leaves were significantly higher (40.00 leaves plant⁻¹) in T-16-401 with artificial infestation of 5 aphids plant⁻¹ and lower (22.00 leaves plant⁻¹) in Peela Raya with artificial infestation of 15 aphids plant⁻¹. Overall mean number of leaves were significantly higher of 38.28 leaves plant⁻¹ in Altex and lower of 21.83 leaves plant⁻¹ in Legend.

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

Table 1: Aphids density and Yield and Yield Components of 12 *Brassica* Genotypes (0, 5, 10 and 15 aphids/plant) during 2006-08.

Brassica Species	Genotypes	Aphids Density /Plant	Seed Yield/plant Grams	Straw Yield/Plant	Plant Height (cm)	Branches (no.)	Siliquae main raceme /Plant	Leaves
<i>Brassica napus</i>	Westar	0.00	5.97b	24.16cd	134.1f	6.17f	39.00ab	30.83def
		70.00bc	4.83	21.31	108.1f	5.83f	33.67a	29.17cdef
		117.0a	3.92	19.89	82.10f	5.67 def	32.33 a	28.83 cde
		137.7cd	2.83	14.68	56.10 f	5.33 e	32.00 a	27.83cd
	Average	108.2b	3.86abc	18.63ab	82.10e	5.61f	32.67a	28.61cd
<i>B. napus</i>	Ganyou-5	0.00	6.09b	22.83cde	157.4cd	6.33ef	37.00bc	27.17fg
		37.83ef	4.98	20.48	131.4cd	6.00ef	33.17a	26.17def
		62.67cd	4.57	19.16	105.4cd	5.67 def	30.00 ab	23.83 f
		82.83 f	3.45	14.91	79.43 cd	5.50 de	28.17 b	22.67e
	Average	61.11e	4.33a	18.18abc	105.4c	5.72f	30.45ab	24.22fg
<i>B. napus</i>	Rainbow	0.00	5.41bc	21.00de	149.5cde	6.33ef	36.00bcd	26.50fg
		106.2a	4.05	18.57	123.5cde	5.67f	30.83ab	24.83ef
		110.0ab	3.78	17.16	97.47cde	5.50 ef	30.83 ab	24.33 ef
		200.7a	3.00	13.99	71.47 cde	5.00 e	23.83cd	23.50de
	Average	138.9a	3.61abcd	16.57abc	97.47cd	5.39f	28.50abc	24.22fg
<i>B. napus</i>	Oscar	0.00	3.62e	20.46e	144.1def	7.17de	34.00bcde	38.67ab
		49.33de	2.55	17.53	118.1def	6.67cdef	21.83de	35.67ab
		108.0ab	1.60	15.44	92.07def	6.33 cde	21.00 c	35.00 ab
		184.3ab	1.22	12.51	66.07 def	6.00 cde	18.17 ef	34.17 ab
	Average	113.9ab	1.79g	15.16bcd	92.07de	6.33e	20.33bc	34.95b
<i>B. napus</i>	Vanguard	0.00	4.93cd	30.52a	140.3ef	7.33cd	24.00f	36.17bc
		74.33b	3.21	25.90	114.3ef	7.00bcde	19.83e	29.50cde
		97.00abc	1.83	20.46	88.30ef	6.50 cd	19.50 c	28.67 cde
		132.7cde	1.19	12.49	62.30 ef	6.00 cde	19.00 ef	23.33de
	Average	101.3bc	2.08fg	19.61a	88.30de	6.50de	19.44cd	27.17def
<i>B. napus</i>	Crusher	0.00	5.70bc	25.12bc	161.4c	8.00bcd	30.67de	35.33bcd
		68.50bc	3.22	20.36	135.4c	6.17def	24.00cd	33.83bc
		95.83abc	2.87	17.85	109.4c	6.00 def	18.00 c	32.17 bc
		142.0c	2.28	13.56	83.38 c	5.17 e	16.33 f	26.00cde
	Average	102.1bc	2.79def	17.26abc	109.4c	5.78f	19.44cd	30.67c
<i>B. napus</i>	Torch	0.00	6.01b	24.95bc	143.4ef	6.00f	39.33ab	26.00g
		59.33cd	3.31	17.84	117.4ef	5.67f	31.17a	24.00f
		77.67bcd	2.95	15.08	91.37ef	5.33f	28.33 ab	23.50 f
		101.2def	2.73	13.43	65.37 ef	5.17 e	26.17 bc	22.33 e
	Average	79.39cde	3.00cde	15.45bcd	91.37de	5.39f	28.56abc	23.28g
<i>B. napus</i>	Legend	0.00	4.89cd	23.34cde	157.2cd	8.17bc	43.33a	30.17efg
		69.67bc	4.02	17.57	131.2cd	7.83b	32.00a	25.50def
		125.7a	3.67	16.52	105.2cd	7.50 b	30.67 ab	23.17 f
		149.2 bc	2.15	12.14	79.23 cd	6.83 bc	26.67 bc	16.83 f
	Average	114.8ab	3.28bcd	15.41bcd	105.2c	7.39bc	29.78abc	21.83g
<i>B. napus</i>	Altex	0.00	5.54bc	27.96ab	190.8b	7.67cd	31.33de	41.33a
		73.83b	4.55	22.85	164.8b	7.17bcd	24.00cd	39.17a
		97.00abc	3.18	17.12	138.8b	7.00 bc	20.17 c	38.83 a
		101.5def	0.70	6.33	112.8 b	6.67 bcd	18.33 ef	36.83 a
	Average	90.78bcd	2.81def	15.43bcd	138.8b	6.95cd	20.83bc	38.28a
Average for <i>B. napus</i>		101.16	3.06	16.86	101.12	6.12	25.56	28.14
<i>Brassica juncea</i>	Raya Anmol	0.00	7.33a	24.41c	160.6c	8.67b	31.67cde	33.83cde
		27.67f	5.57	19.60	134.6c	8.00b	29.67ab	30.17cd
		57.67d	3.81	14.05	108.6c	7.83 b	27.67 b	29.17 cd
		100.7 ef	2.76	10.45	82.60 c	7.50 b	17.17 f	25.00cde
	Average	62.00e	4.04ab	14.70cd	108.6c	7.78b	24.84abc	27.72cde
<i>Brassica carinata</i>	Peela Raya	0.00	4.46de	23.41cde	205.4a	13.50a	14.00g	34.00bcde
		30.17f	2.87	16.47	179.4a	12.83a	11.50f	27.17def
		63.50cd	2.41	13.34	153.4a	12.5 a	8.333 d	26.00 def
		103.5def	1.40	7.86	127.4 a	10.83a	6.00g	22.00 e
	Average	65.72de	2.23efg	12.56d	153.4a	12.05a	8.61d	25.06efg

<i>Brassica campestris</i>	T-16-401	0.00	3.93e	22.42cde	178.5b	8.00bcd	30.33e	41.33a
		37.33ef	3.22	19.46	152.5b	7.67bc	27.00bc	40.00a
		54.50d	3.06	17.55	126.5b	7.50 b	21.67 c	39.33 a
		85.17 f	2.77	16.11	100.5 b	7.33b	20.83 de	29.67 bc
	Average	59.00e	3.02cde	17.71abc	126.5 b	7.50b	23.17abc	36.33 ab

Means within a column followed by similar letters are non-significant from each other using LSD test at p value of 0.05.

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