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Seasonal Incidence of Major Pest Complex and Natural Enemies of Chilli in Relation to Meteorological Parameters in Jabalpur Condition

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ABSTRACT

A field experiment was conducted during winter season 2009-2010. The results revealed that the infestation and severity of insect pests and beneficials were highly influenced by weather parameters .Six species of insect pests and two species of Coleopteran natural enemies and one aphid parasitoid was observed. The natural enemies are associated with seasonal occurrence of sucking pests like whitefly, thrips, aphids and borers at various stages of the chilli crop at Jabalpur, Madhya Pradesh in Central India.

Keywords Chilli pest complex, Correlation, Standard meteorological week (SMW), Weather parameter.

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INTRODUCTION

Chilli, *Capsicum annuum* L. (2n=24) is one of the important cach crops grown in almost all parts of the country. It is commonly used as condiments; India is a major producer, exporter and consumer of chilli . The area of chilli in the country is 794 thousand hectares and in Madhya Pradesh is 54.41 thousand hectare with an annual production of 1304 and 93.57 metric tones and productivity of 1.6 and 1.71 metric tonnes/ha as respectively (Anonymous 2013).

In Madhya Pradesh, major producing districts are Khargone, Dhar, Khandwa,Indore, and Betul (Anonymous 2010). The area is high whereas, production and productivity is less significant. Although there are number of factors responsible for depressing the yield of chilli but incidence of various insect pests is one of major bottlenecks of production.

The insect pests which cause significant damage to the crop are comprises of more than 39 genera and 51 species of insects and mite species in the field as well as in the storage (Hosamani et al. 2005). Till date 55 (insect and non-insect) pests are reported to infest chilli crop (Jadhav et al. 2004).

During study correlation between various abiotic factors and thrips population were found to be significant positive correlation with maximum and minimum temperature, wind speed similar findings reported by Varadharajan and Veeravel (1995) and evaporation. Significant negative correlation with percentage morning and evening relative humidity has been found with conformity of the findings of Panickar and Patel (2001), Patel et al. (2009), Barot et al. (2012). On the contrary Shukla (2006) reported population trend of *S. dorsalis* not indicate strong correlation with temperature and relative humidity.

In light of these facts and changing scenario of pest complex in relation to weather parameters were planned to study insect pests and their natural enemies associated with chilli crop ecosystem.

MATERIALS AND METHODS

Succession of insect pests and their natural enemies were studied on chilli genotype MHCP-370. Crop was raised following all recommended agronomic practices. Seedling at 3-4 leaved stage were transplanted in plot of size 72 sq m with spacing 50 cm × 45 cm during last week of October. The sequence in which the pests and natural enemies appeared was noted on 25 tagged plants, from seven days after transplanting. For sucking pest complex (whitefly,thrips, aphids and jassids) nymphs and adults population were recorded on six leaves (two each from bottom, middle and top) of each plant whereas borer complex were recorded on whole plant. Observations were recorded twice in a standard week. The crop was kept unprotected for this purpose.

RESULTS AND DISCUSSION

For conducting studies on population dynamics of major insect pests and their natural enemies the experimental details were as follows.

Whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera : Aleyrodidae)

Whitefly was first recorded during the first week of November i.e. during the 45th standard week (SW) and reached at its peak (4.88 whitefly / 2 leaves) during 49th SW (i.e. first week of December). After 49th SW there was a gradual decline in the whitefly population with slight fluctuation in the 52nd SW (1.03 whitefly/2 leaves) and reached minimum (0.37 whitefly/2 leaves) during 3rd SW. After 3rd SW there was an increase in the whitefly population and it attained 2nd peak during 7th SW (2.53 whitefly/2 leaves). After that decline in the whitefly population and were disappeared during the 12th SW. Findings nearly similar with Meena et al. (2013) *B. tabaci* appeared on chilli soon after transplanting and reached its peak during 1st week of September. After 13th SW whitefly population (0.45 whitefly/2 leaves) again appeared and active up to 14th SW. Similar findings, reported *B. tabaci* as the predominant species and maximum mean number of whitefly population (5.49/leaf) in the summer season crop (Kethran et al. 2014). Correlation between various abiotic factors and whitefly population on chilli crop were found to be non-significant is similar with findings of Khalid et al. (2009) revealed that the environmental factors namely, rainfall ($r = -0.186$, $p > 0.05$), sunshine duration ($r = 0.156$, $p > 0.05$) and relative humidity ($r = -0.443$, $p > 0.05$) had no significant role on the abundance of alate whitefly.

Chilli thrips, *Scirtothrips dorsalis* (Hood.) (Thysanoptera : Thripidae)

Thrips was first recorded on crop during the second week of November (46th) SW. The activity of the pest continued from the incidence to first week of April with similar finding of Patel et al. (2009) that thrips observed from the first week of September until harvesting (February to March) and (Barot et al. 2012) stated that incidence started from one week after transplanting (35th standard week) and remained in field till maturity of the crop (3rd week of February) in the range of 0.50 to 10.54 with an average of 4.37 thrips/twig. Thrips population reached its first peak (2.22 thrips/2 leaves) during 48th SW. Rai et al. (2009) findings nearly similar that incidence of thrips, *S. dorsalis* on chilli found to persist from 2nd week of September to first week of November with being maximum (2 thrips/three terminal leaves) and another researchers reported, peak period was in November (4.99 to 5.54 thrips/leaf) and February to March (5.29 to 7.38 thrips/leaf) (Patel et al. 2009, Lingeri et al. 1998).

Thrips population decline with slight fluctuation in the 52nd SW (0.55 thrips/2 leaves). After that there was a decline and reached minimum (0.08 thrips/2 leaves) during 4th SW. After 4th SW thrips attained 2nd peak during 11th SW (1.63 thrips/2 leaves) and

Table 1. Incidence of pest complex and natural enemies on chilli at Jabalpur during 2009-2010.

Standard weeks	Insect pests and natural enemies: Mean population of (adult and nymph) of sucking pest complex / 2 leaves / plant				Mean population of larvae /plant		Mean population of grub and adult / plant	% parasitized aphids by unknown parasitoid
	Whitefly	Thrips	Aphids	Jassids	*H. armigera*	*S. litura*	Lady bird beetle (*C. septempunctata* and *M. sexmaculatus*)	
45	0.33	0.00	0.00	0.00	-	-	-	-
46	0.63	0.00	0.00	0.00	-	-	-	--
47	1.02	0.55	0.00	0.00	-	-	-	-
48	1.05	2.22	1.48	0.00	-	-	-	-
49	4.88	1.63	0.85	0.00	-	-	-	-
50	1.97	1.62	1.12	0.00	-	-	-	-
51	0.67	0.40	0.93	0.00	-	-	-	-
52	1.03	0.55	1.45	0.00	-	-	-	-
1	0.62	0.42	0.98	0.00	0.00	0.00	1.50	0.00
2	0.42	0.52	0.87	0.00	0.00	0.00	2.00	0.00
3	0.37	0.23	1.25	0.00	0.00	0.00	1.50	0.00
4	0.57	0.08	2.85	0.00	0.00	0.00	2.50	20.47
5	1.03	0.47	3.55	0.00	0.00	0.00	7.50	28.28
6	2.27	0.38	4.48	0.00	0.00	0.00	19.50	38.16
7	2.53	0.33	5.03	0.00	0.00	0.00	24.50	50.97
8	1.75	0.15	3.97	0.00	0.00	0.00	86.50	52.78
9	0.73	0.45	7.17	0.00	4.50	0.00	68.00	57.76
10	0.43	0.83	4.17	0.08	12.50	0.00	26.00	71.91
11	0.17	1.63	0.53	0.22	13.00	1.50	2.00	78.08
12	0.00	1.50	0.00	0.28	2.50	6.00	2.00	100.00
13	0.00	4.30	0.00	0.28	4.00	3.00	0.00	0.00
14	0.45	2.50	0.00	0.35	0.00	0.00	0.00	0.00

it attained 3rd peak during 13th SW (4.30 thrips/2 leaves). Findings are similar with Patel et al. (2009) and against with Shukla (2006) he reported the peak activity (3.32 thrips/twig) was observed during 9th SW. Positive correlation with maximum and minimum temperature, wind speed and evaporation. The present findings are in agreement with Varadharajan and Veeravel (1995) and on the contrary of Panickar and Patel (2001), Barot et al. (2011) who reported maximum temperature had negative effect on thrips population.

In the present study significant negative correlation with percentage morning and evening relative humidity has been found, these findings are in conformity with Panickar and Patel (2001), Bhede et al. (2008), Patel et al. (2009), Barot et al. (2012), Pathipati et al. (2014). On the contrary Shukla (2006) reported population trend of *S. dorsalis* not indicate strong correlation with temperature and relative humidity.

Correlation studies Tables 1 and 2 and Figs. 1— 4.

Correlation studies revealed that maximum and minimum temperature, wind speed and evaporation showed significant positive correlation (r = 0.67, 0.67, 0.57, 0.71 and 0.72 respectively) with thrips population. The regressions equations being: Y = -2.75 + 0.13x (R^2 = 0.47), Y = -0.86 + 0.17x (R^2 = 0.45), Y=-0.30 + 0.57x (R^2= 0.33), Y = -0.24 + 0.40x (R^2 = 0.51) respectively. The equations it expressed that with every unit increase in maximum and minimum temperature, wind speed and evaporation there was an increase of 0.13, 0.17, 0.57 and 0.40 thrips per 2 leaves respectively.

Correlation studies further revealed that percentage morning and evening relative humidity showed significant negative correlation (r = -0.76 and -0.55 respectively) with thrips population. The regressions equations being : Y = 5.79 - 0.06x (R^2 = 0.58), Y = 2.59 - 0.05x (R^2 = 0.30) respectively. From the

Table 2. Correlation (r) and regression coeficient (byx) of abiotic factors on chilli pest complex and natural enemies (2009-10). *Significant at 5% level, **Significant at 1% level, NS= Non-significant.

Weather factors	Sucking pest complex							
	Whitefly		Thrips		Aphid		Jassid	
	r	byx	r	byx	r	byx	r	byx
Max temp ^{0}C	-0.20 NSs	-	0.67**	3.58	0.48 NS	-	0.95	0.03
Min temp ^{0}C	-0.27 NS	-	0.67*	2.73	0.41 NS	-	0.65 NS	-
Sunshine (h)	-0.28 NS	-	0.26 NS	-	0.14 NS	-	0.26NS	-
Rainfall (mm)	-0.15 NS	-	-0.20 NS	-	-0.38NS	-	-0.15 NS	-
% Morning R. H	0.30 NS	-	0.76*	-0.06	-0.59	-0.20	-0.65 NS	-
% Evening R. H	0.14 NS	-	-0.55*	-0.05	-0.60	-0.12	-0.95	-0.01
Wind speed (km/h)	-0.39 NS	-	0.57**	0.58	0.22 NS	-	0.51 NS	-
Morn vapor pressure (mm)	-0.01.NS	-	0.25 NS	-	0.11 NS	-	-0.51 NS	-
Even vapor pressure (mm)	0.16 NS	-	-0.28 NS	-	-0.33 NS	-	-0.81 NS	-
Evaporation (mm)	-0.32 NS	-	0.72**	0.40	0.56	1.17	0.85 NS	-
Rainy days	-0.19 NS	-	-0.15 NS	-	-0.45	-	-0.15 NS	-

Table 2. Continued.

Weather factors	Lepidopteran borer				Natural enemies			
	H. armigera		*S. litura*		Lady bird beetle		% parasitized aphids	
	r	byx	r	byx	r	byx	r	byx
Max temp ^{0}C	-0.90	-0.17	-0.95 NS	-	0.23 NS	-	0.97	5.64
Min temp ^{0}C	-0.80 NS	-	-0.90 NS	-	0.12 NS	-	0.88	8.21
Sunshine (h)	0.52 NS	-	-0.38 NS	-	0.28 NS	-	0.42 NS	-
Rainfall (mm)	-0.37 NS	-	0.87 NS	-	-0.26 NS	-	0.22 NS	-
% Morning R.H	0.64 NS	-	0.99 NS	-	-0.16 NS	-	-0.90	-3.06
% Evening R. H	0.75 NS	-	0.91 NS	-	-0.34 NS	-	-0.86	-2.97
Wind speed (km/h)	-0.68 NS	-	-0.81 NS	-	-0.02 NS	-	0.61 NS	-
Morn vapor pressure (mm)	-0.26 NS	-	1.00 NS	-	0.19 NS	-	0.79	12.04
Even vapor pressure (mm)	0.44 NS	-	0.94 NS	-	-0.05 NS	-	-0.10 NS	-
Evaporation (mm)	-0.76 NS	-	-1.00 NS	-	0.17 NS	-	0.96	19.84
Rainy days	-0.37 NS	-	0.87 NS	-	-0.30 NS	-	0.34 NS	-

equations, it may be expressed that with every unit increase in percentage morning and evening relative humidity there was a decrease of 0.06 and 0.05 thrips per 2 leaves respectively. Correlation studies further revealed that sunshine and morning vapor pressure exhibited positive correlation (r = 0.26 and 0.25 respectively); further, rainfall, evening vapor pressure and rainy days exhibited negative correlation (r = -0.20, -0.28 and -0.15 respectively), but statistically non-significant with thrips population.

Aphid, *Aphis gossypii* (Glover) (Hemiptera : Aphididae)

Aphid, was first recorded on the crop during third week of November i. e. during the 47th SW. The activity of the pest continued to second week of March started decreasing from 48th SW there was a gradual decline in the aphid population with slight fluctuation (1.45 aphid/2 leaves) in the 52nd SW and reach minimum (0.85 aphid/2 leaves) during 2nd SW and

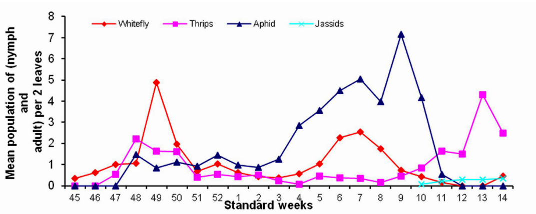

Fig. 1. Incidence of sucking pest complex on chilli at Jabalpur during 2009-2010.

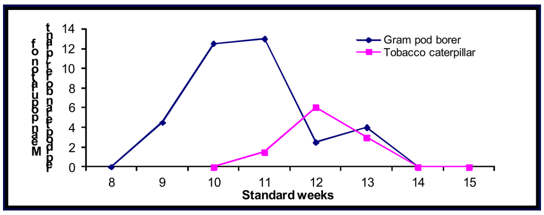

Fig. 2. Incidence of Lepidopteran borer complex on chilli at Jabalpur during 2009-10.

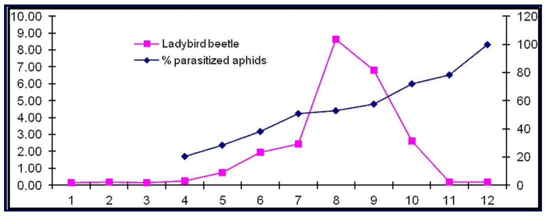

Fig. 3. Occurrence of natural enemies on chilli at Jabalpur during 2009-10.

reached at its peak (7.16 aphid/2 leaves) during 9th SW and attained second peak (7.17 aphid/ 2 leaves) in 11th SW. The present findings have similar with Meena et al. (2013) who reported aphid to be most active on chilli during September-October 2006-07 and 2007-08. The population declined from mid-May to the end of June on chilli, due to high temperatures (40-45 ^{0}C). Our results are inconsults with (Mani and Krishnamoorthy 2004) who reported that highest aphid population was recorded during the first fortnight of February followed by last two weeks of January. The aphid however was found to damage the crop during entire growth period.

Correlation between various abiotic factors and aphid population were found to be non-significant except evaporation and morning and evening relative humidity which had significant positive and negative influence on the pest population respectively. Which show every unit increase similarly increase of 1.17 aphids and decrease of 0.20 and 0.12 aphids per 2 leaves respectively.

Correlation studies

Correlation studies revealed that evaporation showed significant positive correlation (r = 0.56), with aphid population. The regression equation is : Y = -0.46 + 1.17x (R^2 = 0.31).

From the above equations it may be expressed that with every unit increase in evaporation there was an increase of 1.17 aphids per 2 leaves respectively. Correlation studies further revealed that percentage morning and evening relative humidity showed significant negative correlation (r = -0.59 and -0.60 respectively) with aphid population and the regression equations being: Y = 20.67-0.20x (R^2 = 0.34), Y = 6.88 - 0.12x (R^2 = 0.35) respectively.

From the above equations, it may be expressed that with every unit increase in percentage morning and evening relative humidity there was a decrease of 0.20 and 0.12 aphid per 2 leaves respectively. Correlation studies further, revealed that maximum and minimum temperature, sunshine, wind speed and morning vapor pressure were exhibited positive correlation (r = 0.48, 0.41, 0.14, 0.22 and 0.11), but statistically non-significant.

Further rainfall, evening vapor pressure and rainy days exhibited negative correlation (r = -0.38, -0.33

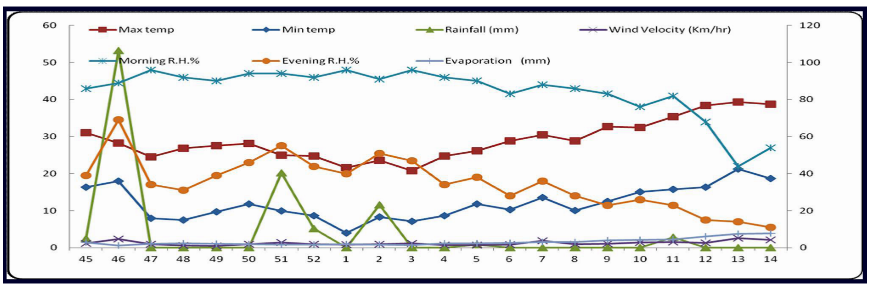

Fig. 4. Weekly meteorological data of Maharajpur field, JNKVV, Jabalpur, MP, 2009-2010.

and -0.45 respectively) with aphid population, but found to be non-significant.

Jassid, *Amrasca bigutula* (Ishida) (Hemiptera : Cicadellidae)

The jassid population was first recorded on crop during the fourth week of February i.e. during the 9th SW. The activity of the pest continued from fourth week of February to first week of April and reached at its peak (0.35 jassid/2 leaves) during 14th SW. Finding are similar (Baloch et al. 1994) that incidence and abundance of jassids on chilli in the summer season.

Correlation studies

Correlation between various abiotic factors and jassid population were found to be non-significant except maximum temperature and percentage evening relative humidity which had significant positive and negative influence (r = 0.95; r = -0.95) on the pest population and the regression equation being: Y = -0.96 + 0.03x (R^2 = 0.89), Y = 0.50 - 0.01x (R^2 = 0.89) respectively.

From the above equations it may be expressed that with every unit increase in maximum temperature, there was an increase of 0.03 jassid population and every unit increase in percentage evening relative humidity there was a decrease of 0.01 jassid per 2 leaves.

Gram pod borer, *Helicoverpa armigera* (Hubner.) (Lepidoptera : Noctuidae)

The gram pod borer was first recorded during the fourth week of February i.e. during the 9th SW. The activity of the pest continued from fourth week of February to fourth week of March and reached at its peak (12.5 larvae/plant) during 11th SW. Correlation between various abiotic factors and gram pod borer population was found to be non-significant except maximum temperature showed significant negative correlation with the larval population. On the contrary Nadaf and Kulkarni (2006) found maximum temperature had positive significant correlation with larvae of *H. armigera.*

Correlation studies

Correlation studies revealed that maximum temperature showed significant negative correlation (r = -0.90) with the larval population and equation Y = 6.70 - 0.17x (R^2 = 0.82).

From the equation, it may be expressed that with every unit increase in maximum temperature there was a decrease of 0.17 larval populations per plant.

Tobacco caterpillar, *Spodoptera litura* (Fab.) (Lepidoptera : Noctuidae)

The tobacco caterpillar was first recorded on crop during the second week of March i.e. during the 11th SW. The activity of the pest continued from second week of March to third week of March and reached at its peak (6.0 larvae per plant) during 12th SW. Correlation between various abiotic factors and tobacco caterpillar population were found to be non-significant.

Ladybird beetle complex, *Menochilus sexmaculatus* (Fab.) and *Coccinella septempunctata* (Linn.) (Coleoptera : Coccinellidae)

The beetle complex was first recorded on crop during the first week of January i.e. during the 1st SW. The activity of the pest continued from first week of January to third week of March and reached at its peak (8.65 beetle complex per plant) during 8th SW and similar findings reported by Varma et al. (2010) coccinellids appeared in first week of December peaked at first week of January (1.51 coccinellid/leaf) during 2004-05 and fourth week of November reached its peak fifth standard week in February (4.02 coccinellid/leaf) during 2005-06. Correlation between various abiotic factors and coccinellid population was found to be non-significant.

Further correlation studies between coccinellid complex (grub and adult) and aphid (nymphs and adult) population found positive correlation (r = 70). Y = -0.61 + 0.91x (R^2 = 0.49), it may be expressed that with every unit increase in aphid (nymphs and adult) population, there was an increase of 0.91 beetle complex (grub and adult) per plant.

Unknown parasitoid on aphid

The parasitized aphid was first recorded in crop during the fourth week of January i.e.during the 4th SW continued up to third week of March and reached at its peak (100% parasitized aphid population) during 12th SW. Correlation studies revealed that maximum and minimum temperature, morning vapor pressure and evaporation showed significant positive correlation (r=0.97, 0.88, 0.79 and 0.96) respectively with percent aphid parasitization and regression equations being : $Y = -118.66 + 5.64x$ ($R^2 = 0.95$), $Y = - 48.68+ 8.21x$ ($R^2 = 0.78$), $Y = -64.21 + 12.04x$ ($R^2 = 0.62$), $Y = -15.173 + 19.84x$ ($R^2 = 0.93$) respectively.

From the equations it expressed that with every unit in maximum and minimum temperature,morning vapor pressure and evaporation increase there was an increase of 5.64, 8.21, 12.04 and 19.84% parasitized aphid population respectively.

Further correlation studies revealed that percentage morning and evening relative humidity showed significant negative correlation (r = -0.90 and -0.86 respectively) with percent parasitized aphid population. $Y = 309.41 - 3.06x$ ($R^2 = 0.81$), $Y = 138.09 -2.97x$ ($R^2 = 0.74$) respectively, from the equation, it may be expressed that with every unit increase in percentage morning and evening relative humidity there was a decrease of 3.06 and 2.97% parasitized aphid population respectively.

Further correlation studies, revealed that aphid (nymphs and adult) population were negative correlation (r = -47) with percent parasitized aphid population, but statistically found to be non-significant.

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