The Pharma Innovation Journal 2023; SP-12(12): 1779-1782

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(12): 1779-1782

www.thepharmajournal.com
Received: 17-10-2023
Accepted: 22-11-2023

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Population dynamics of aphid, *Aphis gossypii* glover and its natural enemies on cumin, *Cuminum cyminum* Linn. in relation to abiotic factors

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Abstract
Population dynamics of aphids have been studied under field condition at instructional farm of Entomology, JAU, Junagadh during Rabi season, 2019-20 in cumin crop. The incidence of aphid, *A. gossypii* was started from 2nd week of December and continued till 3rd week of February having peak during 3rd week of January in cumin crop. Simultaneously, higher population of coccinellids was showed during 4th week of December to 2nd week of February and showed significantly highly positive correlation with aphid population.

Keywords: Cumin, population dynamics, aphid, *A. gossypii*

1. Introduction
Cumin (*Cuminum cyminum* Linnaeus) locally known as 'Jeera' or 'Jeru' belongs to family Umbelliferae. It is an indispensable condiment generally used in preparation of almost all the types of diets. Cumin oil is used in perfumery, flavouring liquors and in pleasants. It isa good medicine for digestive and intestinal upsets and used in veterinary medicine (Aiyer and Narayan, 1950) [1]. India is the leading producer (70% of world production), consumer and exporter of cumin in the world. Almost 80% of the crop cultivated is consumed in India. The area under cumin cultivation in India is about 8.08 lakh ha with annual production of 5.03 lakh MT (Anon., 2018a) [2]. Cumin accounts for 7-8% of India's total spice exports. During 2017-18, total volume of 1.43 lakh tones of cumin valued at Rs 2,418 crore was exported (Anon., 2018b) [3]. Cumin is commercially cultivated in the semi-arid tracts of Gujarat and Rajasthan. In Gujarat, Surendranagar, Banaskantha, Jamnagar and Patan are major cumin producing districts of Gujarat.
The insects are one of the limiting factors for higher production of good quality seeds. Aphid, thrips, cutworm, tobacco caterpillar and root-knot nematode are attacking the cumin crop in field, while cigarette beetle & drugstore beetle are attacking in storage under Indian condition. The aphid is very serious problem on cumin. Both nymphs and adults suck the cell sap from leaves and tender parts, thereby, inducing premature senescence. Owing to the high rate of reproduction of this pest and continuous disappearing of the flowers; the grain formation is very much reduced. In case of severely infested umbels, the fruits were not set all or poorly developed which fail to add flavor in vegetable preparation and other consumable products.

2. Materials and Methods
2.1 Method of recording observation
The population study of aphid was carried out on cumin variety GC-4 during *Rabi* 2019. The crop was grown in a plot size of 20 x 20 m at the spacing of 20 x 10 cm. All other agronomical practices were followed as per the scientific recommendation. The crop under the experiment was kept free from any insecticidal sprays throughout the crop season. For recording the observations, the plot was divided in twenty equal quadrates each of size 1.0 x 1.0 m from which 5 plants were randomly selected and tagged. The observation on population of aphids was recorded at weekly interval, starting from germination to harvest of the crop. The population of aphid was estimated by adopting Zero to four index through the observation made on leaves and twigs as described by Kathrotia, (1995) [6].

Index	
0.	Plant free from aphid infestation
1.	Aphids present but colonies are not build up. No injury due to pest appearance on the plant.
2.	Small colonies of aphids are present.
3.	Large colonies of aphids are present on tender parts (count of aphids in colonies is possible and tender plant parts show the damage symptoms due to aphid).
4.	Entire plant is cover by aphids (Counts of aphids in colonies are impossible and plant show the damage symptoms due to aphids) and finally plant dies.

The average aphid index was worked out by using the following formula.

$$\text{Average aphid index} = \frac{0N+1N+2N+3N+4N}{\text{Total number of plants observed}}$$

Where,
0, 1, 2, 3 and 4 are the aphid index
N = Number of plant showing respective aphid index

The observations on aphid index were recorded visually from five randomly selected plants from each plot. The average aphid index was worked out by the above formula.
The observation on population of coccinellid predator was also recorded. The data on weather parameters like maximum (MaxT) and minimum temperature (MinT), morning (RH_1) and evening relative humidity (RH_2), wind velocity (WV), bright sunshine hours (BSS) obtained from meteorological observatory, college of Agriculture, Junagadh.

2.2 Correlation study
In order to study the influence of different meteorological parameters on pest incidence, simple correlation between the weather factors and population of aphid was worked out. Similarly, simple correlation between population of aphid and coccinellid predators also worked out by using Microsoft Excel 2013.

3. Results and Discussion
3.1. Infestation to plants due to aphids, *A. gossypii*
The data indicated that the incidence of aphid was started from 2ndweek of December *i.e.* 50th Standard Meteorological Week (SMW) and continued till 3rdweek of February (7th SMW) which ranged from 0.84 to 3.40 [aphid index (A.I.) /plant]. The population of *A. gossypii* fluctuated during the crop period. The infestation (0.84 A.I. /plant) was started from the 2nd week of December (50ndSMW) and showed the first peak (3.4 A. I./plant) during the 3rd week of January (3rdSMW). In subsequent weeks, the incidence was decreased and reached to 0.5 A.I. / plant during the 3rdweek of February (7th SMW). Starting from the infestation to the harvest of the crop pest showed a continuing trend of increasing and after reaching its first peak aphids were continuously decreased.
A close examination of this pest indicated that relatively higher (2.24 to 3.26 A. I. /plant) infestation of aphid was recorded during 1stweek of January to 4th week of January with a peak on 3rdweek of January. Kathrotia (1995) [6] reported that the population dynamics of *A. gossypii* on cumin and observed that the aphid remained active from December to February. The highest activity of this pest was showed in the last week of January. According to Ranila (2013) [9] observed that the incidence of aphid, *A. gossypii* on coriander, started from the 3rdweek of December (51st SMW) and continued till the 1stweek of March (10th SMW) with a peak level during 5th week of January (5thSMW). Yadav *et al.* (2018) [13] studied the seasonal incidence of *M. persicae* on cumin and recorded incidence of aphid started in the last week of December and reached its peak in the fourth week of January and gradually declined thereafter.

3.2. The occurrence of coccinellid predators on aphid infestation
An attempt was also made to know the role of coccinellid predators on population instability of the aphids on cumin crop. The coccinellid predator *viz.*, *Coccinella septempunctata* L., *C. transversely* L., *Cheilomenesn sexmaculatus* (F) and *Hippodamia convergens* were found to appear after the third week from starting the incidence of *A. gossypii* on cumin crop. Out of this *Coccinella septempunctata* L. was found to be the foremost one.

Table 1: Population of aphid, *A. gossypii* and coccinellids in cumin

Sr. No.	SMW	Month	Mean A.I. /plant	No. of coccinellids /plant
1	2	3	4	5
1	50	December	0.84	0.00
2	51		1.06	0.00
3	52		1.17	0.44
4	1	January	2.24	1.32
5	2		3.32	3.32
6	3		3.4	10.84
7	4		3.26	7.48
8	5	February	2.64	4.4
9	6		1.8	1.12
10	7		0.5	0.00

The data (Column 5 in Table 2) revealed that the population of coccinellids started from the 4th week of December *i.e.* 52nd Standard Meteorological Week (SMW) and continued till 2ndweek of February (6th SMW) which ranged from 0.44 to 10.84coccinellids /plant. The population of coccinellids fluctuated during the crop period based on the aphid population.

Table 2: Correlation of *A. gossypii* with biotic and abiotic factors in cumin

Factors	Aphid	Coccinelids
1	2	3
Bright Sunshine Hours, hrday^{-1} (BSS)	0.189	0.468
Maximum Temperature, ^{0}C (MaxT)	-0.635*	-0.504
Minimum Temperature, ^{0}C (MinT)	-0.641*	-0.693*
Morning Relative Humidity, % (RH_1)	0.305	0.354
Evening Relative Humidity, % (RH_2)	0.117	-0.266
Wind Speed, kmhr^{-1} (WS)	0.277	0.209
Coccinelids	0.839**	1

r=0.632 at 5%, r=0.765 at 1%
* Significant at 5% level
** Significant at 1% level

The population (0.44coccinellids /plant) was started from 4thweek of December (52rd SMW) and showed its first peak (10.84 coccinellids /plant) during 3rd week of January (3rd SMW). In subsequent weeks, the population was decreased and reached to 1.12 coccinellids/plant during 2ndweek of February (6th SMW). Starting from the population to the harvest of the crop coccinellids showed a continuing trend of increasing and after reaching its first peak they were

continuously decreased.
Thus, it is clear from the data that relatively higher (1.32 to 10.84coccinellids /plant) population was recorded during the 1st week of January to the 4th week of January having the highest peak on 3rd week of January.

3.3. Effect of weather parameters on aphid, *A. gossypii* population

The data on the relationship between aphid infestation and weather factors indicated that there was a negative significant impact on the incidence of aphid due to MinT(-0.641*) and MaxT(-0.635*). There was no significant linear correlation either negative or positive between incidences of aphid population for the rest of the physical factors. However, relative humidity (RH_1 [0.305], RH_2 [0.117]), bright sunshine hours (BSS) [0.189] and wind speed (0.277) were positively correlated with the incidence of aphid population but the relationship was non-significant.
According to Kathrotia (1995) [6], both maximum and minimum temperatures showed anegative correlation and positive correlation with BSS, whereas highly significant with the coccinelid population with cumin aphid. The population of aphid has a negative significant correlation with maximum temperature (MaxT), minimum temperature (MinT) and have a positive correlation with wind speed and bright sunshine hour and highly positive significant with coccinellids population in coriander (Ranila, 2013) [9]. According to Yadav (2018) [13], maximum temperature showed the negative significant correlation was a positive correlation with both relative humidities whereas highly significant with the coccinelid population with cumin aphid. In the present investigation, the results are nearer to the earlier findings but not the same which is might be due to the variation in the sowing periods or environmental conditions during the experimentation.

3.4. Effect of biotic and abiotic factors on coccinellids

The data on the relationship between coccinellids and biotic (aphid infestation) as well as abiotic factors (weather parameters) indicated that there was negative significant impact on the population of coccinellids due to MinT(-0.693*) while the highly positive significant impact on the population of coccinellids due to aphid population [0.839**]. There was no significant linear correlation either negative or positive between incidences of coccinellids for the rest of the physical factors. However, bright sunshine hours (BSS) [0.468], relative humidity (RH_1 [0.354] and wind speed (WS) [0.209] were positive whereas, RH_2 [-0.266], MaxT(-0.504) were negatively correlated with the incidence of aphid population but the relationship was non-significant.
Overall the pest, *A. gossypii* was highly active during 2nd week of December to 3rd week of February had the highest peak on the 3rd week of January in cumin crop while, a relatively higher population of coccinellids was observed during the 4th week of December to the 2nd week of February. Among the different abiotic factors, MinT and MaxT exerted their negative significant relationship with the aphid population while rests of the abiotic factors were positively or negatively correlated with aphid population but the relationship was non-significant. Coccinellids have a significant negative correlation with MinT while a highly positive significant relationship with aphid population.

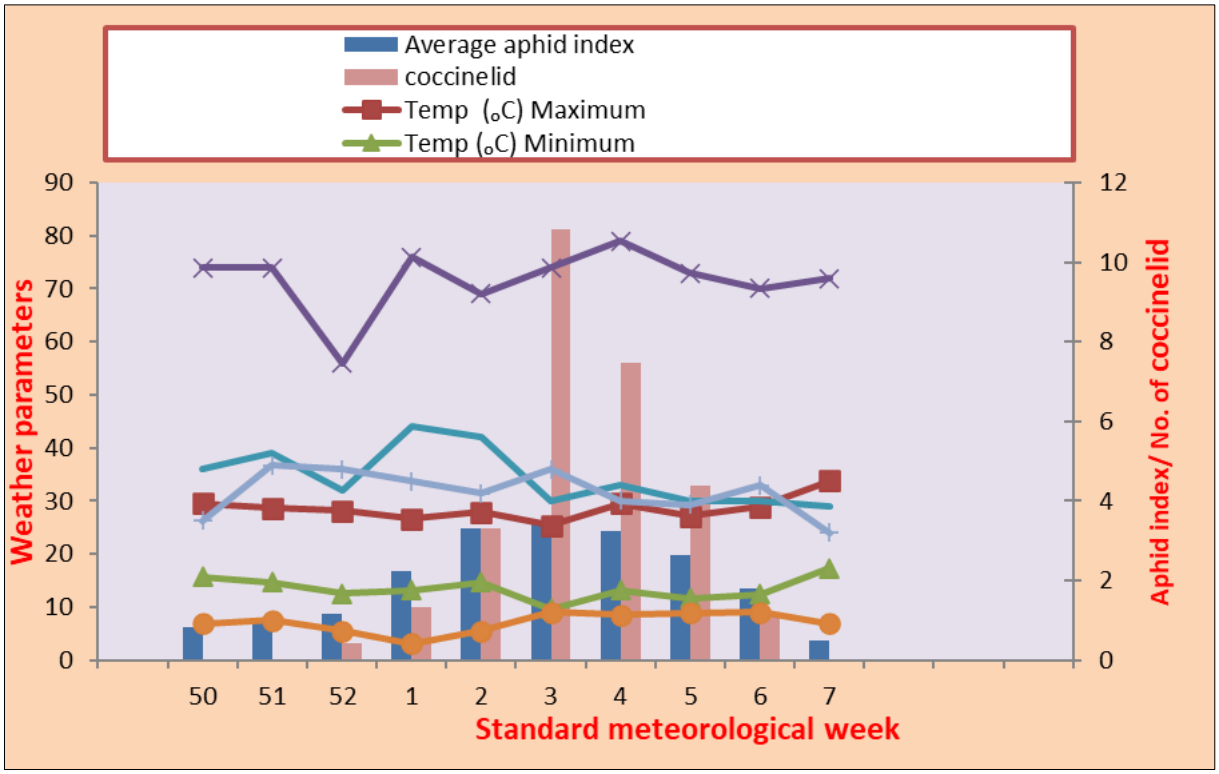

Fig 1: Effect of biotic and abiotic factors on aphid, *A. gossypii*

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