Int.J.Curr.Microbiol.App.Sci (2018) *7*(8): 2337-2350

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 08 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.708.235

Seasonal Incidence of Major Pests of Pongamia (*Milletia pinnata* L.) in Nursery Conditions

D. Devika Rani*, D. Jemla Naik and K.S. Jagadish

Department of Agricultural Entomology, UAS, GKVK, Bengaluru - 560065, India

**Corresponding author*

Keywords

Pongamia, *Aceria pongamiae*, Leaf galls, Flower galls, Weather parameters

Article Info

Accepted:
12 July 2018
Available Online:
10 August 2018

A B S T R A C T

The incidence of major pests of pongamia in relation to weather parameters was observed during 2016-17 at Zonal Agricultural Research Station, UAS, GKVK, Bengaluru. The important pests recorded on pongamia were blotch miner (*Acrocercops anthrauris* Fabricius), spiralling whitefly *Aleurodiccus disperses* (Russel), and the eriophyid mite, *Aceria pongamiae* Channabasavanna causing leaf galls. Correlation between *A. pongamiae* with weather variables of the corresponding fortnight revealed that it had highly significant and positive correlation with minimum temperature i.e. (r = 0.845**, p<0.01), maximum temperature (r = 0.471*, p<0.05) and total rainfall (r = 0.464*) respectively. Leaf gall number was significantly and positively correlated with minimum temperature (r = 0.605, p<0.01). Regarding correlation with preceding fortnight weather data, *A. pongamiae* incidence was significantly and positively correlated with maximum temperature (r= 0. 571, p<0.01) and minimum temperature (r = 0.868, p<0.01), leaf gall number due to *A. pongamiae* was significantly and positively correlated with minimum temperature (r = 0.586**, p<0.01), total rainfall (r = 0.478, p<0.05) and wind speed (r = 0.508*, p<0.05). Blotch miner incidence was significantly and positively correlated with maximum temperature (r = 0.413, p<0.01), minimum temperature (r = 0.684, p<0.01), wind speed (r = 0.361**, p<0.01), afternoon RH (r = 0.290, p<0.05) and total rainfall (r = 0.292, p<0.05) of the preceding week. Spiralling whitefly incidence was significantly positively correlated with maximum temperature (r = 0.072, p<0.01), minimum temperature *i.e.* (r =0.517, p<0.01) and afternoon RH (r = 0.520, p<0.01). Regarding correlation with the corresponding week weather parameters, blotch miner showed significant and positive correlation with minimum temperature (r= 0.775, p<0.01), maximum temperature (r = 0.289, p<0.05), afternoon relative humidity (r= 0.336, p<0.05) and wind speed (r= 0.359, p<0.01). Spiralling whitefly, incidence showed significant positive correlation with maximum temperature (r = 0.069, p<0.01), minimum temperature *i.e.* (r =0.523**, p<0.01) morning RH (r = 0.277, p<0.05) afternoon RH (r = 0.536**, p<0.01) and rainfall (r = 0.353, p<0.05)

Introduction

Pongamia (*Milletia pinnata* L.), belongs to family Fabaceae, is a medium-sized evergreen or briefly deciduous, glabrous shrub or tree normally growing to a height of 15-25 m high, with straight or a crooked trunk of 50-80 cm diameter and broad crown of spreading or drooping branches [7] It is a medium sized glabrous tree, mainly distributed in tidal forests of India. Recent recognition of the importance of the seeds of this plant as a raw material for biofuel production extends its economic utility for industrial applications also.

The non-edible oil contains several unsaponifiable and toxic components, which make them unsuitable for human consumption. Karanja (*Pongamia pinnata*) is an underutilized plant which is grown in many parts of India. Sometimes the oil is contaminated with high free fatty acids (FFA) depending upon the moisture content in the seed during collection as well as oil expression [3]. The eriophyid mite *A. pongamiae* Channabasavanna and flower galls caused due to *A. pongamiae* Mani are the major pests. *A. pongamiae* feeds on the leaves which lead to the formation of elongate finger-like pouches of varying dimensions on both surfaces of the leaves. Individual galls fuse to form complex, irregularly shaped, massive structures, covering the entire laminar area including the midrib, vein and veinlets. This results in severe distortion of the leaves and drastically affects the photosynthetic activity of the plant, leading to reduction of biomass and adversely affects the growth of *P. pinnata*. The pest showed a higher percentage of damage and number of galls during May, leading to a significant reduction in leaf area [4]. Growth attributes *viz*., length, collar girth and biomass in treated (non-infested) seedlings are significantly higher than the untreated (infested) seedlings of *P. pinnata*, ($p<0.001$) [5]**.** However, flower galls caused by *A. pongamiae*, are also important due to its negative impact on seed set [8]. The present investigation focuses on the population dynamics of major pests of Pongamia in relation to the climatic factors, the findings of which are discussed in the light of earlier reports on the similar type of investigations.

Some important natural enemies observed on *P. Pinnata was Green lacewing, Chrysoperla* sp. Mantids, Spiders, Predatory red stink bug, *Euthyrhynchus floridanus* Linnaeus, Lady bird beetle [6].

Material and Methods

Incidence of eriophyid mite, *Aceria pongamiae* and Leaf gall

For the purpose of recording the incidence of eriophyid mite, *A. pongamiae* and leaf gall it causes on Pongamia, fifteen galled leaf samples were collected randomly from Pongamia and observations were carried out for one year, at fortnightly intervals. The leaf samples were put in polythene bags and tied loosely with rubber bands for subsequent transportation to the laboratory for further observation under the microscope. Data was recorded on the number of galls developed on both abaxial and adaxial surface of the leaves. Data on temperature, relative humidity, and rainfall of the study site were obtained from AICRP (Agrometeorology), UAS, GKVK, Bengaluru. The incidence of *A. pongamiae* and the number of leaf galls was subjected to correlation and multiple linear regression analysis with the weather parameters of the corresponding fortnight and also with that of the preceding fortnight.

Incidence of blotch miner and spiralling whitefly caused by *Acrocercops anthrauris* Fabricius

The data pertaining to the incidence of insect pests of blotch miner, spiralling whitefly and flower galls on Pongamia were recorded at weekly interval for a period of one year. Fifteen trees were labelled and observed for the incidence of these three pests at weekly intervals. The observation on the pest population was recorded from five upper, five middle and five lower leaves, in each of the fifteen plants in each replication. The same set of labelled plants was used for continuously recording observations during the study period. Incidence of blotch miner, spiralling whitefly and flower galls was subjected to correlation and multiple linear regression analysis with weather parameters of both preceeding and corresponding week.

Weather parameters were mentioned in regression tables as

R_1 = Maximum temperature (^{0}C)
R_2 = Minimum temperature (^{0}C)
R_3 = Relative Humidity morning (%)
R_4 = Relative Humidity afternoon (%)
R_5 = Wind speed (Km/day)
R_6 = Bright sunshine(Hrs)
R_7 = Total Rainfall (mm)

Results and Discussion

Incidence of *Aceria pongamiae* and leaf galls in relation to weather parameters in nursery

The results pertaining to the incidence of major pests of pongamia (*Milletia pinnata* L.) are discussed below. Maximum mite (*Aceria pongamiae*) population was observed in II fortnight of May (198.92), followed by I fortnight of May (179.30). No mite population was observed in the entire month of February and I fortnight of January (Table 1).

Maximum number of leaf galls due to *Aceria pongamiae* infestation was observed during II fortnight of June (66.76), followed by I fortnight of June (59.71). No leaf gall infestation was observed during II fortnight of January and I fortnight of February (Table 1).

From this results we can conclude that the number of gall to be highest during May. Population studies carried out on *A. pongamiae* enabled to record seasonal fluctuations in the mite density within the leaf galls. The initiation of infestation was recorded in February, reaching to peak population in May. The decline in mite population since June would be reflecting the negative impact of rain fall received by the site. There is no mite population and galls recorded on Pongamia in January and February because of shedding of their leaves. Even though the mites enjoy a highly secluded habitat available within the leaf galls, rain fall exerts an adverse effect by penetrating through the holes in to the interior of the gall cavity [1].

Our results have been found to be in conformity with the findings of (Aratchige *et al.*, 2012) who reported a significant negative impact of rainfall on the population density of *Neoseiulus baraki.*, low number of mites recorded inside the dried galls during October and November could be possibly explained on the grounds of their escape in search of suitable sites like the under surfaces of the bark or to hibernate/or tide over the unfavourable conditions through the phenomenon of deuterogyny. The plants shed the leaves in January. The trend observed on the population fluctuation of *A. pongamiae* has been found to be in accordance with the findings of who reported maximum population density of *A. litchi* during April-May and minimum during November-December. Another study also recorded similar trends in population of *Aculus euphorbiae* feeding on *euphorbia* spp. recording a lower population in winter [4].

Correlation between incidence of *Aceria pongamiae* and leaf galls with weather parameters of preceding fortnight in nursery

The correlation between eriophyid mite population with weather parameters of preceding fortnight was found to be highly significant and positively correlated with maximum temperature (r= 0. 571, $p<0.01$) and minimum temperature (r = 0.868, $p<0.01$), while it was non - significant and positive with wind speed (r = 0.166) total rainfall (r = 0.531) and afternoon RH (r = 0.173).

However, mite incidence was negatively correlated with morning RH (r = - 0.071), and sunshine hours (r = -0.313).

The correlation between number of leaf galls caused by mite with weather parameters of preceding fortnight was found to be significantly positively correlated with minimum temperature (r = 0.586**, $p<0.01$), total rainfall (r = 0.478, $p<0.05$) and wind speed (r = 0.508*, $p<0.05$). However, gall incidence was found to have non - significant positive correlation with maximum temperature (r = 0.352), morning RH (r = 0.027) and afternoon RH (r = 0.159). It was non - significantly negatively correlated with sunshine hrs. (r = -0.276).

Correlation between incidence of *Aceria pongamiae* and leaf galls with weather parameters of corresponding fortnight in Nursery

The correlation analysis between eriophyid mite population with weather parameters of corresponding fortnight was found to be significantly positively correlated with minimum temperature i.e. (r = 0.845**, $p<0.01$), maximum temperature (r = 0.471*, $p<0.05$) and total rainfall (r = 0.464*) and mite population showed non - significant positive correlation with afternoon RH (r = 0. 212), wind speed (r = 0. 200) and Negative correlation was recorded between morning RH (r = -0. 060), sunshine hrs (r = -0. 301) with mite incidence, but this relationship was found to be non - significant.

The correlation between incidence of leaf galls with weather parameters of corresponding fortnight was found to be significant and positively correlated with minimum temperature (r = 0.605, $p<0.01$), while it showed non - significant positive correlation with maximum temperature (r = 0.199), morning RH (r = 0.136), afternoon RH (r = 0.225) wind speed (r = 0.043) and total rainfall (r = 0.155) (Table 2 and 3).

However, leaf gall number was negatively correlated with sunshine hours (r = -0.446) and this relationship was non - significant.

Multiple linear regression between incidence of *Aceria pongamiae* and leaf galls with weather parameters of preceding fortnight in Nursery

Multiple linear regression analysis revealed that the weather parameters of preceding fortnight influenced *A. pongamiae* and leaf gall formation to an extent of 87.9 and 53.4 per cent, respectively. [1, 4] also reported a similar impact of weather parameters on leaf galls and eriophyid mites (Table 4).

Multiple linear regression between incidence of *Aceria pongamiae* and leaf galls with weather parameters of corresponding fortnight in Nursery

Multiple linear regression analysis revealed that the weather parameters of corresponding fortnight influenced *A. pongamiae* and leaf gall formation to an extent of 77.10 and 45.10 per cent, respectively (Table 5).

[1] and [4] also reported about weather parameters influencing leaf galls and eriophyid mites to an extent of 78.3 and 50.28 per cent, respectively, which was similar to the present findings.

Table.1 Incidence of *Aceria pongamiae* and leaf galls caused by *A. pongamiae* in relation to weather parameters of the preceding fortnight *(2016-17)* (Nursery)

Fort night of eachMonth	Std. Met. week	Date of Observation	No of *A.Pongamiae/ gall*	Leaf galls(No /leaf)	Temp (^{0}C)		RH (%)		Wind speed (Km/day)	Sunshine (Hrs)	Total Rainfall (mm)
					Max.	Min.	Morning	A/N			
I FN. Oct	40	3-10-2016	146.73	7.26	28.89	19.05	93.15	50.86	6.20	5.40	16.40
II FN. Oct	42	17-10-2016	119.24	11.41	29.42	18.76	84.93	48.07	4.45	7.05	30.20
I FN. Nov	45	7-11-2016	109.52	13.35	29.68	17.76	80.86	46.50	3.70	8.80	0.00
II FN. Nov	47	21-11-2016	78.65	12.08	29.33	17.20	81.43	45.36	6.20	8.40	0.00
IFN. Dec	49	5-12-2016	67.56	6.64	29.69	21.80	82.29	40.22	5.35	8.70	1.70
II FN. Dec	51	19-12-2016	10.32	4.32	26.09	15.36	86.22	49.57	7.45	4.70	58.20
I FN. Jan	2	9-01-2017	3.65	2.32	28.03	13.76	89.07	48.57	5.30	9.15	0.000
II FN. Jan	4	23-01-2017	0.00	0.00	27.30	13.64	88.5	41.43	5.15	8.80	0.00
I FN. Feb	6	6-02-2017	0.00	0.00	27.03	14.76	89.36	39.00	9.10	7.60	0.00
II FN. Feb	8	20-02-2017	0.00	3.66	28.59	14.66	84.22	36.29	5.65	10.40	0.00
I FN. Mar	11	13-03-2017	34.50	7.07	30.69	15.20	84.29	34.79	8.05	9.95	1.40
II FN. Mar	13	27-03-2017	25.40	9.10	32.13	17.55	82.64	35.22	6.05	9.15	0.00
I FN. Apr	15	9-04-2017	149.86	10.87	32.83	20.22	81.00	41.00	6.70	8.95	1.60
II FN. Apr	17	23-04-2017	161.29	13.98	34.80	21.00	82.00	36.50	6.95	8.95	0.00
I FN. May	19	7-05-2017	179.30	22.56	35.15	22.15	83.00	36.00	7.55	8.10	41.00
II FN. May	21	21-05-2017	198.92	36.52	34.05	21.65	83.00	33.50	6.50	8.50	179.20
I FN. Jun	23	4-06-2017	172.83	59.71	33.05	21.05	83.00	41.50	7.35	7.45	29.90
II FN. Jun	25	18-06-2017	169.80	66.76	31.10	19.85	87.50	44.50	9.40	7.35	40.60
I FN. Jul	27	2-07-2017	101.43	43.12	28.80	20.40	89.00	55.00	10.55	4.55	13.40
II FN. Jul	29	16-07-2017	94.23	34.75	28.20	19.75	88.50	55.00	11.15	4.95	16.00
I FN. Aug	31	01-08-2017	112.21	32.85	28.50	19.75	91.50	59.00	9.70	3.95	77.40
II FN. Aug	34	16-08-2017	159.45	23.67	28.70	19.65	86.50	54.50	11.60	6.05	97.00
I FN. Sep	36	05-09-2017	155.86	16.89	28.05	19.90	91.00	56.00	5.85	3.35	130.00
II FN. Sep	38	19-09-2017	149.53	13.08	27.50	19.70	91.00	61.50	7.25	3.35	48.60

Table.2 Correlation between incidence of *Aceria pongamiae* and leaf galls with weather parameters of the preceding fortnight (Nursery)

Mite / leaf gall	Temp (^{0}C)		RH (%)		Wind speed (Km/day)	Bright Sunshine (Hrs)	Total Rainfall (mm)
	Max.	**Min.**	**Morning**	**A/N**			
Aceria pongamiae	0. 571**	0.868**	- 0.071	0.173	0.184	-0.313	0.531
Leaf galls	0. 352	0. 586**	0.027	0.159	0.508*	-0.276	0.347

Table.3 Correlation between incidence of *Aceria pongamiae* and leaf galls with weather parameters of the corresponding fortnight (Nursery)

Mite / leaf gall	Temp (^{0}C)		RH (%)		Wind speed (Km/day)	Bright Sunshine (Hrs)	Total Rainfall (mm)
	Max.	**Min.**	**Morning**	**A/N**			
Aceria pongamiae	0.471*	0.845**	-0. 060	0. 212	0. 200	-0. 301	0.464*
Leaf galls	0.199	0.605**	0.136	0.225	0.043	-0.446	0.155

Table.4 Multiple linear regression between incidence of *Aceria pongamiae* and leaf galls with weather parameters of the preceding fortnight (Nursery)

Mite / leafgall	Regression equation	R^2
Aceria pongamiae	$Y= -1003.141+16.907 R_1 + 10.452 R_2 + 2.052 R_3 + 4.308 R_4 - 1.933 R_5 + 4.780 R_6 + 0.346 R_7$	87.90
Leaf gall	$Y= -183.755+ 2.846R_1 + 1.521R_2+ 0.220R_3 + 0.707R_4 + 3.586R_5 + 1.478R_6 + 0.053R_7$	53.40

Table.5 Multiple linear regression between incidence of *Aceria pongamiae* and leaf galls with weather parameters of the corresponding fortnight (Nursery)

Mite / leaf gall	Regression equation	R^2
Aceria pongamiae	$Y= - 165.878 - 2.760 R_1 + 22.354 R_2 - 2.510 R_3 + 2.144 R_4 -1.634 R_5 + 8.632 R_6 + 0.208 R_7$	77.10
Leaf gall	$Y= -19.401 - 0.826R_1 + 4.533R_2 + 0.031R_3 - 0.104 R_4 + 0.178R_5 - 2.168R_6 - 0.068R_7$	45.10

Table.6 Incidence of blotch miner and spiralling whitefly caused by *Acrocercops anthrauris* Fabricius in relation to weather parameters of the preceding week during 2016-17 (Nursery)

Date of observation	Std. Met. week	No. of blotches/ leaf	No. of egg spirals of SWF/leaf	Temp (^{0}C)		RH (%)		Wind speed (Km/day)	Bright Sunshine (Hrs)	Total Rainfall (mm)
				Max.	**Min.**	**Morning**	**A/N**			
3-10-2016	40	17.72	3.13	27.86	19.20	94.29	54.43	6.80	2.50	16.40
10 -10-2016	41	17.83	3.63	29.91	18.91	92.00	47.29	5.60	8.30	0.00
17 -10-2016	42	18.03	3.01	29.09	18.66	92.00	50.57	5.50	4.90	30.2
24-10-2016	43	18.39	3.43	29.74	16.69	77.86	45.57	3.40	9.20	0.00
31 -10-2016	44	17.49	2.63	29.66	17.40	76.71	45.86	3.70	8.80	0.00
7-11-2016	45	16.64	2.61	29.69	18.11	85.00	47.14	3.70	8.80	0.00
14 -11-2016	46	15.83	2.53	29.20	15.97	78.71	45.00	4.70	9.60	0.00
21-11-2016	47	14.99	2.47	29.46	18.43	84.14	45.71	7.70	7.20	0.00
28-11-2016	48	13.53	2.41	29.89	29.60	82.00	38.43	6.70	8.70	0.00
5-12-2016	49	10.24	2.39	29.49	14.00	82.57	42.00	4.00	8.70	1.70
12-12-2016	50	7.93	2.32	27.37	15.60	82.57	43.14	7.70	4.70	0.00
19 -12-2016	51	2.95	2.23	24.80	15.11	89.86	56.00	7.20	4.70	58.20
26 -12-2016	52	1.99	2.17	28.14	13.91	87.43	41.14	5.50	8.60	0.00
2-01-2017	1	1.01	1.91	27.91	13.6	90.71	39.29	5.10	9.70	0.00
9-01-2017	2	0.00	1.63	27.37	12.17	85.86	41.00	5.20	9.40	0.00
16-01-2017	3	0.00	0.00	27.23	15.11	91.14	41.86	5.10	8.20	0.00
23-01-2017	4	0.00	0.00	26.77	14.09	93.14	39.43	8.50	9.40	0.00
30-01-2017	5	0.00	0.00	27.29	15.43	85.57	38.57	9.70	5.80	0.00
6-02-2017	6	0.00	0.00	27.29	15.43	85.57	38.57	4.80	10.50	0.00
13-02-2017	7	0.21	0.00	29.89	13.89	82.86	34.00	6.50	10.30	0.00
20-02-2017	8	3.94	0.00	29.43	14.63	83.86	33.86	10.20	10.00	0.00
27-02-2017	9	7.82	0.00	31.94	15.77	84.71	35.71	5.90	9.90	1.40
06-03-2017	10	13.33	1.05	31.97	15.03	78.71	29.14	5.90	9.90	0.00

Date of observation	Std. Met. week	No. of blotches/ leaf	No. of egg spirals of SWF/leaf	Temp ^{0}C		RH%		Wind speed (Km/day)	Bright sunshine (Hrs)	Total Rainfall (mm)
				Max.	**Min.**	**Morning**	**A/N**			
13-03-2017	11	14.56	1.13	32.29	20.06	86.57	41.29	6.20	8.40	1.40
20-03-2017	12	15.34	1.21	32.26	19.94	83.57	41.57	6.50	8.50	0.00
27-03-2017	13	16.86	2.32	33.40	20.49	78.43	40.43	6.90	9.40	0.00
2-04-2017	14	17.97	2.66	35.00	20.50	82.00	35.00	7.70	9.30	0.00
9-04-2017	15	18.13	2.55	34.60	21.50	82.00	38.00	6.20	8.60	1.60
16-04-2017	16	18.97	2.43	35.70	22.40	82.00	36.00	6.70	8.50	0.00
23-04-2017	17	20.14	2.51	34.60	21.90	84.00	36.00	8.40	7.70	0.00
30-04-2017	18	23.24	2.63	35.40	22.40	84.00	36.00	7.00	8.80	0.00
7-05-2017	19	25.36	2.91	32.70	20.90	82.00	31.00	6.00	8.20	25.80
14-05-2017	20	26.53	3.01	32.60	21.20	81.00	48.00	6.40	6.90	15.20
21-05-2017	21	29.88	3.12	33.50	20.90	85.00	35.00	8.30	8.00	45.60
28-05-2017	22	31.33	4.11	32.20	19.80	87.00	42.00	8.00	6.50	133.6
4-06-2017	23	32.09	4.68	30.00	19.90	88.00	47.00	10.80	8.20	8.30
11-06-2017	24	30.21	4.31	29.50	20.60	88.00	53.00	10.20	6.80	21.60
18-06-2017	25	28.24	4.16	28.10	20.20	90.00	57.00	10.90	2.30	8.00
25-06-2017	26	26.13	3.32	28.10	19.50	90.00	56.00	9.00	4.80	32.60
2-07-2017	27	25.42	3.41	28.30	20.00	87.00	54.00	13.30	5.10	3.20
9-07-2017	28	24.01	3.29	29.00	19.70	93.00	57.00	9.60	4.20	10.20
16-07-2017	29	22.34	2.11	28.00	19.80	90.00	61.00	9.80	3.70	13.40
23-07-2017	30	20.77	2.04	27.50	19.60	88.00	59.00	12.80	4.00	2.60
01-08-2017	31	18.56	2.17	29.90	19.70	85.00	50.00	10.40	8.10	2.40
08-08-2017	32	16.61	2.21	27.10	19.30	93.00	57.00	4.80	2.60	4.60
15-08-2017	33	15.35	3.13	29.00	20.50	89.00	55.00	6.90	4.10	70.40
22-08-2017	34	13.34	3.31	27.50	19.70	92.00	64.00	6.30	3.10	34.20
29-08-2017	35	13.01	3.41	27.50	19.70	90.00	59.00	8.20	3.60	62.80
05-09-2017	36	16.23	3.49	27.20	19.80	95.00	58.00	9.40	3.00	30.80
12-09-2017	37	17.11	3.52	28.30	19.50	89.00	56.00	4.20	5.30	99.20
19-09-2017	38	17.27	3.17	28.80	19.30	89.00	57.00	6.40	5.20	24.20
26-09-2017	39	18.12	3.15	28.10	18.80	92.00	65.00	9.70	3.60	24.40

Table.6a Incidence of blotch miner and spiralling whitefly caused by *Acrocercops anthrauris* Fabricius in relation to weather parameters of the corresponding week during 2016 -17 (Nursery)

Date of observation	Std. Met. week	No. of blotches/ leaf	No. of egg spirals of SWF/leaf	Temp (^{0}C)		RH (%)		Wind speed (Km/day)	Bright Sunshine (Hrs)	Total Rainfall (mm)
				Max.	**Min.**	**Morning**	**A/N**			
3-10-2016	40	17.72	3.13	29.91	18.91	92.00	47.29	5.60	8.30	0.00
10 -10-2016	41	17.83	3.63	29.09	18.66	92.00	50.57	5.50	4.90	30.20
17 -10-2016	42	18.03	3.01	29.74	16.69	77.86	45.57	3.40	9.20	0.00
24-10-2016	43	18.39	3.43	29.66	17.4	76.71	45.86	3.70	8.80	0.00
31 -10-2016	44	17.49	2.63	29.69	18.11	85.00	47.14	4.00	8.00	0.00
7-11-2016	45	16.64	2.61	29.20	15.97	78.71	45.00	4.70	9.60	0.00
14 -11-2016	46	15.83	2.53	29.46	18.43	84.14	45.71	7.70	7.20	0.00
21-11-2016	47	14.99	2.47	29.89	15.37	82.00	38.43	6.70	8.70	0.00
28-11-2016	48	13.53	2.41	29.49	14.00	82.57	82.57	4.00	8.70	1.70
5-12-2016	49	10.24	2.39	27.37	15.6	82.57	43.14	7.70	4.70	0.00
12-12-2016	50	7.93	2.32	24.80	15.11	89.86	56.00	7.20	4.70	58.20
19 -12-2016	51	2.95	2.23	28.14	13.91	87.43	41.14	5.50	8.60	0.00
26 -12-2016	52	1.99	2.17	27.91	13.60	90.71	39.29	5.10	9.70	0.00
2-01-2017	1	1.01	1.91	27.37	12.17	85.86	41.00	5.20	9.40	0.00
9-01-2017	2	0.00	1.63	27.23	15.11	91.14	41.86	5.10	8.20	0.00
16-01-2017	3	0.00	0.00	26.77	14.09	93.14	39.43	8.50	9.40	0.00
23-01-2017	4	0.00	0.00	27.29	15.43	85.57	38.57	9.70	5.80	0.00
30-01-2017	5	0.00	0.00	27.29	15.43	85.57	38.57	4.80	10.50	0.00
6-02-2017	6	0.00	0.00	29.89	13.89	82.86	34.00	6.50	10.30	0.00
13-02-2017	7	0.21	0.00	29.43	14.63	83.86	33.86	10.20	10.00	0.00
20-02-2017	8	3.94	0.00	31.94	15.77	84.71	35.71	5.90	9.90	1.40
27-02-2017	9	7.82	0.00	31.97	15.03	78.71	29.14	5.90	9.00	0.00
6-03-2017	10	13.33	1.05	32.29	20.06	86.57	41.29	6.20	8.40	1.40
Date of observation	**Std. Met. week**	**No. of blotches/ leaf**	**No. of egg spirals of SWF/leaf**	**Temp ^{0}C**		**RH%**		**Wind speed (Km/day)**	**Bright Sunshine (Hrs)**	**Total Rainfall(mm)**
				Max.	**Min.**	**Morning**	**A/N**			

13-03-2017	11	14.56	1.13	32.26	19.94	83.57	41.57	6.50	8.50	0.00
20-03-2017	12	15.34	1.21	33.40	20.49	78.43	40.43	6.90	9.40	0.00
27-03-2017	13	16.86	2.32	35.00	20.50	82.00	35.00	7.70	9.30	0.00
2-04-2017	14	17.97	2.66	34.00	21.50	82.00	38.00	6.20	8.60	1.60
9-04-2017	15	18.13	2.55	35.70	22.40	82.00	36.00	6.70	8.50	0.00
16-04-2017	16	18.97	2.43	34.60	21.90	84.00	36.00	8.40	7.70	0.00
23-04-2017	17	20.14	2.51	35.40	22.40	84.00	36.00	7.00	8.80	0.00
30-04-2017	18	23.24	2.63	32.70	20.90	82.00	31.00	6.00	8.20	25.80
7-05-2017	19	25.36	2.91	32.60	21.20	81.00	48.00	6.40	6.90	15.20
14-05-2017	20	26.53	3.01	33.50	20.90	85.00	35.00	8.30	8.00	45.60
21-05-2017	21	29.88	3.12	32.20	19.80	87.00	42.00	8.00	6.50	133.60
28-05-2017	22	31.33	4.11	30.00	19.90	88.00	47.00	10.80	8.20	8.30
4-06-2017	23	32.09	4.68	29.50	20.60	88.00	53.00	10.20	6.80	21.60
11-06-2017	24	30.21	4.31	28.10	20.20	90.00	57.00	10.90	2.30	8.00
18-06-2017	25	28.24	4.16	28.10	19.50	90.00	56.00	9.00	4.80	32.60
25-06-2017	26	26.13	3.32	28.30	20.00	87.00	54.00	13.30	5.10	3.20
2-07-2017	27	25.42	3.41	29.00	19.70	93.00	57.00	9.60	4.20	10.20
9-07-2017	28	24.01	3.29	28.00	19.80	90.00	61.00	9.80	3.70	13.40
16-07-2017	29	22.34	2.11	27.50	19.60	88.00	59.00	12.80	4.00	2.60
23-07-2017	30	20.77	2.04	29.90	19.70	85.00	50.00	10.40	8.10	2.40
01-08-2017	31	18.56	2.17	27.10	19.30	93.00	57.00	4.80	2.60	4.60
08-08-2017	32	16.61	2.21	29.00	20.50	89.00	55.00	6.90	4.10	70.40
15-08-2017	33	15.35	3.13	27.50	19.70	92.00	64.00	6.30	3.10	34.20
22-08-2017	34	13.34	3.31	27.50	19.70	90.00	59.00	8.20	3.60	62.80
29-08-2017	35	13.01	3.41	27.20	19.80	95.00	58.00	9.40	3.00	30.80
05-09-2017	36	16.23	3.49	28.30	19.50	89.00	56.00	4.20	5.30	99.20
12-09-2017	37	17.11	3.52	28.80	19.30	89.00	57.00	6.40	5.20	24.20
19-09-2017	38	17.27	3.17	28.10	18.80	92.00	65.00	9.70	3.60	24.40
26-09-2017	39	18.12	3.15	27.30	19.10	90.00	60.00	4.30	4.00	108.60

Table.7 Correlation matrix between incidence of blotch miner and spiralling whitefly weather parameters of preceding week (Nursery)

Pest/Damage	Temp (^{0}C)		RH (%)		Wind speed (Km/day)	Bright Sunshine (Hrs)	Total Rainfall (mm)
	Max.	**Min.**	**Morning**	**A/N**			
Blotches/ leaf	0.413**	0.684**	-0.022	0.290*	0.361**	-0.324*	0.292*
Egg spirals/leaf	0.072**	0.517**	0.181	0.520**	0.181	-0.484**	0.437

Table.8 Correlation matrix between incidence of blotch miner and spiralling whitefly with weather parameters of corresponding week (Nursery)

Pest/Damage	Temp (^{0}C)		RH (%)		Wind speed (Km/day)	Bright Sunshine (Hrs)	Total Rainfall (mm)
	Max.	**Min.**	**Morning**	**A/N**			
Blotches/ leaf	0.289*	0.775**	0.030	0.336*	0.359**	-0.409**	0.281*
Egg spirals/leaf	0.069**	0.523**	0.277*	0.536**	0.157	-0.537	0.353*

Table.9 Multiple linear regression between incidence of blotch miner and spiralling whitefly with weather parameters of preceding week (Nursery)

Pest	Regression equation	R^2
Blotches/ leaf	$Y= - 68.001+ 2.178 R_1 + 0.611 R_2 - 0.293 R_3+ 0.561 R_4 + 0.893 R_5 - 0.038 R_6 + 0.052 R_7$	70.10
Spirals/leaf	$Y= - 5.372 + 0.157 R_1 + 0.083R_2 - 0.031R_3 + 0.089R_4 - 0.009 R_5 + 0.005 R_6 + 0.011 R_7$	56.40

Table.10 Multiple linear regression between incidence of blotch miner and spiralling whitefly weather parameters of corresponding week (Nursery)

Pest	Regression equation	R^2
Blotches/ leaf	$Y= - 0.498- 0.236R_1 + 2.457R_2 - 0.509R_3 + 0.284R_4 + 0.767R_5 +0.385R_6 + 0.037 R_7)$	71.50
Spirals/leaf	$Y= 0.339 - 0.114R_1+ 0.280 R_2 - 0.018R_3+ 0.042R_4 - 0.035R_5 +0.019R_6+ 0.003 R_7)$	51.80

Incidence of blotch miner and spiralling whitefly in relation to weather parameters in Nursery

Maximum blotch miner population was observed in I week of June (32.09), followed by last week of May (31.33).

Maximum spiralling whitefly population (*i.e.* egg spiral number) was observed in I week of June (4.68), followed by II week of June (4.31) (Table 6 and 6a).

Correlation between incidence of Blotch miner, Spiralling whitefly and Flower galls with weather parameters of preceding week in Nursery

The correlation analysis between number of leaf blotches with weather parameters of preceding week (Table 7) was found to be highly significant and positively correlated with maximum temperature (r = 0.413, p<0.01), minimum temperature (r = 0.684, p<0.01), wind speed (r = 0.361**, p<0.01), afternoon RH (r = 0.290, p<0.05) and total rainfall (r = 0.292, p<0.05).

Negative correlation existed between blotch number and sunshine hrs. (r = -0.324) and morning RH (r = -0.022), but this relationship was non - significant.

The correlation between spiralling whitefly with weather parameters of preceding week (Table 7) was found to be highly significant and positively correlated with maximum temperature (r = 0.072, p<0.01), minimum temperature *i.e.* (r =0.517, p<0.01) and afternoon RH (r = 0.520, p<0.01).

Non significant, positive correlation existed with rainfall (r = 0.437), morning RH (r = 0.181) and wind speed (r = 0.181) but non - significant negative correlation was observed with sunshine hrs (r = -0.484).

Correlation matrix between incidence of blotch miner and spiralling whitefly with weather parameters of corresponding week in Nursery

The correlation between leaf blotches with weather parameters of corresponding week (Table 8) was found to be significant and positive with minimum temperature (r= 0.775, p<0.01), maximum temperature (r = 0.289, p<0.05), afternoon relative humidity (r= 0.336, p<0.05) and wind speed (r= 0.359, p<0.01). However it was significantly negatively correlated with sunshine hrs (r= --0.409, p<0.01) and non – significant with morning relative humidity (r= 0.030).

The correlation between spiralling whitefly with weather parameters of preceeding week (Table 7) was found to be highly significant and positively correlated with maximum temperature (r = 0.069, p<0.01), minimum temperature *i.e.* (r =0.523**, p<0.01) morning RH (r = 0.277, p<0.05) afternoon RH (r = 0.536**, p<0.01) and rainfall (r = 0.353, p<0.05), Non significant, positive correlation existed with and wind speed (r = 0.181) but non - significant negative correlation was observed with sunshine hrs (r = -0.537). [2] substantiating that intensive study on the incidence of whitefly family *Aleyrodidae* was Undertaken at monthly intervals and the weather condition was recorded. The incidence of whitefly was maximum in May and June months, it is due to suitable temperatures for whitefly population.

The mean maximum population of blotch miner was observed in the provenance Jabalpur which was recorded 8.41 blotches/leaf and minimum in the provenance Zaheerabad which was recorded as 3.33 blotch/leaf during August to April. Hence, it can be concluded that Jabalpur provenance was more susceptible and Zaheerabad provenance was less susceptible to the attack of leaf blotch miner [6].

Multiple linear regression between incidence of blotch miner and spiralling whitefly with weather parameters of preceding week in Nursery

Multiple linear regression revealed that the weather parameters of preceding week influenced blotch miner and spiralling whitefly incidence to an extent of 70.10 and 56.40 per cent, respectively.

Multiple linear regression between incidence of blotch miner and spiralling whitefly with weather parameters of corresponding week in Nursery

Multiple linear regression revealed that the weather parameters of corresponding week influenced blotch miner and spiralling whitefly incidence to an extent of 71.50 and 51.80 per cent, respectively (Table 9 and 10).

According to [1] the initiation of *Aceria pongamiae* infestation was recorded during February, reaching peak population levels by May. The decline in mite population during June would be reflecting the negative impact of rainfall received by the site. Even though the mites enjoy a highly secluded habitat available within the leaf galls, rainfall exerts an adverse effect by penetrating through the holes into the interior of the gall cavity. But the results of the present study are not in conformity with findings of [1] which could be due to differences in geographical location and variations in the environmental conditions and crop situations.

Acknowledgement

The authors wish to express their heartfelt gratitude to the Indian Council of Agricultural Research, New Delhi, for providing financial support and Dr. N. Srinivasa and Dr. C. Chinnamade Gowda Professors, AINP (Agricultural Acarology), UAS, GKVK, Bengaluru for providing facilities for conducting this investigation and in taking scanning electron micrographs of the mite

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How to cite this article:

Devika Rani, D., D. Jemla Naik and Jagadish, K.S. 2018. Seasonal Incidence of Major Pests of Pongamia (*Milletia pinnata* L.) in Nursery Conditions. *Int.J.Curr.Microbiol.App.Sci.* 7(08): 2337-2350. doi: https://doi.org/10.20546/ijcmas.2018.708.235