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Impact of weather on incidence of sucking pests in groundnut

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Abstract
Population dynamics of sucking pests of groundnut *viz.* aphids, leaf hoppers and thrips were studied. Correlation between the pest population and weather parameters was analyzed and regression equations were developed. Incidence of aphids, leaf hoppers and thrips on groundnut crop during *kharif* season has started on 27th SMW. Aphid population (12.1 aphids/plant) reached the peak in the 31 SMW; whereas, leaf hopper (3.5 /plant) and thrips (3.5 thrips/ plant) attained peak in the 31st SMW. The population of aphids, leafhopper and thrips then decreased till the 38th SMW. Aphid population showed significant positive correlation with mean atmosphere temperature(r = 0.673) and non-significant negative correlative with mean relative humidity(r = -0.211) and rainfall (r = -0.0268). Leaf hopper exhibited significant positive correlation with mean temperature (r = 0.573) while, non-significant negative correlation with mean relative humidity(r = -0.297) and rainfall(r = -0.274). Thrips population exhibited significant positive correlation with relative humidity (r=0.503) while, non-significant correlation with mean relative humidity(r=0.105) and rainfall (r=-0.471). Incidence of aphids, leaf hoppers and thrips on groundnut crop during *rabi* season has started on 51th SMW. Aphid population (16.5 aphids/plant) reached the peak in the 9 SMW; whereas, leaf hopper (3.64 /plant) and thrips (7.14 thrips/ plant) attained peak in the 7th and 5th SMW respectively. Later, the population of aphids, leafhopper and thrips then decreased till the 12th SMW. The correlation between weather parameters and sucking pest population followed the pattern similar to *kharif* season. Regression analysis data of revealed that the multiple non-linear regression equations are sufficient enough to predict the pest population with prevailing weather parameters.

Keywords: Leaf hoppers, aphids, thrips, groundnut, weather, pest incidence, correlation

Introduction
Groundnut (*Arachis hypogaea* L.) is an essential oilseed crop of the world [1]. It is the fourth principal source of edible oil and the third largest source of vegetable protein and grown in tropical and subtropical countries. India is one of the world's largest exporters and trades closely with Brazil, the US and China with a 20-25% stake in global markets [2]. In the year 2017-18, India produced over 69.7 lakh tons of groundnut making India the leading global exporter of groundnut oil during same year [3]. Groundnut is primarily cultivated in the South and Northwest states of India; Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Madhya Pradesh, which together occupy 84 % of the acerage in India. In Andhra Pradesh, groundnut is cultivated in an area of 10.0 lakh ha and production of 6.1 lakh tons. (Anonymous, 2018) [4].

The productive cultivation of the crop is prone to severe constraints by insect pests. The yield is severely impacted by the attack on various pests (Kumar *et al.*, 2002) [5]. In Andhra Pradesh eight species of insect pests are considered to be economically important. Aphid, thrips, stem borer, jassid, red hairy caterpillar, white grub, bihar hairy caterpillar, leaf minor, tobbaco cater pillar, termite are the most common insect pests of the groundnut [6]. Nevertheless, until late 1980, aphid was not known to be a major groundnut pest [7]. The aphid does direct damage to the crop and also induces sap suction to the viral diseases caused by rosette [8-11].

In designing appropriate management schedules, the awareness of the seasonal occurrence of insecticides at various stages of development would be beneficial. A region-based study was thus conducted on population dynamics of sucking pests that would provide an insight into the peak cycle and that aid in the creation of pest management strategies. Hence the present study was contemplated to observe the incidence of insect pests of groundnut in relation to various weather parameters under unprotected field conditions at Agricultural Research Station, Yellamanchili, Andhra Pradesh.

Materials and Methods

The experimental study was conducted at Agricultural Research Station, Yellamanchili, Visakhapatnam, Andhra Pradesh during *rabi* 2017-18 and *kharif* 2018 to investigate the seasonal incidence of insect pests of groundnut under unprotected field conditions.

Cultivation of groundnut

Untreated groundnut seed of variety K-9 was sown in the a bulk plot of size 0.2 ha, adopting 30 cm row to row and 10 cm plant spacing, during *rabi* and *kharif* seasons. All recommended agronomical practices were adopted. Basal manure and fertilizers were applied @ FYM 10t/ha and 20:40:50 kg NPK/ ha. The second split of nitrogen @ 10 kg/ha was applied at 30 DAS. Coinciding with flowering, gypsum @ 500 kg/ha was applied by placement. In *kharif*, the groundnut was raised as rainfed crop, whereas, in *rabi*, need based irrigations were given as there was no rainfall in the crop growth period during *rabi*. Manual weeding was done twice during each of the season. No plant protection measures were taken up during the entire crop growth period during both the seasons.

Data on population of sucking pests

Data was recorded in the early hours between 7:00 am and 9:00 am on randomly selected plants in the plot using standard sampling methods [11]. The population of sucking pests viz., aphids, leaf hoppers and thrips were recorded from 10 plants per spot from five random spots in the plot of 0.2 ha. The population of thrips and leaf hoppers were counted on top three terminal leaves of the plant whereas aphids were counted on the entire plant. The recorded populations of sucking pests were presented standard week-wise from 20 DAS to crop harvesting.

Weather data

Weather data pertaining to maximum and minimum temperature (^{o}C); maximum and minimum relative humidity (%) and rainfall (mm) were collected for the standard weeks from the observatory located at Agricultural Research Station, Yellamanchili.

Statistical analysis

Using Microsoft Excel software, data on insect species and weather parameters were statistically analysed for correlation. The data collected on sucking pests were correlated with the weather parameters following the standard weather week. (SMW) [12].

$$r_{xy} = \frac{\sum XY - \sum X \sum Y}{\sqrt{\left[\sum X^2 - \frac{\sum X^2}{n}\right] - \left[\sum Y^2 - \frac{\sum Y^2}{n}\right]}}$$

Where

$r_{xy} = Simple\ corelation\ coefficient$

X = Variable (abiotic component.)

Y = Variable (No. of Insects per plant)

n = Number of observations

The correlation coefficient (r) values were subjected to the test of significance using t-test

$$t = \frac{r}{\sqrt{1-r^2}} X \sqrt{n-2} \sim t_{n-2} d.f$$

The calculated t-value obtained was compared with tabulated t-value at 5% level of significance

Regression analysis

The data on insect populations and weather parameters was subjected to non linear regression analysis was carried out using microsoft excel software and developed the regression equations [12].

Results and Discussion

The mean population of aphids, leaf hoppers & thrips and the standard week wise weather parameters are presented in Table 1(*kharif*) and Table 2 (*rabi*). The findings of the current investigation and the related discussion are outlined hereunder.

Population dynamics of aphids

Incidence of aphids during *kharif* season reported initially on 27th standard meteorological week (SMW) with an average population of 1.0 aphid/ 3 leaves. The population steadily increased and peaked during 31st SMW with an average population of 12.1 aphids/plant, the mean temperature and relative humidity of 30.8 °C and 70%, respectively were recorded during this week. The population then decreased till the 38th SMW with average population of 3.4 aphids/plant amid rise in population during 35-37th SMW (3.5-6.7 aphids/plant) as depicted in Fig.1. The mean temperature varied between 26.9-30.8 °C, while the maximum temperature varied in the wide range (28.9-35.5 °C) and minimum temperature in the narrow range (23.2 - 26 °C)with positive correlation with aphid population as shown in Table 1&3. The mean relative humidity ranged between 70-81%, while the minimum relative humidity varied in the wide range (49-75%) and maximum relative humidity in the narrow range (83-91%) with negative correlation with aphid population as shown in the Table 1&3. Aphid population showed significant positive correlation with mean atmosphere temperature(r = 0.673) and Non significant negative correlative with mean relative humidity (r = -0.211) and rainfall (r = -0.268).

During *rabi* season the aphid population initially observed on 51th SMW then steadily increased till 9th SMW and peaked with 16.5 aphids/plant, thereafter population decreased slowly and finally reported 7.9 aphids on 12th SME as shown in Fig.4. The mean temperature varied between 20.4-26 °C, while the maximum temperature varied in the wide range (29.3-34.3 °C) and minimum temperature in the narrow range (11.4-17.8 °C). Aphid population shown positive correlation with mean atmosphere temperature (r=0.206) and Non-significant negative correlative with mean relative humidity (r= -0.641). It has been confirmed that the temperature favored to building up the pest population and relative humidity and rainfall constrained the aphid population as depicted in Table 2. These results are in accordance with the Ahir *et al.*, 2017 [13], Singh *et al.*, 2005 [14], Yadav *et al.*, 2012 [15] and Kandakur *et al.*, 2012 [16].

Population dynamics of leaf hoppers

Incidence of leaf hoppers during *kharif* season reported during 27th standard meteorological week (SMW) with an average population of 1.0 leaf hopper/plant. The population steadily increased and peaked during 31st SMW with an average

population was 3.5 aphids/ plant, the mean temperature and relative humidity of 30.8 °C and 70%, respectively observed during the week. The population then decreased till the 38th SMW with average population of 1.5 leaf hopper/plant as shown in Fig.2. The leaf hopper exhibited significant positive correlation with mean temperature (r =0.573) while, non-significant negative correlation with mean relative humidity(r = -0.297) and rainfall (r =-0.274). Leaf hopper population shown positive correlation with maximum relative humidity (r = 0.689) and negative with minimum relative humidity(r = -0.297).

Similar trend was also observed during *rabi* season, the leaf hopper population observed on 51 SMW with an average population of 0.7 leaf hopper/ plant and steadily increased till 7th SMW and peaked with 3.64 leaf hoppers/ plant, thereafter population decreased slowly and finally reported 0.86 leaf hoppers on 12th SME as shown in Fig.5. The mean temperature(r=0.118), maximum temperature(r=0.376) and minimum temperature(r = 0.118) had positive insignificant correlation with leaf hopper population and shown non-significant negative correlative with mean relative humidity (r=-0.395), minimum relative humidity(r=-0.406) and positive correlation with maximum relative humidity(r=0.263). It has been confirmed that the temperature favored to the pest population and relative humidity controlled the leaf hopper population as depicted in Table 2 and Table 3. These results are in accordance with the Yadav *et al.*, 2007 [15] and Kandakur *et al.*, 2012 [16].

Population dynamics of thrips

The thrips incidence reported during 27th standard meteorological week (SMW) in the *kharif* season with an average population of 1.0 /plant. The population increased and peaked during 31st SMW with an average population was 3.5 thrips/plant. The population then decreased till the 35th SMW with average population of 0.2 thrips/ 3 leaves later slowly raised till the 38th SMW (1 thrips/plant) as reported in Fig.3. The thrips population exhibited significant positive correlation with relative humidity (r=0.504) while, non-significant positive correlation with mean relative humidity(r=0.105) and rainfall(r=-0.471) as shown in Table 2. Leaf hopper population shown positive correlation with maximum relative humidity and negative with minimum relative humidity.

During *rabi* season, the thrips population observed on 51 SMW with an average population of 1.9 thrips/plant and increased till 5th SMW and peaked with 7.14 thrips/plant, thereafter population decreased slowly and finally reported 3.22 thrips on 12th SME as shown in Fig.6. The mean temperature(r=0.815), maximum temperature(r=0.708) and minimum temperature(r =0.797) had positive insignificant correlation with thrips population and shown non-significant negative correlative with mean relative humidity(r=-0.314), minimum relative humidity(r = -0.436) and positive correlation with maximum relative humidity(r=0.734). It was indicated that the mean temperature and relative humidity favored the pest population. These results are in accordance with the Ahir *et al.*, 2017 [13] and Kandakur *et al.*, 2012 [16].

Regression analysis

The multiple non linear regression equation fitted with weather factors during for prediction of aphids, leaf hopper and thrips population and presented in the Table 4. The regression equation for estimation of aphids population during *kharif* season is (X_k) =-91.8-0.24(T_{max}) +0.46(T_{min}) +1.2(RH_{max})-0.17($RH_{min.}$)+0.0088(Rain) (R^2=0.8), for leaf hoppers (Y_K)=-13.6-0.107(T_{max})+0.045($T_{min.}$)+0.24(RH_{max})-0.04($RH_{min.}$)+0.0024(Rain)(R^2=0.69) and for thrips (Z_k)=-27.7-0.11(T_{max})+0.23(T_{min})+0.31(RH_{max})-0.004(RH_{min})+0.001(Rain) with R^2 of 0.78.

Similarly the non linear regression equation for estimation of pest population for *rabi* season has been developed. The equation for prediction of aphids population is given as (Xr)=-49.47+0.14(T_{max})-0.26(T_{min}) +0.49(RH_{max})-0.012($RH_{min.}$) (R^2=0.73), for leaf hoppers Yr=18.78-0.59(T_{max}) +0.44(T_{min})-0.03(RH_{max})-0.04(RH_{min}) (R^2=0.56) and for thrips Zr=74.26+0.99(T_{max})-0.61(T_{min})-0.803(RH_{max})-0.43(RH_{min}) with R^2 of 0.45. These findings were in conformity with the reports of Harish *et al*., 2015 [17], Radhika, 2013 [18].

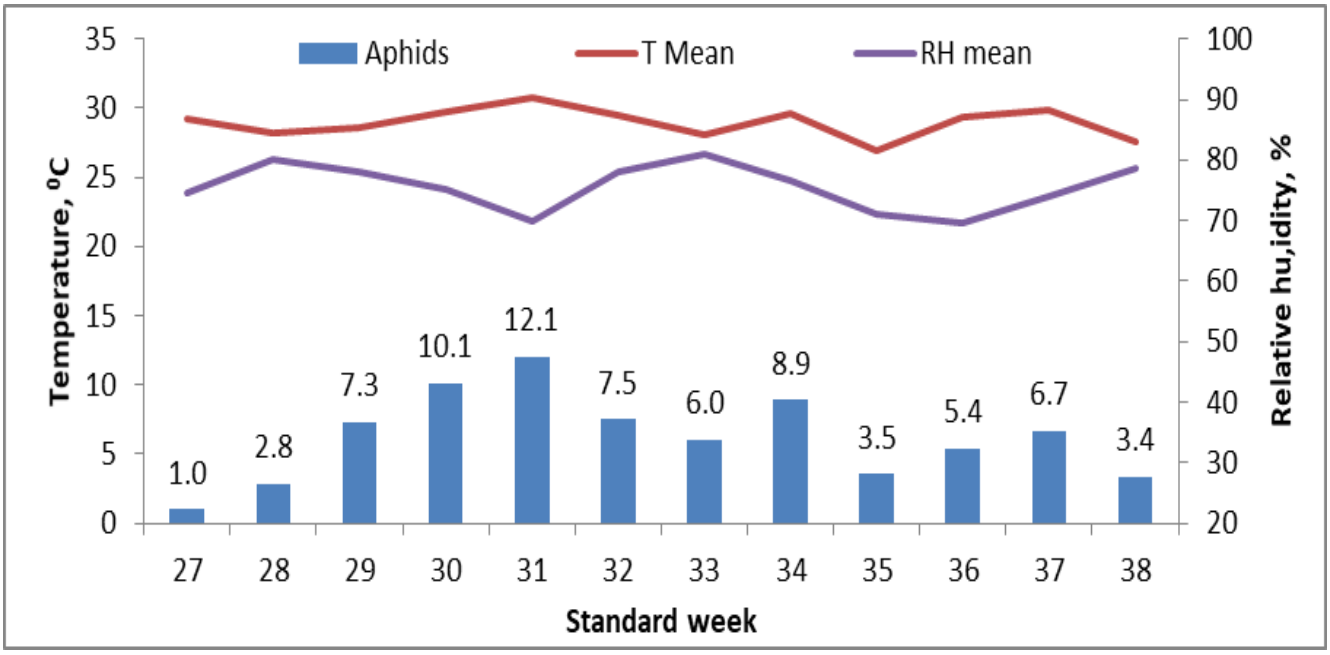

Fig 1: Influence of weather parameters on aphids during *kharif* on groundnut

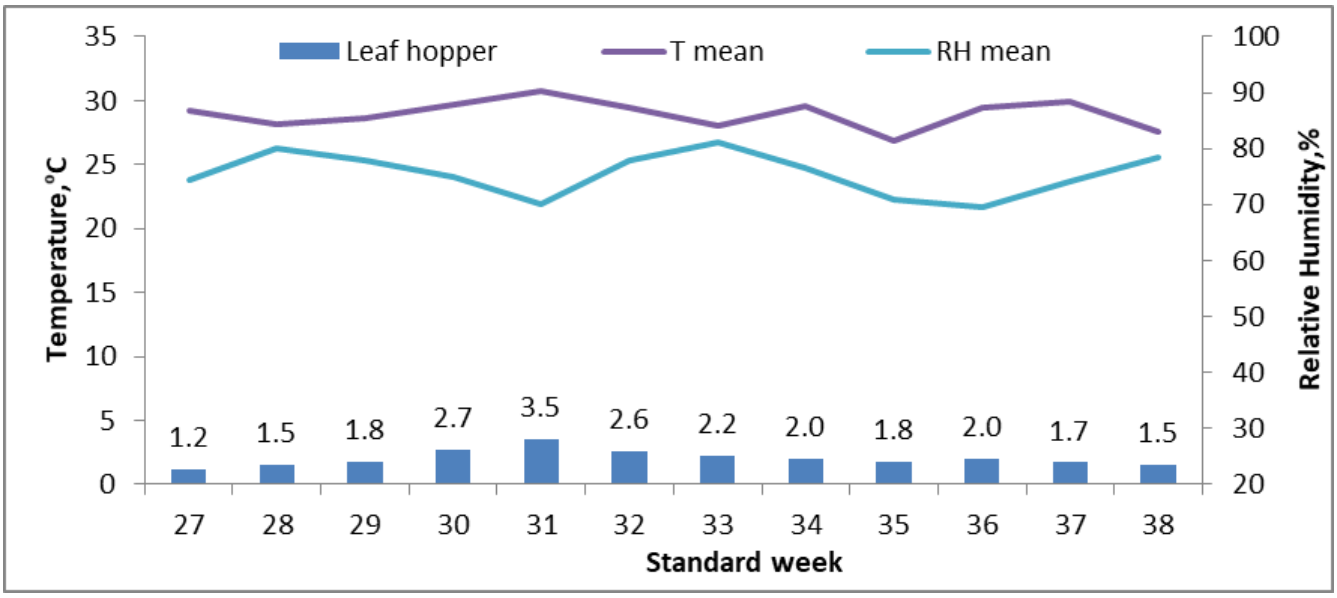

Fig 2: Influence of weather parameters on leaf hoppers during *kharif* on groundnut

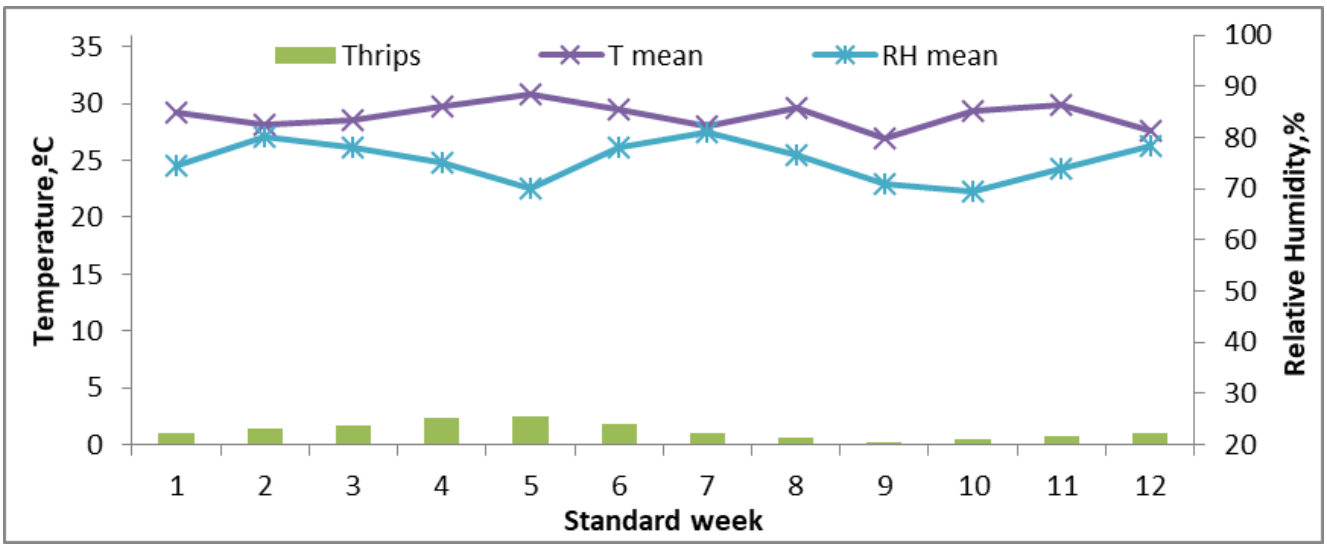

Fig 3: Influence of weather parameters on thrips during *kharif* on groundnut

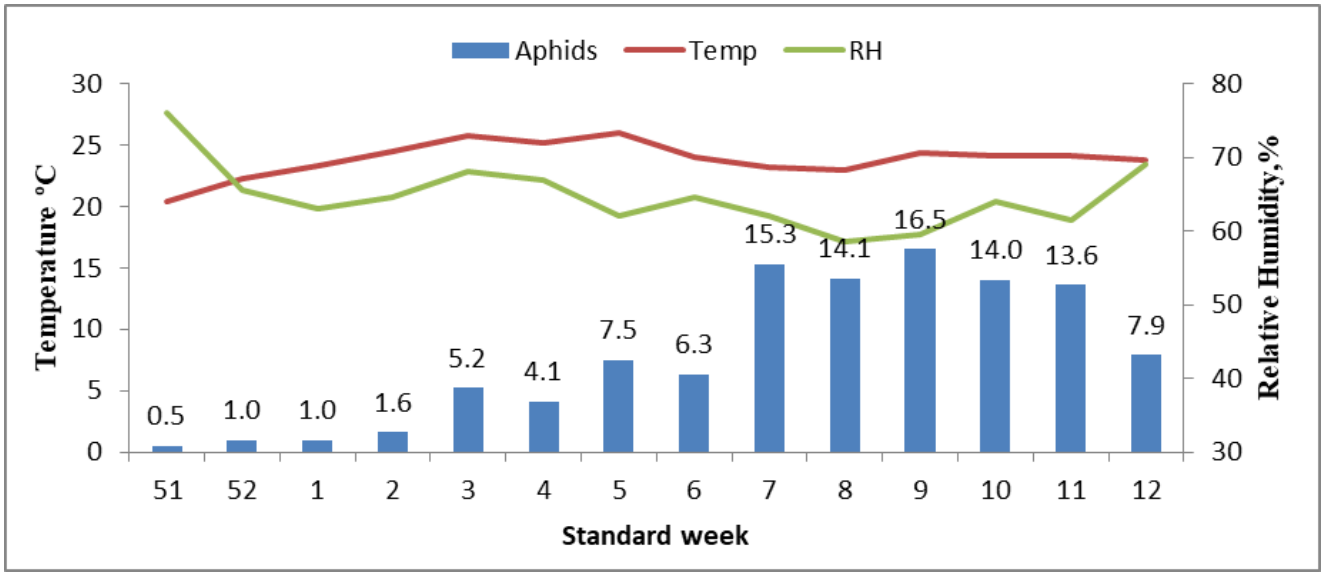

Fig 4: Influence of weather parameters on aphids during *rabi* on groundnut

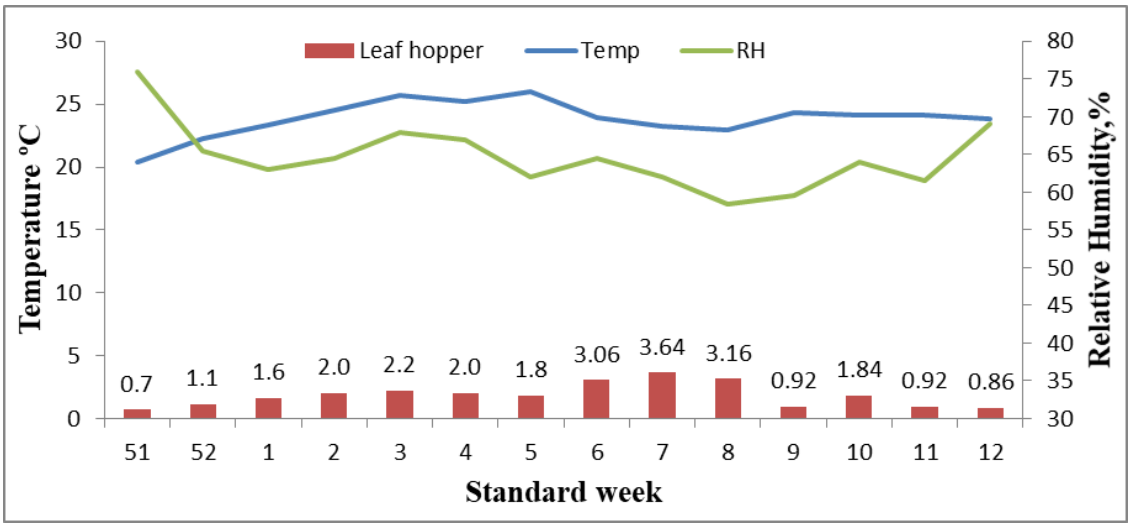

Fig 5: Influence of weather parameters on leaf hoppers during *rabi* on groundnut

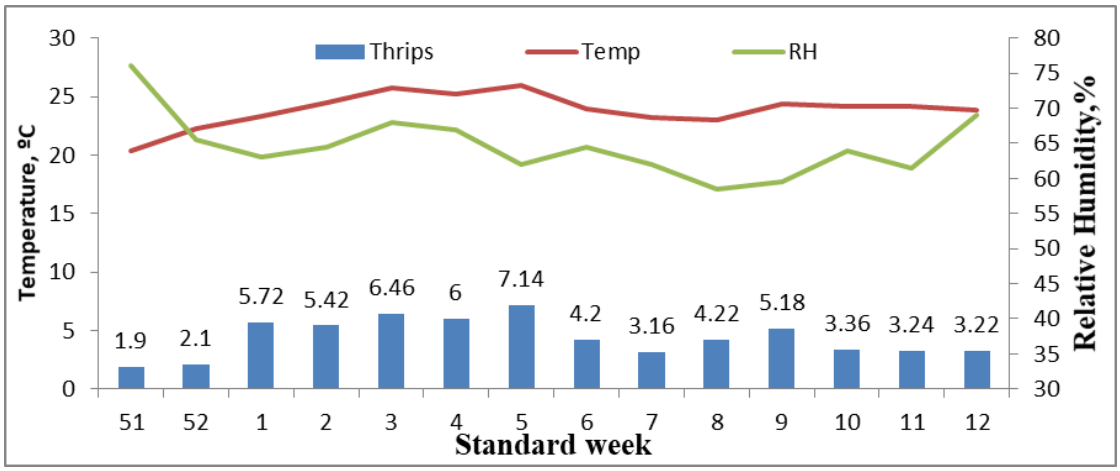

Fig 6: Influence of weather parameters on thrips during *rabi* on groundnut

Table 1: Incidence of sucking pests with respect to weather parameters during *kharif* in groundnut

Std. Week	Pests Observed (population per plant)			Weather parameters						
	Aphids	Leaf hoppers	Thrips	Max.Temp. (^{0} C)	Min.Temp. (^{0} C)	Mean Temp. (^{0} C)	RH Max (%)	RH Min (%)	Mean RH (%)	Rainfall (mm)
27	1.0	1.2	1.0	33.2	25.3	29.3	85	64	75	29.9
28	2.8	1.5	1.5	31.2	25.1	28.2	87	73	80	5.0
29	7.3	1.8	1.7	31.9	25.3	28.6	88	68	78	50.4
30	10.1	2.7	2.4	33.8	25.6	29.7	90	60	75	11.7
31	12.1	3.5	2.5	35.6	26.0	30.8	91	49	70	11.4
32	7.5	2.6	1.8	33.8	25.1	29.5	88	68	78	16.7
33	6.0	2.2	1.0	31.6	24.5	28.1	87	75	81	62.9
34	8.9	2.0	0.6	33.8	25.3	29.6	88	65	77	24.3
35	3.5	1.8	0.2	28.9	24.9	26.9	83	59	71	12.6
36	5.4	2.0	0.5	34.4	24.4	29.4	85	54	70	2.8
37	6.7	1.7	0.7	35.5	24.3	29.9	88	60	74	21.9
38	3.4	1.5	1.0	32.0	23.2	27.6	87	70	79	75.1

Table 2: Incidence of sucking pests with respect to weather parameters during *rabi*

Std. Week	Pests observed (population per plant)			Weather parameters					
	Aphids	Leaf hoppers	Thrips	Max.Temp. (^{0} C)	Min.Temp. (^{0} C)	Mean Temp. (^{0} C)	RH Max (%)	RH Min (%)	Mean RH (%)
51	0.50	0.70	1.90	29.3	11.4	20.4	86	66	76.0
52	1.00	1.10	2.10	30.6	13.9	22.3	88	43	65.5
1	1.00	1.60	5.72	32.6	14.0	23.3	89	37	63.0
2	1.60	2.00	5.42	32.5	16.5	24.5	90	39	64.5
3	5.20	2.20	6.46	33.7	17.8	25.8	93	43	68.0

4	4.10	2.00	6.00	33.2	17.2	25.2	90	44	67.0
5	7.50	1.80	7.14	34.3	17.7	26.0	92	32	62.0
6	6.30	3.06	4.20	31.7	16.2	24.0	90	39	64.5
7	15.30	3.64	3.16	31.0	15.4	23.2	88	36	62.0
8	14.10	3.16	4.22	31.6	14.3	23.0	90	27	58.5
9	16.50	0.92	5.18	33.0	15.7	24.4	91	28	59.5
10	14.00	1.84	3.36	33.5	14.8	24.2	90	38	64.0
11	13.60	0.92	3.24	33.6	14.7	24.2	89	34	61.5
12	7.90	0.86	3.22	32.8	14.8	23.8	88	50	69.0

Table 3: Correlation coefficient of pest population with respect to weather parameters

Parameter	Aphids	Leaf hoppers	Thrips
Temperature(Max)	0.577	0.457	0.360
Temperature(Min)	0.505	0.521	0.567
Temperature(Mean)	0.673	0.573	0.504
Relative Humidity(Max)	0.819	0.689	0.823
Relative Humidity(Min)	-0.443	-0.491	-0.128
Relative Humidity(Mean)	-0.211	-0.297	0.105
Rain fall	-0.268	-0.274	-0.471
Rabi			
Temperature(Max)	0.287	0.166	0.708
Temperature(Min)	0.115	0.376	0.797
Temperature(Mean)	0.206	0.118	0.815
Relative Humidity(Max)	0.210	0.263	0.834
Relative Humidity(Min)	-0.619	-0.406	-0.436
Relative Humidity(Mean)	-0.641	-0.395	-0.314

Table 4: Regression analysis of pest population with respect to weather parameters

Pest	Regression equation	Regression coefficient
Kharif Season		
Thrips	X_k=-27.7-0.11(T_{max}) +0.23(T_{min}) +0.31(RH_{max})-0.004(RH_{min})+ 0.001(Rain)	R^2=0.78
Leaf hopper	Y_k=-13.6-0.107(T_{max})+0.045(T_{min})+0.24(RH_{max})-0.04(RH_{min}) + 0.002(Rain)	R^2=0.69
Aphids	Z_k=-91.8-0.24(T_{max}) +0.46(T_{min}) +1.2(RH_{max})-0.17(RH_{min})+0.0088(Rain)	R^2=0.80
Rabi Season		
Thrips	Xr=-49.47+0.14(T_{max})-0.26(T_{min}) +0.49(RH_{max})-0.012(RH_{min}.)	R^2 = 0.73
Leaf hopper	Yr=18.78-0.59(T_{max}) +0.44(T_{min})-0.03(RH_{max})-0.04(RH_{min})	R^2 = 0.56
Aphids	Zr=74.26+0.99(T_{max})-0.61(T_{min})-0.803(RH_{max})-0.43(RH_{min})	R^2 = 0.45

Conclusion

The population dynamics of sucking pests on groundnut (aphids, leaf hoppers and thrips) were studied and weather parameters were correlated. The study concluded that, the maximum, minimum temperatures and maximum relative humidity have positive correlation with aphids, leafhopper and thrips population and negative correlation with minimum relative humidity and rainfall. The information about the seasonal incidence and abundance may be utilized for formulating effective management strategies in advance during *kharif* and *rabi* groundnut crops and thus avoiding the yield loss caused by sucking pests.

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