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Study on Aphids density and yield components of 12 *brassica* genotypes under field conditions in Peshawar-Pakistan

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Abstract
In the present study aphids density and yield components of 12 genetically diversified *Brassica* genotypes were determined under field conditions during 2006-08. The genotypes tested were *Brassica napus* (Westar), *B. napus* (Ganyou-5), *B. napus (*Rainbow), *B. napus* (Oscar), *B. napus* (Vanguard), *B. napus* (Crusher), *B. napus* (Torch), *B. napus* (Legend), *B. napus* (Altex), *B. juncea* (Raya Anmol), *B. carinata* (Peela Raya) and *B. campestris* (T-16-401). The results showed that mean aphids density was significantly higher (37.94 aphids plant-1) on Legend and lower (12.84 aphids plant-1) on Vanguard. With respect to yield and its components, highest values for seed yield (2386 kg/ha), plant height (214.3cm) and number of branches/plant (19.20) were recorded in Peela Raya, whereas maximum 1000 grain weight (4.80g), siliqua length (8.31cm) and seed/siliqua (23.57 seed) were found in Westar, Ganyou-5, and Oscar, respectively. Overall, among the 12 genotypes Vanguard, Crusher and Legend were the best. Based on comparatively better performance against aphids attack and giving better yield components, Vanguard, Crusher and Legend were found best among the *Brassica* genotypes.

Keywords: *Brassica* genotypes, *Lipaphis erysimi*, Yield Components

1. Introduction
In Pakistan, the important *Brassica* species grown as oilseed crops are sarson (*B. campestris)*, raya (*B. juncea*) and Taramira (*Eruca sativa*). These species are considered to be early maturing, drought tolerant and resistant to aphids but inferior in oil recovery and oil quality. The recently introduced *B. napus* (canola) is generally with lesser levels of glucosinolates and erucic acid, better in oil content and quality than rapeseed cultivars but is late maturing and susceptible to insects, particularly aphids [1].

In general, the yield of *Brassica* oilseeds crops in Pakistan is much lower (812 kg/ha) than the average yield in developed countries (1560 kg/ha). The factors responsible for it have been identified as the lack of suitable genotypes and several a-biotic and biotic environmental stresses, the more important being insect pests, diseases, drought and frost [2, 3].

A number of efforts have been undertaken to improve the rapeseed-canola cultivars to improve the quality, production and resistance against aphids. In this respect new genotypes and varieties have been evolved and tested in different parts of Pakistan. The new genotypes are better in quality, oil contents and vigor [2].

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.) [4].

Aphids are the most important insect pests, causing 70-80% yield losses [5], 80% yield losses to complete crop failure, if attack comes at seedling stage [6], 35-75% yield losses [7] and 6% losses in oil contents [8]. In a field survey damage by aphids has been indicated as the biggest hesitation of farmers, planting these crops on large fields [9].

Aphids 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 [10]. Under favorable circumstances, aphid's populations increase very rapidly by making dense colonies on all parts of plants [8].

Keeping in view the importance of *Brassica* crop and the losses caused to it by aphids, the present study aimed to determine relationship between aphids density and yield losses in different *Brassica* genotypes under screen house conditions.

2. Materials and Methods

The present study of determining aphids density and yield components of 12 *Brassica* genotypes were conducted under field 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* twelve (12) *Brassica* genotypes were sown in plots measuring 5x4 meters, having rows of 5 meters, with 75 cm row-to-row distance and 40-50cm plant-to-plant distance with four replications using a Randomized Complete Block Design (RCBD). Each genotype was sown in four rows. 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).

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

The number of aphids per plant and its effect on different yield components, i.e. plant height, primary branches, siliquae main racem^{-1}, siliqua length, seed siliqua^{-1}, 1000-grain weight and yield plant^{-1}, recorded were as following:

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 racem^{-1}:** 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 on brassica crop

The results showed that mean aphids density was significantly higher (37.94 aphids plant^{-1}) on Legend and lower (12.84 aphids plant^{-1}) on Vanguard.

The aphid frequently reported on *Brassica* in this area is Mustard aphid, *Lipaphis erysimi* (Kaltenbach) [11]. Aphids appeared on different *Brassica* genotypes in the 1st and 2nd week of February (2008) and (2007) respectively.

From the perusal of results of experimental trials on the performance of *Brassica* genotypes against aphids it appears that no genotype was completely free of aphid's infestation. All the genotypes varied in degree of aphids' density and showed different response towards holding aphids' infestation under the prevailing field and weather conditions. Based on aphids population under field conditions Vanguard is considered relatively tolerant to aphids, while, T-16-40, Torch, Rainbow, Raya Anmol and Oscar had moderate level of aphid's density. Legend and Ganyou-5 had highest mean number of aphids. Therefore, Legend and Ganyou-5 are termed as susceptible genotypes to aphids, under prevailing conditions.

Some earlier researchers found Oscar as intermediately susceptible and Crusher relatively resistant among 22 cultivars of *Brassica napus* against turnip aphid, *Lipaphis erysimi* Kalt [12]. Some researchers have concluded that the resistant or less susceptible variety had lower aphid infestation. Vanguard had less aphid population, which means it has some degree of resistance as compared to the other genotypes [13]. Some earlier researchers had reported per plant aphid's population for Westar (98.40), Rainbow (44.92) and Oscar (76.77) as compared to 23.41, 26.86 and 30.47 aphids/plant in the present study, respectively confirming similar pattern [14]. None of the variety completely free from aphid's infestation among the ten tested canola Genotypes. Maximum mean aphid population was recorded on Con-I (57.8), followed by Oscar (55.9 aphids), Con-III (50.5 aphids), Dunkeld (48.9), Shiralee (45.5 aphids), Westar (41.9 aphids), Con-II (41.6 aphids), Rainbow (36.9 aphids) and Abaseen (35.7 aphids) [4]. In comparison we had in our study 30.47 aphids/plant on Oscar, 23.41 aphids/ plant on Westar and 26.86 aphids/plant on Rainbow, respectively, showing perfect parity with results. It was concluded from an experiment on 6 canola Genotypes that none of the variety was resistant/ tolerant to the attack of aphids [15].

Our result disagrees with those of [16]. They stated that *B. campestris* varieties as a group harbored relatively higher populations of aphid than *B. juncea* varieties. In our case *B. juncea* group harboured more aphids than *B. campestris*, however the difference was non-significant. Also, our results were contrary to those of [17]. They found fewer aphids on all *B. napus* than on *B. campestris*. Our results showed more aphids on some genotypes in *B. napus* than *B. campestris*. The difference in the results could be due to the difference in the tested varieties/genotypes and ecological conditions for the studies.

3.2 *Brassica* Height Plant^{-1}

The mean plant height was significantly higher (214.3 cm) of Peela Raya and lower (150.4 cm) of Westar.

The plant height of the 12 genotypes ranged from 150.4 to 214.3 cm with a mean value of 182.35 cm. Lower plant height of 137.0 and 156.7cm for Altex and Oscar have been reported as compared to 195.1 and 173.4cm in our study, respectively [18]. Also, much lower mean value for Altex (104.7) and Oscar (98.72cm) have been observed than the values (195.1 cm and 173.4 cm) recorded in the present study [19]. Maximum plant height (212.0 cm) with the application of 150 kg/ha of Sulphur and minimum (185.6 cm) in Canola variety ZAFAR-2000 have been found, which were comparable to ours (150.4 to 214.3 cm) [20]. Much lower plant height of 118.5 cm in Rainbow than 165.8 cm found in the present study [15]. Plant height of different Brassica genotypes ranged from 140.9 to 208.2 cm, with mean value of 182.2cm. The present results are comparable to theirs. They found plant height for Rainbow (141 cm) which is lower than in our study (165.8 cm) [21]. Plant height (182.5cm) in new hybrid Durr-e-NIFA, developed from an Australian canola genotype 'Dunkeld' and a local rapeseed mutant variety 'Abasin 95' was recorded, which were comparable to the present results [22]. Lower values of plant height for Westar, Rainbow, Oscar and Peela Raya as 73.47, 63.87, 60.13 and 258.2cm, respectively were recorded as compared to 150.4, 165.8, 173.4 and 214.3 cm, respectively, in the present study [23]. Lower plant height values for Westar, Rainbow and Oscar as 215.3, 177.9 and 185.5cm respectively were noted as compared to 150.4, 165.8 and 173.4cm, respectively, in the present study [24].

3.3 Primary Branches Plant^{-1}

The mean number of primary branches were significantly higher (19.20 plant^{-1}) in Peela Raya and lower (6.94 plant^{-1}) in Westar.

The primary branches recorded on all the tested genotypes ranged from 6.94 to 19.20 with a mean value of 13.07. The number of primary branches ranged from 5.5 to 14.6 with a mean value of 8.1, which is similar to the present results, except for Peela Raya (19.20 braches) [21]. The numbers of primary branches for Rainbow were 8.08 and 8.05 in our and their study, respectively. The number of primary branches recorded for Westar, Rainbow, Oscar and Peela Raya as 7.76, 7.0, 8.0 and 8.3[23] were lower as compared to 6.94, 8.08, 8.25 and 19.20 branches in the present work, respectively.

3.4 Number of Siliquae Raceme Plant^{-1}

The mean number of siliquae raceme were significantly higher of 70.20 plant $^{-1}$ in Vanguard and lower of 20.76 plant^{-1} in Peela Raya.

The number of siliqua raceme^{-1} of different genotypes ranged from 20.76 to 70.20 siliqua with a mean value of 45.48 siliqua. The values recorded for siliqua per raceme of 68.3 to 94.1 with mean value of 82.2 siliqua were much higher than our results [21]. They reported value for siliqua per raceme for Rainbow as 71.0, that was also much higher than (58.28) in our studies for the same genotype.

3.5 Siliquae Length Plant^{-1}

The mean siliquae length was significantly higher (8.31 cm plant^{-1}) in Ganyou-5 and lower (4.02 cm plant^{-1}) in Altex.

The siliqua length of different genotypes ranged from 4.02 to 8.31 cm with a mean value of 6.16 cm. Earlier record of siliqua length for Altex, Oscar and Rainbow as 6.7, 5.5 and 5.9 cm were comparable to the present findings of 4.0, 6.9 and 6.8cm, respectively [25]. Earlier results of siliqua length of 5.5 and 5.3 cm for Altex and Oscar were higher as compared to 4.02, 6.9 cm, respectively in the present study [19]. Earlier results of siliqua length 3.70, 5.50, 5.70, 3.42 and 3.30 cm for Oscar, Crusher, Torch, Raya Anmol and T-16-401, were lower than 6.92, 6.12, 6.94, 4.41 and 4.69 cm, respectively, in the present study [2]. Also, siliqua length as 5.50 cm for Crusher was also lower than 6.12 cm in the present study. Earlier recorded siliqua length for various brassica populations from 3.8 to 6.8 cm with a mean value of 5.7 cm, were close to our results [21]. Their value for Rainbow was 5.0 cm as compared to 6.8cm found in the present work.

3.6 Number of Seeds per Siliquae

The mean number of seeds per siliquae were significantly higher (23.57) in Oscar and lower 9.38) in Legend.

The number of seed siliqua^{-1} of different genotypes ranged from 9.38 to 23.57 with a mean value of 16.475. In an earlier study number of seeds siliqua^{-1} recorded for Altex and Oscar were 22.85 and 21.37, respectively [19]. Higher number of 17.53 seed/siliqua for Altex and lower number of 17.67 for Oscar was recorded earlier than the present values of 9.99 and 23.57, respectively [18]. Comparatively higher values of 20.0, 17.8, 20.6, 10.0 and 12.0 number of seed siliqua^{-1} for Oscar, Crusher, Torch, Raya Anmol and T-16-401 were reported than the present values of 23.57, 15.57, 13.55, 10.04 and 9.74 seeds siliqua^{-1}, respectively [2]. Higher number of 21.45 seeds siliqua^{-1} in Rainbow was recorded as compared to 17.11 in the present study [15]. Number of seeds siliqua^{-1} ranged from 19.63 to 24.67, which was comparable to our results [20]. Higher number of seed siliqua^{-1} for Westar, Rainbow, Oscar and Peela Raya as 22.93, 22.1, 24.6 and 19.7 were found than the present values of 16.35, 17.11, 23.57 and 11.58 in the present work, respectively [23]. The number of seeds siliqua^{-1} for Westar, Rainbow and Oscar as 26.4, 22.3 and 24.4 were found higher as compared to 16.35, 17.11 and 23.57 seeds, respectively in the present study [24].

3.7 Thousand Gram Weight

Mean 1000 gram weight was significantly higher (4.80 g) in Westar and lower (3.37 g) in T-16-401.

Weight of 1000-grain of the different genotypes ranged from 3.37 to 4.80 with a mean value of (4.085 g). Lower 1000 seed weight for Altex and Oscar as 2.55 and 3.17grams; 3.00 and 3.38 grams and 7.3 and 17.6 grams was reported than 4.65 and 3.67 grams respectively, found in our study [19, 18, 25]. Higher value for 1000 seeds in Rainbow as 8.1 [25] but lower of 3.10 grams [15] was recorded than the present value 4.6 grams. The 1000-seed weight ranged from 3.29 to 3.65 for canola cv. ZAFAR-2000 recorded earlier was in the range of the present results [20]. Lower 1000 seeds weight for Westar, Rainbow and Oscar as 3.42, 3.04 and 3.63 grams was recorded earlier [24] than 4.80, 4.57 and 4.65 grams, respectively in the present study.

3.8 Brassica Seed Yield Plant^{-1}

Mean seed yield was significantly higher of 45.89 g plant^{-1} in Peela Raya and lower of 20.75 g plant^{-1} in Westar.

The seed yield per plant of different genotypes ranged from 20.75 (Westar) to 45.89 g in Peela Raya with a mean value of

39.93 g. Much lower seed yield/plant for Oscar and Altex as 4.05 and 3.68 grams/plant was recorded earlier than 22.03 and 26.84 grams/plant found in the present study, respectively [19]. Similarly, much lower seed yield of 17.0, 13.74, 5.89, 22.0 and 10.61 grams/plant for Raya Anmol, Oscar, Crusher, Torch and T-16-401 [2] was reported earlier than the present values of 36.83, 22.03, 31.35, 29.04 and 24.61 grams/plant, respectively.

3.9 *Brassica* Yield (Kg Ha^{-1})

Peela Raya gave significantly highest mean seed yield of 2386 kg ha^{-1} and Westar lowest of 1079 kg ha^{-1}.

Yield kg ha^{-1} for different genotypes ranged from 1079 to 2386 kg ha^{-1} with mean value of 1732.5 kg ha^{-1}. Different authors have reported different yield for *Brassica* genotypes. Seed yield kg/ha^{-1} reported earlier was in the high range of 2870 to 3725 kg/ha^{-1} [20]. Lower Seed yield kg/ha^{-1} for Oscar and Altex as 825.3, 720.8 [19] but higher of 2500.0, 2388.9 [18] than the present values of 1146 kg/ha and 1396 kg/ha^{-1} have been reported, respectively. New hybrid Durr-e-NIFA, developed from an Australian canola genotype 'Dunkeld' and a local rapeseed mutant variety 'Abasin-95', yielded highest of 2630 kg/ha [22] than the present yield (1595 kg/ha) for *B. napus* genotype Legend. The difference in yield could be due to the difference in the varieties/genotypes and ecological conditions. Our yield values for different genotypes are comparable to those of rapeseed genotypes used in advanced lines yield trail conducted at NIFA during 2000-01 [22]. Seed yield kg/ha^{-1} for Westar, Rainbow, Oscar and Peela Raya as 1107, 1349, 1356 and 1279 was comparable to 1079, 1399, 1146 and 2386, respectively, found in the present work [23]. But higher seed yield ha^{-1} for Westar, Rainbow and Oscar as 1825, 1801 and 1843 kg/ha has been reported earlier [24]. Also, much higher seed yield (3330.0 Kg/ha) for Rainbow [14] has been reported earlier than found in the present study (1399 kg ha^{-1}).

3.10 Brassica Biological Yield (Kg Ha^{-1})

Genotype T-16-401 yielded significantly highest mean biological yield of 13480 kg ha^{-1} and Ganyou-5 lowest of 12150 kg ha^{-1}.

The biological yield kg ha^{-1} ranged from 12150 to 16270 kg ha^{-1} with a mean value of 14210 kg ha^{-1}. Higher biological yield for *Brassica* genotypes, ranging from 17460 to 24340 kg ha^{-1}, has been reported earlier [20]. But, biological yield ha^{-1} recorded earlier for Westar, Rainbow and Oscar as 13437, 11568 and 13333 kg [24] was comparable to 12540, 12380 and 13260 kg ha^{-1}, respectively, found in the present study

Table 1: Aphids density and yield components of 12 genetically diversified *Brassica* genotypes during 2006-08.

Genotype	Aphids Density Plant^{-1}	Plant Height (cm)	Primary Branch-es (No)	Siliquae Raceme^{-1} (No)	Siliqua Length (cm)	Seeds Siliqua^{-1} (No)	1000 g Seed Weight (g)	Seed Yield g Plant^{-1}	Seed Yield (Kg ha^{-1})	Biological Yield (kg ha^{-1})
Westar	23.41 def	150.4e	6.94f	50.88ef	8.23a	16.35c	4.80a	20.75 d	1079d	12540de
Ganyou-5	34.87 ab	176.4c	8.89cde	61.46bc	8.31a	17.54b	4.56ab	24.77cd	1288cd	12150e
Rainbow	26.86 cde	165.8d	8.08e	58.28cd	6.76c	17.11b	4.57ab	26.91cd	1399cd	12380de
Oscar	30.47 bc	173.4c	8.25e	48.85f	6.92c	23.57a	4.65a	22.03d	1146d	13260bcde
Vanguard	12.84 g	162.2d	8.08e	70.20a	7.60b	15.89cd	4.02cd	29.16bcd	1516bcd	14360b
Crusher	18.42 f	177.1c	8.28e	55.36de	6.12d	15.57d	3.98cd	31.35bc	1630bc	12780cde
Torch	25.39 cde	160.6d	9.84bc	63.11b	6.94c	13.55e	4.39abc	29.04bcd	1510bcd	13860bc
Legend	37.94 a	165.5d	8.45de	53.80de	6.91c	9.38g	4.11bcd	30.67bc	1595bc	13410bcd
Altex	21.57 ef	195.1b	9.39bcd	35.04h	4.02g	9.99g	3.67de	26.84cd	1396cd	14430b
Raya Anmol	27.57 cd	173.6c	10.41b	43.63g	4.41f	10.04g	3.83de	36.83b	1915b	15810a
Peela Raya	23.55 def	214.3a	19.20a	20.76i	5.10e	11.58f	3.71de	45.89a	2386a	16270a
T-16-401	24.89 de	192.3b	10.01 b	38.49h	4.69f	9.74g	3.37e	24.61cd	1280cd	13460bcd

Means in columns followed by similar letters are non-significant at = 0.05% level of probability (DMR test).

4. Conclusion and Recommendation

In the present research work aphid's density and yield components of 12 *Brassica* genotypes were determined under field conditions at the NDF, UAP during 2006-08. The results showed that mean aphids density was significantly higher on Legend and lower on Vanguard. With respect to yield components, highest values for seed yield, plant height and number of branches/plant were recorded for Peela Raya, whereas maximum 1000 grain weight, siliqua length and seed/siliqua were found for Westar, Ganyou-5, and Oscar, respectively. On the basis of aphids density and yield components genotypes Vanguard, Crusher and Legend proved to be the best.

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