

Calculation of the Economic Injury Level (EIL) of cabbage aphid *Brevicoryne brassicae* L(Hem.: Aphididae) on canola *Brassica napus* L. Hydromel cultivar

Hossein Noori

drhn55@gmail.com

Iranian Research Institute of Plant Protection <https://orcid.org/0000-0002-1190-6372>

Maryam Fourouzan

Agricultural and Natural Resources Research Organization: Agricultural Research Education and Extension Organization

Research Article

Keywords: Canola, cabbage aphid, EIL

Posted Date: June 17th, 2025

DOI: <https://doi.org/10.21203/rs.3.rs-6454722/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

The cabbage aphid, *Brevicoryne brassicae* is one of the important pests of canola in Iran. The aphid causes significant yield losses by feeding on plant sap, particularly affecting the inflorescence and leaves. This study aimed to determine the economic injury level (EIL) and economic threshold (ET) of this aphid on the Hydromel cultivar of canola using a randomized block design with four replicates in West Azerbaijan province during the 2016-2018. The most widely cultivated canola cultivar, Hydromel was exposed to cabbage aphid feeding under natural infestation conditions in eight treatments (Ts): (T1) seven weekly Imidacloprid SC35 at 2000 PPM sprays since the beginning of the shooting stage (aphid-free); (T2) six sprays, one week after the shooting stage; (T3) five sprays, two weeks after the shooting stage; (T4) four sprays, three weeks after the shooting stage; (T5) three sprays, four weeks after the shooting stage; (T6) two sprays, five weeks after the shooting stage; (T7) one spray, six weeks after the shooting stage; and (T8) control; Full pest presence without any insecticide, only water spraying. The mean aphid population, canola yield, and thousand-seed weight in different treatments were analyzed using Duncan's multiple range test. The regression equations were established between aphid population density and yield per square meter. Additionally, the yield loss per aphid was also estimated. The results showed that the economic injury level (EIL) of cabbage aphids in West Azerbaijan Province on the Hydromel cultivar was 6.6 aphids per 10 cm² of flowering stem per plant.

INTRODUCTION

Canola (*Brassica napus* L.) is susceptible to a wide range of damaging agents from the seedling stage through to reproductive growth. Among the most destructive insect pests affecting canola is the cabbage aphid, *Brevicoryne brassicae* L. (Keyhanian *et al.*, 2008). Insect control operations, such as using insecticides, are justified only when the insect density reaches a certain threshold. Determining this economically pest activity level, where control becomes necessary, can be challenging. As long as the pest density remains below this threshold, no control operations are needed. However, if the insect population exceeds this level, control operations are recommended. The variation in the threshold depends on the level of damage that can be tolerated. The value of the crop can be easily determined and the economic injury level (EIL) can be considered accordingly. We can easily determine both the value of the produced crop and a threshold for operations based on this economic value (economic injury threshold), which essentially forms the basis for integrated pest management recommendations in crop production. The aim of the economic injury threshold is to prevent the pest population from reaching a point where the damage could incur financial losses equivalent to the cost of control (Nick Seiter, 2018). The proposed economic threshold occurs when 25 millimeters of the cluster of flowers on the main or primary lateral stems are covered with aphids, particularly during the sensitive flowering stage (Brier, H., D. Murray, *et al.* 2008). Berlandier and Baker (2007) calculated the ET for cabbage aphid on canola as the point when more than 10 percent of canola plants harbored stems with over 25 mm of each stem infested by the pest. A study on the EIL and Loss assessment of cabbage aphid in Gaburon city, Botswana showed that the aphid density on each plant significantly decreased with an increase in the number of pesticide sprays. Additionally, a significant and inverse correlation was found between aphid density and canola yield after two weeks. Without insecticide use, yield losses exceeded 70% (Mosweu *et al.*, 2015).

Given the emphasis on reducing pesticide use and optimizing, it is crucial to measure the pest density level that causes economic damage (EIL) to prevent excessive pesticide use in the sensitive canola agroecosystem. This study was conducted to achieve this objective.

MATERIALS AND METHODS

The experiment was conducted in West Azerbaijan Province, Iran using a randomized complete block design (RCBD) with four replications under local canola farming conditions. The most widely cultivated canola cultivar, Hydromel was exposed to cabbage aphid feeding under natural infestation conditions in eight treatments (Ts) following the method applied by Obopile (2006): (T1) seven weekly Imidacloprid SC35 at 2000 PPM sprays since the beginning of the shooting stage (aphid-free); (T2) six sprays, one week after the shooting stage; (T3) five sprays, two weeks after the shooting stage; (T4) four sprays, three weeks after the shooting stage; (T5) three sprays, four weeks after the shooting stage; (T6) two sprays, five weeks after the shooting stage; (T7) one spray, six weeks after the shooting stage; and (T8) control; Full pest presence without any insecticide, only water spraying. The insecticidal sprays were made using Imidacloprid SC35 at 2000 PPM. Five canola plants were randomly selected from each plot. An upper shoot part approximately 10 cm in length was selected per plant. The number of aphids (adults and larvae) was counted and recorded one day before the insecticidal treatment (Aslam *et al.*, 2005). Yield and thousand-seed weight were assessed for all treatments after harvesting all the crops from each plot. Data were analyzed with ANOVA using SAS ver. 9.1 (SAS Institute, 2003). Regression equations were determined for relationships between yield (Y) and aphid numbers (X), and between aphid numbers (X) and yield loss percentage (%Y). The economic injury level (EIL) was calculated as the number of aphids per plant causing economic damage, using the formula by Pedigo *et al.* (1986) and colleagues:

$$EIL = C/VIDK$$

Where C is controlling cost, V is market value per unit of yield, I is injury per pest, D is damage per unit injury, and K is controlling efficacy. For piercing-sucking insects like aphids, where injury and damage are difficult to separate, the regression slope (b) represents damage per insect ($b = I \times D$) (Pedigo and Rice, 2009).

RESULTS

The combined comparison of the mean number of aphids, yield per square meter, and thousand-seed weight in different treatments during the 2017-2018 in West Azerbaijan Province is shown in Table 1. For the number of aphids, treatment 7 had the highest mean (367.88 aphids) and was in group A, while treatment 8 (no aphids) was in group F. For yield per square meter, treatments 8 and 1 had the highest means (322.29 g and 313.67 g, respectively) and were in group A, while treatment 7 had the lowest mean (225.29 g) and was in group C. For thousand-seed weight, treatment 8 had the highest mean (5.09 g) and was in group A, while treatments 6 and 7 had the lowest means (2.88 g and 2.63 g, respectively) and were in group E.

Table 1. Comparison of combined mean number of aphids, crop yield per square meter and thousand-seed weight in different treatments in canola cultivar Hydromel in West Azarbaijan 2017-2018.

Treatments	Mean number of aphids	Treatments	Crop yield per square meter (gr)	Treatments	Thousand-seed weight (gr)
7	A 367.88±27.88 ^a	8	A 363.54±15.99 ^a	8	A 5.09±0.09 ^a
6	B 289.25±10.78 ^b	1	A 346.17±6.22 ^a	1	AB 4.88±0.2 ^{ab}
5	B 278.00±27.22 ^b	2	AB 323.03±8.85 ^{ab}	2	B 4.58±0.36 ^b
4	C 219.00±37.16 ^c	3	BC 299.58±18.47 ^{bc}	3	C 3.90±0.21 ^c
3	D 116.25±13.90 ^d	4	BC 285.37±11.17 ^{bc}	4	C 3.79±0.09 ^c
2	DE 68.00±7.64 ^{de}	5	DC 269.43±15.69 ^{dc}	5	D 3.44±0.15 ^d
1	EF 31.5±10.77 ^{ef}	6	DC 262.00±18.83 ^{dc}	6	E 2.88±0.09 ^e
8	F 0.00±0.0 ^f	7	D 229.04±18.61 ^d	7	E 2.63±0.09 ^e

Means within columns followed by the same letter are not significantly different (Duncan's test, $P < 0.05$).

In 2017 in West Azerbaijan, the regression equation between aphid density (y) and canola yield (x) was defined: as $y = -0.3229x + 344.3$, with $b = -0.3229$ and $R^2 = 0.8189$ (Figure 1). A negative correlation was observed between aphid density and yield, with a coefficient of determination (R^2) of 82% in the first year.

In 2018 in West Azerbaijan, the regression equation between aphid density (y) and canola yield (x) was defined as $y = -0.2688x + 352.88$, with $b = -0.2688$ and $R^2 = 0.8533$ (Figure 2). A negative correlation was observed between aphid density and yield, with a coefficient of determination (R^2) of 85% in the second year.

The EIL for the cabbage aphid *Brevicoryne brassicae* L. on canola (Hydromel cultivar) in West Azerbaijan in 2017 was calculated using the formula by Pedigo *et al.* (1986). Results are shown in Table 2.

Table 2. Economic Injury Level (EIL) of cabbage aphid on canola Hydromel cultivar in West Azerbaijan Province, 2017.

Treatment	Aphid mean per plant	Yield mean per plant	Damage percentage	EIL (Aphids per squer centimeter of flowering stem)
1	35.00	5.68	7.34	9.04
2	60.05	5.14	16.15	4.11
3	124.75	4.76	22.35	2.97
4	202.5	4.52	26.26	2.53
5	276	4.33	29.36	2.26
6	353.75	4.23	31.00	2.14
7	370.05	3.42	42.95	1.50
8	0.00	6.13	0.00	0.00
Average				3.51
EIL				

The EIL for the cabbage aphid *Brevicoryne brassicae* L. on canola (Hydromel cultivar) in West Azerbaijan in 2018 was calculated using the formula by Pedigo *et al.* (1986). Results are shown in Table 3.

Table 3. Economic Injury Level (EIL) of cabbage aphid on canola Hydromel cultivar in West Azerbaijan Province in 2018.

Treatment	Aphid mean per plant	Yield mean per plant	Damage percentage	EIL (Aphids per squer centimeter of flowering stem)
1	28.00	5.85	2.17	34.94
2	75.05	5.61	6.18	12.30
3	107.75	5.22	12.70	5.97
4	202.25	4.99	16.55	4.58
5	235.05	4.76	20.40	3.72
6	302.05	4.50	24.74	3.07
7	365.25	4.21	29.59	2.57
8	0.00	5.98	0.00	0.00
Average				9.59
EIL				

To prevent economic damage caused by the cabbage aphid, it is essential to determine its Economic Threshold (ET). Since ET is approximately 75% of the EIL, the ET for this pest in the West Azerbaijan province was calculated to be between 2.63 and 7.19 aphids per 10 cm of flowering stem.

DISCUSSION

The Economic Injury Level (EIL) of the cabbage aphid (*Brevicoryne brassicae*) on Hydromel cultivar was determined to be 3.51 and 9.59 aphids per 10 cm of flowering stem in West Azerbaijan Province in 2017 and 2018, respectively. The variation in EIL between the two years can be attributed to differences in the aphid's damage potential during these periods. The findings of this study align with Thomas E. *et al.* (2009), who suggested that fluctuations in EIL may result from several factors, including pest density, climate, crop type and variety, growth stage, cultural practices (e.g., planting date), and particularly market value and control costs.

A close correlation was observed between the length of canola flowering stems colonized by cabbage aphids and yield, oil content, and seed weight. This relationship can be expressed by the equation: $Y = -125.87X + 1055.8$, where Y and X represents the yield (kg/ha) and length of the flowering stem colonized by aphids (in cm), respectively, with an R^2 value of 0.5778 (Harries *et al.*, 2019). In the present study, a direct and significant correlation was also found between different densities of cabbage aphids at different treatments, damage to canola yield and subsequent yield reduction.

Prasad and Phadke (1982) calculated the EIL for 70 to 110 days old crops to be 4.8 to 36.4 aphids per 30 cm of terminal shoot per plant, respectively. The EIL for 70 days old crops was somewhat similar to the results from the first year of sampling in West Azerbaijan Province.

Our findings in the first year of study in West Azerbaijan were consistent with Whaley *et al.* (2018), who established the economic injury level of cabbage aphids on rosette-stage canola at 5 aphids per leaf.

Similarly, Imtiaz *et al.* (2015) found that yield reduction in canola genotypes infested with 5, 10, and 15 aphids per plant ranged from 11.08% to 75.88%. Therefore, control measures should be implemented when aphid densities reach 5 aphids per plant during the early budding stage in various canola genotypes. These findings partially overlap with the results from West Azerbaijan Province.

The EIL is a dynamic variable that changes with crop type, market price, chemical control costs, and climatic conditions. Therefore, it is recommended that future research on the economic thresholds of key pests, be conducted in representative regions with diverse climates and widely cultivated crop varieties to establish reliable EIL and ET values for Integrated Pest Management (IPM) programs.

Declarations

ACKNOWLEDGEMENTS

The authors are sincerely thankful to the Iranian Research Institute of Plant Protection as well to the West Azerbaijan Province Agricultural and Natural Resources Research and Education Center for the financial and technical support of the project.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data Availability

The data supporting this study are openly available.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contributions

Both authors (H. Noori and M. Fourouzan) contributed equally to the preparation of this manuscript.

REFERENCES

1. Aslam, M., Razaq, M. and Shahzad, A. 2005. Comparison of different canola (*Brassica napus* L.) varieties for resistance against cabbage aphid (*Brevicoryne brassicae* L.). *International Journal of Agriculture and Biology*, **7**:781-782.
2. Berlandier, F. A. and Baker, G. J. 2007. Winter oilseeds. In: *Pests of field crops and pastures: identification and control*. (ed. PT Bailey) pp 135-154. CSIRO Publishing: Melbourne.
3. Berlandier, F. A., Severtson, D. and Mangano P. 2010. Aphid management in canola. Farmnote 440. DAFWA. Perth.
4. Brier, H., D. Murray, *et al.* 2008. "An overview of integrated pest management (IPM) in north-eastern Australian grain farming systems: past, present and future prospects." *Australian Journal of Experimental Agriculture* **48**: 1574-1593.
5. Harries, m., Seymour, m. and Micic, s. 2019. Canola yield loss to aphids, Geraldton 2015 trial report. <https://www.agric.wa.gov.au/canola/canola-yield-loss-aphids-geraldton-2015-trial-report>
6. Imtiaz, A. K., Mansoor, A., Rasheed, A., Sajjad, H., Muhammad, S., Abid, F., Ruidar, A. Sh., Waliya, F., Bismillah, S. and Mir Manzar U. D. 2015. *Journal of Entomology and Zoology Studies*; **3(6)**: 16-19
7. Keyhanian, M., Khajehzadeh, Y., Khanizad, A., and Tagadosi, M. V. 2008. The effect of planting date and varieties of canola on yield and population of the cabbage aphid, *Brevicoryne brassicae* L. *Proceeding of the 18th Iranian Plant Productions Congress*, Hamadan, Iran.
8. Mosweu, R. Obopile, M. and Tshegofatso, A. 2015. Economic injury level and yield loss assessment caused by cabbage aphid (*Brevicoryne brassicae*) on rape (*Brassica napus*). *Journal of Entomological Research* **39(2)**:101
9. Obopile, M. 2006. Economic threshold and injury levels for control of cowpea aphid, *Aphis crassivora* Linnaeus (Homoptera: Aphididae), on cowpea. *African Plant Protection* **12**: 111–115.
10. Pedigo, L. P., Hutchins, S. and Higley, L. G. 1986. Economic injury levels in theory and practice. *Annual Review of Entomology* **31**, 341-368.
11. Pedigo, L.P. and Rice, M.E. 2009. *Entomology and Pest Management*. 6th Edition. Pearson Prentice Hall.
12. Prasad, S. K. and Phadke, K. G. 1982. Yield infestation relationship and economic injury level of mustard aphid, *Lipaphis erysimi* Kalt. infesting canola crop. *Journal of Entomological Research* **6(2)**, 117-122.
13. Seiter, N., 2018. Integrated Pest Management: What are economic thresholds, and How are they developed?. <https://econpape.rs.repec.org/RePEc:ags:illufd:284360>.

14. Thomas, E., Hunt Wright, R. J. and Hein L. 2009. Economic Thresholds for Today's Commodity Values. Adapted from Proceedings of the UNL Crop Production Clinics, pp. 93-96.
15. Whaley, D., Crowder, D. and Esser, A. 2018. Identifying and Managing Insect Pests of Canola. Whashington State University Extension. [.http://css.wsu.edu/oilseeds](http://css.wsu.edu/oilseeds)

Figures

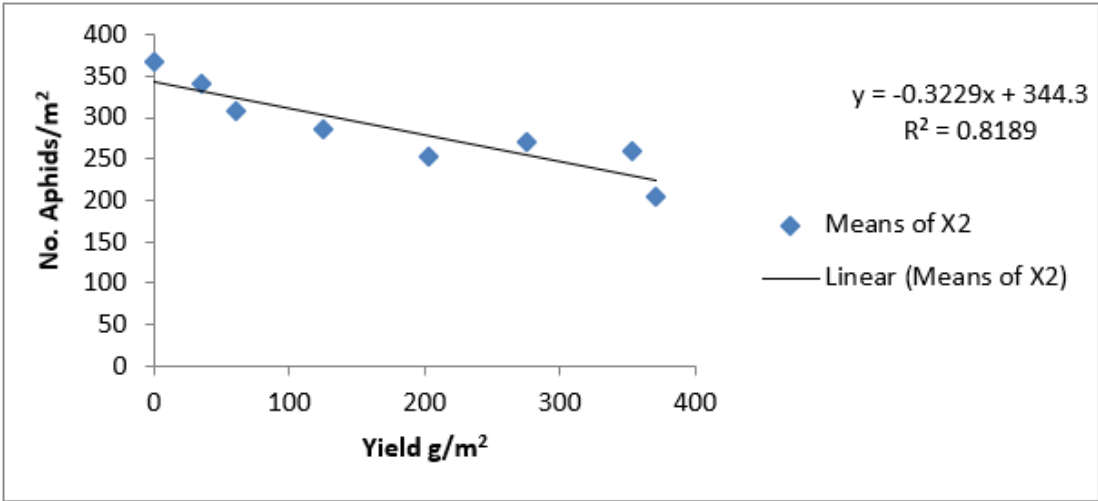


Figure 1

Linear regression of yield (g/m²) versus aphids density per square meter in West Azerbaijan Province, 2017.

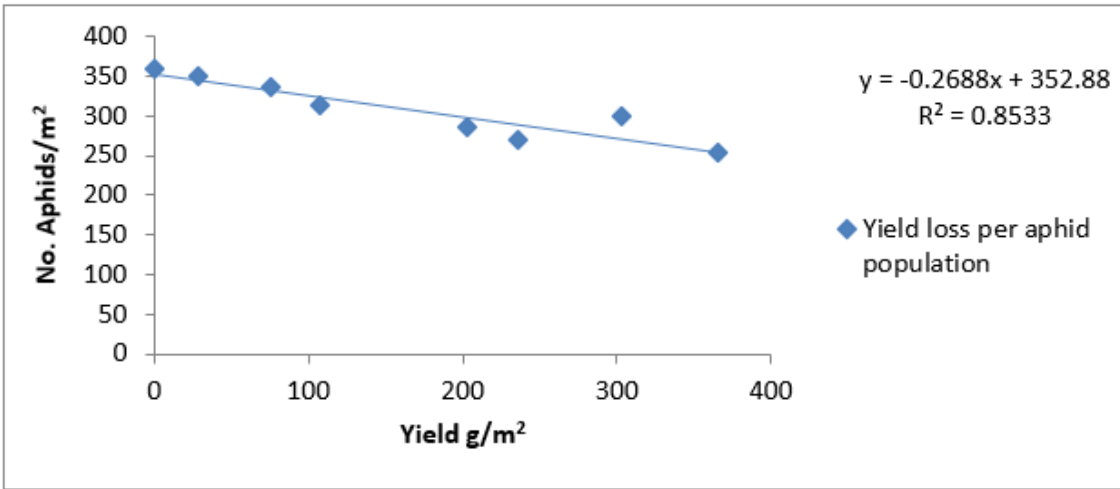


Figure 2

Linear regression of yield (g/m²) versus aphids density per square meter in West Azerbaijan Province, 2018.