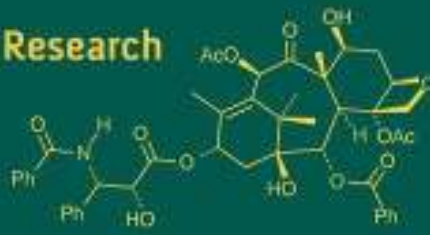
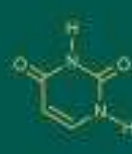
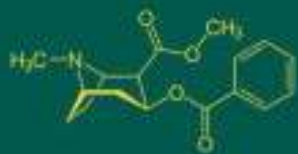


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2025; SP-9(1): 532-537
www.biochemjournal.com
Received: 19-01-2025
Accepted: 30-01-2025

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Seasonal incidence of invasive thrips, *Thrips parvispinus* (Karny) infesting chilli

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DOI: <https://doi.org/10.33545/26174693.2025.v9.i1Sg.3546>

Abstract

The present investigation was carried out to study the seasonal incidence of invasive thrips infesting chilli at the Department of Entomology, Anand Agricultural University, Anand (Gujarat), during *kharif-rabi*, 2022-23 and 2023-24. Present study revealed invasive thrips incidence on chilli twigs began in October (43rd SMW) during *kharif-rabi* 2022-23, with population peaks in the 2nd (8.20 thrips/twig) and 8th SMW (9.00 thrips/twig), which declined by the 11th SMW (5.60 thrips/twig). Highly negative correlations were observed with morning vapour pressure ($r = -0.67^{**}$) and minimum temperature ($r = -0.51^{*}$). In the year 2023-24, infestation started in September (38th SMW) and peaked in December (49th SMW). The infestation exhibited a highly significant negative correlation with the maximum temperature, minimum temperature, morning vapour pressure, evening vapour pressure, and rainfall. On chilli flowers, the infestation began as soon as flowering began in November (48th SMW) during *kharif-rabi*, 2022-23. It peaked in January (1st SMW, 10.80 thrips/flower), and it showed a significant negative correlation with the maximum temperature ($r = -0.52^{*}$). In *kharif-rabi* 2023-24, the infestation started in October (43rd SMW) and peaked in December (52nd SMW, 10.60 thrips/flower), showing significantly negative correlations with maximum temperatures, minimum temperatures, and morning vapor pressure. The incidence of black thrips persisted throughout the crop period in both years.

Keywords: Chilli black thrips, *Thrips parvispinus*, seasonal incidence, population dynamics, weather parameters, correlation

Introduction

Chilli (*Capsicum annum* L.), often referred to as the "wonder spice," holds significant importance as a commercial spice and vegetable crop. Originating from Latin America, it was introduced to Asia, including India, by Portuguese traders around 450–500 years ago (Berke and Sheih, 2000) [3]. Since then, it has become a staple in Indian agriculture and cuisine, used as a vegetable, spice, condiment, and in medicinal preparations. Globally, major chilli-growing countries include India, Thailand, China, Bangladesh, and Pakistan, with India leading in production. In 2022-23, India cultivated green chillies over 413,000 hectares, yielding 4.495 million tonnes, alongside significant production of capsicum and dry chillies (Anonymous, 2024a) [1]. Major chilli-growing states such as Andhra Pradesh, Maharashtra, and Gujarat contribute over 70% of the country's acreage, with Gujarat alone producing 27,270 tonnes of chillies from 14,060 hectares (Anonymous, 2024b) [2].

Chilli cultivation faces significant challenges from biotic stresses, particularly insect pests, which reduce yield potential and total production. Among these, thrips (*Scirtothrips dorsalis* Hood and *Thrips parvispinus* Karny) are notorious for inflicting severe damage. Thrips feed on plant tissues, causing leaf curling, necrosis, flower drop, and fruit distortion, leading to yield losses of up to 74% (Patel and Gupta, 1998; Sridhar *et al.*, 2021) [9, 12]. *T. parvispinus*, an invasive species recently reported in major chilli-growing regions of India, has emerged as a significant pest, capable of replacing native *S. dorsalis* due to its competitive edge and adaptability. This species causes widespread damage to flowers and fruits, with losses reported as high as 100% in severely infested areas (Lodaya *et al.*, 2022) [7]. The lifecycle and reproductive strategies of thrips, including parthenogenesis and rapid multiplication, make them formidable pests. Environmental factors such as temperature, humidity, and rainfall further influence their population dynamics and distribution. This study focuses on understanding the seasonal incidence of invasive thrips (*T. parvispinus*) in chilli crops.

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By elucidating its population dynamics and correlating them with environmental factors, the research aims to provide critical insights for developing integrated pest management strategies, thereby safeguarding chilli production and enhancing agricultural sustainability.

Materials and Methods

The experiment on seasonal incidence of invasive thrips in chilli was conducted at the Department of Entomology, Anand Agricultural University, Anand (Gujarat), in the month of October, 2022 and September, 2023 during *kharif-rabi*, 2022-23 and 2023-24, respectively. For the purpose, seedlings of local cultivar (VNR 332) were transplanted at spacing of 60 x 60 cm in the 12 x 12 m plot. All standard agronomical practices were followed to raise the chilli crop only except insecticidal applications. The plot was divided into four equal quadrates of 6.0 x 6.0 m. From each quadrate, five plants were randomly selected and observed at weekly interval starting from one week after transplanting till the termination of chilli crop. From each selected plant, three twigs and flowers from the upper, middle and lower canopy were shaken/tap gently over a white paper (A4 size) which subsequently covered with transparent sheet to restrict the movement of thrips. Invasive black thrips that fell on the white paper were counted with the help of a magnifying glass. The number of healthy and damaged fruits per quadrate were recorded at each picking and percent fruit damage was worked out. The weight of healthy and damaged fruits was also recorded. The invasive thrips data obtained were correlated with abiotic parameters *viz.*, maximum (MaxT) and minimum (MinT) temperature, morning (RH1) and evening (RH2) relative humidity, evaporation (EP), morning vapour pressure (VP1) and evening vapour pressure (VP2), bright sunshine (BSS), rainfall (RF) and wind speed (WS). The data obtained during the investigation were used to work out correlation coefficient with help of SPSS software.

Results

Incidence of invasive thrips infesting chilli

First year (*Kharif-rabi*, 2022-23)

The data on the infestation caused by invasive thrips on chilli twig during *kharif-rabi* 2022-23 are detailed in Table 1 and portrayed in Figure 1. It evident from the data that the population of invasive thrips started from 7 days after transplanting (DAT) *i.e.*, 43rd Standard Meteorological Week (SMW) [0.40 thrips/twig]. Afterward, the population gradually increased and attained its first peak at 84th DAT in January, 2023 *i.e.*, 2nd SMW (8.20 thrips/twig) and second peak at 126th DAT in February, 2023 *i.e.*, 8th SMW (9.00 thrips/twig). Later, the population of invasive thrips gradually decreased but in 10th SMW thrips population slightly increase and then again decrease upto 5.60 thrips/twig at 147th DAT in March, 2023 *i.e.*, 11th SMW. The incidence of invasive thrips on flowers during *kharif-rabi* 2022-23 are detailed in Table 1. Population of invasive thrips commenced from 42 DAT *i.e.*, 48th SMW [1.80 thrips/flower]. Afterward, the population gradually increased and attained its peak at 77th DAT in January, 2023 *i.e.*, 1st SMW (10.80 thrips/flower). Thereafter, the invasive thrips population gradually decreased and reached to 7.60 thrips/flower at 147th DAT in March, 2023 *i.e.*, 11th SMW [Figure 1].

Second year (*Kharif-rabi*, 2023-24)

Infestation caused by invasive thrips during *kharif-rabi* 2023-24 are detailed in Table 2 and depicted in Figure 2. It evident from the data that the population of invasive thrips started from 7th DAT *i.e.*, 38th SMW (0.20 thrips/twig). Subsequently, the population gradually increased and attained its first peak at 70th DAT in December, 2023 *i.e.*, 47th SMW (8.00 thrips/twig) and second peak at 84th DAT in December, 2023 *i.e.*, 49th SMW (8.20 thrips/twig). Afterward, the population of invasive thrips fluctuate and at 6th SMW it reached upto 8.00 thrips/twig. In case of, the data recorded on the infestation caused by invasive thrips on flowers, the population of invasive thrips started from 42nd DAT *i.e.*, 43rd SMW [1.40 thrips/flower]. Then, the population gradually increased and attained its first peak at 70th DAT in November *i.e.*, 47th SMW (9.40 thrips/flower) and second peak at 105th DAT in December, 2023 *i.e.*, 52nd SMW (10.60 thrips/flower) as depicted in Figure 2. Subsequently, the population of invasive thrips gradually decreased upto 5th SMW then afterward reached to 7.40 thrips/flower at 147th DAT in February it again increase in reached to 7.40 thrips/flower at 6th SMW.

The seasonal incidence of *T. parvispinus* was studied during *kharif-rabi* 2022-23 and 2023-24. Based on two years study, it can be concluded that the activity of invasive thrips on chilli twigs was started from first week after transplanting (WAT) the crop and gradually increased in subsequent weeks, which observed throughout the cropping period. The appearance of *T. parvispinus* in chilli flowers was observed on sixth week after transplanting (42 DAT) and remained up to crop termination. Moreover, the peak incidence was noticed on the chilli plants at fruit maturation period from tenth to sixteen weeks after transplanting. The chilli crop carried higher thrips population at peak flowering stage as it feeds on pollen of the flowers.

Correlation matrix of the relationship between weather parameters and incidence of invasive thrips

In nature, the population of insect-pests is never truly stable. The rise and fall of the population density of any organism depends on many abiotic factors like temperature, rainfall, humidity *etc.* To measure the effect of various weather parameters on the population of invasive thrips on chilli, simple correlation was worked out. The correlation data between invasive thrips incidence with weather parameters during *kharif-rabi*, 2022-23 and 2023-24 are presented in Table 3.

First year (*Kharif-rabi*, 2022-23)

The correlation analysis of thrips per twig with various weather parameters was worked out during *kharif-rabi*, 2022-23 and the data obtained are presented in Table 3. In 2022-23, thrips per twig showed highly negative correlation with morning vapour pressure ($r = -0.67^{**}$) and showed negative correlation with minimum temperature ($r = -0.51^*$) and evaporation ($r = -0.53^*$) whereas, there was no significant relation with maximum temperature, morning and evening relative humidity, evening vapour pressure, bright sunshine hours, rainfall and wind speed. The data on correlation analysis of thrips infesting flowers with various weather parameters recorded during *kharif-rabi*, 2022-23 are presented in Table 3. Maximum temperature exhibited a significant negative correlation ($r = -0.52^*$) with thrips on flower, suggesting that higher temperatures may be

associated with reduced thrips presence per flower. Whereas, all other weather parameters (maximum Temperature, morning and evening Relative humidity, morning and evening vapour pressure, evaporation, bright sunshine hours, rainfall, wind speed) have no significant influence on thrips per flower.

Second year (*Kharif-rabi*, 2023-24)

Thrips population on twig exhibited a highly significant negative correlation with maximum temperature ($r = -0.57^{**}$), minimum temperature ($r = -0.81^{**}$), morning vapour pressure ($r = -0.89^{**}$), evening vapour pressure ($r = -0.75^{**}$) and rainfall ($r = -0.56^{**}$) whereas, morning and evening relative humidity, evaporation, bright sunshine hours and wind speed showed no significant correlation with thrips on chilli twigs. During 2023-24, the invasive thrips population highly negatively affected by maximum temperature ($r = -0.81^{**}$), minimum temperature ($r = -0.56^{**}$) and morning vapour pressure ($r = -0.60^{**}$). Whereas, it showed significantly positive correlation with evening relative humidity. Furthermore, remaining weather parameters *viz.*, morning relative humidity, evening vapour pressure, evaporation, bright sunshine hours, rainfall and wind speed did not have any correlation with invasive thrips.

Fruits Damaged due to *T. parvispinus* (On number base)

The data on fruit infestation by invasive thrips based on numbers reveals important trends over different pickings during the *kharif-rabi* 2022-23 and 2023-24 growing seasons as mentioned in Table 4. In 2022-23, fruit damage started relatively high at 18.76% during the first picking and peaked during the second picking, where damage increased to 21.59%. Following this, there was a slight decline, with damage percentages of 20.40 and 20.79% during the third and fourth picking, respectively. As the season progressed, the damage percentage showed some stabilization, recording 21.34% in the fifth picking, and then decreased to 19.54% during the sixth picking. Interestingly, damage levels remained relatively stable during the seventh picking, with 20.24% recorded, and finally decreased to 18.35% in the eighth picking. The mean fruit damage for the 2022-23 seasons stood at 20.13%, reflecting consistent damage across the pickings, particularly in the early to mid-season. In contrast, the 2023-24 season exhibited lower fruit damage percentages overall, starting at 12.06% during the first picking. Damage levels gradually increased as the season progressed, with the second picking recorded 17.62% and the third picking showed 20.13%. The fourth picking experienced a slight decrease to 18.06%, followed by fifth picking at 17.75%. In, sixth picking damage stabilized around 20.04% and seventh picking recorded with highest damage 21.66%. Thereafter, damage was slightly decreased to 20.42% in the eighth and final picking. The overall mean damage for the 2023-24 season was relatively lower than in the previous year, at 18.47%.

The pooled data, which average the damage percentages across both seasons, provided further comprehensive overview. The first picking showed a mean damage of 15.41%, followed by 19.61% in the second picking. Fruit damage remained higher in third picking *i.e.*, 20.27% damage, whereas it remained more or less similar from fourth to sixth pickings, with mean percentage ranging from 19.43 to 19.79%. The highest pooled damage occurred

during the seventh picking, where 20.95% was recorded, before dropping to 19.38% during the final picking. The pooled mean across all pickings and both years was 19.30%, indicated that thrips-induced fruit damage was most significant during the mid-season pickings (second to sixth), necessitating consistent pest management throughout these critical periods. The trends in this data highlighted the necessity for early and continued management of invasive thrips population, as damage tends to peak during the middle of the picking cycle.

Fruits Damaged due to *T. parvispinus* (On weight base)

The data on fruit infestation by invasive thrips based on weight reveals important trends over different pickings during the 2022-23 and 2023-24 growing seasons. In 2022-23, fruit damage started relatively high at 16.95% during the first picking and peak damage (20.56%) recorded in second picking. Followed by a slight decline, with damage percentages of 19.58 and 19.74% during the third and fourth picking, respectively. As the season progressed, the damage percentage showed some stabilization, and recorded 20.37% damage in the fifth picking, which was further declined to 18.47% during the sixth picking. Interestingly, damage levels remained relatively stable during the seventh picking, with 18.71% recorded, and finally decreased to 17.21% in the eighth picking. The mean fruit damage for the 2022-23 season stood at 18.95%, reflecting consistent damage across the pickings, particularly in the early to mid-season. In contrast, the 2023-24 season exhibited lower fruit damage percentages overall, starting at 11.13% during the first picking. Damage levels gradually increased as the season progressed, with the second picking recording 16.34% and the third picking showing 18.57%. The fourth picking experienced a slight decrease to 16.99%, followed by 16.37% in the fifth picking. In, sixth picking damage stabilized around 18.65% whereas, seventh picking recorded with highest damage 20.15%. Then, damage levels declined to 18.83% in the last picking. The overall mean damage for the 2023-24 season was lower (17.13%) than in the previous year.

The pooled data, which averages the damage percentages across both seasons, provides a more comprehensive overview. The first picking showed a mean damage of 14.04%, followed by 18.45% in the second picking. Chilli crop recorded with 19.08% damage in third picking. Thereafter, fruit damage remained moderate through the fourth to sixth pickings, with mean percentages ranging from 18.36 to 18.56%. The highest pooled damage occurred during the seventh picking with 19.43% damage, before dropping to 18.02% during the final picking. The pooled mean across all pickings and both years was 18.04%, indicating that thrips-induced fruit damage was most significant during the mid-season pickings (second to sixth), necessitating consistent pest management throughout these critical periods.

Discussion

T. parvispinus is an invasive pest which cause havoc in recent years; therefore, only one correlation study of researcher was found to compare with present investigations' results. However, it is also compared with earlier findings on chilli thrips, *S. dorsalis*. Lokare *et al.* (2024) [8], as they studied population dynamics of black thrips on chilli during the summer season. They recorded

that population of black thrips initiated on 2nd week of March (11th SMW) with 0.20 thrips/leaves and reached its peak (13.85 thrips/leaves) on 2nd week of May (19th SMW). The variation is observed due to difference of experimental seasons as well as locality and variety. Also they observed non-significant positive association with maximum temperature ($r=0.478$) and bright sunshine hours ($r=0.199$) with invasive black thrips population, *T. parvispinus*, whereas non-significant negative correlations with minimum temperature ($r=-0.238$), morning relative humidity ($r=-0.497$) and evening relative humidity ($r=-0.135$). The chilli thrips, *S. dorsalis* population was negatively correlated with sunshine hours ($r=-0.137$), and significantly negative with average relative humidity ($r=-0.620^*$) as per reports Borgohain *et al.* (2024) [4]. They also recorded that rainfall had no significant effect on incidence of pest population in chilli. Reddy *et al.* (2017) [11]. They

recorded the seasonal incidence of *S. dorsalis* in chilli during *kharif* and noticed highest thrips population during January 3rd SMW with 24.82 thrips per five leaves in *kharif*, 2015-16, while, it was December's last week (52nd SMW) with 17.01 thrips per five leaves during *kharif*, 2016-17. Kotresh *et al.* (2020) [5] recorded peak chilli thrips, *S. dorsalis* incidence during the 48th SMW with significant negative correlation with sunshine hours and evaporation. First incidence of thrips, *S. dorsalis* was noticed in chilli during fourth week of November (47th SMW) and reached its peak (20.2 thrips/plant) during the second week of April (15th SMW) by Kumar *et al.* (2020) [6]. Prathyusha *et al.* (2021) [10] revealed that occurrence of thrips was started during 35th SMW and reached the peak during 44th SMW and population exhibited non-significant positive correlation with maximum temperature.

Table 1: Incidence of invasive thrips and its damage to chilli during *kharif-rabi*, 2022-23 (*n=21, **n=16)

Month	SMW	DAT	Thrips/ Twig*	Thrips/ Flower**	Temperature (°C)		Relative Humidity (°C)		Vapour Pressure		EP	BSS	RF	WS
					Max.	Min.	Mor.	Even.	Mor.	Even.				
October	43	7	0.40	0.00	34.4	18.6	84	28	15.1	10.8	3.8	10.0	0.0	2.4
	44	14	1.40	0.00	34.6	17.6	84	28	14.3	11.0	4.1	9.8	0.0	1.8
November	45	21	2.40	0.00	34.8	19.0	89	33	15.8	12.9	4.2	9.2	0.0	1.5
	46	28	3.00	0.00	32.4	16.5	81	33	12.5	11.3	4.2	9.1	0.0	2.3
	47	35	3.40	0.00	30.7	13.5	74	27	9.7	8.3	4.4	9.5	0.0	2.9
	48	42	4.60	1.80	30.6	15.1	77	37	10.5	11.6	4.6	9.4	0.0	3.1
December	49	49	5.20	3.40	29.6	16.2	78	39	11.2	11.6	4.7	8.6	0.0	3.6
	50	56	6.00	6.20	29.9	18.5	71	50	11.9	15.3	4.6	7.8	0.4	5.1
	51	63	7.00	8.00	31.3	16.1	86	33	12.2	10.7	4.6	8.4	0.0	1.9
	52	70	7.40	9.20	23.4	11.1	71	39	8.0	10.0	4.5	8.0	0.0	3.3
January	1	77	7.60	10.80	25.0	12.5	77	44	8.6	10.2	3.4	8.5	0.0	6.3
	2	84	8.20	10.20	27.8	12.4	85	40	9.8	10.5	3.3	9.0	0.0	2.9
	3	91	7.80	9.60	25.6	10.0	77	38	7.4	9.1	3.2	9.5	0.0	3.9
	4	98	6.60	9.40	25.5	11.5	84	44	8.8	9.9	3.2	8.7	0.0	4.4
	5	105	5.80	9.00	27.2	14.1	82	46	10.3	11.8	3.1	7.4	0.0	4.6
February	6	112	6.80	8.60	31.6	12.3	87	28	9.8	9.1	2.8	10.2	0.0	2.3
	7	119	8.60	7.20	32.7	13.1	78	22	9.4	8.3	2.8	10.4	0.0	2.8
	8	126	9.00	6.80	34.7	14.1	84	27	11.0	10.1	2.8	10.5	0.0	2.4
	9	133	8.20	6.40	35.0	16.4	78	28	11.9	11.5	2.8	10.1	0.0	2.1
March	10	140	8.40	7.00	35.4	18.4	65	23	11.5	9.5	3.0	9.9	0.0	4.2
	11	147	5.60	7.60	34.7	19.5	75	34	13.5	12.9	3.1	7.3	2.0	3.2

Note: (i) n - Total number of observations

(ii) SMW- Standard Meteorological Week, DAT- Days after transplanting, EP- Evaporation BSS- Bright Sunshine hours, RF- Rainfall, WS- Wind speed, Max-Maximum, Min-Minimum, Mor- Morning, Eve- Evening

Table 2: Incidence of invasive thrips and its damage to chilli during *kharif-rabi*, 2023-24 (*n=21, **n=16)

Month	SMW	DAT	Thrips/ Twig*	Thrips/ Flower**	Temperature (°C)		Relative Humidity (%)		Vapour Pressure		EP	BSS	RF	WS
					Max.	Min.	Mor.	Even.	Mor.	Even.				
September	38	7	0.20	0.00	30.8	25.7	95	75	24.3	23.7	4.1	3.3	127.2	5.7
	39	14	0.40	0.00	33.5	25.7	92	67	23.8	24.0	4.3	5.9	29.4	2.9
October	40	21	1.40	0.00	34.5	23.7	85	49	20.4	19.0	4.5	9.9	0.0	3.1
	41	28	3.00	0.00	34.6	22.9	87	44	20.4	17.7	4.6	9.8	0.0	2.5
	42	35	3.20	0.00	35.5	23.1	83	41	19.2	16.7	4.7	9.0	0.0	1.9
	43	42	4.60	1.40	36.0	20.6	84	29	16.6	12.2	4.7	9.6	0.0	1.7
November	44	49	5.20	3.20	35.1	19.1	79	29	14.3	11.6	4.8	9.8	0.0	2.0
	45	56	6.80	5.40	35.1	19.5	85	29	15.1	11.8	4.8	9.4	0.0	1.5
	46	63	7.80	8.00	32.5	17.2	74	34	11.8	11.7	4.8	9.2	0.0	3.4
	47	70	8.00	9.40	32.0	18.7	80	43	13.4	14.3	4.8	8.9	0.0	3.0
December	48	77	7.40	7.80	26.8	18.8	89	70	14.9	17.3	4.8	4.2	10.6	4.3
	49	84	8.20	7.40	27.1	19.0	91	66	15.1	16.8	4.8	6.6	12.8	6.6
	50	91	7.60	9.20	29.3	16.8	87	49	12.7	14.1	4.6	9.2	0.0	2.8
	51	98	7.20	10.00	27.2	15.1	75	40	9.9	10.3	4.5	6.5	0.0	4.9
January	52	105	6.40	10.60	25.4	13.9	79	45	10.9	13.3	4.5	7.8	0.0	2.3
	1	112	7.60	10.20	25.7	14.8	92	64	12.0	14.3	2.3	7.2	0.0	4.5
	2	119	7.80	9.20	27.2	16.4	91	55	13.0	14.5	2.3	6.5	0.0	4.3
	3	126	7.40	8.40	27.6	11.8	86	37	9.2	9.6	3.3	9.4	0.0	2.0
February	4	133	7.00	8.00	28.1	11.0	83	33	8.6	9.1	3.2	9.4	0.0	1.9
	5	140	6.80	6.80	29.9	14.7	89	41	11.8	12.5	3.2	9.3	0.0	1.6
February	6	147	8.00	7.40	29.3	15.8	77	42	10.7	11.8	4.2	9.5	0.0	3.2

Note :	(i) n - Total number of observations
	(ii) SMW- Standard Meteorological Week, DAT- Days after transplanting, EP- Evaporation, BSS- Bright Sunshine hours, RF- Rainfall, WS- Wind speed, Max- Maximum, Min- Minimum, Mor- Morning, Eve- Evening

Table 3: Correlation of invasive thrips and its damage to chilli plant in relation to weather parameters

Weather Parameters Invasive thrips	Year	n	Temperature (°C)		Relative Humidity (%)		Vapour Pressure		EP	BSS	RF	WS
			Max.	Min.	Mor.	Even.	Mor.	Even.				
Thrips/twig	2022-23	21	-0.30	-0.51*	-0.28	0.07	-0.67**	-0.29	-0.53*	0.02	-0.02	0.35
	2023-24		-0.57**	-0.81**	-0.34	-0.27	-0.89**	-0.75**	-0.20	0.19	-0.56**	0.06
Thrips/flower	2022-23	16	-0.47	-0.52 *	0.22	0.18	-0.47	-0.36	-0.44	-0.17	-0.02	0.26
	2023-24		-0.81**	-0.56 *	0.03	0.49 *	-0.60 *	0.16	-0.33	-0.42	-0.01	0.42

Note:	(i) * Correlation is significant at the 0.05 level (2-tailed)
	(ii) ** Correlation is significant at the 0.01 level (2-tailed)
	(iii) NS- Non-Significant; SMW- Standard Meteorological Week, EP- Evaporation, BSS- Bright Sunshine hours, RF- Rainfall, WS- Wind speed, Max- Maximum, Min- Minimum, Mor- Morning, Eve- Evening
	(iv) n - Total number of observations

Table 4: Infestation of invasive thrips to the green chilli fruits

Year Pickings	Damage on number basis (%)			Damage on weight basis (%)		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
1	18.76	12.06	15.41	16.95	11.13	14.04
2	21.59	17.62	19.61	20.56	16.34	18.45
3	20.40	20.13	20.27	19.58	18.57	19.08
4	20.79	18.06	19.43	19.74	16.99	18.36
5	21.34	17.75	19.54	20.37	16.37	18.37
6	19.54	20.04	19.79	18.47	18.65	18.56
7	20.24	21.66	20.95	18.71	20.15	19.43
8	18.35	20.42	19.38	17.21	18.83	18.02
Mean	20.13	18.47	19.30	18.95	17.13	18.04

Conclusion

The incidence of invasive thrips on chilli twigs initiated in October month (0.40 thrips/twig, 43rd SMW) and September (0.20 thrips/twig, 38th SMW) during *kharif-rabi* 2022-23 and 2023-24, respectively. Thereafter, the population gradually increased and attained its first peak in January (8.20 thrips/twig, 2nd SMW) as well as second peak in February

(9.00 thrips/twig, 8th SMW) during first season. Then, it declined to 5.60 thrips/twig in month of March (11th SMW). During second season, thrips population attained first peak in November month (8.00 thrips/twig, 47th SMW) and second peak in December (8.20 thrips/twig, 49th SMW). In which, invasive thrips showed highly negative correlation with morning vapour pressure ($r = -0.67^{**}$) and negative

correlation with minimum temperature ($r = -0.51^*$) and evaporation ($r = -0.53^*$). Later in the subsequent year (2023-24), thrips population reached its peak in December month (8.20 thrips/twig, 49th SMW). Furthermore, at the time of crop termination it was registered 8.00 thrips/twig in February month (6th SMW). During which, the invasive thrips population exhibited a highly significant negative correlation with maximum temperature ($r = -0.57^{**}$), minimum temperature ($r = -0.81^{**}$), morning vapour pressure ($r = -0.89^{**}$), evening vapour pressure ($r = -0.75^{**}$) and rainfall ($r = -0.56^{**}$). While, no any significant association was found with remaining weather parameters.

Thrips incidence on chilli flowers commenced in November month (1.80 thrips/flower, 48th SMW) and October (1.40 thrips/flower, 43rd SMW) month during *kharif-rabi* 2022-23. Afterward, thrips numbers progressed and registered peak in January month (10.80 thrips/flower, 1st SMW). Further, population noted 7.60 thrips/flower on 11th SMW in March. Similarly, in case second season, first peak observed in November (9.40 thrips/flower, 47th SMW) and second peak in December (10.60 thrips/flower, 52nd SMW). Here, only maximum temperature exhibited a significant negative association ($r = -0.52^*$) with invasive thrips incidence on chilli flowers. Approaching to the second year (*kharif-rabi* 2023-24), invasive thrips infestation started in October and registered peak in December month (10.60 thrips/flower, 52nd SMW). Later, invasive thrips incidence recorded as 7.40 thrips/flower on 6th SMW at the time of crop termination. In which, invasive thrips population displayed highly negative association with maximum temperature ($r = -0.81^{**}$), minimum temperature ($r = -0.56^*$) and morning vapour pressure ($r = -0.60^{**}$).

The infestation of invasive thrips on green chilli fruits commenced from month of October-November with 15.51% fruit damage. Whereas, the highest fruit damage was recorded as 21.59 and 21.66% in first and second year, respectively.

The study on seasonal occurrence revealed that the incidence of invasive thrips on chilli twigs started from 1st week after transplanting (WAT) of seedlings. Then, it gradually increased in subsequent weeks and remained throughout the crop duration. The commencement of *T. parvispinus* in chilli flowers was observed on 6th WAT which persisted up to crop termination. Moreover, the peak incidence was noticed on the chilli plants at fruit maturation period from tenth to sixteenth weeks after transplanting.

Acknowledgment

The authors take this opportunity to express gratitude to B.A. College of Agriculture, Anand Agricultural University, Anand, for the provision of research facilities and constant guidance during the course of the investigation. Also, authors are thankful to Dr. R. R. Rachana, Scientist, Division of Insect Systematics, ICAR-National Bureau of Agricultural Insect Resources, P. B. No. 2491, H. A. Farm Post, Bellary Road, Hebbal, Bangalore-560 024, Karnataka, India, for confirming the identity of invasive thrips species infesting chilli as *Thrips parvispinus* (Karny).

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