SURVEY OF INSECT PESTS AND NATURAL ENEMIES ASSOCIATED WITH CHILLI IN VARIOUS DISTRICTS OF KYMORE PLATEAU & SATPURA HILLS ZONE OF MADHYA PRADESH

Abstract

The present investigations were carried out to survey insect pests and natural enemies associated with chilli crop in Kymore Plateau & Satpura Hills zone of Madhya Pradesh during *Rabi* 2017-18 and 2018-19 growing season. Observations were conducted thrice at vegetative, flowering~~,~~ and fruiting stages of the crop at each of the 4 selected locations (pesticide-free fields). The status of insect pests in each district of the zone is presented based on the mean of 4 locations. The ~~outcome of the experiment revealed that four species~~incidence of insects *i.e.* whiteflies, *Bemisia tabaci* (Gennadius), thrips, *Scirtothrips dorsalis* Hood, jassids, *Amrasca biguttula biguttula* (Ishida), and fruit-borers, *Helicoverpa armigera* Hubner, one species of mites i.e. *Polyphagotarsonemus latus* (Banks), ~~and~~ one species of predator, transverse ladybird beetle *i.e. Coccinella transversalis* Fabricius ~~to be associated with~~ occurred at various stages of chilli crop and leaf curl disease incidence ~~at~~ in various districts, such as, Seoni, Jabalpur, Katni, Rewa, Satna, Panna, and Sidhi. ~~Leaf curl incidence was also observed~~. The pooled mean populations of *B. tabaci* in districts Seoni, Jabalpur, Katni, Rewa, Satna, Panna, and Sidhi were 2.86, 2.45, 2.67, 2.79, 2.90, 2.86, and 2.70 individuals/ 10 cm twig, respectively at the flowering stage. 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. Peak mean 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. Peak mean populations of *P. latus* were recorded 0.86, 1.01, 0.92, 0.99, 0.95, 1.13 and 0.96/ leaf at fruiting stage. 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. 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 the fruiting stage. Pooled data revealed that incidences of the leaf curl (% ~~leaves~~ leaf 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.

Key words: Chilli, Survey, whiteflies, thrips, jassids, mites, fruit borer, Ladybird beetle.

Comment [a1]: revise the sentence by giving the range of insects instead of all the values

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 not only the largest producer but also the largest consumer of chilli in the world and it is considered as one of the commercial spice crops. It is widely used as a spice universally, named as “wonder spice” (Pawar et al., 2011)[22].

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 (Gill, 1989)[10].

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 (Anonymous, 2009)[1].

Comment [a2]: not necessary, can delete or can be clubbed with first paragraph

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 (Anonymous, 2013)[2].

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 (Anonymous, 2019)[5]. The productivity of dried chilli was reported to be 2.84 tonnes/hectare in 2017-18 (Anonymous, 2018a)[3].

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 (Anonymous, 2018b)[4].

The most important chilli growing states in India ~~were~~ 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 (Anonymous, 2018b)[4].

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 (Reddy and Puttaswamy, 1983)[25]. 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 (Patel and Gupta, 1998)[21]. Nearly 35 species of insect pests were reported on chilli which includes thrips, aphid, whitefly, fruit borer, cutworm, plant bug, mite, and other minor pests (Sorensen, 2005)[28]. 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)[7]. The estimated losses due to sucking pests were up to 30 to 50 percent (Varadharajan, 1994)[30]. The yield losses range from 50-90 percent due to insect pests in chilli (Nelson and Natrajan, 1994)[17].

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)[23].

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 complex is caused by Geminivirus transmitted by whitefly, *Bemisia tabaci*, and also by thrips, *Scirtothrips dorsalis*, and *Polyphagotarsonemus latus* (Venkatesh *et al.*, 1998)[31].

Chilli leaf curl locally known as "Murda" is a most destructive disease of chilli in India. Leaf curl of chilli is caused by tobacco leaf curl virus (*Ruga tabaci*) which is transmitted by vector *B. tabaci*. The diseases caused by genus Begomovirus in the family Geminiviridae are easily recognized by their distinctive symptoms with upward curling,

puckering, and reduced size of leaves. Severely affected plants are stunted and produce no fruits. The symptoms are broad of three types vein yellowing, yellow mosaic, and leaf curl (Zehra et al., 2017)[34]. In the last two decades, *Begomoviruses*, largely leaf curl viruses have emerged as a major threat to vegetable crops, including chilli causing up to 90% yield loss in India (Suresh et al., 2013)[29]. Chilli leaf curl virus was first reported in India in 1954, which was later reported infrequent intervals. However, after 2005 the virus complex has been emerging rapidly across India and the subcontinent (Kenyon et al., 2014)[12]. Chilli leaf curl virus is mainly transmitted by whitefly and grafting (Senanayke et al., 2012)[27]. The incidence of chilli leaf curl disease in major chilli growing regions of Madhya Pradesh was severe (88-100%) (Kumar et al., 2016)[13].

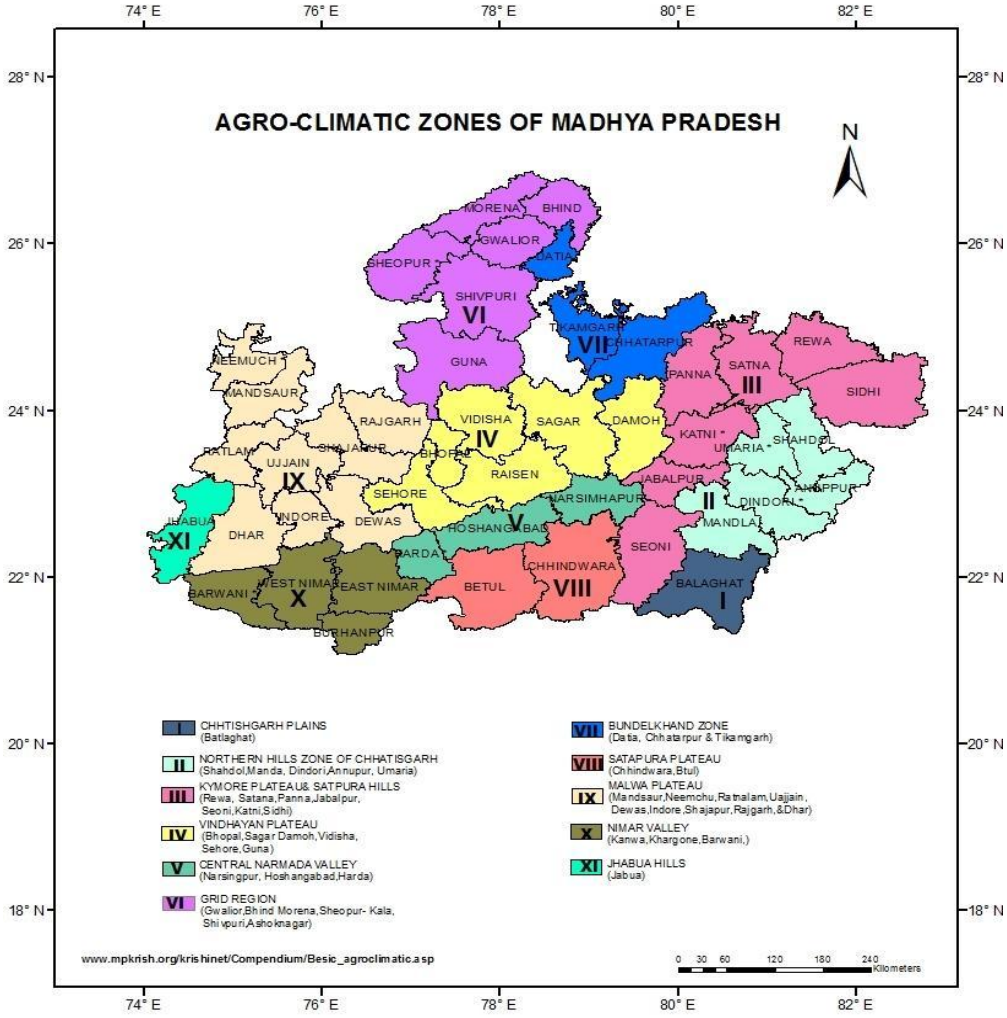
Any pest management program is successful only when due care is extended in augmenting and conserving the natural enemies. Present studies include the maintenance of district wise record on the activity of insect pests & natural enemies in chilli crop, in Kymore Plateau and Satpura hills zone of Madhya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

Material and Methods

Survey to record insect pests and natural enemies associated with chilli crop in Kymore Plateau ~~&~~ and Satpura Hills zone of Madhya Pradesh ~~were~~ was conducted 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 districts Seoni, Jabalpur, Katni, Rewa, Satna, Panna, and Sidhi. The population of major insect pests and natural enemies were recorded in each sample. 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.

Comment [a3]: how can a farmer keep the field pesticide free?? is it farmers field or research station field??

Comment [a4]: Which method, how many plants form each plot, and insect pests from how many leaves, should specify the methodology followed for the study



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

Results and Discussion

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

The pooled mean populations of *B. tabaci* in districts Seoni, Jabalpur, Katni, Rewa, Satna, Panna, and Sidhi were 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).

Comment [a5]: Is it standard method??

Similar to present findings Meena et al. (2013)[15] 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.

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).

Comment [a6]: Pest status at various stages of survey should be mentioned

Raizada (1965)[24] 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 (1972)[18] 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 (1982)[14] reported that though the incidence of thrips was found throughout the year, a higher population was recorded during the dry season.

Patel and Khatri (1982)[20] 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 (2003)[16] 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. (2013)[15] 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.

Jassid, *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).

Comment [a7]: pest status at other stages of survey??

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/ leaf at fruiting stage (Table 1 & Fig. 4).

Similar to present findings Meena et al. (2013)[15] 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.

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).

Comment [a8]: Pest status at different stages of survey and it should be discussed in the light of available research reports

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).

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. (2006)[32] 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. (2014)[9] reported a total of 7 species i.e. aphid, jassid, thrips, whitefly, mealy bugs, termites, and fruit borers at different growth stages.

Pandey (2014)[19] 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. Seasonal incidence of insect pests on chilli crop revealed chilli thrips, *S. dorsalis* during 11th SW and was available up to 21st SW. The mean thrips population increasing from 11th SW with an average (0.08 thrips/ 6 leaves) and reached its peak (0.47 thrips /6 leaves) during 12th SW. After 20th SW there was a gradual decline in the mean thrips population and was observed up to 21st SW with an average population of 2.50 thrips /6 leaves. The infestation of the fruit borer, *H. armigera* started in the 12th SW with an average of 0.38 larva/plant. The gradual increasing trend in the population of the fruit borer was observed and reached its

peak at 21st SW with an average of 2.17 larvae/plant. In the present experiment also the population of *H. armigera* remained below 2 larvae/plant.

Harne (2014)[11] 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. Whiteflies remained active throughout the crop season (SMW 45 to SMW 14) with two distinct population peaks, first during SMW (standard meteorological week) 49 (3.46 individuals/ sample) & second during SMW 12 (2.24 individual/sample). Thrips remained active throughout the crop season (SMW 45 to SMW 14) with two distinct population peaks, first during SMW 10 (3 individuals/ sample) and the second during SMW 12 (2.64 individual/sample). Fruit borer, *H. armigera* was first observed in the crop 119 days after transplanting (SMW 9) at maturity stage and remained active till harvest. The pest remained active from SMW 9 to 14 with two distinct population peaks, first during SMW 10 (1.1 individual/ sample) and the second during SMW 13 (0.82 individual/sample). 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. It remained active all through the crop season (SMW 1 to SMW 14) with peak population during SMW 5 (3.5 individuals/ sample). 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 (2014)[26] 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. (2015)[8] 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 (2015)[6] 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. (2017)[33] 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. Their findings indicate the same activity periods as observed in the present survey.

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

District & crop stage		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**
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

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

Stages of crop		Mean population /sample					
		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**

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

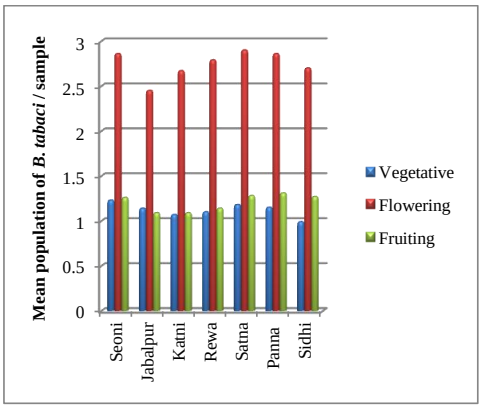

Fig. 1: Population trend of *B. tabaci* on chilli

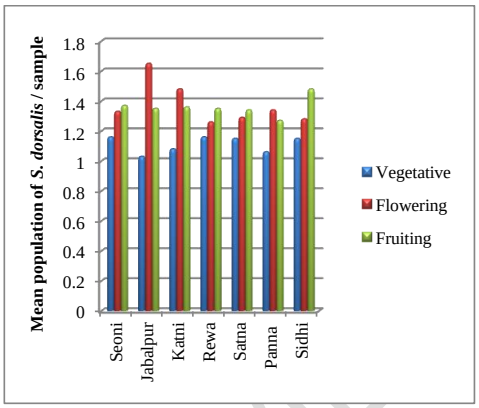

Fig. 2: Population trend of *S. dorsalis* on chilli

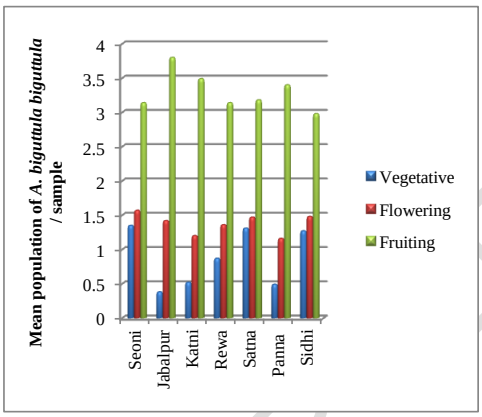

Fig. 3: Population trend of *A. biguttula biguttula* on chilli

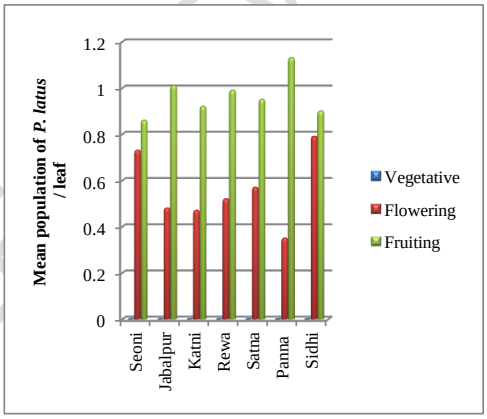

Fig. 4: Population trend of *P. latus* on chilli

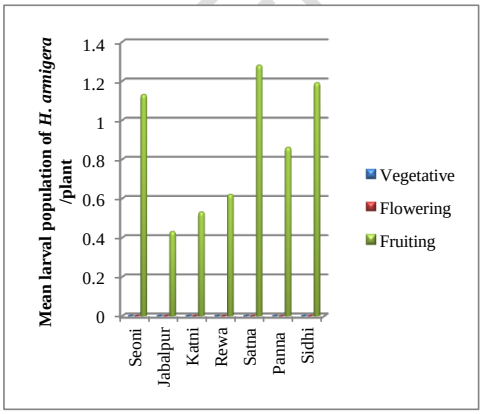

Fig. 5: Population trend of *H. armigera* on chilli

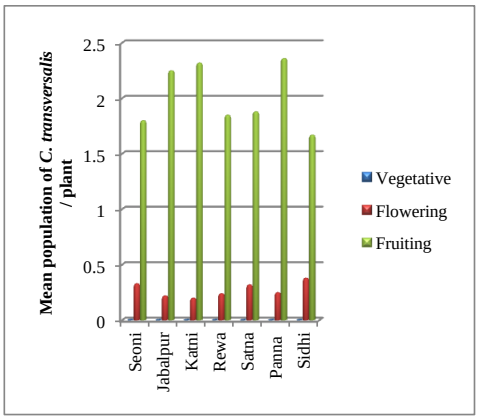

Fig. 6: Population trend of *C. transversalis* on chilli

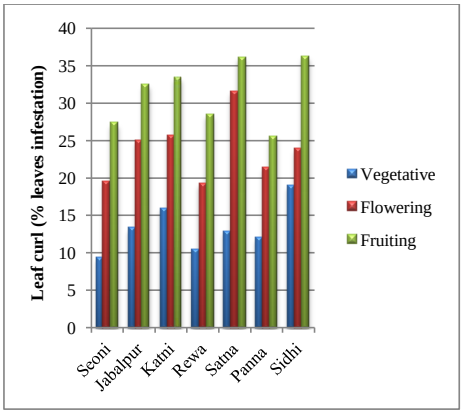

Fig. 7: Leaf curl incidence trend on chilli