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RESEARCH ARTICLE

Relative abundance and population dynamics of chilli thrips *Scirtothrips dorsalis* (Hood) (Thripidae: Thysanoptera) and its correlation with weather parameters

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Abstract

Thrips, particularly *Scirtothrips dorsalis* (Hood) (Thripidae: Thysanoptera), are major sucking pests of chilli, with their populations varying throughout crop growth period depending on seasonal conditions. Field experiments were carried out during the *rabi* and *kharif* seasons of 2024 in Coimbatore, Tamil Nadu to study the population dynamics of susceptible and resistant chilli plants about weather parameters. In the *rabi* season, thrips infestation began in the second week of January and continued till March 2024. The peak population was recorded during the flowering stage in the 6th Standard Meteorological Week (SMW), with 4.73 thrips per three leaves in the susceptible entry IC-537583 and 2.73 thrips in the resistant IC-344364 at 75 days after transplanting (DAT). The associated weather conditions included 32 °C maximum temperature, 22 °C minimum temperature, 84 % maximum relative humidity, 41 % minimum relative humidity, 5.0 km/h wind speed, no rainfall and 4.07 sunshine hours. The thrips population declined at crop maturity, with 3.53 thrips in IC-537583 and 1.87 thrips in IC-344364. During the *kharif* season, initial thrips populations were recorded at the 28th SMW, peaking at the 32nd SMW, with lower populations of 3.73 thrips in IC-537583 and 1.33 thrips in IC-344364, primarily due to heavy rainfall from July to September. Correlation analysis showed that thrips incidence was positively correlated with maximum temperature, sunshine hours and wind speed in the first season. In contrast, minimum temperature, rainfall and relative humidity (both maximum and minimum) had a negative correlation. In the second season, maximum and minimum temperatures, maximum relative humidity and sunshine hours positively influenced the thrips population, whereas minimum relative humidity and rainfall had a negative impact. Multiple regression analysis accounted for 73 % and 64 % variation in thrips population during *rabi* and 64 % and 48 % during *kharif.*

Keywords: *Capsicum annum*; crop phenology; incidence; *kharif*; *rabi*; thrips

Introduction

Chilli (*Capsicum annuum* L.) is the second most crucial solanaceous vegetable after tomato. It is cultivated globally as a spice and vegetable crop (1). *Capsicum* spp. is documented to have originated from South and Central America (2). It was first domesticated in Mexico and is considered its primary centre of origin, while Guatemala is recognized as its secondary centre of origin (3). Genus *Capsicum* consists of approximately 38 species, exhibiting significant diversity in plant, flower and fruit traits (4). *C. annuum* L., *C. frutescens* L., *C. chinense* Jacq., *C. baccatum* L. and *C. pubescens* L. are the five domesticated species among which *C. annum* is the most widely cultivated and consumed species (5). Chilli is of significant economic value in India. India is the world's leading producer of dried chilli, contributing 39.78 % of global production. The country produces 3.26 Mmt of chilli annually, cultivated across 739000 hectares (6). During the 2023-24 period, the export value of dried chilli from India reached 14434.59 million US dollars (7).

In the recent climate change scenario, new insect pests and diseases hinder achieving higher yields in chilli. As a result, many farmers are abandoning cultivation due to severe yield losses. Chilli crop is infested by 293 species of insects that are considered serious threats, causing significant damage in both field and storage conditions (8). Currently, 16 thrips (Thysanoptera) species have been identified as pests that cause damage to chilli plants worldwide (9). Thrips generally damage crops by scraping the outer epidermal layer and sucking the cell sap from young leaves. This causes the leaves to curl and shrink, ultimately affecting the growth of the shoots (10). In addition to causing direct crop loss, thrips indirectly harm plants by transferring plant viruses, as they act as carriers for these viruses (11). In chilli, global losses caused by thrips are estimated to range between 50 % and 90 % (12). During dry weather seasons, thrips reproduce rapidly, leading to 30 to 50 % yield losses in India (13, 14).

Among the thrips complex recorded in chilli, *Scirtothrips dorsalis* is a predominant pest in chilli in India with ETL of 2 thrips/leaf (15). *Scirtothrips dorsalis* dominated during the nursery stage, primarily feeding on leaves, but as the crop reached the reproductive stage, *Thrips parvispinus* gradually took over, outcompeting native thrips *Scirtothrips dorsalis* and infesting all parts of the plant (16). However, in the recent invasion and dominnce of *Frankliniella occidentalis* and *Thrips parvispinus* in chilli it is inevitable to study the relative abundance of *S. dorsalis* its population dynamics on susceptible and resistant chilli genotypes and to analyse the influence of weather parameters on thrips incidence during the *rabi* and *kharif* seasons under these circumstances, so as to take up appropriate management measures.

Materials and Methods

The study on abundance, population dynamics and seasonal incidence of *Scirtothrips dorsalis* was carried out in resistant entry IC-344364 and susceptible entry IC-537583 of chilli under natural conditions at the orchard of Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu from December 2023 to March 2024 (*rabi*) and from June 2024 to September 2024 (*kharif*). The genotypes were selected based on the field screening experiment carried out earlier. Seeds of the entries were obtained from the National Bureau of Plant Genetic Resources (NBPGR), New Delhi. The experiment was laid out in a randomized block design. With three replications, the plants were transplanted randomly. chilli seeds were sown in a nursery tray and 40-day-old seedlings were transplanted in the main field with a 60 × 45 cm spacing in three replications. Recommended dosage of fertilizers were given to the plants at timely intervals and intercultural operations were carried out regularly under unprotected conditions.

Population count

Observations on the population of nymphs and adults of thrips were taken from three leaves *viz.,* one each from the top, middle and bottom in five tagged chilli plants, at fortnightly intervals during different growth stages of the crop on 45, 60, 75, 90 and 105 days after transplanting (DAT). The population (Nymphs and adults) were counted visually with a magnifying lens from 7.00 am to 9.30 am (17). The relative abundance was calculated and expressed in per cent. Weather data was provided by the Department of Agrometeorology, TNAU, Coimbatore and correlations between the thrips population and weather parameters were analysed at different crop growth stages.

Data analysis

The data obtained on population dynamics of thrips from resistant and susceptible chilli plants was correlated with weather parameters like maximum temperature, minimum temperature, relative humidity, wind speed, rainfall and sunshine hours using R software version (2024.12.0 + 467).

Results and Discussion

The relative abundance and population dynamics of *Scirtothrips dorsalis* from 45 DAT to 105 DAT of the crop showed varying results. The results showed that the maximum relative abundance of thrips was observed during the flowering phase (IC-537583 = 27.01 % and IC-344364 = 30.04 %) followed by flower initiation stage (IC-537583 = 24.52 % and IC-344364 = 22.94 %), the harvesting stage (IC-537583 = 20.75 % and IC-344364 = 21.78 %) and crop maturity stage (IC-537583 = 17.59 % and IC-344364 = 15.73 %) and minimum relative abundance was recorded during vegetative stage (IC-537583 = 10.10 % and IC-344364 = 9.54 %) as shown in (Table 1). The differences in relative abundance of thrips at different growth stages in both resistant and susceptible chili genotypes are shown in (Fig. 1). The reason for the higher abundance of thrips in reproductive phase *viz*., flower initiation to fruit maturity may be attributed to abundant source of nutritional compounds in green leaf foliage and the flowers may exude a blend of volatile compounds which may attract the thrips for feeding. Research reported that chilli flowers release a blend of volatile organic compounds and exhibit unique visual signals, which play an essential role in the host-recognition behaviour of certain thrips species (18). Research indicates that due to the abundance of floral chemicals, thrips showed a stronger preference for the volatiles released by plants during the flowering period than those emitted during the vegetative period (19). The present results were corroborated by the findings that the population of the thrips peaked during the flowering stage, ranging from 5.25 to 9.35 thrips per top three leaves and began to decline at the crop maturity stage (20). Moreover, the population tends to decline during fruit harvesting stage and at the crop maturity stage because as the crop matures, the nutritional content in the plants decreases, making the plants less favourable for thrips.

Table 1. Relative abundance and population of thrips at different growth stages of the crop

Stage of the crop	***Rabi* season**				***Kharif* season**			
	IC-344364 (R)	**RA of thrips (%)**	**IC-537583 (S)**	**RA of thrips (%)**	**IC-344364 (R)**	**RA of thrips(%)**	**IC-537583 (S)**	**RA of thrips (%)**
45 DAT	1.27 ± 0.09	12.11	2.47 ± 0.18	12.91	0.27 ± 0.10	6.87	0.93 ± 0.15	7.30
60 DAT	2.47 ± 0.52	23.75	4.47 ± 0.25	23.36	0.87 ± 0.08	22.13	3.27 ± 0.15	25.68
75 DAT	2.73 ± 0.13	26.25	4.73 ± 0.16	24.72	1.33 ± 0.18	33.84	3.73 ± 0.18	29.30
90 DAT	2.07 ± 0.15	19.90	3.93 ± 0.34	20.54	0.93 ± 0.12	23.66	2.67 ± 0.23	20.97
105 DAT	1.87 ± 0.17	17.98	3.53 ± 0.20	18.45	0.53 ± 0.17	13.48	2.13 ± 0.13	16.73

Values are presented as the means ± SE.m of thrips from three leaves. R- Resistant; S- Susceptible; RA- Relative abundance.

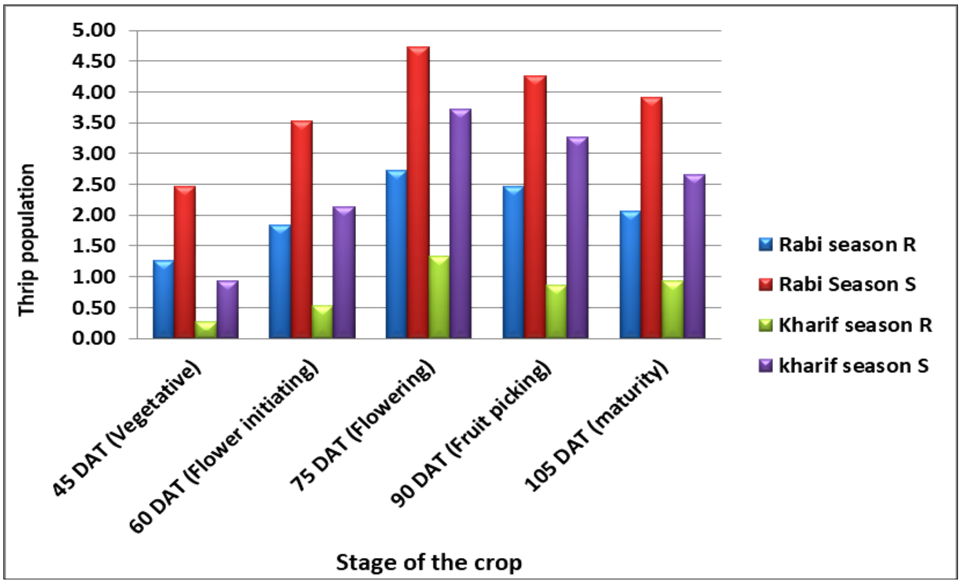

Fig. 1. Graph showing relative abundance of thrips at different crop growth stages.

Influence of weather factors on the population dynamics of chilli thrips

Based on the cultivation season, the population of thrips ranged from 1.27 nos/ 3 leaf to 4.73 nos/ 3 leaf during *rabi* season and 0.27 nos/ 3 leaf to 3.73 nos/ 3 leaves during *kharif* season. As mentioned earlier in flowering stage maximum thrips population was recorded during *rabi* season when maximum temperature was 32 °C, minimum temperature was 22 °C, maximum and minimum relative humidity was 84.0 % and 41 % respectively and wind speed, rainfall and sunshine hr were 5.0 km/h, 0 mm and 4.07 hr respectively. Similarly, during the *kharif* season, the maximum thrips population was observed during the flowering phase. This coincided with a maximum temperature of 30.6 °C, a minimum temperature of 23.6 °C, maximum relative humidity of 85 %, minimum relative humidity of 62.3 %, a wind speed of 9.4 km/h, rainfall of 9.4 mm and 8.3 hr of sunshine. Thrips are weak fliers, so they depend on the wind for dispersal. Winds associated with heavy rains in *kharif* have negatively correlated with thrips population. Research reported that the pest population gradually increased and peaked at the flowering stage (13.81 per leaf) and then the population dropped sharply, reaching a very low level (0.21 per leaf) (21). The present findings align research indicated stated that the insect was first observed at the 6-8 leaf stage of the crop in both seasons, with the population gradually peaking at 14 MSW (10.95 thrips per leaf) during the first season and 13 MSW (9.83 thrips per leaf) during the second season (22).

From the above result, it can be inferred that the *rabi* season has harboured a higher intensity of *Scirto-thrips dorsalis* than the *kharif* season, even during the flowering season, because of heavy rains during the *kharif* season. Additionally, the availability of nitrogenous fertilizers during the *rabi* season may have promoted lush green foliage, creating a favourable microclimate that potentially harboured more thrips. Research indicates that the abundance of thrips was higher during the flowering period of the dry season and decreased during the flowering stage of the rainy season (23).

Correlation of thrips population with weather parameters

The correlation between the thrips population and meteorological data from two seasons showed varying results. A significant positive correlation was observed between the maximum temperature during *rabi* season in IC-344364 (r = 0.751*) (Fig. 2A) and IC- 537583 (r = 0.795*) (Fig. 2B) (Table 2) while in *kharif* season a significant positive correlation observed in IC-344364 (0.523*) (Fig. 2C) and non significant positive correlation in IC-537583 (0.235) (Fig. 2D) with thrips population (Table 2). The present findings corroborated with an earlier study that a notable positive correlation between maximum temperature and the incidence of thrips (16). In contrast, the minimum temperature in *rabi* season exhibited a non-significant negative correlation with the thrips population in IC-344364 (r = -0.036) (Fig. 2A) and IC-537583 (r = -0.017) (Fig. 2B). In comparison, it showed a significant positive correlation in *kharif* season in IC-344364 (r = 0.817*) (Fig. 2C) and IC-537583 (r = 0.547*) (Fig. 2D). The thrips population exhibited a significant positive correlation with maximum temperature, while showing a negative correlation with minimum temperature, relative humidity (both morning and evening) and rainfall (24). On the other hand the sunshine hours showed a significant positive correlation in both *rabi* and *kharif* seasons i.e r = 0.905* in IC-344364 (Fig. 2A) and r = 0.941* in IC-537583 (Fig. 2B) during *rabi* season and a similar trend was observed in *kharif* i.e, r = 0.636* in IC-344364 (Fig. 2C) and r = 0.847* (Fig. 2D) in IC-537583. These findings are consistent with a previous study in which it was observed that a non-significant positive correlation between sunshine hours (r = 0.054) and *Scirtothrips dorsalis* numbers (19). Rainfall showed significant negative correlation in IC-537583 (-0.886*) (Fig. 2A) and IC-344364 (-0.837*) (Fig. 2B) in *rabi,* whereas in *kharif* it showed significant negative correlation in IC- 344364 (-0.525*) (Fig. 2C) and non-significant negative correlation in IC-537583 (-0.375*) (Fig. 2D) (Table 2). There is a significant negative correlation with rainfall and relative humidity which supports the present study's findings (25). In contrast, maximum relative humidity in *rabi* season showed a significant negative correlation with thrips in IC-344364 (r = -0.634*) (Fig. 2A) and IC-537583 (r = -0.694*) (Fig. 2B) chilli entries. In contrast, it showed non significant positive correlation with thrips in *kharif* season in IC-344364 (r = 0.227) (Fig. 2C) and IC-537583 (r = 0.102) (Fig. 2D). Another previous study identified a negative correlation with minimum

Table 2. Correlation coefficient between thrips and weather factors in resistant and susceptible chilli germplasms in two seasons

Parameters	Correlation (r)			
	First season		Second season	
	IC-344364 (R)	IC-537583 (S)	IC-344364 (R)	IC-537583 (S)
Max Temp (^{0}C)	0.751*	0.795*	0.523*	0.235^{NS}
Minimum temperature (^{0}C)	-0.036^{NS}	-0.017^{NS}	0.817*	0.547*
Max Relative humidity (RH)	-0.634*	-0.694*	0.227^{NS}	0.102^{NS}
Min Relative humidity (RH)	-0.926*	-0.958*	-0.366^{NS}	-0.102^{NS}
Wind speed (kmph)	0.786*	0.746*	-0.710*	-0.507*
Rain fall (mm)	-0.837*	-0.886*	-0.525*	-0.375^{NS}
Sunshine (hours)	0.905*	0.941*	0.847*	0.847*

'*' indicates significant at (P = 0.05 %); NS– non significant; R- resistant; S- susceptible

temperature, morning and evening relative humidity and average rainfall (26). However, minimum relative humidity displayed a significant negative correlation with the thrips population in IC- 344364 (r = -0.927*) (Fig. 2A) and IC-537583 (r = -0.958*) (Fig. 2B) chilli plants (Table 2) in *rabi* season while in *kharif* season it showed a non significant negative correlation in IC-344364 (r = -0.384) (Fig. 2C) and IC-537583 (r = -0.102) (Fig. 2D) with thrips population (Table 2). The current findings are consistent with a previous study that found that thrips population had a strong negative correlation with relative humidity (r = -0.561*) and a positive correlation with sunshine hours (r = 0.476) (22). Wind speed, on the other hand, exhibited a significant positive correlation with thrips population, with r = 0.786* in IC-344364 (Fig. 2A) and r = 0.746* in IC-537583 (Fig. 2B) during *rabi* season The present findings were consistent with an earlier study (27). Whereas in the *kharif* season it exhibited a significant negative correlation in IC- 344364 (r = -0.710*) (Fig. 2C) and IC- 537583 (r = -0.507*) (Fig. 2B) (Table 2). Research observed a strong negative and significant relationship between minimum temperature, relative humidity and rainfall with the incidence of *S. dorsalis* (28). Similarly, research identified a negative correlation with

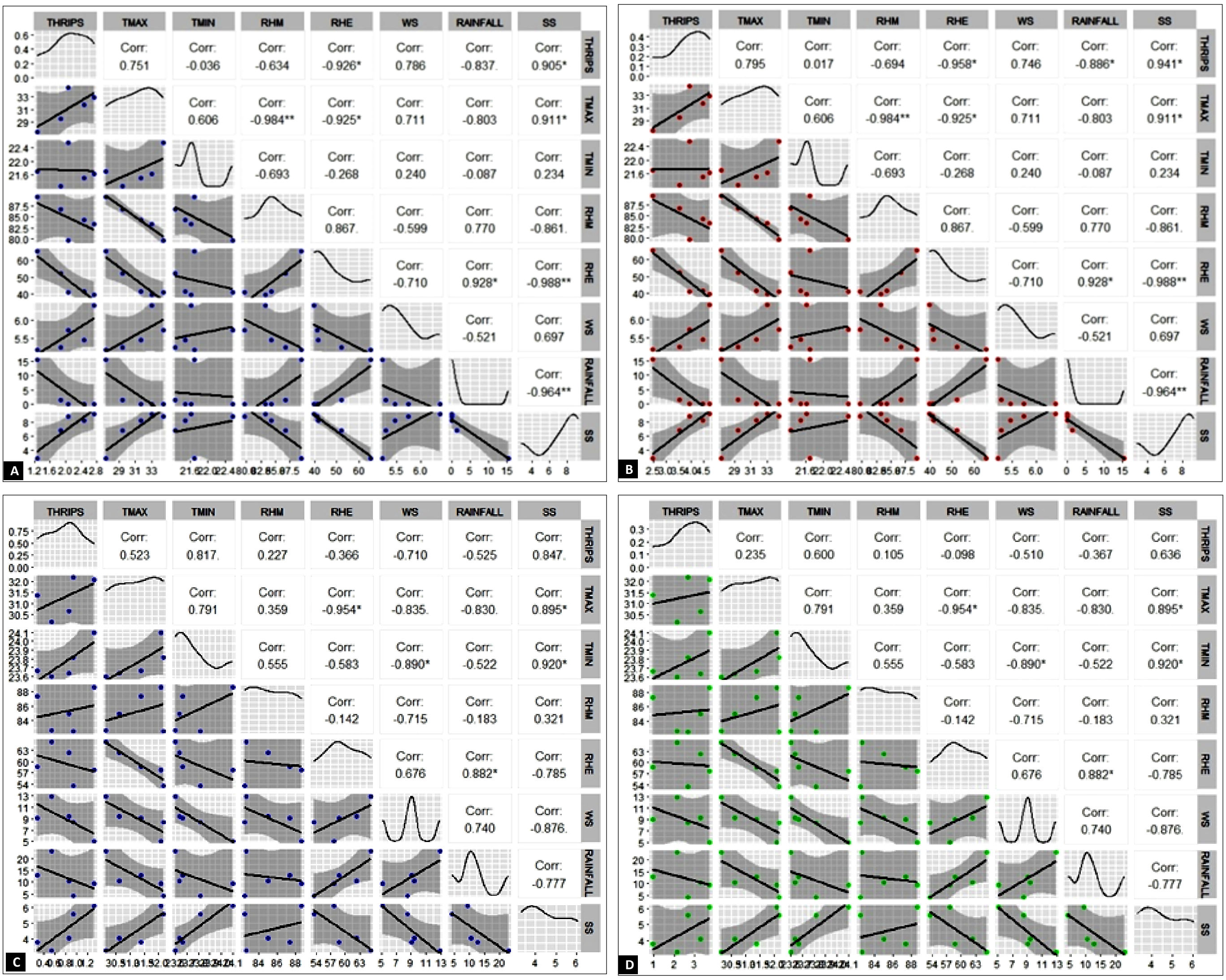

Fig. 2. Graph showing the correlation between weather parameters and *Scirtothrips dorsalis* during different seasons. A) IC-344364 (*rabi*); B) IC-537583 (*rabi*); C) IC -344364 (*kharif*); D) IC-537583 (*kharif*).

minimum temperature, morning and evening relative humidity and average rainfall (26). There is a significant positive correlation between thrips population and maximum temperature. At the same time, it showed a negative correlation with rainfall and relative humidity, supporting the present study's findings (25).

Multiple regression analysis

The multiple regression analysis revealed that the weather parameters *viz.*, maximum, minimum temperature, maximum and minimum relative humidity, rainfall, wind speed and sunshine hours influence the thrips population up to 73 % in *rabi* season in IC-344364 with one unit increase in maximum temperature, maximum relative humidity, wind speed, rainfall and sunshine hours increased thrips population by 0.59, 0.104, 0.23, 0.010 and 0.082 units respectively. In comparison, minimum temperature and minimum relative humidity increase in one unit resulted in a decrease of thrips population by -0.26 and -0.076 units (Table 3). In *kharif* season, the weather parameters in IC-344364 influence the thrips population up to 64 %. One unit increase in minimum temperature, minimum relative humidity and sunshine hours resulted in 0.245, 0.074 and 0.54, respectively. In comparison, one unit increase in maximum temperature, maximum relative humidity, wind speed and rainfall decreased thrips population by -0.18, -0.211, -0.378 and -0.022 units respectively. Meteorological factors caused 42.8 % and 46.9 % variations in thrips population (29). In *rabi* season, the weather parameters influenced 64 % of the thrips population in IC-537583, with an increase in one unit of maximum temperature, maximum relative humidity, wind speed, rain fall and sunshine hours increased thrips population by 0.66, 0.133, 0.175, 0.008 and 0.082 units (Table 3). While one unit increase in minimum temperature and minimum relative humidity resulted in decrease of the thrips population by -1.06 and 0.114 units respectively the results were following that weather factors accounted for 50–79 % of the variation in thrips activity with maximum temperature, bright sunshine hours and evaporation positively impacted thrips population. In contrast, rainfall and wind speed had a negative effect on thrips (30). In *kharif* the weather parameters influenced 41 % of thrips population in IC-537583 with one unit increase in maximum temperature, minimum temperature, maximum relative humidity, wind speed and rainfall resulted in decrease of the thrips population by -0.139,-0.89, -0.59, -0.987 and -0.0032 units. In contrast, minimum relative humidity and sunshine hours increased thrips population by 0.337 and 0.610 units (Table 3). These results are consistent that weather parameters influenced thrips population by 26 % (R^2= 0.260) and 55.4 % (R^2 =0.260) in the first season and 40.6 % (R^2 =0.406) and 18.9 % (R^2 =0.189) in the second season (22). During *rabi*, the resistant genotype IC-344364 showed non-normal residuals (p = 0.046) but no heteroscedasticity (p = 0.660). In the susceptible IC-537583, residuals were normally distributed (p = 0.054) and homoscedastic (p=0.660). During *Kharif*, IC-344364 showed normal residuals (p = 0.302) and homoscedasticity (p = 0.660). Similarly, IC-537583 had normal residuals (p = 0.846) and homoscedasticity (p = 0.660). These results validate the assumptions for multiple regression analysis.

Conclusion

The relative abundance and population of thrips were observed to be maximum during the flowering stage of the crop and then gradually decreased at the crop maturity stage due to non non-availability of nutritional compounds in the crop. The population of the thrips was found to be higher during *rabi* season than *kharif* season due to the availability of favourable conditions for their growth and reproduction during *rabi* season. Correlation analysis revealed that maximum temperature and sunshine hours positively correlated with thrips. In contrast, minimum temperature, maximum and minimum relative humidity, wind speed and rainfall negatively correlated with thrips population. Multiple regression analysis showed fluctuations in thrips population, explaining 73 % and 64 % of the variation in the *rabi* season, compared to 64 % and 48 % in the *kharif* season. Targeted management during the flowering stage, particularly in the *rabi* season, enables effective thrips control. Weather-based predictions help farmers in timely interventions, minimizing crop losses, reducing pesticide use and lowering production costs.

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Authors' contributions

TR carried out the experiment, recorded and analyzed the data. NC assisted in writing, reviewing and approving the manuscript. MM helped in data analysis, editing reviewing the manuscript. RP suggested ideas and helped in editing and revising the overall manuscript. MK helped in collection of the specimen from the field and carrying out the experiment. DU helped in summarizing and revising the manuscript.

Table 3. Multiple regression analysis of weather parameters with thrips population

Rabi	**Intercept**	**R^2**
IC-344364 (R)	$Y= - 4.49 + 0.59X_1 - 0.26X_2 + 0.104X_3 - 0.076X_4 + 0.23X_5 + 0.0103X6 + 0.082X_7$	0.732
IC-537583 (S)	$Y= - 2.98 + 0 .66X_1 - 1.06X_2 + 0.133X_3 - 0.114X_4 + 0.175X_5 + 0.008X_6 + 0.082 X_7$	0.641
Kharif	**Intercept**	
IC-344364 (R)	$Y=17.48 - 0.18X_1 + 0.245X_2 – 0.211X_3 + 0.074X_4 – 0.378X5 -0.022X_6 + 0.54X_7$	0.643
IC-537583 (S)	$Y= 41.89 - 0.139X_1 - 0.89X_2 - 0.592X_3 + 0.337X_4 - 0.987X_5 - 0.0032X_6 + 0.610X_7$	0.480

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

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