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Succession of Insect-pests Infesting Sesame during Summer

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Abstract

Field experiment was carried out during summer (February–May, 2022) at Regional Research Station, Anand Agricultural University, Anand, Gujarat, India to find out the succession of insect pests and its fluctuation under the impact of biotic and abiotic factors on the abundance of major insect pests on sesame. Results revealed that the population of whitefly and jassid started from 10th standard meteorological week and till the 20th standard meteorological week. Population of *Antigastra catalaunalis* was first recorded during 12th standard meteorological week and reached at peak level during 15th standard meteorological week. Leaf, flower and capsule damage continuously increased and attained at peak during 16th and 20th standard meteorological week, respectively. The population of coccinellids and spider was highest during 14th and 15th standard meteorological week, respectively. The correlation with abiotic factors indicated that whitefly population showed highly significant negative correlation with wind speed and significantly negative correlation with minimum temperature, evening relative humidity and evening vapour pressure. Whereas, jassid population exhibited significantly negative correlation with WS, RH_2 and VP_2. However, *A. catalaunalis* showed significantly negative correlation with MinT, RH_2 and VP_2. Leaf damage showed significant negative correlation with RH_2 and VP_2. The flower damage had highly significant correlation with VP_2 and significant negative correlation were observed with MinT and RH_2. While, capsule damage had significantly positive correlation with MinT and VP_2. Whereas, the natural enemies viz., coccinellids and spider exhibited significantly negative correlation with RH_2.

Keywords: Capsule borer, coccinellid, correlation, jassid, sesame, whitefly

1. Introduction

Sesame (*Sesamum indicum* Linnaeus), often identified as the "Queen of oil seeds" belongs to Pedaliaceae (Alegbejo et al., 2003). Its origins can be traced back to East Africa and India. Sesame is the oldest indigenous oil plant with longest history of its cultivation in India (Biswas et al., 2001). In India, it is grown in all the crop growing seasons viz., *kharif*, *rabi* and summer. The primary challenges in global sesame production include the absence of widely adaptable cultivars, capsule shattering at maturity, nonsynchronous maturity, poor stand establishment, limited response to fertilizers, excessive branching, and a low harvest index (Ashri, 1994). A sizable proportion of the population generates income from oilseed farming, trade and processing. Sesame seed oil has long shelf life due to the presence of lignans, which have a remarkable antioxidant function (Chakraborthy et al., 2008). Due to the presence of potential antioxidants, sesame seeds are known as "the seed of immortality". The sesame crop is predominantly cultivated in tropical and subtropical regions, with major production share from India, China, Turkey, Myanmar, Pakistan, Egypt, Sudan, Tanzania, Greece, Venezuela, Argentina, Colombia and USA (Gebregergis et al., 2018). India is the world's largest producer and exporter of sesame in the world (Naik et al., 2016). In India, the cultivation is mainly confined to Uttar Pradesh, Rajasthan, Madhya Pradesh, Andhra Pradesh, Odisha, Gujarat etc (Choudhary et al., 2020). India contributes the highest sesame acreage of about 16.22 lakh ha with production of 6.57 lakh tones and productivity of 405.70 kg ha^{-1} (Anonymous, 2020). In Gujarat total sesame growing area is 2.08 lakh hectares with production of 1.33 lakh tones and productivity is 641.22 kg ha^{-1}. Summer sesame growing area is 1.07 lakh ha with production of 1.00 lakh tones and productivity is 930.80 kg ha^{-1} in Gujarat (Anonymous, 2022). A large number of insect pests *i.e*. 67 are known to damage sesame crop viz., leaf webber or roller and capsule borer, *Antigastra catalaunalis* Duponchel; gall fly, *Asphondylia sesame* Felt; whitefly, *Bemisia tabaci* (Gennadius) and jassid, *Orosius albicinctus* Distant (Ahirwar et al., 2009; Biswas and Das, 2011; Thangjam and Vastrad, 2015). Those insect pests infest sesame crop at different stages of sesame growth, trigger significant damage to the crop resulting into huge losses in sesame production (Thangjam and Vastrad, 2018). *A*. *catalaunalis* larva is a most serous damaging insect pests that affect the production of sesame by causing huge loss of sesame production (Gebregergis et al., 2018). The larvae of *A. catalaunalis* attack seed capsules and cause yield loss up to 100% in heavy infestation (Geremedhin and Azerefegne, 2020). However, whitefly, *B. tabaci* has been reported carrying devastating diseases like fungal infection (Gangwar and Gangwar, 2018; Roda et al., 2020). Jassids (*O. albicinctus*) are also responsible to transmit phyllody. Pathological symptoms appear in the form of crowding of leaves and short internodes, especially near the growing top, so that the leaves appear as if they are emerging from one point resembling a rose (Fakeer and Gameel, 2022). The concept of Integrated Pest Management (IPM) relies on a fundamental understanding of pest ecology, with region-specific strategies necessitating detailed knowledge of seasonal pest incidence. Since, little work has been done on pest succession of sesame ecosystem especially in summer, the present experiment was undertaken to record the diversity of insect pest and its correlation with abiotic factors.

2. Materials and Methods

Field study on succession of various insect pests infesting sesame based on occurrence during the crop period and association with weather factors as well as natural enemies, a field experiment was conducted at Regional Research Station, Anand Agricultural University, Anand during summer (February -May, 2022) (Lat: 22.530161°; Long: 72.964606). The plot size was taken as 9×12 m^2. The healthy seeds of sesame variety Gujarat Junagadh Til 5 (GJT 5) was sown by dibbling method (2 seeds per hill).

2.1. Method of recording observations

For recording observations on major insect pests and natural enemies, the experimental plot was divided into six equal quadrates (1.5-×-2 m^2) and kept free from application of any insecticides. From each quadrate ten plants were randomly selected. The population of sucking insect pests (nymphs and adults) was counted from three (upper, middle and lower) leaves per plant. Number of larvae per plant (leaf webber and capsule borer) was recorded. Alongside this, healthy and damaged leaves, flowers and capsules per plant was also recorded and % damage was worked out. As per the following formula:

"Leaf/flower/capsule damage (%)=(Number of damaged leaf/flower/capsule)/(Total number of leaf/flower/capsule)×100

Observations were recorded on a weekly basis, commencing from one week after germination and continuing till harvest.

2.2. Correlation study

The data thus obtained were correlated with bright sunshine hours (BSS), wind speed (WS), maximum (MaxT) and minimum (MinT) temperature, morning (RH_1) and evening (RH_2) relative humidity as well as morning (VP_1) and evening vapour pressure (VP_2). Correlation coefficient was worked out between various insect pests and their predatory fauna. The data obtained were analysed by following standard statistical technique given by Steel and Torrie (1980).

3. Results and Discussion

3.1. Succession based on occurance and weather factors

3.1.1. Whitefly, bemisia tabaci

The data on population of whitefly are presented in Table 1 and Figure 1 and 2. It was evident that activity of whitefly (3.60 whiteflies three $leaves^{-1}$) started from 1^{st} week after germination (WAG) *i.e*. 1^{st} week of March (10^{th} SMW) on sesame and till the 11^{th} WAG *i.e*. 2^{nd} week of May (20^{th} SMW). The population of whitefly ranged from a minimum of 0.60 to a maximum of 9.40 whiteflies three $leaves^{-1}$. The infestation continuously increased and reached at peak level (9.40 whiteflies three $leaves^{-1}$) during 5^{th} WAG *i.e*. 4^{th} week of March (13^{th} SMW). After which, the population recorded continuous decline and reached the lowest level (0.60 whitefly three $leaves^{-1}$) during 12^{th} WAG *i.e*. 2^{nd} week of May (20^{th} SMW). The data relevant to correlation study between whitefly and weather factors are given in Table 2 and Figure. 2, which state that all weather parameters under exhibited non-significant correlation with the incidence of the whitefly except wind speed (WS), minimum temperature (MinT), evening relative humidity (RH_2) and evening vapour pressure (VP_2). Whitefly population showed highly significant ($r= -0.745^{**}$) and significant ($r= -0.611^{*}$, -0.615^{*} and -0.675^{*}) negative correlation with WS, MinT, RH_2 and VP_2 respectively.

A similar study revealed that the higher activity *B. tabaci* was observed on 4^{th} week of March (Chaitra, 2016). Likewise, the highest whitefly population (6.85 whiteflies three $leaves^{-1}$) was recorded during 13^{th} SMW on sesame (Mohanlal, 2022). According to Bondre et al., 2016 whitefly, *Bemisia tabaci* recorded higher in number to infesting sesame crop. The minimum temperature was significantly (r=-0.50) negatively correlated with whitefly population (Gupta et al., 2009).

3.1.2. Jassid, O. albicinctus

The activity of jassids was recorded during summer, 2022 are presented in Table 1 and Figure 1 and 2. Initial population of jassid on sesame was observed during 1^{st} WAG *i.e.* 1^{st} week of March (10^{th} SMW) and continued till the 11^{th} WAG *i.e.* 2^{nd} week of May (20^{th} SMW), which ranged from 0.60 to 7.90 jassids

Table 1: Population of insect pests infesting sesame crop and their natural enemies

Month/ Week		SMW	WAG	No. of sucking Insects-pests three leaves^{-1}		No. of leaf webber and capsule borer larva(e) plant^{-1}	Damage by leaf webber and capsule borer (%)			No. of natural enemies plant^{-1}	
				Whitefly	Jassid		Leaf	Flower	Capsule	Coccinellids	Spider
March	I	10	1	3.60	2.40	-	-	-	-	-	-
	II	11	2	6.60	5.60	-	-	-	-	0.40	-
	III	12	3	8.00	6.80	1.20	12.90	-	-	0.80	0.20
	IV	13	4	9.40	7.90	1.80	17.60	18.90	-	1.00	0.40
April	I	14	5	9.00	6.20	2.30	23.90	22.90	-	1.20	0.80
	II	15	6	8.40	7.30	2.90	28.30	27.59	18.30	1.00	0.88
	III	16	7	5.40	5.80	2.20	30.74	30.30	19.30	0.60	0.60
	IV	17	8	5.10	3.90	1.90	25.02	23.75	24.75	1.00	0.80
	V	18	9	1.40	2.00	1.20	18.76	12.60	25.90	0.20	0.10
May	I	19	10	1.20	1.20	0.90	13.24	9.10	27.60	0.02	0.18
	II	20	11	0.60	0.60	0.50	8.30	6.60	28.90	0.00	0.00

SMW: Standard meteorological week; WAG: Weeks after germination; -: Pests was not appeared

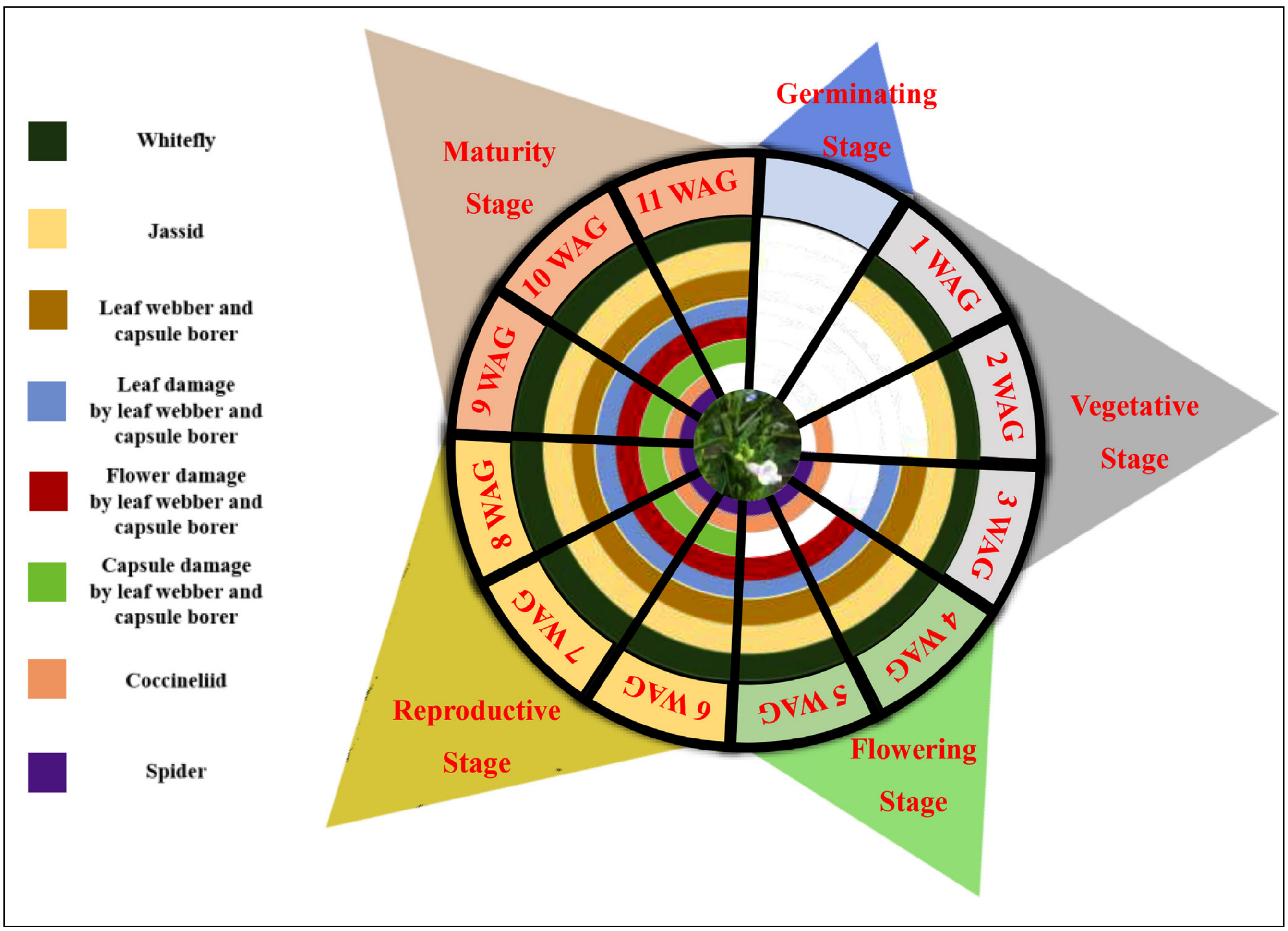

Figure 1: Succession of insect pests and natural enemies in sesame

Table 2: Correlation coefficient (r) between weather factors and insect pests as well as their natural enemies in sesame

Weather factors / Particulars	Whitefly (n=11)	Jassid (n=11)	Leaf webber and capsule borer (n=9)	Damage by leaf webber and capsule borer (%)			Natural enemies plant^{-1}	
				Leaf (n= 9)	Flower (n= 8)	Capsule (n= 6)	Coccinellids (n= 11)	Spider (n= 11)
Bright sunshine, hrs day^{-1} (BSS)	-0.471	-0.472	0.073	0.167	-0.355	0.597	-0.151	0.297
Wind speed, kmph (WS)	-0.745**	-0.639*	-0.652	-0.443	-0.632	0.663	-0.519	-0.155
Maximum temperature, °C (MaxT)	-0.121	-0.093	0.084	0.129	-0.205	0.382	0.250	0.390
Minimum temperature, °C (MinT)	-0.611*	-0.530	-0.606*	-0.429	-0.708*	0.841*	-0.278	0.037
Morning relative humidity, % (RH_1)	0.0613	0.098	0.276	0.162	-0.021	-0.231	0.0758	0.038
Evening relative humidity, % (RH_2)	-0.615*	-0.605*	-0.732*	-0.720*	-0.777*	0.651	-0.639*	-0.610*
Morning vapour pressure, mm of Hg (VP_1)	-0.488	-0.406	-0.192	-0.094	-0.605	0.438	-0.186	0.128
Evening vapour pressure, mm of Hg (VP_2)	-0.675*	-0.656*	-0.719*	-0.675*	-0.899**	0.837*	-0.519	-0.432

*: Significant at (p=0.05) level, **: Significant at (p=0.01) level

per three leaves. Since initial occurance, jassid population continuously increased and reached a peak level (7.90 jassids three leaves^{-1}) on 5th WAG *i.e.* 4th week of March (13th SMW). Thereafter, the population exhibited slight decrease (6.20 jassids three leaves^{-1}) during 6th WAG *i.e.* 1st week of April (14th SMW). Thereafter, a slight upsurge (7.30 jassids three leaves^{-1}) during 7th WAG *i.e.* 2nd week April (15th SMW) was observed. Population reached at minimum level (0.60 jassid three leaves^{-1}) during 12th WAG *i.e.* 2nd week of May (20th SMW). The wind speed (WS), evening relative humidity (RH_2) and evening vapour pressure (VP_2) showed significantly (r= -0.639*, -0.605* and -0.656*, respectively) negative correlation

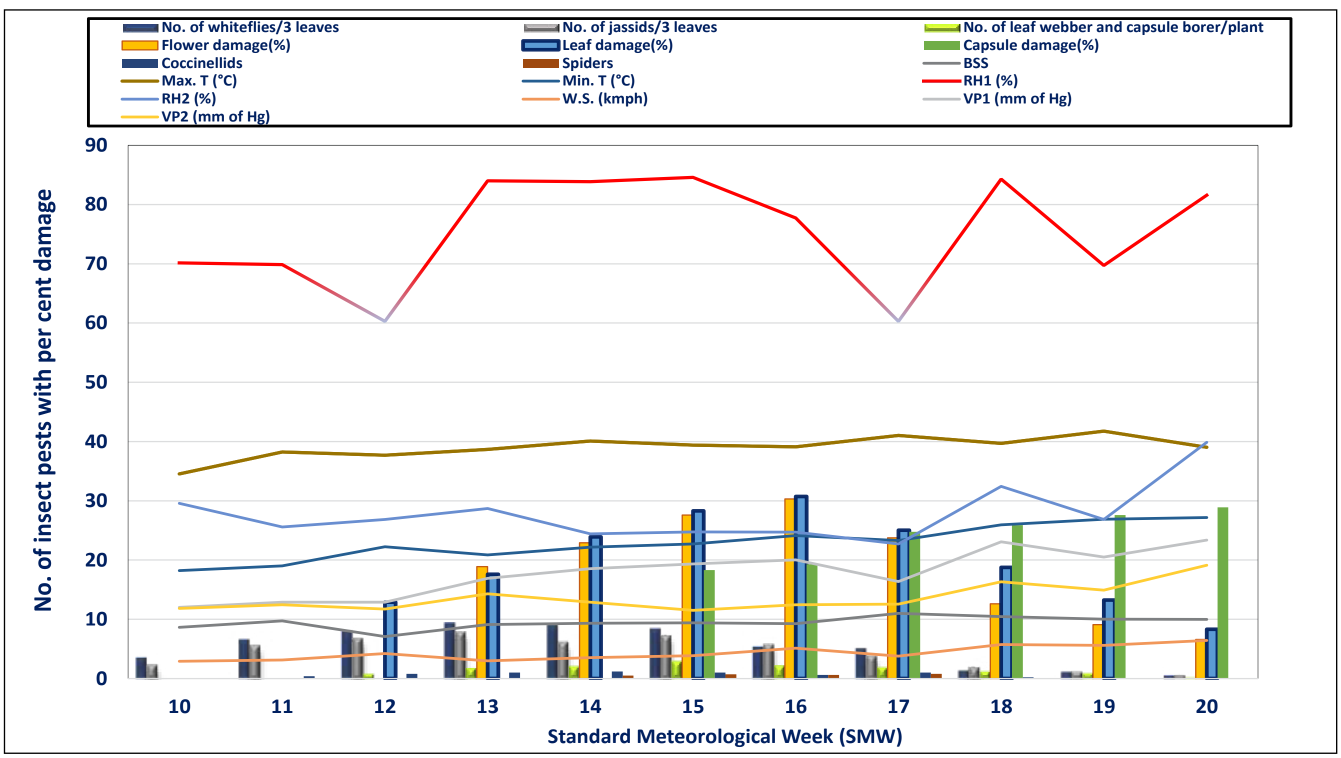

Figure 2: Succession of insect pests and their correlation with weather parameter

with jassid population (Table 2 and Figure 2).

In partial harmony with present findings, highest population of *Orosius* sp. was observed by El-Sharkawy et al., 2024. Whereas, the peak period for the activity of jassid (5.76 jassids plant^{-1}) was recorded during 14th standard meteorological week (Mohanlal, 2022). The highest (6.08 jassids three leaves^{-1} plant^{-1}) jassids population was observed during 15th standard meteorological week. Morning relative humidity had non-significant positive correlation with the jassid alongside BSS, which had non-significant negative correlation (Mohanlal, 2022).

3.1.3. Leaf webber and capsule borer, A. catalaunalis

A close perusal of the data on population of leaf webber and capsule borer presented in Table 1 and Figure 1 and 2. Specifies that larval population was first observed on (1.20 larvae plant^{-1}) sesame after 3rd WAG *i.e.* 3rd week of March (12th SMW). The activity of pest increased slowly and record peak level (2.90 larvae plant^{-1}) during 6th WAG *i.e.* 2nd week of April (15th SMW). Thereafter larval population decreased attaining a population of 0.50 larva plant^{-1} during the 11th WAG *i.e.* 2nd week of May (20th SMW). The correlation study between capsule borer and abiotic factors are depicted in Table 2 and Figure 2, which indicate that all the weather parameters viz., MinT, RH_2 and VP_2 were significantly (r=-0.606*, -0.732* and -0.719*, respectively) negative correlation with leaf webber and capsule borer population. However, VP_1 had negative correlation with leaf webber and capsule borer population.

Somewhat similar results were observed with the highest (0.92 larva plant^{-1}) larval population of leaf webber and capsule borer during 13th standard Meteorological week alongside, the maximum temperature showed positive non-significant (r=0.233) association with leaf webber and capsule borer in summer (Omprakash et al., 2021). Yalawar et al., 2020 reported that the highest larval observed during 37th standard Meteorological week with the population of 6.40 larvae five plants^{-1}.

3.1.4. Leaf damage caused by A. catalaunalis

Leaf damage by leaf webber and capsule borer commenced from 3rd WAG *i.e.* third week of March (12th SMW) and succeeded till 2nd week of May (20th SMW) which varied between 8.30 to 30.74% (Table 1 and Figure 1 and 2). Leaf damage continuously increased and attained a peak level (30.74%) during 7th WAG *i.e.* 3rd week of April (16th SMW). Thereafter, leaf damage continuously declined and reached at lowest level (8.30%) on 11th WAG *i.e.* 2nd week of May (20th SMW). The correlation between leaf damage and abiotic factors presented in Table 2 and Figure 2, reveal that all the weather parameters are non-significantly correlated with leaf damage except for RH_2 and VP_2. Leaf damage showed significantly (r= -0.720* and -0.675*) negative correlation with RH_2 and VP_2, respectively.

Alongside this the highest (17.51%) leaf damage caused by *A. catalaunalis* during 35th SMW (Yadav et al., 2020). Gangwar et al., 2014 also reported that the highest (17.62%) shoot infestation was observed during 37th standard week (56 days old crop).

3.1.5. Flower damage caused by A. catalaunalis

The flower damage inflicted by leaf webber and capsule borer from 4th WAG *i.e.* 4th week of March (13th SMW) continued till the 11th WAG *i.e.* 2nd week of May (20th SMW), which ranged from 6.60 to 30.30%. The peak (30.30%) flower infestation was observed during 7th WAG *i.e.* 3rd week of April (16th SMW), thereafter it depicted a continuous decrease (Table 1 and Figure 1 and 2). The data between flower damage and weather parameters depicted in Table 2 and Figure 2, detail that highly significant (r= -0.899**) and significant (r= -0.708* and -0.777*) negative correlation were observed with VP_2, MinT and RH_2, respectively.

The highest flower damage (24.13% and 30.08%) was also reported (Chaitra, 2016; Gangwar et al., 2014).

3.1.6. Capsule damage caused by A. catalaunalis

Capsule damage was observed at initiation of capsule during sixth week (Table 1 and Figure 1 and 2). It started with 18.30% capsule damage from 6th WAG *i.e.* 2nd week of April (15th SMW) and continuous increasing and reached at highest (28.90%) on the 11th WAG *i.e.* 2nd week of May (20th SMW). The data pertinent to correlation between capsule damage and abiotic factors are presented in Table 2 and Figure 2, reveal that all the parameters under study showed non-significant correlation on capsule damage except for MinT and VP_2. Capsule damage showed significantly (r= 0.841* and 0.837*) positive correlation with MinT and VP_2.

The highest (16.63%) pod damage during 42nd SMW (Gangwar et al., 2014) and the higher (11.97% plant^{-1}) pod damage was observed during 39th SMW (Yadav et al., 2020), which are partially parallel to the present results. Minimum temperature during first year had significantly (r=-0.862*) negative association with capsule infestation (Gangwar et al., 2014). Earlier findings are more or less similar to present findings.

3.1.7. Coccinellids

The activity of coccinellids (Table 1 and Figure 1 and 2) on sesame crop began from 2nd WAG *i.e.* 2nd week of march (11th SMW) with a population of 0.40 coccinellid plant^{-1}. After that coccinellid population increased often and attained peak (1.20 coccinellids plant^{-1}) level on 5th WAG *i.e.* 1st week of April (14th SMW). Thereafter, population declined up to 1st week of May (19th SMW) with 0.02 coccinellid plant^{-1} and diminished. Coccinellids population (Table 2 and Figure 2) showed significantly (r=-0.639*) negative correlation with evening relative humidity (RH_2). Abiotic factors viz., BSS, WS, MinT, VP_1 and VP_2 were negatively associated with coccinellids population but were non-significant.

3.1.8. Spider

The spider population started from 3rd week after germination *i.e.* 3rd week of March (12th SMW) with 0.20 spider per plant (Table 1 and Figure 1 and 2). Population steadily increased and observed a peak level (0.88 spider $plant^{-1}$) during 6th week after germination *i.e.* 2nd week of April (15th SMW). Thereafter, population continuously declined following which, spiders disappeared. Correlation coefficient between spider population and weather parameters are presented in Table 2 and Figure 2, state that evening relative humidity (RH_2) exhibited significantly (r=-0.610*) negative correlation with spider population. While, BSS, MaxT, MinT, RH_1 and VP_1 had positive correlation but stood non-significant.

4. Conclusion

The activity of whitefly and jassid ranged from 10th to 20th SMW. Larval population and damage to leaves was observed during 12th SMW and till 20th SMW. The flower damage initiated from 13th SMW and continued till 20th SMW. Capsule damage commenced from 15th SMW. Predatory fauna appeared from 2nd week of March. The insect pest showed significant negative correlation with wind speed and WS, RH_2, MinT and VP_2. Capsule damage had significantly positive correlation with MinT and VP_2.

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