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Population Dynamics of Aphid, *Hyadaphis coriandri* Das Infesting Fennel with Relation to Biotic and Abiotic Factors

Heera Kumari[1*], S.K. Khinchi[2], Sheetal Kumawat[1], Pappu Lal Dalal[3], Suman Choudhary[2] and Arti Sharma[1]

[1]M.Sc. Student, Department of Agricultural Entomology,
S.K.N. College of Agriculture, Jobner (Rajasthan), India.
[2]Assistant Professor, Department of Agricultural Entomology,
S.K.N. College of Agriculture, Jobner (Rajasthan), India.
[3]Ph.D. Scholar, Department of Agricultural Entomology,
S.K.N. College of Agriculture, Jobner (Rajasthan), India.

(Corresponding author: Heera Kumari)*
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ABSTRACT: The present investigation on "Population dynamics of aphid, *Hyadaphis coriandri* Das infesting fennel with relation to biotic and abiotic factors" was carried out under field conditions at Research Farm, Department of Agronomy, College of Agriculture, Sri Karan Narendra Agricultural University, Jobner during *Rabi* season, 2021-22. The presence of fennel aphid was observed from the 3rd Standard Meteorological Week (SMW) and persisted until the 13th SMW, with its peak occurring during the 9thSMW in fennel crops. At the same time, higher population of *Coccinella septempunctata* was noted between the 4th SMW and 9th SMW, displaying a notably strong positive correlation with the aphid population in the fennel crop. The aphid population exhibited a significant correlation with maximum temperature, while minimum temperature, average relative humidity, and rainfall displayed insignificant effects. None of the weather parameters showed a significant correlation with *C. septempunctata*.

Keywords: Fennel, aphid, *Hyadaphis coriandri*, Population dynamics, *Coccinella septempunctata.*

INTRODUCTION

Fennel (*Foeniculum vulgare* Mill.), with a chromosome number of 2n=22, is a herbaceous plant that can be biennial or perennial. It belongs to the Apiaceae family and has its origins in Southern Europe and the Mediterranean region. In India, it goes by various names, such as 'Variali' in Gujarati and 'Saunf' in Hindi, and it is highly regarded as a valuable seed spice crop (Kanjiya *et al*., 2018). Fennel is primarily cultivated during the *Rabi* season and is a commercially important crop with various applications. This herb is predominantly grown in several states of India, including Gujarat, Rajasthan, Uttar Pradesh, Karnataka, Bihar, Maharashtra, Punjab, Tamil Nadu, Haryana, and Madhya Pradesh (Meena *et al*., 2020). Fennel seeds are notable for their composition, containing approximately 9.5% protein, 42.3% carbohydrates, 10.0% fat, 18.5% crude fiber, 13.4% minerals, and are also rich in vitamins and volatile oils, typically ranging from 2.17 to 2.60 percent (Pruthi, 1976).

As of the 2019-20 season, the total cultivated area for fennel in India covered around 83 thousand hectares, resulting in a production of 140 thousand metric tonnes and a productivity rate of 1687 kg/ha (Anonymous, 2020a). In Rajasthan, fennel is cultivated on an area of 30.67 thousand hectares, with an annual production of 35.29 thousand metric tonnes and a productivity of 1150.33 kg/ha during the same period (Anonymous, 2020b). The key cultivating districts are Sirohi, Tonk, Jodhpur, Baran, Pali, Bikaner, Dausa, Alwar, Sawai Madhopur, and Jaipur.

Various biotic and abiotic factors have been implicated in reducing fennel productivity. Insect pests represent a significant biotic challenge in achieving optimal fennel production. The crop was affected by various species of sucking insect pests such as Thrips (*Thrips tabaci* and *Thrips flavus*), Jassids (*Empoasca kerri*), whiteflies (*Bemisia tabaci*), aphids (*Hyadaphis coriandri* and *Aphis gossypii*), and several types of bugs. Other pests damaging the fennel crop under semi-arid conditions in Rajasthan include Chalcid wasps (*Systole albipennis*), cutworms (*Agrotis* spp.), lepidopteran caterpillars, and grasshoppers (*Acrida* spp.). Among these, the aphid *H. coriandri* is a severe pest causing substantial yield losses in fennel crops. Both nymphs and adults of this aphid species extract cell sap from leaves, stems, and umbels, weakening and stunting the plant. Moreover, they excrete excessive honeydew, promoting the growth of sooty mold and hindering plant growth. In Gujarat conditions, Mittal and Butani (1989) reported fennel seed losses due to aphids of up to 903 kg/ha, accounting for 50% of crop losses in the region. It is considered a major pest of fennel, posing a significant threat to seed spice production. The aphid population varies throughout different months of the crop's growth period and can be managed by timely foliar spray applications before severe aphid infestations emerge. With this in mind, a study on the population dynamics of *H. coriandri* was conducted on fennel crop.

MATERIALS AND METHODS

The study on the population dynamics of aphid, *H. coriandari*, was conducted on fennel at the Research Farm of the College of Agriculture, Sri Karan Narendra Agricultural University, Jobner, Rajasthan, during the *Rabi* season of 2021-22. The variety RF-205 was sown on 30th October 2021. The plot size was 2.0 × 2.25 m^2 with row to row and plant to plant distance of 45 and 20 cm respectively. The recommended agricultural practices were followed for cultivating the crop.

The aphid population was monitored by recording data from twenty-five randomly selected and tagged plants. The presence of aphid was observed by weekly visits early in the morning at the experimental field. As soon as the aphid population became noticeable, the numbers were counted from three umbels (lower, middle, and upper) of each plant. Concurrently, data on the presence of the predator *C. septempunctata* was also recorded. Weather parameters were obtained from the meteorological observatory at the Agriculture Research Station, Sri Karan Narendra Agricultural University, Jobner. Correlation coefficient was calculated to assess the relationship between the aphid population and biotic factors, particularly *C. septempunctata*, as well as abiotic factors such as temperature, relative humidity and rainfall.

RESULTS AND DISCUSSION

A. Infestation of aphids, H. Coriandrion fennel plants

The data presented in Table 1 revealed that the presence of aphids, specifically *H. coriandri*, began in the 3rd Standard Meteorological Week (SMW). This infestation continued until the 13th SMW, with the aphid population ranging from 0.20 to 58 aphids per plant. The *H. coriandri* population exhibited fluctuations throughout the crop's growing period. Infestation, initially recorded at 0.20 aphids per plant, began in the third week of January (3rd SMW) and reached its peak at 58 aphids per plant during the fourth week of February and the first week of March (9th SMW). In the following weeks, the presence of aphids steadily declined, reaching a count of 16 aphids per plant by the 13th SMW. From the initial infestation until the crop's harvest, the pest displayed a consistent pattern of initially rising, reaching its initial peak, and then consistently decreasing.

The present results get supported from the observations of Kalra *et al*. (2006); Patel *et al*. (2011); Purti *et al*. (2017); Kanjiya *et al*. (2018) who reported the appearance of *H. coriandari* on fennel in different weeks of February. However, Hirpara (2000); Meena *et al*. (2009); Pareek *et al*. (2013); Swami *et al*. (2018) reported the incidence of aphid started in the month of January. The present findings arecontrary to Kumar and Sagar (1994) who recorded *H. coriandari* population during the month of December on coriander.

In the present investigation the *H. coriandari* population increased gradually and reached at its peak in 9th SMW. The present finding is supported from the observations of Hirpara (2000); Aslam *et al.* (2007); Patel *et al.* (2011); Purti *et al.* (2017); Pareek *et al.* (2013); Swami *et al.* (2018); Choudhary *et al.* (2022) who recorded peak population of aphid in the 9th SMW. At the same time, the presence of the predator, *C. septempunctata*, aligned with the aphid population. The population of *C. septempunctata* ranged from 0.20 to 8.24 coccinellid per plant. Initially, the population of *C. septempunctata* stood at 0.20 individuals per plant in the 4th Standard Meteorological Week (SMW). Subsequently, the population of *C. septempunctata* increased gradually week by week and reached its peak in the first week of March, specifically during the 9th SMW, with 8.24 coccinellid per plant. Swami *et al.* (2018); Kanjiya *et al*. (2018) recorded the peak activity of *C. septumpuctata* with the peak infestation of aphid on coriander during 4th week of January to 3rd week of March. However, Purti *et al*. (2017) observed highest population of coccinellids in the 2nd week of March which support the present findings.

B. Correlation of H. Coriandri with biotic and abiotic factors

The data in Table 1 and Fig. 1 suggest a significant and positive correlation between *H. coriandri* infestation and maximum temperature (r = 0.55). However, there were no notable significant correlations, whether positive or negative, found between the aphid population and the other weather factors. Despite this, there appeared to be a positive correlation with minimum temperature (r = 0.53) regarding the incidence of *H. coriandri*, while relative humidity (r= -0.41) and rainfall (r= -0.32) showed a negative correlation with the aphid population, although these relationships were not statistically significant. These findings support earlier research conducted by Jain and Yadav (1988a); Kumari and Yadav (2006); Pareek *et al.* (2013); Purti *et al.* (2017b); Swami *et al.* (2018), which also concluded that maximum temperature significantly impacted aphid populations, while minimum temperature, average relative humidity, and rainfall did not have a substantial effect on the aphid population.

The correlation findings from Table 1 and Fig. 1 suggest that abiotic factors had an insignificant impact on the population of coccinellids. However, the presence of aphid had a highly positive and significant impact on the population of *C. septempunctata* (0.87). Regarding *C. septempunctata*, there were non-significant correlations with maximum temperature (r=0.18), minimum temperature (r= -0.08), relative humidity (r= -0.08), and rainfall (r= -0.28). Notably, a significant positive correlation was found between the population of *C. septempunctata* and the aphid population on fennel (Table 1). Previous studies conducted by Patel *et al.* (2011); Swami *et al.* (2018); Kanjiya *et al.* (2018); Choudhary *et al.* (2022) also demonstrated a significant positive relationship between coccinellids and aphid populations on coriander and fennel crops. However, Meena *et al*. (2009) reported a significant negative correlation between adult coccinellids as well as grubs and aphid populations.

Amidst the various weather parameters, maximum temperature and coccinellids exhibited a positive association with the aphid population. Conversely, the remaining abiotic factors showed either positive or negative correlations with the aphid population, yet these connections lacked statistical significance. These findings partly coincide with the discoveries of Lekha (2002); Bana (2007); Meena *et al.* (2009); Pareek *et al.* (2013); Pruti *et al.* (2017b). Swami *et al.* (2018) similarly observed that both maximum and minimum temperatures, average relative humidity, and rainfall did not notably impact the coccinellid predators.

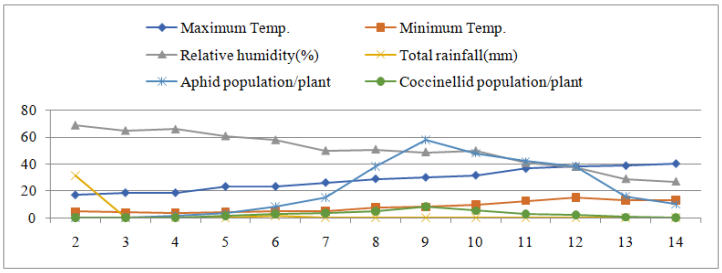

Fig. 1. Population dynamics of *H. coriandri* (Das) with relation to biotic and abiotic factors during *Rabi*, 2021-22.

Table 1: Population dynamics *H. coriandri* (Das) with relation to biotic and abiotic factors during *Rabi*, 2021-22.

Sr. No.	Standard Meteorological week	Maximum Temp. (°C)	Minimum Temp. (°C)	Relative humidity. (%)	Total rainfall (mm)	Aphid population/ plant	Coccinellid population/ plant
1.	2	17.3	4.5	69	0	0	0
2.	3	18.9	3.9	65	0	0.2	0
3.	4	18.9	3.4	66	0	1.4	0.2
4.	5	23.5	4.1	61	0	3.2	1.2
5.	6	23.5	5.1	58	1.5	8.4	2.92
6.	7	26.3	4.7	50	0	15	3.44
7.	8	29	7.4	51	0	38.12	5
8.	9	30.1	8	49	0	58	8.24
9.	10	31.6	9.8	50	0	48	5.2
10.	11	36.5	12.7	41	0	42	3
11.	12	38.1	15.2	38	0	38	2.12
12.	13	38.6	12.9	29	0	16	0.4
13.	14	40.1	13	27	0	10	0
	Correlation (r) of aphid	0.555*	0.538	-0.412	-0.324		0.874*
	Correlation (r) of Coccinellid	0.186	-0.082	-0.082	-0.286		

* Significant at 5%

CONCLUSIONS

The presence of *H. coriandri* commenced in the third week of January (3rd SMW) and persisted until the fourth week of March (13thSMW), with numbers ranging from 0.20 to 58 aphids per plant. The highest population of *H. coriandri* (58 aphids per plant) was noted during the fourth week of February (9thSMW). There was a relatively higher population of coccinellid predators (ranging from 1.4 to 8.24 coccinellids per plant) observed from the fourth week of January to the third week of March, peaking during the fourth week of February. Analysis of the correlation between *H. coriandri* and *C. septumpuctata* demonstrated a significant positive relationship. However, the variables of maximum and minimum temperatures, average relative humidity, and rainfall did not exert a significant impact on *C. septumpuctata*. Among these variables, only maximum temperature significantly influenced the population of *H. coriandri*, while minimum temperature, average relative humidity, and rainfall did not show significant effects on its population.

FUTURE SCOPE

The presence of the aphid *H. coriandri* poses the greatest threat to fennel crops. Therefore, acquiring a thorough grasp of the population trends of this particular aphid species holds paramount importance in protecting the crop. Attempts were focused on predicting the abundance of aphids and developing expert systems to aid farmers in optimizing preventive actions while minimizing expenses. Consistently, these studies highlighted the superiority of forecasting as a strategy over scenarios where there's no control or overreliance on preventive measures alone. The application of forecasting techniques typically leads to average to above-average crop yields.

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Conflict of Interest. None.

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