Legume Research, 38 (4) 2015: 524-535
Print ISSN:0250-5371 / Online ISSN:0976-0571

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com/www.legumeresearch.in

Impact of weather on the occurrence pattern of insect pests on groundnut

G. Harish*, M.V. Nataraja, Poonam Jasrotia, Prasanna Holajjer, S.D. Savaliya and Meera Gajera

Directorate of Groundnut Research,
P. B. No. 5, Junagadh-362 001, Gujarat, India.
Received: 02-01-2014 Accepted: 16-04-2014 DOI:10.5958/0976-0571.2015.00108.3

ABSTRACT

The study was carried out to know the impact of weather on the occurrence pattern of insect pests of groundnut. The population of *Spodoptera litura* (Fabricius) reached its maximum (30.5 moths/trap) at 40th standard week, whereas *Helicoverpa armigera* (Hubner) peaked at 46th standard week (5.5 moths/trap). Maximum number of leafhoppers (78.5 adults/5 sweeps) and thrips (22.5 adults/5 sweeps) were recorded at the end of 8th and 4th standard weeks, respectively. Both the maximum temperature (^{0}C) and sunshine (h) were found to show direct relationship with the populations of *S. litura*, *H. armigera*, leafhopper and thrips during *kharif* season. Multiple regressions analysis indicated that the population of *S. litura* and leafhopper with different weather parameters had a significant interaction during *kharif* whereas; population of leafhopper and thrips had a significant interaction with different weather parameters during summer.

Key words: *Arachis hypogaea*, Correlation, *Helicoverpa armigera*, Leafhoppers, Regression, Seasonal incidence, *Spodoptera litura*, Thrips.

INTRODUCTION

The survival, reproduction and development of any insect depend mainly on the climate, availability of host and activity of natural enemies. Weather parameters affect lifecycle, propagation and outbreaks of insects (Pedigo, 2004) and sudden changes in these abiotic factors adversely affect the population dynamics of insects (Prasad and Logiswaran, 1997). Groundnut crop is attacked by more than 100 species of insect pests and mites from sowing to till harvest and even in stored produce (Nandagopal, 1992). The tobacco caterpillar, *Spodoptera litura* (Fabricius) and gram pod borer, *Helicoverpa armigera* (Hubner) are known to inflict direct damage to the crop by consuming the photo-synthetically active foliage, they can cause 30 to 40 per cent loss in pod yield during severe pest outbreaks (Nandagopal, 2004).

In groundnut, two species of leaf hoppers, *Balclutha hortensis* Lindberg and *Empoasca kerri* (Pruthi) (Nandagopal and Reddy, 1987); four species of thrips, *Scirtothrips dorsalis* Hood, *Frankliniella schultzei* Trybom, *Thrips palmi* Karny *and Caliothrips indicus* (Bagnall) (Nandagopal and Vasanta, 1991; Ranga Rao and Wightman, 1993) and one species of aphid, *Aphis craccivora* Koch are known to occur as sucking pests. They feed on the plant sap (direct damage) and also act as vectors for plant viral diseases (indirect damage). The peanut stripe virus (PStV), peanut bud necrosis disease (PBND) are transmitted by thrips and groundnut rosette disease is transmitted by aphids (Vijayalakshmi, 1994 and Naidu *et al* 1998). The leafhoppers can cause up to 22 per cent of yield loss in groundnut (Vyas, 1984), while thrips up to 17 to 40 per cent (Ghewande, 1987).

Population dynamics of any insect pest is highly dependent on abiotic factors like temperature; relative humidity; sunshine and rainfall (Saminathan *et al* 2003). The present study was aimed to know the seasonal occurrence of insect pests and the relationship between the weather parameters and pest population. It is important to study these relationships as it helps to plan appropriate management strategies in advance to minimize the crop losses.

MATERIALS AND METHODS

Seasonal occurrence of insect pests on groundnut were studied during 2010 and 2011 calendar years, at Directorate of Groundnut Research farm, Junagadh (70.36^{0} E longitude and 21.31^{0} N latitude and at an altitude of 60 m above mean sea level). The groundnut variety, GG-2 was sown in plots of size 5 m X 2 m, on first week of every month. The crop was made available for the pests throughout the year. The recommended package of practices was followed except crop protection in order to avoid influence of chemicals on insect population. The pheromone traps containing spodolure (sex pheromone for *S. litura*) and helilure (sex pheromone for *H. armigera*) were installed in the experimental plot to

*Corresponding author's e-mail: hari4065@gmail.com.

monitor the defoliator pests. A modified sweep net method (Nandagopal *et al* 2007) was followed to monitor sucking pest populations where, five sweeps were taken randomly using the sweep net from each experimental plot. The leafhoppers and thrips caught in the sweep net were then transferred into polythene bags, allowed to settle down and counted in laboratory. The weekly observations were recorded on number of moth catches per trap and number of adults of leafhoppers and thrips caught in the sweep net. Weather data pertaining to maximum and minimum temperature (^{0}C); morning and evening relative humidity (%); sunshine (h) and rainfall (mm) were collected daily from the observatory. The data on insect populations and the weather parameters were statistically analyzed for correlation and regression using DSAASTAT software (Onobri, 2007).

RESULTS AND DISCUSSION

Population dynamics of insect pests on groundnut and their interaction with weather parameters during different seasons (*kharif*, *rabi* and summer) are graphically represented. The population of *S. litura* was recorded throughout the *kharif* season where, it started increasing gradually at starting of season and reached its maximum (30.5 moths/trap) at the end of 40th standard week and then declined by the end of season (Fig. 1). Similarly, the *S. litura* trap catches were abundant from 19th to 43rd standard week on tomato and cauliflower (Monobrullah *et al* 2007). Gedia *et al* (2007) observed that *S. litura* peaked during 42nd standard week on groundnut. The population of *H. armigera* started to appear in *kharif* season from 29th standard week and reached its maximum at the end of 42nd standard week (5.0 moths/trap). In *rabi* season (Fig. 2) initially there was no *S. litura* moth catches during 46th, 50th and 51st standard weeks but suddenly its population peaked during 1st standard week (15.0 moths/ trap). Whereas, population of *H. armigera* was highest at 46th standard week (5.5 moths/trap), then declined gradually towards the end of the season and there were no moth catches recorded in last four (6th, 7th, 8th and 9th) standard weeks of the season. However Rajesh and Durairaj (2012) observed that, the peak emergence of *H. armigera* was during 51st and 52nd standard week on pigeon pea in Tamil Nadu. During the summer, *S. litura* moth activity was observed during first two (10th and 11th) standard weeks, but there was no moth catches from 12th to 17th standard week (Fig. 3). Populations of *S. litura* started increasing from 18th standard week and reached a maximum (4.0 moths/trap) at 20th standard week and then started to decline by the end of the season. There was no incidence *H. armigera* throughout the summer season and no moth catch could be recorded from 10th to 26th standard week. The moth emergence patterns of pests depend mainly on the biological rhythms of the pest species and on the abiotic factors to a great extent. The *S. litura* and *H. armigera* moths (♂)started to emerge from their pupal hideouts (soil or leaf litter) just after the receipt of the rainfall (Ranga Rao and Wightman, 1994).

The populations of leafhoppers and thrips occurred at serious proportions during early stages of the crop growth. The insects sucked sap from tender leaves and buds and also from the floral parts. The maximum number of leafhoppers was recorded at the end of 41st standard week (26.5/five sweeps) and then population started declining (Fig. 4). The highest population of thrips (12.0/five sweeps) could be recorded at the end of 27th standard week. Similarly, in *rabi* season the highest leafhopper population recorded was 78.5/ five sweeps at the end of 8th standard week (Fig. 5). The highest thrips population (22.5/five sweeps) was recorded in 4th standard week. During summer season, thrips were recorded in good numbers. The thrips population was consistently found above 10 per five sweeps from 18th to 22nd standard weeks. However maximum number of thrips recorded was 15/five sweeps at the end of 15th standard week (Fig. 6). The highest leafhopper population (22.5/five sweeps) was recorded in 10th standard week. Later on the population started declining gradually. Prasad *et al* (2008) recorded maximum population of leafhoppers during *rabi* followed by *kharif* and summer.

Correlation between insect populations and weather parameters during *kharif*, *rabi* and summer seasons (Table 1 and 2) showed that, in *kharif* season populations of *S. litura, H. armigera*, leafhoppers and thrips showed direct and significant relationship with maximum temperature (^{0}C) and sunshine (h). These findings were in agreement with observations of Kant *et al* (2007). Whereas, in *rabi* season the population of *S. litura* showed direct but non-significant relationship with morning relative humidity (%) as reported by Gedia *et al* (2007); the populations of *H. armigera* showed direct and significant relationship with all-weather parameters except sunshine (h) and both the populations of leafhopper and thrips had a direct and significant relationship with maximum temperature (^{0}C) and sunshine (h) but non-significant relation with minimum temperature (^{0}C). The results were in accordance with the findings of Jayanthi *et al* (1993) and Ratnapara *et al* (1994). In summer, the population of *S. litura* showed direct and significant relationship with minimum temperature (^{0}C) and non-significant relationship with morning and evening relative humidities (%) as well as sunshine (h). Whereas, the population of *H. armigera* showed no relationship with any of the weather parameters. The populations of leafhopper and thrips showed a direct and

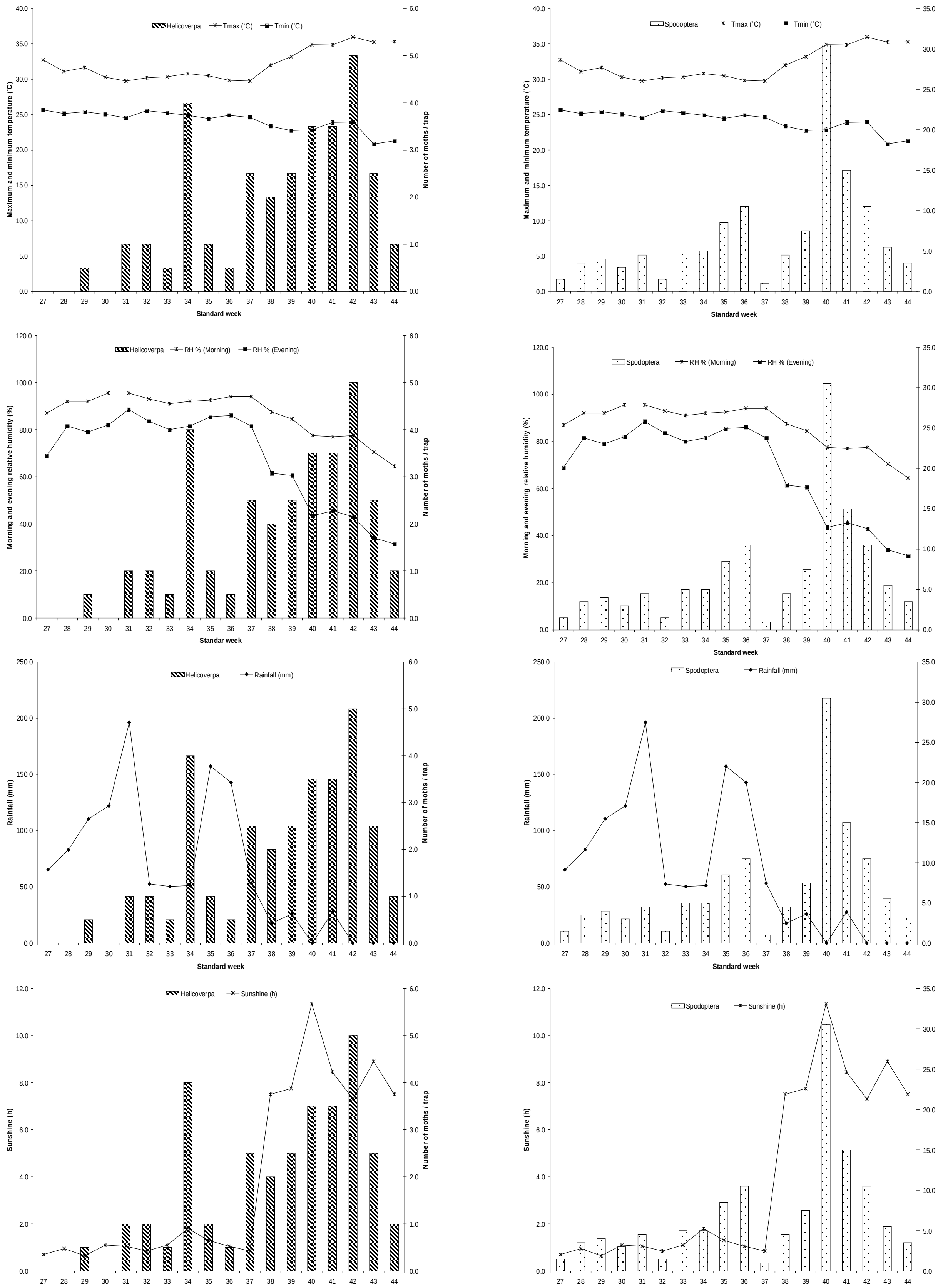

FIG 1: Population dynamics of *S. litura* and *H. armigera* of groundnut during *kharif*

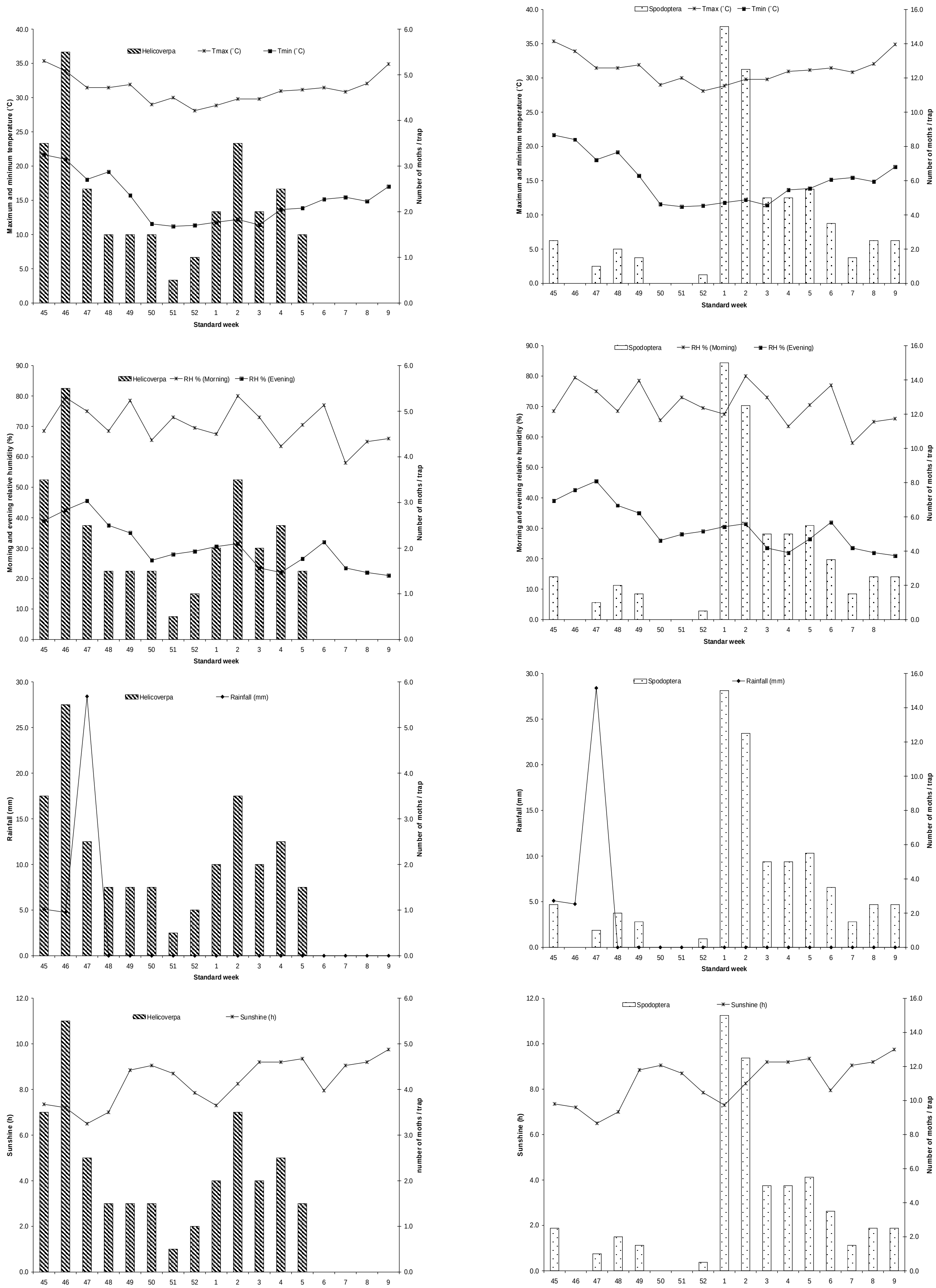

FIG 2: Population dynamics of *S. litura* and *H. armigera* of groundnut during *rabi*

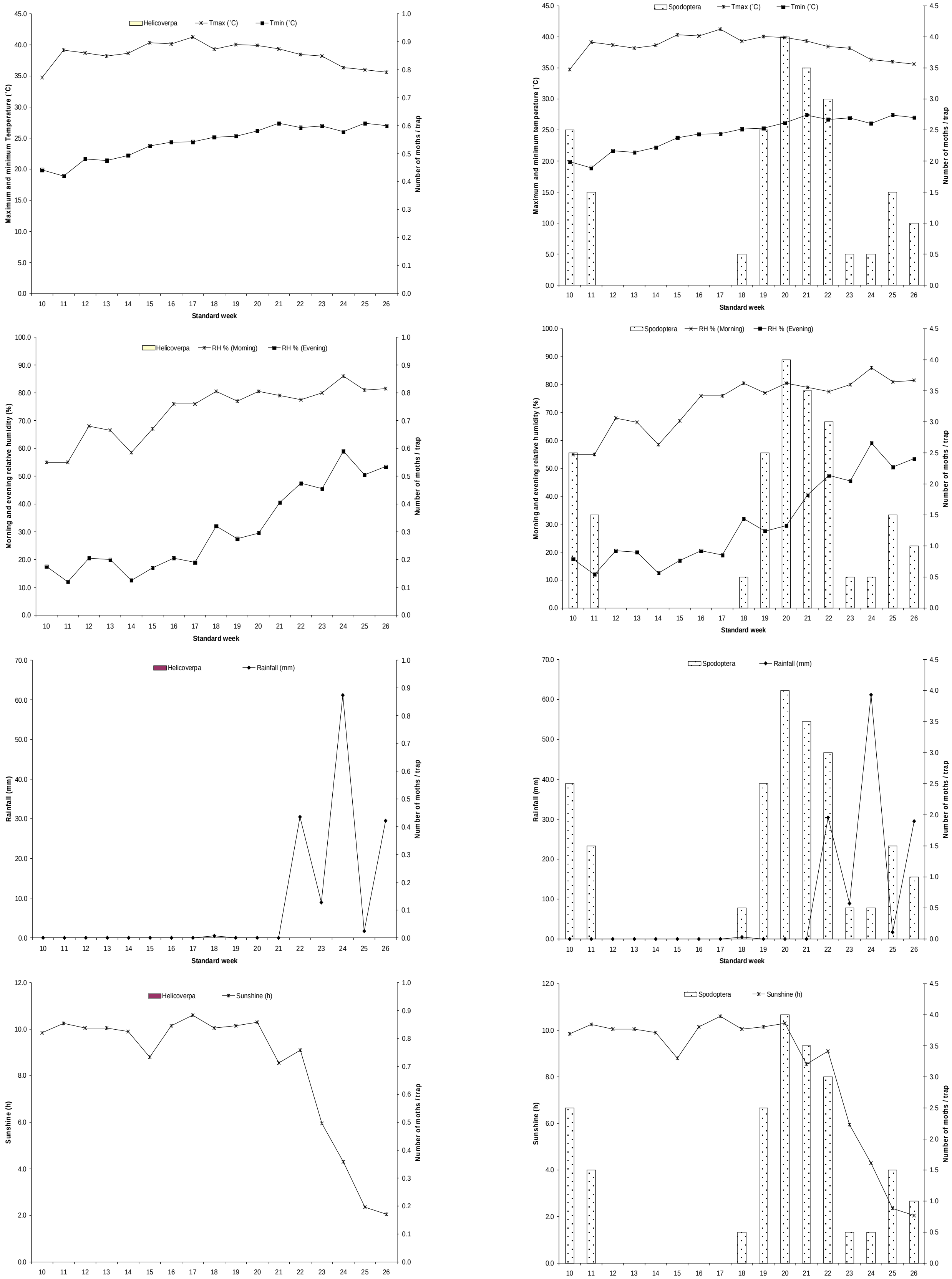

FIG 3: Population dynamics of *S. litura* and *H. armigera* of groundnut during summer

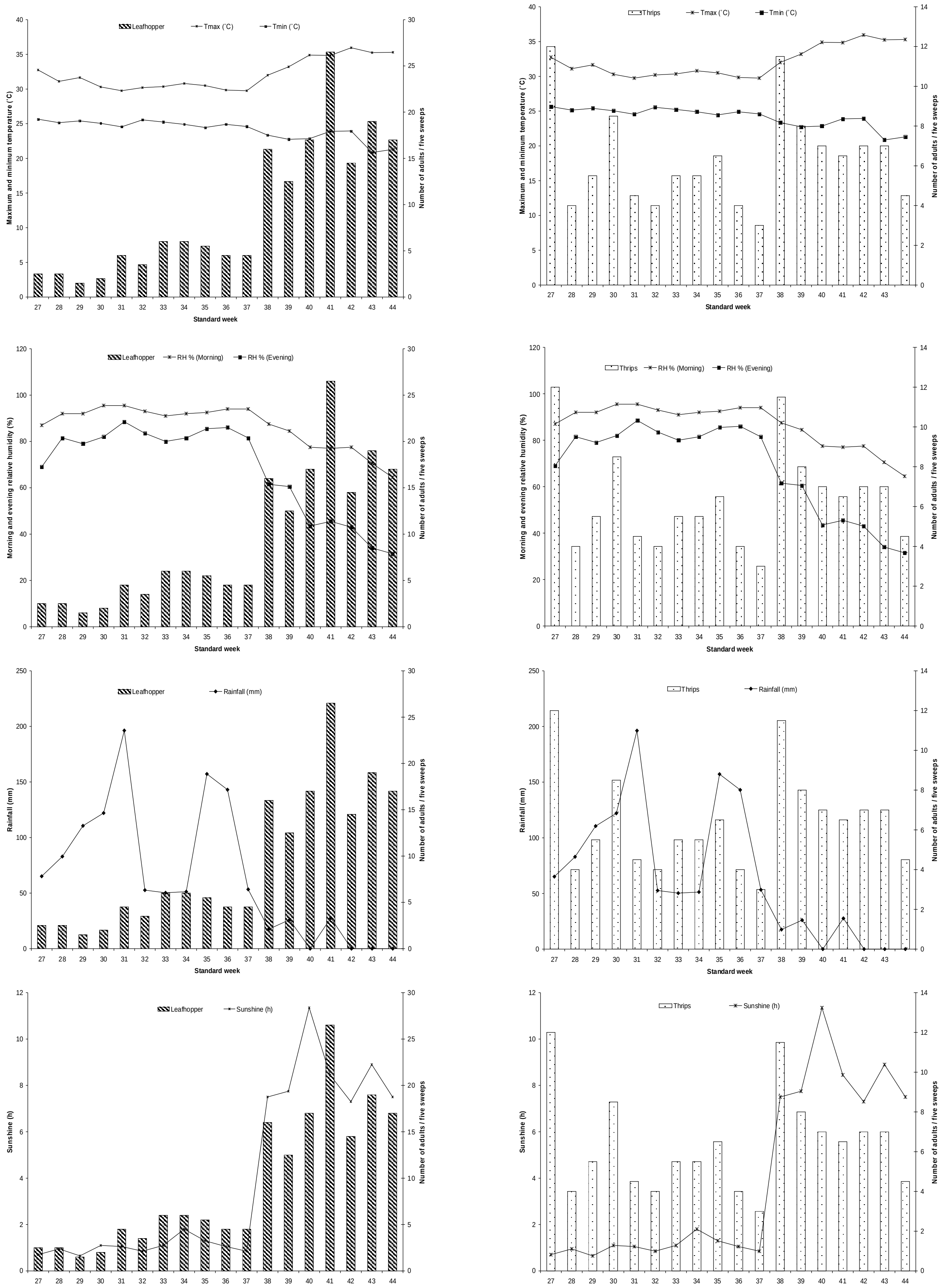

FIG 4: Population dynamics of sucking pests of groundnut during *kharif*

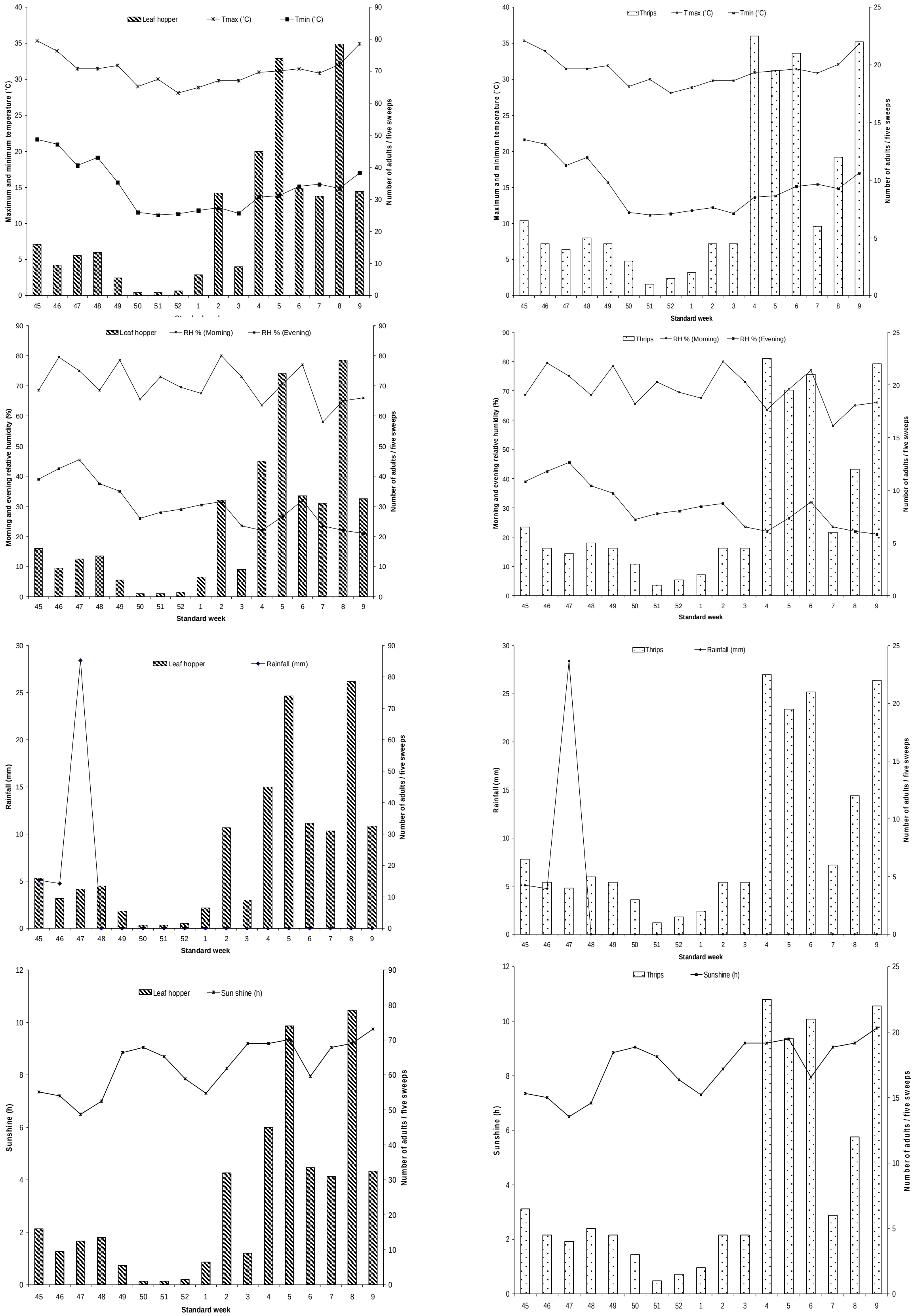

FIG 5: Population dynamics of sucking pests of groundnut during *rabi*

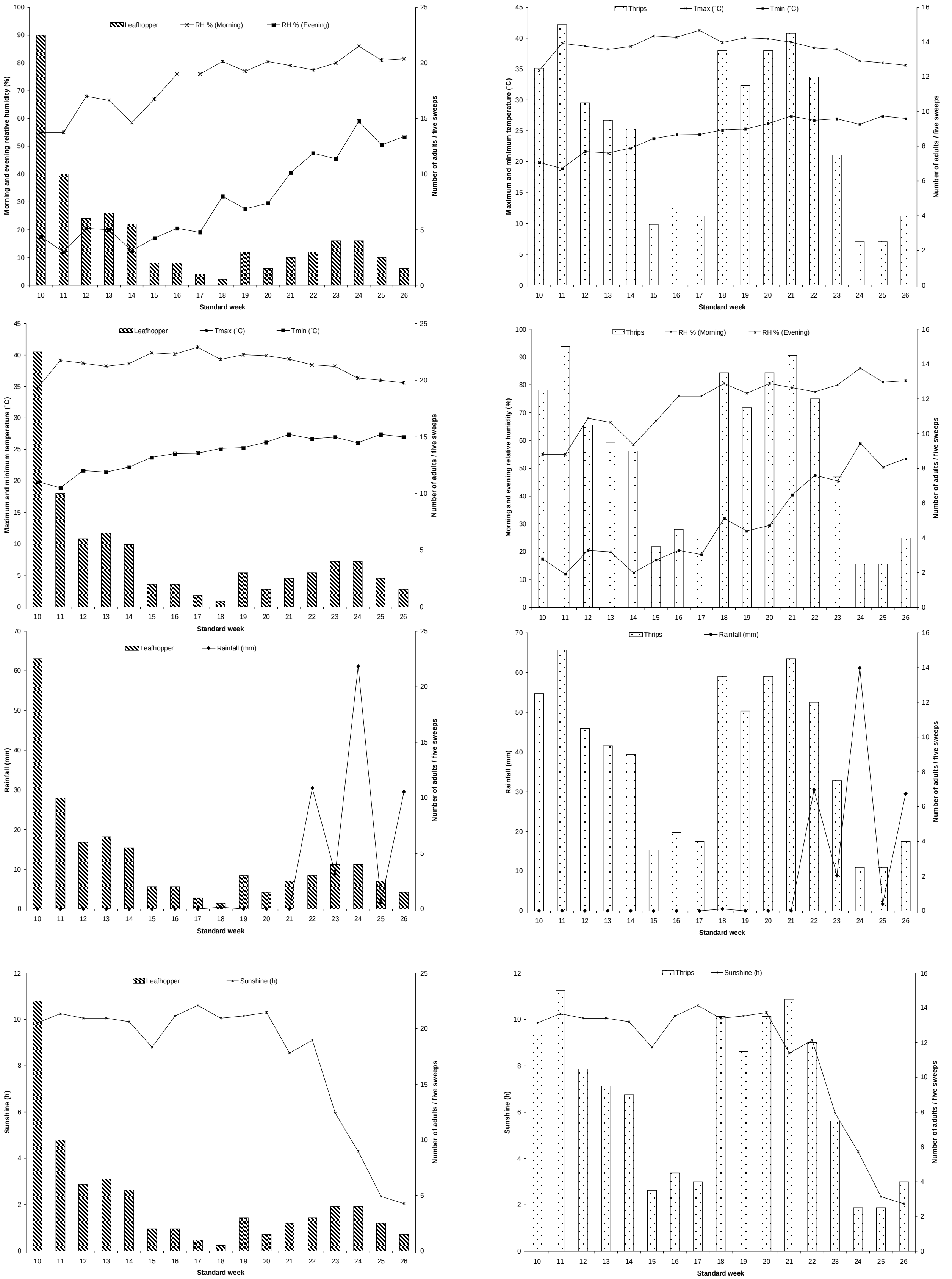

FIG 6: Population dynamics of sucking pests of groundnut during summer

significant relation with sunshine (h) but only thrips population showed a direct and non-significant relation with maximum temperature (^{0}C).

Multiple regression analysis of the *S. litura* population showed a significant interaction with weather parameters during *kharif* but there was no significant interaction during *rabi* and summer seasons (Table 3). In *kharif* season minimum temperature and sunshine showed significant interaction with the population. The coefficient of multiple determination (R^2) was 76, 35 and 53 per cent during *kharif*, *rabi* and summer seasons, respectively. Whereas, the population of *H. armigera* had no significant interaction with weather parameters (Table 4) where, the coefficient of multiple determination (R^2) was 55 and 40 per cent during *kharif* and *rabi* seasons, respectively. However R^2 value of 0.528 revealing 52.8% was observed by Rajesh and Durairaj (2012).

The population of leafhopper had significant relation with weather parameters during *kharif* and summer seasons, however in *rabi*, there was no significant interaction. Only the sunshine has contributed to increase in leafhopper population in *kharif* and summer seasons whereas maximum temperature had significant relation during summer (Table 5). The coefficient of multiple determination (R^2) was 89, 43 and 88 per cent during *kharif*, *rabi* and summer seasons, respectively. However, Prasad *et al* (2008) observed that the population of leafhoppers was dependent on abiotic factors and R^2 was 30.19, 11.39 and 12.02 per cent during *kharif*, *rabi* and summer seasons, respectively. No significant relation between weather parameters and thrips population was observed during *kharif* and *rabi*. But during summer, evening relative humidity, rainfall and sunshine showed significant effect on occurrence and abundance of thrips population. The coefficient of multiple determination (R^2) was 36, 54 and 80 per cent during *kharif*, *rabi* and summer seasons, respectively (Table 6).

Insect pests need congenial weather conditions for their survival and reproduction. The population of *S. litura* reached its maximum at the end of 40th standard week whereas; *H. armigera* peaked at 46th standard week thus indicating *kharif* season is most favorable for their occurrence and abundance on groundnut. The leafhopper and thrips populations peaked at the end of 8th and 4th standard weeks, indicating feasibility of conditions during the summer season. The relationships between pest population and weather parameters were further confirmed by the correlation and multiple regression studies. The maximum temperature (^{0}C) and sunshine (h) are important weather parameters deciding the seasonal occurrences of the

TABLE 1: Correlation of weather parameters with occurrence of *S. litura* and *H. armigera* in groundnut

Season	Weather parameters: Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	Sunshine (h)
	Maximum	Minimum	Morning	Evening		
S. litura						
Kharif	0.46**	-0.29*	-0.35**	-0.42**	-0.25*	0.64**
Rabi	-0.30*	-0.35**	0.09	-0.14	-0.20*	-0.05
Summer	-0.09	0.29*	0.15	0.24	-0.01	0.06
H. armigera						
Kharif	0.56**	-0.39**	-0.43**	-0.53**	-0.58**	0.64**
Rabi	0.21*	0.39**	0.47**	0.61**	0.30*	-0.50**

N= 102, *Significant at p=0.05 **Significant at p=0.01

TABLE 2: Correlation of weather parameters with occurrence of sucking pests in groundnut

Season	Weather parameters: Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	Sunshine (h)
	Maximum	Minimum	Morning	Evening		
Leafhoppers						
Kharif	0.81**	-0.76**	-0.82**	-0.87**	-0.68**	0.92**
Rabi	0.23*	0.02	-0.27**	-0.43**	-0.16	0.45**
Summer	-0.52**	-0.70**	-0.73**	-0.36**	-0.13	0.20*
Thrips						
Kharif	0.31**	-0.10	-0.15	-0.27**	-0.24*	0.30**
Rabi	0.39**	0.11	-0.20*	-0.41**	-0.18	0.46**
Summer	0.18	-0.31**	-0.35**	-0.32**	-0.37**	0.60**

N= 102, *Significant at p=0.05 **Significant at p=0.01

TABLE 3: Multiple regressions with population of *S. litura* and weather parameters

Weather parameters	**Partial regression coefficients**	**Standard error**	**'t' value**	**R^2**
		Kharif		
Intercept	-73.48	77.97	-0.94	0.76**
X_1=Maximum temperature (^{0}C)	-0.23	2.46	-0.09	
X_2=Minimum temperature (^{0}C)	5.22**	2.18	2.40	
X_3=Morning relative humidity (%)	-1.18	0.69	-1.71	
X_4=Evening relative humidity (%)	0.67	0.52	1.28	
X_5=Rainfall	0.05	0.03	1.54	
X_6=Sunshine (h)	4.17**	0.90	4.62	
		Rabi		
Intercept	19.51	40.36	0.48	0.35^{NS}
X_1=Maximum temperature (^{0}C)	1.56	1.95	0.80	
X_2=Minimum temperature (^{0}C)	-1.28	1.55	-0.82	
X_3=Morning relative humidity (%)	0.13	0.38	0.35	
X_4=Evening relative humidity (%)	-0.42	0.71	-0.58	
X_5=Rainfall (mm)	-0.11	0.23	-0.47	
X_6=Sunshine (h)	-5.05	3.03	-1.67	
		Summer		
Intercept	1.85	9.23	0.20	0.53^{NS}
X_1=Maximum temperature (^{0}C)	-0.24	0.37	-0.64	
X_2=Minimum temperature (^{0}C)	0.39	0.39	1.01	
X_3=Morning relative humidity (%)	-0.13	0.09	-1.41	
X_4=Evening relative humidity (%)	0.13	0.09	1.38	
X_5=Rainfall (mm)	-0.03	0.03	-0.98	
X_6=Sunshine (h)	0.56	0.21	2.63	

N= 102, *Significant at p=0.05 **Significant at p=0.01, ^{NS}- Non Significant

TABLE 4: Multiple regressions with population of *H. armigera* and weather parameters

Weather parameters	**Partial regression coefficients**	**Standard error**	**'t' value**	**R^2**
		Kharif		
Intercept	-32.05	23.73	-1.35	0.55^{NS}
X_1=Maximum temperature (^{0}C)	0.78	0.75	1.04	
X_2=Minimum temperature (^{0}C)	-0.18	0.66	-0.27	
X_3=Morning relative humidity (%)	0.07	0.21	0.32	
X_4=Evening relative humidity (%)	0.10	0.16	0.64	
X_5=Rainfall (mm)	-0.01	0.01	-1.22	
X_6=Sunshine (h)	0.29	0.27	1.05	
		Rabi		
Intercept	-6.12	13.72	-0.45	0.40^{NS}
X_1=Maximum temperature (^{0}C)	0.04	0.66	0.06	
X_2=Minimum temperature (^{0}C)	0.01	0.53	0.01	
X_3=Morning relative humidity (%)	0.04	0.13	0.30	
X_4=Evening relative humidity (%)	0.12	0.24	0.48	
X_5=Rainfall (mm)	-0.03	0.08	-0.34	
X_6=Sunshine (h)	0.02	1.03	0.02	

N= 102, *Significant at p=0.05 **Significant at p=0.01, ^{NS}- Non Significant

TABLE 5: Multiple regressions with population of leafhoppers and weather parameters

Weather parameters	Partial regression coefficients	Standard error	't' value	R^2
	Kharif			
Intercept	92.30	56.88	1.62	0.89**
X_1=Maximum temperature (^{0}C)	-2.97	1.79	-1.66	
X_2=Minimum temperature (^{0}C)	2.75	1.59	1.73	
X_3=Morning relative humidity (%)	-0.55	0.50	-1.08	
X_4=Evening relative humidity (%)	-0.25	0.38	-0.65	
X_5=Rainfall (mm)	0.02	0.02	1.00	
X_6=Sunshine (h)	2.13**	0.66	3.24	
	Rabi			
Intercept	123.75	214.73	0.58	0.43^{NS}
X_1=Maximum temperature (^{0}C)	-6.74	10.40	-0.65	
X_2=Minimum temperature (^{0}C)	9.84	8.25	1.19	
X_3=Morning relative humidity (%)	2.23	2.03	1.10	
X_4=Evening relative humidity (%)	-5.85	3.79	-1.54	
X_5=Rainfall (mm)	1.29	1.20	1.07	
X_6=Sunshine (h)	-2.44	16.14	-0.15	
	Summer			
Intercept	107.68	17.67	6.09	0.88**
X_1=Maximum temperature (^{0}C)	-2.39**	0.71	-3.36	
X_2=Minimum temperature (^{0}C)	-0.30	0.74	-0.41	
X_3=Morning relative humidity (%)	-0.21	0.17	-1.19	
X_4=Evening relative humidity (%)	0.08	0.18	0.45	
X_5=Rainfall (mm)	-0.03	0.06	-0.44	
X_6=Sunshine (h)	1.12**	0.41	2.72	

N= 102, *Significant at p=0.05 **Significant at p=0.01, ^{NS}- Non Significant

TABLE 6: Multiple regressions with population of thrips and weather parameters

Weather parameters	Partial regression coefficients	Standard error	't' value	R^2
	Kharif			
Intercept	-42.48	45.98	-0.92	0.36^{NS}
X_1=Maximum temperature (^{0}C)	0.46	1.45	0.32	
X_2=Minimum temperature (^{0}C)	-0.15	1.28	-0.11	
X_3=Morning relative humidity (%)	0.73	0.41	1.80	
X_4=Evening relative humidity (%)	-0.37	0.31	-1.22	
X_5=Rainfall (mm)	0.00	0.02	0.26	
X_6=Sunshine (h)	-0.29	0.53	-0.55	
	Rabi			
Intercept	2.13	62.14	0.03	0.54^{NS}
X_1=Maximum temperature (^{0}C)	-0.03	3.01	-0.01	
X_2=Minimum temperature (^{0}C)	2.13	2.39	0.89	
X_3=Morning relative humidity (%)	0.75	0.59	1.29	
X_4=Evening relative humidity (%)	-1.91	1.10	-1.74	
X_5=Rainfall (mm)	0.35	0.35	1.01	
X_6=Sunshine (h)	-2.51	4.67	-0.54	
	Summer			
Intercept	5.88	19.99	0.29	0.80**
X_1=Maximum temperature (^{0}C)	0.32	0.80	0.39	
X_2=Minimum temperature (^{0}C)	-0.92	0.84	-1.10	
X_3=Morning relative humidity (%)	-0.36	0.20	-1.81	
X_4=Evening relative humidity (%)	0.73**	0.20	3.65	
X_5=Rainfall (mm)	-0.20**	0.07	-2.88	
X_6=Sunshine (h)	2.21**	0.46	4.76	

N= 102, *Significant at p=0.05 **Significant at p=0.01, ^{NS}- Non Significant

S. litura, H. armigera, leafhoppers and thrips on groundnut. The information about the seasonal incidence and abundance may be utilized for planning the appropriate insect pest management strategies in advance during *kharif*- and *rabi*-summer crops to protect the yield loss caused by defoliators and sucking pests, respectively.

REFERENCES

Gedia, M.V.; Vyas, H.J. and Acharya, M.F. (2007). Influence of weather parameters on *Spodoptera litura* in pheromone trap and oviposition on groundnut. *Annal. Pl. Prot. Sci.*, **15** : 316-320.

Ghewande, M.P. (1987). Virus diseases of groundnut and their management. In: "Symposium on diseases of oilseed and pulse crops and their control". (Eds. S. C. Vyas and V. N. Shorofgf). pp. 62-67. (Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Indore, M.P.).

Jayanthi, M.; Singh, K. M and Singh, R. N. (1993). Population buildup of insect pests on MH-4 variety of groundnut influenced by abiotic factors. *Indian J. Ento.*, **55**: 109-123.

Kant, K.; Kanaujia, K.R. and Kanaujia, S. (2007). Role of plant density and abiotic factors on population dynamics of *Helicoverpa armigera* (Hubner) in chickpea. *Annal. Pl. Prot. Sci.*, **15 (2)**: 303-306.

Monobrullah, Md.; Poonam Bharti, Uma Shankar, Gupta, R.K., Kuldeep Srivastava and Hafeez Ahmad (2007). Seasonal incidence of *Spodoptera litura* on cauliflower and tomato. *Annal. Pl. Prot. Sci.*, **15 (1)**: 73-76.

Naidu, R.A.; Bottenberg, H., Subrahmanyam, P., Kimmins, F.M., Robinson, D.J and Thresh, J.M. (1998). Epidemiology of groundnut rosette virus disease: current status and future research needs. *Ann. Appl. Biol.*, 132: 525–548.

Nandagopal, V. (1992). Studies on integrated pest management in groundnut in Saurashtra. Ph. D. Thesis, Saurashtra University, Rajkot, pp. 246.

Nandagopal, V. (2004). Insect pests of economic importance and their management in Groundnut. In: Groundnut research in India (Eds. M.S. Basu and N. B. Singh). National Research Centre for Groundnut, Junagadh. pp. 480.

Nandagopal, V. and Reddy, P. S. (1987). Outbreak of *Balclutha hortensis* Lindb., a new pest species of groundnut. *J. Oilseed Res.*, 4:300.

Nandagopal, V. and Vasanta, S. (1991). Influence of plant growth regulators on the population of thrips, *Caliothrips indicus* (Bagnall) and damage in groundnut. *Entomon*, 16: 87-89.

Nandagopal, V.; Geetha, N. and Gedia, M.V. (2007). Evaluation of sampling procedure for leafhopper and thrips in groundnut. *J. Entomol. Res.*, 31 (4): 279-284.

Onobri, A. (2007). Routine statistical analysis of field experiments by using an excel extension. Proceedings 6th national conference Italian Biometric Society: "La statistica nelle science della vita e dell anbi ante" 20-22 June, Pisa, pp.93-96.

Pedigo, L.P. (2004). Entomology and Pest Management. Prentice Hall of India, New Delhi. 4th edition, pp. 175-210.

Prasad, S.G. and Logiswaran, G. (1997). Influence of weather factors on population fluctuation of insect pest of brinjal at Madurai, Tamil Nadu. *Indian J. Ent.*, **59**: 385-388.

Prasad, T.V.; Nandagopal, V and Gedia, M.V. (2008). Effect of weather parameters on the seasonal abundance of leafhopper, *Balclutha hortensis* in groundnut ecosystem. *Indian. J. Pl. Prot.*, 36 (1): 43-47.

Rajesh, K.J. and Durairaj, C. (2012). Population dynamics of gram pod borer (*Helicoverpa armigera*) in relation to weather factors under Tamil Nadu condition. *J. Food Legumes.*, **25 (1)**: 83-85.

Ranga Rao, G.V and Wightman, J.A. (1993). Groundnut thrips of economic importance, their occurrence and seasonal distribution. *J. Entomol. Sci.*, 4: 13.

Ranga Rao, G.V and Wightman, J.A. (1994). "First annual *Rabi/Summer* groundnut research workers group meeting".12-15 September, Indian Institute of Technology, Kharagpur, West Bengal, pp. 36.

Ratnapara, H.C.; Shek, A.M., Patel, J.R and Patel, N.M. (1994). Effect of weather parameters on brinjal jassid, *Amrasca biguttula biguttula* Ishida. *Gujarat Agril. University Res. J.*, 19:39-43.

Saminathan, V.R.; Jayaraj, S. and Regupathy, A. (2003). Correlation between Coccinellids (*Menochilus sexmaculatus* Fab.) (Coleoptera: Coccinellidae) on cotton and major weather factors in southern Tamil Nadu. *Madras Agric. J.*, **90 (4-6)**: 363-365.

Vijayalakshmi, K. (1994). Transmission and ecology of *Thrips palmi* Karny, the vector of peanut bud necrosis virus. Ph. D. thesis. Andhra Pradesh Agric. University, Rajandra Nagar, Hyderabad, India. pp. 99.

Vyas, H.N. (1984). Losses due to insect pests in groundnut (*Arachis hypogaea*). Proceedings of the all India workshop on crop losses on insect pests. *Indian J. Ento.*, 2: 312-317.