Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2020; 8(1): 870-874

Received: 01-11-2019
Accepted: 05-12-2019

Rajesh Aarwe
Department of Entomology College of Agriculture, Jabalpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Abhishek Shukla
Department of Entomology College of Agriculture, Jabalpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Rakesh Bajpai
Department of Forestry College of Agriculture, Jabalpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

AK Bhowmick
Department of Entomology College of Agriculture, Jabalpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

RB Singh
Department of Mathematics and Agril. Statistics, College of Agriculture, Jabalpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Rajesh Aarwe
Department of Entomology College of Agriculture, Jabalpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Seasonal incidence of insect pests and abundance of natural enemies in chilli crop

Rajesh Aarwe, Abhishek Shukla, Rakesh Bajpai, AK Bhowmick and RB Singh

Abstract
The present investigations were carried out at farmers' fields, Jabalpur, Madhya Pradesh (Central India) during *Rabi* 2017-18 and 2018-19 growing season. Regular weekly observations were recorded in chilli crop on farmers' fields, at four locations, during both the years. Major insect pests to attack the crop in vegetative stage were whiteflies, *Bemisia tabaci* (Gennadius), thrips, *Scirtothrips dorsalis* Hood, and jassids, *Amrasca biguttula biguttula* (Ishida), which were observed till maturity of the crop. Mites, *Polyphagotarsonemus latus* (Banks), attacked in late vegetative stage and fruit-borers, *Helicoverpa armigera* Hubner in fruiting stage of the crop. The *Coccinella transversalis* Fabricius, predator was present on the crop from the vegetative stage till the crop maturity stage. Pooled peak activity of whiteflies was recorded in standard meteorological week (SMW) # 2 (2.98 individuals/ 10 cm twig), while in thrips it was 2.54 individuals per sample during SMW # 16, in jassids SMW # 10 (5.25 individuals/ 10 cm twig), peak population of mites (1.27 / leaf) during SMW # 10, in fruit borer SMW # 12 (1.2 larvae/ plant). Peak activity of ladybird beetle was recorded in SMW # 11 (3.01 beetles/ plant).

Keywords: Chilli, whiteflies, thrips, jassids, mites, fruit borer

Introduction
Chilli (*Capsicum annuum* L.) belonging to family Solanaceae is one of the important spices cum vegetable crops of India and is being widely cultivated throughout warm temperate, tropical and subtropical countries.

It is grown throughout the year as a cash crop and pods are used in fresh green stage, eaten raw in salad or as cooked vegetable. Red ripe dried stage is known for its pleasant aromatic flavour, pungency and high colouring substance. Nutritionally, it is a rich source of vitamin A, B, C, oleoresin and red pigment. *Capsaicin* an alkaloid responsible for pungency in chillies has medicinal properties and it prevents heart attack by dilating the blood vessels (Gill, 1989) [7].

Chilli occupied an area of 316 thousand hectares in India with annual production of 3634 thousand million tonnes in 2016-17 (Anonymous, 2017) [3]. Its productivity was reported to be 1.95 tonnes / hectare (Anonymous, 2015) [1]. In Madhya Pradesh the area under chilli crop was 25.75 thousand hectare with annual production of 514.1 thousand million tonnes in 2015-16. The major chilli producing districts of Madhya Pradesh are Khandwa, Jhabua, Alirajpur, Devas, Shivpuri, Shahdol and Khargone (Anonymous, 2016) [2]. Many factors are responsible for low production and productivity of chilli crop that include biotic factors like the incidence of insect pests and diseases.

About 51 insect and 2 mites species, belonging to 27 families and 9 orders were found infesting chilli (Reddy and Puttaswamy, 1983) [20]. Among these, thrips, *Scirtothrips dorsalis* Hood; whitefly, *Bemisia tabaci* Gennadius; aphid, *Aphis gossypii* Glover; jassid, *Amrasca biguttula biguttula* and mite, *Polyphagotarsonemus latus* Banks are major sucking pests causing 60 to 75 per cent yield loss in green chilli (Patel and Gupta, 1998) [16]. Nearly 35 species of insect pests were reported on chilli which include thrips, aphid, whitefly, fruit borer, cutworm, plant bug, mite and other minor pests (Sorensen, 2005) [22]. Among all the sucking pests attacking chilli crop the thrips, *Scirtothrips dorsalis* Hood and whitefly, *Bemisia tabaci* Gennadius were reported as dominant pests (Berke and Sheih, 2000) [4]. The estimated losses due to sucking pests were up to 30 to 50 per cent (Varadharajan, 1994) [23]. The yield losses range from 50-90 per cent due to insect pests in chilli (Nelson and Natrajan, 1994) [13].

Mites have become a major problem in chilli cultivation. It appears in the nursery itself and spreads to the main field during November. Leaves damaged by *Polyphagotarsonemus latus*

(Banks) curl downward and the flowers become distorted and fail to open normally. In most attacked hosts the internodes are greatly shortened and fruit drop may occur under severe infestations (Pena and Bullock, 1994) [18]. Since the activity of various insect pests differs at different places the present experiment was framed to study the seasonal activity of insect pests in chilli crop at Jabalpur (Kymore Plateau & Satpura Hills zone of M.P.).

Material and Methods

Regular observations were conducted throughout the cropping season, at weekly intervals, starting with 7 days old transplanted crop, to record insect pests and their natural enemies on pesticide free chilli crop. The observations were conducted at 4 locations and 50 samples were observed at each location, starting with 15 day's old transplanted crop. Sample unit was 10 cm twig for recording sucking insect pests namely whiteflies, *Bemisia tabaci;* thrips, *Scirtothrips dorsalis* (Hood) and jassids, *Amrasca bigutulla* (Ishida). Populations of mites, *Polyphagotarsonemus latus* were recorded randomly considering single leaf as a sample unit. Larval populations of *Helicoverpa armigera* were recorded on 50 sample plants, considering one plant as the sample unit. Population of natural enemies was recorded on 50 sample plants, selected randomly, at each location.

Results and Discussion

Studies on seasonal incidence of insect pests and abundance of natural enemies in chilli revealed five species of insects and one species of predator to be associated with various stages of chilli crop at Jabalpur, Madhya Pradesh in Central India during *Rabi* 2017-18 and 2018-19 growing season.

Similar to present findings Chintkuntlawar *et al*. (2015) [5] reported six species of insect pests, two species of cocinellid predator and one braconid parasitoid of aphid in chilli. Whitefly, thrips, aphids, jassids, *H. armigera* and *Spodoptera litura* appeared on the crop.

In present studies the major insect pests to attack the crop in vegetative stage were whiteflies, *Bemisia tabaci* (Gennadius), thrips, *Scirtothrips dorsalis* Hood, and jassids, *Amrasca biguttula biguttula* (Ishida), which were observed till maturity of the crop. Mites attacked in late vegetative stage and fruit-borers in fruiting stage of the crop.

Present findings are in accordance with those of Pandey (2014) [15] who recorded thrips, *S. dorsalis* in the vegetative stage that remained on crop up to maturity; and chilli fruit-borer, *H. armigera was* observed during the reproductive stage to maturity of the crop, as has also been observed in present experiment. Meena *et al*. (2013) [11] also reported the incidence of thrips, *S. dorsalis*, whiteflies, *B. tabaci*, aphids, *A. gossypii* and mites, *P. latus* on chilli crop soon after transplanting.

Seasonal activity of *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae)

Activity of *B. tabaci* during both the years of study in different weather weeks is presented in Table 1. Mean population of *Bemisia tabaci*, during 2017-18 season, ranged between 0.75 and 3.62 individuals (nymphs and adults) per 10 cm twig. Its population was first noticed in standard meteorological week # 48 with 1.19 individuals/ sample. Its activity increased continuously with peak population of 3.62 individuals/ sample in SMW # 2. Thereafter, its population declined but remained above 0.75 individuals per sample. The pest activity was recorded till crop maturity i.e. SMW # 18.

Mean population of *Bemisia tabaci* during 2018-19, ranged between 0.92 and 3.87 individuals per 10 cm twig. It appeared in SMW # 48 at a level of 1.11 individuals with a gradual increase upto SMW # 4 with its peak level of 3.87 individuals per 10 cm twig. Its population indicated continuous presence till SMW # 18 (0.92 individuals).

Pooled values of population indicated the presence of *Bemisia tabaci* between 0.93 and 2.98 individuals/ 10 cm twig. Its peak activity was recorded in SMW # 2 (2.98 individuals per sample) and thereafter the population gradually declined, showing its presence till crop maturity with 0.93 individuals per sample.

In contrast to present findings, Yadav *et al*. (2017) [24] observed peak population of whiteflies, *B. tabaci* on chilli crop from mid-April to mid-May with 6.28 insects per plant. In contrary to present findings, Meena *et al*. (2013) [11] reported that whitefly attained their peak in first and second week of September during 2006-07 (6.9 whiteflies/3 leaves/ plant) and during 2007-08 (6.7 whiteflies/ 3 leaves/ plant). Saini *et al*. (2017) [21] studied the incidence of whitefly which commenced in last week of July and touched peak in second week of September (6.8 whiteflies/ 3 leaves). Similar to present findings, Padhi *et al*. (2017) [14] studied the seasonal incidence of whitefly in chilli. It started from the 45th standard week of observations (2.07 adults/ three leaves), and reached its peak in 48th standard week of observations (7.07 adult/ three leaves) and again declined subsequently upto 1st standard week of observation with a population of 1.8 adult/ three leaves. Its incidence reached the peak again in 4th and 5th standard week of observations (6.4 adults/ three leaves) and gradually declined. Contrary to present findings, Moanaro and Choudhary (2018) [12] studied seasonal incidence of sucking pest complex on *capsicum* during 2014-2015 in Eastern Plateau and Hill region of India. Incidence of *B. tabaci* started from second to third week of September and reached its peak in month of October. Similar to present findings Ghose *et al*. (2018) [6] reported that the whitefly infested the crop from first fortnight of November to first week of April with peak population during end of March. Contrary to present findings Rajput *et al*. (2017) [19] reported peak activity of whitefly during second week of September (7.12 whitefly/ 3 leaves).

Seasonal activity of *S. dorsalis* Hood (Thysanoptera: Thripidae)

Activity of *S. dorsalis* during both the years of study in different weather weeks is presented in Table 1. The numbers of thrips (nymphs and adults) were recorded on 10 cm twig of the plant. During the year 2017-18 the first appearance of *S. dorsalis* was noted during SMW # 48 (1.13 individuals per sample).

Population of thrips indicated first peak in SMW # 4 with 2.38 individuals per sample and thereafter the population declined gradually till first week of April (i.e. SMW # 14). Its population indicated rise in SMW # 15 with second peak in SMW # 16 (2.64 individuals /sample).

During the year 2018-19, the population of *S. dorsalis* was noticed at a low level (0.98 individuals /sample) in SMW # 48. Its activity remained more or less static during the month of December. It increased gradually with first peak of 2.19 individuals in SMW # 4. Its population declined thereafter, with second peak of 2.44 individuals during SMW # 16. It was present in the crop till crop maturity.

Pooled values of *S. dorsalis* population indicated similar

trend. The population appeared in SMW # 48 with 1.03 individuals /sample of 10 cm twig. First peak was observed in SMW # 4 with 2.28 individuals. The population declined thereafter but remained above 0.91 individuals /sample till March end. The population indicated an increasing trend thereafter with its peak of 2.54 individuals per sample during SMW # 16. Its presence was recorded till crop maturity.

In contrast to present findings are with those of Yadav *et al*. (2017) [24] who observed the peak population of thrips, *S. dorsalis* on chilli crop from mid-April to mid-May (45.86 insects per plant). In contrast Havanoor and Rafee (2018) [10] reported initiation of thrips activity in fourth week of July and peak activity of thrips during last week of August (4.20/leaf). While, Meena *et al*. (2013) [11] reported peak population of thrips (14.5 and 14.7/ 3 leaves) in first week of October. In contrary to present findings, Moanaro and Choudhary (2018) [12] reported seasonal incidence of sucking pest complex on *Capsicum* sp. in Eastern Plateau and Hill region of India. Incidence of pests started from second to third week of September and reached its peak in October. Ghose *et al*. (2018) [6] reported appearance of thrips on the crop during last week of January that continued till April, with its peak population during end of March to first week of April, which is in accordance with present findings. Contrary to present findings, Rajput *et al*. (2017) [19] reported commencement of incidence of thrips, *S. dorsalis* during the second week of August which reached at peak during third week of September (9.5 thrips/ 3 leaves). Gopal *et al*. (2018) [8] reported peak activity of chilli thrips during SMW # 4 (169 thrips/ 50 fruits).

Seasonal activity of *A. biguttula biguttula* (Ishida) (Hemiptera: Cicadellidae)

Activity of *A. biguttula biguttula* during both the years of study in different weather weeks is presented in Table 1.

During the year 2017-18, the population of jassids, *Amrasca biguttula biguttula* ranged between 0.40 and 5.22 jassids /10 cm twig. The pest indicated its presence in SMW # 48 (0.4 individuals) that increased gradually and continuously till SMW # 10 with peak population of 5.22 individuals. Thereafter the population indicated gradual reduction till SMW # 18 (0.93) when the crop was in matured stage.

During Rabi 2018-19, the jassids population indicated its appearance in SMW # 48 (0.39 individuals /10 cm twig). Its population increased continuously till SMW # 10 (5.28 individuals) and thereafter the population trend was declining till crop maturity in SMW # 18 (0.88 individuals).

Pooled population of *A. biguttula biguttula* indicated similar trend, with 0.39 individuals in SMW # 48. Its population increased continuously till SMW # 10 (5.25 individuals /10 cm twig) and thereafter the population started declining, with 0.91 individuals in SMW # 18.

Saini *et al*. (2017) [21] reported commencement of jassids commenced in second week of August and touched peak in second week of September (5.4 jassids/ 3 leaves). Rajput *et al*. (2017) [19] reported that leafhopper; *A. biguttula biguttula* commenced the activity during the last week of July. The peak activity of leafhopper was recorded during the second week of September (6.44 leafhopper/ 3 leaves).

Table 1: Seasonal incidence of *B. tabaci*, *S. dorsalis*, *A. biguttula*, *P. latus* and *H. armigera* during *Rabi* season 2017-18 and 2018-19

Month & SMW #	Mean population /sample														
	B. tabaci			*S. dorsalis*			*A. biguttula biguttula*			*P. latus*			*H. armigera*		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Dec. 48	1.19	1.11	1.15	1.13	0.93	1.03	0.40	0.39	0.39	0.00	0.00	0.00	0.00	0.00	0.00
49	1.32	1.33	1.32	1.24	1.04	1.14	0.71	0.66	0.68	0.00	0.00	0.00	0.00	0.00	0.00
50	1.45	1.44	1.44	1.29	1.09	1.19	1.11	1.06	1.08	0.00	0.00	0.00	0.00	0.00	0.00
51	2.14	1.52	1.83	1.32	1.12	1.22	1.23	1.22	1.22	0.23	0.30	0.26	0.00	0.00	0.00
52	2.43	1.59	2.01	1.37	1.17	1.27	1.36	1.33	1.34	0.33	0.39	0.36	0.00	0.00	0.00
Jan. 1	2.63	2.27	2.45	1.75	1.55	1.65	1.41	1.48	1.45	0.45	0.51	0.48	0.00	0.00	0.00
2	3.62	2.34	2.98	1.89	1.69	1.79	2.12	2.21	2.16	0.51	0.57	0.54	0.00	0.18	0.09
3	1.45	2.43	1.94	2.31	2.10	2.20	2.38	2.47	2.42	0.65	0.70	0.68	0.22	0.23	0.22
4	1.24	3.87	2.55	2.38	2.19	2.28	2.56	2.66	2.61	0.74	0.80	0.77	0.37	0.33	0.35
Feb. 5	1.29	1.37	1.33	1.93	1.73	1.83	3.02	3.10	3.06	0.81	0.86	0.83	0.59	0.54	0.56
6	0.79	0.99	0.89	1.77	1.57	1.67	3.19	3.27	3.23	0.93	0.93	0.93	0.81	0.76	0.79
7	1.02	1.17	1.09	1.45	1.25	1.35	3.78	3.87	3.82	1.01	1.02	1.01	0.45	0.40	0.43
8	1.17	1.21	1.19	1.42	1.22	1.32	4.03	4.10	4.06	1.13	1.14	1.13	0.53	0.48	0.51
Mar. 9	0.78	1.35	1.06	1.01	0.81	0.91	4.83	4.90	4.86	1.19	1.20	1.19	0.47	0.43	0.45
10	0.75	1.39	1.07	1.09	0.89	0.99	5.22	5.28	5.25	1.27	1.28	1.27	0.39	0.35	0.37
11	0.94	1.43	1.18	1.14	0.94	1.04	4.78	4.84	4.81	0.97	0.98	0.97	0.29	0.26	0.28
12	1.16	1.57	1.36	1.23	1.03	1.13	3.93	3.99	3.96	0.85	0.85	0.85	1.22	1.18	1.20
13	1.24	1.19	1.21	1.30	1.10	1.20	3.36	3.42	3.39	0.79	0.79	0.79	0.26	0.23	0.24
Apr. 14	1.03	0.93	0.98	1.21	1.01	1.11	2.76	2.80	2.78	0.65	0.64	0.64	0.38	0.35	0.36
15	1.10	0.99	1.04	2.50	2.30	2.40	1.91	1.94	1.92	0.41	0.42	0.41	0.60	0.56	0.58
16	1.20	1.15	1.18	2.64	2.44	2.54	1.75	1.79	1.77	0.23	0.22	0.23	0.46	0.43	0.44
17	1.14	1.08	1.11	1.49	1.29	1.39	1.15	1.21	1.18	0.17	0.17	0.17	0.36	0.33	0.34
May 18	0.95	0.92	0.93	1.34	1.14	1.24	0.93	0.88	0.91	0.09	0.07	0.08	0.24	0.20	0.22

Broad mite, *Polyphagotarsonemus latus* (Acari: Tarsonemidae)

In the year 2017-18 first appearance of mites was recorded during SMW # 51. The number of mites (nymph+adult) was worked out as weekly average per sample (single leaf as a sample unit) and its highest population was observed during SMW # 10 (1.27 / leaf).

In the year 2018-19 first appearance of mites was recorded during SMW # 51. The number of mites (nymph+adult) was highest during SMW # 10 (1.28 / leaf).

Pooled data revealed crop infestation by mites between SMW # 51 and SMW # 18 and its peak population (1.27 / leaf) was

observed during SMW # 10. Mite incidence was too low in the crop during both the years of study (Table 1).

Havanoor and Rafee (2018) [10] observed that mites incidence commenced during first week of August and reached peak during September third week (3.72/leaf). Meena *et al*. (2013) [11] reported that mite population reached to its peak in the second week of September (9.2 and 9.0 mites/ 3 leaves/ plant) during both the years of study. Similar to present findings, Pathipati *et al*. (2014) [17] reported that mite population steadily reached two peak levels during 47th and 3rd SMW. In contrary to present findings, Moanaro and Choudhary (2018) [12] reported that mites, *P. latus* incidence started from second to third week of September and reached its peak in month of October. Similar to present findings, Ghose *et al*. (2018) [6] reported chilli mite during November to first fortnight of January with its peak during first fortnight of December.

Fruit borer, *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae) incidence in chilli

Larval population of *Helicoverpa armigera* was recorded in chilli crop throughout the season. Weekly mean population during Rabi 2017-18 indicated initiation of pest activity during SMW # 3 (0.22 larva/ sample). Peak activity of *H. armigera* was noticed in the month of March (SMW # 12) with 1.22 individuals per plant. Thereafter, its population declined but it remained on the crop till maturity.

In the year 2018-19, the activity of *H. armigera* was first noticed on chilli crop during SMW # 2 (0.18 larva/ plant). Highest mean population of 1.18 larva/ plant was observed during SMW # 12, and afterwards its population declined but indicated its existence at very low level (0.20 larva/ plant) till crop maturity.

Pooled mean population of *H. armigera* indicated the initiation of pest activity during SMW # 2 (0.09 larva/ plant) and its peak activity during SMW # 12 (1.2 larvae/ plant) (Table 1).

Yadav *et al*. (2017) [24] observed peak population of fruit borer, *H. armigera* on chilli crop from mid-April to mid-May with 1.56 insects per plant. Ghose *et al*. (2018) [6] reported that fruit borers were active from first week of February to first week of April, showing peak population during first fortnight of March, which is in line with present observations.

Table 2: Seasonal activity of *C. transversalis* during *Rabi* season 2017-18 and 2018-19. (weekly mean)

Month & SMW #	Mean population of *C. transversalis*/plant		
	2017-18	2018-19	Pooled
Dec. 48	0.00	0.00	0.00
49	0.00	0.00	0.00
50	0.00	0.00	0.00
51	0.00	0.00	0.00
52	0.00	0.00	0.00
Jan. 1	0.00	0.43	0.22
2	0.00	0.58	0.29
3	1.00	0.89	0.94
4	1.25	1.14	1.19
Feb. 5	1.51	1.40	1.45
6	1.75	1.65	1.70
7	2.31	2.20	2.25
8	2.57	2.46	2.51
Mar. 9	2.27	2.16	2.21
10	3.00	2.87	2.93
11	3.07	2.96	3.01
12	2.21	2.13	2.17
13	1.99	1.93	1.96
Apr. 14	1.77	1.67	1.72
15	1.36	1.26	1.31
16	1.10	1.00	1.05
17	0.90	0.81	0.85
May 18	0.66	0.57	0.61

Activity of natural enemies

Transverse ladybird beetle, *Coccinella transversalis* Fabricius (Coleoptera: Coccinellidae)

During the year 2017-18, the first activity of ladybird beetle was noticed during SMW # 3 at a low level of 1.0 individuals/ sample. Its mean population level increased gradually upto SMW # 11 with peak population of 3.07 beetles/ plant during that week. Its population declined gradually towards crop maturity but it remained active till SMW # 18 (0.66 beetles/ plant).

Activity of ladybird beetle, in the year 2018-19, started in SMW # 1 with a mean population of 0.43 beetles per plant. Its population indicated a gradual increase till SMW # 11 with peak of 2.96 beetles per plant during the week. It was active till crop maturity; however, a gradual decline was recorded after SMW # 11 towards crop maturity.

Pooled data on mean population of ladybird beetle of both the crop seasons indicated initiation of its activity, at low level (0.22 beetle), during SMW # 1. Its numbers increased gradually till SMW # 11 (3.01 beetles per plant). Thereafter, a decline in its activity was recorded as the crop attained maturity. It was observed till SMW # 18, with 0.61 beetles per plant. (Table 2)

Present findings are in accordance with those of Harne (2014) [9] who first observed *Coccinella septumpunctata* in the crop at 63 days after transplanting (SMW 1st). It remained active all through the crop season (SMW 1st to SMW 14th) with peak population during SMW 5th (3.5 individuals/ sample).

Conclusion

The present investigations revealed that major insect pests to attack the crop in vegetative stage were whiteflies, *Bemisia*

tabaci (Gennadius), thrips, *Scirtothrips dorsalis* Hood, and jassids, *Amrasca biguttula biguttula* (Ishida), which were observed till maturity of the crop. Mites, *Polyphagotarsonemus latus* (Banks), attacked in late vegetative stage and fruit-borers, *Helicoverpa armigera* Hubner in fruiting stage of the crop. The *Coccinella transversalis* Fabricius, predator was present on the crop from the vegetative stage till the crop maturity stage.

References

1. Anonymous. http://www.mospi.gov.instatistical-year book-india, 2015.
2. Anonymous. http://agricoop.nic.in/statistics/horticulture/ 2016, 205, 304-305, 476.
3. Anonymous. http://www.agricoop.nic.instatisticsstate-level, 2017.
4. Berke T, Sheih SC. Chilli peppers in Asia. Capsicum and Egg Plant Newsletter. 2000; 19:38-41.
5. Chintkuntlawar PS, Pawar UA, Saxena AK. Insect pest complex of chilli, *Capsicum annum* L. and their natural enemies in Jabalpur. International Journal of Plant Protection. 2015; 8(2):270-278.
6. Ghose Mousumi, Bhattacharya Swarnali, Mandal SK. Seasonal incidence of pests of bell pepper (*Capsicum annum* var grossum Sendt) and their correlation with weather parameters. Journal of Entomology and Zoology Studies. 2018; 6(3):825-830.
7. Gill HS. Improved technologies for chilli production. Indian Cocoa Arecanut and spices Journal. 1989; 12:118-119.
8. Gopal G Venu, Lakshmi K Vijaya, Sarath Babu B, Kishore Varma P. Seasonal incidence of chilli thrips, *Scirtothrips dorsalis* hood in relation to weather parameters. Journal of Entomology and Zoology Studies. 2018; 6(2):466-471.
9. Harne A. Studies on insect-pests incidence on chilli, *Capsicum annum* L. and evaluation of insecticides for their management. M.Sc. Agriculture (Entomology), thesis submitted to JNKVV, Jabalpur, (M.P.), 2014, 35, 39, 25.
10. Havanoor RK, Rafee CM. Seasonal incidence of sucking pests of chilli (*Capsicum annum* L.) and their natural enemies. Journal of Entomology and Zoology Studies. 2018; 6(4):1786-1789.
11. Meena RS, Ameta OP, Meena BL. Population dynamics of sucking pests and their correlation with weather parameters in chilli, *Capsicum annum* L. crop. The Bioscan. 2013; 8(1):177-180.
12. Moanaro and Choudhary JS. Seasonal incidence of major sucking pests complex of *Capsicum* in relation to weather parameters in Eastern Plateau and Hill region of India. Journal of Entomology and Zoology Studies. 2018; 6(2):270-273.
13. Nelson SJ and Natarajan S. Economic threshold level of thrips in semi-dry chilli. South Indian Horticulture. 1994; 42(5):336-338.
14. Padhi Gayatri Kumari, Labani Maity, Chattopadhyay A and Arunava S. Population dynamics of whitefly (*Bemisia tabaci* Genn.) in chilli and screening of genotypes against chilli leaf curl virus. Journal of Entomology and Zoology Studies. 2017; 5(5):104-107.
15. Pandey A. Study on insect pest complex of chilli and their management. M.Sc. Agriculture (Entomology), thesis submitted to JNKVV, Jabalpur, (M.P.), 2014, 21-23.
16. Patel VN, Gupta HCL. Estimation of losses and management of thrips infesting chillies. In National Seminar on "Entomology in 21st Century" Biodiversity, Sustainability, Environmental Safety and Human Health. Rajasthan Agriculture University, Udaipur, 1998, 99.
17. Pathipati VL, Vijayalakshmi T, Naram Naidu L. Seasonal incidence of major insect pests of chilli in relation to weather parameters in Andhra Pradesh. Pest Management in Horticultural Ecosystems. 2014; 20(1):36-40.
18. Pena JE, Bullock RC. Effects of feeding of broad mite (Acari: Tarsonemidae) on vegetative plant growth. The Florida Entomologist. 1994; 77(1):180-184.
19. Rajput VS, Prajapati BG, Pareek A, Patel PS. Studies on population dynamics of major insect pests infesting chilli (*Capsicum annum* L.). International Journal Pure & Applied Bioscience. 2017; 5(6):1465-1470.
20. Reddy DNR, Puttaswamy. Pest infesting chilli (*Capsicum annuum* L.) in the nursery. Mysore Journal of Agriculture Science. 1983; 17(3):122-125.
21. Saini Arti, Ahir KC, BS Rana, Kumar Ravi. Population dynamics of sucking pests infesting chilli (*Capsicum annum* L.). Journal of Entomology and Zoology Studies. 2017; 5(2):250-252.
22. Sorenson KA. Vegetable insect pest management, 2005. www.ces.ncsu.edu/depts/ent/notes.
23. Varadharajan S. Studies on host plant resistance and biology of chilli thrips, *Scirtothrips dorsalis* Hood. M.Sc. (Agri.) thesis submitted to Annamalai University, Annamalainagar, Tamil Nadu (India), 1994. Vegetables/veg37.html-11k.
24. Yadav LK, Deole S, Yadu YK, Gauraha R. Rabi - summer chilli crop-the spectrum of major insect pests. International Journal of Plant Protection. 2017; 10(1):47-51.