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RESEARCH PAPER

Incidence of potato pests in relation with weather parameters during *kharif* 2024

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Abstract: Potato (*Solanum tuberosum* L.) is a major food crop in India, vulnerable to several insect pests that cause substantial yield losses. Field study was conducted at MARS, Dharwad during *kharif* 2024 using the variety Kufri Jyothi to assess the seasonal incidence of key insect pests and their relationship with weather parameters. Observations on aphids, leafhoppers, thrips, whiteflies, mites, *Spodoptera litura*, shoot borer and natural enemies (coccinellids, spiders, chrysopids) were recorded at weekly intervals from crop emergence to harvest. Results revealed that maximum populations of major sucking pests (aphids, leafhoppers, thrips, whiteflies and mites) occurred in 33rd standard meteorological week (mid-August), coinciding with high temperature and low rainfall. These pests exhibited strong positive correlations with maximum and minimum temperatures and negative correlations with relative humidity and rainfall. Among them, leafhoppers, thrips, whiteflies and mites showed significant positive correlations with maximum temperature. *Spodoptera litura* population increased under higher temperatures but declined with increased humidity and rainfall. Maximum shoot borer infestation was observed during the 36th-37th SMWs (early September) and showed significant negative correlations with maximum relative humidity and rainfall. Natural enemies, particularly coccinellids, increased with rising pest populations and were strongly influenced by minimum temperature. Findings highlight the strong influence of weather parameters on pest population dynamics and emphasize the importance of seasonal monitoring for scheduling effective pest management strategies in potato.

Key words: Aphids, Kufri Jyothi, Leafhoppers, Mites, *Spodoptera litura,* Thrips

Introduction

Potato (*Solanum tuberosum* L.) is one of the world's most important high-yielding horticultural food crops. It is native to the Peru–Bolivia region of the Andes in South America and was introduced to India from Europe by the Portuguese in the early 17th century. The domestic demand for potato in India is projected to reach 122 million tons by 2050.Globally, potato ranks as the third most important food crop for human consumption, after rice and wheat. India and China together account for one-third of global potato production, making Asia a leading contributor. Within India, potato is the most predominant vegetable, consumed widely in households and processed food industries.Currently, around 68% of domestic potato production is consumed fresh, 7.5% is used for processing, 8.5% is retained as seed, while nearly 16% is lost due to post-harvest wastage (Singh, 2023). Economically, potato contributes 2.86% to India's agricultural GDP from just 1.32% of cultivable land. In comparison, rice and wheat occupy far more land but their GDP contribution per unit land is much lower, making potato about 3.7 times more efficient than rice and 5.4 times more than wheat in terms of land productivity.In India, the major potato-growing states are Uttar Pradesh, Assam, West Bengal, Punjab, Madhya Pradesh and Karnataka. Specifically, Karnataka is a key potato-growing state where the crop is cultivated mainly in Hassan, Dharwad, Belgaum, Chikkaballapur and Kolar districts. Rich in vitamin C, several B vitamins and potassium, potatoes offer valuable nutritional benefits. (Surekha *et al*., 2024)

Among the various pests affecting potato, aphids, leafhoppers, thrips, cutworms, Epilachna beetles, defoliating caterpillars, shoot borer and potato tuber moths are regarded as serious threats, leading to considerable economic losses. However, information on the seasonal incidence of these insect pests in the potato ecosystem, particularly under specific agro-climatic situations, remains limited. Meteorological factors strongly influence the life cycle and population build-up of insect pests; hence, examining their relationship with pest activity is vital. Such investigations contribute to the development of predictive models that enable more precise forecasting of pest outbreaks. It is thus necessary to examine how potato pest populations fluctuate with changing climatic variables, as such factors strongly regulate their abundance

Material and methods

Field experiment was conducted at MARS, Dharwad during *kharif* 2024. The variety Kufri Jyothi was planted in a plot size of 120 sq. mts (6 plots) with 60cm X 20 cm spacing. No insect protection measures were taken in order to determine the incidence of key pests of potato. Observations on insect populations was recorded at weekly intervals starting from 15 days after emergence of plant till harvest of the crop. Ten plants were selected randomly and tagged. From which observations on the incidence of major pests such as shoot borer, aphids, whiteflies, jassids, thrips, hoppers and mites were recorded.The extent of damage caused by different insect pests and weekly observations on abiotic parameters such as maximum and minimum temperature, relative humidity and rainfall were also recorded. The pest damage was then correlated with these weather factors to understand the influence of abiotic conditions on pest incidence.

Observations recorded

For shoot borer, per cent shoot damage by shoot borer was calculated by counting number of shoots infested per plant and total number of shoots per plant by using the formula mentioned below:

$$\text{Per cent shoot infestation} = \frac{\text{No. of shoot infested}}{\text{Total no.of shoot}} \times 100$$

For aphids, from each plant, three compound leaves (one each from top, middle, bottom) was examined. Aphid counts per compound leaf was recorded using a 10X hand lens and expressed in terms of aphid numbers per compound leaf (Anon., 1995). For leafhoppers, thrips and whiteflies, ten plants were randomly selected and tagged. From each plant, three leaves were sampled from the top, middle and lower portions. The total number of nymphs and adults of the above mentioned insects on each leaf was counted and expressed in terms of number of insects per three leaves per plant (Bhatnagar, 2007). To sample mites, ten plants were chosen at random and three leaves each from the upper, middle and lower canopy were collected in polythene bags. The collected leaves were then taken to the laboratory and examined under a stereo-binocular microscope to detect the presence of mites and the number of mites per leaf was recorded (Patil, 2005). For leaf eating caterpillar (*S. litura*), 10 random spots of one meter row length were selected. Larval counts were taken by gently shaking the plant over a white cloth placed between the rows. The average number of caterpillars found per meter of row length was calculated. Predatory ladybird beetles, chrysopids and spiders was recorded separately from ten plants and expressed in terms of numbers per plant.

Results and discussion

Data related to population dynamics of major insect pests of potato are presented in Table 1, while their correlation with weather parameters in Table 2.

Aphids (*Myzuspersicae*)

Aphid incidence on potato began at a low level (0.42/3 leaves) in the 30th MSW, reached peak at 10.58 in the 33rd MSW, and then declined sharply, remaining negligible by the 37th–38th MSW. Excess rainfall during the initial 30th and 34th weeks likely reduced the aphid population by washing them off the plants, contributing to the observed decline in their numbers. Kumara *et al.* (2017) reported peak aphid populations on potato during early July and late August (81 and 117 aphids/102 leaves), while Natikar *et al.* (2022) observed *Myzuspersicae* appearing from the 29th to 39th MSW, with a peak of 12.41 aphids/leaf at the 33rd MSW.

Correlation analysis of aphid population with weather parameters revealed that 56% of the population variation was influenced by these parameters. The aphid population exhibited a non-significant positive correlation with maximum temperature (r = 0.451) and minimum temperature (r = 0.388) and a non-significant negative correlation with maximum relative humidity (r = -0.053), minimum relative humidity (r = -0.205) and rainfall (r = -0.317). Kumara *et al.* (2017) observed that aphid populations in potato crops showed a positive correlation with temperature and wind speed, while exhibiting a negative correlation with rainfall and humidity.Mahore *et al.* (2022) observed that brinjal aphid populations exhibited positive associations with temperature, but negative relationships with morning relative humidity. Nayak *et al.* (2019) revealed that aphid populations showed a significant positive correlation with maximum temperature, while demonstrating significant negative correlations with morning, evening and average relative humidity across both *rabi* seasons. Prashanth *et al.* (2023) found aphid populations showed strong positive correlations with maximum temperature and sunshine duration, while demonstrating significant negative correlations with morning relative humidity and evening relative humidity. Rainfall also exhibited a significant negative relationship with aphid incidence.

Leaf hoppers (*Empoasca sp.* and *Amarasca biguttula biguttula*)

The seasonal incidence of leaf hoppers across the standard meteorological weeks (SMWs) began with no infestation (0.00 insects per three leaves) in the 30th SMW, followed by a small rise to 0.33 in the 31st SMW and 0.58 in the 32nd SMW. A sharp rise was observed in 33rd SMW with 3.17 insects, marking the peak incidence for leaf hoppers, after which the population slightly decreased to 2.98 in 34th SMW. It then dropped further to 0.42 in 35th SMW, increased to 1.07 in the 36th SMW, declined

Table 1. Incidence of insect pests and natural enemies on potato during *kharif* 2024

Meteorological standard week	Sucking pests (Number of insects per three leaves per plant)					*Spodoptera litura* (No of caterpillars/ meter row length)	Shoot borer (%)	Natural enemies (numbers per plant)		
	Aphids	Leaf hopper	Thrips	Whiteflies	Mites**			Coccinellids	Spiders	Chrysopids
30	0.42	0.00	0.00	0.78	12.20	0.00	0.00	0.33	0.07	0.00
31	2.45	0.33	0.03	0.79	12.90	0.00	0.93	0.38	0.12	0.14
32	5.75	0.58	2.08	1.76	14.00	0.20	8.95	0.25	0.18	0.20
33	10.58	3.17	15.42	4.93	16.80	1.00	15.55	0.58	0.43	0.25
34	0.52	2.98	9.40	3.17	17.1	0.50	19.43	0.38	0.13	0.18
35	0.68	0.42	0.17	1.25	15.80	0.20	23.93	0.18	0.22	0.15
36	0.15	1.07	4.92	1.78	15.00	0.00	25.76	0.33	0.13	0.09
37	0	0.67	2.75	3.80	15.90	0.00	26.78	0.00	0.00	0.00
38	0.02	1.68	5.17	3.83	16.30	0.00	25.36	0.03	0.00	0.00

** Number of mites per leaf,

to 0.67 in 37th SMW and finally rose to 1.68 in 38th SMW. The present findings are supported by Natikar *et al*. (2022) reported leafhopper incidence starting at the 30th MSW (0.45/3 leaves) and reached peak at the 36th MSW (12.10) in *kharif* 2016, while in 2017 it began at 31st MSW, reached peak at 35th MSW (10.01), and then declined.

Leafhopper population showed a significant positive correlation with maximum temperature (r = 0.775*) and a non-significant positive correlation with minimum temperature (r = 0.216). It exhibited non-significant negative correlations with maximum relative humidity (r = -0.105), minimum relative humidity (r = -0.512) and rainfall (r = -0.438). **Kunwar *et al.* (2022)** revealed that leafhopper populations exhibited a significant positive correlation with maximum temperature while morning and evening relative humidity showed negative correlations with leafhopper numbers, suggesting higher humidity suppresses their activity. Kumar *et al.* (2021) found that leafhopper populations exhibited strong positive correlations with both maximum (T max) and minimum (T min) temperature and inversely related to relative humidity (RH).

Thrips (*Scirtothrips dorsalis* and *Thrips palmi*)

Thrips incidence started with no population in the 30th SMW and 0.03 insects/3 leaves in 31st SMW, reached peak sharply at 15.42 insects/3 leaves in 33rd SMW, then declined to 9.40 in 34th and dropped to 0.17 in 35th SMW. Natikar *et al.* (2022) reported that thrips incidence began at the 30th–31st MSW, reached peak at 36th MSW (8.92 and 7.43 thrips per three leaves during *kharif* 2016 and 2017, respectively) and declined thereafter.

Thrips population showed a significant positive correlation with maximum temperature (r = 0.822**) and a non-significant positive correlation with minimum temperature (r = 0.256). Non-significant negative correlations were observed with maximum relative humidity (r = -0.247), minimum relative humidity (r = -0.525) and rainfall (r = -0.491).

Whiteflies (*Bemisia tabaci*)

Whiteflies maintained a moderate presence throughout the season, starting at 0.78 per three leaves in 30th MSW and peaking at 4.93 in 33rd MSW, coinciding withthe thrips outbreak. Their population remained steady at moderate levels thereafter (1.25–3.83, 35th–38thMSW). These results align with Natikar *et al.* (2022), who reported similar trends during *kharif* 2016, with a peak of 6.95 whiteflies in the 35th MSW.

Whitefly population showed a strong, significant positive correlation with maximum temperature (r = 0.946**) and non-significant negative correlations with minimum temperature, maximum and minimum relative humidity and rainfall. Prashanth *et al.* (2023) found whitefly populations showed a highly significant positive correlation with maximum temperature. Rainfall also had a significant negative influence on whitefly incidence.

Mites

Mites exhibited a consistently high population, starting at 12.20 per three leaves in 30th MSW and peaking at 17.10 in 34th MSW, followed by slight declines and minor fluctuations (15.00–16.30) up to the 38th MSW. These observations are

Table 4. Correlation and regression values for insect pests and natural enemies in potato with weather parameters during *kharif* 2024

Variables	Correlation coefficient (r) Meteorological parameters					R^2	Regression equation
	Temperature (° C)		Relative humidity (%)		Rainfall		
	Max.Temp (X1)	Min.Temp (X2)	RH Max (X3)	RH min (X4)	(mm) (X5)		
Aphids (Y1)	0.451	0.388	-0.053	-0.205	-0.317	0.56	Y1 =”106.959"0.22X1 +5.543X2 +0.236X3 “0.215X4 “0.073X5
Leaf hopper (Y2)	0.775*	0.216	-0.105	-0.512	-0.438	0.90	Y2 =”53.531+0.746X1 +0.763X2 +0.21X3 “0.007X4 +0.002X5
Thrips (Y3)	0.822**	0.256	-0.247	-0.525	-0.491	0.98	Y3 =”188.596+3.06X1 +5.211X2 +0.07X3 “0.065X4 +0.027X5
Whiteflies (Y4)	0.946***	-0.301	-0.476	-0.816**	-0.702*	0.91	Y4 =”32.53+0.983X1 “0.302X2 +0.148X3 +0.004X4 +0.004X5
Mites (Y5)	0.817**	-0.208	-0.368	-0.596	-0.745*	0.79	Y5 =”41.623+0.939X1 “0.509X2 +0.419X3 +0.052X4 “0.033X5
Spodoptera litura (Y6)	0.585	0.518	0.065	-0.235	-0.362	0.97	Y6 =”18.038+0.082X1 +0.501X2 +0.076X3 “0.012X4 “0.007X5
Shoot borer (%) (Y7)	0.608	-0.526	-0.679*	-0.507	-0.757*	0.66	Y7 =122.832+3.472X1 “8.659X2 “0.745X3 +0.562X4 “0.142X5
Coccinellids (Y8)	0.028	0.897**	0.348	0.296	0.257	0.94	Y8 =”6.543+0.058X1 +0.32X2 “0.015X3 +0X4 +0.003X5
Spiders (Y9)	0.348	0.633	0.039	0.013	-0.269	0.80	Y9 =”4.73"0.01X1 +0.25X2 +0.01X3 “0.01X4 +0X5
Chrysopids (Y10)	0.235	0.623	0.23	0.17	-0.237	0.82	Y10 =”4.96+0.01X1 +0.11X2 +0.03X3 +0X4 +0X5

** Significant at 1% * Significant at 5 %

consistent with Basavaraju *et al.* (2010) and Natikar *et al.* (2022), who reported similar population trends in potato during *kharif* seasons.

Mite population showed a significant positive correlation with maximum temperature (r = 0.817**) and significant negative correlation with rainfall (r = –0.745*), while correlations with minimum temperature (r = –0.208), maximum relative humidity (r = –0.368) and minimum relative humidity (r = –0.596) were negative but non-significant. Natikar *et al.* (2018) reported that the incidence of mites showed a significant negative correlation with maximum relative humidity, minimum relative humidity and rainfall.

Spodoptera litura

Spodoptera litura showed a low but distinct seasonal incidence, appearing from the 32nd MSW (0.20 per plant) and peaking at 1.00 in 33rd MSW, before declining to 0.20–0.50 in the 34th–35th MSW. These findings align with Patil (2005) and Natikar (2022), who reported peak populations during the mid- to late-growth stages (34th MSW) of the crop.

Spodoptera litura showed moderate positive correlations with both maximum (r = 0.585) and minimum temperatures (r = 0.518). Warmer conditions accelerate larval development and boost adult moth activity, allowing faster reproduction and more generations per year. Rainfall had a negative correlation (r = -0.362), as heavy rains can drown young larvae and wash away eggs. Natikar *et al.* (2018) found non-significant positive correlations between *Spodoptera litura* larvae and minimum temperature (r=0.140).

Shoot borer (*Leucinodes orbonalis*)

Shoot borer incidence was low to moderate throughout the observation period. It first appeared in the 32nd MSW at 2.08%, reached peak at 15.42% in the 33rd MSW during the mid-growth stage of the crop and then gradually declined to 9.40% in the 34th MSW, 0.17% in the 35th MSW and remained low (0–5.17%) from the 36th to 38th MSW. Similar findings were reported by Gupta *et al.*(2021) reported that brinjal shoot borer (*Leucinodes orbonalis*) infestation initiated during the 32nd SMW, reaching peak damage intensity by the 40th SMW.Nandi *et al.* (2017) also found that the seasonal patterns of *L. orbonalis* infestation, with initial activity typically emerging in August and reaching peak intensity by mid-to-late September. Shobharani and Nandihalli (2011), revealed that shoot borer infestation in potato commenced by the 31st standard week during *kharif*, reaching peak activity by the 37th standard week. Mahajan *et al.* (2020) revealed that *Leucinodes orbonalis* infestation on brinjal shoots began in the 32nd SMW (0.32%) and peak at 34.62% during the 42nd SMW (third week of October).

Shoot borer incidence was positively correlated with maximum temperature (r = 0.608) and negatively correlated with minimum temperature (r = –0.526), maximum relative humidity (r = –0.679*), minimum relative humidity (r = –0.507) and rainfall (r = –0.757**). Weather parameters explained 66% of the variation in shoot borer incidence (R^2 = 0.66).

Natural enemies (Coccinelids, chrysopids and spiders)

Population of natural enemies on potato showed noticeable temporal variations from meteorological standard week (MSW) 30 to 38. Coccinellids, the most dominant natural enemy, increased steadily from 0.00 per plant in MSW 30 to a peak of 26.78 per plant in MSW 37, followed by a slight decline to 25.36 per plant in MSW 38, reflecting their positive response to the rising populations of sucking pests such as aphids and thrips. Spiders maintained low numbers throughout the observation period, starting at 0.33 per plant in MSW 30, peaking at 0.58 per plant in MSW 33 and gradually declining to 0.03 per plant by MSW 38. Chrysopidswere consistently low, ranging from 0.00 to 0.25 per plant, with the highest counts recorded during MSW 32 and 33.

Coccinellids Population showed a strong positive correlation with minimum temperature (r = 0.897**), while other weather factors had minimal effects. High R^2 (0.94) indicates most variation is explained by weather, with regression confirming minimum temperature as the key driver.Natikar *et al.* (2022) reported that the coccinellid population peaked during the 34th SMW.

Spiders: Moderate positive correlation with minimum temperature (r = 0.633) and weak influence from other factors. R^2 = 0.80; regression shows minimum temperature mainly drives abundance.Natikar *et al.* (2022) also reported that spider incidence started at the 32nd SMW and continued up to the 39th SMW.

Chrysopids: Moderately influenced by minimum temperature (r = 0.623), with minor effects of maximum temperature, humidity and slight negative effect of rainfall. R^2 = 0.82; regression highlights minimum temperature as dominant. Natikar *et al.* (2022) reported that the incidence of chrysopids was first noticed in the 31st SMW and continued up to the 36th SMW.

Conclusion

Maximum populations of major sucking pests such as aphids, leafhoppers, thrips, whiteflies and mites were recorded during the 33rd standard meteorological week (mid-August). This period coincided with high temperatures and low rainfall. These pests exhibited a strong positive correlation with both maximum and minimum temperatures, while showing a negative correlation with maximum and minimum relative humidity as well as with rainfall. Particularly, leafhoppers, thrips, whiteflies and mites showed a significant positive correlation specifically with maximum temperature. *Spodoptera litura* population increased with higher temperatures and decreased under high humidity and rainfall, indicating temperature as the key factor affecting its abundance. Maximum shoot infestation by shoot borer was observed at the later crop stage, during the 36th and 37th standard meteorological weeks (early September). Shoot borer incidence showed a significant negative correlation with maximum relative humidity and rainfall, a non-significant positive correlation with maximum temperature and a non-significant negative correlation with minimum temperature and minimum relative humidity.Seasonal pest incidence helps in planning pest management strategies for potato.

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