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Kiran Patel
Department of Entomology Indira Gandhi Krishi Vishwavidyalaya Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

KL Painkra
Department of Entomology Indira Gandhi Krishi Vishwavidyalaya Raj Mohini Devi College of Agriculture and Research Station, Ambikapur , Chhattisgarh, India

PK Bhagat
Department of Entomology Indira Gandhi Krishi Vishwavidyalaya Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

GP Painkra
Department of Entomology Indira Gandhi Krishi Vishwavidyalaya College of Agriculture and Research Station, Shankargarh, Balrampur, Chhattisgarh, India

Corresponding Author:
KL Painkra
Department of Entomology, Indira Gandhi Krishi Vishwavidyalaya
RMD College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

Impact of intercrops for the management of diamondback moth (*Plutella xylostella* L.) and yield on cabbage

Kiran Patel, KL Painkra, PK Bhagat and GP Painkra

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Abstract
The present work entitled "Study the impact of intercrops for the management of diamondback moth (*Plutella xylostella* L.) and yield on cabbage" was carried out at the Horticulture Hi-Tech Field, in RMD College of Agriculture & Research Station, Ambikapur, Chhattisgarh during the *Rabi* season of 2024-25. The effect of different intercrops (*i.e.* marigold, tomato, cauliflower, broccoli, mustard, radish and knolkhol) on cabbage was studied for the management of diamondback moth, the result revealed that intercropping treatments significantly influenced the DBM incidence. The cabbage + tomato intercrop (T_3) recorded the lowest seasonal mean larval population of DBM (1.20 larvae/plant), followed by cabbage + mustard intercrop (T_5) and cabbage + marigold intercrop (T_1) with 1.28 and 1.44 larvae/plant, respectively. In contrast, sole cabbage (T_8) with 2.23 larvae/plant and crucifer-based intercrops such as cabbage + broccoli (T_4), and cabbage + cauliflower (T_2) recorded higher pest loads with 2.08 and 1.95 larvae/plant, respectively. The cabbage + tomato intercrop (T_3) also produced the highest marketable yield (245.00 q/ha), followed by cabbage + mustard intercrop (T_5) and cabbage + marigold intercrop (T_1) with 226.90 and 216.27 q/ha, whereas the lowest yield (194.68 q/ha) was recorded in the sole cabbage as untreated plot (T_8). The cabbage + tomato intercrop (T_3) also recorded the highest marketable yield (245.00 q/ha), followed by cabbage + mustard intercrop (T_5) and cabbage + marigold intercrop (T_1) with 226.90 and 216.27 q/ha, whereas the lowest yield (194.68 q/ha) was recorded in the sole cabbage as untreated plot (T_8). Thus, intercropping cabbage with tomato, marigold and mustard not only minimized pest infestation but also enhanced yield, suggesting a promising agroecological approach for sustainable cabbage cultivation. Therefore, such cropping strategies can be recommended for eco-friendly and sustainable pest management in cabbage cultivation during the *Rabi* season.

Keywords: Chhattisgarh, cabbage, diamondback moth, intercrops

Introduction
Cabbage (*Brassica oleracea* var. capitata L.) belongs to the family Cruciferae. It is one of the important vegetable crops in India and origin is the Western Europe and North shores of the Mediterranean Sea (Singh *et al.* 2021) [11]. In India, cabbage is attacked by approximately 35 insect pests. Due to its high nutritional value and succulent nature, cabbage attracts various insect pests that feed on it. Some of these pests were found in significant numbers and others in very low numbers, classified as major and minor pests, respectively (Yadav *et al.* 2015) [20]. Intercropping systems can significantly influence pest population dynamics through both physical and biological mechanisms. Physical factors such as wind protection, shading, sheltering, altered light penetration, and disruption of pest dispersal play a key role in reducing pest colonization. Biologically, intercropping can enhance the activity of natural enemies and introduce adverse chemical stimuli that deter pests. By modifying crop geometry and introducing crop diversity, intercropping serves as an ecologically sound and economically viable strategy for pest management. It aligns with sustainable agricultural practices by minimizing reliance on chemical inputs. Cabbage bordered with Indian mustard had significantly fewer immature DBM compared to other border crops. Moreover, plots bordered with Indian mustard and coriander recorded the highest marketable yields, showing a clear difference between marketable and unmarketable heads (Hasheela *et al.* 2010) [4]. Increasing crop diversity reduces insect populations, and intercropping systems benefit from enhanced botanical diversity to reduce pest prevalence.

However, limited research has been available on the specific effects of intercropping on the population of diamondback moth in cabbage ecosystems (Andow, 1991) [1]. Therefore, exploring suitable intercrop combinations could offer an effective, eco-friendly strategy for managing this pest and improving cabbage production.

Materials and Methods

The present investigation entitled "Study the impact of intercrops for the management of diamondback moth on cabbage" was conducted during winter season of 2024-25. The experiment was scheduled to take place at the Hi-tech farm of Raj Mohini Devi College of Agriculture and Research Station, Ajirma, Ambikapur, Surguja (C.G.) 497001. All crops namely cabbage, tomato, cauliflower, broccoli, marigold, and knol-khol except Indian mustard and radish, were raised separately in the hi-tech nursery for 20 days until they were ready for transplanting. Seeds of Indian mustard and radish were directly sown at the time of transplanting cabbage seedlings. The intra row spacing for the intercrops was maintained at 60 cm. Twenty-day-old cabbage seedlings were transplanted into well-ploughed and finely tilled plots, with a spacing of 60 cm between rows and 50 cm between plants, under different intercropping treatments. The experiment was laid out in a Randomized Block Design (RBD) with eight treatments and three replications each.

Results and Discussion

The impact of different intercrops for the management of diamondback moth (*P. xylostella*) on cabbage result revealed that the incidence of DBM on cabbage under different intercropping systems showed considerable variation across treatment during the study period. The weekly observations of mean larval population per plant recorded under various treatments, which are presented in Table 1 and 2. The result revealed that the larval population of *P. xylostella* (L.) during early crop growth stages remained negligible across all treatments. In the 46th SMW and 47th SMW no infestation was recorded in any of the intercropped or sole cabbage plots. However, the first signs of DBM infestation were observed in the 48th SMW (4th week of November). The mean larval population per plant ranged from 0.29 to 0.71 larvae/plant among treatments.

A noticeable increase in *P. xylostella* larval population was observed during the 49th SMW. Among the intercropping systems, cabbage + tomato (T_3) registered the lowest mean larval population followed by cabbage + mustard (T_5), and cabbage + marigold (T_1). In the 50th SMW, there was a decline in larval population across all treatments. During the 51st SMW and 1st SMW, the larval population remained low across all treatments. A gradual increase in *P. xylostella* population was observed during the 52nd SMW, coinciding with favourable weather conditions.

The 2nd SMW marked the beginning of peak infestation period of *P. xylostella*. During the 3rd SMW and 4th SMW DBM population further increased, with the untreated control (T_8) reaching, followed by cabbage + broccoli (T_4) and cabbage + cauliflower (T_2). The infestation reached its peak level during the 5th SMW. The cabbage + tomato intercrop (T_3) recorded the lowest larval population (1.20 larvae/plant), followed by cabbage + mustard intercrop (T_5) and cabbage + marigold intercrop (T_1) with 1.28 and 1.44 larvae/plant, respectively. In contrast, sole cabbage (T_8) recorded higher pest loads with 2.23 larvae/plant.

The yield of cabbage was significantly influenced by different intercropping treatments as shown in Table 2. Among all the treatments, the highest cabbage yield was recorded in T_3 (cabbage + tomato as intercrop), which produced 245.00 q/ha, indicating the most favorable interaction. This was followed by T_5 (cabbage + mustard intercrop) with a yield of 226.90 q/ha, and T_1 (cabbage + marigold intercrop) which recorded 216.27 q/ha. Moderate yields were obtained in T_7 (cabbage + knol-khol intercrop) and T_6 (cabbage + radish intercrop) with 211.36 q/ha and 208.67 q/ha, respectively. Comparatively lower yields were observed in T_2 (cabbage + cauliflower intercrop) and T_4 (cabbage + broccoli intercrop), which recorded 201.12 q/ha and 198.44 q/ha, respectively. The lowest cabbage yield was observed in the sole cabbage plot (T_8 -control) with 194.68 q/ha, clearly indicating the positive effect of certain intercrops on cabbage productivity. Thus, the ascending order of cabbage yield under different treatments was: $T_8 < T_4 < T_2 < T_6 < T_7 < T_1 < T_5 < T_3$.

These findings are in close agreement with those reported by Burandy and Raros (1973) [2], Srinivasan (1994) [13], Vostrikov (2015) [18] and Wu *et al.* (1999) [19], who found significantly fewer eggs and adults of *P. xylostella* in tomato-intercropped plots. Jayarathnam (1977) [6] also supported this, attributing the reduction to compounds such as coumarin in tomato that act as oviposition deterrents. Further, Sivapragasam *et al.* (1982) [12] reported about 36% reduction in DBM infestation due to tomato intercropping. The results of the present study reinforce these findings and suggest that tomato is a suitable intercrop for managing DBM in cabbage under field conditions. Pawar and Lawande (1995) [9] and Luther *et al.* (1996) [8], reported that Indian mustard acts as an effective trap crop for DBM and other lepidopteran pests. However, the limited reduction observed in this study aligns with the findings of Talekar *et al.* (1986) [15], who noted that mustard had no significant effect on reducing *P. xylostella* populations compared to other intercrops. Moreover, Subrahmanyam (1998) [14] emphasized that although mustard can function as a trap crop, its economic feasibility is questionable due to additional space requirements and reduced cabbage yield. Therefore, while mustard showed some potential in diverting DBM, it was not as effective as other intercrops like tomato and garlic in significantly suppressing larval populations. Jankowska (2010) [5] reported that cabbage intercropped with pot marigold (Calendula officinalis) had significantly fewer *P. xylostella* larvae and pupae. Similarly, Sharma *et al.* (2022) [10] found that cabbage intercropped with marigold in combination with insecticide sprays resulted in the lowest mean larval populations. According to Andow (1991) [1], insects with a narrow host range such as the diamondback moth (*P. xylostella*), which feeds exclusively on cruciferous crops can be more effectively suppressed when host crops are interplanted with non-host crops.

The increased yield in tomato and mustard intercrops might be attributed to their ability to repel or distract pests, improve microclimate, or enhance soil nutrient availability through complementary growth patterns. These intercrops not only reduced pest load but also contributed economically through their own harvestable yields, making

them suitable options for sustainable and profitable cabbage production in Rabi season.

Gawade *et al*. (2002) [3] and Kumari (2021) [7] found that cabbage intercropped with radish gave the highest yield and profitability. Verma *et al*. (2024) [17] observed maximum yield and lowest pest incidence in cabbage + coriander. Theunissen *et al*. (1995) [16] also supported intercropping with clover, noting better quality and financial returns despite slight yield reduction. These findings suggest that well-chosen intercrops can enhance yield, reduce pest pressure, and improve farm profitability.

Table 1: Impact of different intercrops on the incidence pattern of *Plutella xylostella* in cabbage during Rabi 2024-25

Tr. No	Treatment	Patern	Larval population of *Plutella xylostella*/plant												
			13/11/24	20/11/24	27/11/24	04/12/24	11/12/24	18/12/24	25/12/24	02/01/25	09/01/25	16/01/25	23/01/25	30/01/25	Overall Mean
			46 SMW	47 SMW	48 SMW	49 SMW	50 SMW	51 SMW	52 SMW	1SW	2SW	3SW	4SW	5SW	
T_1	Cabbage + Marigold as intercrop	(2:1)	0.00 (0.00)	0.00 (0.00)	0.40 (1.18)	0.93 (1.38)	0.55 (1.24)	0.25 (1.11)	1.40 (1.55)	0.27 (1.12)	1.81 (1.67)	3.71 (2.16)	3.61 (2.14)	4.39 (2.32)	1.44 (1.58)
T_2	Cabbage+ Cauliflower as intercrop	(2:1)	0.00 (0.00)	0.00 (0.00)	0.55 (1.24)	1.67 (1.63)	0.69 (1.30)	0.43 (1.19)	1.90 (1.70)	0.41 (1.18)	2.56 (1.88)	4.67 (2.37)	5.01 (2.45)	5.50 (2.54)	1.95 (1.45)
T_3	Cabbage + Tomato as intercrop	(2:1)	0.00 (0.00)	0.00 (0.00)	0.29 (1.13)	0.65 (1.28)	0.43 (1.19)	0.15 (1.07)	1.22 (1.48)	0.18 (1.08)	1.16 (1.46)	3.46 (2.10)	2.81 (1.95)	3.99 (2.23)	1.20 (1.24)
T_4	Cabbage + Broccoli as intercrop	(2:1)	0.00 (0.00)	0.00 (0.00)	0.60 (1.26)	1.73 (1.65)	0.74 (1.31)	0.55 (1.24)	2.00 (1.72)	0.48 (1.21)	2.67 (1.91)	4.95 (2.43)	5.39 (2.52)	5.88 (2.62)	2.08 (1.48)
T_5	Cabbage + Mustard as intercrop	(2:1)	0.00 (0.00)	0.00 (0.00)	0.35 (1.16)	0.80 (1.34)	0.50 (1.22)	0.22 (1.10)	1.36 (1.53)	0.21 (1.10)	1.23 (1.49)	3.53 (2.12)	3.15 (2.03)	3.99 (2.23)	1.28 (1.27)
T_6	Cabbage + Radish as intercrop	(2:1)	0.00 (0.00)	0.00 (0.00)	0.51 (1.23)	1.40 (1.54)	0.65 (1.28)	0.37 (1.16)	1.82 (1.67)	0.38 (1.17)	2.42 (1.84)	4.22 (2.28)	4.87 (2.42)	5.23 (2.49)	1.82 (1.42)
T_7	Cabbage + Knol-khol as intercrop	(2:1)	0.00 (0.00)	0.00 (0.00)	0.48 (1.21)	1.22 (1.48)	0.60 (1.26)	0.30 (1.14)	1.67 (1.63)	0.35 (1.16)	2.13 (1.76)	3.96 (2.22)	4.45 (2.33)	4.76 (2.39)	1.66 (1.38)
T_8	Sole cabbage as control	-	0.00 (0.00)	0.00 (0.00)	0.71 (1.30)	2.12 (1.76)	0.88 (1.37)	0.61 (1.26)	2.30 (1.81)	0.50 (1.22)	2.84 (1.95)	5.12 (2.47)	5.67 (2.58)	6.01 (2.64)	2.23 (1.53)
SE(m)			0.00	0.00	0.02	0.08	0.03	0.02	0.13	0.03	0.11	0.28	0.24	0.20	0.10
C.D.@5%			0.00	0.00	0.06	0.24	0.10	0.07	0.39	0.09	0.34	0.87	0.74	0.63	0.29

The figures in parentheses are $\sqrt{x+0.5}$ transformed values, NS=nonsignificant, SMW=standard meteorological week, and *mean of three replications

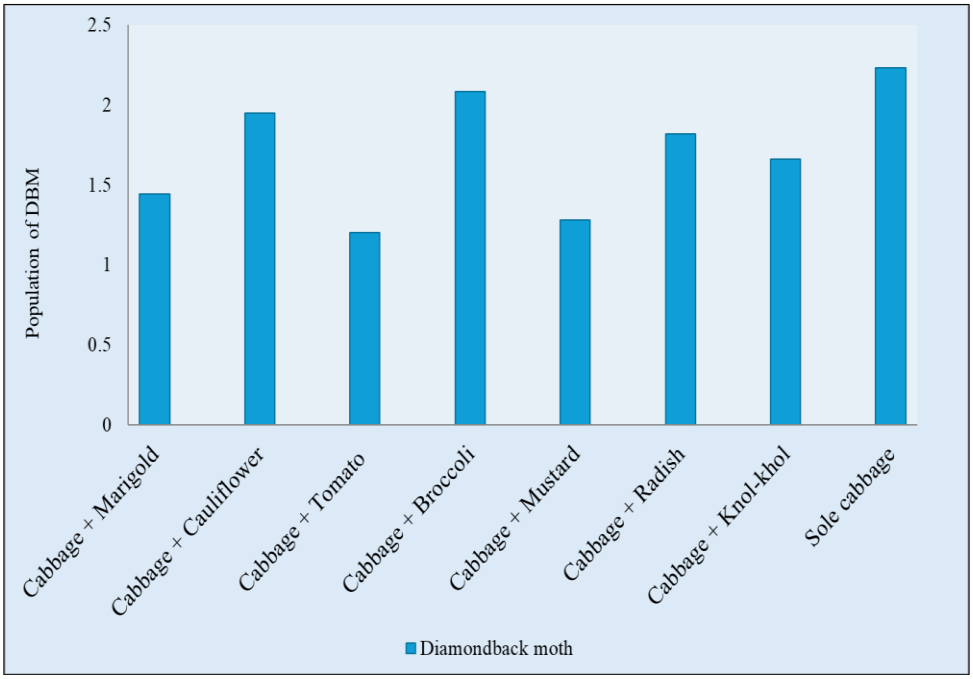

Fig 1: Impact of different intercrops on the incidence pattern of *Plutella xylostella* in cabbage during Rabi 2024-25

Table 2: Effect of intercrops on the yield of cabbage

Tr. No.	Name of Treatments/Crops	Pattern	Average yield of cabbage as main crop(q/ha)
T_1	Cabbage + Marigold as intercrop	(2:1)	216.27
T_2	Cabbage + Cauliflower as intercrop	(2:1)	201.12
T_3	Cabbage + Tomato as intercrop	(2:1)	245.00
T_4	Cabbage + Broccoli as intercrop	(2:1)	198.44
T_5	Cabbage + Mustard as intercrop	(2:1)	226.90
T_6	Cabbage + Radish as intercrop	(2:1)	208.67
T_7	Cabbage + Knol-khol as intercrop	(2:1)	211.36
T_8	Sole cabbage as control	-	194.68

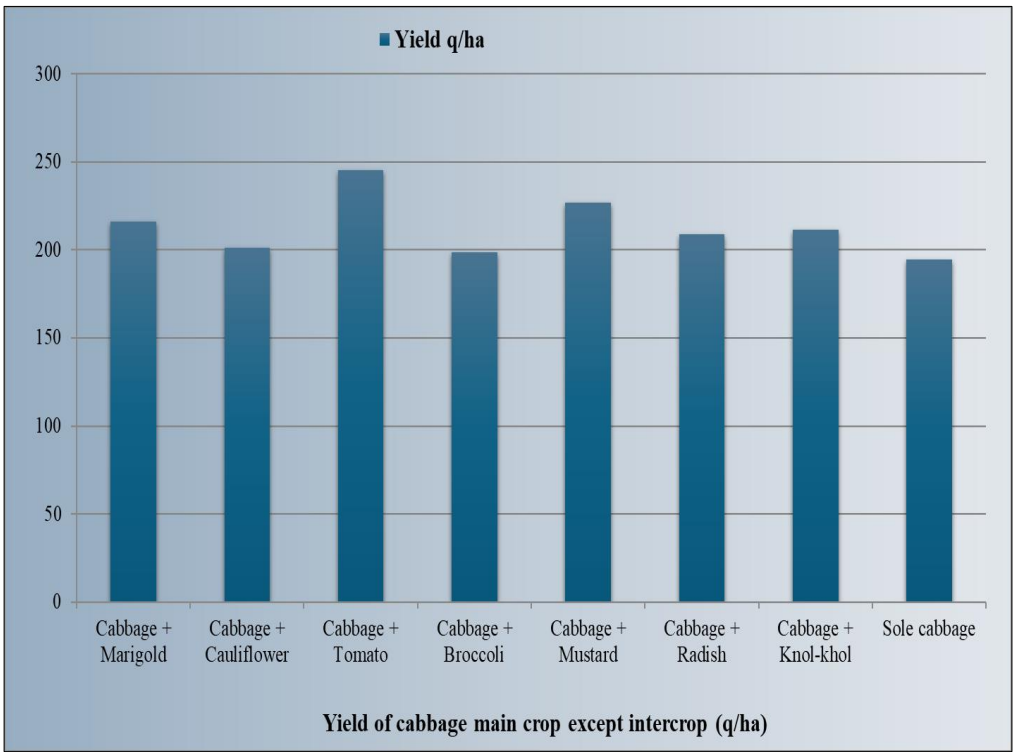

Fig 2: Effect of intercrops on the yield of cabbage

Plate 1: Cabbage with Tomato

Plate 2: Cabbage with Marigold

Plate 3: Cabbage with Mustard

Plate 4: Cabbage with Cauliflower

Plate 5: *Plutella xylostella* L

Plate 6: Cabbage Field

Conclusion

The effect of different intercrops (*i.e.* marigold, tomato, cauliflower, broccoli, mustard, radish and knolkhol) on cabbage for the management of diamondback moth result indicated that intercropping treatments significantly influenced the DBM incidence. The cabbage + tomato intercrop (T_3) recorded the lowest larval population, followed by cabbage + mustard intercrop (T_5) and cabbage + marigold intercrop (T_1) respectively. The cabbage + tomato intercrop (T_3) also produced the highest marketable yield, followed by cabbage + mustard intercrop (T_5) and cabbage + marigold intercrop (T_1) recorded in the sole cabbage as untreated plot (T_8). In contrast, sole cabbage (T_8) recorded higher pest loads. Thus, intercropping cabbage with tomato, marigold and mustard not only minimized pest infestation but also enhanced yield, suggesting a promising agroecological approach for sustainable cabbage cultivation. Therefore, such cropping strategies can be recommended for eco-friendly and sustainable pest management in cabbage cultivation during the *Rabi* season.

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