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Seasonal build-up and post-spray resurgence of mustard aphid, *Lipaphis erysimi* (Kaltenbach) in protected and unprotected Indian mustard in middle Gujarat

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Abstract
The weekly build-up of the mustard aphid, *Lipaphis erysimi* (Kaltenbach), was recorded in an unprotected and an insecticide-protected plot of Indian mustard (cv. GDM 4) at Anand, Gujarat, during *rabi* 2024-25 and 2025-26. Five plants per plot were scored each week on a 0-5 aphid index. In the unprotected plot, the aphid was first recorded 2-5 weeks after sowing (WAS), all sampled plants were infested from 6-8 WAS onwards, and the population peaked at an index of 3.4 in the second week of February 2024-25 (12 WAS) and 2.8 in the first week of February 2025-26 (10 WAS), declining sharply before harvest. In the protected plot, the index never exceeded 1.4. Every spray that cleared the aphid (four of the five aphid-period sprays) was followed by recolonisation, the index returning to 0.8-1.4, with 80-100 per cent of plants infested, within two weeks of the post-spray observation, so that the population had recovered by the time the next spray was due. The seasonal mean index was 1.19 and 1.20 in the unprotected plot against 0.33 and 0.37 in the protected plot, and protection reduced the area under the aphid-index curve by 75.00 and 70.39 per cent in the two seasons. The unprotected plot carried a significantly higher aphid load in both years (paired *t* test, $p \leq 0.01$). The critical period of aphid build-up in middle Gujarat falls from mid-January to the third week of February, and a fixed three-week spray interval permits rapid resurgence, pointing to the need for monitoring-based timing of aphid sprays.

Keywords: *Brassica juncea*, aphid index, population dynamics, resurgence, spray interval, area under pest curve

Introduction
Indian mustard, *Brassica juncea* (L.) Czern. & Coss., is the principal *rabi* oilseed crop of India. Among its insect pests, the mustard aphid, *Lipaphis erysimi* (Kaltenbach), is the most damaging. Protection against this aphid has been shown to prevent 10.2 to 61.1 per cent loss in seed yield across *B. juncea* cultivars [1], and losses of up to 15 per cent in oil content have been recorded under heavy infestation [2]. Increasing aphid intensity progressively lowers the seed yield, oil content and oil yield of the crop [3].

The timing of aphid build-up differs between regions. At Jobner, Rajasthan, the aphid appeared in the last week of December and peaked in the 6th standard meteorological week (SMW) [4], whereas at Kanpur, Uttar Pradesh, it appeared in the first week of January at flowering and peaked in the 7th SMW [5]. At Mandor, Rajasthan, infestation began in the 51st SMW and peaked in the 4th SMW [6], and at Meerut, Uttar Pradesh, the aphid appeared in the 51st standard week, peaked in the 5th and declined by the 9th [7]. Patel *et al.* [8] identified the third week after aphid appearance, at the flowering stage, as the critical period of crop exposure and advised that control should begin before flowering. Such information is location-specific, and week-by-week records for middle Gujarat are limited.

In farmers' fields, aphid sprays are often applied on fixed calendar dates. How quickly the aphid recolonises a crop between such sprays has received little attention, although it directly decides whether the spray interval is adequate. The present study, therefore, documented the weekly build-up of *L. erysimi* in an unprotected and a protected mustard crop over two seasons, with particular attention to its resurgence after each spray.

Materials and Methods
Experimental site and crop
The study was conducted at the Research Farm of the Medicinal and Aromatic Plants Research Station, Anand Agricultural University, Anand, Gujarat, during *rabi* 2024-25 and 2025-26. Mustard cv. GDM 4 was sown on 14 November 2024 and 17 November 2025 at 45 × 15 cm spacing and harvested on 4 March 2025 and 9 March 2026, respectively. The recommended agronomic practices were followed, with a fertiliser dose of 50:50:00 kg N:P_2O_5:K_2O/ha.

Treatments
Two adjacent plots of 15 × 15 m each were maintained, one unprotected (no insecticide) and one protected. The protected plot received carbofuran 3 CG @ 2000 g a.i./ha as soil application at sowing (14 November 2024; 17 November 2025), followed by foliar sprays of chlorpyriphos 20 EC @ 100 g a.i./ha (24 December 2024; 26 December 2025), quinalphos 25 EC @ 300 g a.i./ha (15 January 2025; 16 January 2026) and thiamethoxam 25 WG @ 20 g a.i./ha (4 February 2025; 6 February 2026), *i.e.*, at intervals of about three weeks.

Observations
A sampling sector of 1.35 × 1.5 m was marked within each plot. Observations were recorded every week, mostly on

Monday or Tuesday, from 1 WAS until harvest. In each plot, five plants were selected at random within the sector and each plant was scored on the 0-5 aphid index of Bakhetia and Sandhu [9], where 0 = healthy plant with no aphids; 1 = normal growth, no curling or yellowing of leaves, only a few aphids with little or no injury (up to 20 aphids per plant); 2 = curling and yellowing of a few leaves, small colonies on a few twigs (20-100 aphids); 3 = stunted growth, curling and yellowing of leaves, colonies on almost all twigs (100-200 aphids); 4 = very poor growth, heavy curling and yellowing, very heavy population on all parts of the plant (200-400 aphids); and 5 = complete drying of plants due to heavy infestation (more than 400 aphids). The weekly aphid index of a plot was the mean of the five plants, and a plant with an index of 1 or more was counted as infested. In the spray weeks, the protected plot was observed after the spray. Observation weeks are expressed as weeks after sowing (WAS) together with the calendar month-week.

Data analysis

The 15 weeks common to both plots (1-15 WAS) were used for comparison; the final protected-plot reading, taken at harvest, had no matching unprotected reading and was excluded. For each week, the plant-wise index values of the two plots (five plants each) were compared by the exact Mann-Whitney *U* test. The seasonal difference between plots was tested by a paired *t* test on the weekly mean indices, using the weeks in which aphids were recorded in at least one plot, and confirmed by the Wilcoxon signed-rank test. The total aphid load of a season was expressed as the area under the aphid-index curve (AUC, index-weeks), calculated by the trapezoidal rule. The per cent reduction in the protected plot was calculated as $[(U - P) / U] \times 100$, where U and P are the values for the unprotected and protected plots. Analyses were done in Python (SciPy library), with significance judged at $p < 0.05$.

Results and Discussion

Aphid build-up in the unprotected crop

In 2024-25, the aphid was first recorded at 5 WAS (third week of December) at a low index (0.2). The population remained low until 7 WAS, then rose steadily from 1.2 at 8 WAS to a peak of 3.4 at 12 WAS (second week of February), an average rise of about 0.55 index units per week (Table 1, Fig. 1a). All five sampled plants were infested continuously from 8 to 14 WAS (Fig. 2a). The index stayed at 3 or above for two weeks (12-13 WAS) and then fell to 1.8 at 14 WAS and 0.4 at 15 WAS as the crop matured.

Table 1: Weekly aphid index (mean ± SE, n = 5 plants) of *Lipaphis erysimi* in unprotected and protected mustard (*rabi* 2024-25 and 2025-26)

WAS	2024-25				2025-26			
	Month-week	Unprotected	Protected	p	Month-week	Unprotected	Protected	p
1	Nov-3	0.0 ± 0.00	0.0 ± 0.00	–	Nov-4	0.0 ± 0.00	0.0 ± 0.00	–
2	Nov-4	0.0 ± 0.00	0.0 ± 0.00	–	Dec-1	0.2 ± 0.20	0.0 ± 0.00	0.690
3	Dec-1	0.0 ± 0.00	0.0 ± 0.00	–	Dec-2	0.4 ± 0.24	0.0 ± 0.00	0.421
4	Dec-2	0.0 ± 0.00	0.0 ± 0.00	–	Dec-3	0.2 ± 0.20	0.2 ± 0.20	1.000
5	Dec-3	0.2 ± 0.20	0.0 ± 0.00	0.690	Dec-4	0.4 ± 0.24	0.4 ± 0.24	1.000
6	Dec-4	0.4 ± 0.24	0.0 ± 0.00	0.421	Jan-1	1.0 ± 0.00	0.0 ± 0.00	<0.01*
7	Jan-1	0.4 ± 0.24	0.0 ± 0.00	0.421	Jan-2	1.4 ± 0.24	0.2 ± 0.20	0.032*
8	Jan-2	1.2 ± 0.20	0.2 ± 0.20	0.032*	Jan-3	1.8 ± 0.37	1.2 ± 0.37	0.421
9	Jan-3	1.8 ± 0.20	0.2 ± 0.20	0.016*	Jan-4	2.6 ± 0.24	0.0 ± 0.00	<0.01*
10	Jan-4	2.2 ± 0.20	0.8 ± 0.20	<0.01*	Feb-1	2.8 ± 0.20	0.6 ± 0.24	<0.01*
11	Feb-1	2.8 ± 0.20	1.4 ± 0.24	0.016*	Feb-2	2.2 ± 0.20	1.4 ± 0.24	0.095
12	Feb-2	3.4 ± 0.24	0.0 ± 0.00	<0.01*	Feb-3	2.6 ± 0.24	0.0 ± 0.00	<0.01*
13	Feb-3	3.2 ± 0.20	0.2 ± 0.20	<0.01*	Feb-4	1.6 ± 0.24	0.2 ± 0.20	0.016*
14	Feb-4	1.8 ± 0.20	1.0 ± 0.32	0.151	Mar-1	0.6 ± 0.24	0.8 ± 0.20	0.690
15	Mar-1	0.4 ± 0.24	1.2 ± 0.20	0.095	Mar-2	0.2 ± 0.20	0.6 ± 0.24	0.421

WAS = weeks after sowing; p = exact Mann-Whitney U test between plots; * significant at p < 0.05; – no aphids in either plot. Sprays in the protected plot were applied between 5 and 6 WAS (chlorpyriphos), 8 and 9 WAS (quinalphos) and 11 and 12 WAS (thiamethoxam) in both seasons.

In 2025-26, sporadic aphids appeared earlier, from 2 WAS (first week of December), but a sustained build-up began at 6 WAS (first week of January), when all sampled plants became infested (Fig. 2b). The index rose to a peak of 2.8 at 10 WAS (first week of February), dipped to 2.2 at 11 WAS, rose again to 2.6 at 12 WAS and then declined to 0.2 at 15 WAS (Table 1, Fig. 1b). Plants scoring 3 or more (100-200 aphids or above) made up 15 of 75 plant observations in 2024-25 and 12 of 75 in 2025-26 (Table 2).

In both seasons, the main build-up thus took place from mid-January to the third week of February, with the peak in the first or second week of February, roughly SMW 5-7. This agrees closely with the peaks in the 6th SMW at Jobner [4], the 7th SMW at Kanpur [5] and the 5th standard week at Meerut [7], and with the peak at about 61 days after sowing reported by Singh *et al.* [10]. The first appearance of the aphid in the second half of December in 2024-25 also matches its onset in the 51st SMW at Mandor [6] and Meerut [7], although the peak at Mandor came somewhat earlier, in the 4th SMW [6]. In 2024-25, all sampled plants were infested three weeks after the aphid was first seen, which matches the critical period of crop exposure, three weeks after aphid appearance, identified by Patel *et al.* [8]. The steep decline at the end of the season coincided with crop maturity and drying of the plants, as also observed at Meerut [7].

Table 2: Seasonal parameters of *Lipaphis erysimi* in unprotected and protected mustard

Parameter	2024-25		2025-26	
	Unprotected	**Protected**	**Unprotected**	**Protected**
First record of aphid (WAS)	5	8	2	4
Peak aphid index (WAS)	3.4 (12)	1.4 (11)	2.8 (10)	1.4 (11)
Weeks with all sampled plants infested	7	2	8	1
Plant observations with index ≥ 3 (of 75)	15	0	12	0
Seasonal mean aphid index	1.19	0.33	1.20	0.37
Reduction in seasonal mean (%)	–	71.91	–	68.89
Area under aphid-index curve (index-weeks)	17.60	4.40	17.90	5.30
Reduction in area under curve (%)	–	75.00	–	70.39
Paired t test on weekly means	t = 3.17, df = 10, p = 0.010		t = 3.29, df = 13, p = 0.006	

Seasonal mean = mean of the 15 weekly observations (1-15 WAS); WAS = weeks after sowing.

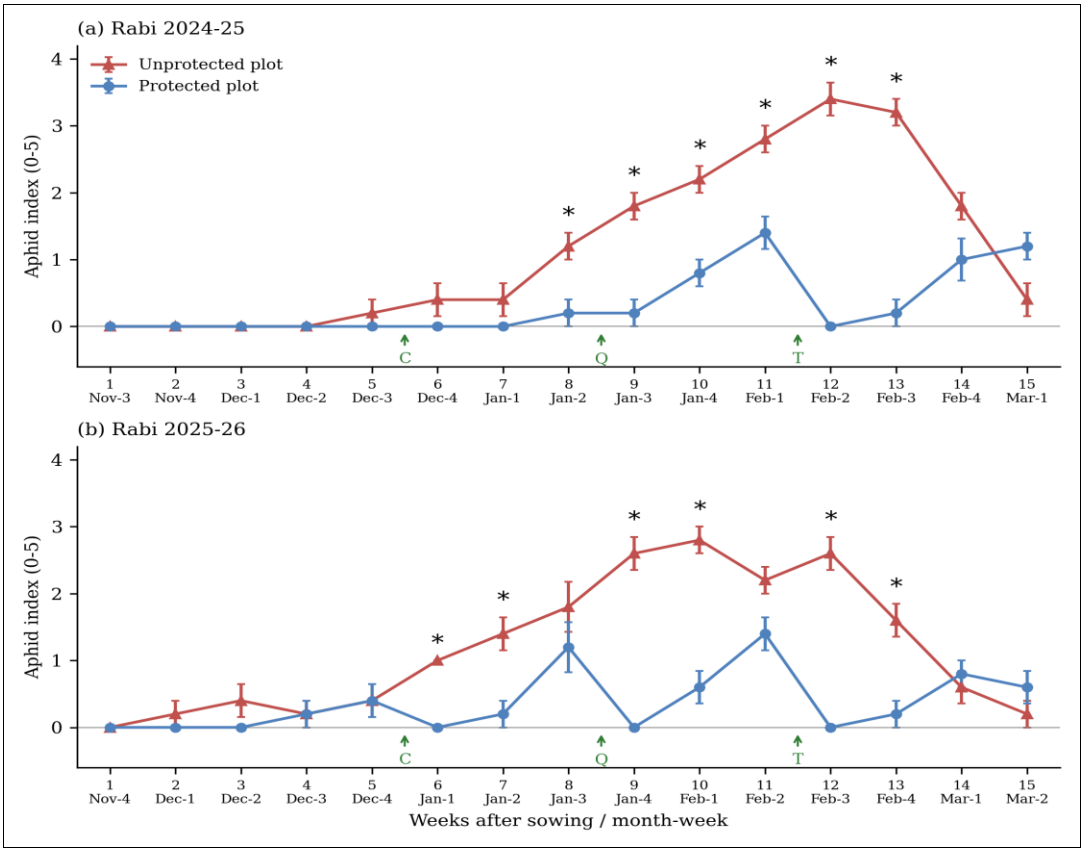


Fig 1: Weekly aphid index (mean ± SE, n = 5 plants) of *Lipaphis erysimi* in unprotected and protected mustard during *rabi* 2024-25 (a) and 2025-26 (b). Arrows mark the sprays in the protected plot (C = chlorpyriphos, Q = quinalphos, T = thiamethoxam); * = significant difference between plots (Mann-Whitney U test, $p < 0.05$).

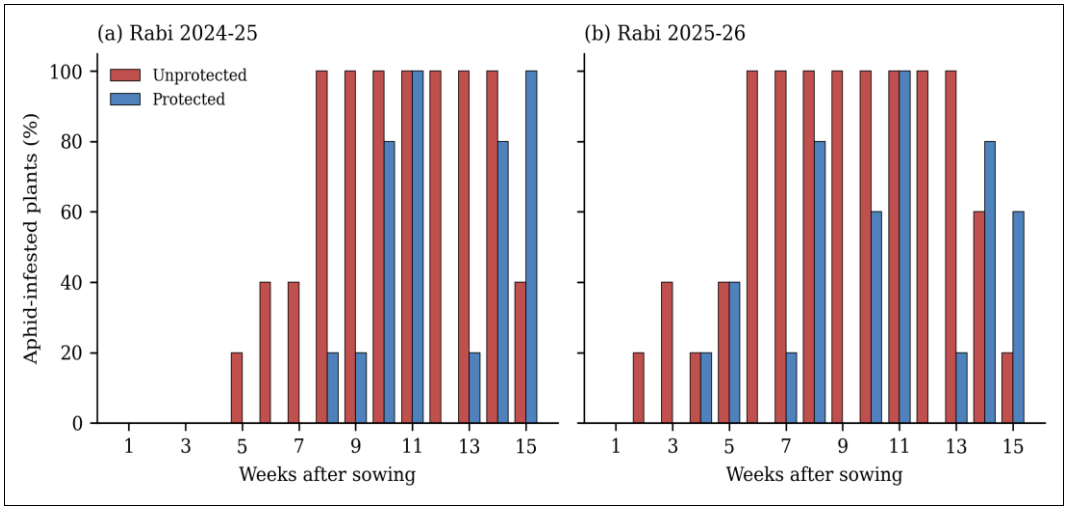


Fig 2: Weekly percentage of aphid-infested plants (index ≥ 1) in unprotected and protected mustard during *rabi* 2024-25 (a) and 2025-26 (b)

Aphid population in the protected crop and post-spray resurgence

In the protected plot, the index never exceeded 1.4 in either season (Table 1). The population, however, did not stay down. In 2025-26, each of the three sprays cleared the aphid. After the chlorpyriphos spray (26 December), the index fell from 0.4 to zero at 6 WAS and rebuilt to 1.2 by 8 WAS. After the quinalphos spray (16 January), it fell from 1.2 to zero at 9 WAS and rebuilt to 0.6 and 1.4 over the next two weeks. After the thiamethoxam spray (6 February), it again fell to zero at 12 WAS and rebuilt to 0.2 and 0.8 (Fig. 1b). In 2024-25, the aphid had not yet established in the protected plot at the time of the chlorpyriphos spray. The quinalphos spray (15 January) did not check it: the index stayed at 0.2 and then rose to 0.8 and 1.4 over the next two weeks. The thiamethoxam spray (4 February) brought it from 1.4 to zero at 12 WAS, after which it rebuilt to 0.2, 1.0 and 1.2 (Fig. 1a).

Thus, every spray that cleared the aphid was followed by recolonisation. Within two weeks of the post-spray zero reading, the index had returned to 0.8-1.4, with 80-100 per cent of plants infested, and by the time the next spray was due the population had recovered to 1.2-1.4. This rapid resurgence can be explained by the biology of the aphid: females reproduce without mating and give birth to live young, and the generations overlap, so a few survivors or immigrant winged aphids can rebuild a colony within days. Tomar *et al.* [11] observed the same pattern after thiamethoxam sprays at Meerut, where aphid numbers fell by 7 days after spraying but rose again by 10 days, and they identified resurgence as a serious problem in aphid management.

The thiamethoxam spray cleared the aphid in both seasons, consistent with reports that it is among the most effective insecticides against *L. erysimi* [1, 11]. Under south Gujarat conditions, however, thiamethoxam was only moderately effective, and flonicamid, afidopyropen and tolfenpyrad performed better [12], which suggests that rotating such newer chemistries could slow the resurgence observed here. Efficacy trials in Gujarat commonly repeat the spray 15 days after the first [12], whereas the interval in the present study was about three weeks. The aphid regained its pre-spray level within two weeks of each effective spray, so the crop was exposed to a fresh build-up during the second half of every interval. This also explains why aphid suppression in this plot (about 70 per cent) was lower than the reductions of up to 99.6 per cent reported after targeted insecticide applications [1].

Seasonal aphid load

Over the whole season, the unprotected plot carried a significantly higher aphid load than the protected plot in both years (2024-25: $t = 3.17$, df = 10, $p = 0.010$; 2025-26: $t = 3.29$, df = 13, $p = 0.006$; Wilcoxon signed-rank test $p < 0.01$ in both years). The seasonal mean index was 1.19 and 1.20 in the unprotected plot against 0.33 and 0.37 in the protected plot, a reduction of 71.91 and 68.89 per cent. The area under the aphid-index curve was 17.60 and 17.90 index-weeks without protection, against 4.40 and 5.30 index-weeks with protection, a reduction of 75.00 and 70.39 per cent, respectively (Table 2). Week-wise, the difference between plots was significant from 8 to 13 WAS in 2024-25 and at 6, 7, 9, 10, 12 and 13 WAS in 2025-26 (Table 1). It was not significant in the weeks just before a spray, when the protected plot had rebuilt its population, or near harvest, when the aphid declined in both plots.

The two seasons gave remarkably similar seasonal loads in each plot, despite a difference of about two weeks in the timing of the peak. This suggests that the total aphid pressure at the site is fairly stable from year to year, while the timing of build-up shifts with the season. Monitoring from the last week of December onwards, rather than spraying on fixed dates, would therefore help to place sprays at the start of the build-up and to repeat them before resurgence reaches damaging levels.

The study has some limitations. Each treatment was a single large plot, and the weekly observations came from five plants in one sampling sector per plot. The plants are therefore sub-samples of one plot, and the results describe the population trend at this site rather than a replicated comparison of treatments. Weather data were not recorded, so the role of temperature and humidity in the timing of the peak could not be tested. The yield of the crop was influenced by the whole insect pest complex and is therefore not reported here. Replicated trials with weather records would help to confirm the resurgence interval and to fix an economic threshold for the region.

Conclusion

In middle Gujarat, the mustard aphid built up mainly from mid-January and peaked in the first or second week of February, with all sampled plants infested for seven to eight weeks in the unprotected crop. Insecticidal protection kept the index at or below 1.4, but after every effective spray the aphid rebuilt to its pre-spray level within about two weeks. Spray schedules for this pest should therefore be based on regular monitoring from late December, with the interval between sprays kept short enough, or the chemistry rotated, to prevent resurgence during the critical period from mid-January to the third week of February.

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Conflict of interest

The authors declare no conflict of interest.

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