

“Effect of Trap Cropping of *Brassica juncea* (Linn.) on the Management of *Lipaphis erysimi* (Kalt.) on *B. oleracea var. capitata* (Linn.)”

Abstract

Indian mustard cv. Laha 101 was used as a trap crop to manage the mustard aphid, *Lipaphis erysimi* (Kalt.) on cabbage cv. K-1 during the rabi season 2022-23. Trap cropping ratios showed significantly lower aphid densities compared to sole crop (cabbage). The lowest density of aphids (4.60 aphid/plant) was recorded in cabbage under trap cropping ratio (3:2) and peak infestation occurred (19.05 aphid/plant) on mustard of the same trap cropping ratio when compared with other trap cropping ratios on 7th SMW (February 11th). Even with highest (28.13 aphid/plant) on the sole crop (cabbage) which yielded (49.23 t/ha), with a benefit cost ratio (2.07) due to two sprays of insecticide (Malathion 50 EC), which was not done in the trap cropping ratios. Thus, trap cropping ratio (3:2) (2.31) has the best cost benefit ratio followed by the trap cropping ratio (1:1) (2.19) having second best cost benefit ratio, with recorded produce of (42.61 t/ha), (41.29 t/ha) respectively.

Keywords: Mustard aphid *Lipaphis erysimi* (Kalt.), trap crop, sole crop, *Brassica*, density, benefit Cost Ratio

INTRODUCTION

The mustard aphid, *Lipaphis erysimi* (Kalt.) (Homoptera: Aphididae) has emerged as a prominent pest of *Brassica* species in India (Yue and Liu, 2000). They have evolved to consume phloem sap rather than macerate plant tissue as chewing herbivores. Short generation durations and high asexual fertility cause a sharp rise in aphid population density (Gill *et al.*, 2013). They feed by sucking sap from its host and cause damage ranging from 50 to 100% (Andeka *et al.*, 2021). Indirect losses include sooty mold formation on honeydew secretions and transmission of plant viruses as a vector (Blackman and Eastop, 2000; Ng and Perry, 2004).

Development of insecticide resistance, and of the stimulatory effects of sublethal dosages of some insecticides on aphid reproduction (Arora 1999) along with the detection of high residues of insecticides in plant produce have exposed the limit of exclusive reliance on a broad spectrum, synthetic organic insecticides for controlling this nefarious insect (Dhaliwal and Ramesh 2001). So, considering only chemical management is not an ecological, and financially sound option.

Isolation of certain kinds of insects from the group by the trap cropping, which enables the use of biological control, selective pesticide application, a decrease in the use of treatments such as insecticides and others without affecting each other. (Hokkanen 1991).

Indian mustard is used as a trap crop for diamondback moth in cabbage fields (Srinivasan and Moorthy 1991, Ansari *et al.*, 2010). Indian mustard is used as a trap crop in cabbage fields in Guam for the control of mustard aphids (Muniappan and Maruthi 1992; Muniappan *et al.*, 1997). Indian mustard is an attractive to diamondback moths and used as a trap crop for cabbage (Charleston and Kfir 2000).

For the benefit of resource-constrained farmers, particularly in developing nations, the profitability of any agricultural production methods should be carefully viewed. Furthermore, sustainable crop production with low-cost along with ecologically safe technology must also be taken into consideration.

In this study, we assessed the advantages of Indian mustard as a trap crop on cabbage for the management of aphid.

MATERIAL AND METHODS

Field experiments were conducted to manage the *L. erysimi* on cabbage crop when trap cropped with Indian mustard in the Department of Plant Protection, Aligarh Muslim University, Aligarh during *rabi* season of 2022-2023.

Agronomical practices

Seed of cabbage cv. K-1 (150 grams) was used for growing in the nursery bed. Raised beds measuring 3 x 0.6 m with a height of 10-15 cm was prepared and the seed was broadcasted on 7th November 2022. Intercultural practices were performed: FYM well-decomposed @ 35g/m, sprinkler was used, weeding was done time to time as required and 70 cm space was maintained between two beds. The surface of the beds was maintained in smooth and levelled manner. Raised bed was maintained to minimize water logging. It was drenched with Bavistin (15-20g) to prevent the seedling mortality owing to damping off.

The field measuring 234 m² area was prepared by ploughing followed by levelling. 6 weeks-old seedlings of cabbage cv. K-1 were transplanted with spacing of 30 X 30 cm in 18 plots on 15th December 2022, along with a single crop (cabbage) with same spacing between rows and between plants in a randomized block designed (RBD) plots. Being scanty winter rainfall season, for favorable response immediate irrigation was followed right after transplantation. A week later i.e., 22nd December, booster dose (N- 4.68, P-2.92, K-3.51 kgs) was given for better growth and immediate irrigation was given for better uptake of nutrients.

After a week i.e., on 31st December 2023 Indian mustard cv. Laha 101 with a seed rate of

200grams were sown between the rows of cabbage with spacing of 15 cm in different plots as a trap crop. An immediate irrigation was given for ensuring better germination. All recommended agronomic practices and intercultural operations like gap filing, thinning and handweeding were adopted timely during the growth period of the plants and insecticide spraying was done on sole crop (cabbage).

water requirement of cabbage and mustard i.e., (cabbage 4 times), (mustard 2 times). The 2 irrigations of cabbage were given prior planting of mustard for better growth, and the remaining 2 irrigations (1st after 2nd booster dose application of fertilizer, 2nd on pod formation of mustard) was

given after planting the mustard between the rows of respective trap cropping ratio. In sole crop (cabbage) all agronomic practices including spraying were done on general schedule for ensuring better yield.

Evaluation of density of mustard aphid on different treatments of trap cropping ratios (1:1, 2:1, 3:2) in cabbage with Indian mustard

For density evaluation of mustard aphid in treatments of different trap cropping ratios, the weekly mean value data obtained from each plot by counting the number of aphids, from seven randomly chosen tagged plants per plot of each treatment and then were averaged with the sample number, replication number, and weekdays for an efficacious mean value. Comparison between the treatments for the significant difference in density of mustard aphid between the different trap cropping ratios (1:1, 2:1, 3:2) along with a sole crop (cabbage) was done by one factor analysis with an equal number of replications.

According to Dotasara *et al.* (2017), the numerical count approach was used to estimate the aphid population in cabbage.

Treatments combinations

T1 – 1:1, trap cropping ratio (aphid density on cabbage)

T2 – 1:1, trap cropping ratio (aphid density on mustard)

T3 – 2:1, trap cropping ratio (aphid density on cabbage)

T4 – 2:1, trap cropping ratio (aphid density on mustard)

T5 – 3:2, trap cropping ratio (aphid density on cabbage)

T6 – 3:2, trap cropping ratio (aphid density on mustard)

Statistical analysis

The data for the average density of aphids on each experimental unit were converted to square root values and analyzed using Fisher and Yates (1963) "Analysis of variance" approach. To measure the effectiveness of each trap cropping ratio, at a 5% level of probability, the Standard Error of Difference (S.E_d) and critical difference (C.D.) were determined.

$$(1). \text{Standard Error of Difference (S.E}_d) = \frac{\sqrt{\text{Ems}}}{r}$$

Ems (\pm) = Error mean, sum of square

r = replications number, which are equal for all treatments under comparison

$$(2). \text{Critical difference (CD)} = \text{SE}_d \times \text{table-value at 5 percent level of significance and error d.f.}$$

Least significant difference (LSD): CD values at the 5% significance level (table t-value at 5%)

Cost-effectiveness assessment of selected trap cropping ratios with a sole crop (cabbage)

Each treatment's marketable produce was gathered and weighed separately. The cost of the insecticides used in this experiment was recorded throughout the biof of 2022–2023. Pesticides were purchased from nearby markets. Treatment costs, sprayer rental costs, and labor costs for spraying were all included in the overall cost of plant protection. Two sprays took place throughout the research period, and the sum of plant protection costs was calculated. It is technically possible to calculate the B:C ratio.

Benefit Cost Ratio = Net returns / costs

Total return, equal to marketable yield \times market price / kg

The net return is calculated as Gross return minus the cost of cultivation.

RESULTS AND DISCUSSION

1) Estimation on peak stage of *L. erysimi* density on the ratios of trap planting

The density of mustard aphid in treatments of different trap cropping ratios was recorded. Miraculously, it is showing that during the 7th SMW i.e., on 11th February 2023 mean aphid population density reached peak stage in all treatments along with sole crop (cabbage). The findings of Zia and Hasseb (2019) and Kumar *et al.* (2000) support the present findings. They reported that from the 3rd SMW (January 2nd week) through the 11th standard week (March 2nd week) mustard aphid incidence was observed in the field. According to their study, the population of mustard aphid's peak stage in the 7th SMW (February). Research by Bhavani and Punnaiah (2006) also supports the recent findings. They reported that, according to seasonal variations in

the pest populations, the months of January and February are ideal for the growth for the main insect pests of cabbage. The second week of February holds the largest mustard aphid population, while the last week of March has the lowest number. Studies conducted by Ansari et al., (2007) also support the present findings in the aspect of initial incidence (January 1st week), peak stage (7th SMW), and decline phase of mustard aphid (after March 3rd week).

The trap ratio (3:2) (4.60 aphid/plant) showed its effectiveness at the peak stage (7th SMW) with lower densities of aphids on cabbage compared to other trap ratios and single crop (cabbage). The highest aphid density (19.05 aphid/plant) was found in mustard of the same trap cropping ratio when compared with other trap cropping ratios.

a) Comparison of *L. erysimi* density on cabbage in different trapping ratios

A one factorial analysis was carried out between trap planting proportions of cabbage, and it was found that in the seventh (SMW), that is, on February 11, 2023, there were significant differences in the average population density of cabbage between different treatments. On 7th (SMW) i.e., 11th February 2023, the treatment of trap cropping ratio (3:2) harbored less mean absolute mustard aphid density (4.60 aphid/plant) and shows a significant difference ($p > 0.02$) with the treatment of trap cropping ratio (1:1) (12.61 aphid/plant). treatment of trap cropping ratio (3:2) also shows a significant difference ($p > 0.03$) with the trap cropping ratio (2:1) (10.29 aphid/plant).

b) Comparison of *L. erysimi* density on mustard in different trapping ratios

A factorial analysis was carried out among different trap planting proportions of mustard, and it was found that in the seventh (SMW), that is, on February 11, 2023, there were significant differences in the average population density of mustard between different treatments. On 7th (SMW) i.e., 11th February 2023, the treatment of trap cropping ratio (3:2) harbored high mean aphid density (19.05 aphid/plant) and shows a significant difference ($p > 0.01$) with the treatment of trap cropping ratio (1:1) (11.64). treatment of trap cropping ratio (3:2) also shows a significant difference ($p > 0.01$) with the trap cropping ratio (2:1) (10.75 aphid/plant).

2) Cost-effective evaluation between different treatments of trap cropping ratios with a sole crop (cabbage)

a) Effect of insecticide treatment on the yield of cabbage

Table-5 shows the total produce data of treatments along with a sole crop (cabbage) (49.23 t/ha). Variation in production data between treatments and sole crop (cabbage) is due to Malathion 50EC spraying twice in sole crop (i.e., on 8th (SMW) (February 18th, 2023) and 9th (SMW) i.e., 11th March 2023) which was not done in the trap cropping ratios. Trap cropping ratio (3:2) had the highest cabbage production (42.61

t/ha), between different treatments of trap cropping ratios. Studies conducted by Zorempuii and Kumar (2019) supported the present findings on cost-effective evaluation between different treatments of trap cropping ratios (1:1), (2:1), and (3:2) with sole crop (cabbage). They found that the application of Malathion 50EC showed the best yield (66.66 t/ha) compared to other treatment applications for a single crop (cabbage).

b) Benefit Cost Ratio

In Comparing for benefit cost ratio between different treatments of trap cropping ratios (1:1, 2:1, 3:2) with a sole crop (cabbage). it was recorded that best benefit cost ratio (2.31) was observed in the trap cropping ratio (3:2) over trap cropping ratio (1:1) (2.19), trap cropping ratio (2:1) (2.02) and sole crop (cabbage) (2.07), even though sole crop (cabbage) was recorded the yield (49.23 t), the highest total price of the yield (1,23,075 ₹) and highest net return (83,072 ₹), while the trap cropping ratio (3:2) was recorded the yield of (42.61 t), (1,06,525 ₹) total price of the yield and (74,422 ₹) of net return.

c) Additional income generated by adopting trap cropping ratio.

The data in Table-6 on extra revenue returns beyond sole crop (cabbage), demonstrated that each trap cropping ratio (1:1, 2:1, 3:2) generated (7,700 ₹) rupees as additional income due to no application of insecticides. The campaign was carried out twice in a single crop (cabbage).

SUMMARY AND CONCLUSION

The minimum aphid density was recorded in trap cropping ratio (3:2) (5.60), when compared with trap cropping ratios (1:1) (12.61), (2:1) (10.75), and a sole crop (cabbage) (28.13) during peak aphid population stage at 7th (SMW) i.e., 11th February 2023.

Several trap cropping ratios (1:1, 2:1, 3:2) were compared with a single crop (cabbage). It was found that the ratio of trapping planting (3:2) had the highest benefit-cost ratio (2.31), higher than the ratio of trapping planting (1:1) (2.19), trapping planting ratio (2:1) (2.02) and single crop (cabbage) (2.07). The additional income return beyond a single crop (cabbage) shows that trap planting ratios (1:1, 2:1, 3:2) yielded (7,700 ₹) more due to the absence of insecticide treatment income, performed twice in a single crop (cabbage).

From the above critical studies, it was concluded that trap cropping ratio (3:2) shown the best

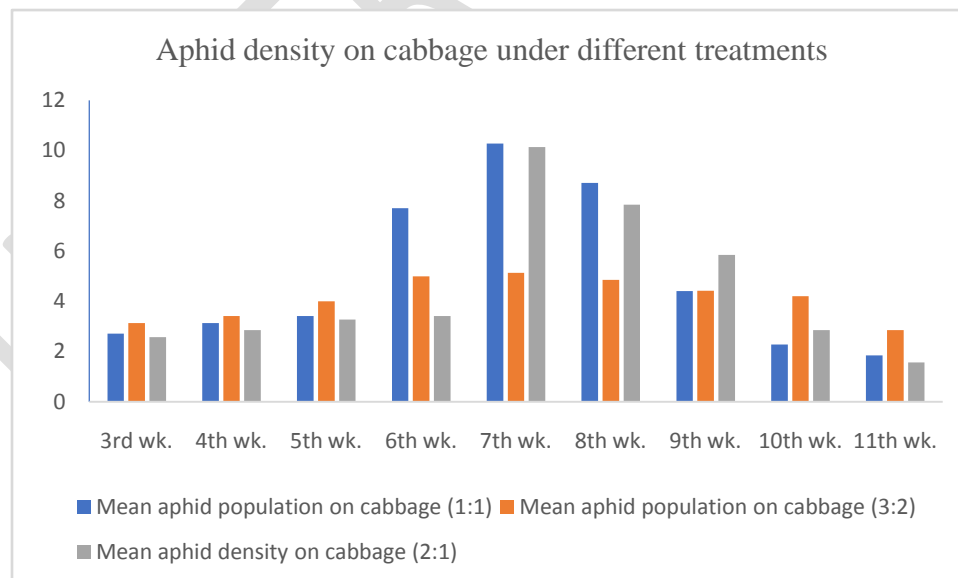
efficacy in aspects of both cost effective and management of mustard aphid, when compared with other treatments of Trap cropping ratios (1:1), (2:1) and sole crop (cabbage).

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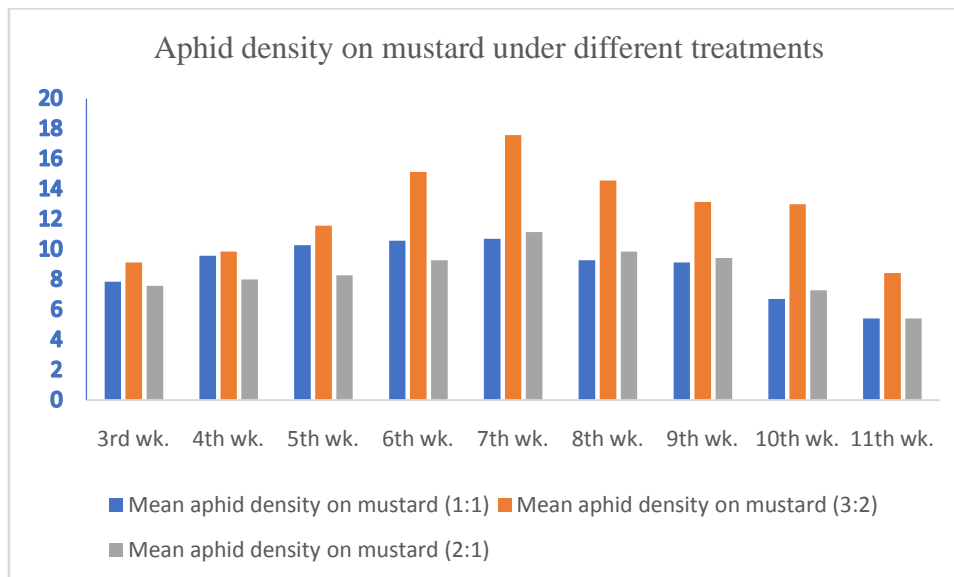


Fig 1 :Density of *L.erysimion* cabbage and mustard under different trap cropping ratios from 3rd standard week (14th January 2023) to 11th standard week (11th March 2023)

Table-1 Density of *L.erysimion* trap cropping ratios on cabbage in 2022-23

Treatments	3 rd SMW January 14	4 th SMW January 21	5 th SMW January 28	6 th SMW February 4	7 th SMW February 11	8 th SMW January 18	9 th SMW January 25	10 th SMW March 4	11 th SMW March 11
Sole crop (cabbage)	11.75 (3.42)	11.84 (3.44)	16.44 (4.05)	19.91 (4.46)	28.13^a (5.30)	20.92 (4.57)	3.47 (1.86)	2.02 (1.42)	1.17 (1.29)

Trap cropping ratio (1:1)	2.90 (1.70)	2.80 (1.67)	3.12 (1.76)	6.81 (2.60)	12.61^{ab} (3.55)	9.23 (3.03)	4.69 (2.16)	4.10 (2.02)	2.01 (1.41)
Trap cropping ratio (2:1)	3.11 (1.76)	2.71 (1.83)	3.41 (1.84)	3.25 (1.80)	10.29^{bc} (3.20)	9.42 (3.06)	5.85 (2.41)	4.54 (2.13)	2.42 (1.55)
Trap cropping ratio (3:2)	2.73 (1.65)	3.01 (1.64)	4.07 (2.01)	3.83 (1.95)	4.60^d (2.13)	3.62 (1.90)	3.71 (1.92)	3.76 (1.93)	2.84 (1.68)
C.D.					3.387				
SE (d)					1.358				
C.V.					11.952				
D.F.					4,10				

Table-2 Density of *L. erysimion* trap cropping ratios of mustard in 2022-23

Treatments	3 rd SMW January 14	4 th SMW January 21	5 th SMW January 28	6 th SMW February 4	7th SMW February 11	8 th SMW January 18	9 th SMW January 25	10 th SMW March 4	11 th SMW March 11
Trap cropping ratio (1:1)	8.57 (2.92)	8.21 (2.86)	9.68 (3.11)	10.56 (3.24)	11.64^a (3.41)	8.40 (2.89)	8.56 (2.92)	5.60 (2.36)	4.83 (2.19)
Trap cropping ratio (2:1)	8.43 (2.90)	7.60 (2.75)	8.43 (2.90)	8.67 (2.94)	10.75^{ab} (3.27)	8.50 (2.91)	8.91 (2.98)	7.82 (2.79)	4.64 (2.15)
Trap cropping ratio (3:2)	8.14 (2.85)	8.52 (2.91)	10.70 (3.27)	14.52 (3.81)	19.05^c (4.36)	13.64 (3.69)	12.49 (3.53)	11.57 (3.40)	8.63 (2.93)
C.D.					2.771				
SE (d)					0.972				
C.V.					8.615				
D.F.					3,7				

Figures in parenthesis are square root transformed values.

Figures in 7th SMW (peak stage) followed by same letters are not significantly different.

SMW (standard meteorological week)

Table-3 Multiple comparisons in density of *L. erysimion* intracropping ratios (7th SMW) on cabbage

Treatments	Density of <i>L. erysimi</i> (cabbage) in trapcroppingratio(2:1)	Density of <i>L. erysimi</i> (cabbage) in trapcroppingratio(3:2)
Density of <i>L. erysimi</i> (cabbage) in trapcroppingratio(1:1)	0.62	0.02*
Treatments	Density of <i>L. erysimi</i> (cabbage) in trapcroppingratio(1:1)	Density of <i>L. erysimi</i> (cabbage) in trapcroppingratio(3:2)
Density of <i>L. erysimi</i> (cabbage) in trapcroppingratio(2:1)	0.62	0.03*
Treatments	Density of <i>L. erysimi</i> (cabbage) in trapcroppingratio(1:1)	Density of <i>L. erysimi</i> (cabbage) in trapcroppingratio(2:1)
Density of <i>L. erysimi</i> (cabbage) in trapcroppingratio(3:2)	0.02*	0.03*

LSD= $p < 0.05^*$

Table-4 Multiple comparisons in density of *L. erysimi* in trapcropping ratios (7th SMW) on mustard

Treatments	Density of <i>L. erysimi</i> (mustard) in trapcroppingratio(2:1)	Density of <i>L. erysimi</i> (mustard) in trapcroppingratio(3:2)
Density of <i>L. erysimi</i> (mustard) in trapcroppingratio(1:1)	0.78	0.01*
Treatments	Density of <i>L. erysimi</i> (mustard) in trapcroppingratio(1:1)	Density of <i>L. erysimi</i> (mustard) in trapcroppingratio(3:2)
Density of <i>L. erysimi</i> (mustard) in trapcroppingratio(2:1)	0.78	0.01*
Treatments	Density of <i>L. erysimi</i> (mustard) in trapcroppingratio(1:1)	Density of <i>L. erysimi</i> (mustard) in trapcroppingratio(2:1)
Density of <i>L. erysimi</i> (mustard) in trapcroppingratio(3:2)	0.01*	0.01*

Trapcrop pingratio(2:1)	-NA-	-NA-	-NA-	-NA-	-NA-	-NA-
Trapcrop pingratio(3:2)	-NA-	-NA-	-NA-	-NA-	-NA-	-NA-
Sole crop(cab bage)	Malathion 50EC(5 L/ha	Malathion5 0EC(5 L/ha	700/- /L	7,000/- /10L	700/-	7,700/-

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