Research Article

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Population dynamics of leaf gall midge, *Asphondylia phyllanthi* on aonla

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ABSTRACT

Leaf gall midge is a major pest that can significantly affect aonla production by causing leaf galls, reducing photosynthesis, and leading to overall plant stress. Population dynamics studies were carried out on gall midge (*Asphondylia phyllanthi* Felt) insect, which has been found causing galls on the leaves and shoots of *Phyllanthus emblica*. Initiation of Aonla leaf gall midge, damage was started in the month of February and it was reached at its maximum level in the month of September from 2010 to 2016. Insect population with meteorological observations showed that insect population positively correlated with the minimum and maximum temperature and negatively correlated with the relative humidity and rainfall during the study periods. It was found that 2-3 overlapping generations developed in March-May. The infestation damaged the axillary buds, inhibiting growth and normal branching.

Introduction

Aonla *(Phyllanthus emblica* Gaertn.) is nutritional and medicinal valued crop in India for its fruits and other products. Numerous galls caused by *A. phyllanthi* were observed on the leaves and shoots in orchards in Rajasthan, the infestation being particularly severe at Chomu, Jaipur and Pushkar areas of Rajasthan. Plant gall is an abnormal growth on any part of a plant formed due to active mitosis and morphogenesis of an affected cell. A galI results from hypertrophy (over growth) and hyperplasia (excessive cell division), usually under the influence of a parasitic organism (Mani, 1973). Galls may also be described as 'pathologically' developed cells, tissues or organs of plants. Galls were formed between Feb. and May, and were oval, scaly, hollow, soft, dehiscent and sessile. Larval development within them was completed in 28-34 days so that 2-3 overlapping generations developed. *Phyllanthus emblica* (*Emblica officinalis*) a euphorbiaceous tree that yields products used medicinally and in dying and tanning, and is also valued for its water-resistant timber. Asphondylia belongs to the tribe Asphondyliini, currently with 505 species, and within Asphondyliini to the sub-tribe Asphondyliina, which is diverse in the Neotropics (Gagné & Jaschhof, 2014). The subtribe contains 19 genera that share clear morphological apomorphies, but no cladistic or other phylogenetic analysis has been conducted upto 2016 to till date. All genera included in this group other than *Asphondylia* are small (with between one and 11 species), and most are restricted to South America. By contrast, *Asphondylia* is one of the largest genera in the family Cecidomyiidae, with 320 described species that feed on a great diversity of plant families worldwide (Gagné & Jaschhof, 2014), and the number of undescribed species in this genus is probably far greater. All *Asphondylia* species are gall inducers, and the galls are

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almost always associated with a fungus that lines the inside walls of the gall. Similar associations are known in other cecidomyiid genera, and although several studies suggested that the larvae of such 'ambrosia' gall midges feed on the fungus rather than on the plant tissue (Bisset & Borkent, 1988; Rohfritsch, 2008; Adair *et al*., 2009). Phytophagous insects are well-known models for studying diversification and speciation (Futuyma and Agrawal, 2009; Nosil, 2012). Numerous galls caused by the cecidomyiid, *A. phyllanthi* were observed on the leaves and shoots in orchards in different parts of the country including Rajasthan. Leaf gall midges cause extensive damage, reducing yield and quality. Studying the pest's life stages (egg, larva, pupa, and adult) to target control measures, understanding how gall midges induce gall and affect the physiology of the tree, seasonal patterns and environmental factors (temperature, humidity) influencing outbreaks, photosynthesis, nutrient uptake, yield losses and fruit quality and overall tree health. Eggs were laid in late May, which developed to the 2nd instar and remained in the undeveloped galls (less than 1 mm in diam.) until the following year, the first adults emerging in late February damaged the crop. The research on screening of aonla cultivars resistant or tolerant to leaf gall midge infestation has been limited. Early identification of pest presence and damage is crucial for timely intervention. The influence of climate change on the life cycle and distribution of the leaf gall midge has not been fully studied. The changes in temperature, humidity, and seasonal patterns could affect the pest's behaviour, population dynamics and the timing of infestations, but it requires the location specific research for developing sustainable pest management strategies. Keeping in view this study was conducted to develop the strategies for the management of leaf gall midge in aonla.

Material and Methods

The experiment was carried out during 2010 to 2016 at Experimental Station of Asalpur Farm, under SKN College of Agriculture, Jobner on fully-grown aonla trees of NA-7 cultivar. For recording observation on leaf gall midge, *Asphondylia phyllanthi,* ten aonla tree were selected from an orchard on which observation was recorded. On each tree, three branches were selected and tagged. Five twigs were selected randomly on each branch and per cent damaged and healthy twigs were counted (Fifteen twigs from each tree) at fifteen days interval throughout the year along with natural enemies. Simultaneously observations recorded on meteorological factors including temperature, RH, sunshine hrs/ day and rainfall. Correlation worked out by taking the previous fortnight data. Fortnightly observation were recorded on 10 randomly selected plants of NA-7 cultivar to find out the influence of abiotic factors on population/ infestation of leaf gall midge, *A. phyllanthi* on Indian gooseberry consecutively for seven years and percent galls/ plants worked out. The initiation of Aonla leaf gall midge, *Asphondylia phyllanthi* damage was started in the month of February and it was reached at its maximum level in the month of September in all the years.

Result and Discussion

Population dynamics study of Aonla Leaf gall midge, *Asphondylia phyllanthi* revealed that the initiation of Aonla leaf gall midge, *Asphondylia phyllanthi* damage was started in the month of February and it was reached at its maximum level in the month of September in all the years (Table 1). The population density of leaf gall midge were evaluated in every year and data showed that maximum population fluctuation was observed on 25-26, 29-30 SMW in the year 2010 (Table 2). In the year 2011 maximum population fluctuation were observed on 13-14, 15-16 & 37-38 SMW. In 2012 maximum population fluctuation were observed on 15-16 & 35-36 SMW. During the year 2013 maximum population fluctuation were observed on 25-26, 29-30 & 35-36 SMW i.e. 3.69, 8.53 & 7.27 respectively. In the year 2014 maximum population density were observed on 13-14, 23-24 & 33-34 SMW whereas the population was 6.20, 8.20 & 12.40, respectively. In 2015, the maximum population density in leaf gall midge was observed on 17-18, & 33-34 SMW where the population density was 15.98 & 9.0, respectively. In 2016 maximum population density was observed in 17-18, 21-22 &33-34 SMW where the population fluctuation was 18.49, 8.18 & 7.56, respectively. The pest population increased with the increasing September month temperature and decreased with the increasing of relative humidity in field conditions. This insect population density remained low during October- February month and active from March to September (peak). The meteorological study showed that pest population positively correlated with the minimum and maximum temperature and negatively correlated with the relative humidity and rainfall (Table 3). The finding are in close conformity to Dorchin e*t al.* (2015). Mani (1952) found that gall midge larvae feed within plant tissue, causing abnormal plant growth called galls that can damage to mango leaves, flowers, fruit and shoots. Uma and Verghese (2008) also reported that *Asphondylia phyllanthi* Felt damaged the Aonla leaves in India.

Table 1. Mean fortnightly meteorological data with peak incidence of Aonla Leaf gall midge, *Asphondylia phyllanthi* (2010-2016)

Year	Peak Time	% Infested leaves/ tree	Max. Temp. (°C)	Min.Temp.(°C)	R.H. (%) Morning	RH (%)Evening	Total Rain fall (mm)
2010	Sept	80.0	31.98	23.88	88.50	63.75	237.05
2011	Sept.	60.0	32.30	22.40	87.0	53.00	371.8
2012	Sept.	40.0	31.70	21.90	92.0	63.30	549.2
2013	Sept.	40.75	33.40	22.70	85.0	57.50	416.20
2014	Sept.	54.20	33.20	22.65	83.50	55.50	171.50
2015	Sept.	60.21	36.80	23.10	75.0	46.0	257.55
2016	Sept.	59.88	36.40	22.85	72.0	43.0	206.10

Table 2. Population fluctuation of Aonla leaf gall midge, *Asphondylia phyllanthi* at fortnightly interval under field conditions

SMW	2010	2011	2012	2013	2014	2015	2016
1-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-6	0.0	0.0	0.0	0.48	0.0	2.91	2.28
7-8	0.0	0.0	0.0	0.24	4.00	3.33	3.29
9-10	5.5	4.00	0.0	0.0	0.0	0.13	0.13
11-12	3.50	2.80	0.0	0.25	1.00	0.0	0.02
13-14	4.50	6.00	1.40	0.07	6.20	1.54	2.09
15-16	6.00	10.40	4.40	0.14	2.20	1.11	0.09
17-18	4.50	4.20	1.40	0.23	3.80	15.98	18.49
19-20	6.50	4.20	1.80	0.22	2.40	5.00	3.57
21-22	5.50	3.40	1.10	0.90	1.60	8.00	8.18
23-24	5.00	3.80	2.30	0.0	8.20	4.00	3.17
25-26	8.50	3.20	1.20	3.69	6.80	1.00	2.01
27-28	4.50	2.60	0.20	0.45	0.20	0.0	0.0
29-30	7.50	3.20	3.20	8.53	0.60	0.0	0.0
31-32	6.50	3.40	6.80	0.58	1.80	0.0	0.0
33-34	3.50	2.80	4.80	3.37	12.40	9.00	7.56
35-36	4.50	2.00	2.20	7.27	0.80	7.00	8.02
37-38	4.00	4.00	9.20	6.31	2.20	1.00	0.44
39-40	0.0	0.0	0.0	8.02	0.0	0.0	0.0
41-42	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43-44	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45-46	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47-48	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49-50	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51-52	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3. Correlation Matrix of Aonla leaf gall midge, *Asphondylia phyllanthi* population with environmental factor at field condition

Year	Temperature		Relative humidity		Rainfall
	Maximum	Minimum	Morning	Evening	
2010	0.592**	0.192	-0.773**	-0.638**	-0.407
2011	0.564**	0.386	-0.458*	-0.265	-0.086
2012	0.523*	0.452*	-0.495*	-0.272	-0.190
2013	0.247	0.163	-0.171	-0.114	-0.280
2014	0.410	0.393	-0.423	-0.150	-0.354
2015	0.500*	0.329	-0.627**	-0.422	-0.353
2016	0.322	0.224	-0.374	-0.240	-0.154

*Significant at 5% and ** significant at 1%

Conclusion

The aonla leaf gall midge damage was started in the month of February and it was reached at its maximum level in the month of September during the year 2010-2016. The meteorological study showed that pest population positively correlated with the minimum and maximum temperature and negatively correlated with the relative humidity and rainfall.

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Conflict of Interest

The authors have no conflict of interest.

Data Sharing

All relevant data are within the manuscript.

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