



Short Communication

Estimation of economic decision levels of Aphid, *Lipaphis erysimi* (Kalt.) on Indian mustard, *Brassica juncea* (L.)

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Abstract

An experiment was conducted at the research farm of Rajasthan Agricultural Research Institute, Durgapura, Jaipur, during Rabi, 2020–21 and 2021–22, to study the estimation of economic decision levels of aphid, *Lipaphis erysimi* (Kalt.) on Indian mustard, *Brassica juncea* (L.). The highest net return (Rs. 23601 ha⁻¹) was found at the plot where aphid population obtained 8.00 aphids/five plants after the different scheduled of insecticide spray. The aphid population and seed yield had negative significant ($r = -0.977$) correlation coefficient with a regression equation $Y = 13.82 - 0.052x$ which represent yield losses from each unit of aphid density. Seed threshold, economic injury levels (EIL) and Increase rate of aphid population were calculated and found 75.38 kg ha⁻¹, 14.50 aphids per plants and 4.12 aphids per day per plant respectively. Economic threshold levels (ETL) were estimated (10.38 aphids/ plant) by deducting increase rate of aphid population from economic injury levels.

Key words: *Brassica juncea* (L.), EIL, ETL, *Lipaphis erysimi* (Kalt.), seed threshol

Introduction

Brassica juncea (L.) Czern & Coss, also known as Indian mustard, is a member of the mustard family of plants, or *Brassicaceae* (Cruciferae). Along with four other closely related cultivated species, *Brassica rapa*, *B. napus*, *B. carinata*, and *Eruca sativa*, it is referred to as rapeseed-mustard in the trade. In India, rapeseed-mustard covered an area of 13.26 million ha with productivity of 1444 kg ha⁻¹ with four major producing states are Rajasthan, Haryana, Uttar Pradesh and Madhya Pradesh (Sharma *et al.*, 2026). Rajasthan ranks first in terms of total acreage, with the crop occupying about 5.76 million hectares, accounting for 43.43% of the total area at the national level (Directorate of Economics and Statistics, 2024).

In India rapeseed-mustard accounted for an area 6.78 million hectors, production 9.12 million tonnes and yield 1345 kg ha⁻¹ with four major producing states are Rajasthan, Haryana, Uttar Pradesh and Madhya Pradesh (Anonymous, 2020-21). Rajasthan is the leading producing state with the total 4.22 million tonnes production and share of 46.28 per cent compared to all India mustard production (Anonymous, 2021). Aphid, *Lipaphis erysimi* (Kalt.) is main important pest of mustard-cultivated areas. It is estimated loss of 9-96 per cent in

crop production and a 15 per cent decline in oil production in Indian mustard-rapeseed. Its nymph and adult stages which attack vegetative buds and later spread to the entire plant are destructive. Heavy infestation causes the plant to become stunted and dry out, which prevents the formation of pods (Vishal *et al.*, 2019). The aphids also secrete honeydew on the plant's surface, which creates an ideal environment for the growth of sooty mould, which eventually impedes photosynthesis and causes a sharp decline in yield (Yadav and Singh 2016).

Economic threshold levels (ETL) are the most well-known and frequently used index when deciding how to manage pests. According to Dhaliwal and Arora (2018), it is the population density at which control measures against an expanding pest population should be started in order to prevent financial harm. The importance of economic decision levels cannot be overstated because they show when any pest situation requires action to be taken (Naga and Kumawat 2015). We can reduce the cost of control by avoiding the indiscriminate use of chemicals and reducing the number of sprays by using economic judgement. For the purpose of applying need-based insecticide, it is fundamental and imperative to understand the relationship between the pest population and the yield. One of the most crucial factors in choosing a pest

management strategy is the economic injury level (EIL) concept. The current investigations were conducted in this context to establish the EIL of aphids on rapeseed.

Materials and Methods

An experiment were conducted at the research farm of the Rajasthan Agricultural Research Institute, Durgapura, Jaipur, during *Rabi*, 2020–21 and 2021–22, to study the estimation of economic decision level of Aphid, *Lipaphis erysimi* (Kalt.). The Randomised Block Design (RBD) used for eight treatments each replicated three times to grow the Varuna (T-59) variety with the Row to row and plant to plant distances were kept at 30 cm and 10 cm, respectively, for the plot's size of 4.0 x 3.0 m². The crop was alternately sprayed with dimethoate 30 EC and malathion 50 EC @ 0.03 and 0.05% until it reached the necessary stage as specified in the treatments. Every time a single spray is mentioned in the treatment (Table 1.), dimethoate 30 EC was used. At regular intervals as stated in the treatments, the spray was repeated. At weekly intervals, the top 10 centimetres of the tagged plants aphid populations were counted. When the crops were harvested from each plot, the seed yield was noted.

The cost of insecticides and the gross return per hectare were taken into account when calculating the benefit cost ratio of each treatment. For convenience in the subsequent algorithm of EIL, the regression coefficient (Ordinary least square estimates) between the population levels and yield parameter was calculated using the equation (Acharya and Madnani 1988).

$$\text{Regression coefficient (b)} = \frac{\sum xy - \frac{\sum x \sum y}{N}}{\sum x^2 - \frac{(\sum x)^2}{N}}$$

$$\text{Intercept on y} = a = \frac{\sum y}{N} - b \frac{\sum x}{N}$$

$$Y = a - bX, \quad \text{where}$$

Y = Yield (q/ha)
X = Number of aphids per plant

Using the approach recommended by Johnson and Bishop (1987) and Pedigo (1989), the Seed threshold and economic injury level (EIL) were calculated, taking into account the reduction in yield caused by various levels of aphid density.

$$\text{Seed threshold (kg ha}^{-1}\text{)} = \frac{\text{Management cost (Rs ha}^{-1}\text{)}}{\text{Market value of the produce (Rs kg}^{-1}\text{)}}$$

$$\text{EIL} = \frac{\text{Seed threshold (kg ha}^{-1}\text{)}}{\text{Regression coefficient}}$$

Table 1: Insecticides spray scheduled with different treatments.

Treatments	Treatments with Spray Scheduled
T ₁	One spray at initiation of aphid population
T ₂	Two sprays (T ₁ + Second spray after 15 days of T ₁)
T ₃	Three sprays (T ₁ + Two subsequent sprays at the interval of 15 days)
T ₄	Four sprays (T ₁ + Three subsequent sprays at the interval of 15 days)
T ₅	Three sprays (As in the T ₄ except T ₁)
T ₆	Two sprays (Last two sprays of T ₄)
T ₇	One spray (Last spray of T ₄)
T ₈	Untreated control

Results and Discussion

Aphid population at different insecticide spray schedules and net returns

During the studied estimation of economic decision levels Pooled data *Rabi*, 2020-21 and 2021-22, revealed that maximum increase of yield over untreated control was found in the levels of 8.00 aphids/five plants (5.62 q ha⁻¹). This levels of increased with 15.25, 20.63, 48.31, 54.74, 88.68 and 90.36 aphids/five plants and increase of yield over untreated control as 5.34, 5.24, 3.86, 3.72, 0.54 and 1.14 q ha⁻¹. Minimum increase of yield over untreated was found in the level of 88.68 aphids/five plants (0.54 q ha⁻¹).

Maximum gross returns of different aphid population over untreated control was found 8.00 aphids/five plants (Rs. 27257 ha⁻¹) followed by 15.25 aphids/five plants (Rs. 25899 ha⁻¹). Total cost of expenditure were include various type of insecticide and labor cost which range from 862 to 3656 (Rs ha⁻¹) the minimum in 88.68 and maximum in 8.00 aphids/five plants. Maximum net returns of different aphid population over untreated control was found 8.00 aphids/five plants (Rs. 23601 ha⁻¹) followed by 15.25 aphids/five plants (Rs. 23105 ha⁻¹). Minimum net returns found over aphid population 88.68 aphids/five plants (Rs. 1757 ha⁻¹). Maximum incremental cost benefit ratio (ICBR) was (9.10) derived from T₂ at 48.31 aphids/five plants, followed by T₆ (8.74) at 54.74 aphids/five plants and T₅ (8.31) at 20.63 aphids/five plants. Minimum incremental cost benefit ratio was (2.04) derived from T₇ at 88.68 aphids/five plants followed by T₁ (4.58) at 90.36 aphids/five plants and T₄ (6.46) at 8.00 aphids/five plants (Table: 2.).

Table 2: Net returns at different population densities of mustard aphid (*Lipaphis erysimi*) (Kalt.) (Pooled of Rabi 2020-21 and 2021-22)

Aphid/ five plants	No. of spray	Yield (q/ha ⁻¹)	Increase in yield (q ha ⁻¹)	Returns of increased yield (Rs ha ⁻¹)*	Total cost of expenditure (Rs ha ⁻¹)**	Net profit (Rs ha ⁻¹)	ICBR
90.36	1	8.80	1.14	5529	991	4538	4.58
48.31	2	11.52	3.86	18721	1853	16868	9.10
15.25	3	13.00	5.34	25899	2794	23105	8.27
8.00	4	13.28	5.62	27257	3656	23601	6.46
20.63	3	12.90	5.24	25414	2731	22683	8.31
54.74	2	11.38	3.72	18042	1853	16189	8.74
88.68	1	8.20	0.54	2619	862	1757	2.04
128.65	-	7.66	-	-	-	-	-

Ordinary least square (OLS) estimation of two variables in simple linear regression

In ordinary least square (OLS) find the relationship between two variables is liner whole range under condition. Similar relationship was evident between aphid population per five plants and the seed yield of mustard. The correlation coefficient analyzed which was negative significant ($r = -0.977$) between the aphid population and seed yield of mustard.

A regression equation $Y = 13.82 - 0.052x$ was derived from aphid population and seed yield of mustard which represent yield losses from each unit of aphid density (Fig 1). The regression equation indicates that 13.82 is the intercept and presence of one aphid per plants was responsible of seed yield losses @ 0.052 q ha⁻¹. The

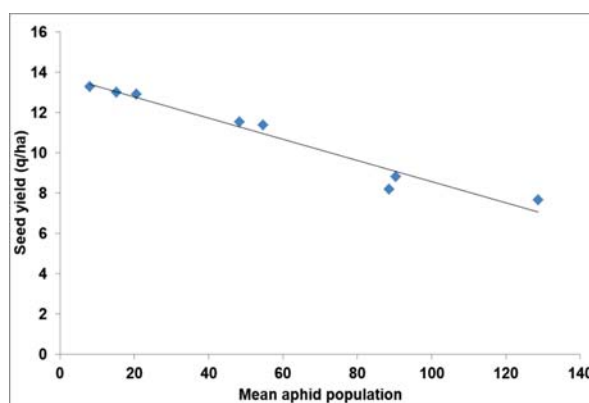


Fig. 1. Linear relationship between seed yield and mean aphid population

Table 3: Ordinary least square (OLS) estimates of parameters of two variable simple linear regressions ($Y = \hat{a} + \hat{a}X$) (On the basis of pooled of Rabi, 2020-21 and 2021-22)

S. No.	X	Y	X ²	Y ²	YX	X(X-x)	Y(Y-2)	x ²	y ²	xy	v	E(Y-v)
T ₁	90.36	8.80	8164.93	77.44	795.17	33.53	-2.04	1124.43	4.17	-68.49	9.12	-0.32
T ₂	48.31	11.52	2333.86	132.71	556.53	-8.52	0.68	72.55	0.46	-5.77	11.31	0.21
T ₃	15.25	13.00	232.56	169.00	198.25	-41.58	2.16	1728.69	4.65	-89.70	13.03	-0.03
T ₄	8.00	13.28	64.00	176.36	106.24	-48.83	2.44	2384.12	5.94	-119.02	13.40	-0.12
T ₅	20.63	12.90	425.60	166.41	266.13	-36.20	2.06	1310.26	4.23	-74.48	12.75	0.15
T ₆	54.74	11.38	2996.47	129.50	622.94	-2.09	0.54	4.36	0.29	-1.12	10.97	0.41
T ₇	88.68	8.20	7864.14	67.24	727.18	31.85	-2.64	1014.58	6.98	-84.17	9.21	-1.01
T ₈	128.65	7.66	16550.82	58.68	985.46	71.82	-3.18	5158.47	10.13	-228.58	7.13	0.53
Total	454.62	86.74	38632.38	977.34	4257.89	0.00	0.00	12797.46	36.86	-671.32	86.92	-0.18
Mean	56.83	10.84										

Table 4: Correlation and regression coefficient between aphid, *Lipaphis erysimi* (Kalt.) population and seed yield of mustard (On the basis of pooled of Rabi, 2020-21 and 2021-22)

Aspect	Correlation coefficient (r)*	Regression equation ($Y = \alpha + \beta x$)**	Coefficient of determination (R ²)
Aphid population v/s seed yield	-0.977	13.82-0.052x	0.96

economics of treatments were showed that height net return of Rs 23601 ha⁻¹ was obtained from aphid population minted at 8.00 per five plants. The decreasing trend was evident when aphid density increased (Table 3 and 4).

Seed threshold, EIL and ETL

Seed threshold was calculated on the base of current market whole sale price of mustard seed (48.50 kg⁻¹) and management cost (Rs 3656 ha⁻¹) which come to be 75.38 kg ha⁻¹. The economic injury levels (EIL) were calculated by used to regression coefficient which comes to be 14.50 aphids per plants. Increase rate of aphid population was mathematically calculated and found 4.12 aphids per day per plant, on the base of peak mean aphid population. Economic threshold levels (ETL) were estimated (10.38 aphids/ plant) by deducting increase rate of aphid population from economic injury levels (Table 5). As per available literature plenty of research works have been done by various researchers in which we found some results that Bath and Singh (1989), Begum (1995), Dutta (1992) and Singh and Malik (1998) studied of *Lipaphis erysimi* (Kalt.) and workout ETL on the base of formula given present studied. Present findings economic injury levels are similar to Prasad and Phadke (1982) was found EILs of *Lipaphis erysimi* (Kalt.) on mustard 4.8, 24.2, 23.1, 39.4 and 36.4 aphid/20 cm of inflorescence. Kunvarji (1991) also found similar result to present findings EIL and ETL of mustard aphid *Lipaphis erysimi* (kalt.) on different treatments i. e. EIL were 12.54, 11.26, 18.21, 11.55, 16.06 and 14.60 aphids/twig.

ETL were 7.75, 6.47, 13.42, 6.76, 11.27, 9.81 aphids/twig. Jeevan (2002) calculate ETL of aphid, *Uroleucon compositae* on safflower with different treatments scheduled and used to highest benefit cost ratio (12.79) ETL was 17.08 aphids per ten centimetres shoot per umbel, was similar to present findings. Khedkar (2004) and Karuppaiya (2007) were studied of ETL on aphid, *Uroleucon compositae* on safflower and aphid, *Hyadaphis coriandri* (Das) on coriander with different treatments scheduled respectively. Found Benefit cost

ratio (5.21 to 11.35) and (8.38 to 14.79) respectively. Used to highest benefit cost ratio and the one previous to calculate ETL were 14.45 and 21.59 respectively and average was 18.02 aphids per ten centimetre shoot per umbel found by Khedkar (2004) and ETL were 22.15 and 29.61 respectively and average was 25.88 aphids per ten centimetre shoot per umbel found by Karuppaiya (2007). Those findings were similar to present findings. Samota *et al.* (2014) studied on *Aphis craccivora* (Koch), Samota *et al.* (2014) studied *Myzus persicae* (Sulz.) on cumin, *Cuminum cyminum* (Linn.) and Naga and Kumawat (2015) aphid, *Acyrtosiphon pisum* (Harris) population and seed yield of fenugreek were estimated ETL. They found Seed threshold 341.5, 18.60 and 94.72 kg ha⁻¹, EIL were 24.9, 7.15 and 9.48 aphids per central shoot, ETL were 21.10, 3.74 and 5.18 aphids per central shoot. Those findings were collaborated with present findings. Regar *et al.* (2016) studied aphid, *Aphis craccivora* (Koch) on cowpea, *Vigna unguiculata* (Linn.) Walp and Swami (2018) studied aphid, *Hyadaphis coriandri* (Das) in Coriander, *Coriandrum sativum* (Linn.) with different treatments scheduled to determine the economic threshold levels respectively. On the base of highest cost of management (Rs 2136 and 3656/ ha), seed threshold (213.60 and 69.46 kg ha⁻¹), EIL (16.18 and 15.45) and ETL (14.63 and 8.42) were workout respectively. They support present findings.

Conclusion

Seed threshold was calculated on the base of current market whole sale price of mustard seed (Rs 48.50 kg⁻¹) and management cost (Rs 3656 ha⁻¹) which arrived to 75.38 kg ha⁻¹. The economic injury levels (EIL) were calculated by used to regression coefficient which comes to be 14.50 aphids per plants. Increase rate of aphid population was mathematically calculated and found 4.12 aphids per day per plant, on the base of peak mean aphid population. Economic threshold levels (ETL) were estimated (10.38 aphids/plant) by deducting increase rate of aphid population from economic injury levels.

Table 5: Gain threshold, economic injury level (EIL) and economic threshold level (ETL) of aphid, on mustard (On the basis of pooled of Rabi, 2020-21 and 2021-22)

S.N.	Treatments	Management cost at varying prices (Rs ha ⁻¹)	Seed threshold (kg ha ⁻¹)	EIL (aphid/plants)	Increase in rate of population of aphid /days	Economic threshold level (aphid/ plant)
1*	T ₄	3656	75.38	14.50	4.12	10.38
2**	T ₄	4021.60	82.92	15.95	4.12	11.83
3**	T ₄	4387.20	90.46	17.40	4.12	13.28

* EIL calculated at current prices of insecticides and labour cost** EIL calculated at 10 and 20 per cent higher prices of insecticides and labour cost

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