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Seasonal incidence of major insect pests of chilli crop and their correlation with abiotic factors

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Abstract
A field experiment was conducted during *rabi* season in the year 2018 at Vegetable Research Centre, Pantnagar to study the seasonal incidence of major insect pests of chilli crop in relation to weather parameters. The results depicted the first incidence of aphids, thrips on the 43rd SMW, whitefly appeared on 45th SMW while borers (*Helicoverpa armigera* and *Spodoptera litura*) were recorded in the trial field on 1st SMW. The predators (spiders and ladybird) were reported in the field on 44th SMW. The sucking pest complex (aphids, thrips and whitefly) attained their peak on 6th SMW while the borer reached their peak densities on 7th SMW. The predator populations were maximum on 6th SMW. Aphids and thrips were positively correlated with mean temperature (r= 0.503* and r= 0.393), mean relative humidity (r= 0.218 and r= 0.251) and rainfall (r= 0.296 and r= 0.284). Borers (*Helicoverpa armigera* and *Spodoptera litura*) showed positive and significant correlation (r= 0.491* and r= 0.476*) with rainfall. Maximum temperature (r= -0.663** and r= -0.632**) and sunshine hours (r= -0.604** and r= -0.570**) had highly significant and negative influence on spiders and ladybird population.

Keywords: Insect pests, predators, chilli, seasonal fluctuation

Introduction

India is the second largest producer of vegetables in the world (NHB, 2017) [14]. Vegetables occupy a prominent position in human diet regime. They are low in fats and carbohydrates while minerals, vitamins, antioxidants, micronutrients and dietary fibers are present in high amount. Uttar Pradesh with 15% share in the total vegetable production is the leading vegetable producing state followed by West Bengal (14.6%), Madhya Pradesh (9.5%), Bihar (8.1%), Gujarat (7.7%), Maharashtra (5.9%), Odisha (5%) and Karnataka (4.7%) (NHB, 2018) [15].

Chilli (*Capsicum annuum* L.) representing a diverse vegetable group belongs to Solanaceae family. It is one of the important commercial and valuable spice crop grown throughout the world. In India, Karnataka ranks first in terms of area and production of chilli. It covers an area of 45.4 thousand hectare and production of 607.94 thousand tonnes (NHB, 2017) [14], respectively. Other chilli growing states in the country are Madhya Pradesh, Andhra Pradesh, Bihar, Maharashtra and Chhattisgarh. Our country is the largest producer of dry chillies in the World (FAO, 2012) [4]. Twenty five to thirty species are present in the genus *Capsicum.* However, only five species have been brought under cultivation by man i.e. *Capsicum. annuum, C. pubescens, C. frutescens, C. chinese, C. baccatum* (Idris *et al*., 2001) [7]. Only two species of chilli are cultivated in India viz. *Capsicum frutescens* and *Capsicum annuum*. However, most of the varieties that are cultivated belong to *Capsicum annuum.*

In Uttarakhand, chilli is grown in an area of 2091 hectare with the productivity of 7625 MT (Tukaram, 2017) [23]. Owing to its pungency, colour and sharpness Uttarakhand's chilli occupies a unique place in the Indian market. Chilli is widely cultivated for its valuable fruits in India. It is used for the preparation of pickles, condiments, sauces, soups, chutneys and various curries. Chilli pods either fresh or dry are used for culinary purposes. It is nutritionally very rich, with high amount of vitamins particularly vitamin A and C, minerals like potassium, magnesium and manganese. The presence of secondary metabolites such as Capsaicin makes chilli highly pungent (Anonymous, 2018) [1]. The red colour of chilli is due to the presence of the capsanthin pigment which is used to impart the natural colouration to squashes and jellies.

Insect pest infestation causes the significant damage to the crop and its holds the major share for low quality and productivity of chilli. The crop is attacked by 55 species of insect pests (Jadhav *et al*., 2004) [8]. The major pests attacking chilli crop are thrips (*Scirtothrips dorsalis* Hood), whiteflies (*Bemisia tabaci* Gennadius), aphids (*Aphis gossypii* Glover), armyworm (*Spodoptera litura* Fabricius), jassids (*Amrasca bigutulla bigutulla* Ishida), fruit borer (*Helicoverpa armigera* Hubner) and mites (*Polyphagotarsonemus latus* Banks) (Sorensen, 2005) [20]. These pests attack chilli crop from the time of transplanting till the final harvest of the crop. The insect being the prime production constraints can cause the yield loss ranging from 50-90 percent (Kumar, 1995) [11]. Thrips alone can cause the yield loss of 30-50 percent (Bhede *et al*., 2008) [9].

The infestation level and the economic losses caused by these pests differ from region to region due to variation in the agro climatic conditions. The level of infestation however depends upon the number of abiotic factors (temperature, relative humidity, sunshine hours and wind velocity) and biotic factors (natural enemies). Thus, it becomes necessary to continuously survey the insect pest population under the field condition which gives the idea of peak period of their activity which would help to prevent sudden pest outbreak and to formulate economically effective insect pest management strategy.

Materials and Methods

The present field experiment on seasonal incidence of major insect pests of chilli crop and their correlation with abiotic factors was carried out at Vegetable Research Centre, GBPUA&T, Pantnagar, Udham Singh Nagar, Uttarakhand during *Rabi* season in the year 2018. Seedlings of chilli (Pusa Jwala) were raised in nursery beds and 45 days old chilli seedlings were transplanted on 20th October, 2018. The experiment was laid out in Randomized Block Design (RBD) with spacing of 60x45 cm and plot size of 5X5 m^2 respectively.

The surveillance of chilli crop to study the fluctuation in population of insect pests and their natural enemies was done throughout the crop growing season. The data on seasonal incidence was recorded during the morning hours (7-10 am) since the winged insects were sluggish hence, could be counted easily. The observations were taken at the weekly intervals.

To study the sucking insect pest (thrips, aphids and whitefly) population, five plants were selected randomly from each plot and were tagged. The number of insects involving both nymphs and adults of whitefly, thrips and aphids on three leaves *viz.* each from upper, middle, and lower portion of plant were recorded till the final harvesting (Bhatt and Karnatak, 2018) [2]. The data for insect pests was recorded on per leaf basis. To study the population of natural enemies' five plants were selected in a random manner. The number of predator *viz.* spiders and coccinellids was recorded as number of spiders and *Coccinella* spp. per plant at a weekly interval. The other natural enemies were also present in the field but their population size was too small to be used for statistical analysis.

The data collected during the course of study was correlated with weather parameters. The weather data was obtained from the meteorological observatory located at Norman E. Borlaug Crop Research Centre, Pantnagar. The data was further subjected to statistical analysis and correlation coefficient was worked out using OPSTAT software.

Result and Discussion

The following results were obtained during the course of above study have been summarized in table 1 and table 2:

Aphids

The first incidence of aphids (9.20 aphids/ leaf) was recorded soon after the transplanting of chilli crop. A gradual increase and a subsequent decrease were observed in the aphid population. The maximum aphid population (9.40 aphids/ leaf) was observed in the 6th SMW. Thereafter, the population decreased in a gradual manner. However, the pest population was observed till the final maturity of the crop. On working out the correlation coefficient a significant and positive correlation of aphid population was observed with minimum temperature (r= 0.652**), mean temperature (r= 0.503*) and wind velocity (r= 0.565**) while morning relative humidity (r= -0.106) and sunshine hours (r= -0.075) had a non significant negative correlation with the pest population. The remaining weather factors affected the aphid population in a positive and non significant manner. Hadiya and Kalariya, 2017 [5] calculated the correlation coefficient values for aphid population and abiotic factors which showed that morning relative humidity and sunshine hours had a non significant negative correlation with the aphid population. Havanoor and Rafee, 2018 [6] reported maximum temperature (r= 0.15) had non significant positive influence on aphid population. Ghose *et al*., 2018 [12] recorded a highly significant positive correlation with minimum temperature and wind velocity while non significant positive correlation was observed with rainfall.

Thrips

The incidence of thrips (6.81 thrips/ leaf) was observed in the 43rd SMW (Standard Meteorological Week) when the maximum and minimum temperature was 29.6^{0}C and 12^{0}C, morning and evening relative humidity was recorded as 90.4% and 50.7% respectively, the sunshine hours and wind velocity was measured as 8.6 hrs and 3.4 km/hr in the month of October just after transplanting. Thrips (*Scirtothrips dorsalis* Hood) population gradually increased and attained its peak (9.40 thrips / leaf) in 6th SMW. Thereafter, a significant decline in thrips population was recorded reaching 3.83 thrips/ leaf at the end of crop growing season. Correlation of thrips population with various weather parameters was worked out and correlation coefficient was calculated. The results revealed a positive and highly significant correlation (r= 0.545**) with minimum temperature. A negative and non significant correlation was observed between thrips population and morning relative humidity (r= -0.089) and sunshine hours (r= -0.162). The results are in accordance with Reddy *et al*., 2017 [18] who recorded a non significant and negative correlation (r= -0.27) between thrips population and morning relative humidity. Similarily, a positive correlation (r= 0.358, r= 0.219) was observed with maximum and minimum temperature by Jayewar *et al*., 2018 [9]. A positive correlation of thrips population was recorded with maximum temperature by Patel *et al*., 2009 [16].

Whitefly

The first incidence of whitefly (5.72 whitefly/ leaf) was observed in 45th SMW when the maximum and minimum temperature was 27.5^{0}C and 11.7^{0}C, morning and evening relative humidity was measured as 93.9% and 54% respectively, sunshine hours were recorded as 7.7 hrs while wind velocity was observed to be 2.8 km/hr. A gradual increase was observed in its population followed by a decrease, while the peak population of whitefly (6.70 whitefly/ leaf) was recorded in 6th SMW when maximum and minimum temperature was 21.1⁰C and 9.1⁰C, morning and evening relative humidity was measured as 95% and 66% respectively, sunshine hours were recorded as 4.7 hrs while wind velocity was observed to be 3.4 km/hr. Correlation coefficient revealed a negative and non significant correlation (r= -0.078, r= -0.052, r= -0.167) of whitefly population with maximum and mean temperature and sunshine hours respectively. However, all other weather parameters were positively and non significantly correlated with whitefly population. The present findings are in accordance with Khalid *et al*., 2006 [10] who also observed no correlation between whitefly (immature and adult) population and wind speed, relative humidity and rainfall amount throughout chilli cropping period. Jha and Kumar, 2017 [21] reported a negative correlation of whitefly population with maximum temperature (r= -0.481) and sunshine hours (r= -0.641) while a positive and non significant correlation was observed with minimum temperature (r= -0.483), morning relative humidity (r= 0.514), evening relative humidity (r= 0.483) and wind speed (r= 0.007).

Helicoverpa armigera and *Spodoptera litura*

The incidence of *Helicoverpa armigera* (4.83 larvae/ plant) and *Spodoptera litura* (3.40 larvae/ plant) was first observed during 1st SMW when maximum and minimum temperature was 21.3⁰C and 6.1⁰C, morning and evening relative humidity was recorded as 91% and 60% respectively and sunshine hours was recorded as 6 hrs. The maximum population (5.70 larvae/ plant and 4.38 larvae/ plant) of both the pests was recorded on 7th SMW with maximum and minimum temperature recorded as 22.7⁰C and 10.8⁰C, morning and evening relative humidity measured as 94% and 64% respectively while sunshine hours and wind velocity were recorded as 6 hrs and 1 km/hr respectively. On working out the correlation coefficient a significant positive influence of maximum temperature (r= 0.458*) and a significant negative influence of sunshine hours (r= -0.474*) was observed in *Helicoverpa armigera* population. The population of *Spodoptera litura* was negatively and significantly correlated with sunshine hours (r= -0.430*). Minimum temperature, mean temperature, evening relative humidity and wind velocity were negatively but non significantly associated with both the pest population. The present results are in agreement with Tompe *et al*., 2020 [22] who observed a positive correlation of *Spodoptera litura* moth population, morning relative humidity and maximum temperature while evening relative humditiy and minimum temperature had negative association with *Spodoptera litura* moth population and fruit infestation caused by this pest. A non significant and negative association of *Helicoverpa armigera* was observed with minimum temperature and positive correlation was recorded with morning relative humidity by Pathipati *et al*., 2014 [17]. Nadaf and Kulkarni, 2006 [13] reported a positive significant influence with larval population of *H. armigera*.

Seasonal incidence of Ladybird beetle and Spider population

The first incidence of spiders (0.30 spiders/ plant) and coccinellids (0.46 *Coccinella*/ plant) in chilli field was observed on 44th SMW with the mean temperature and mean relative humidity of 21.8⁰C and 71% respectively. The predator (spider and coccinellids) population showed a slow increase reaching its maximum (2.81 spiders/ plant and 2.72 *Coccinella*/ plant) on 6th SMW. A simple correlation of predator population was worked out with abiotic factors and results of the study revealed a significant negative influence of maximum temperature (r= -0.663** and r= -0.632**), mean temperature (r= 0.518* and r= -0.515*) and sunshine hours (r= -0.604** and r= -0.570**) on spiders and ladybird beetle population respectively. Amount of rainfall was positively and significantly correlated with spiders (r= 0.614**) and *Coccinella* (r= 0.553*) population. Wind velocity, morning relative humidity, evening relative humidity and mean relative humidity had positive and non significant impact on predator population. According to Hadiya and Kalariya, 2017 [5] there was a highly significant negative correlation of ladybird beetle and spider population with maximum temperature, minimum temperature and mean temperature. Samanta *et al*., 2017 [19] reported a positive and non significant association of wind velocity with coccinellid and spiders population.

Table 1: Seasonal incidence of major insect pests and their predators on chilli crop during 2018

SMW	Month and Date	Aphids/3 leaves	Thrips/3 leaves	Whitefly/3 leaves	*Helicoverpa armigera*/3 leaves	*Spodoptera litura*/3 leaves	Spiders/ Plant	*Coccinella/ Plant*
	Oct							
43	22-28	9.20	6.81	0	0	0	0	0
	Oct-Nov							
44	29-04	9.70	6.62	0	0	0	0.30	0.46
	Nov							
45	05-11	8.42	5.70	5.72	0	0	0.41	0.59
46	12-18	7.11	5.30	5.45	0	0	0.48	0.71
47	19-25	6.60	5.53	5.36	0	0	0.57	0.77
	Nov-Dec							
48	26-02	6.83	5.90	5.42	0	0	0.66	0.93
	Dec							
49	03-09	5.91	5.04	3.80	0	0	0.84	1.06
50	10-16	5.54	3.83	3.66	0	0	1.00	1.24
51	17-23	5.24	3.73	3.50	0	0	1.11	1.44
52	24-31	4.92	3.32	2.30	0	0	1.28	1.51
	Jan							
1	01-07	5.46	5.30	2.37	4.83	3.40	1.36	1.67
2	08-14	5.80	5.81	2.60	4.50	4.15	1.55	1.83
3	15-21	6.31	5.93	2.71	4.10	3.77	1.88	1.95
4	22-28	6.00	4.54	2.43	4.07	3.30	2.20	2.23

	Jan-Feb							
5	29-04	5.73	4.17	2.92	5.05	3.11	2.53	2.45
	Feb							
6	05-11	9.40	7.53	6.70	5.74	3.83	2.81	2.72
7	12-18	7.12	6.10	4.18	5.70	4.38	2.72	2.66
8	19-25	9.33	7.30	6.37	5.51	3.70	2.40	2.49
	Feb-Mar							
9	26-04	8.25	5.55	5.50	5.04	3.54	2.22	2.21
	Mar							
10	05-11	7.64	5.91	5.08	4.61	3.34	1.91	2.00
11	12-18	6.32	4.63	4.67	3.70	3.09	1.37	1.84
12	19-25	4.20	3.83	3.00	2.11	2.75	1.05	1.63

Table 2: Correlation of major insect pests of chilli crop with abiotic factors

Insect Pests	Temperature (^{0}C)			Relative Humidity (%)			Rainfall (mm)	Sunshine Hours	Wind Velocity (km/hr)
	Maximum	Minimum	Mean	Morning RH	Evening RH	Mean RH			
Aphids	0.327	0.652**	0.503*	-0.106	0.332	0.218	0.296	-0.075	0.565**
Thrips	0.222	0.545**	0.393	-0.089	0.364	0.251	0.284	-0.162	0.282
Whitefly	-0.078	0.196	-0.052	0.274	0.368	0.406	0.121	-0.167	0.023
Helicoverpa armigera	0.458*	-0.114	-0.263	0.197	-0.296	0.163	0.491*	-0.474*	-0.101
Spodoptera litura	0.402	-0.115	-0.286	0.265	-0.161	0.033	0.476*	-0.430*	-0.154
Spiders	-0.663**	-0.289	-0.518*	0.062	0.385	0.319	0.614**	-0.604**	0.068
Coccinella	-0.632**	-0.320	-0.515*	0.022	0.294	0.233	0.553**	-0.570**	0.044

Conclusion

The results of the present study depicted that the insect pests were recorded on chilli crop just after transplanting and the peak population of insect pests was reached in the month of February. Thus, from the present study it can be concluded that the seasonal abundance and activity of insect pests and their predators on chilli crop is influenced by various abiotic factors. The results obtained from the study can play an significant role in developing weather based insect pest forecasting models and in addition it can also help the farmers of Tarai region in adjusting the transplanting date for chilli crop for effective management of insect pest population.

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