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Seasonal variations of sucking insect pests and associated natural enemies in cotton ecosystems of Odisha

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Abstract
This study assessed the seasonal dynamics of sucking insect pests and their natural enemies during the *kharif* season of 2021 at the Regional Research and Technology Transfer Station in Bhawanipatna, Odisha, from 30th to 52nd Standard Meteorological Weeks (SMW). Jassids (*Amrasca biguttula biguttula*) showed low initial numbers but increased significantly from the 34th week, peaking at 14.57 to 14.98 jassids per 3 leaves in the 42nd and 43rd weeks before declining, with a mean of 5.59±4.59 jassids per 3 leaves. Aphid (*Aphis gossypii*) populations peaked at 38.43 aphids per 3 leaves in the 34th week but then dropped to negligible levels, averaging 7.53±11.58 aphids per 3 leaves. Whiteflies (*Bemisia tabaci*) remained consistently low, peaking at 2.42 whiteflies per 3 leaves in the 46th week, with a mean of 1.00±0.68. Thrips (*Thrips tabaci*) increased from the 36th week, peaking at 10.22 per 3 leaves in the 38th week, with a mean of 3.01±3.42. Natural predators, including ladybird beetles, spiders, and green lacewings, peaked at 3.05 per plant in the 35th week, averaging 1.11±0.95. Weather factors significantly impacted pest and predator populations: minimum temperature correlated positively with jassids (r = 0.432) and predators (r = 0.673), while evening humidity correlated positively with jassids (r = 0.497) and thrips (r = 0.405). Rainfall significantly correlated with thrips (r = 0.582).

Keywords: Seasonal dynamics, sucking insect, natural enemies, weather factors, correlation

Introduction
Cotton is a key cash crop in Odisha, playing a significant role in the state's agricultural economy. In the 2021-22 growing season, cotton was cultivated on 2.16 lakh hectares, achieving a productivity of 555 kg/ha and a total production of 7.05 lakh bales (Annual report, AICRP on Cotton, 2022-23). It serves as a primary source of livelihood for farmers, particularly in the western and southern regions of the state, and is integral to employment in the textile and related industries. However, cotton cultivation faces substantial challenges due to pest infestations, which can lead to significant yield losses and a decline in fibre quality.

Among the various pests affecting cotton, sucking insects such as aphids (*Aphis gossypii*), jassids (*Amrasca biguttula biguttula*), whiteflies (*Bemisia tabaci*), and thrips (*Thrips tabaci*) are particularly detrimental (Meena *et al.*, 2023) [9]. These pests feed on the plant's sap, causing stunted growth, leaf yellowing, and overall weakening of the crop (Nihal *et al.*, 2019) [10]. Moreover, their feeding behaviour facilitates the transmission of viral diseases, further intensifying crop damage (Garzo *et al.*, 2020) [4]. The population dynamics of these pests are closely linked to seasonal changes, necessitating an understanding of their trends and critical periods of infestation (Bhattacharyya *et al.*, 2019; Behera *et al.*, 2018) [2, 1].

Cotton ecosystems also attract a variety of natural enemies that help regulate pest populations (Chi *et al.*, 2021) [3]. Key predators include coccinellid beetles such as *Coccinella septempunctata* (Linnaeus) and *Cheilomenes sexmaculatus* (Fabricius), the green lacewing *Chrysoperla carnea* (Stephens), and several species of spiders including the lynx spider (*Oxyopes javanus*), orb spider (*Argiope minuta*), wolf spider (*Lycosa pseudoannulata*), long-jawed spider (*Tetragnatha javana*), *Neoscona theisi*, and *Peucetia*

viridana (Stoliczka) (Kannan *et al.,* 2004) [7]. These natural enemies play a decisive role in maintaining the balance within the cotton ecosystem by preying on sucking pests.

This study aims to investigate the seasonal dynamics of sucking insect pests and their natural enemies in Odisha's cotton areas to enhance pest management strategies, thereby improving crop productivity and quality.

2. Materials and Methods

2.1. Experimental site and methodology

The study was conducted at the Regional Research and Technology Transfer Station (RRTTS) in Bhawanipatna, OUAT, Odisha, during the *kharif* season of 2021, aiming cotton-growing regions in the western and southern parts of the state, where diverse agro-climatic conditions impact pest dynamics. A field trial was set up using untreated cotton varieties to monitor the populations of key sucking insect pests, including jassids (*Amrasca biguttula biguttula*), aphids (*Aphis gossypii*), whiteflies (*Bemisia tabaci*), and thrips (*Thrips tabaci*). Pest sampling was executed from 30th Standard Meteorological Week (SMW) using the standard leaf count method, focusing on leaves from the top, middle, and bottom sections of the plants, and continued until harvest (52th SMW). Observations of natural enemy populations, including ladybird beetles, spiders, and *Chrysoperla carnea*, were conducted on a whole-plant basis, with data collected weekly. Alongside pest population data, environmental parameters such as temperature, humidity, and rainfall were recorded weekly from RRTTS, Bhawanipatna meteorological station.

The cropping season was divided into vegetative, flowering, and boll formation stages to evaluate pest incidence across different growth phases. Statistical analysis was performed to assess seasonal pest population trends and their correlations with weather parameters. Descriptive statistics, correlation analysis, and t-tests at a 5% significance level were utilized to determine the relationships between pest populations and climatic factors, with correlation coefficients and t-values calculated to test for significance.

The formula for the t-test used in the analysis is: $t = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}}$

Where,

$\bar{X}$= Sample mean

μ= Population mean

σ= Sample standard deviation

n= Sample size

3. Results and Discussion

3.1. Seasonal incidence of sucking insect pests and predators in cotton

The seasonal dynamics of sucking insect pests were monitored from the 30th to the 52nd standard weeks (July to December) in 2021-22 (Table 1). The population trends reveal significant fluctuations across different weeks.

3.1.1. Jassids (*Amrasca biguttula biguttula*): The population of jassids initially remained low but started increasing from the 34th standard meteorological week (SMW) with a recorded density of 0.67 jassids per 3 leaves. A significant peak was observed during the 42nd (14.57 jassids per 3 leaves) and 43rd (14.98 jassids per 3 leaves) weeks, which contrasts with the findings of Bhattacharyya *et al*. (2019) [2], who reported a peak population of 4.70 jassids per leaf during the 39th SMW (Sep. 24-30). In comparison, Jat *et al*. (2023) [6] recorded a peak of 30.25 jassids per plant during the 34th SMW. The jassid population gradually declined towards the end of the season. Overall, the population ranged from 0.64 to 14.98 jassids per 3 leaves, with an average of 5.59±4.59 jassids per 3 leaves, indicating notable fluctuations in pest activity. The variation in jassid population dynamics could be attributed to differences in local climatic conditions, host plant varieties, and the timing of peak pest activity across different studies.

3.1.2. Aphids (*Aphis gossypii*): Aphid populations exhibited considerable variability, with a significant peak observed during the 34th week (38.43 aphids/3 leaves), whereas Jat *et al*. (2023) [6] reported the peak population in the 40th SMW (49.20 aphids/plant). Following this peak, aphid numbers rapidly declined, reaching negligible levels toward the end of the season. The population ranged from 0.00 to 38.43 aphids/3 leaves, with a mean of 7.53±11.58 aphids/3 leaves. The high standard deviation suggests the sporadic and localized nature of aphid infestations, likely influenced by microclimatic conditions, localized host plant availability, and variations in environmental factors across regions.

3.1.3. Whiteflies (*Bemisia tabaci*): The population of whiteflies observed consistently in low numbers throughout the season, with the highest recorded density in the 46th week (2.42 whiteflies/ 3 leaves). The population ranged between 0.17-2.42 whiteflies/ 3 leaves, with a mean of 1.00±0.68 whiteflies/ 3 leaves, indicating a moderate yet significant presence. The peak population of whiteflies (32.40 whiteflies/ plant) was recorded during the 31st SMW (Jat *et al*, 2023) [6]

3.1.4. Thrips (*Thrips tabaci*): Thrips populations exhibited an increasing trend starting from the 36th week, peaking at 10.22 thrips per three leaves during the 38th week, before declining gradually. The population fluctuated between 0.00 and 10.22 thrips per three leaves, with an average of 3.01±3.42 thrips per three leaves. Thrips activity was highest in mid-season, leading to considerable crop damage during this period. Notably, the peak population of 41.60 thrips per plant was observed during the 36th standard meteorological week (Jat *et al.,* 2023) [6].

3.1.5. Natural enemies: The population of natural enemies, including ladybird beetles, spiders, and green lacewings, fluctuated throughout the study period, with a peak density observed in the 35th week at 3.05 predators per plant. The predator population ranged from 0.00 to 3.05 predators per plant, averaging 1.11±0.95 predators per plant. Although predators were consistently present, their numbers remained relatively low, suggesting limited natural control of the pest population. The predominant predators identified included the ladybird beetle (*Menochilus sexmaculatus*), the green lacewing (*Chrysoperla carnea*), and one species of spider. According to Bhattacharyya *et al*. (2019) [2], peak activity of the ladybird beetle (2.75 per plant) and spider (2.68 per plant) occurred during the 39th standard week (September 24-30). The green lacewing was active throughout the crop's growth period, with its highest occurrence of 1.30 per plant recorded during the 41st standard week (October 8-14).

The data indicate that jassids and thrips posed a significant threat during the mid-season, while whiteflies and predators maintained consistent but lower levels. Aphid populations were erratic, with a high early-season spike followed by a decline. Overall, the results indicated the need for timely management interventions, especially during peak pest periods, to safeguard cotton productivity.

3.2. Effect of weather factors on incidence of sucking insect pests and natural enemies in cotton

The analysis of the correlation between meteorological parameters and the incidence of sucking pests (aphids, jassids, whiteflies, thrips) and their predators (Ladybird beetle, spiders, green lace wings) in cotton indicates that temperature plays a critical role in influencing both pest and predator populations. Specifically, minimum and mean temperatures show significant positive correlations with aphids, jassids, and predators, suggesting that warmer conditions promote the development, survival, and reproduction of these species. The minimum temperature had a strong positive correlation with predators (r = 0.673), emphasizing the enhanced activity and effectiveness of natural enemies at higher temperatures. Maximum temperature also showed a significant correlation with jassids (r = 0.432) and predators (r = 0.521), reinforcing the idea that elevated temperatures favour the proliferation of these organisms. Overall, these results emphasize that temperature is an important factor in the population dynamics of both pests and their natural enemies.

Relative humidity displayed mixed effects, with morning humidity showing an insignificant negative correlation with jassids and predators, while evening humidity was positively correlated with jassids (r = 0.497) and thrips (r = 0.405). This suggests that higher evening humidity may provide conducive conditions for the activity and survival of these pests. Rainfall had a significant positive correlation with thrips (r = 0.582), indicating that increased rainfall can lead to higher thrips populations, possibly due to the favourable microclimatic conditions it creates. However, the impact of rainfall on other pest groups was less consistent, reflecting the complexity of interactions between rainfall and pest populations.

The correlation coefficient study reveals that the population of jassids, aphids, whiteflies, thrips and mealybugs was positively correlated with mean temperature, relative humidity and total average rainfall, and the population of these pests was found significantly positive with the relative humidity (Jat *et al*, 2023) [6]. The results are consistent with previous research findings by Bhattacharyya *et al.* (2019) [2], Behera *et al.* (2018) [1], and Krishna *et al.* (2020) [8], which demonstrated significant correlations between temperature, rainfall, and relative humidity with the incidence of sucking pests in cotton. The abiotic factors such as maximum temperature, minimum temperature, evening relative humidity and rainfall had a positive effect on the leafhopper, whitefly and aphid population corroborates the findings of Bhattacharyya *et al.*, (2019) [2]

Table 1: Seasonal dynamics of sucking insect pest population during 2021-22

Standard week	Jassid/3 leaves	Aphids/3 leaves	Whitefly/3 leaves	Thrips/3 leaves	Predators/plant	Temp. (°C)		RH (%)		Rainfall (mm)
						Max.	Min.	Morning	Evening	
30 (23-29 July)	0.00	0.62	0.00	0.00	0.05	24.2	27.2	73.2	82	56.40
31 (30 -5 Aug)	0.00	4.33	0.00	0.00	0.20	24.0	31.0	82.0	77.6	34.00
32 (6 -12 Aug)	0.00	28.75	0.00	0.00	0.65	24.5	33.9	75.9	78.0	16.40
33 (13-19 Aug)	0.00	32.93	0.00	0.00	1.05	23.7	32.0	87.0	82.1	87.40
34 (20-26 Aug)	0.67	38.43	0.00	0.93	2.70	24.2	33.7	74.9	81.0	6.60
35 (27-2 Sept)	0.65	6.62	0.17	1.47	3.05	23.3	32.4	82.7	82.9	55.40
36 (3-9 Sept)	1.57	10.77	1.02	5.07	2.40	23.3	31.8	81.6	79.1	88.60
37 (10-16 Sept)	4.63	7.08	0.60	8.25	1.55	23.3	30.5	89.9	83.1	118.60
38 (17-23 Sept)	7.48	6.10	0.52	10.22	1.10	23.2	33.1	83.0	81.9	80.00
39(24- 30 Sept)	5.10	2.67	0.45	6.08	1.20	23.6	32.3	82.0	75.7	6.00
40 (1-7 Oct)	6.58	2.03	1.45	3.97	1.30	22.9	34.3	84.0	59.6	0.00
41 (8- 14 Oct)	10.07	0.72	1.12	1.95	2.30	21.9	33.4	85.0	53.7	1.00
42 (15-21 Oct)	14.57	0.00	0.18	0.32	2.10	23.3	32.8	90.1	62.0	1.20
43 (22-28 Oct)	14.98	0.35	0.96	0.00	0.90	18.2	32.1	85.0	45.1	0.00
44 (29-4 Nov)	8.12	1.24	1.24	0.40	0.64	21.1	30.9	92.6	59.0	26.00
45 (5-11Nov)	5.38	2.48	1.56	0.32	0.40	16.6	29.8	88.4	42.9	0.00
46 (12-18 Nov)	4.08	2.24	2.08	0.20	0.00	22.3	29.7	90.3	74.1	6.00
47 (19-25 Nov)	3.84	1.64	2.42	0.00	0.20	20.7	31.2	92.4	59.9	1.60
48 (26-2 Dec)	1.08	1.08	1.08	0.00	0.24	14.2	28.6	90.9	38.6	0.00
49 (3-9 Dec)	0.64	0.48	0.20	0.00	0.20	17.3	24.8	94.6	73.6	4.40
50 (10-16 Dec)	0.00	0.00	0.00	0.00	0.00	14.9	27.0	93.1	47.7	0.00
51 (17-23 Dec)	0.00	0.00	0.00	0.00	0.00	8.8	26.3	91.1	33.0	0.00
52 (24-31 Dec)	0.00	0.00	0.00	0.00	0.00	16.1	27.4	90.9	54.3	0.00
Range	0.64-14.98	0.00-38.43	0.17-2.42	0.00-10.22	0.00-3.05					
Mean±SD	5.59±4.59	7.53±11.58	1.00±0.68	3.01±3.42	1.11±0.95					
	S	NS	S	S	S					

Table 2: Effect of weather parameters on incidence of the sucking pests and their predators in cotton

Meteorological parameters	Simple correlation coefficient (r)				
	Aphids	Jassids	Whiteflies	Thrips	Predators
Temp. (Min) (°C)	0.444*	0.445*	0.179	0.363	0.673*
Temp. (Max) (°C)	0.144	0.432*	-0.001	0.358	0.521*
Temp. (Mean) (°C)	0.283	0.473*	0.075	0.389	0.628*
R H (Morning) (%)	0.146	-0.514	0.323	-0.176	-0.390
R H (Evening) (%)	-0.243	0.497*	-0.261	0.405*	-0.390
R H (Mean) (%)	-0.220	0.355	-0.164	0.395	0.283
Rain fall (mm)	-0.179	0.297	-0.204	0.582	0.315
P=0.05	0.404				
P=0.01	0.515				

4. Conclusion

These findings highlight the need for weather-based pest management strategies. By incorporating weather parameters into decision-making, farmers can optimize the timing of control measures, such as pesticide applications, and enhance the effectiveness of integrated pest management (IPM) practices. Furthermore, understanding these relationships is key for developing climate-resilient pest management strategies as weather patterns continue to change due to global warming.

References

1. Behera UK, Jena BC, Satapathy CR. Effect of weather factors on seasonal incidence of major sucking insect pests on Bt and non-Bt cotton under rainfed conditions of Odisha. Journal of Entomology and Zoology Studies. 2018;6(4):1027-1033.
2. Bhattacharyya K, Das A, Mondal B, Bhattacharyya M, Mohapatra LN. Seasonal incidences of some sucking pests in cotton and their correlation with abiotic factors at south coastal districts of Odisha. Journal of Entomology and Zoology Studies. 2019;7(2):949-953.
3. Chi BJ, Zhang DM, Dong HZ. Control of cotton pests and diseases by intercropping: A review. Journal of Integrative Agriculture. 2021;20(12):3089-3100. doi: 10.1016/S2095-3119(20)63318-4.
4. Garzo E, Moreno A, Plaza M, Fereres A. Feeding behavior and virus-transmission ability of insect vectors exposed to systemic insecticides. Plants. 2020;9(7):895. doi: 10.3390/plants9070895.
5. Indian Council of Agricultural Research - All India Coordinated Research Project on Cotton. ICAR-AICRP (Cotton) Annual Report (2023-24). Nagpur: A-2. 2024. Available from: https://aiccip.cicr.org.in/pdf/annual_report/AICRP_AR_2023_24.pdf.
6. Jat S, Mahla MK, Saini DK, Ramesh Babu S. Population dynamics of major sucking insect pests infesting Bt cotton (*Gossypium hirsutum* L.) and their natural enemies. The Pharma Innovation Journal. 2023;12(12):17-22.
7. Kannan M, Uthamasamy S, Mohan S. Impact of insecticides on sucking pests and natural enemy complex of transgenic cotton. Current Science. 2004;86(5):726-729. Available from: https://www.jstor.org/stable/24108912.
8. Krishna MS, Reddy YR, Chandrayudu E. Impact of weather parameters on seasonal incidence of insect pests in Bt and non-Bt cotton. Journal of Pharmacognosy and Phytochemistry. 2020;9(6):696-701.
9. Meena SK, Mishra S, Kumawat S. Major Insect Pests of Cotton and Their Eco-Friendly Management. In: Insect Pests of Crops and Their Eco-Friendly Management. Bhumi Publishing, India. 2023; ISBN: 978-93-88901-25-3:70-82. Available from: https://www.researchgate.net/publication/377307069.
10. Nihal R, Bala SC, Sarkar A. Population dynamics of aphid (*Aphis gossypii*) and jassid (*Amrasca biguttula biguttula*) in Bt cotton. Journal of Entomology and Zoology Studies. 2019;7(2):1015-1019.