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SUCCESSION OF INSECT-PESTS INFESTING GROUNDNUT DURING *KHARIF* SEASON

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ABSTRACT

A field study was conducted during the *kharif* season of 2024 at SMC Polytechnic Farm, BACA, Anand Agricultural University, Anand, Gujarat, to investigate the succession of insect-pests and their natural enemies in groundnut (*Arachis hypogaea* L.) in relation to crop growth stages and prevailing weather conditions. Thrips infestation commenced from the 1st week after germination (WAG) and persisted until maturity (14th WAG), with two major peaks at the 31st standard meteorological week (SMW) (3.8 thrips/trifoliate leaf/plant) and the 38th SMW (3.0 thrips/trifoliate leaf/plant). Aphid activity began at the 4th WAG and peaked during the 37th SMW (7.20 aphids/trifoliate leaf/plant). Leaf-eating caterpillar incidence was noted from the 3rd to 14th WAG, with the highest count in the 33rd SMW (5.62 larvae/plant). Leaf miner infestation exhibited two peaks, 32nd SMW (2.80 larvae/plant) and 34th SMW (3.20 larvae/plant), while hairy caterpillar appeared from the 4th WAG and reached its peak during the 36th SMW (11.4 larvae/plant). Among the natural enemies, spider activity began in the 2nd WAG (peak 32nd SMW, 2.30/plant), coccinellids showed two peaks in the 32nd (2.4/plant) and 37th SMW (2.8/plant) and syrphid flies peaked in the 37th SMW (1.8/plant). Correlation analysis revealed that thrips population had a significant negative association with rainfall, while the aphid population was positively correlated with bright sunshine hours and negatively with humidity. Leaf-eating caterpillar incidence showed a positive correlation with minimum temperature, whereas leaf miner and hairy caterpillar populations were positively associated with rainfall and humidity but negatively with maximum temperature. Spider and coccinellid populations were negatively correlated with maximum temperature, and syrphid fly activity was negatively linked to both maximum temperature and wind speed. Strong positive associations were observed between pest species and their corresponding natural enemies, notably between aphids and coccinellids. These findings underline the role of weather parameters in shaping pest dynamics and the importance of natural enemies in regulating pest populations for sustainable groundnut production during *kharif*.

Keywords **:** Groundnut, pest succession, insect-pests, natural enemies, weather correlation, *kharif* season.

Introduction

Groundnut (*Arachis hypogaea* L.) is an important oilseed-cum-fodder legume crop belonging to the family Leguminosae. It is a self-pollinated, herbaceous annual that originated in South America, most likely in Brazil or Peru and was introduced into India in the sixteenth century. The genus name *Arachis* means legume, and *hypogaea* refers to pods forming below ground. Commonly known as peanut, earthnut, monkey nut or manilla nut, it is the 13th most important food crop and the 4th most important oilseed crop in the world (Ramanathan, 2001).

Groundnut is valued for its multiple uses, its seeds contain 43-45% edible oil and 25-28% protein (Arya *et al*., 2016) and provide essential vitamins such as B, E and K. The crop also improves soil fertility through biological nitrogen fixation, benefiting subsequent crops in rotation. In India, groundnut occupies about 4.70 million hectares, producing 10.18 million tonnes

with a productivity of 2163 kg/ha (Anonymous, 2024). Gujarat is the leading producing state.

Despite its economic significance, groundnut yields are reduced by several insect-pests (Atwal and Dhaliwal, 2015). Among them, thrips (*Scirtothrips dorsalis*), aphid (*Aphis craccivora*), leaf miner (*Aproaerema modicella*), tobacco caterpillar (*Spodoptera litura*) and hairy caterpillar (*Spilosoma obliqua*) are of major importance. Sucking pests damage plants by extracting sap and transmitting viral diseases such as peanut bud necrosis virus, while defoliators feed on leaves, reducing photosynthetic activity and yield (Bajia *et al*., 2017). Losses of 16-40% from sucking pests and 26-75% from defoliators have been reported (Jayanthi *et al*., 2000).

The order of appearance and dominance of different pests during the cropping season is known as pest succession, which is influenced by crop stage, weather parameters and the activity of natural enemies such as spider, coccinellids and syrphid flies. Earlier studies on groundnut have shown that different pests appear and become more common at certain crop stages. Saritha *et al*. (2020) reported that thrips activity in groundnut peaks around the 31st SMW during the *kharif* season. Similarly, Venkateswarlu *et al*. (2019) found that thrips populations reached their maximum in the 31st SMW, followed by a decline. Gocher and Ahmed (2019) observed that aphid populations peaked during the 37th SMW, while syrphid fly activity reached its maximum in the 38th SMW.

Materials and Methods

For observations five plants were randomly selected from each section and the number of sucking insect-pests (nymphs and adults) were recorded from a trifoliate leaf per plant. For lepidopteran insect-pests, ten plants were randomly selected and the larval population per plant was counted. Likewise, the population of natural enemies (spider, coccinellids, syrphid fly) per plant was also recorded. Observations were recorded every week, starting from one week after germination and continued until the harvest of the crop.

Correlation Study

The recorded data were correlated with bright sunshine hours (BSS), rainfall (RF), wind speed (WS), maximum temperature (MaxT) and minimum temperature (MinT), morning relative humidity (RH_1) and evening relative humidity (RH_2), which obtained from meteorological observatory of AAU, Anand. The data obtained was analyzed by using standard statistical techniques (Steel and Torrie, 1980).

Results and Discussion

The pattern of occurrence of insect-pests and their natural enemies in groundnut during the *kharif* season of 2024 is presented in Table 1 and illustrated in Fig. 1. Thrips were the first pests to infest the crop, appearing at the seedling stage (1st WAG) and remaining present until harvest. Leaf miner and leaf eating caterpillar infestations began during the vegetative stage (3rd WAG) and persisted through to crop maturity. Aphid and hairy caterpillar appeared slightly later, from the 4th WAG and continued until maturity. Among the natural enemies, coccinellids were observed from the 3rd WAG up to maturity, while spider appeared earlier from the 2nd WAG and remained till maturity. Syrphid fly activity was recorded between the 4th WAG and the pod formation stage.

Thrips

Thrips infestation in groundnut was first recorded during the 1st week after germination (26th SMW) with a mean population of 0.60 thrips per trifoliate leaf and persisted until the 14th WAG (39th SMW). The population varied between 0.40 and 3.8 thrips per trifoliate leaf, reaching its first peak (3.8 thrips per trifoliate leaf per plant) in the 31st SMW. Thereafter, the population declined, followed by a second peak (3.0 thrips per trifoliate leaf per plant) in the 38th SMW. Wankhede *et al*. (2020) reported that thrips population were initially observed at the seedling stage, during the 1st WAG (initially after sowing) and were monitored weekly until harvest. The pest appeared in the 27th SMW and persisted up to the 39th SMW.

Aphid

Aphid infestation was first observed in the 4th WAG, corresponding to the 29th SMW (3rd week of July), with the population of 3.40 aphid per trifoliate leaf per plant. The population showed a fluctuating trend, peaking twice; first in the 33rd SMW with 4.20 aphid per trifoliate leaf per plant and again in the 37th SMW reaching the highest count of 7.20 aphid per trifoliate leaf per plant. Following this peak, the population gradually declined, reaching a low of 1.80 aphid per trifoliate leaf per plant by the 40th SMW. According to Gocher and Ahmed (2019), the aphid population was first observed during the 4th WAS and gradually increased to reach its maximum level (9.89 aphid/trifoliate leaf/plant) in the 37th SMW.

Leaf eating caterpillar

The initial occurrence of leaf eating caterpillar was recorded during the 28th SMW (2nd week of July) with a population of 4.76 larvae per plant. The

population showed a marked increase, reaching a first peak with 5.20 larvae per plant in the 30th SMW and a second peak with 5.62 larvae per plant in the 33rd SMW. Thereafter, the population gradually declined to 2.2 larvae per plant by the 40th SMW. Dudhatra *et al.* (2024), who observed that the first population peak occurred in the 34th SMW, reaching 2.64 larvae per plant.

Leaf miner

The infestation of leaf miner began in the 3rd WAG, around the 2nd week of July (28th SMW), with an initial population of 1.2 larvae per plant and continued till the 13th WAG. The population gradually increased, reaching its first peak during 32nd SMW with 2.8 larvae per plant. After a slight decline, a second and higher peak occurred in the 4th week of August (34th SMW) with 3.2 larvae per plant. The population then steadily declined, dropping down 1.4 larvae per plant by 37th SMW. Further, it reduced to 0.4 larvae per plant during 38th SMW. According to Radhika (2013), the initial appearance of leaf miner in July, with maximum population recorded between the 32nd and 34th SMW, followed by a decline in subsequent weeks.

Hairy caterpillar

The pest appeared from the 4th WAG, which corresponds to the 29th SMW. The initial population was 4.20 larvae per plant. The number of larvae steadily increased in the following weeks, reaching its first and second peak in the 32nd SMW (7th WAG) and 36th SMW (11th WAG) with the larval count of 7.6 and 11.4 larvae per plant, respectively. After this peak, the population sharply declined to 5.2 larvae per plant in the 37th SMW (12th WAG) and eventually dropped to 1.8 larvae per plant by the 40th SMW (15th WAG) in early October. The incidence of bihar hairy caterpillar (*S. obliqua*) was first seen in the first week of August (32nd SMW) with about 0.26 larvae per meter of row. Its population reached the highest level of 3.80 larvae per meter in the second week of September (37th SMW) (Meena *et al*., 2024).

Spider

The spider population was first observed 0.6 per plant in 27th SMW. Their numbers gradually increased, reaching a peak of 2.3 spider per plant in the 32nd SMW (2nd week of August). After this peak, the population declined steadily, dropping to 0.2 spider per plant by the 40th SMW.

Coccinellid

Coccinellid activity began in 28th SMW with 0.8 individuals per plant. The population reached its first peak at 2.4 individuals per plant during 32nd SMW, followed by a second, higher peak of 2.8 individuals per plant in 37th SMW. After this, the population declined steadily, dropping to 1.2 and 0.6 individuals per plant in 39th and 40th SMW. According to Kumar *et al*. (2023), the coccinellid population attained peak during 38th SMW with 3.2 coccinellid/plant.

Syrphid fly

The syrphid fly population was first observed at 0.6 maggot/plant in the 29th SMW (3rd week of July). Their numbers gradually increased, reaching a peak of 1.8 maggots/plant in the 37st SMW. After this peak, the population declined steadily to 0 by the 40th SMW. According to Kumar *et al*. (2023), the syrphid population attained peak during 37th SMW with 1.9 maggots/plant.

Interaction with Weather Factors

Thrips

The thrips population in groundnut showed a significant negative correlation with rainfall (r=-0.520*), suggesting that increased rainfall may adversely affect their survival or activity. Other abiotic factors such as minimum temperature (r=0.407) and wind speed (r=0.329) had shown non-significant positive association, whereas maximum temperature, bright sunshine hours and morning and evening relative humidity exhibited negative, non-significant correlation. According to Saritha *et al*. (2020), rainfall exhibited a negative correlation (r = -0.471) with thrips population, whereas thrips population showed a positive correlation with minimum temperature and negative correlation with evening relative humidity.

Aphid

The aphid population exhibited a significant positive correlation with bright sunshine hours (r=0.622*) and significant negative correlation with morning relative humidity (r=-0.619*) and evening relative humidity (r = -0.580*). Non-significant positive association were recorded with maximum temperature (r = 0.529), minimum temperature (r = 0.240) and wind speed (r = 0.199), whereas rainfall showed a negative but non-significant correlation (r=-0.458). Findings closely align with those of Saritha *et al*. (2020), who reported that aphid population are positively correlated with both maximum (r = 0.577) and minimum temperatures (r = 0.505).

Leaf eating caterpillar

Leaf eating caterpillar exhibit a significant positive correlation with minimum temperature (r = 0.590*). However, non-significant positive correlation

were observed with rainfall (r = 0.016), wind speed (r = 0.313), morning relative humidity (r = 0.085) and evening relative humidity (r = 0.353). In contrast, non-significant negative correlation were found with bright sunshine hours (r = -0.466) and maximum temperature (r = -0.154). Dudhatra *et al*. (2024) found that the population of leaf eating caterpillar exhibits a significant positive correlation with minimum temperature (r = 0.616*) and morning relative humidity (r = 0.638*).

Leaf miner

There is a strong positive and highly significant correlation with rainfall (r = 0.733**), indicating that increased rainfall favours the incidence of leaf miner, likely the both morning (r = 0.559*) and evening (r = 0.590*) relative humidity also show significant positive correlation. In contrast, bright sunshine hours (r = -0.572*) and maximum temperature (r = -0.569*) are significant negatively correlated with leaf miner population. According to Kumbhar *et al*. (2021) leaf miner showed a highly significant positive correlation with morning (r = 0.569*) and evening (r = -0.569*) relative humidity and found a significant negative correlation with maximum temperature (r = -0.525*).

Hairy caterpillar

Hairy caterpillar population and weather conditions indicated that the population have a significant positive correlation with rainfall (r = 0.678*) and morning relative humidity (r = 0.599*). There is a significant negative correlation with maximum temperature (r = -0.598*). Non-significant positive correlation are observed with wind speed (r = 0.421) and evening relative humidity (r = 0.465). In contrast, non-significant negative correlation are found with bright sunshine hours (r = -0.378) and minimum temperature (r = -0.157). Kumbhar *et al*. (2021) revealed that significant negative correlation between hairy caterpillar population and maximum temperature (r = -0.599), whereas positive association with morning relative humidity (r = 0.264) and rainfall (r = 0.183).

Spider

Spider population has a significant negative correlation with maximum temperature (r = -0.613*), indicating that higher maximum temperatures are associated with reduced spider abundance. Non-significant positive correlation were observed with rainfall (r = 0.280), wind speed (r = 0.244), morning relative humidity (r = 0.364) and evening relative humidity (r = 0.326). In contrast, non-significant negative correlation are seen with bright sunshine hours and minimum temperature.

Coccinellid

Coccinellid population has a significant negative correlation with maximum temperature (r = -0.587*), whereas non-significant positive correlation were observed with bright sunshine hours (r = 0.079), rainfall (r = 0.231), wind speed (r = 0.290), morning relative humidity (r = 0.183) and evening relative humidity (r = 0.040). According to Gocher and Ahmed (2019), who reported a significant negative correlation between coccinellid population and maximum temperature (r = -0.538).

Syrphid fly

The syrphid fly population showed (Table 4.3) a highly significant negative correlation with maximum temperature (r = -0.675**). Non-significant positive correlation were observed with rainfall, wind speed, morning and evening relative humidity, while non-significant negative correlation were seen with bright sunshine hours and minimum temperature. These findings corroborate the results of Gocher and Ahmed (2019), who reported a significant negative correlation between syrphid fly population and maximum temperature (r = -0.390).

Correlation of insect-pests with natural enemies

The correlation analysis during *kharif*, 2024 in groundnut revealed significant positive associations among several insect-pests and their natural enemies. The leaf eating caterpillar showed strong correlations with leaf miner (*r* = 0.703*), spider (0.770**), coccinellid (0.717**) and syrphid fly (0.598*). Leaf miner was significantly associated with hairy caterpillar (0.875**), spider (0.809**), coccinellid (0.673*) and syrphid fly (0.664*). Aphid population in groundnut showed a significant positive correlation with coccinellid (*r* = 0.698*) and syrphid fly (*r* = 0.661*), indicating their simultaneous occurrence and complementary role in aphid suppression. Among natural enemies, spider abundance was highly related to coccinellid (0.798**) and syrphid fly (0.905**), while coccinellid and syrphid fly also showed a strong association (0.837**).

Table 1: Succession of insect-pests as well as natural enemies in groundnut (*Kharif*, 2024)

Sr. No	Common name	Prevalence of pest during cropping period	Crop stage	Nature of occurrence	Economic status
1.	Thrips	1st to 14th WAG	Seedling to maturity stage	Regular	Major
2.	Leaf eating caterpillar	3rd to 15th WAG	Vegetative to maturity stage	Regular	Major
3.	Leaf miner	3rd to 14th WAG	Vegetative to maturity stage	Regular	Minor
4.	Aphid	4th to 15th WAG	Vegetative to maturity stage	Regular	Major
5.	Hairy caterpillar	4th to 15th WAG	Vegetative to maturity stage	Seasonal	Major
6.	Spider	2nd to 15th WAG	Vegetative to maturity stage	Regular	Natural enemy
7.	Coccinellid	3rd to 15th WAG	Vegetative to maturity stage	Regular	Natural enemy
8.	Syrphid fly	4th to 13th WAG	Vegetative to pod formation stage	Occasional	Natural enemy

Note: WAG = Week After Germination

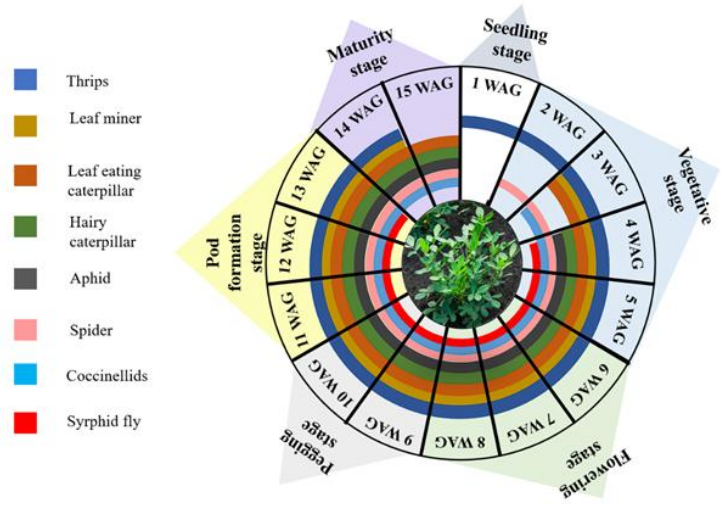

Fig. 1 : Succession of insect-pests and natural enemies in groundnut (*Kharif*, 2024)

Table 2: Population of insect-pests infesting groundnut crop and their natural enemies (*kharif*, 2024).

Month/Week		SMW	WAG	Number of sucking insect-pests/trifoliate leaf/plant		Number of lepidopteran larva(e)/plant			Natural enemies/plant		
				Thrips	Aphid	Leaf eating caterpillar	Leaf miner	Hairy caterpillar	Spider	Coccinellid	Syrphid fly
June	IV	26	1	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
July	I	27	2	2.80	0.00	0.00	0.00	0.00	0.60	0.00	0.00
	II	28	3	3.40	0.00	4.76	1.20	0.00	0.80	0.80	0.00
	III	29	4	2.40	3.40	4.80	2.00	4.20	0.90	1.00	0.60
	IV	30	5	2.00	2.08	5.20	1.60	5.60	1.64	2.20	1.40
August	I	31	6	3.80	2.02	4.98	2.20	5.80	1.80	2.40	1.20
	II	32	7	3.00	2.86	5.24	2.80	7.60	2.30	2.40	1.60
	III	33	8	2.80	4.20	5.62	1.80	6.00	1.60	2.00	1.00
	IV	34	9	1.20	3.44	4.26	3.20	8.20	1.58	1.80	1.00
September	I	35	10	0.40	2.34	4.08	3.00	8.60	1.20	2.20	1.20
	II	36	11	1.60	2.80	3.58	2.80	11.40	1.60	2.00	1.40
	III	37	12	2.80	7.20	3.40	1.40	5.20	1.16	2.80	1.80
	IV	38	13	3.00	6.20	3.28	0.40	3.40	0.80	2.00	1.00
October	I	39	14	1.00	2.12	2.70	1.20	4.60	0.60	1.20	0.00
	II	40	15	0.00	1.80	2.22	0.00	1.80	0.20	0.60	0.00

Note: SMW = Standard Meteorological Week, WAG = Week After Germination

Table 3: Correlation coefficient (r) between weather factors and insect-pests as well as their natural enemies in groundnut (*Kharif*, 2024)

Weather factors	Thrips (n = 14)	Aphid (n = 12)	Leaf eating caterpillar (n = 13)	Leaf miner (n = 12)	Hairy caterpillar (n = 12)	Natural enemies		
						Spider (n = 14)	Coccinellid (n = 13)	Syrphid fly (n = 10)
Bright sunshine hours (BSS)	-0.034	0.622*	-0.466	-0.572*	-0.378	-0.301	0.079	-0.241
Rainfall (RF)	-0.520*	-0.458	0.016	0.733**	0.678*	0.280	0.231	0.374
Wind speed (WS)	0.329	0.199	0.313	0.399	0.421	0.244	0.290	0.349
Maximum temperature (MaxT)	0.083	0.529	-0.154	-0.569*	-0.598*	-0.613*	-0.587*	-0.675**
Minimum temperature (MinT)	0.407	0.240	0.590*	-0.131	-0.157	-0.182	-0.423	-0.169
Morning relative humidity (RH_1)	-0.245	-0.619*	0.085	0.559*	0.599*	0.364	0.183	0.263
Evening relative humidity (RH_2)	-0.143	-0.580*	0.353	0.590*	0.465	0.326	0.040	0.244

Note: * Significant at 0.05 % level, ** Significant at 0.01 % level

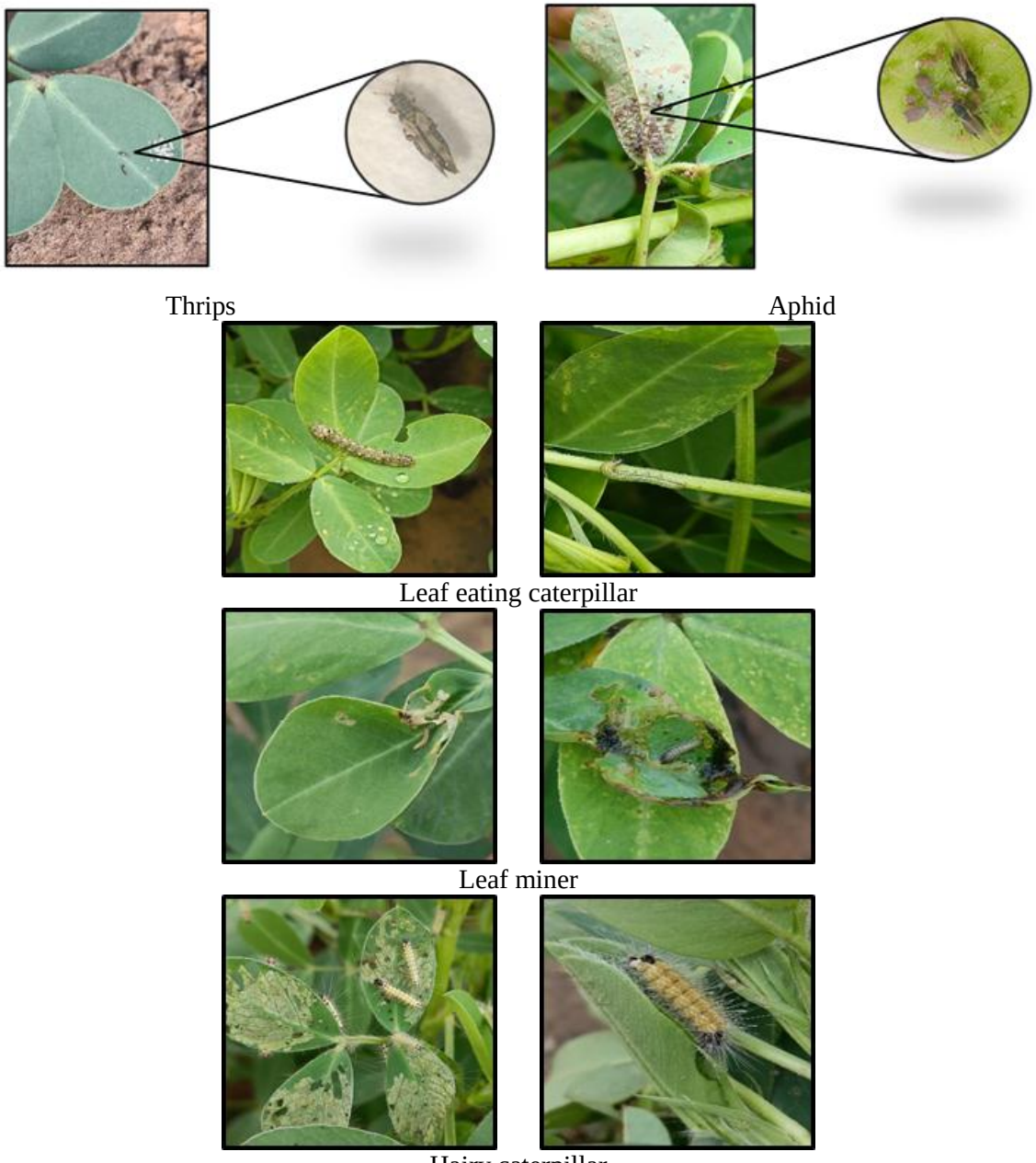

Plate 1: Insect-pests recorded in groundnut crop

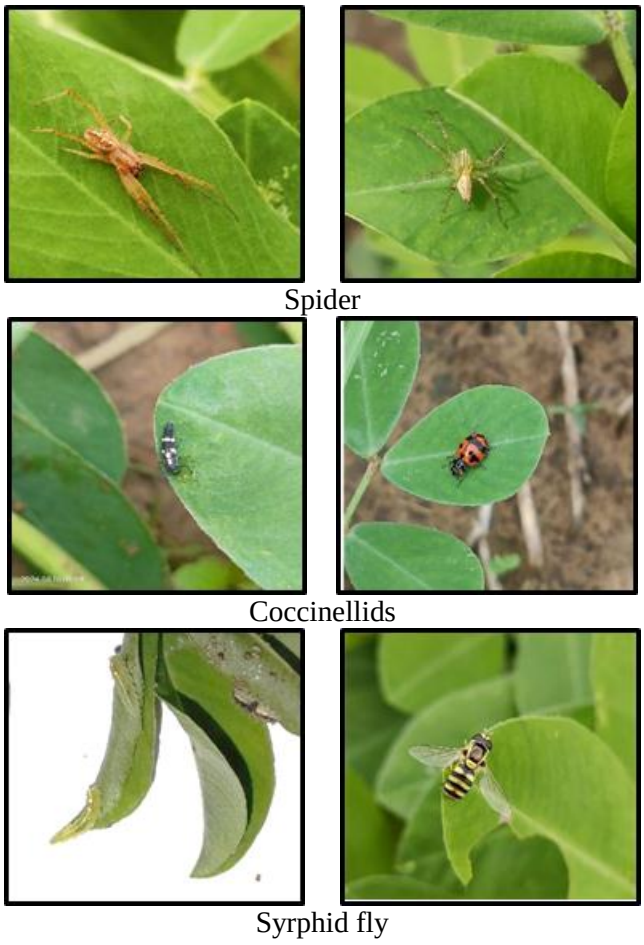

Plate 2: Natural enemies recorded in groundnut crop

Conclusions

The study during the kharif season showed that thrips, leaf eating caterpillar, aphid and hairy caterpillar were the major pests infesting groundnut from seedling to maturity, while leaf miner remained minor. Aphid population peaked twice, with a maximum aphids per trifoliate leaf per plant in the 37th SMW and were positively correlated with bright sunshine hours but negatively with morning and evening relative humidity. Leaf eating caterpillar abundance was significantly influenced by minimum temperature, whereas hairy caterpillar and leaf miner populations increased with greater rainfall and humidity. Natural enemies such as spider, coccinellids and syrphid flies helped regulate pest populations, but their activity declined with rising maximum temperature, as seen in spider and coccinellids. These findings highlight that pest dynamics are strongly influenced by weather conditions, enabling forecasting through climatic data. Implementing weather-based pest management along with the conservation of natural enemies can support sustainable groundnut production in the region.

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