

Population Trend of Canola Aphid, *Lipaphis erysimi* (Kalt.) (Homoptera: Aphididae) and its Associated Natural Enemies in Different *Brassica* Lines Along With the Effect of Gamma Radiation on Their Population

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Abstract.- Studies regarding the determination of population trend of *Lipaphis erysimi* (Kalt.) and its associated natural enemies in different *Brassica* lines along with the effect of gamma radiation on their population were conducted at Agricultural Research Farm, Malakandher, Khyber Pakhtunkhwa Agricultural University, Peshawar during spring 2007. Three different *Brassica* lines F6B3, F6B6 and F6B7 were used, which were replicated four times in Randomized Complete Block Design. The data revealed that aphid infestation invariably started in all three varieties during last week of February 2007 (1st observation). The peak population of 4.39 aphids leaf⁻¹ was recorded during 2nd week of March and lowest population of 1.02 aphids leaf⁻¹ was recorded during 5th week of March. The species of lady bird beetle (*Coccinella septempunctata*) and syrphid fly (*Syrphus balteatus*) first appeared on 24th February with a mean number of 0.40 lady bird beetle leaf⁻¹ and 0.87 syrphid fly leaf⁻¹, respectively. At the time when aphid population started to increase the peak population of *C. septempunctata* (0.70 lady bird beetle leaf⁻¹) and *S. balteatus* (1.04 syrphid fly leaf⁻¹) was recorded on the 2nd week of March. *Chrysoperla carnea* appeared in the 1st week of March and their peak population was recorded during the 3rd week of March with mean population of 1.46 *C. carnea* leaf⁻¹. Among all the *Brassica* lines, F6B7 showed comparatively more resistance as compared to F6B3 and F6B6. F6B3 showed least resistance against *L. erysimi*, which was found to be the most susceptible cultivar. F6B7 was also found superior in terms of natural enemies. Maximum number of all natural enemies was recorded on this variety followed by F6B6. Lowest number of natural enemies was recorded in F6B3. No significant effect was recorded for the effect of gamma radiation on the population of aphids, natural enemies and on the varieties.

Key Words: Canola aphid, *Lipaphis erysimi*, natural enemies, *Brassica* lines, gamma radiation.

INTRODUCTION

The name canola refers to cultivars of those species that produce seed with lower level of glucosinolates and erucic acid compared with rapeseed cultivars. In Pakistan, canola (*Brassica napus* L and *B. campestris* L.) is attaining the status of leading oilseed crop, both as a source of edible oil for human and protein supplement of animals. It is cultivated throughout the country.

Canola oil is made at a processing facility by crushing the genetically modified rapeseed. The oil has many non-food uses, and often replaces non-

renewable resources in products including industrial lubricants, biofuels, candles, lipsticks, and newspaper inks (Brown *et al.*, 1996).

Among different factors which are responsible for the low yield of canola crop is the attack of aphids. Canola crop is heavily attacked by different species of aphids, which results in poor growth and low yield. Under favorable conditions, aphids populations multiply very rapidly and they form dense colonies on plants. Aphids also transmit plant viral diseases, like turnip mosaic virus, which can be only managed by effective control of aphids. Aphids are the most important insect pests, causing 70-80% losses in yield (Bedford and Henry, 1998).

The mustard aphid, *Lipaphis erysimi* (Kalt.) is one of the serious pests of rape and mustard crop. Its population reaches its peak when the crop is about 70 days old. Both adults and nymphs feed on

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leaves, inflorescence and pods, which results in pale and curled leaves and consequently plant growth and development of flowers and pods are adversely affected. This aphid has become one of the primary pests of fall and spring seeded canola. The feeding just prior to and during bloom, results in aborted flower buds, deformed developing pods and generally decreased vigor in plant growth resulting in yield losses of up to 40 percent in untreated fields (Agarwala and Datta, 1999).

There are different methods which are used for the management of aphids such as use of pesticides, bio-control agents, resistant varieties and gamma radiation. Secondary pest outbreaks, pesticide resistance, more stringent pesticide regulation, and concern about human health and environmental quality have renewed the interest in integrated pest management programs that emphasize biological control. The screening of varieties/lines and determination of resistance in different varieties against aphids is the key component of an IPM package. γ -radiation has also been used in different IPM programs against different insect pests.

No work has been conducted on the population density of *L. erysimi* and its proper identified natural enemies on the different *Brassica* lines along with the effect of γ -radiation on their population. The present study was therefore conducted to evaluate population density/trend of *L.erysimi* and their associated natural enemies, in addition to determining the comparative resistance in different *Brassica* lines against *L. erysimi* and their responses to its associated natural enemies. The response to γ -radiations was also studied for all these parameters.

MATERIALS AND METHODS

Population trends of L. erysimi

The following parameters were considered: (1) Population density/trend of *L. erysimi*, (2) Population density/trend of natural enemies, (3) Identification of their associated natural enemies, such as ladybird beetle (*Coccinella septempunctata*), syrphid fly (*Syrphid balteatus*) and green lacewing (*Chrysoperla carnea*), (4) Effect of γ -radiation on *L. erysimi* population, its associated natural enemies and on *Brassica* lines.

Seed irradiation and sowing

Seeds of all *Brassica* lines were irradiated with a dose of 0.8 KGY (Kilo Gylussac) each with gamma rays from Co⁶⁰ (Cobalt 60 radiation source at the nuclear Institute for Food and Agriculture (NIFA) Tarnab, Peshawar). The irradiated seeds along with parental lines were sown at the newly developed farm near Institute of Biotechnology and Genetic Engineering, Khyber Pakhtunkhwa Agricultural University, Peshawar on 29th October, 2006. There were total 24 sub-plots. Each sub plot was divided in to 10 rows.

Population density/trend of L. erysimi

In order to study the population densities of *L. erysimi*, three different *Brassica* lines including F6B3, F6B6 and F6B7 were sown in different sub plots. All these *Brassica* lines were replicated four times. Number of aphids was counted on the three leaves, top, middle and lower region of 4 randomly selected plants in each variety in each replication avoiding the boarder rows from each plot. Data were collected at weekly intervals.

Population trend of natural enemies

In order to study the population trend of natural enemies, three different *Brassica* lines, F6B3, F6B6 and F6B7 were sown in different sub-plots. All these *Brassica* lines were replicated four times. The numbers of natural enemies *i.e.*, syrphid fly, green lacewing and ladybird beetle were counted on 4 randomly selected plants from each variety, from each replication. Data were collected at weekly intervals and specimens were identified by the Plant Protection Department of the University, Peshawar.

Identification of natural enemies

The species of natural enemies were collected from the field and identified as ladybird beetle (*Coccinella septempunctata*), syrphid fly (*Syrphid balteatus*) and green lacewing (*Chrysoperla carnea*).

Effect of γ -radiation on L. erysimi population and their associated natural enemies

Aphid number and their associated natural enemies were counted on three leaves, top, middle,

and lower region of the plant. All these *Brassica* lines were replicated four times. The numbers of aphids and natural enemies were counted on 4 randomly selected plants from each variety in each replication in the irradiated plots as well as in the control plots.

Data were taken at weekly intervals from each plot from the last week of February to the fourth week of March, 2007 and analyzed by M-State-C computer package, using Randomized Complete Block Design. The means were separated by Duncan's Multiple Range Test (DMR-T) (Steel and Torrie, 1960).

RESULTS

Population density/trend of L. erysimi

Table I shows the the mean number of *L. erysimi* leaf⁻¹ of *Brassica* plants at different time intervals. The maximum number of aphids (2.18 aphids leaf⁻¹) was recorded in the F6B3 line, followed by F6B6 (1.80 aphids leaf⁻¹), the lowest mean population (1.66 leaf⁻¹) was recorded in line F6B7. The highest average population was recorded in 3rd week (3.07 aphids leaf⁻¹), followed by 2nd week (2.18 aphid leaf⁻¹) and 1st week (1.56 aphid leaf⁻¹). The least mean number of aphids (1.15 aphid leaf⁻¹) was recorded during the last week. Maximum aphid population (3.99 aphid leaf⁻¹) was recorded at 3rd week for F6B3, followed by F6B6 (2.74 aphid leaf⁻¹) in 3rd week, while the minimum number of aphids (1.05 aphid leaf⁻¹) was recorded for F6B7 in 5th week.

Table I shows the effect of radiation on the mean population of *L. erysimi*. Mean value of the data indicated that, initially the mean aphid population was found low, with the passage of time the aphid population increased and peak population (3.07 aphid leaf⁻¹) was recorded on 3rd week. After 3rd week the population started to decline and low population (1.15 aphid leaf⁻¹) was recorded on week 5.

Radiation shows a significant response towards the mean aphid population. In most of the cases, non-significant results were recorded for the effect of radiation, when we compared it with the treated *Brassica* lines (Table I).

Effect of radiation showed that in almost all cases initially the population was found less, with the passage of time the aphid population increased. Generally maximum number of aphids was recorded in F6B6 during 3rd week. Peak population (4.39 aphid's leaf⁻¹) was recorded on week 3rd. After week 3rd the population started to decline. The lowest population (1.02 aphids leaf⁻¹) was recorded during 5th week in F6B6 (Table I).

No significant effect was recorded for the effect of *Brassica* (Table I).

Green lacewing population

Table II shows the mean number of green lacewing population at different time intervals. Among the *Brassica* lines, maximum green lacewing population of 0.92 green lacewing leaf⁻¹ was recorded on F6B7, followed by 0.69 green lacewing leaf⁻¹, while the lowest number of 0.52 green lacewing leaf⁻¹ was observed in F6B3. In almost all cases aphid population was recorded lower as compared with the onward observation. Peak population was recorded in week 4, after that decline started. Among all interactions high number (1.65 green lacewing leaf⁻¹) of green lacewing was recorded for F6B7 on week 4.

Table II shows the effect of radiation on the mean population of green lacewing. Initially the mean green lacewing population was recorded in lower number, with the passage of time the population increased and maximum population (1.46 green lacewing leaf⁻¹) was observed in 4th week. After this the population started to decline. The radiation showed non-significant response to mean green lacewing population.

Ladybird beetle population

Table III shows that *Brassica* line F6B7 was superior where maximum number of ladybird beetle population (0.69 ladybird beetle leaf⁻¹) was recorded, followed by F6B6 (0.50 ladybird beetle leaf⁻¹), the least mean numbers were recorded on F6B3 (0.35 ladybird beetle leaf⁻¹).

Initially the mean number of ladybird beetle population was found lower, but with the passage of time it increased and highest average population (0.70 ladybird beetle leaf⁻¹) was recorded during week 3, after that the decline started.

Table I.- Effect of γ radiation at different time interval (weeks) on the mean number of *Lipaphis erysimi* (Kalt) per leaf of plants (n=16) of different *Brassica* lines during spring 2007.

<i>Brassica</i> Lines	Radiation	Time Interval (weeks)					Total mean
		W1 24/2/07	W2 31/2/07	W3 7/3/07	W4 14/3/07	W5 21/3/07	
Without radiation (Control)							
F6B3		1.69e	2.34c	3.99a	1.64ef	1.25g-i	2.18a
F6B6		1.56ef	2.12d	2.74b	1.42fg	1.12hi	1.80b
F6B7		1.43fg	2.08d	2.48c	1.28gh	1.05i	1.66c
Total Mean		1.56c	2.18b	3.07a	1.44c	1.15d	
After radiation (Irradiated)							
F6B3	0	1.75g	2.40de	3.59b	1.74g	1.27i-m	2.15 ns
	1	1.58g-i	2.1ef	2.98c	1.43g-l	1.10 lm	1.84
F6B6	0	1.41 g-l	2.1 f	2.48 d	1.27 i-m	1.02 m	1.65
	1	1.63gh	2.3d-f	4.39a	1.56g-j	1.26j-m	2.21
F6B7	0	1.54g-j	2.1ef	2.50d	1.41g-l	1.14k-m	1.75
	1	1.46j-k	2.1ef	2.49d	1.20h-m	1.10lm	1.69
Total Mean		1.56c	2.18b	3.07a	1.44c	1.15d	

Control: LSD for weeks = 0.12; LSD for varieties = 0.92; LSD for interaction = 0.20.

Irradiated: LSD for weeks = 0.12; ns = non significant

Means followed by different letters in columns and rows are significantly different at 5 % of probability.

Table II.- Effect of γ radiation at different time interval (weeks) on the mean number of green lacewing per leaf of plants (n=16) of different *Brassica* lines during Spring 2007.

<i>Brassica</i> Lines	Radiation	Time Interval (weeks)					Total mean
		W1 24/2/07	W2 31/2/07	W3 7/3/07	W4 14/3/07	W5 21/3/07	
Without radiation (Control)							
F6B3		0.00j	0.40h	0.59g	1.30c	0.32i	0.52c
F6B6		0.00j	0.53g	1.00d	1.42b	0.52g	0.69b
F6B7		0.00j	0.85e	1.35bc	1.65a	0.74f	0.92a
Total Mean		0.00e	0.59c	0.98b	1.45a	0.53d	
After radiation (Irradiated)							
F6B3	0	0.00 ns	0.37	0.60	1.31	0.33	0.52 ns
	1	0.00	0.52	0.98	1.42	0.50	0.68
F6B6	0	0.00	0.79	1.29	1.72	0.75	0.91
	1	0.00	0.43	0.58	1.29	0.31	0.52
F6B7	0	0.00	0.54	1.02	1.42	0.54	0.70
	1	0.00	0.90	1.42	1.58	0.73	0.93
Total Mean		0.00e	0.59c	0.98b	1.46a	0.53d	

Control: LSD for varieties = 0.034; LSD for weeks = 0.04; LSD for interaction = 0.08

Radiation:

Radiation: LSD for weeks = 0.04; ns = non significant

Means followed by different letters in columns and rows are significantly different at 5 % of probability.

Initially the population was found lower, but with the passage of time the population increased. In most of the cases the highest number were recorded

during week 3. After that decline was recorded. Highest numbers (0.91 ladybird beetle leaf⁻¹) was recorded in F6B7 after 3 weeks (Table III).

Table III.- Effect of γ radiation at different time intervals (weeks) on the mean number of ladybird beetle per leaf of plants (n=16) of different *Brassica* lines during Spring 2007.

<i>Brassica</i> lines	Radiation	Time Interval (weeks)					Total mean
		W1 24/2/07	W2 31/2/07	W3 7/3/07	W4 14/3/07	W5 21/3/07	
Without radiation (Control)							
F6B3		0.27i	0.34gh	0.47e	0.38fg	0.31hi	0.35c
F6B6		0.36f-h	0.41ef	0.71b	0.54d	0.46e	0.50b
F6B7		0.57cd	0.62c	0.91a	0.72b	0.63c	0.69a
Total Mean		0.40d	0.46c	0.70a	0.55b	0.47c	
After radiation (Irradiated)							
F6B3	0	0.27 ns	0.33	0.45	0.37	0.29	0.34 ns
	1	0.35	0.43	0.71	0.54	0.46	0.50
F6B6	0	0.60	0.62	0.90	0.73	0.64	0.70
	1	0.27	0.35	0.50	0.40	0.33	0.37
F6B7	0	0.37	0.39	0.71	0.54	0.46	0.49
	1	0.55	0.62	0.92	0.71	0.62	0.68
Total Mean		0.40d	0.46c	0.70a	0.55b	0.47c	

Control: LSD for Weeks = 0.04; LSD for varieties = 0.03; LSD for interaction = 0.06.

Irradiated: LSD for Weeks = 0.04 ns = non significant

Means followed by different letters in columns and rows are significantly different at 5 % of probability.

Table IV.- Effect of γ radiation at different time intervals (weeks) on the mean number of syrphid fly per leaf of plants (n=16) of different *Brassica* lines during Spring 2007.

<i>Brassica</i> lines	Radiation	Time Interval (weeks)					Total mean
		W1 24/2/07	W2 31/2/07	W3 7/3/07	W4 14/3/07	W5 21/3/07	
Without radiation (Control)							
F6B3		0.61 ns	0.74	0.84	0.69	0.63	0.70c
F6B6		0.92	1.02	1.13	0.96	0.84	0.97b
F6B7		1.09	1.16	1.15	1.02	1.20	1.12a
Total Mean		0.87c	0.97ab	1.04a	0.89bc	0.89bc	
After radiation (Irradiated)							
F6B3	0	0.64 ns	0.73	0.88	0.70	0.58	0.71 ns
	1	0.90	1.10	1.23	0.92	0.77	0.98
F6B6	0	1.10	1.17	1.14	1.02	1.20	1.13
	1	0.58	0.75	0.80	0.67	0.68	0.70
F6B7	0	0.96	0.94	1.03	1.00	0.91	0.97
	1	1.08	1.15	1.17	1.02	1.21	1.13
Total Mean		0.87 c	0.97ab	1.04a	0.89bc	0.89bc	

Control: LSD value for Varieties = 0.65; LSD value for weeks = 0.085; LSD for interaction = 0.065; ns = non significant

Irradiated: LSD value for weeks = 0.085; ns = non significant

Means followed by different letters in columns and rows are significantly different at 5 % of probability.

Table III shows that radiations do not have any significant effect on the population ($P > 0.05$). Almost in all the cases mean ladybird beetle population was found lower initially and increased with the passage of time. Peak population (0.92

ladybird beetle leaf⁻¹) was recorded by F6B7 during week 3. In most of the cases high number of ladybird beetles were recorded during week 3, after that decline was recorded. The highest average population (0.70 ladybird beetle leaf⁻¹) was recorded

during week 3 ($P < 0.05$), followed by week 4 (0.55 ladybird beetle leaf⁻¹), the lowest population was recorded in week 1 ($P < 0.05$) (Table III).

Syrphid fly population

Table IV shows that *Brassica* line F6B7 was superior where maximum number of syrphid fly population (1.12 syrphid fly leaf⁻¹) was recorded, followed by F6B6 (0.97 syrphid fly leaf⁻¹), the least mean numbers were recorded on F6B3 (0.70 syrphid fly leaf⁻¹).

Initially the mean number of syrphid fly population was found lower, but with the passage of time it increased and highest average population (1.04 syrphid fly leaf⁻¹) was recorded during week 3, after that the decline was started. In almost all cases initially the population was found lower, but with the passage of time the population increased. In most of the cases the highest number were recorded during week 3. After that decline was recorded. Highest numbers (1.15 syrphid fly leaf⁻¹) was recorded in F6B7 after week 3 (Table IV).

Table IV shows non-significant effect of radiation on *Brassica* line ($P > 0.05$). The total average population of syrphid fly, like other natural enemies syrphid fly population was also found lower initially, with the passage of time it increased. Peak population (1.04 syrphid fly leaf⁻¹) and (0.97 syrphid fly leaf⁻¹) was recorded during week 3 and week 2, respectively, It was followed by 0.89 syrphid fly leaf⁻¹ which was recorded during week 4 and week 5. The least numbers (0.87 syrphid fly leaf⁻¹) was recorded during week 1.

DISCUSSION

L. erysimi is the most serious pest of *Brassica* spp. and causes maximum yield losses in *Brassica* so it is very important to study its population trends and thus to control or at least minimize their losses. Weibull and Melin (2003) reported that canola crop is heavily infested by aphids under favorable environmental conditions and reduce its yield drastically.

Similar results were reported by Rana (2006) who stated that the population started multiplying and reached to a peak during the 3rd and 4th weeks of March. After week 3 the population started to

decline and low population was recorded on week 5 (4th week of March).

The *Brassica* line F6B7 showed best response in reducing the aphids population. No literature is available to confirm these findings.

In the present study the population of green lacewing are significantly different for different *Brassica* lines, while the radiation had no significant effect on population of green lacewing. At the beginning the mean green lacewing population was lower but with the passage of time, green lacewing population increased and maximum population was observed in week 4, while minimum population was found in 1st week. Among the *Brassica* lines, maximum green lacewing population was recorded on F6B7 while minimum green lacewing population was observed in F6B3. Our results are in conformity with Sirimachan *et al.* (2005).

Seven spot ladybird beetles (*C. septempunctata*) were a predominant predator in *Brassica* spp. Mustard aphid and *C. septempunctata* appeared simultaneously in early march (Agarwala and Bardhanroy, 1999).

In the present study significant variation occurred in the ladybird beetle population on different *Brassica* lines, whereas radiations have no significant effect the beetle population. Mean ladybird beetle population increased with the passage of time and maximum population was recorded in week 3rd, after that population declined and minimum number of population was observed in week 1. Among *Brassica* lines maximum population of ladybird beetle per leaf was recorded on F6B7 while minimum of ladybird beetle was observed on F6B3. Our results are in conformity with Singh and Sachan (2001) who reported that *C. septempunctata* appeared variably late in February during the studies of three consecutive years in *Brassica* crops.

Syrphid fly population varied significantly on different *Brassica* lines, whereas radiation had no significant affect on mean syrphid fly population. Mean syrphid fly population increased with the passage of time and maximum population was recorded in 3rd week, after that population declined and minimum number of syrphid fly population observed in week 1. Among *Brassica* lines maximum population of syrphid fly per leaf was

recorded on F6B7 while minimum was observed on F6B3. Our results supports the findings of Charlet *et al.* (2002) who reported late build up of population of *C. carnea*.

In the present study it was found that peak population of aphids was observed during week 3. F6B7 was found best in reducing the aphid population. In case of natural enemies, in all cases same trend was observed and peak population was recorded during week 3, after that decline was recorded. Gamma radiations had no significant effect on aphid population.

CONCLUSIONS AND RECOMMENDATIONS

The peak population of 3.07-aphids leaf⁻¹ attained during 2nd week of March and lowest population of 1.15 aphid leaf⁻¹ observed during 4th week of March. *L. erysimi* attacked more on F6B3 because of its susceptible nature, while F6B7 showed comparatively more resistance against its attack. The initial population of natural enemies started in the last week of February attained peak on 2nd week of March and then declined. Ladybird beetle, syrphid fly and *C. carnea* were the main natural enemies observed in the study sites. Ladybird beetle and syrphid fly were recorded at the beginning of the season while green lace wing population was observed during late season. The major species of natural enemies that were observed in the field were ladybird beetle (*Coccinella septempunctata*), syrphid fly (*Syrphid balteatus*) and green lacewing (*Chrysoperla carnea*).

The *Brassica* line F6B7 should be used for cultivation in Peshawar, because of the least preference by the *L. erysimi*. Mass production and rearing of *C. septempunctata* is recommended for the management of *L. erysimi* population. *C. carnea* comes late and may not be successful in Peshawar.

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