Population dynamics of the coriander aphid and their correlation with biotic and abiotic factors

Abstract

Population dynamics of coriander aphid and their correlation with biotic and abiotic factors were studied at instructional farm of the department of Entomology, College of Agriculture, SKRAU Bikaner during *Rabi,* 2020-21 and 2021-22. The incidence of coriander aphid, *H. coriandri* (Das) commenced in the fourth week of January (4th SMW) and remained active throughout the crop season *i.e*. upto third week of March during both the years (2020-21 and 2021-22). The population of *H. coriandri* increased gradually and attained its peak in last week of February/first week of March (9th SMW) during both the years. After peak aphid population started declining and reached to low levels in the 11th SMW near maturity of the crop during both the years. Simultaneously the occurrence of predator, Coccinella septempunctata coincided with the population of aphids during both the years. Maximum and minimum temperatures had positive correlation with aphid population during both the years *i.e.* 2020-21, 2021-22. Morning and evening relative humidity showed negative crrelation with aphid population. whereas, population of *C. septempunctata* was significant positively correlated with aphid population during both years.

Keywords: Coriander, population dynamics, aphid, *Hyadaphis coriandri* (Das), *C. septempunctata*, abiotic factors, correlation

1. Introduction

Coriander (*Coriandrum sativum* L.) is one of the important seed spice of winter season belonging to family *Apiaceae (Umbelliferae).* Mediterranean region is the centre of origin of this crop. Coriander is an annual herbaceous cross pollinated crop. Its name has been derived from Greek word “Koris” means bed-bug, because of unpleasant, fetid

bug like odour of the green unripened fruits [1]. It is commonly known as "*Dhaniya*" in hindi and grown both for green vegetable as well as for seed purpose. Coriander seeds contain volatile oil (0.03 to 2.6 per cent), fixed oil, tannins, cellulose, pentosans and pigments. Its stem, leaves and grains have a pleasant aromatic odour due to the presence of volatile oils.

As far as the nutritive value is concerned 100 gm coriander leaves contains 0.53 mg copper, 4.0 mg sodium, 453.0 mg potassium and 5.0 mg oxalate, while per 100 g seeds contains 14.1 g protein, 16.1 g fat, 32.6 g phosphorus, 17.9 mg iron, 288 k. cal, 950 µg carotene, 0.22 mg thiamine, 1.1 mg niacin (B3) and 0.13 mg riboflavin (B2) [2]. Coriander seeds are considered to be carminative, tonic, stomachic, antibilous, refrigerant and aphrodisiac [3].

India is the largest producer, consumer and exporter of coriander in the world. Coriander crop is extensively grown in the arid to semi-arid regions of India, covering an area of about 6,29,000 hectares with the production of 8,22,000 tonnes [4]. Rajasthan and Gujarat states have emerged as seed spice bowl and together contribute more than 80 per cent of the total coriander production in the country [5]. In Rajasthan, It is cultivated in the districts of Jhalawar, Baran, Kota, Chittorgarh, Bundi, Jaisalmer, Bhilwara, Jodhpur, Jaipur, Sikar, Bikaner and Ajmer. The total area under the crop is 1,84,880 ha with production of 1,76,070 tonnes and productivity of 952 kg per ha [6].

Insect pests are one of the major limiting factors for higher and quality production of coriander. The insect pests *viz*., aphid, *Hyadaphis coriandri* (Das), whitefly, *Bemisia tabaci* (Genn.), pentatomid bug, *Agonoscelis nubila* (Feb.), lucerne caterpillar, *Spodoptera exigua* (Hub.), green peach aphid, *Myzus persicae* (Sulzer), surface grasshopper, *Chrotogonus trachypterus* (Blanch), thrips, *Thrips tabaci* (Linn.) and brown wheat mite, *Petrobia latens* (Muller) have been found

infesting coriander crop [7].. Among the various insect pests, the coriander aphid, *H. coriandri* has been reported as a regular and major pest of coriander in Rajasthan and other parts of the country [7,8,9]. The maximum multiplication of aphids population occur between 20-25 °C (maximum temperature), 2-6 °C (minimum temperature) and 60-65% (relative humidity) [10].

The coriander aphid belongs to the family Aphididae. Both the nymphs and adults of aphid cause qualitative and quantitative losses to seed yields up to 50 per cent by sucking cell sap from inflorescences/umbels during February-March [11,12,13,14]. There are a number of beneficial natural enemies that attack aphids, including host-specialised parasitic wasps, as well as generalist predators such as hoverfly larvae, and adults and larvae of ladybird beetles and lacewings. Among them *Coccinellid* predators, *Coccinella septempunctata* (Linn.) and *Menochilus sexmaculatus* (Fab.) play a significant role in reduction of the aphid population in coriander [7,8,9,15].

It is well known that attack of insect pests depends upon climatic conditions, crop growth and presence of natural enemies at a particular time. The interaction between pest activity, biotic and abiotic factors help in deriving predicative models that in turn forecast the pest incidence. The knowledge of population dynamics is necessary for adopting sustainable management practices against aphid on coriander. The key abiotic factors such as temperature, relative humidity and rainfall play an important role in population fluctuation of coriander aphid. As such the study was undertaken to find out the correlation between the pest population and meteorological parameters to know the most favourable conditions for the aphid to flourish in coriander ecosystem of hyper arid region of Rajasthan.

2. Materials and Methods

To study the Population dynamics of coriander aphid and their correlation with biotic and abiotic factors, the sowing of coriander variety (RCr-435) was done in the field having plot size of 10 × 9 m^2 on 6th November, 2020 and 4th November, 2021 keeping row to row distance of 30 cm and plant to plant 10 cm. The recommended package of practices was followed for raising the crop.

The population of aphid was recorded from ten randomly selected and tagged plants in each plot. Frequent visits of the experimental field were made to observe the occurrence of aphid and predator on the plants. The population estimation was done at weekly intervals as soon as aphid appeared and counted on three umbels (lower, middle and upper) from the tagged plants. The population of aphid was counted in early morning hours at weekly intervals from appearance to harvesting of crop. The population of natural enemies were also recorded from 10 randomly selected plants in experimental plots**.**

The data on weather parameters was obtained from meteorological observatory Agriculture Research Station, Swami Keshwanand Rajasthan Agricultural University, Bikaner.

2.1 Statistical Analysis

The correlation was worked out between aphid population and abiotic factors of environment (maximum & minimum temperature ^{o}C, morning & evening relative humidity and rainfall). The correlation between aphid population and population of *Coccinella septempunctata* were also computed*.* The following formula was used for calculating correlation coefficient.

$$r = \frac{N\,\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{N\Sigma x^2 - (\Sigma x)^2 . N\Sigma y^2 - (\Sigma y)^2}}$$

where,

r = Simple correlation coefficient

x = Independent variable *i.e.* biotic and abiotic component

y = Dependent variable *i.e.* pest

N = Number of observation

3. Results and Discussion

1. Population dynamics of aphid, *H. coriandri* on coriander and their correlation with biotic and abiotic factors

1.1 Aphid, *H. coriandri*

An experiment was undertaken to record the aphid population and its correlation with biotic and abiotic factors. During *Rabi*, 2020-21, the aphid population commenced in the 4th Standard Meteorological Week (SMW) which gradually increased and reached to peak (63.9 aphids/plant) in last week of February/first week of March during 9th SMW at maximum, minimum temperature, morning and evening relative humidity were 33.2 ^{o}C, 13.9 ^{o}C, 62.0% and 25.4% respectively. There after the population declined (Table 1).

Similar trend of aphid incidence was observed during *Rabi,* 2021-22, however, incidence of pest was lower as compared to *Rabi*, 2020-21. The aphid population first appeared in the fourth week of January which was 4th Standard Meteorological Week (SMW) and reached to peak (59.9 aphids /plant) in last week of February/ first week of March during 9th SMW when maximum, minimum temperature, morning and evening relative humidity were 28.1 ^{o}C, 11.1 ^{o}C, 81.1 and 28.4 % respectively (Table 2).

The correlation studies revealed that during *Rabi*, 2020-21, the maximum (r= 0.705*) and minimum temperature (r= 0.618*) had significant positive correlation with aphid population. Whereas, morning relative humidity (r= -0.690*) had significant negative correlation while evening relative humidity had non-significant negative correlation

(r= -314) with aphid population. However, during *Rabi,* 2021-22, similar trend was observed with maximum and minimum temperature but non-significant. The correlation with morning RH (r= -0.282) evening RH (r= -0.474) and rainfall (r= -0.187) also observe negative correlation with aphid population.

1.2 Lady bird beetle, *C. septempunctata*

Under the present study one species of coccinellid predator, *Coccinella septempunctata* L. was found to predating on aphid. During first year *i.e.* 2020-21, the population of *C. septempunctata* was initially noticed in the fourth week of January (4th SMW) and reached to maximum in the last week of Fabraury/ first week of March *i.e*., 9th SMW (4.8/plants) when maximum, minimum temperature, morning and evening relative humidity were 33.2, 13.9 ^{o}C, 62.0, and 25.4 % respectively during 2020-21. (Table 1).

During second year *i.e*. *Rabi,* 2021-22, the population of *C. septempunctata* was initially observed in the fourth week of January (4th SMW) and maximum (3.5/plants) number of predator was found in the last week of Fabraury/ first week of March *i.e*., 9th SMW when maximum, minimum temperature, morning and evening relative humidity were 28.1, 11.1 ^{o}C, 81.1 and 28.4 % respectively. (Table 2)

The population of *C. septempunctata* was declined with the decline of aphid population in 11th SMW during both the years of *Rabi,* 2020-21 & 2021-22. The observation of population of aphid with coccinelid predator, lady bird beetle, *C. septempunctata* indicate that there was significant positive correlation r= 0.968* and r= 0.973* during both the years of 2020-21 and 2021-22, respectively.

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Table 1 Population dynamics of Aphid, *H. coriandri* on coriander and their correlation with biotic and abiotic factors during *Rabi,* 2020-21

SMW*	Period of observations		Temperature (°C)		Relative humidity (%)		Total rainfall (mm)	Aphid population/ plant	*C. septempunctata* population/plant
	From	To	Max.	Min.	Morning	Evening			
3	15-01-2021	21-01-2021	22.5	4.4	82.0	40.7	0.0	0.0	0
4	22-01-2021	28-01-2021	23.3	5.6	78.0	26.1	0.0	7.2	0.9
5	29-01-2021	04-02-2021	27.0	7.1	68.7	20.4	0.0	11.9	1.4
6	05-02-2021	11-02-2021	27.9	7.6	72.1	20.0	0.0	23.3	2.1
7	12-02-2021	18-02-2021	31.0	10.5	70.4	21.4	0.0	34.4	2.4
8	19-02-2021	25-02-2021	33.3	13.5	60.7	25.4	0.0	51.5	3.1
9	26-02-2021	04-03-2021	33.2	13.9	62.0	25.4	0.0	63.9	4.8
10	05-03-2021	11-03-2021	35.1	16.6	55.6	29.7	0.0	38.4	2.4
11	12-03-2021	18-03-2021	34.3	16.3	62.4	27.6	0.0	10.6	1.3
Correlation coefficient with aphid population (*r*)			**0.705***	**0.618***	**-0.690***	**-0.314**	**0.00**		**0.968****

**Significant at 1 per cent level & *Significant at 5 per cent level

SMW* - Standard meteorological week

Table 2 Population dynamics of Aphid, *H. coriandri* on coriander and their correlation with biotic and abiotic factors during *Rabi*, 2021-22

SMW*	Period of observations		Temperature (°C)		Relative humidity (%)		Total rainfall (mm)	Aphid population/ plant	*C. septempunctata* population/plant
	From	To	Max.	Min.	Morning	Evening			
3	15-01-2022	21-01-2022	19.6	5.4	86.9	50.9	0.0	0.0	0
4	22-01-2022	28-01-2022	19.9	5.9	83.6	49.7	3.0	6.5	0.8
5	29-01-2022	04-02-2022	26.9	8.1	77.7	24.3	0.0	10.1	1.3
6	05-02-2022	11-02-2022	25.0	9.2	83.7	31.4	7.4	22.3	2.1
7	12-02-2022	18-02-2022	28.7	9.6	70.9	20.9	0.0	32.4	2.2
8	19-02-2022	25-02-2022	30.2	11.5	70.7	20.7	0.0	50.2	3.1
9	26-02-2022	04-03-2022	28.1	11.1	81.1	28.4	0.0	59.9	3.5
10	05-03-2022	11-03-2022	32.5	13.9	78.3	24.6	0.0	39.2	2.6
11	12-03-2022	18-03-2022	40.0	19.1	68.9	15.7	0.0	8.9	1.1
Correlation coefficient with aphid population (*r*)			**0.300**	**0.286**	**-0.282**	**-0.474**	**-0.187**		**0.973****

**Significant at 1 per cent level & *Significant at 5 per cent level

SMW* - Standard meteorological week

4. Conclusion

The peak infestation of aphid *H. coriandri* on coriander was recorded in the fourth week of February. The maximum temperature had significant effect on aphid population, whereas, minimum temperature, average relative humidity and rainfall had non-significant effect. Among the natural enemies, coccinellids predator, *C. septempunctata* was preying on *H. coriandri*. It had significant positive correlation with aphid population.

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Fig. 1 Population dynamics of coriander aphid and their correlation with biotic and abiotic factors during *Rabi,* 2020-

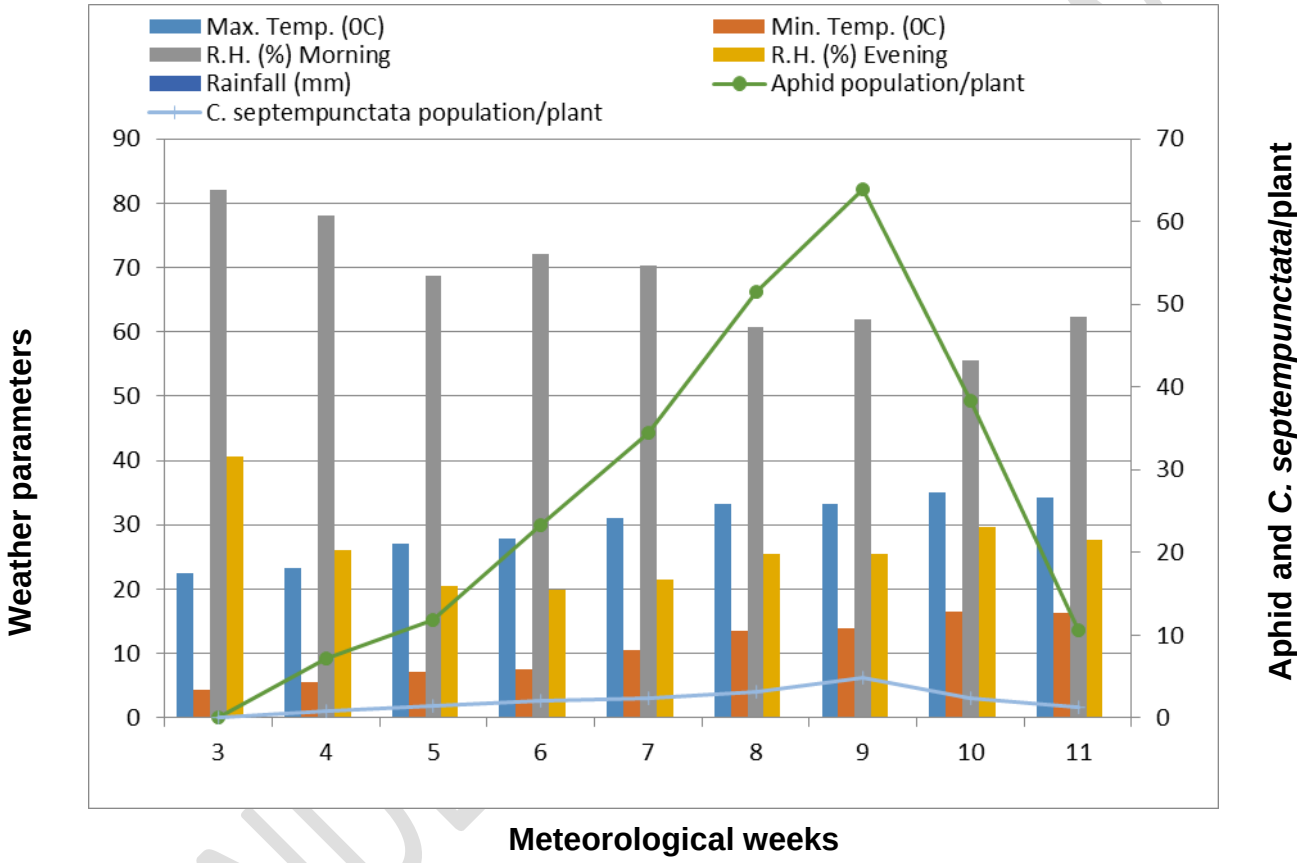

Fig. 2 Population dynamics of coriander aphid and their correlation with biotic and abiotic factors during *Rabi*, 2021-22