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Population Dynamics in Groundnut and their Relationship to the Weather Parameters

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Groundnut crop is the most commonly, and widely grown oil seed crop during the Rabi season at Nagarkurnool district of Telangana state. However, insect pests *viz*., leaf miner (*Aproerima modicella*), tobacco caterpillar (*Spodoptera litura* Fab.), thrips (*Scritothrips dorsalis*) and jassids (*Empoasca kerri* Pruthi) are the major insect pests accounting major yield losses. The sowing window of the crop during rabi starts from 1st Fortnight of September to 1st FN of November. The insect pest's incidence on different dates of sowings varied and ultimately reflecting the final yields under farmer fields. By keeping this in view to suggest a best sowing window where the crop would be less effect by the pests with estimated yields, a study has been taken up to observe the best sowing window where the final yields would be less affected by the pests and diseases.

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Methods: The population dynamics of major insect pests of groundnut were investigated in five different dates of sowings at the Regional Agricultural Research Station, Palem (PJTSAU), Nagarkurnool District, Telangana, during *rabi*, 2019-2021. During the study, the major insect pests *viz*., leaf miner, tobacco caterpillar, thrips, and leafhoppers were observed in all the sowing windows.

Results: The *Spodoptera litura* population initially appeared during 38th SMW. Among all the sowings, the highest infestation occurred in D3 (41.23%) during 48th SMW. Leaf miner incidence was confined to early stage of the crop which was started at 38th SMW and highest incidence of 5.0 webs/plt during 41st SMW in the D1. The maximum leafhoppers population was noticed at D4 (7.2 leafhoppers/plt) and D5 (7.3 leafhoppers/plt) during 50th and 51st SMW. While the highest thrips damage occurred in D3 (3.4 thrips damaged plt/5 plts) at 47th SMW. *S. litura*, leaf miner, and thrips showed a positive correlation with TmaxºC, TminºC, RH-I%, and RH-II% during D1 while the leafhoppers exhibited a positive association with Tmax°C, Tmin°C, RH-I% and a negative correlation with RH-II%. Overall, the study revealed that the D2 was the optimal sowing window with the lowest insect pest population and damage caused by them, while D3 showed the highest pest population among all the sowings.

Keywords: Groundnut; population dynamics; Insect pests; staggered sowings; weather.

1. INTRODUCTION

Groundnut (*Arachis hypogeae* L.) is an important leguminous food crop that originated from South America, it is also known as the poor man's almond that is widely cultivated in the tropical and subtropical regions of India [1,2]. It is valued for its high oil content and edible seeds and a principal source of 35-54 percen of oil content, 6-24 percent carbohydrates and 21-36 percent proteins and forms a high-energy source and vitamins [3,4]. Groundnut is not only an important oilseed crop but also an important agricultural export commodity of India which has global economic significance due to its use as a source of diverse food products.

The world production of groundnut is estimated to be 45.95 million tonnes and China ranked first among a groundnut-producing countries with 17.21 million tonnes followed by India (7.97 million tonnes), USA (2.85 million tonnes), Nigeria (2.65 million tonnes) and Sudan (2.27 million tonnes) [5]. Globally, Groundnut covers 315 lakh hectares with a production of 536 lakh tonnes with a productivity of 1701 kg per hectare [6]. With annual all-season coverage of 55.71 lakh hectares, globally, India ranks first in Groundnut area under cultivation and is the second largest producer in the world with 102 lakh tonnes with productivity of 1831 kg per hectare in 2020-21 [7,8].

It is widely grown in Mahboobnagar, Warangal, Nalgonda and Karimnagar districts [9]. The low productivity of groundnut is attributed to several constraints. Besides abiotic stresses, groundnut crop suffers from a variety of insect pests which cause heavy losses to 2380 million per annum [10]. The low production of groundnut is attributed to several factors, and the biggest threat is due to major insect pests. Leaf miners, tobacco caterpillars, thrips, and leafhoppers each caused losses ranging from 24 to 92%, 16 to 42%, 17 to 40%, and 9 to 22%, respectively [11]. Integrated Pests Management in Groundnut (*Arachis hypogaea L.*) with special reference to India and lowers the mean plant height (20.50%), major branches (24.93%), pods per plant (25.26%), and mean kernel damage (29.61%) [12].

The knowledge of the seasonal incidence of insect pests at different growth stages of groundnut crops will help evolve proper management schedule. Therefore, a region-oriented study on population dynamics of sucking pests was conducted which would give an idea about the peak period of their activity and may help to develop pest management strategies.

2. MATERIALS AND METHODS

To study the seasonal incidence of major insect pests of groundnut, the experiment was conducted in a randomized block design with five replications and five treatments (different dates of sowings- D1: II FN of September, D2: I FN of October, D3: II FN of October, D4: I FN of November, D5: II FN of November) with K-6 groundnut variety at Regional Agricultural Research Station, Palem, (PJTSAU), Nagarkurnool Dist. during *Rabi*, 2019 to 2021. The geographical location of the site (RARS, Palem) was 16 ° 51’ N Latitude and 78 ° 25’ E Longitude and 478 m of average altitude above the mean sea level. The plot size was 5 x 5 m^2, with a spacing of 22.5 cm row to row and 10 cm plant to plant.

The data on the incidence of defoliators and sucking pests *viz*., Leaf miner (Number of webs per plant), Tobacco caterpillar & Gram caterpillar (Number of larvae per plant) Leaf hoppers (Number of leaf hoppers on 3 leaves (upper, middle bottom) per plant), Thrips (Number of thrips per plant) of groundnut was recorded from five randomly selected plants at weekly intervals during the morning hours and the mean insect population was correlated with the weather parameters. The per cent damage by *S. litura* was calculated by the formula:

Per cent damage= (Number of leaves damaged)/ (Total number of leaves) *100

The weekly meteorological data on temperature maximum (Tmax°C), temperature minimum (Tmin°C), relative humidity morning (RH-I %), and evening relative humidity (RH-II %) during the respective Standard Meteorological Weeks (SMW) were recorded from a meteorological observatory farm, RARS, Palem. Effect of weather factors on the incidence of major insect pests were worked out by simple correlation and multiple regression analysis.

3. RESULTS AND DISCUSSION

3.1 Incidence of *S. litura* in Different Dates of Sowings

The population of *S. litura* first appeared at 38^{th} SMW with 0.48% infestation in D1. Among all the sowings (D1, D2, D3, D4 & D5) the highest incidence was observed in D3 with 41.2% during 48^{th} SMW where the Tmax, Tmin, RH-I and RH-II prevailed were 30.0%, 17.1%, 90.5% and 70.0%, respectively. Among all the sowings across the different Standard Meteorological Weeks (SMW) during the crop period, the highest per cent of *S. litura* damage was observed in D4 with an average of 16.9 and the least was noticed in D2 with an average of 7.86%. The results of Yadav et al. [13] were more or less in accordance with our study where the population of *S. litura* population on groundnut was started from the 36^{th} SMW with 0.27 larvae/plant and it reached a maximum during the 41^{st} SMW with 1.07 larvae/plant. According to Ahir et al. [14] the incidence of *S. litura* on groundnut reached a peak during the 40^{th} and 41^{st} SMW with a population of 1.20 and 1.40 larvae/plant, respectively and the results are similar to the current study.

The correlation studies revealed in D2 the population showed a negative correlation with Tmax°C (r=-0.39), Tmin°C (r=-0.24) and a positive association with RH-1% (r=0.28) and RH-II% (r=0.37). While in D4, the population showed a negative correlation with Tmax°C (r=-0.66), Tmin°C (r=-0.81), RH-1 (r=-0.13) and RH-II (r=-0.31). The results are similar to that of Pazhanisamy et al. [15] where in a negative correlation between the temperature maximum during the *kharif,* 2010 and 2011 on *S. litura* in groundnut has been noticed. The multiple regression equation showed that among all the five sowings, the weather parameters had the least (R^2=49.4%) influence on S *litura* incidence at D2 while D4 showed a negative impact with maximum (R^2 = 76.5%) population.

3.2 Leaf Miner

In general incidence of leaf miner is noticed during the initial stage (20 to 40 DAS) of the crop. Leaf miner incidence was first noticed at 38^{th}SMW with 0.85 webs/plant and then the maximum population occurred during 41^{st} SMW with of 5.0 webs/plant in D1 when compared with the other sowings during the crop period. However, the leaf miner population occurred during the D2 with an average population of 0.66 webs/plant across the SMW and the highest was noticed at D1 with 1.87 webs/plant against different sowing windows.

Kharbub et al., [16] noticed that the incidence of leaf miners increased after the 41^{st}SMW where the temperature maximum, temperature minimum, and relative humidity (RH%) favored in increasing the leaf miner population and Singh and Sachan [17] reported that the population of leaf miner was attained a peak during the $40^{th}$and 43^{rd}SMW on tomato, the results are more or less similar to the current studies.

The correlation studies between the leaf miner and weather conditions that prevailed during the respective standard weeks resulted that there is a positive association with Tmax°C, Tmin°C, RH-1, and RH-II (r= 0.60, 0.50, 0.56, & 0.04), respectively in D1. While in D2, there was positive correlation with Tmax°C (r=0.05), Tmin°C (r=0.46), RH-1 (r=0.04), and a negative correlation towards RH-2 (r=-0.59). Our present study was more or less similar of Lewin et al. [18] who noticed that the leaf miner showed a positive

Table 1. Incidence of *S. litura* and leaf miner in groundnut crop in staggered sowings (Pooled 2019-21)

SMW	Temperature (ºC)		Relative Humidity (%)		% *S. litura* damage					Leaf miner webs/plant				
	Tmax	Tmin	RH-1	RH-2	D1	D2	D3	D4	D5	D1	D2	D3	D4	D5
38	29.70	22.90	90.20	87.80	0.48	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.00
39	31.24	20.17	91.00	77.00	1.45	0.00	0.00	0.00	0.00	2.81	0.00	0.00	0.00	0.00
40	30.13	19.70	92.29	80.00	3.17	0.00	0.00	0.00	0.00	4.73	0.28	0.00	0.00	0.00
41	31.83	20.86	90.87	71.39	16.31	1.89	0.50	0.73	0.00	5.00	0.60	0.00	0.00	0.00
42	30.74	21.35	91.29	72.38	25.75	0.62	6.47	1.50	0.00	4.70	0.79	0.35	0.00	0.00
43	30.40	20.43	91.00	66.90	25.85	2.23	10.30	13.11	4.20	3.93	1.84	1.52	0.27	0.00
44	30.20	19.46	88.86	56.24	39.59	4.13	12.82	13.39	5.83	2.45	1.13	2.62	0.49	0.00
45	30.76	18.74	91.71	64.00	33.13	10.87	13.23	11.36	14.76	1.82	0.83	3.72	2.05	0.55
46	30.39	17.75	88.48	67.67	25.33	16.85	17.03	14.91	18.93	0.92	0.8	4.35	2.99	0.86
47	29.43	17.91	89.62	70.52	15.34	25.64	30.67	17.36	15.31	0.83	1.17	3.04	2.73	1.08
48	30.03	17.16	90.57	70.00	13.90	20.50	41.23	22.05	13.77	0.07	1.13	2.68	2.65	1.92
49	29.31	16.88	88.19	68.24	6.02	30.50	37.27	23.07	11.17	0.00	1.13	1.85	1.5	2.39
50	29.40	15.95	86.86	59.76	4.13	19.75	29.30	25.04	23.90	0.00	0.87	1.23	1.07	2.13
51	30.07	15.00	86.95	54.19	2.22	17.74	22.10	39.14	39.34	0.00	0.63	0.83	0.73	2.13
52	28.90	14.06	86.42	46.27	0.45	7.90	12.90	39.37	34.88	0.00	0.67	0.6	0.2	0.91
1	29.60	14.34	80.59	40.79	0.10	3.73	10.50	40.96	27.82	0.00	0.00	0.00	0.00	1.03
2	29.65	15.41	81.57	46.43	0.00	1.63	6.48	37.00	24.33	0.00	0.00	0.00	0.00	0.10
3	29.99	17.16	82.57	60.79	0.00	1.00	4.29	23.19	15.58	0.00	0.00	0.00	0.00	0.00
4	29.87	16.56	84.43	49.21	0.00	0.17	2.77	10.77	9.53	0.00	0.00	0.00	0.00	0.00
5	31.10	18.61	77.29	41.71	0.00	0.00	0.70	3.87	3.20	0.00	0.00	0.00	0.00	0.00
6	29.68	16.43	77.07	41.14	0.00	0.00	0.00	1.13	0.00	0.00	0.00	0.00	0.00	0.00
Avg	**30.12**	**17.94**	**87.04**	**61.54**	**13.33**	**7.86**	**12.93**	**16.09**	**13.13**	**1.87**	**0.66**	**1.42**	**0.98**	**0.87**

Table 2. Incidence of leafhoppers & thrips in groundnut crop in staggered sowings (Pooled 2019-21)

SMW	Temperature ºC		Relative humidity %		Leaf hoppers (U/M/B leaves)/plt					Thrips damaged plants/5 plants				
	Tmax	Tmin	RH I	RH II	D1	D2	D3	D4	D5	D1	D2	D3	D4	D5
38	29.70	22.90	90.20	87.80	0.33	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00
39	31.24	20.17	91.00	77.00	1.11	0.00	0.00	0.00	0.00	0.93	0.00	0.00	0.00	0.00
40	30.13	19.70	92.29	80.00	2.04	0.15	0.00	0.00	0.00	1.35	0.00	0.00	0.00	0.40
41	31.83	20.86	90.87	71.39	2.52	0.69	0.17	0.00	0.00	1.52	0.00	0.00	0.00	0.93
42	30.74	21.35	91.29	72.38	3.37	1.24	0.99	0.37	0.00	1.70	0.00	0.00	0.00	1.57
43	30.40	20.43	91.00	66.90	5.27	2.29	1.89	1.40	0.00	2.18	0.00	0.78	0.27	2.17
44	30.20	19.46	88.86	56.24	5.75	2.53	2.18	2.82	0.17	2.80	0.00	1.52	0.62	2.68
45	30.76	18.74	91.71	64.00	6.59	3.00	3.04	2.98	1.04	2.50	0.17	1.83	1.87	2.70
46	30.39	17.75	88.48	67.67	6.19	2.88	3.32	3.28	2.04	1.70	0.73	2.37	1.90	2.90
47	29.43	17.91	89.62	70.52	5.68	3.70	4.26	3.24	2.03	1.17	0.93	3.38	2.03	3.20
48	30.03	17.16	90.57	70.00	4.06	5.26	5.17	3.44	2.49	0.57	1.67	3.10	2.00	2.63
49	29.31	16.88	88.19	68.24	2.40	2.99	6.49	4.92	3.30	0.25	1.40	2.17	2.00	1.87
50	29.40	15.95	86.86	59.76	0.77	1.69	4.50	7.20	4.19	0.00	1.70	1.27	1.43	0.83
51	30.07	15.00	86.95	54.19	0.42	1.41	2.96	2.73	7.30	0.00	1.53	1.00	1.30	2.07
52	28.90	14.06	86.42	46.27	0.03	0.90	1.92	2.10	4.14	0.00	1.70	0.50	1.10	0.10
1	29.60	14.34	80.59	40.79	0.00	1.13	1.13	0.91	4.08	0.00	1.20	0.20	0.50	0.00
2	29.65	15.41	81.57	46.43	0.00	0.00	0.10	0.47	3.16	0.00	0.83	0.00	0.00	0.00
3	29.99	17.16	82.57	60.79	0.00	0.00	0.00	0.10	2.11	0.00	0.73	0.00	0.00	0.00
4	29.87	16.56	84.43	49.21	0.00	0.00	0.00	0.00	1.18	0.00	0.50	0.00	0.00	0.00
5	31.10	18.61	77.29	41.71	0.00	0.00	0.00	0.00	1.37	0.00	0.27	0.00	0.00	0.00
6	29.68	16.43	77.07	41.14	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00
Avg	**30.12**	**17.94**	**87.04**	**61.54**	**2.22**	**1.42**	**1.82**	**1.71**	**1.88**	**0.80**	**0.64**	**0.86**	**0.72**	**1.15**

correlation to temperature maximum and Pazhanisamy and Hariprasad [19] results showed a significant positive correlation with maximum and temperature minimum and a significant negative correlation with relative humidity on groundnut. The multiple regression equation between the leaf miner population with the weather revealed that the influence of weather had a positive impact during D2 due to which the leaf miner incidence is lesser than the other sowings, while the early sowing, D1 was adversely affected by the weather conditions prevailed with 72.7% of infestation which indicated that weather has place a major role in the population build-up.

3.3 Leafhoppers

In D1, the leafhoppers population first appeared during 38th SMW with 0.33 leafhoppers/plant. However, among all the sowings the highest leaf hoppers population ~~was~~ occurred in D1 with 6.59 leafhoppers/plant at 45th SMW where Tmax°C, Tmin°C, RH-1 and RH-II prevailed were 30.7°C, 18.7°C, 91.7% & 64%, respectively. The least population occurred during D2 (an average of 1.42 leafhoppers/plant) while the highest at D1 (an average of 2.22 leafhoppers/plant). The pest population showed a positive correlation towards Tmax°C, Tmin°C, RH-1 and a negative correlation towards RH-II during D1. In the case of D2, the leafhopper population showed a positive correlation towards all the weather parameters, Mean temperature and the temperature maximum had a positive correlation in the buildup of the leafhoppers population according to Saritha et al. [20] and Kandkoor et al. [21] reported a positive correlation with maximum and temperature minimum these results are more or less by the present study.

By the regression equation it can be said that there is an influence of 35.3 per cent (R^2 = 35.3) on D2 crop and in D1, 73.9 per cent (R^2 =73.9%) influence has been noticed.

3.4 Thrips

Among all other insect pests, thrips incidence and the damage caused it was comparatively less in all the staggered sowings. In D1, thrips were first observed during 38th SMW with 0.23 thrips damaged plants/5 plants. Among all the sowings, the highest damage occurred in D5 with 3.2 thrips damaged plants/5 plants. The overall results revealed among all the sowings, least damage of (0.64 thrips damaged plants/5 plants) during D2 and highest during an average of 1.15 thrips damaged plants/5 plants observed in D5. The findings by Tarun et al. (2019) who noticed the population of thrips from 33rd SMW to 44th SMW on groundnut and Radhika et al. [22] observed the incidence of thrips was highest during the 37th SMW with maximum infestation of 3.21 thrips/plant and at 43rd SMW with 3.1 thrips/plant.

Table 3. Correlation co-efficient between major pests of groundnut with weather parameters

% *S. litura* damage	**Staggered sowings**	**Tmax**	**Tmin**	**RH I**	**RH II**
	D1	0.41	0.36	0.40	0.02
	D2	**-0.39**	**-0.24**	**0.28**	**0.37**
	D3	-0.50	-0.27	0.39	0.41
	D4	-0.66	-0.81	-0.13	-0.31
	D5	-0.53	-0.85	-0.09	-0.30
Leaf miner damage	**D1**	0.60	0.50	0.56	0.04
	D2	**0.05**	**0.46**	**0.04**	**-0.59**
	D3	0.30	0.18	0.32	0.36
	D4	0.22	0.14	0.38	0.73
	D5	-0.46	-0.42	0.02	0.05
No. of Leaf hoppers (U,M,B)/plant	**D1**	0.25	0.19	0.37	-0.01
	D2	**0.06**	**0.36**	**0.67**	**0.62**
	D3	-0.36	-0.11	0.54	0.53
	D4	-0.41	-0.29	0.43	0.44
	D5	-0.57	-0.82	0.04	-0.05
Thrips damaged plts/10 plts	**D1**	0.14	0.35	0.68	0.58
	D2	**0.48**	**0.58**	**0.65**	**0.43**
	D3	-0.03	0.30	0.75	0.82
	D4	-0.11	0.15	0.84	0.81
	D5	-0.58	-0.57	0.44	0.28

Table 4. Multiple regression equation between major pests of groundnut with weather parameters

	Staggered sowings	Regression equation	R2
%*S. litura* damage	**D1**	Y= -25.8+(-0.5102) Tmax+ (3.6375) Tmin+(3.3481) RH-1+(-1.1889) RH-2	**60.3**
	D2	Y= 30.570+(-0.9699) Tmax+ (-3.7160) Tmin+(0.5226) RH-1+(0.4500) RH-2	**49.4**
	D3	Y= 51.528+(-2.9439) Tmax+ (-4.1010) Tmin+(1.1900) RH-1+(0.3160) RH-2	**49.1**
	D4	Y= 109.1+(-2.8005) Tmax+ (-4.9520) Tmin+(1.0053) RH-1+(-0.1286) RH-2	**76.5**
	D5	Y= 23.34+(-0.14184) Tmax+ (-5.0576) Tmin+(0.9909) RH-1+(-0.0335) RH-2	**75.5**
Leaf miner damage	**D1**	Y= -45.31+(0.6714) Tmax+ (0,4209) Tmin+(0.2638) RH-1+(-0.06646) RH-2	**72.7**
	D2	Y= -4.393+(0.6714) Tmax+ (-0.2074) Tmin+(0.1414) RH-1+(-0.0344) RH-2	**50.4**
	D3	Y= -13.643+(0.01612) Tmax+ (-0.1192) Tmin+(0.2153) RH-1+(-0.02302) RH-2	**23.6**
	D4	Y= -5.7750+(0.1293) Tmax+ (-0.3145) Tmin+(0.06707) RH-1+(-0.0387) RH-2	**30.7**
	D5	Y= 2.3472+(0.002) Tmax+ (-0.3943) Tmin+(0.03210) RH-1+(-0.0405) RH-2	**59.2**
No. of Leaf hoppers (U,M,B)/plant	**D1**	Y= -41.264+(-0.0134) Tmax+ (0.3015) Tmin+(0.5262) RH-1+(-0.1191) RH-2	**73.9**
	D2	Y= -11.201+(-0.1675) Tmax+ (-0.2097) Tmin+(0.2607) RH-1+(-0.0204) RH-2	**35.3**
	D3	Y= 2.9718+(-0.4863) Tmax+ (-0.5241) Tmin+(0.2442) RH-1+(0.0226) RH-2	**44.7**
	D4	Y=6.043+(-0.6062) Tmax+ (-0.4512) Tmin+(0.2442) RH-1+(0.0112) RH-2	**41.5**
	D5	Y=9.1990+(0.1955) Tmax+ (-0.9264) Tmin+(0.0061) RH-1+(0.0532) RH-2	**47.1**
Thrips damaged plts/ 10 plts	**D1**	Y=-22.22+(0.0813) Tmax+ (0.2277) Tmin+(0.2331) RH-1+(0.0762) RH-2	**37.9**
	D2	Y=-41.265+(-0.0134) Tmax+ (0.3015) Tmin+(0.5262) RH-1+(-0.01191) RH-2	**0.47**
	D3	Y=-1.285+(-0.1790) Tmax+ (-0.2315) Tmin+(0.1241) RH-1+(0.01448) RH-2	**32.7**
	D4	Y=-2.219+(-0.0558) Tmax+ (-0.2831) Tmin+(0.1006) RH-1+(0.01522) RH-2	**48.8**
	D5	Y=-17.299+(-0.0011) Tmax+ (-0.0393) Tmin+(0.2487) RH-1+(-0.0400) RH-2	**72.8**

The correlation studies between the thrips population and weather conditions that prevailed during the respective standard weeks showed that in D2 there is a positive association of Tmax°C, Tmin°C, RH-1, and RH-II (r= 0.14, 0.35, 0.68), respectively. The population of leaf miners showed a negative correlation towards Tmax°C (r=-0.58), Tmin°C (r=-0.57) whereas it showed a positive response to RH-1 (r=0.44) and RH-II (r=0.28) in D5. Kandkoor et al. [21] observed that thrips incidence has shown a positive correlation with the temperature maximum and temperature minimum which is similar to the current studies. The multiple regression studies revealed that an adverse effect (R^2 = 72.8) of weather parameters on the thrips was noticed during D1 when compared with the other sowings, while the least impact was noticed in D2 (R^2 =0.47).

4. CONCLUSIONS

The overall results of the study revealed that D2 (I FN Oct) was the optimal sowing window with a significantly lesser pest population and damage caused by them, whereas D3 showed the largest pest population (II FN Nov) when compared with the other sowings. The correlation study between the population of major insect pests at different sowing windows and the weather conditions that prevailed during the respective standard weeks showed that *S. litura* (r = 0.41, 0.36, 40, 0.02), leaf miner (r = 0.50, 0.50, 56, 0.04), and thrips (r =0.14, 0.35, 0.68, 0.58) population exhibited a positive association with TmaxºC, TminºC, RHI% and RH-II%. Leafhoppers population showed a positive association with Tmax°C (0.25), Tmin°C (0.19), RH-1 (0.37) and a negative correlation with RH-II (-0.01) in D1 where the maximum incidence of insect pests was observed. According to the results of the multiple regression equation, the meteorological parameters had major impact on the incidence of *S litura*, leaf miner, and thrips populations during D3, and leafhopper populations during D5.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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