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RESEARCH PAPER

Documentation of different pests and their natural enemies on tomato

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Abstract: Tomato (*Solanum lycopersicum* L.) is one of the most popular and widely grown vegetable crop of both tropics and subtropics of the world. It is a member of the family Solanaceae. Low tomato yields have been ascribed to a variety of issues, including poor seed quality, pest infestations and severe weather conditions. The field study conducted in Main Agriculture Research Station, Dharwad revealed that, there are totally 8 species of pests, 3 species of coccinellids and 10 different species of spiders were recorded in tomato ecosystem. The peak incidence of aphid, leafhopper, whitefly, thrips and mites was observed during last week of January, second week of January, first week of March, last week of February and third week of February, respectively. The peak incidence of leaf miner, fruit borer and pinworm was observed during last week of February, second week of March and third week of February, respectively. Correlation coefficient between different weather parameters and population of tomato pests revealed that, maximum temperature recorded significant positive correlation with population of whitefly, thrips, mites, leafminer, fruit borer and pinworm but negatively correlated with aphid and leafhopper.

Key words: Correlation, Incidence, Pests, Tomato

Introduction

Tomato, *Lycopersicon esculentum* Mill, is one of the most popular and widely grown vegetables in the world as well as India, ranking second in importance next to potato. Tomato is infested by almost 13 major insect pests but most important are fruit borer, *Helicoverpa armigera* Hubner, whitefly, *Bemisia tabaci* Gen, and jassids, *Amrasca devastans* Ishida. Reproduction, growth and survival of these insect pests are affected by number of abiotic factors *viz.,* temperature, humidity and rainfall (Ajij *et al*., 2009) temperature plays a great in population dynamics of pests by exerting effects on egg laying and ovipositional behavior (Cammel and Knight, 1992). Similarly, frequent and high intensity precipitation dislodged the eggs and washed away the neonates of insects (Kadam and Khaire, 1995). Among the biotic factors natural enemies such as coccinellids and spiders are important which are most prevalent in natural conditions. These natural enemies are affected by temperature which are ultimately affects the pests population (Yadav *et al*., 2012). But the relationship among abiotic factors and tomato insect pests population are non significant (Naik *et al*., 2009 and Meena *et al.,* 2010). So, to understand the relationship between insect pests, biotic and abiotic factors of environment, to generate a general population trends and estimation role of natural control, there is a need to carry out a study. It prevents the indiscriminate use of pesticides and saves agro-ecosystem balance. Therefore, keeping the above information in view to study the Influence of abiotic and biotic factors on the incidence of various insect pests and their natural enemies under field conditions on tomato was carried out.

Material and methods

The field experiment was conducted at Main Agriculture Research Station, Dharwad, during *rabi* 2021-22. The Durga variety tomato seedlings were transplanted during 2nd fortnight of October, in a plot size of 10×10 m with 60×45 cm spacing. The crop was raised by following recommended package of practices. The experimental plot was kept free from insecticidal spray throughout the cropping season in order to record the incidence of insect pests on tomato. Ten plants were randomly selected from experimental plot and observations were recorded at weekly intervals throughout the crop season starting from 30 days after transplanting. Plants were randomly observed for infestation of leafhopper, aphids, thrips and whitefly by counting total number of insects and mites in three leaves from top, middle and bottom canopy of each plant, mites were observed by using 10X magnifying hand lens. Fruit borer (*Helicoverpa armigera*) and pinworm (*Tuta absoluta)* population was recorded on the basis of number of larvae per plant. Serpentine leaf miner population was assessed by counting number of maggots per three leaves, by selecting top, middle and lower leaves from the plant. To assess the pinworm damage to foliage, total number of damaged leaves per plant were observed. Further fruit damage by *H. armigera* and *T. absoluta* was assessed by counting damaged fruits by selecting 100 fruits from each plot replication wise during harvest. Natural enemies like coccinellids (adults and grubs) and spider populations were recorded on tomato ecosystem at weekly interval on randomly selected ten plants and expressed as number per plant.

Results and discussion

Insect pests and natural enemies reported on tomato during *rabi* 2021-22

The field studies on insect pests incidence on tomato revealed that 8 species of insects pests, 3 species of coccinellids, one mirid bug, one Chrysopid and some spider species were recorded during entire crop period. The aphid, leafhopper, leaf miner, thrips, mites, and whitefly were observed as the major group of insect pests attacked during vegetative

Table 1. Insect pests recorded on tomato during *rabi* 2021-22

Plant stage	Insect pests	Scientific Name	Order	Family	Damaging stage	Period of activity
Vegetative	Serpentine leaf miner	*Liriomyza trifolii*	Diptera	Agromyzidae	Maggot	November-March
Vegetative and Fruiting	Tomato leafminer	*Tuta absoluta*	Lepidoptera	Gelechiidae	Larva	December-March
Vegetative	Aphid	*Aphis gossypii*	Hemiptera	Aphididae	Nymph and Adult	December-March
Vegetative	Jassid	*Amrasca biguttula biguttula*	Hemiptera	Cicadellidae	Nymph and Adult	November-March
Vegetative	Whitefly	*Bemisia tabaci*	Hemiptera	Aleyrodidae	Nymph and Adult	December-March
Vegetative	Thrips	*Thrips tabaci*	Thysanoptera	Thripidae	Nymph and Adult	January-March
Vegetative	Mite	*Tetranychus urticae*	Trombidiformes	Tetranychidae	Nymph and Adult	January-March
Fruiting	Fruit borer	*Helicoverpa armigera*	Lepidoptera	Noctuidae	Larva	January-March

stage of tomato. The coccinellids and spiders were observed almost during entire crop period. The tomato fruit borer and pin worm were observed damaging tomato fruits belongs to second major group of insect pests.

Incidence of tomato pests in relation to weather parameters

Aphids

Incidence of aphids on tomato initiated from third week of December with population of 2.32 aphids per three leaves and peak population of 23.29 aphids per three leaves was attained during last week of January. From third week of December to last week of January there was gradually increase in population but after January fourth week population showed decreasing trend upto last week of March 2022 (2.32 aphids/3 leaves). A non-significant negative correlation was observed between aphids population and maximum temperature (r = -0.196) and significant negative correlation with minimum temperature (r = -0.624). Aphids population also exhibited a non correlation with maximum relative humidity (r = -0.016) and non significant negative correlation with minimum relative humidity (r = -0.142), where as, a significant negative correlation was observed with rainfall (r = -0.542). These observance were in accordance with the studies reported by Patel and Pathak (1995). According to them aphid population decreased in the month of December increased in the month of January and later there was a gradual decline in aphid population. Bhute *et al*. (2012) reported rainfall, rainy days, morning relative humidity and evening relative humidity showed negative correlation with aphids population.

Leafhopper

Leafhopper appeared during second week of December then gradually increased until second week of January where, it reached the peak population of 16.30 leafhopper per three leaves from there after the population shown a decreasing trend upto last week of March with population of 3.66 leafhopper per three leaves. Second highest population was found during third week of January (15.21 leafhopper/3 leaves). A non-significant negative correlation was observed between leafhopper population and maximum temperature (r = -0.351) and significant negative correlation with minimum temperature (r = -0.735). Leafhopper population also exhibited a non significant positive correlation with maximum relative humidity (r = 0.110) and zero correlation with minimum relative humidity (r = 0.006), whereas, a significant negative correlation was observed with rainfall (r = -0.573). The results were in close accordance with Mandloi *et al.* (2015) who reported that the pest incidence was present throughout the crop period with peak during January. Pazhanisamy and Hariprasad (2020) reported significant negative correlation with minimum temperature and Anitha, (2007) reported significant negative relationship with maximum and minimum temperature and also neutral effect of rainfall on population buildup.

Whitefly

Whiteflies appeared from last week of December with the population of 5.21 whiteflies per three leaves afterwards it remained a constant with peak incidence during first week of

Table 2. Predators recorded on tomato crop during *rabi* 2021-22

Common name	Scientific name	Order	Family
Lady bird beetle	*Coccinella transversalis*	Coleoptera	cociinellidae
	Cheilomenes sexmaculata		
	Illeis cincta		
Spider	*Neoscona* sp.	Araneae	Araneidae
	Thomisus sp.		Thomisidae
	Oxyopes sp.		Oxyopidae
	Tetragnatha sp.		Tetragnathidae
	Neoscona sp.		Araneidae
	Cyrtophora sp.		Araneidae
Green lace wing	*Chrysoperla zastrowi sillemi*	Neuroptera	Chrysopidae
Tomato mirid bug	*Nesidiocoris tenuis*	Hemiptera	Miridae

Table 3. Incidence of insect pests of tomato during *rabi* 2021-22

Month	SMW	Sucking pests (no. of nymphs and adults /3 leaves)					Insect defoliators & borers (Average no. of larvae / plant)			Natural enemies (Average number / plant)	
		Aphid	Leafhopper	Whitefly	Thrips	Mites	Leaf miner	Fruit borer	Pin worm	Coccinellids	Spiders
DEC	49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00
	50	2.32	6.31	0.00	0.00	0.00	0.20	0.00	0.00	0.89	0.00
	51	6.50	7.82	0.00	0.00	0.00	0.40	0.00	0.70	0.60	0.10
	52	8.95	11.43	5.21	0.00	0.00	0.90	0.00	1.20	1.01	0.45
JAN	01	20.00	14.96	5.80	0.00	0.00	1.20	0.00	1.90	1.00	0.90
	02	21.44	16.30	6.90	0.58	1.20	1.70	0.80	2.20	1.78	1.25
	03	23.20	15.21	5.80	0.93	2.90	2.90	0.90	3.80	1.23	1.45
	04	23.29	10.53	6.85	1.80	3.40	3.80	1.40	4.49	1.50	2.30
FEB	05	19.80	9.71	7.90	2.30	6.30	6.90	2.80	4.82	1.41	3.40
	06	17.30	8.35	7.77	6.40	11.30	8.50	3.20	6.25	1.09	1.42
	07	15.40	8.81	7.62	5.59	13.20	11.50	4.60	6.66	0.80	2.24
	08	11.15	6.80	8.40	8.49	11.60	12.80	4.80	5.95	1.56	1.20
MAR	09	8.87	5.90	9.91	5.63	8.40	8.40	5.90	5.56	1.89	0.45
	10	5.32	5.59	9.30	4.32	6.50	6.20	6.50	6.23	0.88	1.34
	11	4.60	3.40	7.20	3.60	3.20	5.60	5.30	5.12	0.85	1.30
	12	2.32	3.66	6.40	2.10	2.40	3.40	4.40	4.85	0.90	2.49

SMW- Standard meterological week

March (9.91 whiteflies per three leaves). Whereas second highest population was recorded during second week of march with a population of 9.30 whiteflies per three leaves. The correlation coefficient values indicated that the whitefly population exhibited a significant positive correlation with maximum temperature (r = 0.699), whereas, a non-significant positive correlation with minimum temperature (r = 0.084). A significant negative correlation was observed between whitefly populations and weather parameters *viz*., maximum relative humidity (r = -0.650), minimum relative humidity (r = -0.790). Whereas, a non significant negative correlation was observed between whitefly population and rainfall (r = -0.330). Present results are in agreement with Choudhuri and Senapathi (2001) reported that population attained its peak during mid of February and maintained up to mid of March. In earlier studies, Saini *et al.,*(2017), Moanro and Choudhary (2018) and Yadav (2018) reported that whitefly population density showed a positive and significant correlation and with the mean atmospheric temperature that confirms to our findings.

Thrips

Incidence of thrips on tomato initiated from second week of January with population of 0.58 thrips per three leaves and peak population of 8.49 per three leaves was attained during last week of February. From second week of January to last week of February there was gradually increase in population but after March first week population showed decreasing trend upto last week of March 2022 (2.10 thrips/3 leaves). Thrips population showed a significant positive correlation with maximum temperature (r = 0.762) and non significant positive correlation with minimum temperature (r = 0.263). Thrips population also exhibited a significant negative correlation with maximum relative humidity (r = -0.767) and minimum relative humidity (r = -0.817), whereas, a non-significant negative correlation was observed with rainfall (r = -0.237). The results are in close agreement with the findings of Roopini (2016) who reported that maximum population of thrips in the month of February. Soujanya *et al.* (2010) reported that thrips population had a positive correlation with maximum temperature, minimum temperature and evening relative humidity. Moanaro and Choudhary (2018) reported negative correlation between the number of thrips and rainfall.

Mites

Incidence of mites on tomato initiated from second week of January with population of 1.20 mites per three leaves and peak population of 13.20 per three leaves was attained during third week of February. From second week of January to third week of February there was gradually increase in population but after fourth week of February population showed decreasing trend upto last week of March 2022 (2.40 mites/3 leaves). The mites population exhibited significant positive correlation with maximum temperature (r = 0.666) and non significant positive correlation with minimum temperature (r=0.171), whereas, a

Table 4. Correlation of weather parameters with the incidence of tomato pests and predators during *rabi* 2021-22

Parameters	Pests and predators									
	Aphids	Whitefly	Leaf hopper	Thrips	Mites	Leaf miner	Fruit borer	Pin worm	Coccinellids	Spiders
Max. temp.	-0.196	0.699**	-0.351	0.762**	0.666**	0.720**	0.946**	0.793**	0.248	0.395
Min. temp.	-0.624**	0.084	-0.735**	0.263	0.171	0.177	0.527*	0.257	0.331	0.119
Max. RH	-0.016	-0.650**	0.110	-0.767**	-0.815**	-0.780**	-0.814**	-0.697**	-0.375	-0.155
Min. RH	-0.142	-0.790**	0.006	-0.817**	-0.777**	-0.810**	-0.852**	-0.821**	-0.443	-0.300
Rainfall	-0.542*	-0.330	-0.573*	-0.237	-0.237	-0.299	-0.049	-0.214	-0.477	0.004

*Significant at 5 % ** Significant at 1%

significant negative correlation was observed with maximum and minimum relative humidity (r = -0.815 and r = -0.777). A non-significant negative correlation was observed between mites population and rainfall (r = -0.237). The present findings were supported by Anitha (2007) who concluded that the incidence was started from second week of December (2.12 mites/ 3 leaves) and attained peak in the first week of March (30.17 mites/ 3 leaves). Meena *et al.* (2013) who reported that the population of mites exhibited a positive correlation with the mean temperature and negative correlation with rainfall.

Serpentine leaf miner

Pest appeared from third week of December with the population of 0.20 leaf miner per three leaves afterwards it remained a constant with peak incidence during last week of February(12.80 leaf miner per three leaves). Whereas second highest population was recorded during third week of February with a population of 11.50 leaf miner per three leaves. A significant positive correlation was observed between leaf miner population and maximum temperature (r = 0.720) and non significant positive correlation with minimum temperature (r = 0.177). Leaf miner population also exhibited a significant negative correlation with maximum relative humidity (r = -0.780) and minimum relative humidity (r = -0.810), whereas, a non significant negative correlation was observed with rainfall (r = -0.299). The present study was in conformity with Ramya *et al*. (2017) who revealed that leafminers were most important insects damaging tomato during November to March. The peak population observed during 8th and 9th SMW. Durairaj (2007) who reported that serpentine leaf miner incidence exerted a positive association with maximum and minimum temperature, while association was negative with relative humidity and rainfall.

Pinworm

Incidence of pin worm on tomato initiated from last week of December with population of 0.70 pin worm per plant and peak population of 6.66 per plant was attained during third week of February. From last week of December to third week of February there was gradually increase in population but after fourth week of February population showed decreasing trend upto last week of March 2022 (4.85 pin worm/plant). A significant positive correlation was observed between pin worm population and maximum temperature (r = 0.793) and non significant positive correlation with minimum temperature (r = 0.257). Pin worm population also exhibited a significant negative correlation with maximum relative humidity (r = -0.697) and minimum relative humidity (r = -0.821), whereas, a non significant negative correlation was observed with rainfall (r = -0.214). The present study is in accordance with Mahmoud *et al*. (2015) who reported that *T. absoluta* incidence started from 2nd week of January and reached its maximum activity in the 3rd week of February. Venkataramaniah *et al*. (2021) who recorded that pinworm larvae had exhibited significant positive correlation with maximum temperature and negative relation with rainfall and humidity.

Fruit borer

Fruit borer appeared during second week of January then gradually increased until second week of March where, it reached the peak population of 6.50 larvae per plant from there after the population shown a decreasing trend upto last week of March with population of 4.40 larvae per plant. Second highest population was found during first week of March (5.90 larvae/ plant). The fruit borer population exhibited significant positive correlation with maximum temperature (r = 0.946) and significant positive correlation with minimum temperature (r=0.527), whereas, a significant negative correlation was observed with maximum and minimum relative humidity (r = -0.814 and r = -0.852). No correlation was observed between fruit borer population and rainfall (r = -0.049). Present findings are in accordance with Kurl and Kumar (2010) who found activity of *Helicoverpa armigera* on tomato in 2nd week of January and continued till 21st SMW. Thereafter, the larval population was started to decline. Mondal *et al*. (2018) who revealed that the fruit borer population exhibited positive correlation with maximum and minimum temperature and negative correlation with humidity and rainfall.

Incidence of natural enemies in relation to weather parameters

Coccinellids

Activity of predators coincided with sucking pests. The initial population of 0.42 coccinellids per plant was recorded on second week of December and the population gradually increased to 1.78 coccinellids per plant on second week of January. Thereafter, population showed decreasing trend upto last week of March 2022 (0.90 Coccinellids/plant). A non-significant positive correlation was observed between coccinellid beetle and maximum temperature (r = 0.248) and minimum temperature (r = 0.331), whereas, a non significant negative correlation is observed with maximum and minimum relative humidity (r = - 0.375 and r = - 0.443). A non-significant negative correlation was observed with rainfall (r = -0.447). These finding almost close relation with Harshitha *et al*. (2019) who concluded that the coccinellids started to appear from last fort night of November. Venkateshwarlu *et al.* (2011) the population buildup of coccinellid were directly influenced by maximum and minimum temperature while they were negatively influenced by morning and evening relative humidity.

Spiders

Spiders appeared from last week of December with the population of 0.10 spider per plant afterwards it remained a constant with peak incidence during first week of February (3.40 spiders per plant). Whereas second highest population was recorded during last week of March with a population of 2.49 spiders per plant. Spiders exhibited a non significant positive correlation with maximum temperature (r = 0.395) and minimum temperature (r = 0.119). A non-significant negative correlation was observed between spiders population and maximum relative humidity (r = -0.155) and minimum relative humidity (r = -0.300). Zero correlation was noticed between spiders population and rainfall (r = 0.004). The present work is similar to that of Prasad *et al*. (2008) also reported that the activity of spiders were high between 40 and 60 day after transplanting. Samanta *et al.* (2017) reported that in case of spiders the mean temperature and total rainfall showed positive

correlation and negative correlation. The other factors like relative humidity showed negative correlation with population of spiders.

Conclusion

From the foregoing discussion it can be concluded that different sucking pests *viz.,* aphid (*Aphis gossypii*), leafhopper *(Amrasca biguttula biguttula)*, whitefly (*Bemisia tabaci*), thrips (*Thrips tabaci*), mite (*Tetranychus urticae)* and three defoliator/fruit borers namely serpentine leaf miner (*Liriomyza trifolii),* fruit borer *(Helicoverpa armigera)* and pinworm (*Tuta absoluta*) have been documented on tomato. Further different species of coccinellids *viz., Coccinella transversalis, Cheilomenes sexmaculata, Illeis cincta,* one mirid bug, one Chrysopid and ten different species of spiders from five different families (Araneidae, thomisidae, oxyopidae, salticidae and tetragnathidae) have also been documented in tomato ecosystem. The peak incidence of aphid, leafhopper, whitefly, thrips and mites was observed during last week of January, second week of January, first week of March, last week of February and third week of February, respectively. The peak incidence of leaf miner, fruit borer and pinworm was observed during last week of February, second week of March and third week of February, respectively.

References

Ajij M, Hasan M, Iqbal J and Ali A, 2009, Role of different weather factors on fluctuation of fruit and shoot infestation of Spotted Bollworms, *Earias* spp. on Okra. *Indian Journal of Entomology*, 3(2): 64-72.

Anitha, 2007, Seasonal incidence and management of sucking pests of okra. *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad, Karnataka, India.

Bhute N K, Bhosle B B, Bhede B V and More D G, 2012, Population dynamics of major sucking pests of *Bt* cotton. *Indian Journal of Entomology*, 74(3), pp. 246-252.

Cammel M E and Knight J D, 1992, Effects of climatic change on the population dynamics of crop pests. *Advances in Ecological Research*, 22: 117-162.

Chaudhuri N, Deb D C and Senapati S K, 2001, Assessment of loss in yield caused by pest complex of tomato under terai region of West Bengal. *Research on Crop*, 2(1): 71-79.

Durairaj C, 2007, Influence of Abiotic Factors on the Incidence of Serpentine Leafminer, *Liriomyza trifolii. Indian Journal of Plant Protection,* 35(2): 232-234.

Harshita A P, Saikia D K, Anjumoni B L and Phukan S L, 2019, Seasonal incidence of aphid, *Aphis gossypii* and coccinellid beetles in tomato ecosystem. *Journal of Entomology and Zoology Studies*, 7, pp. 879-882.

Kadam J R and Khaire V M, 1995, Raining and relative humidity: key factors to suppress *Earias vittella* (Fabricius) infestation on 'okra' crop. *Journal of Entomological Research,* 19(3): 201-205.

Kurl S P and Kumar A 2010, Population dynamics of *Helicoverpa armigera* (Hubner) in relation to meteorological parameters. *Journal of Experimental Zoology*, 13(1): 129-132.

Mahmoud Y A, Ebadah I M A, Abd-elrazek A S, Abd-elwahab T E and Marsy S H D, 2015, Population fluctuation of tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) during winter and summer plantations in Egypt. *Research Journal* of *Pharmaceutical*, *Biological and Chemical Sciences,* 6(4): 647-652.

Mandloi R, Pachori R, Sharma A K, Thomas M and Thakur A S, 2015, Impact of weather factors on the incidence of major insect pests of tomato (*Solanum lycopersicon* l.). *The Ecoscan*, 8(1): 7-12.

Meena N K, Kanwat P M and Sharma J K, 2010, Seasonal incidence of leafhopper and whitefly on okra. *Disease Reporter*, 62: 259-262.

Meena R S, Ameta O P and Meena B L, 2013, Population dynamics of sucking pests and their correlation with weather parameters in chilli (*Capsicum annum* L.) crop. *The Bioscan,* 8: 177-180.

Moanaro and Choudhary J S, 2018, Seasonal incidence of major sucking insect pests complex of capsicum in relation to weather parameters in eastern plateau and hill region of India. *Journal of Entomology and Zoology Studies,* 6: 270-273.

Mondal A, Shankar U, Abrol D P, Kumar A and Singh A K, 2018, Incidence of major insect pests on french bean and relation to environmental variables. *Indian Journal of Entomology*, 80(1): 51-55.

Naik V B, Rao P A, Krishnaayya P V and Chalam M V, 2009, Seasonal incidence and management of *Bemisia tabaci* (Gennadius) and *Amrasca devastans* (Ishida) of brinjal. *Annals of Plant Protection Sciences*, 17(1): 9-13.

Patel K D and Pathak V N, 1995, Development of Botryodiplodia rot of guava fruits in relation to temperature and humidity. *Indian Phytopathology*, 48(1): 86-89.

Pazhanisamy M and Hariprasad Y, 2020, Field evaluation of entomopathogens against leafminer, *Aproaerema modicella* (Deventer) (Gelechiidae: lepidoptera) in groundnut. *Plant Archives,* 14(1): 285-288.

Prasad T V, Nandagopal V and Gedia M, 2008, Effect of abiotic factors on the population dynamics of *Aphis craccivora* Koch in groundnut in Saurashtra region of Gujarat. *Indian Journal of Entomology,* 70(4): 309-313.

Ramya S, Shantanu J and Nagulapally S L, 2017, Insect pests of tomato and their weather relations under open and cover cultivation. *International Journal of Current Microbiology and Applied Sciences*, 6(9): 368- 375.

Roopini G A, 2016, Studies on seasonal incidence of pests on *Jasminum spp*. emphasizing on bud borer complex and their management strategies on *J. Multiflorum. M.Sc. (Agri.) Thesis,* University of Horticultural Sciences, Bagalkot, Karnataka, India.

Saini A, Ahir K C, Rana B S and Ravi Kumar, 2017, Population dynamics of sucking pests infesting chilli (*Capsicum annum*). *Journal of Entomology and Zoology Studies,* 5: 250-252.

Samanta A K, Sen and Basu I, 2017, Evaluation of insecticides and acaricides against yellow mite and thrips infesting chilli (*Capsicum annum* L.). *Journal of Crop and Weed,* 13: 180-186.

Soujanya P L, Prasad D and Rao P A, 2010, Population dynamics of sucking pests and their relation to weather parameters in *Bt* stacked *Bt* and non *Bt* cotton hybrids. *Trends in Biosciences*, 3(1): 15-18.

Venkataramanaiah P, Rao S R K, Prasad H K V and Sekhar R M, 2021, Seasonal phenology and pheromone trap catches South American tomato leaf miner of *Tuta absoluta* (Lepidoptera: Gelechiidae) in open field tomato under sub-tropical climatic conditions in Andhra Pradesh. *Journal of Entomology and Zoology Studies*, 9(2): 457-461.

Venkateshwarlu V, Sharma R K, Chander S and Singh S D, 2011, Population dynamics of major insect pests and their natural enemies in cabbage. *Annals of Plant Protection Sciences,* 19: 272-277.

Yadav A K, Yadav S and Singh M K, 2012, Effect of temperature on the population of parasitoids and their impact on the pest, *Melanagromyza obtusa* (Diptera: Agromyzidae). *The Ecoscan*, 1: 45- 50.

Yadav S K, 2018, Bio-ecology and management of major insect pests of chilli (*Capsicum annum* L.). *Ph.D Thesis,* Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India.