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Population of aphids and coccinellid predators in different crop ecosystems of Konkan region in Maharashtra

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Abstract
Studies on the population dynamics of aphids and their coccinellid predators were conducted across seven different crops during the *Rabi* season of 2024-2025. The investigation revealed significant variation in aphid infestation patterns and coccinellid response among different crop systems. Mustard emerged as the most severely aphid infested crop, recording peak aphid populations of 710.0 aphids per plant, while horse gram showed complete resistance with zero aphid counts throughout the growing season. Cowpea demonstrated rapid early-season establishment of aphid with peak populations of 106.3 aphids per plant, followed by substantial coccinellid population of 7.0 predators per plant. Green gram and lablab bean displayed sporadic aphid peaks and moderate coccinellid activities, while black gram and Dolichos bean experienced moderate aphid and coccinellid populations, with predator peaks closely following aphid outbreaks the study provides valuable insights into crop-specific pest-predator dynamics for developing targeted biological control strategies.

Keywords: Aphids, coccinellids, population, biological control, crop ecosystems

Introduction
Insect pests, especially sucking pests like aphids (Hemiptera: Aphididae), have constrained crop production worldwide for millennia. Cowpea aphid (*Aphis craccivora* Koch) and mustard aphid (*Lipaphis erysimi* Kaltenbach) are among the most damaging to legumes and crucifers, reducing crop vigor by feeding on phloem sap (Dixon, 1998) [5], transmitting plant viruses notably all potyviruses and excreting honeydew that promotes sooty mold, impairs photosynthesis, and diminishes yield (Klingler *et al*. 2001) [8]. Aphids thrive in mild, humid conditions, infesting crops from seedling to maturity (Singh & Singh, 2013) [18]. Globally, there are 4,702 aphid species (Remaudiere and Remaudiere, 1997), 1015 are found in the Oriental region, and about 653 species in India, representing 208 genera (Agarwala & Ghosh, 1984) [1]. Aphids' rapid colonization is driven by parthenogenetic viviparity, short and telescoping generations, and polymorphism (Singh and Ghosh, 2002). Their complex life cycles involve alternation of sexual and asexual generations and host switching (Ghosh and Singh, 2000). Honeydew also attracts diverse insects, making aphids hosts for parasitoids, predators, and birds (Singh *et al.*, 2000).
Ladybird beetles (Coccinellidae) are voracious eaters, consuming aphids equal to their body weight daily (Khalid *et al*., 2017) [7], and can also function as ecosystem health indicators (Meshbah *et al*. 2016) [11]. *Aphis gossypii* attacks over 400 plant species in India, acting as a vector for mosaic and leaf curl viruses (Mifsud *et al*., 2011) [12]. *Lipaphis erysimi* is a major mustard pest, causing poor pod formation and plant drying (Arora, 1999) [2]. Though insecticides remain common for aphid control, integrated pest management (IPM) is gaining importance due to health and environmental concerns (Shannag and Jafar, 2007) [17]. Plant resistance boosts yields and reduces pesticide reliance. Overuse of chemicals disrupts natural predators, causes secondary outbreaks, and increases environmental risk.
Conservation and attraction of natural enemies, especially coccinellids, are vital for aphid management. Biodiversity studies and predator abundance insights using diversity indices are key to sustainable pest management (Ramanand and Roy, 2008) [14]. The present study evaluates aphid–coccinellid host-predator relationships and biodiversity in crop ecosystems,

supporting effective IPM strategies and ecological stability.

Materials and Methods

Experimental Details

Field studies on investigation of "Aphids and coccinellid predators in different crops" were conducted at the Department of Agricultural Botany, College of Agriculture, Dapoli during Rabi season of 2024-2025.For the present study, seeds of seven different crops were sown in separate plots of 4.67 x 18 m (84.06 m²) following all the recommended agronomical practices for these crops. The crops were kept unsprayed during the course of study. The details of crops sowed is as follows:

Table 1: Details of crops sowed for field experiment

S. no.	Name of crop	Variety	Spacing (cm)
1	Cowpea *Vigna unguiculata*	Konkan Sadabahar	30x30
2	Mustard *Brassica juncea*	Varuna	30x30
3	Horse gram *Macrotyloma uniflorum*	Dapoli Kulthi 1	30x30
4	Green gram *Vigna radiata*	Dapoli-1	30x30
5	Black gram *Vigna mungo*	Vishwas NUL-7	30x30
6	Dolichos bean *Lablab pupureus*	Konkan Bhushan	30x45
7	Lablab bean *Lablab pupureus*(L)Sweet	Konkan Wal-2	30x45

Methodology

Study of aphid population in different crops

In each plot, 30 randomly selected plants were tagged for weekly aphid observations from crop emergence to harvest. Aphids were counted on shoots, leaves, and pods, and averages per plant were calculated to track population trends across crops. In mustard, where populations were excessively high, a 1 cm scale method was used, aphids were counted within each 1 cm shoot segment, and the remaining infested shoot population was estimated by multiplying the average aphids per centimetre.

Study of coccinellid predators in different crops

The population of coccinellid predators on different crops was recorded at weekly intervals on 30 already selected and tagged plants. For recording the coccinellid population, the whole plant was observed and numbers of grubs and adults were recorded and population was expressed as number of coccinellids per plant.

Results and Discussion

Aphid Population in Different Crops

The population dynamics study revealed significant variations in aphid infestation patterns across the seven crop systems examined. The data presented in Tables 2 and 3 clearly demonstrate the
differential susceptibility of crops to aphid colonization and the corresponding coccinellid population.

Table 2: Population of Aphids in Different Crops

SMW	Cowpea	Green gram	Horse gram	Black gram	Mustard	Dolichos beans	Lablab bean
49	4.7	0	0	1	7.7	2	6
50	9.7	0	0	1.7	8.7	11.3	14
51	106.3	17	0	17	78.3	111.3	115.7
52	25	0.7	0	52.3	197.3	1.7	45.7
1	77.7	0	0	55.3	221.7	13.7	22.3
2	58.3	18.3	0	9.7	140.3	5	0
3	49.3	0	0	0	262.3	0	0
4	0	0	0	0	382.3	0	0
5	0	9.3	0	5	710	31.3	2.3
6	2.7	18.7	0	4.7	371	3.7	0
7	2.7	0	0	0	247.3	0	0
8	6.3	25.3	0	0	58	0	0
9	-	-	-	-	-	17.7	25.3
10	-	-	-	-	-	12.7	31.7
11	-	-	-	-	-	31.7	86.3
12	-	-	-	-	-	21.7	40.7

Cowpea

Cowpea showed rapid early-season aphid establishment, with initial colonization beginning in the 49th Standard Meteorological Week (SMW) at 4.7 aphids per plant. The population increased gradually and attained peak 106.3 aphids per plant within three weeks after sowing, in 51st SMW. Subsequently, there was a sharp decline in aphid population to 25.0 per plant in 52nd SMW, which increased again in 1st SMW (77.7 per plant). Thereafter, there was gradual decline in aphid population in subsequent weeks, with populations dropping to zero in 4th and 5th SMW. Small populations persisted in 6th and 7th SMW (2.7 per plant each) which rose to 6.3 per plant at the end of crop duration.

Green gram
Green gram exhibited a more sporadic infestation pattern with aphid population initiated at three weeks after sowing (17.0 per plant in 51st SMW). The infestation was sporadic and recorded three distinct peaks: first in 2nd SMW (18.3 per plant), then in 6th SMW (18.7 per plant), and highest at the end of crop duration in 8th SMW (25.3 per plant). No aphid counts were recorded in 1st, 3rd, 4th and 7th SMW after the initial infestation.

Horse gram
Horse gram displayed complete resistance to aphid infestation throughout the entire crop growth period, with zero aphid counts across all sampling weeks. This finding suggests inherent resistance mechanisms or unfavourable host plant characteristics that prevent aphid colonization and establishment. Horse gram's complete aphid absence echoes reports of inherent antixenosis and antibiosis, affirming this crop's innate resistance.

Black gram
Black gram supported consistent presence of aphids, with infestation initiated from the first week after sowing (1.0 per plant in 49th SMW) which gradually increased in subsequent weeks and attained peak during 52nd SMW (52.3 aphids per plant). Thereafter, there was sharp decline in aphid population which fluctuated between zero (in 3rd, 4th, 7th and 8th SMW) to 9.7 aphids per plant (in 2nd SMW).

Mustard
Mustard emerged as the most severely affected crop, recording the highest aphid population among all crops studied. The infestation was observed throughout the crop duration, indicating strong preference of aphids for this crop. The lowest aphid population (7.7 per plant) was recorded at first week after sowing which gradually increased in subsequent weeks and attained first peak (221.7 per plant) in 1st SMW. Thereafter, there was small decline in aphid population (140.3 per plant) in 2nd SMW which afterwards gradually increased and attained the highest peak (710.0 per plant) in 5th SMW. Subsequently, there was gradual decline in aphid population up to the end of crop duration (58.0 per plant).

Dolichos bean
Dolichos bean experienced initial aphid population (2.0 per plant) at first week after sowing which suddenly increased and reached to the highest level (111.3 per plant) in 51st SMW. Thereafter, there was sharp decline in the aphid population and was zero during 3rd and 4th SMW. In 5th SMW, small rise in aphid population (31.3 per plant) was observed which declined to 3.7 per plant in subsequent week and was zero in 7th and 8th SMW. During the last four weeks of observations, aphid population fluctuated between 12.7 to 31.7 per plant.

Lablab bean
Lablab bean experienced early aphid infestation from the first week after sowing (6.0 per plant) and suddenly reached the highest level (115.7 per plant in 51st SMW) in third week after sowing. Thereafter, there was gradual decline in aphid population in subsequent weeks and was zero during 2nd, 3rd and 4th SMW. In 5th SMW, small population of aphid (2.3 per plant) was recorded which again declined to zero in 6th to 8th SMW. From 9th SMW, aphid population again started increasing and rose to second peak in 11th SMW (86.3 per plant) which declined to 40.7 per plant at the end of crop duration.

Coccinellid Population in Different Crops
The coccinellid population closely followed the aphid population trends across different crops, demonstrating the fundamental predator-prey relationship as revealed from below in Table 3.

Table 3: Population of Coccinellid Predators in Different Crops

SMW	Cowpea	Green gram	Horse gram	Black gram	Mustard	Dolichos beans	Lablab bean
49	0	0	0	0	0	0	0
50	0	0	0	0	1.3	0.3	0.3
51	7	0	0	0	5	0.7	1
52	3	0.3	0	2	7	0.3	2
1	3	0	0	0.3	9.3	0.7	0
2	3	0.3	0	0	13.3	0	0
3	1.3	3	0	1.3	20	2	0
4	0	0	0	0	17.3	0.3	0.7
5	0.3	0.7	0	0	2.7	1.3	0.7
6	2.7	0.7	0	1.7	7	0.3	0
7	0	0	0	0	4.3	1.7	0
8	1	4	0	0	3.7	3.3	2.7
9	-	-	-	-	-	3.3	3.7
10	-	-	-	-	-	2	3.7
11	-	-	-	-	-	2.7	2.7
12						4	3.7

Cowpea
Coccinellid population in cowpea began to be observed from third week after sowing and reached its maximum density of 7.0 coccinellids per plant in 51st SMW, which coincided with the highest aphid population recorded in this crop. Later, coccinellid population remained constant from 52nd SMW to 2nd SMW (3.0 per plant) and then started to decline, becoming zero in 4th SMW. Population increased thereafter to 0.3 per plant in 5th SMW and 2.7 per plant in 6th SMW, was again zero in 7th SMW, was reached 1.0 coccinellid per plant at the end of crop duration.

Green gram
In contrast to cowpea, green gram recorded the highest coccinellid population at the end of crop duration (4.0 per plant in 8th SMW) which also correlated with the highest aphid population recorded on this crop. Compared to cowpea, green gram recorded lower coccinellid population. It began to be observed from 52nd SMW (0.3 per plant) and attained first peak in 3rd SMW (3.0 per plant). At pod formation stage, population of 0.7 coccinellids per plant was recorded in 5th and 6th SMW. Zero coccinellid counts were recorded intermittently in 1st, 4th and 7th SMW.

Horse gram
Zero coccinellid population was recorded across all sampling weeks, correlating directly with zero aphid population recorded in this crop, confirming the fundamental dependency of predator populations on available prey resources.

Black gram
Black gram recorded overall lowest coccinellid population. The highest coccinellid population (2.0 per plant) was

recorded in the 52nd SMW which correlated with highest aphid population recorded in this week. The coccinellid population was zero in most weeks, except 1st, 3rd and 6th SMW which recorded 0.3, 1.3 and 1.7 coccinellids per plant, respectively.

Mustard

In contrast to other crops, mustard recorded coccinellid population in all meteorological weeks except 49th SMW. The data clearly showed that mustard is the most favourable crop for coccinellid establishment as it also supported high aphid population throughout the crop growth period. Initially lowest coccinellids (1.3 per plant) were recorded in 50th SMW which gradually increased in subsequent weeks and reached the highest (20.0 per plant) in 3rd SMW. Subsequently, it started to decline and was 3.7 per plant at the end of crop duration. Higher coccinellid populations were recorded during flowering stage of the crop.

Dolichos bean

In Dolichos bean, consistent coccinellid population were recorded from 2nd week after sowing up to the end of crop duration except at 6th week after sowing. Compared to initial crop growth stages, somewhat higher coccinellid population were recorded during latter growth stages with highest population of 4.0 per plant recorded in 12th SMW at the end of crop duration.

Lablab bean

In Lablab bean, coccinellid population was observed from 50th SMW (0.3 per plant) which increased to 1.0 per plant and 2.0 per plant in 51st and 52nd SMW, respectively. In the middle of crop growth, coccinellid population was zero except 4th and 5th SMW (0.7 per plant in both weeks). Like Dolichos bean, lablab bean also recorded higher coccinellid population at crop maturity, with highest population of 3.7 per plant recorded in 9th, 10th and 12th SMW.

Discussion

The present investigation studied aphid and coccinellid associations across seven crops at Dapoli, Maharashtra, during Rabi 2024-25. Aphid colonisation patterns varied by crop, with cowpea showing the earliest infestation (49th SMW) and peak aphid (106.3 per plant) and coccinellid (7.0 per plant) densities by 51st SMW. These findings mirror Borad *et al.,* (2020) [4], Rakhshith *et al.,* (2021) who reported predator response lagging aphid peaks and weather influencing population fluctuations.

Green gram showed scattered aphid peaks (17.0 and 25.3 per plant), lower coccinellid densities, and significant weather correlations (Biswas and Banerjee, 2019) [3]. Horse gram remained aphid- and coccinellid-free, confirming innate resistance (Kulkarni and Patel, 2001) [9].

Black gram had steady aphid presence, peaking at 52.3 per plant. Significant negative aphid correlations with max temperature and positive with humidity matched Kumar and Singh (2015) [10], who found aphid infestation begin shortly after sowing.

Mustard suffered the highest, most prolonged aphid infestations (peaks at 382.3 and 710.0 per plant) and highest coccinellid (20.0 per plant) activity. Mustard aphid and predator trends and weather impact concurred with Sreedhar *et al*., (2021) [19] who recorded initial aphid infestations in 3rd SMW (January), with maximum aphid densities. Rana *et al*., (2017) [15] reported that mustard supports higher coccinellid populatons compared to other crops.

Dolichos bean had a double-peaked aphid pattern (111.3, 31.3, 31.7 per plant), coccinellid peak at 4.0 per plant, which matches with results reported by Howal *et al*., (2024) that aphid infestation began in the 50th SMW, peaked early in the 51st, collapsed during SMWs 52–5, and resurged in SMWs 9–12, showing a double peak influenced by predator pressure.

Lablab bean showed early aphid peak (115.7 per plant), later resurgence, and coccinellid peak at 3.7 per plant. Weather sensitivity corroborated Vaidik and Patel (2023) [20] who documented an aphid peak in 2nd SMW. Overall, predator-prey association across crops were consistent with recent literature from multiple Indian agroecosystems.

Conclusion

The study documents aphid pest diversity across seven crop ecosystems in the Konkan region, revealing notable host-specific susceptibility. Mustard supported the highest aphid populations throughout the season and acted as a key reservoir for both aphids and coccinellid predators, while horse gram showed complete resistance with zero infestation, highlighting its potential in diversification-based aphid management. Coccinellid populations closely tracked aphid abundance but with a lag, stressing the importance of proactive monitoring and timely interventions. Pest dynamics were strongly shaped by crop phenology and host traits, emphasizing the need for crop-specific monitoring and tailored strategies. These findings support sustainable integrated pest management approaches that leverage natural biological control while reducing chemical dependence.

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