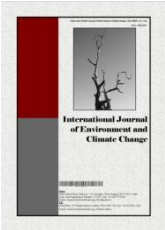

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Arthropod Pests of Chilli and Associated Natural Enemies in Kymore Plateau and Satpura Hill Zone of Madhya Pradesh (India)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The survey was conducted in selected districts of Kymore Plateau and Satpura Hills zone of Madhya Pradesh (India) to assess the pest status of chilli during 2017-18 and 2018-19 *rabi* season. Crop was monitored at vegetative, flowering, and fruiting stages in four selected locations (pesticide-free fields) of seven districts *viz*., Seoni, Jabalpur, Katni, Rewa, Satna, Panna, and Sidhi. The pest spectra included four insect pests and a mite species namely, whitefly, *Bemisia tabaci* (Gennadius), thrips, *Scirtothrips dorsalis* Hood, leafhoppers, *Amrasca biguttula biguttula* (Ishida), fruit-borer, *Helicoverpa armigera* Hubner, and a mite species, *Polyphagotarsonemus latus* (Banks); one species of predator, transverse ladybird beetle, *Coccinella transversalis* Fabricius. The incidence of Leaf curl disease was also observed. The pooled mean population of *B. tabaci* in Seoni, Jabalpur, Katni, Rewa, Satna, Panna, and Sidhi was 2.86, 2.45, 2.67, 2.79, 2.90, 2.86, and 2.70 individuals/ 10 cm twig, respectively at the flowering stage. Mean population of *S. dorsalis* was 1.65, 1.48 and 1.34 individuals/ 10 cm twig at flowering stage in Jabalpur, Katni and Panna, while, in Seoni, Rewa, Satna and Sidhi, it was 1.37, 1.35, 1.34 and 1.48 individuals/ 10 cm twig, respectively at fruiting stage. Population of *A. biguttula biguttula* was 3.14, 3.80, 3.49, 3.14, 3.18, 3.40, and 2.98 individuals/ 10 cm twig at fruiting stage. *P. latus* population was 0.86, 1.01, 0.92, 0.99, 0.95, 1.13 and 0.96 mites/ leaf at fruiting stage. *H. armigera* population was 1.13, 0.43, 0.53,

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0.62, 1.28, 0.86 and 1.19 larvae/ plant at fruiting stage. Populations of *C. transversalis* were 1.80, 2.25, 2.32, 1.85, 1.88, 2.36, and 1.67 beetles/ plant at the fruiting stage. The leaf curl (% leaf infestation) incidence was 27.28, 32.43, 33.33, 28.45, 36.03, 25.53, and 36.19 % at the fruiting stage in the mentioned districts of the zone.

Keywords: Chilli, Survey; whiteflies; thrips; jassids; mites; fruit borer; Ladybird beetle.

1. INTRODUCTION

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

India is the largest producer and consumer of chilli, a commercial spice crop, in the world. It is widely used as a spice universally, named as “wonder spice” [1].

It is grown throughout the year as a cash crop and pods are used in the fresh green stage, eaten raw in a salad or as a cooked vegetable. The red ripe dried stage is known for its pleasant aromatic flavor, pungency, and high coloring substance. Nutritionally, it is a rich source of vitamin A, B, C, oleoresin, and red pigment. *Capsaicin*, an alkaloid responsible for the pungency in chillies, has medicinal properties and it prevents heart attack by dilating the blood vessels [2].

Capsicum is derived from the Greek word "Kapsimo" meaning "to bite". Genus *Capsicum* is divided into three sections by Hunziker - Monotypic *Tubocapsicum*, *Pseudoacnistus*, and *Capsicum*. All the species in the genus have n=12 except *C. ciliatum* and *C. scolnikianum* which have n=13. Genus *Capsicum* includes 22 wild species, three varieties, five domesticated species, and their wild relatives. In general domesticated species have larger but fewer fruits than their wild counterparts, though seed per plant is about the same [3].

Chilli is grown over an area of 2020.91 thousand hectares in the world, with a production of 3762.13 thousand tonnes and 1.86 tonnes per hectare in 2013. Major chilli growing countries are India, Myanmar, Bangladesh, Pakistan, Thailand, Vietnam, Romania, China, Nigeria, and Mexico, etc. India is the world leader in chilli production followed by China, Thailand, and Pakistan [4].

In India green chilli occupied an area of 366 thousand hectares with an annual production of 3737 thousand metric tonnes. Dried chili occupied an area of 739 thousand hectares with an annual production of 2172 thousand metric tonnes in 2018-19 [5]. The productivity of dried chilli was reported to be 2.84 tonnes/hectare in 2017-18 [6].

In Madhya Pradesh, the area under green chilli crop was 41.29 thousand hectares with an annual production of 669.16 thousand metric tonnes and dried chilli crop was 90.98 thousand hectares with an annual production of 244.55 thousand metric tonnes. The productivity of dried chilli was reported to be 2.69 tonnes/hectare in 2017-18 [7].

The most important chilli growing states in India are Karnataka, Madhya Pradesh, Bihar, Andhra Pradesh, and Maharastra in 2017-18. Major chilli producing districts of Madhya Pradesh were Chhindwara, Khandwa, Jhabua, Rewa, Vidisha, Damoh, Khargone, and Agar Malwa in 2016-17 [7].

Many factors are responsible for the low production and productivity of chilli crops that includes 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 [8]. 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 percent yield loss in green chilli [9]. Nearly 35 species of insect pests were reported on chilli which included thrips, aphid, whitefly, fruit borer, cutworm, plant bug, mite, and other minor pests [10]. Among all the sucking pests attacking chilli crop; the thrips, *Scirtothrips dorsalis* Hood and whitefly, *Bemisia tabaci* Gennadius were reported as dominant pests [11]. The estimated losses due to sucking pests were up to 30 to 50 percent [12]. The yield losses ranging from 50-90 percent due to insect pests in chilli was reported [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 [14].

In addition to insect pests, the crop also suffers due to the incidence of diseases. Leaf curl is one of the important diseases leading to yield reduction in chilli.

Chilli leaf curl locally known as "Murda" is a most destructive disease of chilli in India. Causal agent of the disease, tobacco leaf curl virus (*Ruga tabaci*), is transmitted by vector *B. tabaci*. The virus belonged to the genus Begomovirus of the family Geminiviridae. The symptoms included upward curling, puckering, and reduced size of leaves. Severely affected plants are stunted and produce no fruits. The symptoms are of three types; vein yellowing, yellow mosaic, and leaf curl [15]. In the last two decades, *Begomoviruses*, largely leaf curl viruses have emerged as a major threat to vegetable crops, including chilli and causing up to 90% yield loss in India [16]. Chilli leaf curl virus was first reported in India in 1954, which was later reported at infrequent intervals. However, after 2005 the virus complex has been emerging rapidly across India and the subcontinent [17]. Chilli leaf curl virus is mainly transmitted by whitefly and grafting [18]. The leaf curl complex is also reported to be transmitted by whitefly (*B. tabaci*), thrips (*S. dorsalis)* and a mite (*P. latus*) [19].

The incidence of chilli leaf curl disease in major chilli growing regions of Madhya Pradesh was severe (88-100%) [20].

Any pest management program is successful only when due care is extended in augmenting and conserving the natural enemies. Present studies include the maintenance of district wise record on the activity of insect pests & natural enemies in chilli crop, in Kymore Plateau and Satpura hills zone of Madhya Pradesh.

2. MATERIALS AND METHODS

Survey to record the insect pests and natural enemies associated with chilli crop was conducted in Kymore Plateau and Satpura Hill zone of Madhya Pradesh (India) thrice at vegetative, flowering, and fruiting stages of the crop. Fifty samples were observed at each of the 4 selected locations (pesticide-free fields) in Seoni, Jabalpur, Katni, Rewa, Satna, Panna, and Sidhi districts. The population of major insect pests and natural enemies were recorded in each sample.

Sample unit was 10 cm twig for recording sucking insect pests namely whiteflies, thrips, and jassids. Populations of mites were recorded randomly considering single leaf as a sample unit. Larval populations of insects like *Helicoverpa armigera* was recorded considering one plant as the sample unit.

Similarly, the population of natural enemies was recorded each of 10 cm twig selected randomly, at each location.

The incidence of leaf curl disease was also observed in 50 sample plants at each location. The total number of leaves in each sample plant and the infected leaves were counted to work out the infestation percentage. The status of insect pests in each district of the zone was presented based on the mean of 4 locations (*****Map 1).

3. RESULTS AND DISCUSSION

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

The pooled mean population of *B. tabaci* in Seoni, Jabalpur, Katni, Rewa, Satna, Panna, and Sidhi districts was 2.86, 2.45, 2.67, 2.79, 2.90, 2.86, and 2.70 individuals/ 10 cm twig, respectively at the flowering stage (Table 1 & Fig. 1).

Similar to present findings Meena et al. [21] reported that the whiteflies (*B. tabaci* Genn.) appeared on chilli crop soon after transplanting. Whitefly attained their peak in the first week of September during 2006-07 (6.9 whiteflies/ 3 leaves/plant) and during 2007-08 (6.7 whiteflies/ 3 leaves/ plant), respectively.

3.2 Thrips, *Scirtothrips dorsalis* Hood (*Thysanoptera: Thripidae*)

Peak mean population of *S. dorsalis* was 1.65, 1.48 and 1.34 individuals/ 10 cm twig at flowering stage in district Jabalpur, Katni and Panna, while, in district Seoni, Rewa, Satna and Sidhi peak mean population of *S. dorsalis* was 1.37, 1.35, 1.34 and 1.48 individuals/ 10 cm twig, respectively at fruiting stage (Table 1 & Fig. 2).

Table 1. Status of insect pests of Chilli in different districts during *Rabi* season (2017-18 and 2018-19) in Kymore Plateau & Satpura Hills zone of Madhya Pradesh

Districts & crop stages		Mean population /sample/10 cm twig														
		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
Seoni	Vegetative	1.19*	1.28	1.23	1.05	1.27	1.16	1.36	1.34	1.35	0.00	0.00	0.00	0.00	0.00	0.00
	Flowering	2.84	2.88	2.86	1.24	1.43	1.33	1.63	1.51	1.57	0.84	0.62	0.73	0.00	0.00	0.00
	Fruiting	1.29	1.24	1.26	1.35	1.39	1.37	3.24	3.04	3.14	0.98	0.75	0.86	1.07	1.20	1.13
Jabalpur	Vegetative	1.18	1.11	1.14	1.13	0.93	1.03	0.38	0.39	0.38	0.00	0.00	0.00	0.00	0.00	0.00
	Flowering	2.63	2.27	2.45	1.75	1.55	1.65	1.41	1.43	1.42	0.45	0.51	0.48	0.00	0.00	0.00
	Fruiting	1.02	1.17	1.09	1.45	1.25	1.35	3.78	3.82	3.80	1.01	1.02	1.01	0.45	0.40	0.43
Katni	Vegetative	1.17	0.97	1.07	1.03	1.13	1.08	0.49	0.55	0.52	0.00	0.00	0.00	0.00	0.00	0.00
	Flowering	2.62	2.72	2.67	1.44	1.52	1.48	1.18	1.23	1.20	0.46	0.47	0.47	0.00	0.00	0.00
	Fruiting	1.16	1.03	1.09	1.38	1.34	1.36	3.56	3.41	3.49	0.99	0.86	0.92	0.54	0.52	0.53
Rewa	Vegetative	1.17	1.02	1.10	1.18	1.13	1.16	1.20	0.55	0.87	0.00	0.00	0.00	0.00	0.00	0.00
	Flowering	2.77	2.81	2.79	1.31	1.20	1.26	1.39	1.33	1.36	0.51	0.54	0.52	0.00	0.00	0.00
	Fruiting	1.19	1.09	1.14	1.31	1.38	1.35	3.12	3.17	3.14	0.96	1.02	0.99	0.58	0.66	0.62
Satna	Vegetative	1.22	1.15	1.18	1.15	1.15	1.15	1.34	1.28	1.31	0.00	0.00	0.00	0.00	0.00	0.00
	Flowering	2.88	2.93	2.90	1.34	1.25	1.29	1.46	1.47	1.47	0.52	0.63	0.57	0.00	0.00	0.00
	Fruiting	1.32	1.24	1.28	1.35	1.34	1.34	3.18	3.19	3.18	0.85	1.06	0.95	1.18	1.38	1.28
Panna	Vegetative	1.12	1.18	1.15	1.01	1.11	1.06	0.46	0.52	0.49	0.00	0.00	0.00	0.00	0.00	0.00
	Flowering	2.82	2.91	2.86	1.37	1.31	1.34	1.20	1.13	1.16	0.30	0.41	0.35	0.00	0.00	0.00
	Fruiting	1.21	1.41	1.31	1.39	1.15	1.27	3.44	3.36	3.40	1.16	1.10	1.13	0.90	0.83	0.86
Sidhi	Vegetative	1.02	0.97	0.99	1.02	1.28	1.15	1.28	1.26	1.27	0.00	0.00	0.00	0.00	0.00	0.00
	Flowering	2.74	2.66	2.70	1.24	1.31	1.28	1.49	1.47	1.48	0.72	0.87	0.79	0.00	0.00	0.00
	Fruiting	1.21	1.34	1.27	1.44	1.53	1.48	3.23	2.73	2.98	0.97	0.83	0.90	1.05	1.32	1.19

**Mean of 4 locations*

Raizada [22] observed that thrips were present throughout the year in Delhi, with the peak during spring and early summer, which confirm present findings. On the onset of rains during July – September the incidence was low, but the activity resumed in October causing severe damage. The author also observed considerable variation in the abundance of *S. dorsalis* in different years. In Andhra Pradesh, the *S. dorsalis* incidence was serious on chilli during October, February – March in Bihar, August to November in Delhi, Mysore, and Madhya Pradesh, and throughout the year in Tamil Nadu and Maharashtra.

Ningappa [23] observed that the *S. dorsalis* was active throughout the year. The population reached its peak during October and thereafter gradually declined from November onwards reaching the lowest level in May. The difference in peak activity periods of *S. dorsalis* is evident in different states and locations.

Lee and Wen [24] reported that though the incidence of thrips was found throughout the year, a higher population was recorded during the dry season.

Patel and Khatri [25] noted *S. dorsalis* (Hood) in the epidemic form on chillies at Jabalpur, Madhya Pradesh, due to drought conditions in 1979.

Similar to present findings Narvaria [26] studied the incidence of different insect pests on chilli at different stages of crop i.e, vegetative, flowering, fruiting, and maturity stages. Pest recorded were aphids, *Aphis craccivora* (Koch), thrips, *Scitothrips dorsalis* (Hood), mites, *P. latus* (Banks), gall midge, *Asphondylia capsaicin* (Barnes) on chilli crop. Aphids and thrips were present throughout the flowering and fruiting stages of the crop.

Similar to present findings Meena et al. [21] reported that the thrips (*S. dorsalis* Hood) appeared on chilli crop soon after transplanting. The peak population of thrips (14.5 and 14.7 /3 leaves /plant) was recorded in the first week of October.

3.3 Leafhoppers, *Amrasca biguttula biguttula* (Ishida) (*Hemiptera: Cicadellidae*)

Peak mean population of *A. biguttula biguttula* were 3.14, 3.80, 3.49, 3.14, 3.18, 3.40 and 2.98 individuals/ 10 cm twig at fruiting stage (Table 1 & Fig. 3).

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

Peak mean populations of *P. latus* were recorded 0.86, 1.01, 0.92, 0.99, 0.95, 1.13 and 0.96 mites/ leaf at fruiting stage (Table 1 & Fig. 4).

Similar to present findings Meena et al. [21] reported that the mites (*P. latus* Banks) appeared on chilli crop soon after transplanting. Mites population reached its peak in the second week of September (9.2 and 9.0 mites/ 3 leaves/ plant) during both the years.

3.5 Fruit borer, *Helicoverpa armigera* Hubner (*Lepidoptera: Noctuidae*)

Peak mean populations of *H. armigera* were 1.13, 0.43, 0.53, 0.62, 1.28, 0.86 and 1.19 larvae/ plant at fruiting stage (Table 1 & Fig. 5).

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

Peak mean populations of *C. transversalis* were 1.80, 2.25, 2.32, 1.85, 1.88, 2.36 and 1.67 beetles/ plant at fruiting stage (Table 2 & Fig. 6).

3.7 Leaf Curl (% leaves infestation) on Chilli

Pooled data revealed that incidences of the leaf curl (% leaves infestation) were 27.28, 32.43, 33.33, 28.45, 36.03, 25.53, and 36.19 % at the fruiting stage in the mentioned districts of the zone (Table 2 & Fig. 7).

Venzon et al. [27] noted at Brazil the main pests of chillies, which included mites (*Polyphagotarsonemus latus* and *Tetranychus* spp.), aphids, thrips, *Bemisia tabaci*, the gelechiid *Gnorimoschema barsaniella*, *Neosilba* sp., and the noctuid *Agrotis ipsilon*.

Ghulam et al. [28] reported a total of 7 species i.e. aphid, jassid, thrips, whitefly, mealy bugs, termites, and fruit borers at different growth stages.

District wise pooled population trend of individual insect pests at various stages of the crop during *Rabi* season 2017-18 and 2018-19

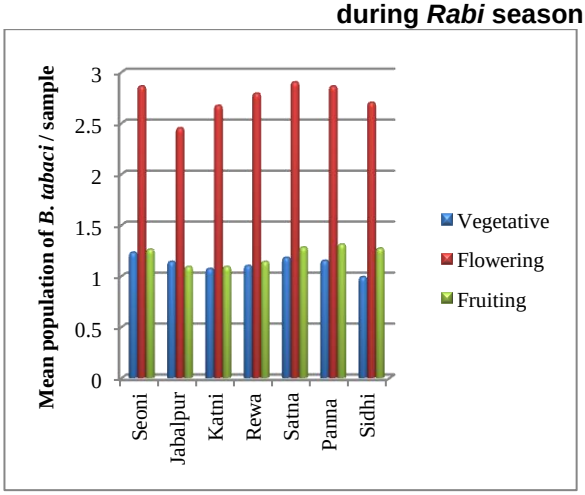


Fig. 1 Population trend of *B. tabaci* on chilli

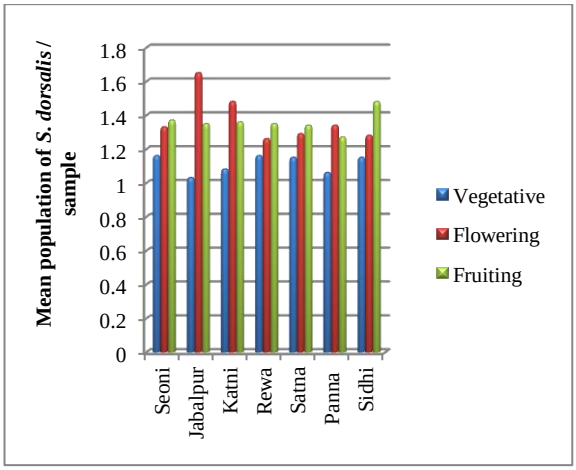


Fig. 2. Population trend of *S. dorsalis* on chilli

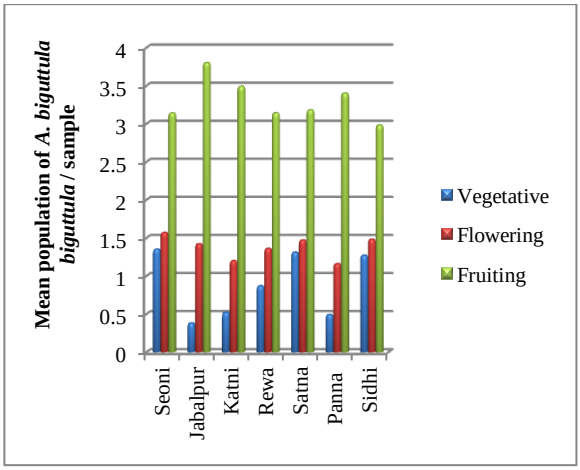


Fig. 3. Population trend of *A. biguttula biguttula* on chilli

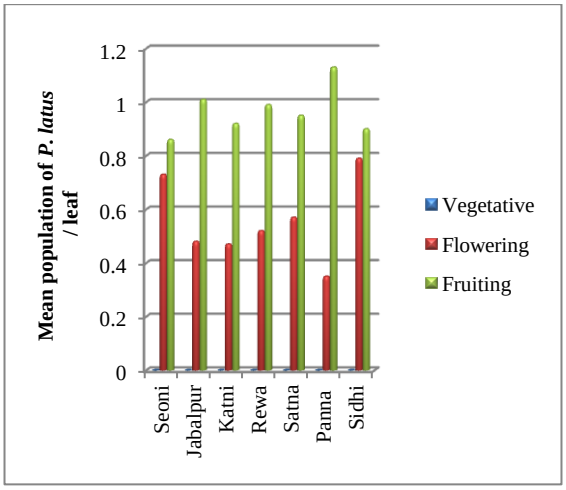


Fig. 4. Population trend of *P. latus* on chilli

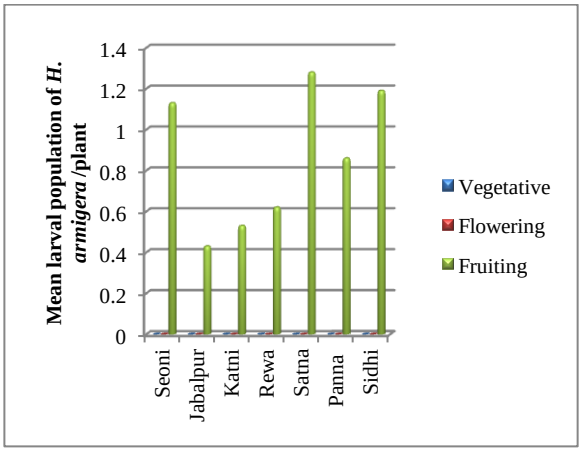


Fig. 5. Population trend of *H. armigera* on chilli

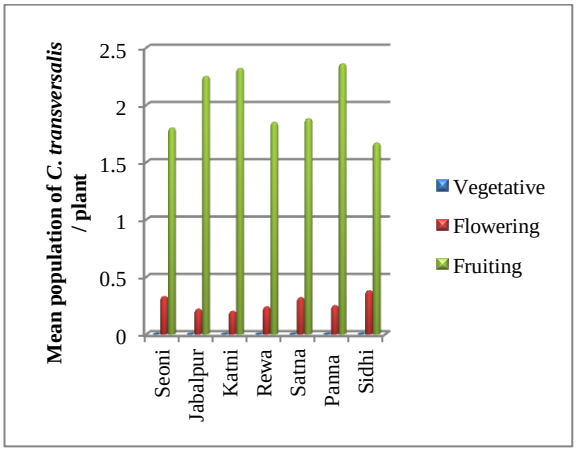


Fig. 6. Population trend of *C. transversalis* on chilli

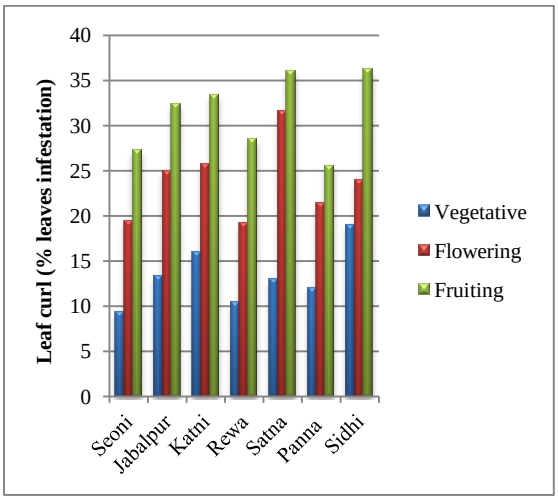
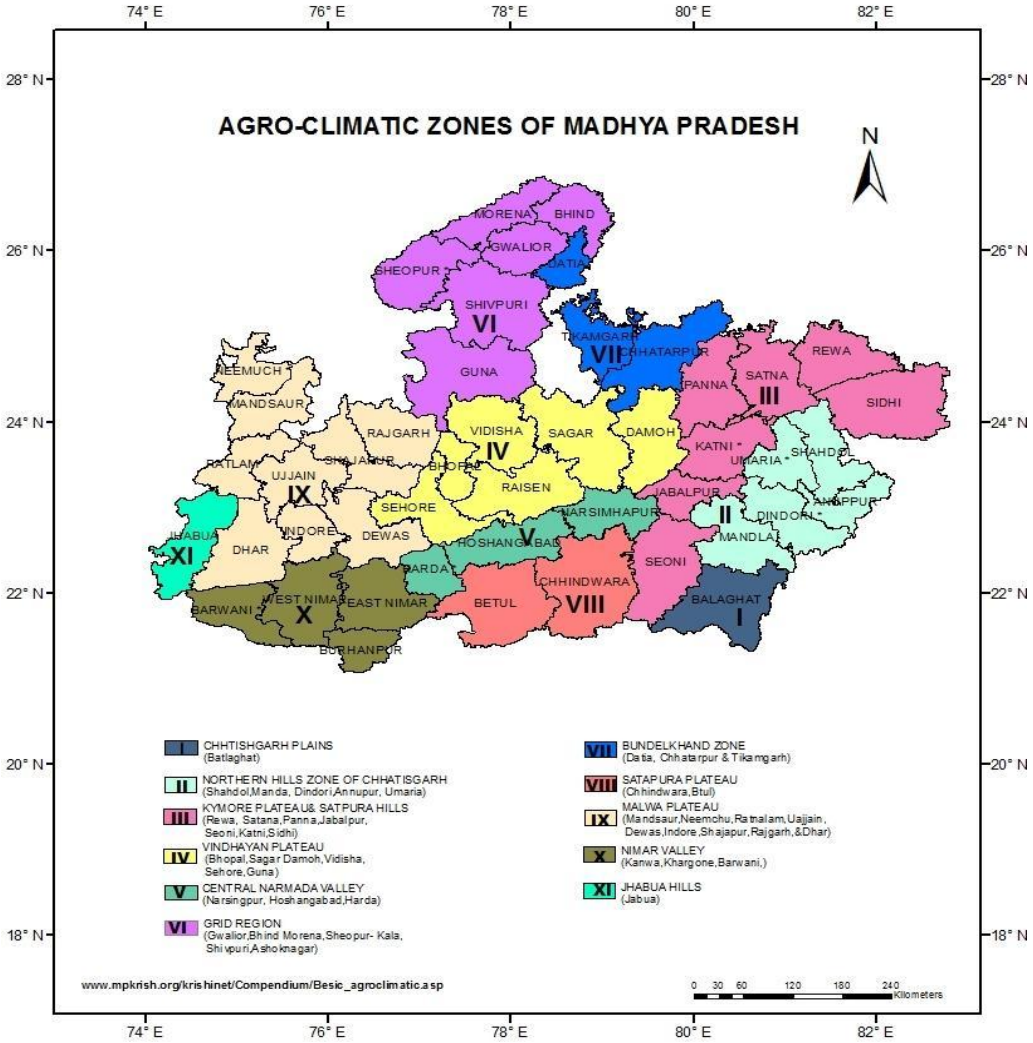


Fig. 7. Leaf curl incidence trend on chilli



Map 1. Map indicating places of observations in Kymore Plateau & Satpura Hills zone of Madhya Pradesh

Table 2. Status of natural enemies and leaf curl incidence during *Rabi* season (2017-18 and 2018-19) in Kymore Plateau & Satpura Hills zone of Madhya Pradesh

Districts / Crop stages		Mean population /sample/10 cm twig					
		Coccinella transversalis			Leaf curl (% leaves infestation)		
		2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Seoni	Vegetative	0.00	0.00	0.00	7.95	10.64	9.29
	Flowering	0.00	0.66	0.33	17.79	21.09	19.44
	Fruiting	1.74	1.87	1.80	26.33	28.23	27.28
Jabalpur	Vegetative	0.00	0.00	0.00	14.44	12.08	13.26
	Flowering	0.00	0.43	0.22	24.26	25.70	24.98
	Fruiting	2.31	2.20	2.25	33.60	31.26	32.43
Katni	Vegetative	0.00	0.00	0.00	16.08	15.84	15.96
	Flowering	0.00	0.40	0.20	25.25	26.03	25.64
	Fruiting	2.30	2.35	2.32	34.13	32.53	33.33
Rewa	Vegetative	0.00	0.00	0.00	8.84	11.89	10.37
	Flowering	0.00	0.49	0.24	17.16	21.19	19.17
	Fruiting	1.66	2.04	1.85	26.06	30.84	28.45
Satna	Vegetative	0.00	0.00	0.00	11.59	14.18	12.88
	Flowering	0.00	0.65	0.32	31.02	32.12	31.57
	Fruiting	1.83	1.94	1.88	36.18	35.87	36.03
Panna	Vegetative	0.00	0.00	0.00	10.70	13.30	12.00
	Flowering	0.00	0.51	0.25	19.87	22.90	21.38
	Fruiting	2.34	2.39	2.36	23.02	28.03	25.53
Sidhi	Vegetative	0.00	0.00	0.00	15.59	22.20	18.90
	Flowering	0.00	0.76	0.38	23.28	24.53	23.90
	Fruiting	1.68	1.67	1.67	34.15	38.23	36.19

**Mean of 4 locations*

Pandey [29] reported 2 major groups of insect pests in chilli. The first recorded on the vegetative stage included aphids, *Aphis gossypii* (Glover) (Hemiptera: Aphididae) and thrips, *Scirtothrips dorsalis* (Hood) (Thysanoptera: Thripidae) that remained on the crop up to maturity. The second major group was of Lepidopteron borer i.e. chilli fruit borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) observed during the reproductive stage to maturity of the crop, similar major pests were observed in the present experiment.

Harne [30] reported four species of insect pests and one natural enemy. Whitefly, *B. tabaci*, and thrips, *S. dorsalis* were first observed seven days after transplanting (SMW 45) and remained active up to the maturity stage of the crop. Fruit borer, *H. armigera* was first observed in the crop 119 days after transplanting (SMW 9) at maturity stage and remained active till harvest. A ladybird beetle, *Coccinella septumpunctata* was first observed in the crop 63 days after transplanting (SMW 1) at the reproductive stage and remained active up to the third week of March. Leaf curl incidence commenced from 3rd December to 23rd March during the crop period. The studies were conducted at Jabalpur and confirm the present trend of incidence of insect-pests.

Roopa and Kumar [31] reported a total of 10 species of insects and mites on the crop at Bengaluru condition. They recorded species belonging to 8 different families in six different orders. The insect pests included *Scirtothrips dorsalis, Myzus persicae, Trialeurodes vaporariorum, Attractomorpha crenulata, Monolepta signata, Myllocerus discolor, Thysanoplusia ni, Spodoptera litura, Helicoverpa armigera* and one mite pest *Polyphagotarsonemus latus. S. dorsalis* and *H. armigera* were the predominant species.

Chintkuntlawar et al. [32] conducted experiment at Jabalpur (M.P.) during the winter season of 2009-10. In chilli, six species of insect pests and two species of cocinellid predator, and one braconid parasitoid of aphid were enumerated. Whitefly, thrips, aphids, jassids, *Helicoverpa armigera*, and *Spodoptera litura* appeared on the crop.

Similar to present findings Asma and Hanumantharaya [33] surveyed chilli and recorded insect, mite pests and their natural

enemies at selected talukas of Chikmagalur district (Mudigere, Chikmagalur, and Kadur), Karnataka, India. During the survey, they found peak incidence of thrips, *Scirtothrips dorsalis* Hood and mites, *Polyphagotarsonemus latus* Banks during May at Mudigere, Chikmagalur, and Kadur. The peak leaf curl incidence due to thrips and mites were noticed during April at Mudigere, during May at both, Chikmagalur and Kadur. The population of fruit borers (*Helicoverpa armigera* Hubner and *Spodoptera litura* Fabricius) and percent infestation due to fruit borers was noticed in May at Mudigere, Chikmagalur, and Kadur.

Yadav et al. [32] observed insect pest succession on chilli crops. Four insect species *viz.,* thrips (*Scirtothrips dorsalis*), aphid (*Aphis gossypii*), whitefly (*Bemisia tabaci*), fruit borer (*Helicoverpa armigera*), and mite (*Polyphagotarsonemus latus*) were noticed causing damage at various growth stages of the crop from vegetative to fruiting stages (February to June). The peak population of thrips (*Scirtothrips dorsalis* Hood), whiteflies (*Bemisia tabaci* Genn.), and fruit borer (*Helicoverpa armigera*) were observed on chilli crop from mid-April to mid-May with 45.86, 6.28, and 1.56 insects per plant, respectively. The findings also indicate the same activity periods as observed in the present survey.

4. CONCLUSION

Present studies include the maintenance of district wise record on the activity of insect pests & natural enemies in chilli crop, in Kymore Plateau and Satpura hills zone of Madhya Pradesh, India. Many factors are responsible for the low production and productivity of chilli crops that includes biotic factors like the incidence of insect pests and diseases.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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