The Andhra Agric. J 58(2):185-191, 2011

Seasonal Incidence of Thrips and its Natural Enemies on Chilli (C*apsicum annuum* L.) in Andhra Pradesh

K Vanisree, P Rajasekhar, G Ramachandra Rao and V Srinivasa Rao
Department of Entomology, Agricultural College, Bapatla 522 101 A P

ABSTRACT

The peak incidence of thrips was recorded during 1st standard week *i.e*., (1st week of January) in both the seasons. Among the abiotic and biotic factors, maximum temperature, spiders and ladybird beetles were significant and positively correlated with thrips population while rainfall and evening relative humidity were negatively correlated with thrips population. The peak incidence of spiders was recorded during 51st standard week *i.e*., (3rd week of December) and the peak incidence of ladybird beetles was recorded during first fortnight of December in both the seasons. Regression analysis shown that every increase in number of thrips population there was a corresponding increase of population of spiders and ladybird beetles.

Key words : Abiotic factors, Biotic, Chillies, Thrips and Seasonal incidence

Chilli, C*apsicum annuum* L. the important and indispensable condiment as well as vegetable in every Indian household in the distant past has attained of late, the status of an important commercial crop earning valuable foreign exchange for the country. Chilli is mainly used in culinary for íts pungency and also for flavour and colour. The pungency in chilli is due to alkaloid capsaicin which has high medicinal value and is used in pain balms and cosmetics. Capsanthin, a pigment in chilli used for natural coloration to jams, jellies and squashes, since it is a natural pigment and no harmful or side effects on human health. It prevents the heart diseases by dilating blood vessels (Thamburaj and Singh, 2001).

India has emerged today as the foremost producer and exporter of chillies contributing to almost 1/4th of the world's production. In India, chilli is grown in an area of 8.06 lakh ha, with a production of 12.98 lakh tonnes (Agricultural Statistics at a glance, 2009). The important chilli growing states in India are Andhra Pradesh, Orissa, Maharashtra, Karnataka and also in a number of other states as a round the year crop. In Andhra Pradesh, chilli is cultivated in an area of 1.89 lakh hectares with a production of 2.08 lakh tonnes. Guntur district in Andhra Pradesh alone contributes to over 35 per cent in area under chilli crop in the state ($\geq$60000 hectares in Guntur District)

The important pests are thrips, *Scirtothrips dorsalis* (Hood), white mite, *Polyphagotarsonemus latus* (Banks), aphids, *Aphis gossypii* Glover and *Myzus persicae* Sulzer as sucking complex and tobacco caterpillar, *Spodoptera litura* (Fabricius) and pod borer, *Helicoverpa armigera* (Hubner) as pod borers (Rao and Ahmed, 1985). Chilli thrips, *Scirtothrips dorsalis* (Hood) (Thysanoptera : Thripidae) is a serious pest of *Capsicum annuum* L. in India, responsible for leaf curling (Ananthakrishnan, 1971). It multiplies appreciably at a faster rate during dry weather periods and the yield loss caused by the thrips is reported to range from 30-90 per cent (Borah, 1987 and Varadharajan, 1994).

Studies on seasonal occurrence of thrips on chillies provide information on the initiation and extent of damage at different growth stages of the crop and its relation to weather parameters which will be of great help to plan appropriate management.

MATERIAL AND METHODS

A plot of 200 Sq m of chilly variety LCA-334 was raised by following recommended agronomic practices without any insecticidal protection for two seasons (*kharif* 2008- 09 and *kharif* 2009 -10) at Agricultural College Farm, Bapatla.

Population of thrips and their natural enemies such as ladybird beetles and spiders were recorded from 25 randomly selected plants at weekly interval throughout the crop period. Thrips counts were taken on terminal six leaves. Natural enemies were also recorded on the entire plant. Simultaneously meteorological data was also recorded and correlated with the incidence of thrips population.

To know the relationship between the incidence and weather parameters simple correlation and multiple regression analysis were carried out. The weather parameters of maximum temperature,

minimum temperature, morning, evening relative humidity and rainfall were correlated with the data on the incidence of the thrips population.

RESULTS AND DISCUSSION

Seasonal incidence of thrips

***Kharif* 2008-2009**

The initial incidence of thrips was noticed during 38th standard week with 0.15/leaf, it was observed that its peak population by 1st standard week (1st week of January) with a population of 9.26/ leaf when the average maximum and minimum temperatures were 34.90^{0}C and 26.00^{0}C, respectively and morning and evening relative humidities were 91.71 and 66.43 per cent, respectively. Thereafter, the population declined gradually and reached to the lowest level by 9th standard week (1st week of March*)* with 0.80/leaf when the average maximum and minimum temperatures were 34.43^{0}C and 22.47^{0}C, respectively and morning and evening relative humidities were 89.86 and 72.00 per cent, respectively (Table 1).

The correlation studies revealed that thrips exhibited significant positive correlation with maximum temperature (r = 0.5079), minimum temperature (r = 0.4528), morning relative humidity (r = 0.4107), population of spiders (r = 0.6869) ladybird beetles (r = 0.5287) and negative correlation with evening relative humidity (r = -0.1966) and rainfall (r = -0.2927) (Table 3)

The regression equation obtained was Y**=** -11.7911+0.4969 X_1-0.0160 X_2+0.0876 X_3-0.1398 X_4-0.1706 X_5+1.4792 X_6+4.8360* X_7 which indicated 81.34 per cent variation (R^2 = 0.8134) of thrips population due to the influence of all biotic and abiotic factors (Table 4).

***Kharif* 2009-2010**

The initial incidence of thrips was noticed during 40th standard week (1st week of October) with 0.12/leaf and its peak population by 1st standard week (1st week of January) with a population of 9.02/ leaf when the average maximum and minimum temperatures were 34.60^{0}C and 25.90^{0}C, respectively and morning and evening relative humidities were 89.86 and 69.00 per cent, respectively. Thereafter, the population declined gradually and reached to the lowest level by 9th standard week (1st week of March*)* with 0.80/leaf when the average maximum and minimum temperatures were 32.10^{0}C and 22.24^{0}C, respectively and morning and evening relative humidity were 88.29 and 76.00 per cent, respectively (Table 2).

The correlation studies revealed that the thrips population shown significant positive correlation with maximum temperature (r = 0.6361), spiders (r = 0.6087) ladybird beetles (r = 0.6386) and exhibited negative correlation with evening relative humidity (r = -0.3685) and rainfall (r = -0.3233) (Table 3).

The regression equation obtained was Y**=** -27.0087+0.6420 X_1+0.2079 X_2+0.2159 X_3-0.2002* X_4+0.0072 X_5+0.2021 X_6+3.8434 X_7 which indicated 76.03 per cent variation (R^2 = 0.7603) of thrips population due to the influence of all biotic and abiotic factors (Table 4).

Seasonal incidence of Spiders

***Kharif* 2008-2009**

The initial incidence of spiders was noticed during 37th standard week (2rd week of September) with 0.14/plant when the average maximum and minimum temperatures were 30.70^{0}C and 18.70^{0}C, respectively and morning and evening relative humidities were 72.86 and 67.14 per cent, respectively and rainfall 0.70 mm. Later a gradual increase was observed and attained its peak population by 51st standard week (3rd week of December) with a population of 2.10/plant when the average maximum and minimum temperatures were 34.60^{0}C and 25.30^{0}C, respectively and morning and evening relative humidities were 92.29 and 66.43 per cent, respectively. Thereafter, the population declined gradually and reached to the lowest level by 10th standard week (2nd week of March*)* with 0.02/ plant when the average maximum and minimum temperatures were 32.76^{0}C and 22.14^{0}C, respectively and morning and evening relative humidities were 87.86 and 70.71 per cent, respectively (Table 1).

The correlation studies revealed that maximum temperature (r = 0.2300), evening relative humidity (r = 0.1243) and rainfall (r = 0.2437) exhibited positive correlation with the population of spiders. However, significant positive correlation was found with minimum temperature (r = 0.4837) and morning relative humidity (r = 0.4755) (Table 3).

The regression equation obtained was Y**=** -0.1140-0.1085 X_1+0.1091 X_2+0.0195 X_3-0.0040 X_4+0.0467 X_5+0.1342* X_6 which indicated 76.70 per cent variation (R^2 = 0.7670) in the population of spiders due to the influence of all biotic and abiotic factors. The partial regression coefficient (b = 0.1342) for thrips was significant and positively correlated with the population of spiders. Therefore, it was evident that every increase in number of thrips population, there was a corresponding increase of 0.1342 population of spiders (Table 4).

Table 1. Incidence of thrips and natural enemies during crop growth period in relation to abiotic factors during *kharif* 2008-2009

Std. week	Max. Temp.(°C)	Min. Temp.(°C)	Morn. RH (%)	Evng. RH (%)	Rain-fall (mm)	Thrips (Mean. No. of thrips per leaf)	Spiders (No. per plant)	Ladybird beetles (No. per plant)
37	30.70	18.70	72.86	67.14	0.70	0.00	0.14	0.10
38	31.60	20.20	72.14	70.71	0.30	0.15	0.21	0.24
39	32.90	21.70	74.57	61.14	1.30	3.20	0.27	0.35
40	33.40	23.10	76.29	75.71	0.90	5.20	0.29	0.33
41	33.60	24.10	78.86	65.57	0.00	6.29	0.45	0.48
42	33.80	20.20	86.00	80.14	4.30	4.28	0.55	0.52
43	34.00	21.80	82.86	72.14	6.10	7.42	0.67	0.55
44	33.90	20.20	79.43	54.86	0.00	7.00	0.97	0.59
45	34.10	23.20	87.86	68.57	0.00	8.32	1.31	0.71
46	29.70	18.70	88.29	79.57	8.60	2.56	1.50	0.85
47	34.30	23.10	90.71	77.00	0.20	8.64	1.49	0.94
48	28.50	21.70	88.71	82.71	22.20	1.25	1.66	0.97
49	34.30	24.10	92.57	77.71	0.00	8.90	1.59	1.16
50	34.40	24.20	91.43	68.71	0.00	8.92	1.87	0.85
51	34.60	25.30	92.29	66.43	0.00	9.03	2.10	0.55
52	34.70	25.50	89.29	68.14	0.00	9.11	1.98	0.36
1	34.90	26.00	91.71	66.43	0.00	9.26	1.39	0.43
2	29.90	18.19	88.29	58.57	0.00	6.65	0.89	0.46
3	30.10	16.67	91.86	61.29	0.00	6.48	0.86	0.36
4	30.10	16.59	92.00	71.29	0.00	6.21	0.75	0.65
5	30.69	18.43	91.71	75.86	0.00	5.28	0.56	0.79
6	30.56	19.09	93.00	70.00	0.00	5.24	0.48	0.29
7	31.16	18.86	88.86	64.29	0.00	3.20	0.39	0.20
8	32.09	18.93	91.00	71.00	0.00	2.10	0.10	0.08
9	34.43	22.47	89.86	72.00	0.00	0.80	0.08	0.06
10	32.76	22.14	87.86	70.71	0.00	0.00	0.02	0.006

***Kharif* 2009-2010**

The initial incidence of spiders was noticed during 38th standard week (3rd week of September) with 0.28/plant when the average maximum and minimum temperatures were 28.20°C and 20.90°C, respectively and morning and evening relative humidities were 77.43 and 66.14 per cent, respectively and the rainfall was 0.10 mm. A gradual increase was observed reaching its peak population by 51st standard week (3rd week of December) with a population of 2.34/plant when the average maximum and minimum temperatures were 29.70°C and 19.70°C, respectively and morning and evening relative humidities were 92.00, 72.43 per cent, respectively and rainfall 0.70 mm. Thereafter, the population declined gradually and reached to the lowest level by 10th standard week (2nd week of March) with 0.07/plant when the average maximum and minimum temperatures were 32.84°C and 23.17°C, respectively and morning and evening relative humidities were 88.14 and 79.14 per cent, respectively (Table 2).

The correlation studies revealed that all the weather parameters except rainfall (r = -0.0322) exhibited positive correlation with the population of spiders. However, significant positive correlation was found with maximum temperature (r = 0.4125) (Table 3).

Table 2. Incidence of thrips and natural enemies during crop growth period in relation to abiotic factors during *kharif* 2009-2010

Std. week	Max. Temp.(°C)	Min. Temp.(°C)	Mom. RH (%)	Evng. RH (%)	Rain-fall (mm)	Thrips (Mean. No. of thrips per leaf)	Spiders (No. per plant)	Ladybird beetles (No. per plant)
38	28.20	20.90	77.43	66.14	0.10	0.00	0.28	0.23
39	30.20	20.70	83.57	75.71	13.80	0.00	0.33	0.30
40	30.60	20.90	76.71	71.14	0.40	0.12	0.39	0.47
41	29.20	22.80	82.00	74.43	0.10	0.08	0.44	0.53
42	31.90	24.20	80.86	67.86	0.00	7.40	0.59	0.59
43	32.60	23.50	78.43	52.86	0.00	7.98	0.58	0.64
44	33.20	23.90	83.43	71.29	0.10	8.08	1.07	0.70
45	29.80	23.00	92.14	88.14	9.60	3.26	1.03	0.71
46	33.60	24.30	90.29	86.71	3.80	8.26	1.47	0.78
47	29.90	23.50	91.57	88.29	7.70	1.65	1.55	0.82
48	34.00	24.80	85.57	68.29	0.00	8.49	1.75	0.94
49	33.40	19.20	90.57	74.57	0.00	7.10	1.88	1.12
50	34.10	25.10	88.57	69.71	0.00	8.57	1.65	1.31
51	29.70	19.70	92.00	72.43	0.70	3.26	2.34	1.03
52	34.30	25.20	83.14	63.71	0.00	8.94	2.08	0.86
1	34.60	25.90	89.86	69.00	0.00	9.02	1.75	0.64
2	29.83	20.47	91.71	76.29	0.47	6.65	1.26	0.43
3	30.47	20.67	91.86	75.14	1.80	2.65	0.94	0.51
4	29.81	16.53	92.43	61.71	0.00	7.26	0.97	0.85
5	30.14	18.36	91.14	63.86	0.00	6.59	0.67	0.65
6	30.06	17.03	91.43	62.71	0.00	5.24	0.57	0.36
7	30.36	18.63	88.86	70.00	0.00	3.20	0.48	0.21
8	31.64	21.01	91.57	71.43	0.00	2.10	0.43	0.11
9	32.10	22.24	88.29	76.00	0.00	0.80	0.08	0.02
10	32.84	23.17	88.14	79.14	0.00	0.00	0.07	0.00

The regression equation obtained was Y= -3.1579-0.0390 X_1+0.0471 X_2+0.0287 X_3+0.0171 X_4-0.0002 X_5+0.1306* X_6 which indicated 51.40 per cent variation (R^2 = 0.5140) in the population of spiders due to the influence of all biotic and abiotic factors. The partial regression coefficient (b = 0.1306) for thrips was significant and positively correlated with the population of spiders. Therefore, it was evident that every increase in number of thrips population, there was a corresponding increase of 0.1306 population of spiders (Table 4).

Seasonal incidence of Ladybird Beetles
***Kharif* 2008-2009**

The initial incidence of ladybird beetles was noticed during 37th standard week (2rd week of September) with 0.10/plant and a gradual increase was observed reaching its peak population by 49th standard week (1st week of December) with a population of 1.16/plant when the average maximum and minimum temperatures were 34.30°C and 24.10°C, respectively and morning and evening relative humidities were 92.57 and 77.71 per cent,

Table 3. Simple correlation between *Scirtothrips dorsalis* (Hood) and certain biotic and abiotic factors on chilli

2008-09	Thrips	spiders	Ladybird beetles	Max temp	Min.temp	RHI	RHII	RF
Thrips	1.0	0.6869*	0.5287*	0.5079*	0.4528*	0.4107*	-0.1966	-0.2927
Spiders		1.0	-	0.2300	0.4837*	0.4755*	0.1243	0.2437
Ladybird beetles			1.0	0.0175	0.1871	0.3280	0.4063*	0.3753
2009-10	Thrips	spiders	Ladybird beetles	Max temp	Min.temp	RHI	RHII	RF
Thrips	1.0	0.6087*	0.6386*	0.6361*	0.2746	0.1479	-0.3685	-0.3233
Spiders		1.0	—	0.4125*	0.2765	0.3462	0.1007	-0.0322
Ladybird beetles			1.0	0.3387	0.2164	0.1564	-0.0412	-0.0153

*Significant at 5% level

Table 4. Multiple linear regression analysis of *Scirtothrips dorsalis* (Hood) on certain biotic and abiotic factors on chilli

2008-2009	Regression equation	R^2
Thrips	$Y=-11.7911+0.4969\ X_1-0.0160\ X_2+0.0876\ X_3-0.1398\ X_4-0.1706\ X_5+1.4792\ X_6+4.8360^*\ X_7$	0.8134
Spiders	$Y=-0.1140-0.1085\ X_1+0.1091\ X_2+0.0195\ X_3-0.0040\ X_4+0.0467\ X_5+0.1342^*\ X_6$	0.7670
Ladybird beetles	$Y=0.3342-0.0276\ X_1-0.0116\ X_2-0.0063\ X_3+0.0194^*\ X_4+0.0217\ X_5+0.0873^*X_6$	0.7103
2009-2010	Regression equation	R^2
Thrips	$Y=-27.0087+0.6420\ X_1+0.2079\ X_2+0.2159\ X_3-0.2002^*\ X_4+0.0072\ X_5+0.2021\ X_6+3.8434\ X_7$	0.7603
Spiders	$Y=-3.1579-0.0390\ X_1+0.0471\ X_2+0.0287\ X_3+0.0171\ X_4-0.0002\ X_5+0.1306^*\ X_6$	0.5140
Ladybird beetles	$Y=0.9595-0.0337\ X_1+0.0011\ X_2-0.0055\ X_3+0.0101\ X_4+0.0087\ X_5+0.0881^*X_6$	0.4808

X_1 -Maximum Temperature, X_2 - Minimum Temperature, X_3 – RHI, X_4 -RHII, X_5 –Rainfall, X_6- Spiders, X_7- Ladybird beetles

respectively. Thereafter, the population declined gradually and reached to the lowest level by 10th standard week (2nd week of March) with 0.006/plant when the average maximum and minimum temperatures were 32.76°C and 22.14°C, respectively and morning and evening relative humidities were 87.86 and 70.71 per cent, respectively (Table 1).

The correlation studies revealed that all the weather parameters exhibited positive correlation with the population of ladybird beetles. However, significant positive correlation was found with evening relative humidity (r = 0.4063) (Table 3).

The regression equation obtained was $Y= 0.3342-0.0276\ X_1-0.0116\ X_2-0.0063\ X_3+0.0194^*\ X_4+0.0217\ X_5+0.0873^*\ X_6$ which indicated 71.03 per cent variation (R^2 = 0.7103) in the population of ladybird beetles due to the influence of all biotic and abiotic factors (Table 4).

***Kharif* 2009-2010**

The initial incidence of ladybird beetles was noticed during 38th standard week (3rd week of September) with 0.23/plant and a gradual increase was observed reaching its peak population by 50th standard week (2rd week of December) with a

population of 1.31/plant when the average maximum and minimum temperatures were 34.10^{0}C and 25.10^{0}C, respectively and morning and evening relative humidities were 88.57 and 69.71 per cent, respectively. Thereafter, the population declined gradually and reached to the lowest level by 9th standard week (1st week of March) with 0.02/plant when the average maximum and minimum temperatures were 32.10^{0}C and 22.24^{0}C, respectively and morning and evening relative humidities were 88.29 and 76.00 per cent, respectively (Table 2).

The correlation studies revealed that all the weather parameters except evening relative humidity (r = -0.0412) and rainfall (r = -0.0153) exhibited positive correlation with the population of ladybird beetle (Table 3).

The regression equation obtained was Y**=** 0.9595-0.0337 X_1+0.0011 X_2-0.0055 X_3+0.0101 X_4+0.0087 X_5+0.0881* X_6 which indicated 48.08 per cent variation (R^2 = 0.4808) in the population of ladybird beetle due to the influence of all biotic and abiotic factors (Table 4).

The incidence of thrips was observed from second fortnight of September to the end of February and the peak incidence was observed in the month of December and January in both the seasons. The present findings are in support with Lingeri *et al*. (1998) and Bindu and Patel (2001) who reported the peak incidence of thrips in the month of December and January. However, Patel *et al*. (2009) reported that the peak incidence of thrips during November and February to March. This variation in thrips population might be due to the geographical location and the variety grown. The correlation analysis showed significant positive correlation with maximum temperature and minimum temperature during 2008-2009, while maximum temperature showed significant positive correlation during 2009-2010 and negative correlation with rainfall in both the years. This is in accordance with Varadharajan and Veeravel (1995), Duraimurugan and Jagadish (2002) and Patel *et al*. (2009) who reported significant positive correlation of thrips with maximum temperature and negative correlation with rainfall.

The population of spiders was observed throughout the crop growth with the peak activity during second fortnight of December during both the seasons coinciding with the peak incidence of thrips. However, Soujanya (2008) reported that the peak incidence of spiders from mid October to mid November, while SrinivasaRao and Rao (2008) reported it during the second week of December. The correlation analysis showed that the influence of weather factors on spider population was varying in both the seasons. Minimum temperature and morning relative humidity showed significant positive influence during 2008-2009, while maximum temperature showed significant positive influence on the population of spiders during 2009-2010. The present findings are in accordance with Kavitha *et al*. (2003) who reported significant positive correlation between maximum temperature and incidence of spiders.

The incidence of ladybird beetles was observed throughout the crop growth with the peak activity during first fortnight of December during both the seasons coinciding with the peak incidence of thrips. However, Soujanya (2008) reported that the peak incidence of coccinellids from mid October to mid November. The correlation analysis showed that the influence of weather factors on population of ladybird beetles was varying in both the seasons. Evening relative humidity showed significant positive influence during 2008-2009. The present findings are in accordance with Soujanya (2008) who reported significant positive correlation between evening relative humidity and incidence of ladybird beetles.

The present study revealed that thrips population inturn encouraged the buildup of natural enemies which was evident in terms of significant and positive relationship between the thrips and natural enemies.

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(Received on 21.03.2011 and revised on 21.04.2011)