Pest Management in Horticultural Ecosystems
Vol. 32, No.1 pp 101-106 (2026)
DOI Number : 10.5958/0974-4541.2026.00019.6

Seasonal incidence of insect pests on Amaranthus and Palak in Malnad region of Karnataka

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ABSTRACT: An investigation was conducted during 2019–20 at the Zonal Agricultural and Horticultural Research Station, Shivamogga, to assess the seasonal incidence of major insect pests of amaranthus and palak and their association with weather parameters. Distinct seasonal trends were observed in pest population dynamics. Tobacco cutworm (*Spodoptera litura*) reached peak incidence during the second week of August in *Kharif* and showed positive correlation with rainfall and evening relative humidity, and negative correlation with sunshine hours and minimum temperature. Leaf miner (*Liriomyza* sp.) incidence was highest during the first week of October in *Kharif* and the fourth week of January in *Rabi*, with positive association with temperature and sunshine hours, and negative association with relative humidity and rainfall. Aphid (*Aphis craccivora*) population peaked during *Rabi* and was positively correlated with maximum temperature and sunshine hours but negatively correlated with rainfall and relative humidity. The findings highlight the strong influence of seasonal weather factors on pest-buildup and provide a basis for weather-based pest monitoring and timely management strategies.

Keywords: Amaranthus, Palak, insect pests, seasonal incidence

INTRODUCTION

Green leafy vegetables are cultivated as a minor crop throughout the year in many parts of the world due to their high nutritional value and short crop duration. In India, leafy vegetables are cultivated both in the plain and hilly regions of Himachal Pradesh, Gujarat, Punjab, Maharashtra, West Bengal, Haryana, Madhya Pradesh, Bihar, Delhi, Uttar Pradesh and Karnataka (Anand *et al*., 2020). The essential leafy vegetables are amaranthus and palak. Amaranthus is very popular due to its early maturity, high nutritional value and palatability. It is also an excellent source of starch, fibre, minerals and vitamins (Coelho *et al.,* 2018). Palak is also one of the important leafy vegetables of the tropical and subtropical regions. It is a rich and cheap source of vitamin A and other essential nutrients. Due to their high nutritional importance and frequent consumption, maintaining their productivity and quality is essential. Leafy vegetables are highly susceptible to several insect and non-insect pests *viz*., leaf webbers, tobacco cutworm, leaf miner, amaranthus bug, aphid, flea beetle, stem weevil, stink bug, grasshopper, thrips, mites, mealy bug and whitefly. These pests directly damage the edible foliage, reducing quality and market value. Since the leaf itself is consumed, even minor infestations can cause significant economic losses. Although pest problems in leafy vegetables have been reported in different regions, there is a lack of systematic and region-specific studies on the incidence, population dynamics and severity of major pests of amaranthus and palak in Karnataka. Pest occurrence and intensity are strongly influenced by local climatic conditions, cropping patterns and agro-ecological factors. Therefore, findings from other regions cannot be directly applied to Karnataka. This highlights the clear research gap: the absence of localised, scientifically documented information on the seasonal incidence and severity of major pests of amaranthus and palak under local conditions. Hence, there is a need to undertake local studies to generate region-specific data, identify peak pest periods and develop effective pest management strategies suitable for supporting sustainable production and minimizing unnecessary pesticide use.

MATERIALS AND METHODS

The studies were conducted during *Kharif* and *Rabi* seasons of 2019-20 at Zonal Agricultural and Horticultural Research Station (ZAHRS), Navile, Shivamogga, to determine the seasonal incidence of major insect and mite pests of amaranthus and palak *viz*., tobacco cutworm (*Spodoptera litura* Fabricius), leaf miner (*Liriomyza* sp.) and aphids (*Aphis craccivora* Walker). The experiment was carried out in an open field using a bulk plot measuring 5 m × 2 m. Seeds were broadcasted uniformly without spacing. For recording pest incidence, ten plants were selected randomly and permanently tagged to ensure sampling consistency throughout the crop period. Observations were recorded at weekly intervals from the fourth week of July to the first week of October during *Kharif* and from the second week of November to the fourth week of January during *Rabi*. Aphid population was assessed by counting the number of aphids present on 5 cm apical shoot length, including young leaves, from each selected plant and the mean number of aphids per 5 cm shoot length was calculated. In the case of tobacco cutworm, the number of larvae present per plant was counted and expressed as mean larvae per plant. For leaf miner, the total number of leaves infested per plant was recorded and expressed as mean number of infested leaves per plant.

The obtained data were subjected to statistical analysis. Correlation analysis was performed to determine the relationship between pest population and weather parameters at $p = 0.01$ and $p = 0.05$ level of significance. The Multiple regression analysis was performed to assess the extent of influence of weather parameters. The weather parameters considered included total rainfall, maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours and wind velocity. Meteorological data were obtained from the meteorological observatory of the College of Agriculture, Navile, Shivamogga. To avoid confounding effects, the experimental plot was selected in a uniform field with similar soil and cropping history. All recommended agronomic practices were uniformly followed except plant protection measures. No insecticides were applied during the crop period to allow natural pest infestation. Regular manual weeding was carried out to prevent weed-mediated pest influence. The experimental area was isolated from pesticide-treated fields to prevent spray drift.

RESULTS AND DISCUSSION

The incidence of insect pests in amaranthus and palak was significantly influenced by various weather parameters. The seasonal incidence of tobacco cutworm (*Spodoptera litura* Fabricius) differed between *Kharif* and *Rabi* seasons in both amaranthus and palak. During *Kharif*, larval population was first recorded in the fourth week of July (1.80 and 1.90 larvae/plant in amaranthus and palak, respectively) and reached a peak during the second week of August (3.20 and 3.10 larvae/plant), followed by a gradual decline toward the first week of October (1.20 and 1.20 larvae/plant). The mean population during *Kharif* was 2.15 ± 0.62 and 2.16 ± 0.55 larvae/plant in amaranthus and palak, respectively. In *Rabi*, infestation commenced during the second week of November (1.00 and 1.10 larvae/plant) and declined steadily to nil population by the third and fourth weeks of January, with seasonal means of 0.418 ± 0.334 and 0.45 ± 0.39 larvae/plant in amaranthus and palak, respectively (Table 1). The present findings are in line with Patel (2010) who reported that the incidence of *Spodoptera litura* on groundnut from 3rd week of July (0.50 larvae/plant) and attained its peak during the 3rd week of August (1.80 larvae/plant). The present findings are also in line with Shakya *et al*. (2015) who reported that the incidence of *S. litura* started from 5th January 2014 on tomato and reached its peak on 26th February.

Table 1: Population dynamics of insect pests in amaranthus and palak during *Kharif* and *Rabi* 2019-20

Season	Period of observation	Standard week	*No. cutworm larvae/ plant		*No. leaf miner larvae/ plant		*No. aphids/5 Cm shoot length
			Amaranthus	Palak	Amaranthus	Palak	Amaranthus
Kharif	July 4th week	30	1.80	1.90	0.10	0.00	3.26
	August 1st week	31	2.70	2.70	0.30	0.20	2.84
	August 2nd week	32	3.20	3.10	0.50	0.40	2.63
	August 3 rd week	33	2.80	2.60	0.90	0.90	3.86
	August 4th week	34	2.50	2.40	1.20	1.30	5.14
	August 5th week	35	2.40	2.40	1.80	1.70	4.86
	September 1st week	36	2.20	2.20	2.20	2.20	4.92

Kharif	September 2nd week	37	1.90	2.00	2.40	2.30	5.63
	September 3rd week	38	1.60	1.80	2.70	2.60	5.92
	September 4th week	39	1.40	1.50	2.90	2.80	5.36
	October 1st week	40	1.20	1.20	3.30	3.10	4.52
	Mean ± SD		2.15±0.62	2.16±0.55	1.66±1.12	1.59±1.099	4.44±1.13
Rabi	November 2nd week	45	1.00	1.10	1.20	1.10	18.34
	November 3rd week	46	0.80	0.90	1.60	1.40	22.83
	November 4th week	47	0.70	0.80	1.90	1.90	25.36
	December 1st week	48	0.60	0.70	1.70	1.50	19.24
	December 2nd week	49	0.50	0.70	1.60	1.20	22.86
	December 3rd week	50	0.40	0.40	1.90	1.70	25.63
	December 4th week	51	0.30	0.20	2.10	2.10	23.36
	January 1st week	52	0.20	0.10	2.00	2.00	24.82
	January 2nd week	1	0.10	0.10	2.30	2.20	25.68
	January 3rd week	2	0.00	0.00	2.70	2.50	26.14
	January 4th week	3	0.00	0.00	2.90	2.80	26.83
	Mean ± SD		0.418±0.334	0.45±0.39	1.99±20.49	1.85±0.53	23.73±2.78

*Mean of 10 plants

Correlation analysis during *Kharif* revealed significant positive association of cutworm population in amaranthus with rainfall (r = 0.630*) and evening relative humidity (r = 0.820*), and significant negative association with minimum temperature (r = –0.777**) and sunshine hours (r = –0.603*). Similar trends were observed in palak, where rainfall (r = 0.643*) and evening relative humidity (r = 0.806**) showed positive correlation, while maximum temperature (r = –0.803**) and sunshine hours (r = –0.616*) showed negative correlation (Table 2). These relationships indicate that humid conditions with reduced sunshine favoured larval buildup. The equation obtained when the data was subjected to multiple linear regression analysis with the coefficients of determination (R^2) of 0.710 and 0.713 during *Kharif* and 0.758 and 0.871 during *Rabi* in amaranthus (71% and 71.30%) and palak (75.80% and 87.10%), respectively indicating the extent of influence of weather parameters on population of cutworm (Table 2, Fig. 1). The results are in close agreement with the findings of Patel (2010) who correlated the incidence of *S. litura* with weather parameters and reported that *S. litura* exhibited a significant positive correlation with evening relative humidity and significant negative correlation with maximum temperature and sunshine hours on groundnut. This is also in close agreement with the results of Shakya *et al*. (2015) who reported that the population of *S. litura* was influenced by weather factors and revealed that there was a significant positive effect with maximum and minimum relative humidity and rainfall, whereas maximum temperature had a significant negative effect on tobacco cutworm population.

Leaf miner (*Liriomyza* sp.) incidence was observed from the fourth week of July (0.10 and 0.00 larvae/plant) and increased progressively to a peak during the first week of October (3.30 and 3.10 larvae/plant) in amaranthus and palak, respectively, with seasonal means of 1.66 ± 1.12 and 1.59 ± 1.09 larvae/plant during *Kharif*. During *Rabi*, infestation ranged from 1.20 and 1.10 larvae/plant in the second week of November to 2.90 and 2.80 larvae/plant in the fourth week of January, with seasonal means of 1.99 and 1.85 larvae/plant in amaranthus and palak, respectively (Table 1). The present findings are in line with Lakshminarayana (2016) who reported that the incidence of groundnut leaf miner was high in August sown crop as compared to June month on groundnut. The present findings are

Table 2: Correlation coefficient (r), Regression equation and Coefficient of determination (R^2) between insect pests and weather parameters in amaranthus and palak during *Kharif* and *Rabi* 2019-20

Insect pest	Correlation coefficient (r) (Amaranthus)												Amaranthus		
	Total Rainfall (mm) (X_1)		Temperature (°C)				Relative humidity (%)				Sunshine (hours/day) (X_6)		Season	Coefficient of determination (R^2)	Regression equation
			Maximum (X_2)		Minimum (X_3)		RH I (X_4)		RH II (X_5)						
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*			
Cut worm (No./ plant)	0.630*	0.448	0.520	-0.585	-0.777**	0.638*	0.586	-0.338	0.820*	0.491	-0.603*	-0.154	***Kharif***	0.710	$Y= 9.810 + 0.630X_1 + 0.520X_2 - 0.777X_3 + 0.586X_4 + 0.820X_5 - 0.603X_6$
													Rabi	0.758	$Y= -3.018 + 0.448X_1 -0.585X_2 + 0.683X_3 - 0.338X_4 + 0{,}491X_5 - 0.154X_6$
Leaf miner (No./ plant)	-0.488	-0.443	0.027	0.694	0.775**	-0.721	-0.485	-0.029	-0.777*	-0.743	0.756**	0.334	***Kharif***	0.538	$Y= -45.022 - 0.488X_1 + 0.027X_2 + 0.775X_3 - 0.485X_4 - 0.777X_5 + 0.756X_6$
													Rabi	0.651	$Y= 7.944 - 0.443X_1 + 0.694X_2 - 0.721X_3 - 0.029X_4 - 0.743X_5 + 0.334X_6$
Aphids (No./ shoot)	-0.721*	-0.819	0.667	0.707	0.071	-0.705	-0456	-0.025	-0.696	-0.668	0.699	0.649	***Kharif***	0.845	$Y= -40.14 - 0.721X_1 + 0.667X_2 + 0.071X_3 - 0.456X_4 - 0.696X_5 + 0.699X_6$
													Rabi	0.721	$Y= 39.81 - 0.819X_1 + 0.707X_2 - 0.705X_3 - 0.025X_4 - 0.668X_5 + 0.649X_6$

Insect pest	Correlation coefficient (r) (Palak)												Palak		
	Total Rainfall (mm) (X_1)		Temperature (°C)				Relative humidity (%)				Sunshine (hours/day) (X_6)		Season	Coefficient of determination (R^2)	Regression equation
			Maximum (X_2)		Minimum (X_3)		RH I (X_4)		RH II (X_5)						
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*			
Cut worm (No./ plant)	0.643*	0.447	-0.803**	-0.640*	0.115	0.622*	0.568	-0.383	0.806**	0.490	-0.616*	-0.145	***Kharif***	0.713	$Y= 9.503 + 0.643X_1 - 0.803X_2 + 0.115X_3 + 0.568X_4 + 0.806X_5 - 0.616X_6$
													Rabi	0.871	$Y= -0.509 + 0.447X_1 - 0.640X_2 + 0.622X_3 - 0.383X_4 + 0.490X_5 - 0.145X_6$
Leaf miner (No./ plant)	-0.508	-0.433	0.770**	0.782	0.024	-0.692	-0.473	-0.022	-0.769**	-0.752	0.760**	0.349	***Kharif***	0.579	$Y= -45.93 - 0.508X_1 + 0.770X_2 + 0.024X_3 - 0.473X_4 - 0.769X_5 + 0.760X_6$
													Rabi	0.672	$Y= 8.302 - 0.433X_1 + 0.782X_2 - 0.692X_3 - 0.022X_4 - 0.752X_5 + 0.349X_6$

N=11; **Correlation is significant at the 0.01 level; Table r value at p=0.01 is 0.735, *Correlation is significant at the 0.05 level; Table r value at p=0.05 is 0.602, X_1= Rainfall, X_2= Maximum temperature, X_3=Minimum temperature, X_4= Morning relative humidity, X_5= Evening relative humidity, X_6= Sunshine hours also in close agreement with Aswathanarayana and Ashok (2005) who conducted studies on the seasonal monitoring of leaf miner on tomato and reported the peak incidence of leaf miner (*Liriomyza trifolii*) during March and April with 4.90 and 4.40 mines per leaf, respectively. Correlation analysis showed that during *Kharif*, leaf miner population in amaranthus had significant positive correlation with minimum temperature (r = 0.775**) and sunshine hours (r = 0.756**), and significant negative correlation with evening relative humidity (r = –0.777*). In palak, maximum temperature (r = 0.770**) and sunshine hours (r = 0.760**) were positively correlated, while evening relative humidity (r = –0.769**) was negatively correlated (Table 2). These results suggest that relatively higher temperatures coupled with increased sunshine hours and comparatively lower relative humidity, favoured leaf miner activity and population buildup. The regression equation obtained showed moderate explanatory power with R^2 values ranging from 0.538 to 0.672, showing about 53.8 to 67.2 per cent of the variation in leaf miner population, with a moderate level of influence (Table 2, Fig. 1). These results are in line with the findings of Lakshminarayana (2016) who reported that the infestation of groundnut leaf miner was positively correlated with maximum temperature, minimum temperature and negatively correlated with morning relative humidity, evening relative humidity and rainfall. The results are also in close line with the findings of Aswathanarayana and Ashok (2005) who reported that the leaf miner population was significantly influenced negatively by rainfall and had a positive correlation with maximum temperature, while morning relative humidity and evening relative humidity showed a negative correlation with leaf miner.

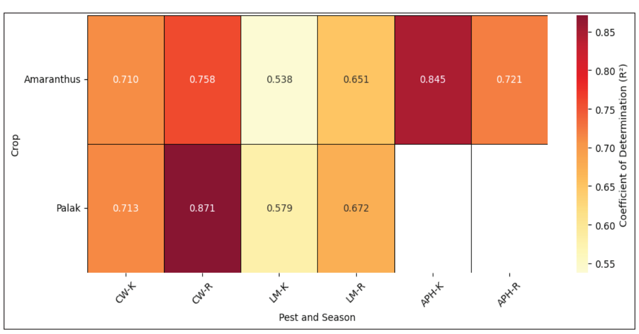

Fig. 1. Heat map of Coefficient of Determination (R^2) between insect pests and weather parameters (2019–20)

CW-K- Cutworm in *Kharif*, CW-R- Cutworm in *Rabi*, LM-K=Leaf miner in *Kharif,* LM-R=Leaf miner in *Rabi*, APH-K=Aphids in *Kharif,* APH-R=Aphids in *Rabi*

Aphid (*Aphis craccivora* Walker) population in amaranthus during *Kharif* ranged from 2.63 to 5.92 aphids per 5 cm shoot length, with peak incidence during the third week of September (5.92 aphids/5 cm shoot) and seasonal mean of 4.44 ± 1.13. During *Rabi*, aphid population increased markedly from 18.34 aphids per 5 cm shoot in the second week of November to a peak of 26.83 aphids per 5 cm shoot in the fourth week of January, with a seasonal mean of 23.73 ± 2.78 (Table 1). These results are in close line with Parul *et al*. (2018) who reported that the population of aphids reached its peak during September (17.2 aphids/5 cm shoot length) in soybean. The findings are also in close agreement with the results of Harshita *et al*. (2019) who reported that the aphid population reached its peak (9.1aphid/leaf) during the first fortnight of February on tomato. Correlation analysis revealed that during *Kharif*, aphid population in amaranthus showed significant negative correlation with rainfall (r = –0.721*) and positive association with maximum temperature (r = 0.667) and sunshine hours (r = 0.699). During *Rabi*, rainfall (r = –0.819) and minimum temperature (r = –0.705) exhibited negative association, while maximum temperature (r = 0.707) and sunshine hours (r = 0.649) showed positive association (Table 2). These findings indicate that reduced rainfall, moderate to higher maximum temperatures and increased sunshine hours, along with comparatively lower minimum temperature and relative humidity, favoured rapid multiplication and population buildup of aphids. The regression model for aphids showed a high coefficient of determination (R^2 = 0.845 during *Kharif* and 0.721 during *Rabi*), indicating strong dependence on weather variables (Table 2, Fig. 1). These results are in close line with Parul *et al*. (2018) who reported that the population of *Aphis gossypii* was influenced negatively by rainfall, morning relative humidity and had a positive correlation with maximum temperature during *Kharif* in soybean. The findings are also in close agreement with the results of Harshita *et al*. (2019) who reported that the aphids showed a positive correlation with maximum temperature and negative correlation with minimum temperature and average relative humidity on tomato.

Overall, the data demonstrate that tobacco cutworm incidence was favoured by higher rainfall and elevated evening relative humidity, whereas leaf miner infestation increased under conditions of higher temperature and greater sunshine hours. In contrast, aphid population buildup was associated with reduced rainfall and moderate temperature conditions. The peak infestation of tobacco cutworm was recorded during August with a maximum population of 3.20 larvae per plant, while leaf miner incidence reached its maximum during October with 3.30 larvae per plant. Aphid population attained its peak during January with 26.83 aphids per 5 cm shoot length. The identification of these distinct peak periods provides a scientific basis for implementing timely and season-specific pest management strategies for amaranthus and palak under Shivamogga conditions.

CONCLUSION

The present investigation established clear seasonal patterns in the incidence of major insect pests of amaranthus and palak under Shivamogga conditions and demonstrated the significant influence of weather parameters on pest population dynamics. Distinct peak periods were identified for tobacco cutworm during early *Kharif*, leaf miner during later crop stages, and aphids during *Rabi*, confirming that pest occurrence is season-specific and weather-driven. These findings provide a scientific basis for developing weather-based pest forecasting and monitoring systems for leafy vegetables in Karnataka. Identification of peak infestation windows enables targeted field scouting and timely interventions before pest populations reach economic threshold levels. The strong association between pest incidence and specific meteorological factors highlights the scope for incorporating climatic indicators into decision-support tools for management scheduling. Adoption of season-specific and need-based pest management strategies based on these findings can reduce unnecessary pesticide applications, lower production costs, minimize residues on edible foliage and promote sustainable cultivation of amaranthus and palak under similar agro-climatic conditions.

ACKNOWLEDGEMENT

Authors are thankful to the authorities of KSNUAHS, Shivamogga for providing necessary facilities, guidance and help during this research study.

AUTHORS CONTRIBUTIONS

MBJ - Design of work, data collection, analysis, interpretation of results, and writing the original manuscript; JNH- Conceptualization, design of work, Review, supervision, and editing the draft; RK, GNB and NA - Review, supervision and editing the draft; DR - Assisted in writing and reviewing the manuscript. All authors read and approved the manuscript.

CONFLICT OF INTEREST

Authors have no conflict of interest to express.

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MS Received: 20 March 2026
MS Acceptance: 18 May 2026