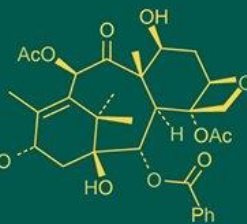
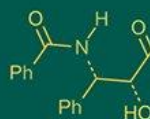


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Effect of intercropping with attractant and repellent plants on occurrence of major insect pests of cabbage

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Abstract

The present investigation was conducted to study the effect of various intercrops on the incidence of major insect pests of cabbage (*Brassica oleracea* var. *capitata* Linn.) during the *Rabi* season of 2021-22 at the Horticulture Farm of S.K.N. College of Agriculture, Jobner, Rajasthan. The experiment was laid out in a randomized block design with four replications and five treatments, viz., cabbage + tomato, cabbage + mustard, cabbage + marigold, cabbage + onion, and sole cabbage. Observations on the population of aphid (*Lipaphis erysimi* Kalt.) and diamondback moth (*Plutella xylostella* L.) were recorded weekly from their initial appearance until crop harvest. The results revealed that intercropping significantly influenced the incidence of both pests throughout the cropping season. Among all intercrop combinations, cabbage + onion recorded the lowest seasonal mean population of aphid (79.75 aphids/plant) and diamondback moth (1.29 larvae/plant), followed by cabbage + tomato (90.51 aphids/plant and 1.44 larvae/plant, respectively). The sole cabbage crop registered the highest incidence of both pests, with seasonal mean populations of 111.15 aphids/plant and 1.88 DBM larvae/plant. Peak activity of aphid and DBM was observed during the second week of February and first week of February, respectively. The suppressive effect of onion and tomato was attributed to volatile sulfur compounds and repellent volatile organic compounds that interfere with host location and oviposition behavior of pests. In terms of productivity, cabbage + onion produced the highest equivalent yield (173.72 q ha⁻¹), followed by cabbage + tomato (149.05 q ha⁻¹), both being significantly superior to sole cabbage (112.41 q ha⁻¹).

Keywords: Diamondback moth, intercrops, seasonal incidence

Introduction

Cabbage (*Brassica oleracea* var. *capitata* Linn.) is one of the most popular winter vegetables grown throughout India. It is consumed as salad, boiled vegetable, in curries, and for pickling. Cabbage is a rich source of vitamins such as A, B1, B2, and C, as well as minerals, and serves as an excellent supporting component for carbohydrates and protein. These nutrients act as natural antioxidants that help prevent heart disease and cancer. The nutritional composition of 100 g of cabbage provides 5.8 g of carbohydrates, 2.5 g of dietary fiber, 1.3 g of protein, is fat-free, and contains 36.6 mg of vitamin C (44% of the daily requirement) and 76 mg of vitamin K (72% of the daily requirement) (USFDA, 2017). According to the Ministry of Agriculture and Farmers Welfare (2025-26), the total area under cabbage cultivation in India is 438.95 thousand hectares, with an annual production of 10,496.98 thousand tonnes. In Rajasthan, the area and production under cabbage are 1.65 thousand hectares and 36.11 thousand metric tonnes, respectively. This represents a notable increase from 2019 levels, when India's area stood at 398 thousand hectares producing 9,213 thousand tonnes, reflecting growing demand for the crop (Sekine *et al.*, 2025) [18].

The cabbage crop is attacked by a number of insect pests from sowing to harvest, including the diamondback moth, *Plutella xylostella* (L.); aphids, *Brevicoryne brassicae* (L.) and *Lipaphis erysimi* (Kalt.); cabbage leaf webber, *Crociodolomia binotalis* (Zell.); painted bug, *Bagrada cruciferarum* (Kirk.); flea beetle, *Phyllotreta cruciferae* (Goeze); and tobacco caterpillar, *Spodoptera litura* (Fab.) (Abdel-Aziz *et al.*, 2025; Mutua *et al.*, 2026) [1, 13]. Among these, the aphid *L. erysimi* and the diamondback moth *P. xylostella* are reported as major insect pests in the semi-arid region of Rajasthan, causing significant losses (Verma *et al.*, 2024) [21]. The *P. xylostella* is one of the most destructive insect pests of cruciferous crops worldwide, causing severe economic losses (Firake and Behere, 2020) [7].

The annual global costs associated with this pest are estimated to be between four and five billion dollars in yield losses and management expenses. In a separate study, Ayalew (2020) [3] reported substantial yield reductions in cabbage due to diamondback moth infestation, with losses varying according to pest population density and management practices.

Aphids, due to their sucking propensities, devitalize plant tissues, leading to yield reduction, and their presence decreases the quality of cabbage heads. According to INRAE (2023) [9], the cabbage aphid *Brevicoryne brassicae* is the most dangerous aphid species on cabbage because it is the most difficult to control, causing leaf curl, crinkling, yellowing, and withering. The young caterpillars of the diamondback moth feed by scraping epidermal leaf tissues, producing typical whitish patches, while advanced-stage larvae bite holes in the leaves. Recent research by Lee *et al.* (2025) [11] confirmed that this feeding damage causes retardation of growth, resulting in undersized cabbage heads. diamondback moth and cabbage aphid as the main pests affecting cabbage production, with peak damage reported during the post-transplanting and heading stages (Niyibizi *et al.*, 2025) [14].

The farmers in our country traditionally practice intercropping or mixed farming, which naturally helps manage many pest problems (Patel *et al.*, 2025) [16]. Intercropping systems can affect pest populations through various physical factors such as protection from winds, sheltering, shading, and prevention of dispersal, as well as biological factors including the presence of natural enemies or the production of adverse chemical stimuli (Novljan *et al.*, 2025) [15]. The use of intercropping provides an excellent opportunity as an ecological approach to pest management, bringing about beneficial changes in cropping systems and crop geometry (Banks, 2003) [4].

It has been well documented that companion plants disrupt host-seeking activity, interfere with oviposition, increase populations of natural enemies, or lure pests to alternative food sources (Kheirodin *et al.*, 2021) [10]. Intercropping cabbage with tomato has been shown to repel adults of *P. xylostella* and other insect pests due to the volatile compounds emitted by tomato plants (Patel *et al.*, 2025) [16]. The cabbage intercropped with tomato recorded the lowest seasonal mean larval population of diamondback moth (1.20 larvae/plant) compared to sole cabbage (2.23 larvae/plant). Similarly, intercropping cabbage with marigold and mustard significantly minimized pest infestation while enhancing marketable yield (Novljan *et al.*, 2025) [15].

The orientation and oviposition choices of *P. xylostella* are mediated by volatile organic compounds (VOCs) emitted by host plants, with different Brassica species exhibiting varying levels of attractiveness to the pest (Ruhanen *et al.*, 2025) [17]. Volatile blends emitted by turnip and *Barbarea stricta* differed significantly from those of cabbage and broccoli, influencing oviposition preferences of diamondback moth females (Ruhanen *et al.*, 2025) [17]. Furthermore, intercropping cabbage with flowering annuals such as chenopodium (*Chenopodium album*) has been shown to reduce aphid and diamondback moth infestations while enhancing the colonization of coccinellid predators and syrphid flies (Sharma *et al.*, 2025) [19]. The enhanced

colonization of natural enemies in diversified plots is attributed to the sugars and protein content in flowers, which boost fecundity and survival during periods of food scarcity (Sharma *et al.*, 2025) [19].

The effectiveness of intercropping for pest management has been demonstrated across different geographical regions, though outcomes may vary depending on local biodiversity, target pest species, plant selection, and climatic conditions (Bickel *et al.*, 2024) [5]. In Japanese cabbage fields, intercropping with wheat or barley combined with flower strips significantly reduced populations of green peach aphid (*Myzus persicae*) and cabbage aphid (*Brevicoryne brassicae*) by supporting the natural enemies hypothesis (Bickel *et al.*, 2024) [5]. Similarly, intercropping leafy daikon (*Raphanus sativus*) with cabbage reduced the occurrence of leaf-chewing pests such as beet semi-loopers (*Autographa nigrisigna*) and small white butterflies (*Pieris rapae crucivora*) (Kheirodin *et al.*, 2021) [10].

Materials and Methods

Location and Site of Experiment

The present investigation was conducted at the Horticulture Farm of S.K.N. College of Agriculture, Jobner, Rajasthan, during the Rabi season of 2021-2022. Geographically, Jobner is located at 75°28' East longitude, 26°06' North latitude, at an elevation of 427 meters above mean sea level (MSL). The site falls under Agro-climatic Zone III A, the "Semi-arid Eastern Plain" zone of Rajasthan, characterized by loamy sand soils.

Climate and Weather Conditions

The climate of the region is typically semi-arid, marked by extreme temperatures in both summer and winter. Summer temperatures may rise as high as 48 °C, while winter temperatures can drop to as low as 2.5 °C. The region receives an average annual rainfall of 400-500 mm, mostly occurring from July to September. This climatic condition provides a safe, long growing season for most crops during the Kharif season.

Nursery Preparation and Sowing

Cabbage seedlings were raised in nursery beds. Beds of size 2.0 m × 1.0 m were prepared by mixing well-decomposed farmyard manure (FYM) into the soil at the rate of 10 kg per square meter. To prevent seedling mortality due to damping-off, the beds were drenched with Bavistin® (carbendazim) at 15 g per liter of water. Prior to sowing, seeds were treated with Thiram at 2 g per kg of seed. The cabbage variety NBH-Arun was sown at a seed rate of 375-400 g per hectare on September 14-15, 2021, during the Rabi season.

Layout and Experimental Design

The experiment was laid out in a simple Randomized Block Design (RBD) consisting of four treatments and four replications. Each experimental plot measured 3.0 m × 22.5 m. The crop was planted at a row-to-row spacing of 60 cm and plant-to-plant spacing of 45 cm. The treatments comprised different transplanting patterns of cabbage intercropped with tomato, mustard, marigold, and onion. Details of the intercrop combinations are presented in Table 1.

Details of intercrops with cabbage as a main crop

S. No.	Treatment	Row combination	Total no. of row/plot
1.	Cabbage + Tomato	Four rows of cabbage and one row of Tomato	5
2.	Cabbage + Mustard	4:1	5
3.	Cabbage + Marigold	4:1	5
4.	Cabbage + Onion	4:1	5
5.	Cabbage sole	-	5

Observations

The population of major insect pests were recorded at weekly interval from their appearance till harvesting of the crop. The method used for recording the population of major insect pests. The crop had been grown in tune with natural environmental conditions without interception of any kind.

Statistical analysis

The data obtained on major insect pests population from experimental field were transformed into $\log(vX + 0.5)$ and subjected to statistical analysis (Analysis of variance).

For comparison of the yield data, the seed yields of different intercropping systems were converted into equivalent yield of cabbage, using prevailing market rate of cabbage and other crops. The equivalent yield so obtained was subjected to analysis of variance.

Result and Discussion

Effect of Intercrops on Incidence of Aphid (*Lipaphis erysimi* Kalt.)

The data on aphid population under different intercrop combinations are presented in Table 1. The infestation of aphid commenced during the third week of December. At the initial stage, the mean aphid population ranged from 61.25 to 90.11 aphids per plant. The minimum population was recorded in the cabbage + onion treatment (61.25 aphids/plant), followed by cabbage + tomato (66.92 aphids/plant), and these two treatments differed significantly from each other. The maximum infestation was observed on the sole cabbage crop (90.11 aphids/plant), followed by cabbage + mustard (85.92 aphids/plant) and cabbage + marigold (77.82 aphids/plant). These treatments were statistically significant from each other, except cabbage + marigold which was at par with others.

The aphid population increased progressively and reached its peak during the second week of February, with mean population ranging from 119.87 to 142.50 aphids per plant. The minimum population at peak was recorded in cabbage + onion (119.87 aphids/plant), followed by cabbage + tomato (128.33 aphids/plant), and both treatments differed significantly from each other while remaining significantly superior to the remaining intercrop combinations. The maximum population was observed on the sole crop (142.50 aphids/plant), followed by cabbage + mustard (139.49 aphids/plant) and cabbage + marigold (136.42 aphids/plant), which were statistically at par with each other.

The seasonal mean aphid population ranged from 79.75 to 111.15 aphids per plant. The lowest overall mean population was recorded in cabbage + onion (79.75 aphids/plant), followed by cabbage + tomato (90.51 aphids/plant), cabbage + marigold (97.02 aphids/plant), and cabbage + mustard (102.21 aphids/plant). All these treatments were statistically

at par with each other except cabbage + onion, which was significantly superior. The highest seasonal mean population was observed on the sole crop (111.15 aphids/plant). Overall, the incidence of *L. erysimi* was markedly reduced in the cabbage + onion and cabbage + tomato intercrop combinations, indicating a definite suppressive effect of these intercrops on aphid population. The present findings clearly demonstrate that intercropping cabbage with onion and tomato significantly reduced the population of *L. erysimi* compared to sole cabbage. The minimum aphid population throughout the crop growth period was consistently recorded in cabbage + onion treatment, followed by cabbage + tomato.

The suppressive effect of onion against aphids observed in the present investigation can be attributed to the volatile sulfur compounds (allicin and other thiosulfinates) emitted by onion plants, which act as strong repellents against sucking insect pests. This finding is in close agreement with Novljan *et al.* (2025) [15], who reported that onion volatiles effectively deterred aphid colonization on cabbage. Similarly, the present study supports the findings of Ruhanen *et al.* (2025) [17], who stated that tomato plants release volatile organic compounds including α -pinene, β -myrcene, and limonene, which interfere with host plant location and feeding behavior of aphids. The present results are in agreement with Patel *et al.* (2025) [16], who reported that intercropping cabbage with tomato and onion significantly lowered aphid infestation compared to sole cropping. The present investigation also corroborates the findings of Sharma *et al.* (2025) [19], who observed that companion planting with non-host crops reduced aphid populations in cabbage fields. The higher aphid population recorded in cabbage + mustard and cabbage + marigold treatments in the present study may be explained by the fact that mustard, being a cruciferous crop, shares similar pest complexes with cabbage. This finding closely associates with Banks (2003) [4], who reported that intercropping with host plants serves as an alternative host and facilitates pest buildup. Although marigold is known to possess biocidal properties, its root exudates containing α -terthienyl are more effective against nematodes than against above-ground sucking pests, which is in line with the observations of Sharma *et al.* (2025) [19]. The progressive increase in aphid population from December to February observed in the present investigation coincides with favorable weather conditions, particularly low temperatures and high relative humidity, which promote rapid multiplication of aphids during the *Rabi* season. This finding is in close agreement with Kheirodin *et al.* (2021) [10], who stated that aphid populations peak during cooler months in semi-arid regions. The peak incidence during the second week of February in this study is consistent with earlier reports by Sachan and Srivastava (1972), who observed similar aphid activity patterns in the semi-arid regions of Rajasthan. The significant reduction in seasonal mean aphid population in intercropped treatments, especially cabbage + onion, supports the resource concentration hypothesis. The present findings are in agreement with Bickel *et al.* (2024) [5], who reported that herbivorous insects are less likely to find and remain on host plants interspersed with non-host species. Thus, the present investigation confirms that intercropping acts as an ecological strategy that disrupts host finding and colonization by aphids.

Effect of Intercrops on Incidence of Diamondback Moth (*Plutella xylostella* L.)

The data presented in Table 2 clearly demonstrate a significant impact of intercropping on the population buildup of diamondback moth (DBM). The infestation first appeared during the third week of December, with population ranging from 0.31 to 0.50 larvae per plant. The minimum population was recorded in cabbage + onion (0.31 DBM/plant), followed by cabbage + tomato (0.37 DBM/plant), and these two treatments were statistically at par with each other. The maximum initial infestation was observed on the sole crop (0.50 DBM/plant), which differed significantly from cabbage + mustard (0.49 DBM/plant) and cabbage + marigold (0.42 DBM/plant).

Peak DBM activity was observed during the first week of February, with population ranging from 2.39 to 3.50 larvae per plant. The minimum population at peak was recorded in cabbage + onion (2.39 DBM/plant), followed by cabbage + tomato (2.69 DBM/plant), both of which were statistically at par with each other. The maximum population was observed on the sole crop (3.50 DBM/plant), followed by cabbage + mustard (2.91 DBM/plant) and cabbage + marigold (2.82 DBM/plant), which were statistically at par with each other. The seasonal mean DBM population ranged from 1.29 to 1.88 larvae per plant. The minimum mean population was recorded in cabbage + onion (1.29 DBM/plant), followed by cabbage + tomato (1.44 DBM/plant), and these two treatments differed significantly from each other. The maximum mean population was observed on the sole crop (1.88 DBM/plant), followed by cabbage + mustard (1.66 DBM/plant) and cabbage + marigold (1.58 DBM/plant), all of which differed significantly from one another. The present results pertaining to diamondback moth incidence revealed that intercropping cabbage with onion and tomato exerted a significant negative impact on DBM population buildup throughout the cropping season. The minimum DBM population at initial, peak, and seasonal mean levels was consistently recorded in cabbage + onion, followed by cabbage + tomato treatments. The strong repellent effect of onion against DBM observed in the present investigation can be explained by the emission of sulfur-containing volatile compounds that interfere with the oviposition behavior of female DBM moths. This finding closely associates with Novljan *et al.* (2025) ^[15], who reported that non-host volatiles disrupt host plant location in diamondback moth. The present study also corroborates the findings of Ruhanen *et al.* (2025) ^[17], who stated that DBM females locate host plants primarily through olfactory cues, and the presence of non-host volatiles reduces egg laying and subsequent larval density. The present findings are in agreement with Patel *et al.* (2025) ^[16], who reported that tomato plants produce a blend of volatile compounds including methyl salicylate and (Z)-3-hexenyl acetate that repel DBM adults and deter oviposition. Similarly, the present investigation supports the earlier observations of Burandy and Rasos (1973) ^[6], Andow *et al.* (1986) ^[2], and Talekar *et al.* (1986) ^[20], who documented that tomato repelled adults of *P. xylostella* due to emission of volatile compounds. The higher DBM infestation in cabbage + mustard treatment observed in the present study, though still lower than sole cabbage, may be due to mustard being a cruciferous host plant for DBM. This finding is in close agreement with Talekar *et al.* (1986) ^[20] and Andow *et al.* (1986) ^[2], who reported that intercropping cabbage with mustard provides alternative oviposition sites and does not

effectively reduce overall pest pressure compared to non-host intercrops. The moderate suppression observed in cabbage + marigold in the present investigation could be attributed to the production of thiophenes and other allelochemicals from marigold. This finding is in agreement with Sharma *et al.* (2025) ^[19], who stated that marigold possesses insecticidal properties against certain lepidopteran larvae, though effectiveness against DBM appears limited. The peak DBM activity during the first week of February observed in the present study aligns with the findings of Firake and Behere (2020) ^[7], who reported that DBM populations in the Indo-Gangetic plains reach their maximum during the late *Rabi* season (January-February) when temperatures range between 15-25 °C. The present investigation also corroborates the findings of Massarolli *et al.* (2024) ^[12], who stated that these temperature conditions are optimal for DBM development and reproduction. The significantly lower DBM population in cabbage + onion and cabbage + tomato treatments throughout the peak activity period in the present study highlights the potential of these intercrops as components of integrated pest management (IPM) strategies. The overall seasonal mean data clearly indicate that intercropping with non-host crops, particularly onion and tomato, reduces DBM incidence by creating associational resistance. This finding is in close agreement with Banks (2003) ^[4] and Bickel *et al.* (2024) ^[5], who reported that the presence of non-host plants reduces the ability of herbivores to locate and colonize host plants. The present findings are also consistent with Kheirodin *et al.* (2021) ^[10], who reported that intercropping cabbage with non-cruciferous companions significantly reduced leaf-chewing pest populations.

Effect of Intercrop Combinations on Yield of Cabbage

The cropping pattern maintained a main crop to intercrop ratio of 4:1 (Table 3). The highest equivalent yield was obtained from the cabbage + onion treatment (173.72 q ha⁻¹), followed by cabbage + tomato (149.05 q ha⁻¹). Both treatments produced significantly higher yields compared to all other intercrop combinations and the sole crop. The minimum equivalent yield was recorded from the sole cabbage crop (112.41 q ha⁻¹). The yield data of the present investigation revealed that intercropping cabbage with onion or tomato resulted in significantly higher equivalent yields compared to sole cabbage and other intercrop combinations. The cabbage + onion treatment produced the highest equivalent yield (173.72 q ha⁻¹), followed by cabbage + tomato (149.05 q ha⁻¹), while sole cabbage gave the lowest yield (112.41 q ha⁻¹).

The higher equivalent yield in intercropped treatments observed in the present study can be attributed to two complementary factors. First, the reduced pest incidence (both aphids and DBM) in cabbage + onion and cabbage + tomato treatments led to better plant health, less feeding damage, and consequently higher marketable cabbage head weight and quality. This finding is in close agreement with Patel *et al.* (2025) ^[16], who reported that pest suppression through intercropping directly translates into enhanced yield. Second, the additional economic return from the intercrop (onion bulbs or tomato fruits) contributed to total system productivity. This corroborates the findings of Novljan *et al.* (2025) ^[15], who stated that intercropping results in a higher land equivalent ratio (LER) compared to sole cropping.

The superior performance of cabbage + onion over cabbage + tomato observed in the present investigation may be explained by the greater compatibility of onion as an intercrop with cabbage. This finding is in agreement with Banks (2003) ^[4], who reported that onion has a slender, upright growth habit that minimizes competition for light, space, and nutrients with the main cabbage crop, whereas tomato is a relatively larger plant that may compete more intensely with cabbage. Additionally, the strong repellent properties of onion against both aphids and DBM, as observed in the present study, resulted in better pest suppression, which translated into higher cabbage yields. This finding closely associates with Patel *et al.* (2025) ^[16], who reported similar results.

The minimum yield recorded from sole cabbage (112.41 q ha⁻¹) in the present investigation, despite having the highest plant population of cabbage per unit area, underscores the impact of pest infestation on crop productivity. This finding is in agreement with Mahla *et al.* (2005) ^[22], who reported

that *P. xylostella* is one of the most destructive pests causing severe yield losses. The present study also corroborates the findings of Krishnamoorthy (2004) ^[23], who stated that unprotected sole crops experience the highest pest pressure, leading to severe feeding damage, retarded growth, and undersized cabbage heads. The present results are in agreement with several previous reports. The present investigation closely associates with Patel *et al.* (2025) ^[16], who observed that cabbage intercropped with onion and tomato produced significantly higher equivalent yields compared to sole cabbage. Similarly, the present findings are in agreement with Novljan *et al.* (2025) ^[15], who reported that companion planting with onion or tomato enhanced cabbage productivity by reducing pest damage and utilizing resources more efficiently. The present study also supports the findings of Sharma *et al.* (2025) ^[19], who documented increased marketable yields in intercropped cabbage plots due to reduced insect pest incidence.

Table 1: Effect of various intercrops on the incidence aphid, *L. erysimi* on cabbage

S. No.	Intercrop combinations	Population of aphid/plant											Mean
		17.12.21	24.12.21	01.01.22	08.01.22	15.01.22	22.01.22	29.01.22	05.02.22	12.02.22	19.02.22	26.02.22	
1	Cabbage + Tomato	66.92	77.91	88.21	107.62	108.52	112.85	118.62	125.62	128.33	90.25	61.25	90.51
		(8.21)	(8.85)	(9.42)	(10.40)	(10.44)	(10.65)	(10.91)	(11.23)	(11.35)	(9.53)	(7.86)	(9.54)
2	Cabbage + Mustard	85.92	95.62	99.41	121.14	121.84	123.47	129.42	135.21	139.49	104.62	70.34	102.21
		(9.30)	(9.80)	(10.00)	(11.03)	(11.06)	(11.13)	(11.40)	(11.65)	(11.83)	(10.25)	(8.42)	(10.13)
3	Cabbage + Marigold	77.82	88.14	92.87	115.87	116.17	120.62	123.57	132.55	136.42	100.11	60.05	97.02
		(8.85)	(9.41)	(9.66)	(10.79)	(10.80)	(11.01)	(11.14)	(11.53)	(11.70)	(10.03)	(7.78)	(9.88)
4	Cabbage + Onion	61.25	68.95	78.98	88.67	90.71	101.64	105.68	114.85	119.87	85.45	40.95	79.75
		(7.86)	(8.33)	(8.92)	(9.44)	(9.55)	(10.11)	(10.30)	(10.74)	(10.97)	(9.27)	(6.44)	(8.96)
5	Cabbage sole	90.11	98.59	113.25	125.04	125.98	132.07	135.87	140.10	142.50	125.68	104.62	111.15
		(9.52)	(9.95)	(10.67)	(11.20)	(11.25)	(11.51)	(11.68)	(11.86)	(11.96)	(11.23)	(10.25)	(10.57)
	SEm +	0.11	0.12	0.15	0.17	0.25	0.26	0.23	0.24	0.16	0.20	0.16	0.17
	CD (p = 0.05)	0.32	0.38	0.46	0.53	0.76	0.80	0.72	0.73	0.51	0.60	0.48	0.53

Figures in the parentheses are $\sqrt{X + 0.5}$ values

**Peak population of aphid during the crop season

Table 2: Effect of various intercrops on the incidence diamond back moth, *Plutella xylostella* (L.) on cabbage

S. No.	Intercrop combinations	Population of diamond back moth/plant											Mean
		17.12.21	24.12.21	01.01.22	08.01.22	15.01.22	22.01.22	29.01.22	05.02.22	12.02.22	19.02.22	26.02.22	
1	Cabbage + Tomato	0.37	0.39	0.77	0.80	0.89	2.10	2.45	2.69	2.30	1.90	1.18	1.44
		(0.93)	(0.94)	(1.13)	(1.14)	(1.18)	(1.61)	(1.72)	(1.79)	(1.67)	(1.55)	(1.30)	(1.39)
2	Cabbage + Mustard	0.49	0.52	0.88	0.91	1.15	2.63	2.83	2.91	2.61	2.11	1.24	1.66
		(0.99)	(1.01)	(1.17)	(1.19)	(1.28)	(1.77)	(1.82)	(1.85)	(1.76)	(1.62)	(1.32)	(1.47)
3	Cabbage + Marigold	0.42	0.49	0.85	0.89	1.05	2.51	2.75	2.82	2.39	1.99	1.22	1.58
		(0.96)	(0.99)	(1.16)	(1.18)	(1.24)	(1.73)	(1.80)	(1.82)	(1.70)	(1.58)	(1.31)	(1.44)
4	Cabbage + Onion	0.31	0.33	0.62	0.66	0.69	1.85	2.24	2.39	2.10	1.81	1.14	1.29
		(0.90)	(0.91)	(1.06)	(1.08)	(1.09)	(1.53)	(1.66)	(1.70)	(1.61)	(1.52)	(1.28)	(1.34)
5	Cabbage sole	0.50	0.60	1.00	1.20	1.48	2.75	3.00	3.50	3.10	2.30	1.30	1.88
		(1.00)	(1.05)	(1.22)	(1.30)	(1.41)	(1.80)	(1.87)	(2.00)	(1.90)	(1.67)	(1.34)	(1.54)
	SEm +	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.03
	CD (p = 0.05)	0.07	0.06	0.05	0.05	0.05	0.07	0.11	0.11	0.16	0.16	0.12	0.11

Figures in the parentheses are $\sqrt{X + 0.5}$ values

**Peak population of DBM during the crop season

Table 3: Cabbage equivalent yield (q/ha)

S. No.	Intercrop combinations	Yield (q ha ⁻¹)		
		Main crop	Intercrop	Equivalent yield
1.	Cabbage + tomato	131.42	23.51	149.05
2.	Cabbage + mustard	113.00	1.95	127.62
3.	Cabbage + marigold	117.00	20.52	142.65
4.	Cabbage + onion	135.52	25.47	173.72
4.	Sole crop	112.41	-	112.41
	SEm +			5.68
	CD. (p = 0.05)			16.32

Conclusion

Intercropping cabbage with onion and tomato significantly suppressed the incidence of both aphid (*Lipaphis erysimi*) and diamondback moth (*Plutella xylostella*) compared to sole cabbage and other intercrop combinations. The cabbage + onion treatment recorded the lowest seasonal mean population of aphid (79.75 per plant) and DBM (1.29 per plant), proving most effective in pest reduction. The highest equivalent yield was also obtained from cabbage + onion (173.72 q ha⁻¹), followed by cabbage + tomato (149.05 q ha⁻¹), both significantly outperforming the sole crop (112.41 q ha⁻¹). Therefore, intercropping cabbage with onion or tomato is recommended as an eco-friendly, sustainable pest management strategy for enhancing cabbage productivity in semi-arid regions.

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