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Impact of Weather Parameters on Population Fluctuation of Chilli Thrips, *Scirtothrips dorsalis* Hood

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ABSTRACT

Chilli var. *Tejaswini* was grown in three quadrates (5.0×6.0 m^2) during *pre-kharif* season (January-June) of 2018 and 2019 at farmer's field, Sriniketan, West Bengal, India to study the fluctuation of thrips population during the crop growing seasons under the influence of varying weather parameters. Population fluctuation of the thrips was recorded at weekly intervals starting from one week after transplanting till the last harvest. The insect first appeared on 6-8 leaves stages of the crop during both seasons and the population gradually reached to peak at 14 MSW (10.95 thrips $leaf^{-1}$) and 13 MSW (9.83 thrips $leaf^{-1}$) during 1st and 2nd seasons, respectively. Correlation of thrips population with both previous and same meteorological standard week data showed different results. Significant negative correlation with relative humidity (r=-0.561*) but positive with sunshine hours (r=0.476*) recorded only during 2018 when correlations were studied with previous week weather data. Studies on multiple regression revealed that combined effect of weather parameters on the population build up of thrips had 26.0% (R^2= 0.260) and 55.4% (R^2=0.554) during 1st season while it was 40.6% (R^2=0.406) and 18.9% (R^2=0.189) during the 2nd season. Trend analysis revealed that during 1st season maximum and minimum temperatures around 35.0°C and 20°C found favourable for pest population build-up, while relative humidity (65% or higher), rainfall (6.0 mm), and bright sunshine (8 h) negatively affected the thrips population. A similar trend in insect population build-up was also recorded during the 2nd season.

KEYWORDS: Chilli, correlation, regression, *Scirtothrips dorsalis*, thrips, trend analysis

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

The usage of chillies in food and traditional medicine dates back to their roots in Mexico and eventually extended throughout the world. Chilli (*Capsicum annuum* L) is regarded as an important commercial spice and vegetable crop currently consumed around the world (Tan et al., 2021, Karim et al., 2021) to add a punch of heat and flavour to dishes. Different varieties are grown for various purposes, such as vegetables, pickles, spices, and condiments. Indian chilli is famous around the world for two important commercial qualities: its colour and pungency. In India, this "wonder crop" is very much popular not only because of its economic importance, but also for the nutritional value of its fruits which are excellent source of natural colours and antioxidant compounds (Jha and Prasad, 2011, Nevarro et al., 2006). The attractive colour is because of presence of a pigment known as 'Capsanthin' and the pungency due to an alkaloid "capsaicin" (Bhavani et al., 2020). India contributes half of the world chilli production. The acreage of chilli in India was around 418 lakh ha with an annual production of 4417.22 mt and an average productivity of 1.94 t ha^{-1} during the year 2021–2022 (Anonymous, 2022a). Major chilli producing states in India are Andhra Pradesh provides (49%), Orissa (18%), Karnataka (15%), Maharashtra (6%), West Bengal (5%), Rajasthan (4%) and Tamil Nadu (3%) (Anonymous, 2022b). A survey during the year 2021–22 reveals that in the state of West Bengal, the major chilli growing districts are Murshidabad, South 24-Parganas, North 24-Parganas, Nadia, East Midnapore, West Midnapore, Coochbehar, Jalpaiguri, and Birbhum (Anonymous, 2022b). Inspite of its major share in world chilli production, the productivity of chilli in India is very low particularly as compared to china. Among the several production constrains infestation by insect pests and mites greatly reduce the chilli production (Chhapekar et al., 2018, Shaker et al., 2019, Mohan and Anilkumar, 2020, Nasrin et al., 2021). Now-a-days, climate change is threatening global food production by changing the pest phenology, rate of multiplication of the pest, host-plant resistance and other biotic factors of both plants and pests. Chilli production is affected by different pests namely thrips, *Scirtothrips dorsalis* Hood, aphids, *Myzus persicae* Sulzer, *Aphis gossypii* Glover, yellow mite, *Polyphagotarsonemus latus* Banks and fruit borer, *Heliothis armigera* Hubner (Mokal et al., 2018, Berke and Shieh, 2000) and among which chilli thrips proved the major biotic constrain (Ali et al., 2006, Priyadarshini et al., 2019) causing yield losses to the extent of 75% or more (Sarkar et al., 2015, Ballal et al., 2022) in favourable weather condition. Weather factors including temperature, relative humidity, rainfall, and sunshine hours directly determine the occurrence and growth of this tiny insect in chilli (Gopal et al., 2018, Mondal and Patra, 2021). In India, varying trend in pest incidence and extent of damage to the crop was recorded due to the variation in agro-climatic conditions of different regions (Saini et al., 2017). Hence, the farmers are highly uncertain to make the right decision to manage this notorious pest as they overlook the trend of insect population fluctuation. The studies on the weather-pest relationship might be the correct direction in predicting the occurrence of pest influence in a given area (Subharani and Singh, 2007) as such studies proved to have great significance in developing effective forecasting system for implementing timely plant protection measures (Havanoor and Rafee, 2018). Considering the above views, present investigation was carried out to study the fluctuation of thrips population during the crop growing seasons under the influence of varying weather parameters in the lateritic zone of West Bengal.

2. MATERIALS AND METHODS

The field experiment was conducted for two consecutive *pre-kharif* season during the months of January–June in the year 2018 and 2019 at farmer's field, Sriniketan, West Bengal, India which is situated at 23.66°N latitude, 87.66°E longitude and at an average altitude of 58.90 m above mean sea level. Chilli var. *Tejaswini* was grown in three quadrates (5.0×6.0 m^2) following the standard agronomic practices without any intervention of plant protection measures. The observations were recorded at weekly intervals starting from one week after transplanting (6 MSW) till the last harvest (23 MSW). During the observation, ten plants were selected randomly from each plot and tagged first. Thereafter, two leaves each from upper and middle canopies of every sampled plant were observed very carefully and minutely with the help of a magnifying glass (10x) for the presence of thrips population. The crop growth stages and weather data were recorded during each observational period. The thrips population during each meteorological standard week (MSW) was correlated with both previous and same week of weather data. Besides multiple regression analysis using thrips population and different weather data (previous and same week) was also carried out to find out the coefficient of determination (R^2) while Trend analysis was also done to know the favourable range of each abiotic factor for population build-up of the pest (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1. *Effect of weather factors on population dynamics of chilli thrips*

3.1.1. *Seasonal incidence of chilli thrips*

A perusal of Table 1 and Figure 1 revealed that the population of thrips during the 1st season initiated on the 1st

Table 1: Incidence of *S. dorsalis* at different growth stages of the chilli crop

MSW	Crop growth stage	Thrips (No./Leaf)		MSW	Crop growth stage	Thrips (No./Leaf)	
		Pre-kharif 2018	*Pre-kharif* 2019			*Pre-kharif* 2018	*Pre-kharif* 2019
6	Planting	0.00	0.00	16	Fruiting Initiation	6.15	6.10
		(0.71)^{e}	(0.71)^{f}			(2.49)^{abc}	(2.48)^{abc}
7	6–8 Leaves	0.42	0.52	17	Fruiting	2.54	6.17
		(0.94)^{de}	(0.99)^{ef}			(1.70)^{bcde}	(2.54)^{abc}
8	1–2 Twigs	1.35	1.12	18	Peak Fruiting	2.68	1.05
		(1.29)^{cde}	(1.27)^{def}			(1.78)^{bcde}	(1.19)^{def}
9	2–3 Twigs	2.21	2.58	19	Fruiting	1.02	0.52
		(1.59)^{bcde}	(1.75)^{cde}			(1.18)^{cde}	(1.01)^{ef}
10	>3 Twigs	4.15	4.15	20	Fruiting	0.59	0.32
		(2.15)^{abcd}	(2.12)^{bcd}			(0.97)^{de}	(0.91)^{ef}
11	Vegetative	6.85	5.85	21	Initiation Senescence	0.35	0.24
		(2.68)^{ab}	(2.52)^{abc}			(0.89)^{de}	(0.85)^{ef}
12	Peak Vegetative	8.04	7.95	22	Senescence	0.22	0.15
		(2.86)^{ab}	(2.89)^{ab}			(0.83)de	(0.80)ef
13	Flower initiation	10.24	9.83	23	Final Harvesting	0.00	0.00
		(3.27)^{a}	(3.20)^{a}			(0.71)e	(0.71)f
14	Flowering	10.95	9.02		SEm±	0.25	0.19
		(3.37)^{a}	(3.09)^{ab}		CD (p=0.05)	0.72	0.52
15	Peak Flowering	5.29	5.28		C.V	24.67	19.31
		(2.39)^{abc}	(2.38)^{abc}				

Figures in parentheses indicate √(x+0.5) transformed values; Means followed by same letter are not significantly different according to Tukey's HSD test at p=0.05

week of February (6 MSW) at very early growth stages of the crop (6–8 leaves). Population built up gradually and attained the peak (10.95 thrips leaf^{-1}) in the last week of March (14 MSW) at the flowering period of the crop which recorded a considerably higher pest population as compared to rest of the periods. Thrips population during the 2nd season also initiated in 1st week of February (6 MSW) at 6-8 leaves stage and gradually increased to reach the peak (9.83 thrips leaf^{-1}) at the end of March (13 MSW) during flower initiation stage. Thereafter, the declined population of insects was recorded which disappeared at the end of July (22 MSW) (Table 1 and Figure 2). Senapati and Mohantynthy (1980) also recorded similar observations with a peak population during 1st week of March, after which a declining population was noticed with the advancement of time while Borah (1987) reported that thrips populations tended to increase during dry periods with lower minimum temperatures and fewer rainy days with lower rainfall intensity. Kumar et al., (2020) recorded the first appearance of chilli thrips during 4th week of November (47 MSW) at vegetative stage with a maximum population of 20.2 thrips plant^{-1} during 2nd week of April (15th MSW).

3.1.2. Correlation of chilli thrips with weather parameters

Table 2 depicted that during the both crop growing seasons the correlations between thrips populations and different weather factors were either positive or negative. However, in majority of cases the correlation coefficient values were small and non-significant. Interestingly, when correlation was carried out with previous week weather data, significant correlation was recorded with relative humidity (r=-0.561*) and sunshine hour (r = 0.476*) during the 1st season while the 2nd season data showed non-significant. Hosmani (2006) found a negative correlation between minimum temperature and rainfall with the thrips population while Patel et al. (2009) recorded a positive correlation between bright sunshine hours and maximum temperature but a negative correlation between relative humidity and rainfall. Deepak et al. (2019) observed positive correlation of thrips

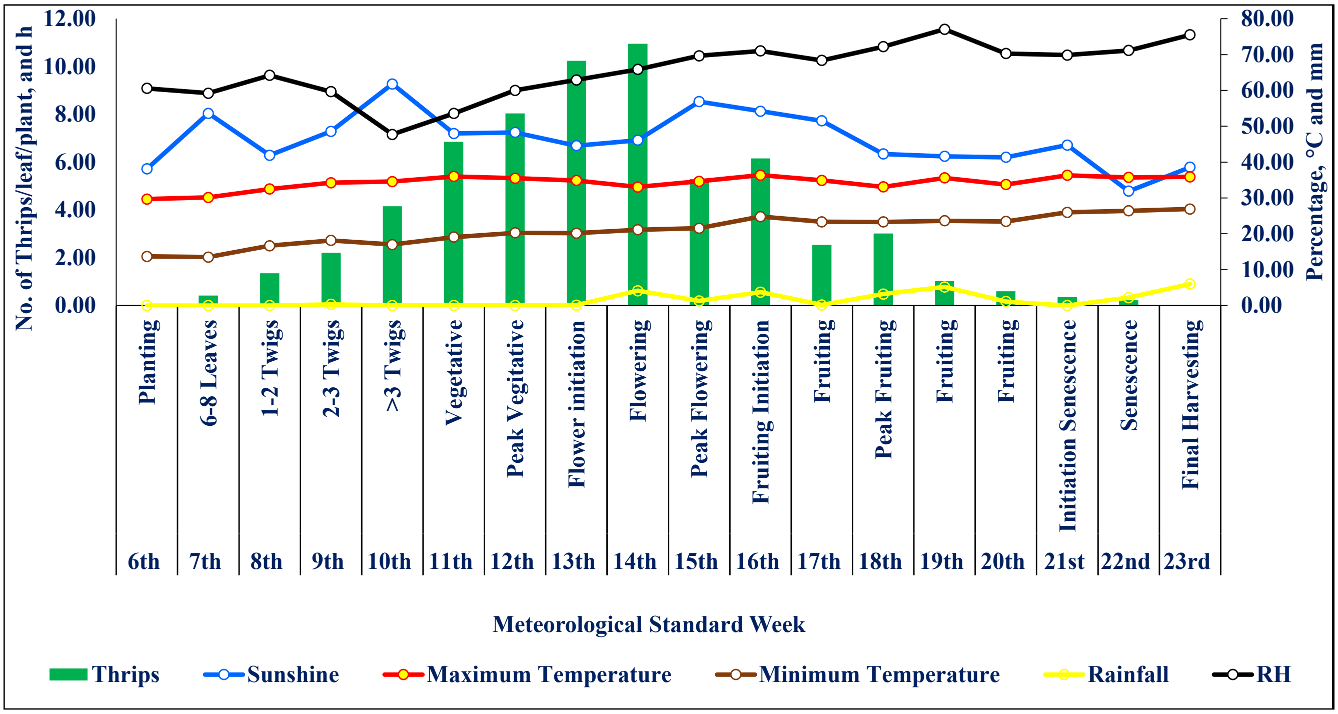

Figure 1: Population fluctuation of Thrips on Chilli at different MSW during *pre-kharif* 2018

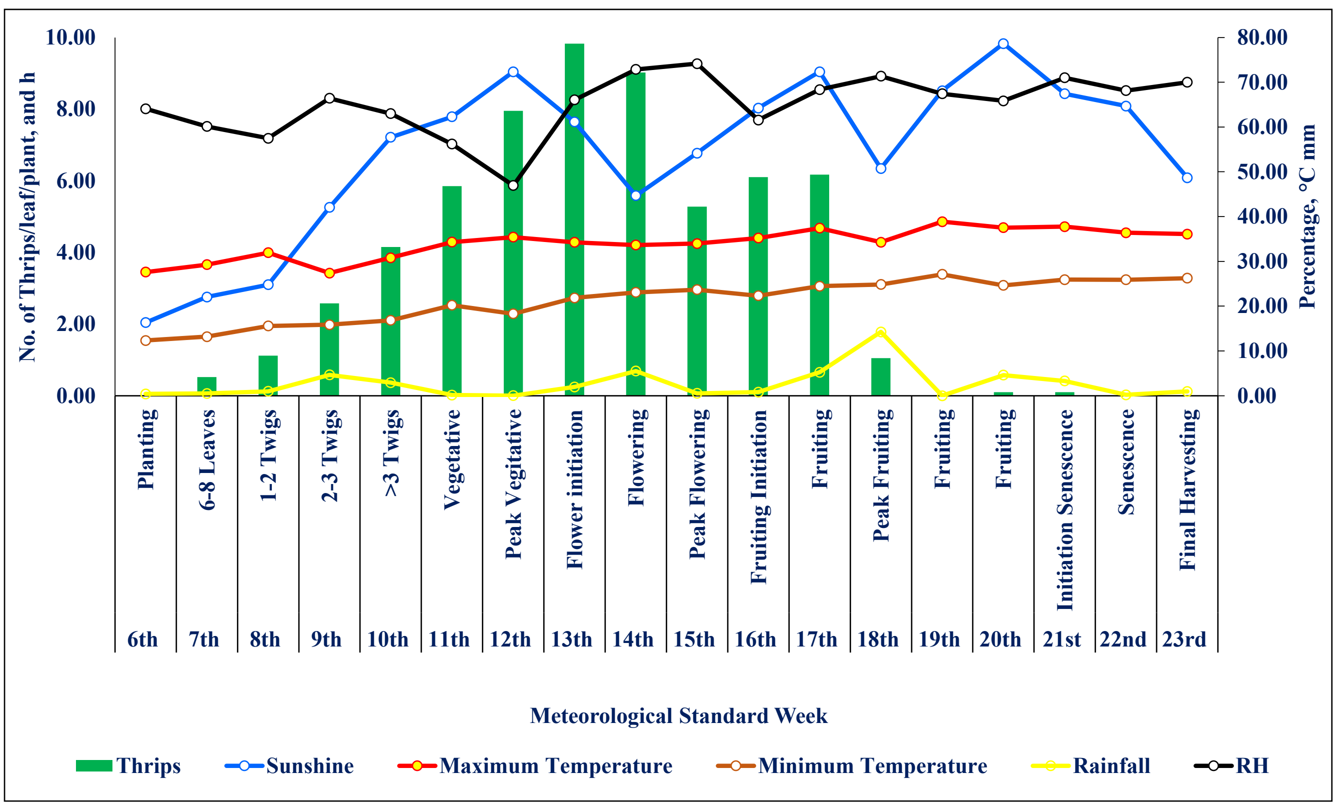

Figure 2: Population fluctuation of Thrips on Chilli at different MSW during *pre-kharif* 2019

population with maximum temperature but negative correlation with morning and evening relative humidity, minimum temperature, and rain fall.

3.1.3. Multiple interactions of ecological parameters with the population of chilli thrips

Multiple regression analysis was also worked out both for

Table 2: Correlation between different weather parameters and mean population of *S. dorsalis* in chilli.

Weather parameters		Thrips (No./leaf/plant)	
		Pre Kharif-2018	*Pre Kharif*-2019
Maximum temperature (°C)	1	0.371	-0.015
	2	0.222	0.030
Minimum temperature (°C)	1	-0.053	-0.063
	2	-0.063	-0.020
Rainfall (mm)	1	-0.252	-0.244
	2	-0.029	-0.025
Relative humidity (%)	1	-0.561*	-0.379
	2	-0.294	-0.193
Sunshine (h)	1	0.476*	0.210
	2	0.368	0.271

*: Correlation coefficient values are significant at p=0.05; 1: Thrips population correlated with previous week weather data; 2: Thrips population correlated with same week weather data

Table 3: Multiple regression analyses using different weather parameters as independent variables and thrips population as dependent variable

Pre-kharif 2018 (1st season) :

Regression equation (1):

$Y=-8.907+0.618X_1-0.118X_2+0.502X3-0.177X_4+0.656X_5$

$R^2=0.260$

Regression equation (2):

$Y=-29.027+1.452X_1-0.620X_2+0.038X_3-0.093X_4+0.286X_5$

$R^2=0.554$

Pre-kharif 2019 (2nd season) :

Regression equation (1):

$Y=66.394-1.803X_1+1.426X_2-0.253X_3-0.527X_4+0.437X_5$

$R^2=0.406$

Regression equation (2):

$Y=18.854-0.542X_1+0.050X_2-0.004X_3-0.077X_4+1.014X_5$

$R^2=0.189$

1: Considering previous week weather data; 2: Considering same week weather data

X_1:Max. Temperature; X_2 :Min. Temperature; X_3 :Rainfall; X_4 :Relative humidity; X_5: Sunshine hour

the previous and the same week of weather data to find out the combined effect of the abiotic factors on the population abundance of chilli thrips. During the 1st season, the weather parameters of the previous week showed only a 26% (R^2 =0.260) contribution towards the fluctuation of the thrips population while the same week of weather data indicated 55.4% (R^2 =0.554) variation in insect population abundance due to the combined effect of the weather factors. Whereas, during the 2nd season, the combined effect of the abiotic factors on the population fluctuation of the insect was 40.6% (R^2 =0.406) and 18.9% (R^2 =0.406), respectively, for the previous and same week of weather data (Table 3). Jayewar et al., (2018) also found similar findings where weather parameters contributed 64.60%, 72.40% and 39.10% of total variation in the population of thrips in chilli during 2016, 2017 and pooled of both years, respectively indicating that the predictions of the thrips population by using weather parameters were more reliable.

3.1.4. Population trend analysis

Trend analysis depicted that maximum temperature (r = 0.222), and Sunshine (r = 0.368) within a range of 26.2-36.2 °C and 5.2-9.2 h, respectively, exhibited a positive influence on the population build-up of thrips, while Minimum temperature (r=-0.063), Rainfall (r=-0.029) and Relative humidity (r=-0.294) within the range of 14.0-26.5 °C, 0-6.0 mm and 48.0-72.0% had a negative effect on the population fluctuation of thrips, respectively during *Pre-kharif* 2018. The results also indicated that maximum and minimum temperatures around 35.0°C and 20°C found favourable for population builds up of the pest while more than 65% RH, 6.0 mm Rainfall and 8 hours of bright sunshine affected the thrips population negatively (Figure 3, 4, 5, 6, 7).

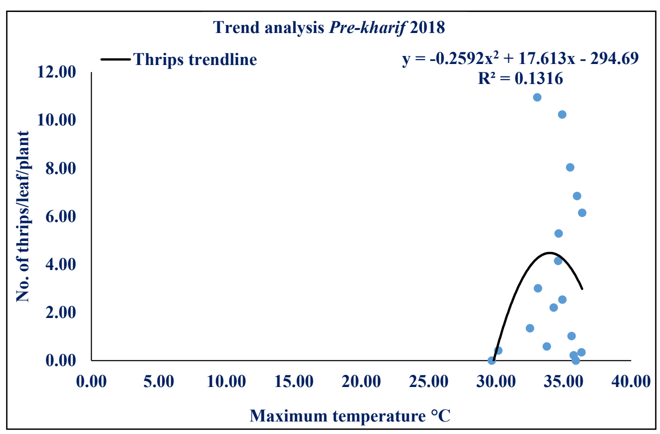

Figure 3: Relationship of thrips population with maximum temperature

Similar to the previous cropping season, Maximum temperature (r=0.030) and Sunshine (r=0.271) within a range of 26.9–38.5°C and 2.0–9.6 h, respectively, had a positive influence on thrips population during *pre-kharif* 2019. Again, Minimum temperature (r=-0.020), Rainfall

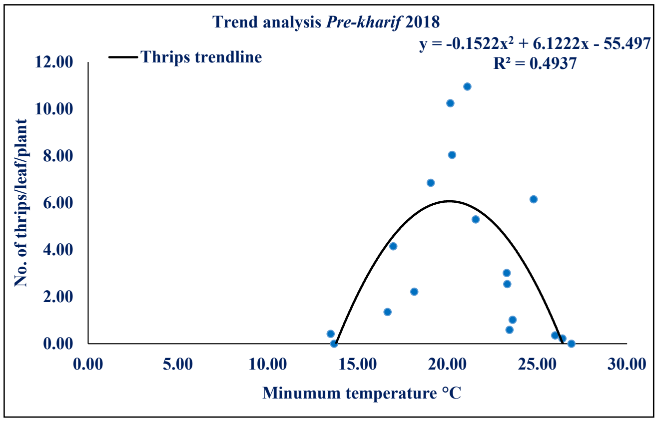

Figure 4: Relationship of thrips population with minimum temperature

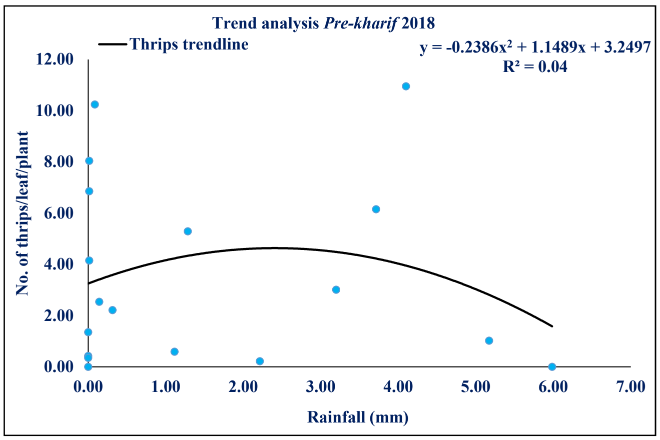

Figure 5: Relationship of thrips population with rainfall

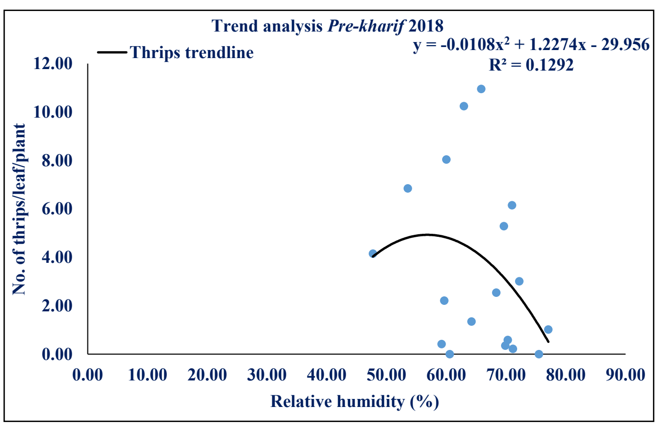

Figure 6: Relationship of thrips population with relative humidity

(r=-0.025), Relative humidity (r=-0.193) within the range of 13.0-26.5°C, 0–14.0 mm and 48.0–70.0%, respectively, played negatively. Trend analysis showed that a Maximum temperature of around 33°C and Minimum temperature close to 20°C found favourable for the insect while nearly 65% of RH, more than 8.0 mm Rainfall and long bright sunshine (more than 7 h) inflicted a decrease of the population, respectively (Figure 8, 9, 10, 11, 12). Sunil

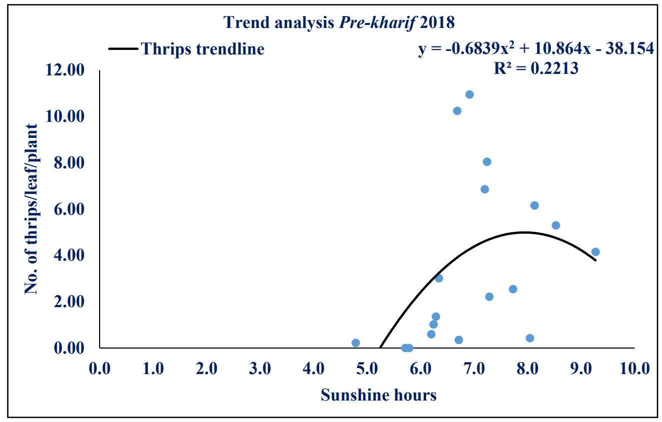

Figure 7: Relationship of thrips population with sunshine hours

et al. (2020) reported that maximum thrips population (20.2 thrips plant^{-1}) was recorded during 2nd week of April when Maximum temperature (39.49°C) and minimum temperature (23.34°C), morning relative humidity (95.86%) and evening relative humidity (71.43%), rainfall (42.8 mm), and sunlight (10.2 hrs day^{-1}) were the dominant meteorological factors.

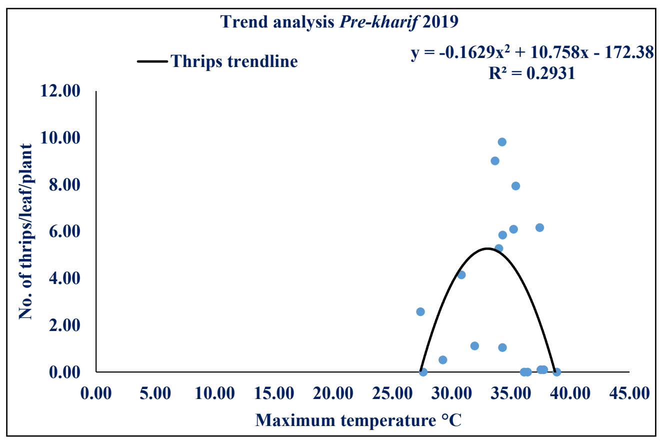

Figure 8: Relationship of thrips population with maximum temperature

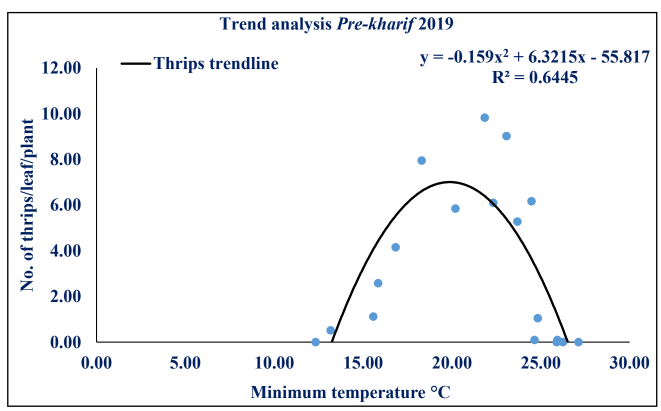

Figure 9: Relationship of thrips population with minimum temperature

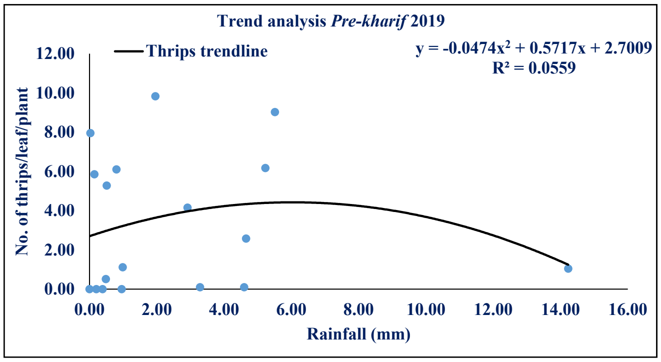

Figure 10: Relationship of thrips population with rainfall

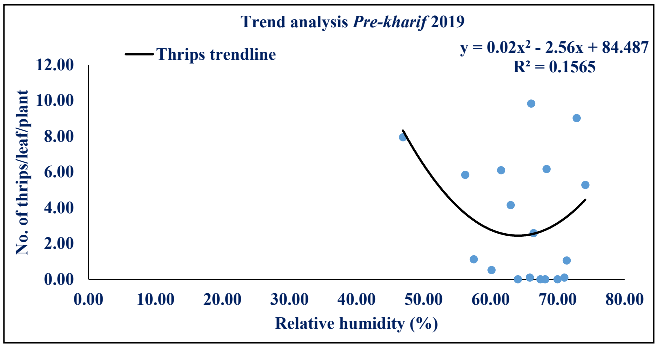

Figure 11: Relationship of thrips population with relative humidity

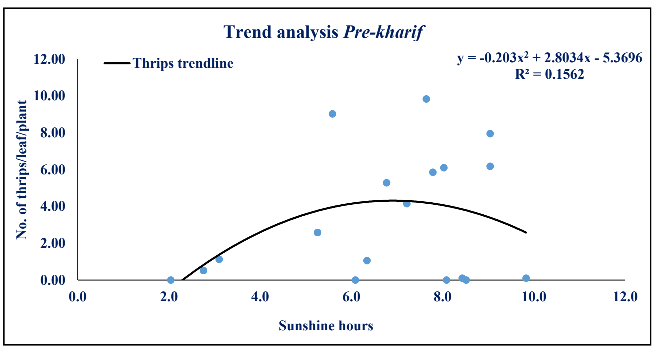

Figure 12: Relationship of thrips population with sunshine hours

4. CONCLUSION

The pest population was observed higher in number in pre-flowering to flowering periods of the crop. Correlation, regression and trend analysis depicted that, the maximum temperature and sunshine hours exhibited a positive influence on the population build-up of thrips, while minimum temperature, rainfall and relative humidity had a negative effect on the population fluctuation of thrips.

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