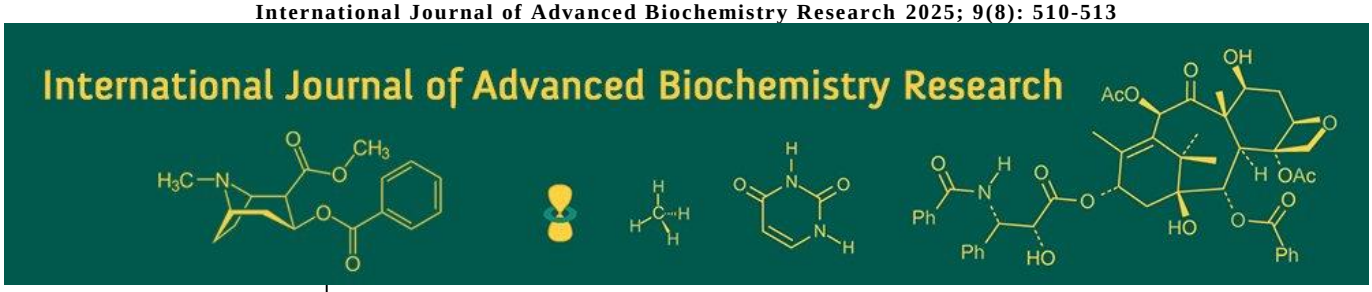

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Seasonal incidence of major insect pests of drumstick along weather parameters with natural enemies

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Abstract
A field study was conducted during *kharif-rabi*, 2024-2025 at Krishi Vigyan Kendra, Dhule, Maharashtra, to assess the seasonal incidence and correlation of insect pests and natural enemies on drumstick (*Moringa oleifera* Lamk.). Weekly observations recorded the population dynamics of major pests and correlated them with prevailing weather parameters. The leaf-eating caterpillar (*Noorda blitealis*) showed two major peaks: 2.78 larvae/branch in the 44th SMW (October) and again 2.78 larvae/branch in the 50th SMW (December), significant positively correlated with maximum temperature (r = 0.684**) and significant negatively correlated with morning relative humidity (r = -0.779**). The hairy caterpillar (*Eupterote mollifera*) peaked at 8.23 larvae/branch in the 47th SMW and showed a weak significant negative correlation with morning relative humidity (r = -0.442*). Tree hopper (*Leptocentrus* spp.) populations peaked at 6.89 tree hoppers/branch in the 43rd SMW, with a significant positive correlation to minimum temperature (r = 0.401*). Whitefly (*Aleurodicus disperses*) reached a maximum of 14.21 whiteflies/3 compound leaves in the 48th SMW, showing significant negative correlations with morning (r = -0.419*) and evening relative humidity (r = -0.651**). Aphid (*Aphis craccivora*) peaked at 7.00 aphids/3 compound leaves in the 49th SMW but did not show significant correlation with any weather parameters. Ladybird beetle (*Coccinella* spp.), a major predator of aphids, peaked at 2.40 beetles/plant in the 1st SMW of January and showed significant negative correlation with evening relative humidity (r = -0.568*). These findings highlight the influence of temperature and humidity in shaping pest dynamics and advocate for climate-based pest forecasting in moringa ecosystems.

Keywords: *Moringa oleifera* Lamk., seasonal incidence, insect pests, weather correlation, leaf-eating caterpillar, hairy caterpillar, whitefly, aphid, tree hopper, ladybird beetle, relative humidity, temperature, pest forecasting, drumstick ecosystem.

Introduction
Moringa oleifera Lamk., commonly known as the drumstick tree, is a highly valued crop native to India and widely cultivated across tropical and subtropical regions for its nutritional, medicinal, and economic importance. Known as the "Kalpavriksha of dryland regions, " moringa provides vitamins, minerals, and antioxidants, and is used for multiple purposes including food, medicine, manure, and dye production. India is the world's largest producer, contributing about 80% of global supply with 2.2 million tonnes grown in 2022 alone (Samsai, 2023 and Fuglie, 2000) [9, 4]. The tree's rapid growth and resilience make it suitable for semi-arid regions, though it requires well-drained soils. However, biotic stresses, particularly insect pests, significantly affect moringa cultivation, reducing both quality and yield (Godino *et al.* 2017 and Butani & Verma, 1981) [5, 2].

Several pests such as *Noorda blitealis*, *Gitona distigma*, aphids, whiteflies, thrips, and hairy caterpillars severely affect different parts of the moringa plant, particularly during the summer (Chandraker and Gupta, 2020; Sivagami and David, 1968) [3, 10]. Among these, *Noorda blitealis* is a primary defoliator, while *Gitona distigma* damages the pods, causing up to 75% loss. The increasing demand and expanding cultivation of moringa have further exacerbated pest incidences. Therefore, understanding seasonal pest occurrence and evaluating effective pest control strategies, particularly ready-mix insecticidal combinations, is essential. The current research focuses on determining seasonal incidence and assessing the efficacy of insecticides against key drumstick pests to aid in developing efficient and sustainable pest management practices (Thumar *et al.* 2017 and Anjaneyamurthy; Regupathy, 1989) [13, 1].

Materials and Methods

The present investigation on the seasonal incidence and correlation of insect pests of drumstick (*Moringa oleifera* Lamk.) was conducted during the year 2024-2025 at the experimental farm of Krishi Vigyan Kendra, Dhule, Maharashtra. This region lies between 20°38′ to 21°16′ North altitude and 73°50′ to 75°11′ East longitude, characterized by a semi-arid climate with hot summers, mild winters, and monsoonal rainfall. The soils in the region are medium black with good drainage and moderate fertility. The average annual rainfall ranges from 499 mm to 864 mm, with a decadal mean of approximately 589 mm. For the present study, the PKM-2 variety of drumstick was selected and maintained under standard agronomic practices. Protective irrigations were provided immediately after sowing and subsequently at 10-15 day intervals using a ridges and furrows layout. To study the seasonal occurrence of insect pests, five drumstick trees were randomly selected from the plantation. On each tree, four branches were marked from all cardinal directions East, West, North, and South for observation. Weekly observations were recorded throughout the cropping season. The incidence of lepidopterous defoliators, such as *Noorda blitealis* and *Eupterote mollifera*, was assessed by counting the number of larvae per branch. The population of sucking pests, including whiteflies and aphids, was monitored by recording the number of individuals on three compound leaves (top, middle, and bottom) from each tree. Similarly, the number of tree hopper nymphs was determined by counting the total individuals from the selected four branches and calculating the average population per branch. In addition to pest incidence, the presence of natural enemies such as parasitoids and predators was also recorded. Species belonging to the families Ichneumonidae (*Peristomarus* sp.) and Braconidae (*Apanteles* sp., *Microbracon brevicornis*, and *Chelonus* sp.), along with spiders, were documented through both field observations and laboratory-based rearing of collected larvae to confirm parasitoid emergence and predatory behavior. To determine the influence of environmental conditions on pest populations, correlation analysis was performed between weekly pest incidence and corresponding weather parameters temperature, relative humidity, and rainfall. The relationship was analyzed using Karl Pearson's correlation coefficient (r), and the statistical significance of the correlation was tested using standard tabulated values.

Results and Discussion

The seasonal incidence of major insect pests and their natural enemies on drumstick was recorded weekly during the *kharif-rabi*, season of 2024-2025 at Dhule, Maharashtra, and correlated with meteorological parameters. The primary insect pests observed were leaf-eating caterpillar (*Noorda blitealis*), hairy caterpillar (*Eupterote mollifera*), tree hopper (*Leptocentrus* spp.), whitefly (*Aleurodicus disperses*), and aphid (*Aphis craccivora*), along with the beneficial predatory insect, the ladybird beetle (*Coccinella* spp.). The population of leaf-eating caterpillar commenced during the 40th Standard Meteorological Week (SMW) with 0.29 larvae/branch and peaked during the 44th and 50th SMWs with 2.78 larvae/branch, coinciding with cooler and drier conditions. A significant positive correlation (r = 0.684**) with maximum temperature, non-significant positive correlation with sunshine hours (r = 0.308) and a significant negative correlation with morning relative humidity (r = -0.779**) and rainfall (r = -0.417*) indicated that this pest thrives in warm, dry weather with increased light availability. These findings align with earlier reports by Joshi *et al.* (2016) [6], who linked increased *Noorda blitealis* activity with dry conditions in Tamil Nadu.

Plate 1: Leaf eating caterpillar, *Noorda blitealis* Walker

The hairy caterpillar remained absent in early crop stages but emerged during the 43rd SMW, reaching its highest population of 8.23 larvae/branch in the 47th SMW. Its activity showed a weak but significant negative correlation with morning relative humidity (r = -0.442*) and a non-significant positive correlation with maximum temperature (r = 0.331), suggesting that moderate dryness favors its buildup, whereas high humidity likely suppresses it. These results are in line with the observations of Sundararaj and Ebenezer (2021) [12], who found that post-monsoon dry periods facilitated larval development of hairy caterpillars in semi-arid regions.

Plate 2: Hairy caterpillar, *Eupterote mollifera* Walker

Tree hopper incidence began from the 40th SMW and peaked at 6.89 tree hoppers/branch during the 43rd SMW. A statistically significant positive correlation with minimum temperature (r = 0.401*) suggests that moderately cool nights favor their activity. Other climatic factors like rainfall and humidity had no significant influence. These findings corroborate with those of Chandrakar and Gupta (2020) [3], who reported similar seasonal spikes of tree hoppers during vegetative flush in October-November in central India.

Plate 3: Tree hopper, *Leptocentrus* spp.

Whitefly populations emerged in early October and reached their peak at 14.21 whiteflies/3 compound leaves during the 48th SMW. This infestation phase coincided with low minimum temperatures (8.10°C) and high morning humidity (89%). Despite these humid conditions, whitefly populations showed significant negative correlation with both morning (r = -0.419*) and evening relative humidity (r = -0.651**), indicating that prolonged high humidity might restrict adult emergence or favor entomopathogenic activity. Patil *et al.* (2019)[8] similarly reported a reduction in whitefly populations under high humidity in moringa fields.

Aphid populations were first recorded during the 40th SMW with a count of 2.0 aphids/3 compound leaves and peaked at 7.00 aphids/3 compound leaves in the 49th SMW. However, no significant correlation was found between aphid population and any of the weather parameters, indicating that aphid dynamics may be more influenced by host plant phenology than climatic variables. These results echo the observations of Suyal (2017) [11], who also reported non-significant weather influence on aphid activity in Brassicaceae crops.

The ladybird beetle, a primary predator of aphids, showed a synchronous rise with aphid abundance and reached its peak (2.40 beetles/plant) in the 1st SMW of January. A significant negative correlation was observed with evening relative humidity (r = -0.568*), suggesting that lower humidity levels favour its activity.The predator-prey synchrony observed between ladybird beetles and aphids in this study is consistent with findings by Naik *et al.* (2022) [7], where Coccinellid beetle activity trailed aphid infestations and was maximal during late winter months.

Plate 4: Lady Bird Beetle, *Coccinella* spp.

Table 1: Seasonal incidence of insect pests on drumstick and their natural enemies during, *kharif-rabi*, 2024-2025.

Month	SMW	Leafeating Caterpillar/ Branch	Hairy Caterpillar /Branch	Tree Hopper/ Branch	Whitefly/3 Compound Leaves	Aphid/3 Compound Leaves	Lady Bird Beetle/ plant	Temperature		Relative humidity		Total rainfall (mm)	Sunshine Hours
								Maximum (°C)	Minimum (°C)	Morning (%)	Evening (%)		
Sep-2024	36	0.00	0.00	0.00	0.00	0.00	0.00	30.10	20.10	92	64	29.50	2.40
	37	0.00	0.00	0.00	0.00	0.00	0.00	31.70	19.10	91	61	3.20	3.20
	38	0.00	0.00	0.00	0.00	0.00	0.00	32.70	19.40	88	57	18.80	5.90
	39	0.00	0.00	0.00	0.00	0.00	0.00	32.10	20.40	92	66	67.20	2.80
Oct-2024	40	0.29	0.00	0.28	1.65	2.00	0.00	33.10	20.20	91	60	0.00	7.40
	41	0.66	0.00	1.65	5.25	3.01	0.20	33.50	19.90	91	59	30.40	5.90
	42	1.13	0.00	3.78	1.33	4.00	0.40	33.10	19.90	92	61	68.30	5.70
	43	2.60	1.20	6.89	0.90	2.00	1.50	32.60	17.70	91	49	10.00	7.50
	44	2.78	2.63	3.28	0.60	1.00	2.00	33.90	16.10	90	41	0.00	8.20
Nov-2024	45	1.89	3.53	2.65	2.33	1.20	1.00	33.40	14.30	89	38	0.00	6.80
	46	2.01	7.33	3.78	6.34	1.40	0.80	31.80	12.40	89	36	0.00	6.60
	47	2.20	8.23	4.89	12.31	2.00	0.23	30.40	11.00	89	35	0.00	5.20
	48	1.72	3.24	2.35	14.21	3.00	0.80	28.60	8.10	89	33	0.00	6.10
Dec-2024	49	0.98	2.57	4.11	13.33	7.00	0.10	30.10	14.30	89	46	0.00	3.60
	50	2.78	3.33	3.80	9.33	4.00	0.80	28.00	5.80	85	38	0.00	7.40
	51	2.03	4.33	3.40	4.25	3.00	1.20	29.90	6.20	88	32	0.00	6.20
	52	2.15	5.00	5.30	2.15	2.00	2.30	28.60	13.50	90	43	2.60	2.00
Jan-2025	1	1.98	4.45	5.20	0.93	0.14	2.40	30.30	9.20	89	36	0.00	6.50
	2	1.56	3.34	3.10	0.40	1.40	1.30	26.90	7.40	89	36	0.00	3.10
	3	1.24	2.45	4.30	0.30	0.20	1.13	29.40	9.90	87	37	0.00	4.70
	4	0.88	1.20	3.80	0.13	1.00	0.80	31.20	10.70	89	37	0.00	7.30
	5	0.00	2.60	4.00	0.10	0.40	0.75	33.00	11.00	88	37	0.00	7.80
Feb-2025	6	1.24	3.10	4.20	0.80	0.80	0.90	31.20	11.60	85	37	0.00	6.80
	7	0.13	0.09	3.20	0.80	0.60	0.60	28.50	10.10	89	41	0.00	1.50
	8	0.03	0.78	1.20	0.70	0.00	0.20	30.40	9.50	87	36	0.00	7.20
	9	0.00	1.20	2.00	0.10	0.00	0.00	34.30	13.70	85	39	0.00	7.90
Mar-2025	10	2.10	0.00	6.00	0.00	0.00	0.00	34.80	12.30	83	46	0.00	8.70
	11	0.00	0.00	0.00	0.00	0.00	0.00	39.30	15.00	88	38	0.00	8.50

Table 2: Correlation between population of insect pests, natural enemies and weather parameters.

Insect Pests	Correlation coefficient t values(r)					
	Temperature(°C)		Relative Humidity (%)		Rainfall (mm)	Sunshine (hr)
	Max. Temp (°C)	Min. Temp (°C)	RH 7:30 (%)	RH 16:30 (%)		
Leaf Eating Caterplilar	0.684**	-0.284	-0.779**	-0.522**	-0.417*	0.308
Hairy Caterpillar	0.331	-0.034	-0.442*	-0.301	-0.288	0.169
Tree Hopper	-0.231	0.401*	0.141	0.110	-0.111	-0.266
Whitefly	-0.003	0.286	-0.419*	-0.651**	-0.353	-0.244
Aphids	-0.329	-0.405	-0.322	-0.321	-0.137	0.130
Lady Bird Beetle	-0.143	-0.400	-0.195	-0.568*	-0.369	0.248

** = Significant at 1% (0.48693), * = Significant at 5% (0.38086)

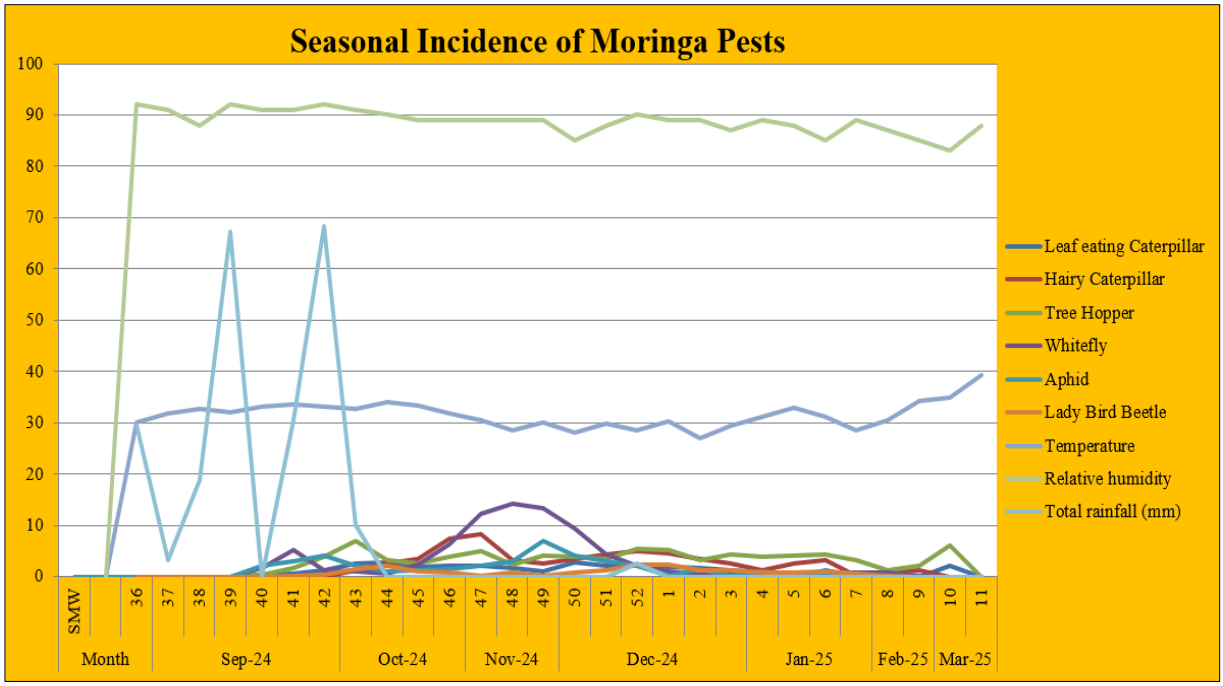

Fig 1: Seasonal incidence of insect pests on drumstick and their natural enemies during, *kharif-rabi*, 2024-2025.

Conclusion

The seasonal incidence of insect pests on drumstick was closely associated with meteorological parameters. *Noorda blitealis* showed a significant positive correlation with maximum temperature (r = 0.684**, $p<0.01$), non-significant positive correlation with sunshine hours (r = 0.308) and a significant negative correlation with morning relative humidity (r = -0.779**, $p<0.01$), evening relative humidity (r = -0.522**, $p<0.01$) and rainfall (r = -0.417*, $p<0.05$). *Eupterote mollifera* exhibited a weak but significant negative correlation with morning relative humidity (r = -0.442*, $p<0.05$). *Leptocentrus* spp. showed a significant positive correlation with minimum temperature (r = 0.401*, $p<0.05$). *Aleurodicus dispersus* had significant negative correlations with morning relative humidity (r = -0.419*, $p<0.05$) and evening relative humidity (r = -0.651**, $p<0.01$). *Aphis craccivora* showed no significant correlations with weather parameters. *Coccinella* spp. had a significant negative correlation with evening relative humidity (r = -0.568*, $p<0.05$).

Declaration

I hereby declare that the research work entitled "Seasonal Incidence of Major Insect Pests of Drumstick Along Weather Parameters With Natural Enemies" submitted to International Journal of Advanced Biochemistry Research, is the original work carried out by me under the guidance of Dr. M. S. Bharati (Assistant Professor of Entomology, AICRP on Chickpea, Pulses Improvement Project, MPKV, Rahuri). All sources of information and data from other researchers have been duly acknowledged and referenced. I take full responsibility for the authenticity of the data and contents of this work.

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