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# Turnip Aphid *Lipaphis erysimi* Kalt. (Homoptera: Aphididae) Biology, Intrinsic Rate of Increase and Development Threshold Temperature on Oilseed *Brassica*

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## Abstract

The biology of turnip aphid apterous (*Lipaphis erysimi* Kelt.) was studied in controlled conditions on four cultivars of *Brassica* viz, *B. campestris* (Toria-A), *B. carinata* (Peela raya), *B. juncea* (Bard-1) and *B. napus* (Wester). Four nymphal instars were observed. The first stadium was the shortest on *B. juncea* and longest on *B. campestris*. Stadia for 2nd, 3rd and 4th instar ranged between 17-23, 20-24 and 29-31 hours, respectively. The reproductive time was the shortest on *B. campestris* and fecundity was at par with other cultivars of *Brassica*. The pre and post-reproductive times were not significantly different and ranged from 16-22 and 17-22 hours, respectively. The developmental time was approximately six days. The reproduction was significantly high on *B. campestris* and *B. napus* leading to higher intrinsic rate of increase on *B. campestris* than *B. juncea* and *B. carinata*.

## Introduction

Oilseed *Brassica* viz, *B. campestris*, *B. napus*, *B. juncea* and *B. carinata*, commonly known as rapeseed and mustard ranks third and second in oil and meal production in the world respectively. Seed contains with 40 percent oil and meal contains 38-40 percent protein, respectively. The Rapeseed and mustard with low erucic acid and glucosinolate contents is known as canola and its growth rate is 8.2 percent in the world, over the last decade (Anonymous, 1992).

The area and production under rapeseed and mustard is 0.280 million ha and 0.203 million tons respectively in Pakistan (Anonymous, 1995). However, the average yield compared to other countries is very low. Its low yield may be attributed to turnip aphid, *Lipaphis erysimi* Kalt. attack. Aphid nymphs and adults suck cell-sap from leaves. Infestation in the early stages causes stunted of the plant growth and reduces their vigour. Attack at the time of flowering and pod formation reduces the yield considerably. It is a serious pest in India and Pakistan and is mainly responsible for low yield of rapeseed and mustard. It reduces yield by 48-78 percent in India (Prasad and Padke, 1984) and in certain areas of Pakistan particularly Sindh province aphid damage result in complete failure of the crop (Aamir and Khalid, 1961).

The basic knowledge about insect biology, intrinsic rate of increase and development threshold temperature are foundations for Integrated Pest Management (IPM). Moreover, it becomes extremely important to determine $r_m$ for particular aphid species/population in a particular environment because the $r_m$ value is different for various aphid population/biotype on separate host plants (Landin and Wennergren, 1987). Insect biology and other biological parameters such as intrinsic rate of increase and development threshold temperature are affected by various factors such as different host plants, cultivars, plant quality and plant growth stage (Kundu and Pant, 1967; Watt, 1979, Raworth, 1984; Kerns *et al*., 1989). The main objectives of the present study were to investigate the turnip aphid, *Lipaphis erysimi* Kalt. biology and $r_m$ on four different oilseed Brassica.

## Materials and Methods

The experiment was conducted at the National Agriculture research Centre (NARC), Islamabad, Pakistan. Seeds of four oilseed *Brassica* (*B. campestris*, *B. carinata*, *B. juncea* and *B. napus*) were planted in plastic cups ($8.5 \times 7.5$ cm) filled with sandy soil. After seedling emergence, single plants were transplanted in individual cups of conical shape (8.5 cm high and with 7.5 cm diameter from the top and 3.5 cm from the bottom) filled with sandy soil mixed with farm yard manure in 3:1 ratio. Plants were watered daily without adding fertilizer and maintained in the growth chamber at $22 \pm 1°C$ for 16 hours photoperiod. At 4-5 leaf stage, the turnip aphid culture collected from NARC and maintained on Shiralee, *B. napus*, at room temperature, were used in these experiments.

The turnip aphid biology was studied in the growth chamber at a temperature of $24.3 \pm 1°C$. Adult apterous aphids from the culture were placed in clip cages, a modified form of Puterka and Peters (1988) on third or fourth leaf of each plant. The cages were checked every 6 hr after infestation until a minimum of one nymph was produced. After which only one nymph in each cage was left for observations. Aphids were transferred to the next leaf on the same plant using a fine camel hair brush before leaf senescening. Newly born nymphs were observed after every eight hr for nymphal duration (stadium). Observations were also recorded for pre-reproductive, reproductive, post-reproductive times and fecundity.

The developmental time i.e., from birth to birth (d) was recorded on all the four Brassica cultivars at $24.3°C \pm 1$, $16.3°C \pm 1$ and $8.3°C \pm 1$ in growth chambers. The observations were continued to determine reproduction i.e., the number of progeny produced for time equivalent to (d) by individual aphid. The experiment was conducted under

completely randomized design, with unequal replications because of aphid mortality and escape from the cages.

The development threshold temperature (D°) was estimated using, linear regression and $r_m$ for each observation was estimated by Wyatt and White (1977).

Data for each nymphal duration, pre-reproductive, reproductive, post-reproductive time, fecundity and $r_m$ were also analyzed using MSTATE-C. LSD values were used for mean comparison.

## Results and Discussion

**Biology:** The turnip aphids had four instars. The first stadium was significantly short on *B. juncea* and was long on *B. campestris* (Table 1). Stadia for 2nd, 3rd and 4th instar ranged from 17-23, 20-24 and 29-30 hours, were not significantly different. The duration of 1st, 2nd, 3rd, apterous nymphs were approximately equal. The 4th instar of *Lipaphis erysimi* Kalt. took 26-50 percent more time is similar to *Brevicoryne brassicae* (Hughes, 1963) and *Diuraphis noxia* (Aalbersberg *et al*., 1987). The pre-reproductive time (time from last skin shedding to start of reproduction) and post-reproductive time ranged from 16-22 and 17-22 hour, respectively on different species. However, post-reproductive time was 12 hour longer on radish plant at similar temperature (Rout and Senapati, 1968). Reproductive time (days) was the shortest on *B. campestris* compared to *B. juncea*, *B. napus* and *B. carinata* (Table 1). However, reproductive time on *B. Juncea*, *B. napus* and *B. carinata* were similar to radish plant (Rout and Senapati, 1968). The total nymphs reproduced were higher on *B. napus* and the loweat on *B. carinata* ranging from 44-65 apterous.

**Reproduction:** The number of young nymphs reproduced and developmental time was significantly higher on *B. campestris* and *B. napus* (Table 1). This variation show that *B. campestris* and *B. napus* are most suitable hosts for reproduction than *B. juncea* and *B. carinata* (Kerns *et al*., 1989). In the present study, the md on *B. campestris* was similar to American turnip aphid population on the same host plant (Amjad and Peters, 1992).

**Intrinsic Rate of Increase:** The intrinsic rate of increase ($r_m$) is a discrete value for quantitative measurement of an insect population increase in a set of environment (Birch, 1948; Messenger, 1964). The $r_m$ value was significantly higher on *B. campestris* than *B. juncea* and *B. carinata*. The observed differences in $r_m$ value on the different oilseed *Brassica* in the similar environment might be due to the plant quality (Nault and Styer, 1972) which significantly affected the aphids reproduction.

The $r_m$ value in the present study was higher than American turnip aphid population on *B. campestris* Toria-A (Amjad and peters, 1 992), but similar to Indian turnip aphid population on *B. juncea* (Landin and Wennergren, 1987). It indicates that turnip aphid population from Pakistan and India has similar reproductive potential but higher than American turnip aphid population.

**Developmental Threshold Temperature (D°):** The rate of development, as a function of temperature was linear on the tested temperatures. The linear "b" coefficient was not significantly different. The intercept (x°) of linear regression, "an estimate of development threshold temperature (D°)", ranged from 4.59-5.64 (Fig. 1). The development threshold temperature in descending order were *B. juncea* > *B. campestris* > *B. carinata* > *B. napus*. The D° in the present study on *B. juncea* is very similar to the Indian turnip aphid population on *B. juncea* (Landin and Wennergren, 1987), but was different than the estimate of DeLoach (1974). This variation may be due to added effect of variation in aphid population from various geographical area and differences in host plant quality. The development threshold temperature of turnip aphid in different studies ranged between 4.6-8°C (Kilian and Nielson, 1971; Campbell *et al*., 1974; Siddiqui *et al*., 1973; Raworth, 1984). It is concluded that the development threshold temperature of each insect biotype, insect population or insect stage may vary in specified environmental condition.

Table 1: Mean biological durations, reproduction and intrinsic rate of increase of turnip aphid on oilseed *Brassica*

| | *B. campestris* (Toria-A) | *B. juncea* (Bard-1) | *B. napus* (Wester) | *B. carinata* (Peela raga) |
|---|---|---|---|---|
| 1st instar | 25.800 ± 1.58a | 19.800 ± 1.58c | 20.400 ± 1.58bc | 24.600 ± 1.58ab |
| 2nd instar | 22.800 ± 1.88 | 21.600 ± 1.88 | 17.400 ± 1.88 | 21.600 ± 1.88 |
| 3rd Instar | 24.000 ± 2.09 | 19.800 ± 2.09 | 23.400 ± 2.09 | 24.000 ± 2.14 |
| 4th Instar | 29.400 ± 2.47 | 30.000 ± 2.47 | 28.800 ± 2.47 | 30.316 ± 2.53 |
| Pre. Rep. Time | 15.900 ± 2.65 | 18.900 ± 2.65 | 18.300 ± 2.65 | 21.900 ± 2.65 |
| Rep. Time | 6.368 ± 0.66b | 10.150 ± 0.64a | 9.444 ± 0.68a | 8.368 ± 0.66a |
| Post Rep. Time | 17.333 ± 2.83 | 18.600 ± 2.69 | 16.737 ± 2.76 | 22.105 ± 2.76 |
| Total Nymphs | 52.667 ± 4.90ab | 58.050 ± 4.65a | 65.667 ± 4.90a | 43.579 ± 4.77b |
| Dev. Time | 5.763 ± 0.17 | 5.750 ± 0.17 | 5.861 ± 0.17 | 6.053 ± 0.17 |
| md | 45.611 ± 2.32a | 34.300 ± 2.20b | 46.833 ± 2.32a | 32.789 ± 2.26b |
| $r_m$ | 0.509 ± 0.03a | 0.445 ± 0.02b | 0.473 ± 0.02ab | 0.426 ± 0.02b |

Means in the same row followed by different letters are significantly different (p = 0.05) by Least Significant Difference Test

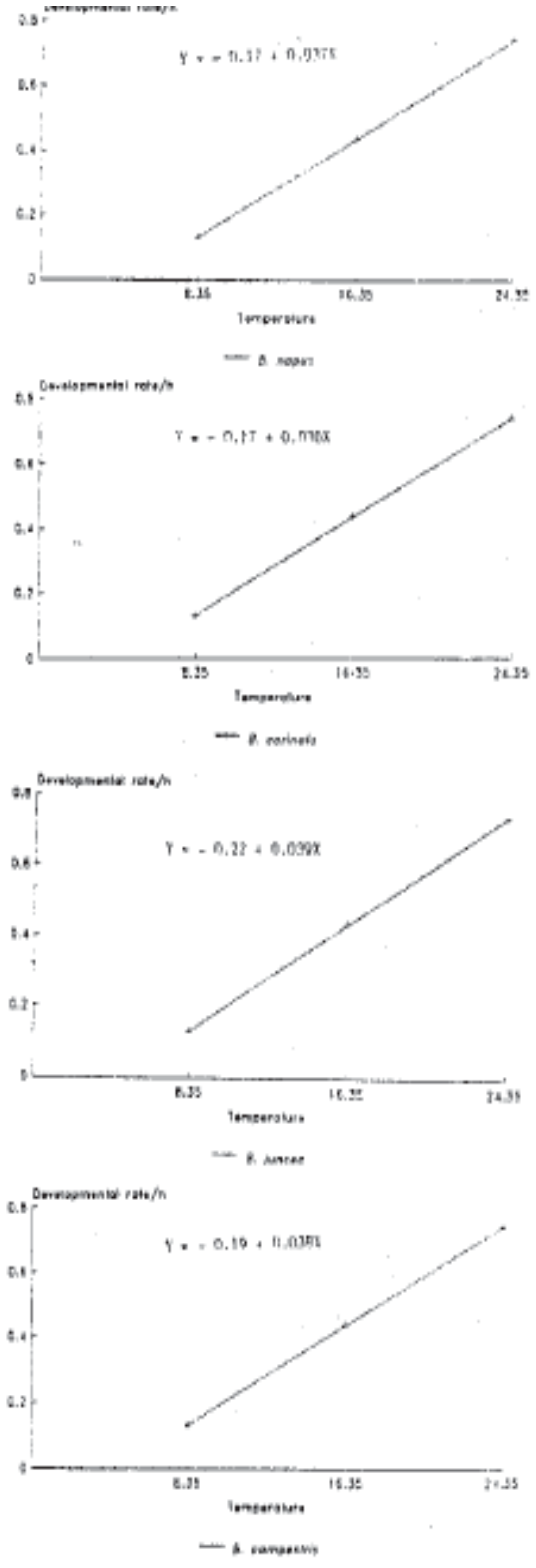


Fig. 1: The mean rate of development and development threshold temperature of turnip aphid on oilseed *Brassica* species.

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