Annals of Bangladesh Agriculture
Journal homepage: gau.edu.bd/aba

ORIGINAL ARTICLE

Effect of sowing dates on the abundance and infestation of aphid and sawfly in mustard field

Ananna Rahman[1], Priyanka Roy[1], Md. Ruhul Amin[1], Erin Zaman[2] and Md. Shamim Hossain[1*]

[1] Department of Entomology, Gazipur Agricultural University, Gazipur 1706, Bangladesh.
[2] Department of Agronomy, Gazipur Agricultural University, Gazipur 1706, Bangladesh.

ARTICLE INFO.

Keywords:

Lipaphis erysimi, *Athalia lugens proxima*, line sowing, broadcasting, BARI Sarisha-14.

Received : 13 January 2026
Revised : 16 May 2026
Accepted : 18 May 2026
Published : 10 June 2026

Citation:

Rahman A., P. Roy, M. R. Amin, E. Zaman and M. S. Hossain. 2026. Effect of sowing dates on the abundance and infestation of aphid and sawfly in mustard field. *Ann. Bangladesh Agric.* 30(1): 117-130

ABSTRACT

Mustard (*Brassica* sp.) is an important oilseed crop in Bangladesh, often infested with aphid (*Lipaphis erysimi* (Kaltenbach)) and sawfly (*Athalia lugens proxima* (Klug)), causing significant yield loss. This study evaluated the effect of sowing dates and methods on pest infestation, growth, reproductive traits and yield of mustard (BARI Sarisha-14) at Gazipur Agricultural University from November 2022 to March 2023. Six treatments were tested: T_1 (15 November, broadcasting), T_2 (15 November, line), T_3 (1 December, broadcasting), T_4 (1 December, line), T_5 (15 December, broadcasting), T_6 (15 December, line) in a randomized complete block design with three replications. Vegetative growth was the highest in T_2 (61.4±3.7 cm height, 6.0±1.0 branches, 27.8±1.8 leaves, 62.7±2.9 mm² leaf area) and lowest in T_5 (46.8±3.3 cm, 2.0±0.0 branches, 18.6±1.1 leaves, 48.2±1.9 mm²). Reproductive traits followed the same trend. Pest infestation was lowest in T_2 (aphid 97.4±5.1 per 10 shoots; sawfly 2.7±0.2 plot^{-1}) and highest in T_5 (aphid 143.9±4.3; sawfly 4.5±0.1). Seed yield and harvest index were highest in T_2 (1.44±0.4 MT ha^{-1}, 30.0±1.3%) and lowest in T_5 (0.59±0.1 MT ha^{-1}, 24.0±1.3%). Early line sowing improved growth, reduced pest pressure, and increased yield, offering a practical strategy for sustainable mustard production in Bangladesh.

*Corresponding Author: *Department of Entomology, Gazipur Agricultural University, Gazipur 1706, Bangladesh. E-mail: shamim.ent@gau.edu.bd

https://doi.org/10.3329/aba.v30i1.87155

Introduction

Mustard (*Brassica sp.*) is a vital oilseed crop in Bangladesh that belongs to the family Brassicaceae, and contributes significantly to the national oilseed economy, meeting approximately one-third of the country's edible oil demand (Ahmed, 2008). Its seeds contain 40-45% oil and 20-25% protein, serving as a good source of dietary energy and fat-soluble vitamins (A, D, E, K), and as raw materials for industrial products such as soaps, lubricants, paints, and pharmaceuticals. The residual oil cake is widely used as livestock feed and organic fertilizer, while mustard leaves serve as a locally consumed vegetable (Ahmed, 2008). In Bangladesh, mustard is cultivated during the *Rabi* season on about 330,723 ha, producing approximately 409,659 metric tons, with an average yield of 202.85 kg ha^{-1} (BBS, 2022). Optimal growth occurs at temperatures between 12°C and 25°C, with recommended harvesting time by mid-February due to short winter season. Yield of mustard is often significantly reduced due to a prevalence of prolonged higher temperatures at crop growth stage (Wahhab *et al*., 2012).

Mustard is highly vulnerable to insect pest attacks throughout its growth cycle. Among the pests, mustard aphid (*Lipaphis erysimi*) and mustard sawfly (*Athalia lugens proxima*) are the most destructive. Aphids extract sap from leaves, stems, inflorescences, and pods, resulting in stunted growth, leaf curling, desiccation, and the development of sooty mold from honeydew deposition. They also act as vectors for plant viruses, causing substantial yield and oil losses (Sharma *et al*., 2019). On the other hand, mustard sawfly larvae skeletonize young leaves and indirectly damage plants during oviposition, particularly affecting seedlings, with measurable reductions in crop yield (Shweta *et al*., 2017; Divakaran and Babu, 2016). The abundance and diversity of insect pests fluctuate with different crop growth stages, often peaking during critical developmental phases, highlighting the need for careful monitoring and timely interventions (Afreen *et al*., 2025).

Sowing method and timing are crucial agronomic factors that influence mustard growth, yield, and susceptibility to pests. Line sowing improves plant spacing and resource use, enhancing growth, yield, and harvest index compared to broadcasting, which can result in uneven plant density and reduced performance (Aziz *et al*., 2024). Early sowing promotes vigorous vegetative growth and higher yields but may increase the risk of cold stress, whereas delayed sowing can shorten the vegetative phase, reduce seed and oil yield, and increase vulnerability to pests (Uzan *et al*., 2009). Seed yield declines progressively with each week of delayed sowing due to adverse effects on flowering, seed development, and pest exposure. Manipulation of cultural practices, particularly sowing date, is a cost-effective ecofriendly strategy to mitigate pest damage, as it can avoid peak pest activity, improve plant tolerance, and enhance recovery from insect damage without heavy reliance on chemical control, which is often unaffordable for smallholder farmers (Ahmad *et al*., 2016; Ramana *et al*., 2021). Considering the combined impact of sowing method and timing on mustard productivity and pest dynamics, the present study was undertaken to evaluate the effect of different sowing dates and methods on the abundance and infestation of aphid and sawfly in mustard fields.

Materials and Methods

Experimental location and duration

The study was conducted in the field of the Department of Entomology, Gazipur Agricultural University (GAU), Gazipur (24.04ºN, 90.4ºE; 34 m above sea level) from November 2022 to March 2023.

Treatments and experimental design

Six treatments were evaluated by combining three sowing dates (15 November, 1 December, and 15 December) with two sowing methods (line sowing and broadcasting), as follows: T_1, 15 November, broadcasting; T_2, 15 November, line; T_3, 1 December, broadcasting; T_4, 1 December, line; T_5, 15 December, broadcasting; and T_6, 15 December, line. The experiment was arranged in a two-factor Randomized Complete Block Design (RCBD) with three replications. Each plot measured 3 × 2 m^2, with 1 m spacing between plots and blocks.

Variety, seed sowing, and intercultural operations

Mustard variety BARI Sarisha-14 was used, collected from Bangladesh Agricultural Research Institute (BARI), Gazipur. The field was ploughed, leveled, and enriched with cow dung manure. Fertilizers (urea 230 kg ha^{-1}, TSP 140 kg ha^{-1}, MoP 50 kg ha^{-1}, borax 10 kg ha^{-1}) were applied at land preparation, with urea split at 0 and 45 days after sowing (DAS). Seeds were sown at 6-7 kg ha^{-1}. Line sowing used 30 cm row spacing; broadcasting was done at random. Seeds were placed at about 2 cm depth. Thinning was performed at 8 and 15 days after sowing (DAS). Irrigation was applied twice (20 and 50 DAS) with prior weeding.

Plant growth, pest assessment, and yield measurement

Plant growth (height, branches, leaf area) and reproductive traits (inflorescences, flowers, siliqua, seeds per siliqua) were recorded weekly from 10 days after sowing. Aphid and sawfly populations were monitored visually and with magnifying glass. Infestation rates were recorded at 30, 45, and 60 DAS. Seed yield, 1000-seed weight, biological yield, and harvest index were measured at maturity.

Data analysis

Data of plant growth, duration, agronomic traits, rate of sawfly and aphid infestation, yield, and harvest index (HI) were analyzed using one-way analysis of variance (ANOVA). The results were expressed as mean±SE, and differences among means were tested using Tukey's HSD post hoc test. All analyses were performed using IBM SPSS 21.0.

Results and Discussion

Phenological responses of mustard to sowing time and method

Sowing time (days after sowing) and method significantly influenced the phenological development of mustard (Table 1). Branch initiation occurred significantly earlier in mid-December sowings compared to those of early November sowings. T_3 (23.0±0.5 DAS) showed the shortest time to branch initiation, statistically similar to those of T_4, T_5, and T_6. In contrast, the longest durations were recorded in T_2 (25.6±0.7) and T_1 (25.3±0.5). These results align with the findings in *Brassica* crops where delayed sowing reduced vegetative phase length, likely due to cooler temperatures and reduced heat unit accumulation early in plant growth (Akhter *et al*., 2015).

Inflorescence initiation did not differ significantly among treatments; numerically shorter durations were observed in mid-December sowings (T_5: 25.3±1.1 DAS; T_6: 25.6±1.3 DAS) compared to those of early November sowings T_1 and T_2, a trend consistent with observations of Tripathi *et al*. (2011) who reported that later sowing compresses the period between vegetative and reproductive transitions in Indian mustard.

Days to 50 % flowering varied significantly across treatments. The shortest duration was recorded in T_5 (32.0±1.9 DAS), followed by T_6, T_3, and T_4, whereas T_2 (38.0±1.9) and T_1 (37.0±2.3) exhibited delayed flowering. Shortened flowering periods with late sowing have been similarly reported in mustard and rapeseed, suggesting that cooler environmental conditions late in the season accelerate reproductive development (Solanki and Mundra 2016).

Significant differences were also observed in days required for siliqua elongation. The earliest siliqua elongation occurred in mid-December treatments (T_5 and T_6: 38.6±1.5 DAS), which were statistically similar to those of T_3 and T_4. The longest duration was observed in November sowings (T_2: 42.6±1.5; T_1: 42.0±1.5). These results mirror the pattern seen in flowering, indicating that both the reproductive initiation and progression phases respond consistently to changes in sowing date.

The shortest maturity period was recorded in T_5 and T_6 (73.0±3.7 and 73.0±5.1 DAS, respectively), followed by T3 and T4, whereas the longest durations were in T_1 and T_2. This progressive reduction in crop duration with delayed sowing is well supported by Akhter *et al*. (2015) and Solanki and Mundra (2016), who documented that early sowing extends crop life cycle due to prolonged vegetative growth under warmer conditions, while late sowing shortens the overall crop season through quicker transition across phenological stages.

Vegetative growth responses of mustard to sowing time and method

Sowing time and method significantly influenced vegetative growth of mustard (BARI Sarisha-14) (Table 2). The tallest

Table 1. Growth and crop duration (no. of days required) of different sowing time and method of mustard grown in Gazipur region during Rabi season 2022-23

Treatment	Branch initiation (DAS)	Inflorescence initiation (DAS)	50% flowering (DAS)	Siliqua elongation (DAS)	Maturity (DAS)
T_1	25.3±0.5a	27.6±1.2a	37.0±2.3a	42.0±1.5a	84.0±4.1a
T_2	25.6±0.7a	28.0±1.5a	38.0±1.9a	42.6±1.5a	84.0±5.0a
T_3	23.0±0.5b	26.3±1.7a	35.0±1.8ab	40.3±1.5ab	78.0±3.8b
T_4	23.3±0.6b	26.6±1.4a	36.0±2.5ab	40.6±1.5ab	78.0±4.5b
T_5	23.3±0.5b	25.3±1.1a	32.0±1.9b	38.6±1.5b	73.0±3.7c
T_6	23.6±0.8ab	25.6±1.3a	33.0±2.2b	38.6±1.5b	73.0±5.1c

* DAS= Days after sowing. Means within a row followed by same letter(s) are not significantly different by Tukey's HSD posthoc statistic at < 0.05.

Here, T_1= 15 Nov. sowing in broadcasting, T_2 = 15 Nov. sowing in line, T_3 = 01 Dec. sowing in broadcasting, T_4 = 01 Dec. sowing in line, T_5= 15 Dec. sowing in broadcasting, T_6 = 15 Dec. sowing in line.

plants were observed in early November sowings, with T_2 and T_1 recording 61.4±3.7 cm and 58.1 ± 4.2 cm, respectively, while late December sowings, T_5 and T_6, produced shorter plants (46.8±3.3 cm and 47.4±4.0 cm, respectively). The number of primary branches was highest in T_2 (6.0±1.0) and T_4 (5.0±0.3) and lowest in T_5 and T_6 (2.0±0.0). Leaf number was also highest in T_2 (27.8±1.8) and T_1 (26.4±1.7) and lowest in T_5 (18.6±1.1) and T_6 (18.9±1.2). Leaf area followed this trend, with T_2 and T_1 showing larger values (62.7±2.9 mm² and 61.3±3.7 mm²) compared to those of T_5 (48.2±1.9 mm²) and T_6 (48.8 ± 1.8 mm²). Leaf trichome density did not vary significantly among treatments (33.3 to 35.3/cm²). These results indicate that early sowing enhanced vegetative growth traits, whereas late sowing reduced them.

This pattern aligns with Manjunath *et al*. (2024), who reported greater plant height and branching with early sowing in *B. juncea* genotypes, attributing this to a longer vegetative period that allows for more cell division and leaf expansion before reproductive transition. Singh *et al* (2024) similarly observed higher plant height, leaf area, and branch number in early November sowings, which they linked to optimal temperature and photoperiod during early vegetative growth, promoting faster biomass accumulation. Kumar *et al*. (2024) found that early October sowing significantly increased plant height, leaf area index, and branches, likely due to higher cumulative growing degree days allowing more extensive shoot and leaf development. Alam *et al* (2014) noted that delayed sowing shortened the vegetative phase, exposing plants to suboptimal temperatures during early growth, which limited cell division, leaf expansion, and branch formation, ultimately reducing overall vegetative growth.

Table 2. Effect of sowing date and method on plant height, branching, leaf development, and trichome number of mustard (BARI Sarisha-14) during the Rabi season 2022-23, Gazipur

Treatment	Plant height (cm) (60 DAS)	No. of primary branches (60 DAS)	Leaf number (60 DAS)	Leaf area (mm^2)	No. of leaf trichome/cm^2 (60 DAS)
T_1	58.1±4.2a	4.0±0.0b	26.4±1.7a	61.3±3.7a	35.2±1.5a
T_2	61.4±3.7a	6.0±1.0a	27.8±1.8a	62.7±2.9a	35.3±1.4a
T_3	55.2±3.8ab	4.0±0.3b	24.2±1.6a	58.7±4.2a	34.0±1.2a
T_4	55.9±4.1ab	5.0±0.3ab	26.2±1.9a	59.9±3.1a	34.1±1.1a
T_5	46.8±3.3b	2.0±0.0c	18.6±1.1b	48.2±1.9b	33.3±0.8a
T_6	47.4±4.0b	2.0±0.0c	18.9±1.2b	48.8±1.8b	33.3±0.8a

* DAS= Days after sowing. Means within a row followed by same letter(s) are not significantly different by Tukey's HSD posthoc statistic at < 0.05.

Here, T_1= 15 Nov. sowing in broadcasting, T_2 = 15 Nov. sowing in line, T_3 = 01 Dec. sowing in broadcasting, T_4 = 01 Dec. sowing in line, T_5= 15 Dec. sowing in broadcasting, T_6 = 15 Dec. sowing in line.

Reproductive growth of mustard in response to sowing time and method

Sowing time and method significantly influenced the reproductive growth and yield contributing traits of mustard (Table 3). Early November sowings produced the highest number of inflorescences per plant, with T_2 and T_1 recording 8.0±0.3 and 5.0±0.0, respectively, while mid-December sowings, T_5 and T_6, produced the fewest inflorescences (1.0±0.0 and 2.0±0.0, respectively). The number of flowers per inflorescence was also highest in early November sowings, with T_2 and T_1 showing 21.0±2.2 and 19.0±1.9, whereas T_5 and T_6 had significantly lower flower numbers (10.0±0.3 and 12.0±0.6, respectively). Similarly, the number of siliqua per inflorescence was greatest in T_2 (18.0±1.3) and T_1 (16.0±1.2), and lowest in T_5 (7.0±0.3) and T_6 (9.0±0.6). Seeds per siliqua followed the same trend, with T_2 producing 31.0±2.6 seeds and T_1 producing 27.0±2.5, whereas T_5 and T_6 produced only 11.0±0.3 and 13.0±0.6, respectively. These results are consistent with Manjunath *et al*. (2024), who reported that early sowing (second week of November) significantly increased the number of siliqua per plant and seeds per siliqua compared with delayed sowing, contributing to higher seed yield in *Brassica juncea*. The enhanced reproductive growth in early sowings is likely due to a longer vegetative phase, which allows more assimilates to accumulate and be allocated to flower and siliqua formation. Similarly, Singh *et al.* (2024) observed that early sowing dates produced higher siliqua and seed counts as key yield components under timely sowing conditions, which can be attributed to optimal temperature and photoperiod during flowering that favor pollination, fertilization, and pod development. Alam *et al*. (2014)

also found that reproductive traits such as siliquae per plant and seeds per siliqua were significantly influenced by the date of sowing, with earlier planting producing superior yield-contributing characteristics, likely because delayed sowing exposes plants to heat or light stress during the reproductive phase, reducing flower retention, pod set, and seed filling.

Sawfly infestation in mustard under different sowing times and methods

Sawfly (*Athalia lugens proxima*) abundance in mustard was significantly influenced by sowing time and method (Table 4). At 30 DAS (days after sowing), the lowest infestation was observed in T_2 (4.6±0.3 sawfly plot^{-1}) and T_1 (5.3±0.3 sawfly plot^{-1}), whereas the highest number recorded in late December sowings, T_5 (7.3±0.6 sawfly plot^{-1}) and T_6 (7.0±1.0 sawfly plot^{-1}). A similar trend persisted at 45 DAS, with early November sowings (T_1 and T_2) recording lower populations (3.6-4.3 sawfly plot^{-1}) compared to those of late sowings (6.0-6.3 sawfly plot^{-1}). By 60 DAS, sawfly populations declined to zero in all treatments, likely due to completion of larval development and reduced host suitability. The mean infestation over the growing period was lowest in T_2 (2.7±0.2 sawfly plot^{-1}) and highest in T_5 (4.5±0.1 sawfly plot^{-1}).

Lower infestation in early-sown crops can be attributed to asynchrony between crop phenology and peak pest activity; early sowings reach more advanced vegetative stages during cooler conditions, which are less favorable for sawfly oviposition and larval survival (Kapure *et al.*, 2024). Line sowing also reduced pest infestation compared to broadcasting, due to better plant spacing and aeration, which create less

Table 3. Effect of sowing date and method on reproductive growth and yield-contributing traits of mustard (BARI Sarisha-14) during the Rabi season 2022-23 in Gazipur

Treatment	No. of inflorescences/ plant	No. of flower/ inflorescence	No. of siliqua/ inflorescence	Seeds/ siliqua
T_1	5.0±0.0b	19.0±1.9a	16.0±1.2a	27.0±2.5a
T_2	8.0±0.3a	21.0±2.2a	18.0±1.3a	31.0±2.6a
T_3	4.0±0.3b	18.0±1.7a	14.0±1.1a	27.0±2.4a
T_4	6.0±0.6ab	19.0±1.8a	16.0±1.0a	29.0±1.9a
T_5	1.0±0.0c	10.0±0.3b	7.0±0.3b	11.0±0.3b
T_6	2.0±0.0c	12.0±0.6b	9.0±0.6b	13.0±0.6b

Means within a row followed by same letter(s) are not significantly different by Tukey's HSD posthoc statistic at < 0.05.

Here, T_1= 15 Nov. sowing in broadcasting, T_2 = 15 Nov. sowing in line, T_3 = 01 Dec. sowing in broadcasting, T_4 = 01 Dec. sowing in line, T_5 = 15 Dec. sowing in broadcasting, T_6 = 15 Dec. sowing in line.

favorable microclimatic conditions for pest development and may enhance natural enemy activity. In contrast, late-sown crops coincide with the pests' peak activity period, resulting in higher initial infestation (Sahu *et al*., 2025). These findings suggest that adjusting sowing dates and methods can effectively reduce sawfly pressure and minimize crop damage in mustard.

Here, T_1= 15 Nov. sowing in broadcasting, T_2 = 15 Nov. sowing in line, T_3 = 01 Dec. sowing in broadcasting, T_4 = 01 Dec. sowing in line, T_5= 15 Dec. sowing in broadcasting, T_6 = 15 Dec. sowing in line.

Significant variation was observed in sawfly infestation rate among the different treatments (Fig. 1). The highest infestation rate was recorded in T_6 (4.2±0.3%), which was statistically similar to T_5 (3.7±0.2%), T_4 (3.0±0.1%), and T_3 (3.5±0.1%). The lowest infestation rate occurred in T2 (2.3±0.0%) and was statistically comparable to T_1 (2.5±0.1%) and other early-sown treatments, except T_5 and T_6.

Aphid infestation in mustard under different sowing times and methods

Significant variation was observed in aphid infestation expressed as number of aphids per 10 apical shoots at 30, 45 and 60 DAS under different sowing times and methods (Table 5). At 30 DAS, the highest aphid population was recorded in T_5 (89.6±5.3), which was statistically similar to those of T_6 and T_3, whereas the lowest infestation was occurred in T_2 (63.1±4.1), followed by T_1 (69.2±3.5). At 45 DAS, aphid infestation increased markedly, with T_5 (169.0±10.5) and T_6 (164.9±9.1) recording the highest populations, while T_2 again showed the lowest aphid density (119.5±6.1). A similar trend

Table 4. Effect of sowing date and method on sawfly abundance in mustard (BARI Sarisha-14) during the Rabi season 2022-23 in Gazipur

Treatment	No. of sawfly plot^{-1}			
	30 DAS	45 DAS	60 DAS	Mean
T_1	5.3±0.3b	4.3±0.3b	0.0±0.0a	3.2±0.1a
T_2	4.6±0.3c	3.6±0.3b	0.0±0.0a	2.7±0.2a
$_T3$	6.0±1.0ab	5.0±1.0ab	0.0±0.0a	3.6±0.4a
T_4	5.6±0.3b	4.6±0.6ab	0.0±0.0a	3.4±0.1a
T_5	7.3±0.6a	6.3±0.6a	0.0±0.0a	4.5±0.1a
T_6	7.0±1.0a	6.0±0.6a	0.0±0.0a	4.3±0.1a

* DAS= Days after sowing. Means within a row followed by same letter(s) are not significantly different by Tukey's HSD posthoc statistic at < 0.05.

Here, T_1= 15 Nov. sowing in broadcasting, T_2 = 15 Nov. sowing in line, T_3 = 01 Dec. sowing in broadcasting, T_4 = 01 Dec. sowing in line, T_5= 15 Dec. sowing in broadcasting, T_6 = 15 Dec. sowing in line.

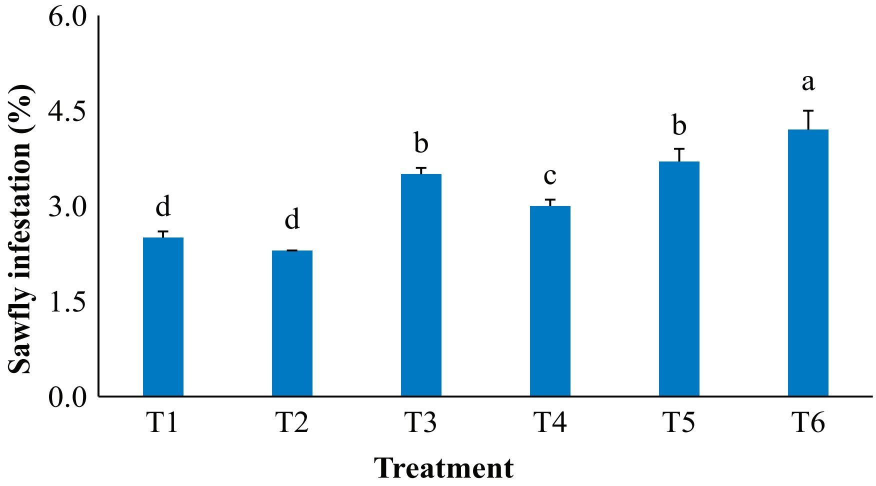

Fig. 1. Effect of different sowing times and method against sawfly infestation (%) on mustard grown in Gazipur region during *Rabi* season 2022-23.

persisted at 60 DAS, where the highest aphid populations were observed in T_5 (173.3±5.2) and T_6 (167.7±5.5), compared to the lowest infestation in T_2 (109.6±5.8). The mean aphid population across growth stages ranged from 97.4±5.1 in T_2 to 143.9±4.3 in T_5, indicating that delayed sowing substantially increased aphid pressure, while early sowing with line planting reduced infestation levels.

This pattern agrees with Mishra and Kanwat (2018), who reported that aphid incidence on mustard increases progressively with crop age and peaks during January under favorable temperature and humidity conditions. Kalita *et al*. (2016) also observed maximum aphid populations during mid to late crop stages. Ahmed *et al*. (2013) reported substantial aphid infestation on *Brassica* cultivars, while Mondal *et al*. (2003) and Rahman (2014) documented significant variation in aphid intensity among plant parts and cultivars, supporting the present findings that sowing time strongly influences aphid population buildup.

Here, T_1= 15 Nov. sowing in broadcasting, T_2 = 15 Nov. sowing in line, T_3 = 01 Dec. sowing in broadcasting, T_4 = 01 Dec. sowing in line, T_5= 15 Dec. sowing in broadcasting, T_6 = 15 Dec. sowing in line.

Significant variation was observed in rates of plant infestation by aphids at different sowing time and method of mustard (Fig. 2). The highest rate of aphid infestation was recorded in T_5 (34.9±1.5%) which was statistically similar to T_6 (33.1±1.1%). Moderate rate of infestation was recorded in T_4 (24.0±1.1%) which was statistically similar to T_3 (27.6±1.1%). The lowest rate of infestation was recorded in T_2 (15.2±0.7%) and T_1 (18.8±1.1%).

Table 5. Effect of different sowing times and method against aphid infestation on mustard grown in Gazipur region during *Rabi* season 2022-23

Treatment	Number of aphid/10 shoots			
	30 DAS	45 DAS	60 DAS	Mean
T_1	69.2±3.5c	127.0±7.6c	117.2±4.9d	104.5±6.8d
T_2	63.1±4.1c	119.5±6.1d	109.6±5.8e	97.4±5.1e
T_3	83.3±5.8ab	151.2±10.3b	164.3±7.8b	132.9±7.6b
T_4	78.2±4.2b	148.4±9.7b	156.5±6.9c	127.7±6.2c
T_5	89.6±5.3a	169.0±10.5a	173.3±5.2a	143.9±4.3a
T_6	88.3±5.2a	164.9±9.1a	167.7±5.5a	140.3±6.0a

* DAS= Days after sowing. Means within a row followed by same letter(s) are not significantly different by Tukey's HSD posthoc statistic at < 0.05.

Here, T_1= 15 Nov. sowing in broadcasting, T_2 = 15 Nov. sowing in line, T_3 = 01 Dec. sowing in broadcasting, T_4 = 01 Dec. sowing in line, T_5= 15 Dec. sowing in broadcasting, T_6 = 15 Dec. sowing in line.

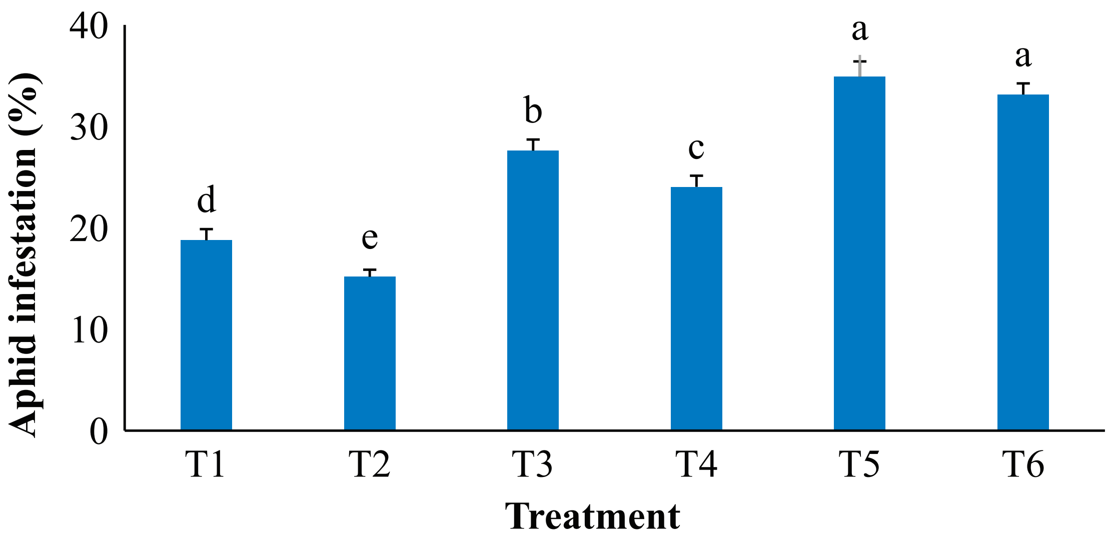

Fig. 2. Effect of different sowing times and methods on aphid infestation (%) in mustard grown in the Gazipur region during the *Rabi* season 2022-23.

Table 6. Yield and yield contributing characters of different sowing time and method of mustard grown in Gazipur during *Rabi* season 2022-23

Treatment	Seed yield/ plot (kg)	1000 seeds weight (g)	Seed yield (MT/ha)	Harvest Index /plot (%)
T_1	0.69±0.1b	2.7±0.1a	1.14±0.2ab	28.9±1.3ab
T_2	0.87±0.1a	2.8±0.1a	1.44±0.4a	30.0±1.3a
T_3	0.54±0.1c	2.3±0.1b	0.89±0.2b	27.3±2.8ab
T_4	0.64±0.1bc	2.3±0.1b	1.06±0.2ab	29.8±1.3a
T_5	0.36±0.0d	1.9±0.1c	0.59±0.1c	24.0±1.3b
T_6	0.40±0.0d	1.9±0.1c	0.66±0.2bc	26.5±1.3ab

Means within a row followed by same letter(s) are not significantly different by Tukey's HSD posthoc statistic at < 0.05.

Here, T_1= 15 Nov. sowing in broadcasting (15 Nov.), T_2 = 15 Nov. sowing in line, T_3 = 01 Dec. sowing in broadcasting, T_4 = 01 Dec. sowing in line, T_5= 15 Dec. sowing in broadcasting, T_6 = 15 Dec. sowing in line.

Yield and yield components of mustard under different sowing times and methods

The yield and yield-contributing traits of mustard were significantly influenced by sowing time and method (Table 6). Seed yield per plot ranged from 0.36±0.0 kg in T_5 to 0.87±0.1 kg in T_2, with T_2 producing the highest yield, which was significantly greater than T_5 and T_6 but statistically similar to T_1. Thousand-seed weight (TSW) was highest in T_2 (2.8±0.1 g) and T_1 (2.7±0.1 g), whereas the lowest TSW was recorded in T_5 and T_6 (1.9±0.1 g). Similarly, seed yield per hectare followed the same pattern, with T_2 producing the highest yield (1.44±0.4 MT ha^{-1}) and T_5 the lowest (0.59±0.1 MT ha^{-1}). The harvest index (HI) also differed significantly among treatments, ranging from 24.0±1.3% in T_5 to 30.0±1.3% in T_2.

The observed variation in seed yield, thousand-seed weight, and harvest index with different sowing times and methods is consistent with earlier findings. For example, Alam *et al*. (2014) reported that seed yield and yield attributes in *Brassica* were significantly influenced by sowing date under Gazipur conditions, with increased yield at earlier sowing. Manjunath *et al*. (2024) and Singh *et al*. (2024) similarly demonstrated that delayed sowing significantly reduced seed yield and yield components, including test weight, compared with early sowing.

Conclusion

The study demonstrated that both the sowing date and method significantly influence the growth, reproductive performance, pest infestation, and yield of mustard (BARI

Sarisha-14). Early sowing on 15 November combined with line planting consistently produced superior vegetative growth, higher reproductive output, reduced aphid and sawfly infestation, and highest seed yield and harvest index. In contrast, delayed sowing in mid-December, particularly with broadcasting, resulted in stunted growth, lower reproductive traits, higher pest pressure, and reduced yield. These findings indicate that optimizing sowing time and adopting line sowing is a practical, cost-effective strategy for enhancing mustard productivity while minimizing pest-related losses thereby increasing oilseed production in Bangladesh.

Acknowledgements

The authors wish to acknowledge the Research Management Wing (RMW) of Gazipur Agricultural University, Gazipur-1706 and the Ministry of Science and Technology, Bangladesh, for funding the research work.

Authors' Contributions

A. Rahman and P. Roy: Conducting research, data analysis and writing the draft manuscript; M.R. Amin and E. Zaman: Reviewing and editing the manuscript, M.S. Hossain: Designing the experiment, research supervision, reviewing and editing the manuscript.

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