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Seasonal incidence of key natural enemies of onion thrips, *Thrips tabaci* L. in relation to weather parameters in the *Terai* region of Uttarakhand, India

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ABSTRACT: *Thrips tabaci*, Lindeman (Thysanoptera: Thripidae) is the most serious pest on onion causing substantial yield losses. The present study aims to document the population dynamics of thrips and natural enemies in the Terai region of Uttarakhand, India. Observations were recorded during the crop growing seasons, *i.e.* April 2021 and April 2022 and the continued till crop harvest. Spiders, Coccinellids, and Orius bugs exhibited distinct activity peaks. Temperature, rainfall (2021), and sunshine hours (2022) positively influenced spider populations. Conversely, morning and evening relative humidity (RH) during 2022 had a negative impact on the spider population. Coccinellids were positively affected by maximum temperature (second year), minimum temperature, and first-year rainfall, while RH negatively influenced them. Orius bugs responded positively to temperature and sunshine hours but were negatively affected by morning and evening RH.

Keywords: Natural enemies, onion, seasonal incidence, thrips

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most significant vegetable crops of the Alliaceae family, originated in Central Asia (Brewster, 1994), and it is grown primarily for its bulb (Sani and Jaliya, 2009). It has been a good source of carbohydrates (11.0 g), proteins (1.2 g), fibre (0.6 g), water (86.8 g), and vitamins such as vitamin A (0.012 mg), vitamin C (11 mg), thiamine (0.08 mg), riboflavin (0.01 mg), and niacin (0.2 mg), as well as minerals such as phosphorus (39 mg), calcium (27 mg), sodium (1.0 mg), iron (0.7 mg), and potassium (157 mg) (Suresh, 2007). Several insect pests infest onion crops, including thrips, onion maggots, cutworms, tobacco caterpillars, etc. The most severe pest of onion is onion thrips, *Thrips tabaci*, Lindeman (Thysanoptera: Thripidae), which has a global distribution and is polyphagous, infesting a wide variety of crops and causing substantial yield losses (Trdan *et al*., 2005). Initially, yield loss ranged between 10-15% owing to insects and diseases, but *T. tabaci* incidence alone resulted in a 30-50% yield decline (Karar *et al*., 2014). While onion agro-ecosystems often host a diverse range of natural predators like spiders, coccinellids, Orius bugs, and green lacewings, the indiscriminate use of broad-spectrum insecticides poses threats to both onion pests and their natural enemies. This practice results in resistance issues and harms the environment, soil fertility, human health, and beneficial insects (Rueda and Shelton, 1995; Rola and Pingali, 1993; Antle and Pingali, 1994; Tjornhom *et al.,* 1997).

Recognizing the importance of preserving these natural enemies, many researchers advocate for their conservation to address pest problems such as onion thrips. A comprehensive understanding of the seasonal occurrence of natural enemies of *T. tabaci* is crucial for devising effective pest management strategies. This study aims to explore the seasonal incidence of key natural enemies of *T. tabaci* and their interactions with weather parameters.

MATERIALS AND METHODS

Field experiments were conducted during the winter seasons of 2020-21 and 2021-22 at the Vegetable Research Centre (VRC), GBPUA&T, Pantnagar, Uttarakhand using the onion variety "Agrifound Light Red" in a randomized block design (RBD) with four replications. Planting was donde on December 20 in 5×5 m plots, maintaining row-to-row and plant-to-plant intervals of 20 and 15 cm, respectively. Adhering to recommended agronomic practices for the region, the crop was diligently managed throughout its growth period. To assess *T. tabaci* predator populations, nymphal and adult stages were quantified. Weekly visual recordings were made on ten randomly selected and tagged plants from the inner rows of each plot, starting from transplanting until crop harvest. They were conducted in the early hours before 9:00 AM to coincide with the insects' least active period. To count predator populations accurately, leaves were gently turned to expose the full underside. Weather parameters (maximum and minimum temperature in °C, morning and evening relative humidity in %, rainfall in mm, sunshine hours in hrs, and wind velocity in km/hr) were recorded during different standard weeks

Table 1. Influence of weather factors on seasonal incidence of spiders, coccinellids and Orius bugs at weekly interval on onion during Rabi, 2020-21

Std. Week	Weather parameters							Population/plant		
	Temperature (^{0}C)		RH (%)							
	Max.	Min.	Mor.	Even.	Rainfall (mm)	Sunshine Hrs	Wind velocity (km/ hr)	Spiders	Coccinellids	Orius bug
9	29.3	11.2	90	37	0.0	9.2	5.8	0.0	0.0	0.25
10	29.6	14.2	83	46	0.0	7.6	3.8	0.0	0.0	1.29
11	30.3	13.6	86	36	0.0	7.0	2.5	0.0	0.0	1.24
12	32.6	14.1	82	27	0.0	8.0	4.2	0.0	0.0	2.54
13	33.4	14.6	84	23	0.0	7.9	4.3	0.4	0.5	1.72
14	37.5	14.1	59	11	0.0	10.0	3.8	0.6	0.7	2.50
15	36.8	17.8	57	17	0.7	8.4	5.2	0.9	0.9	4.81
16	36.7	17.1	52	16	0.0	10.3	3.0	1.2	1.4	3.51
17	34.9	19.9	73	41	36.4	8.5	4.7	1.9	1.7	1.58
18	32.4	21.1	76	50	80.4	5.1	2.4	1.3	1.4	1.32

Std. - Standard; RH- Relative Humidity

Table 2. Influence of weather factors on seasonal incidence of spiders, coccinellids and Orius bugs at weekly interval on onion during Rabi, 2021-22

Std. Week	Weather parameters							Population/plant		
	Temperature (^{0}C)		RH (%)							
	Max.	Min.	Mor.	Even.	Rainfall (mm)	Sunshine Hrs	Wind velocity(km/hr)	Spiders	Coccinellids	Orius bug
11	23.7	9.8	86	45	0	8	6.3	0.0	0.0	1.0
12	24.7	10.0	93	48	2.2	8	3.1	0.0	0.0	1.5
13	27.5	11.3	92	48	0	7	3.4	0.0	0.0	2.1
14	30.7	16.6	90	49	0	7.1	1.9	0.0	0.0	1.9
15	33.9	17.1	84	40	0	8.8	2.4	0.8	0.8	2.4
16	34.0	15.9	80	31	0.0	9.0	4.6	0.9	0.7	2.0
17	37.1	20.9	65	31	2.6	8.3	5.1	1.2	1.2	2.9
18	38.2	19.1	63	19	0.0	9.0	3.5	1.8	1.4	5.4
19	38.0	19.0	54	19	0.0	10.3	4.0	2.2	1.9	3.0
20	35.2	23.3	67	43	5.0	8.5	4.1	1.7	1.5	1.50

Std- Standard; RH- Relative Humidity

throughout the cropping seasons. The relationship between these weather parameters and the incidence of *T. tabaci* predators on onion plants was determined through simple correlation analysis.

RESULTS AND DISCUSSION

The following are the findings and discussions from investigations on the seasonal incidence of *T. tabaci* natural enemies on the onion crop throughout both years:

Seasonal incidence of natural enemies

Spider

This study observed unspecified spider species on onion plants starting from the 13th standard week in the first year and the 15th standard week in the second year until crop harvest (Tables 1 and 2). The spider population exhibited a parallel increase with the thrips population, peaking at 1.9 spiders per plant in the last week of April (17th SW) during the first year and 2.20 spiders per plant in the second week of May (19th SW) in the second year. Subsequently, the spider population declined but persisted on the crop until harvest, ranging between 0.40 and 1.90 per plant in the first year and 0.80 and 2.20 per plant in the second year.

Coccinellids

Concerning coccinellids, three species (*Coccinella septempunctata* Linnaeus, *Menochilus sexmaculatus* Fabricius, and *Brumoides suturalis* Fabricius) were identified on onion crop from the first week of April (13th SW) in 2020-21 and the second week of April (15th SW) in 2021-22 (Tables 1 and 2). The coccinellid population gradually increased, reaching its maximum at 1.7 per plant in the last week of April (17th SW) in the first year and 1.9 per plant in the first week of May (19th SW) in the second year, persisting until crop harvest. Coccinellid population varied between 0.50 and 1.70 per plant in the first year and 0.80 and 1.90 per plant in the second year.

Orius bug

Throughout the crop cycle, the Orius bug exhibited activity against thrips in the onion cultivation area. Nymphs and adults of the Orius bug were first observed in the 9th standard week of the first year and the 11th standard week of the second year (Tables 1 and 2). In the first year, the bug population varied from 0.25 to 4.81 per plant, while in the second year, it ranged from 1.0 to 5.40 per plant. The Orius bug population steadily increased, reaching its peak at 4.81 per plant in the third week of April (15th SW) during the first year and 5.40 per plant in the last week of April (18th SW) in the second year, persisting until crop harvest. Seasonal weekly bug numbers are presented in Tables 1 and 2. This observation aligns with Wagan et al. (2014) findings, reporting spider populations between 0.20 and 4.91 per plant, coccinellid populations ranging from 0.73 to 2.95 per plant, and Orius bug populations recorded at 0.53 to 4.30 per plant, with the highest population (4.30 per plant) observed in the 11th week after transplanting.

Dhaka and Pareek (2007) documented spider populations in a cotton ecosystem ranging from 1.75 to 9.50 per 10 plants in the first year and 2.5 to 19.75 per 10 plants in the second year. Additionally, coccinellid populations varied between 2.25 and 21.00 per 10 plants in the first year and 4.75 to 19.75 per 10 plants in the second year. In a study on Bhut Jolokia, Begam et al. (2016) identified *Coccinella transversalis* and *Micraspis discolor* as the dominant predator species combating sucking pests, including thrips, throughout the cropping season. The highest coccinellid populations (1.86 and 1.80 per plant) were observed in March 2014 and 2015, respectively.

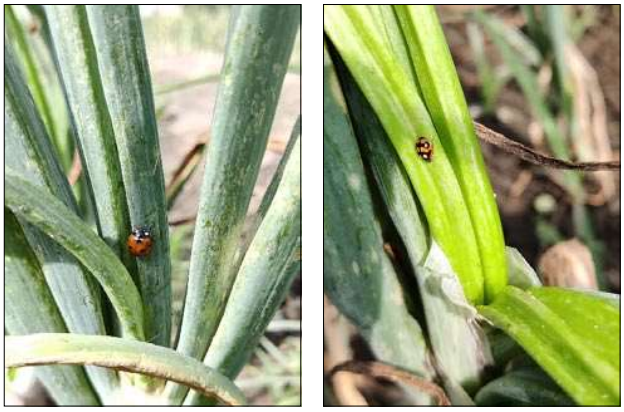
Correlation between seasonal incidence of natural enemies and weather parameters

Spider

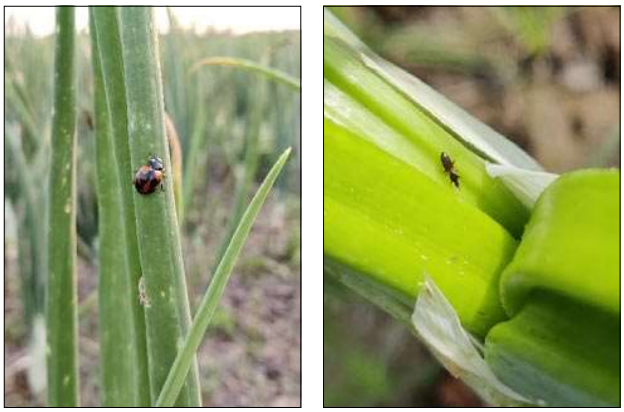
Maximum temperature (r = 0.61 in the first year and r = 0.89 in the second year), minimum temperature (r = 0.88 in the first year and r = 0.81 in the second year), rainfall (r = 0.61 in the first year), and sunshine hours (r = 0.83 in the second year) exhibited a significant positive impact. However, morning relative humidity (r = -0.57 in the first year and r = -0.96 in the second year) and evening relative humidity (r = -0.84 in the second year only) had a significant negative influence on the spider population that preys on onion thrips (Table 3). Meanwhile, all other meteorological factors showed no discernible effect. These findings align with Dhaka and Pareek (2007) study, who observed a positive correlation between maximum and minimum temperatures and the spider population involved in controlling insect pests in cotton.

Coccinellids

The information presented in Table 3 reveals that maximum temperature (r = 0.65 in the first year, r = 0.89 in the second year), minimum temperature (r = 0.88 in the first year, r = 0.83 in the second year), and rainfall (r = 0.60 in the first year only) have a significantly positive impact on the population of Coccinellids. Conversely, morning relative humidity (r = -0.63 in the first year and r = -0.96 in the second year) and evening relative humidity (r = -0.81 in the second year only) significantly negatively influence. The coccinellid population remains

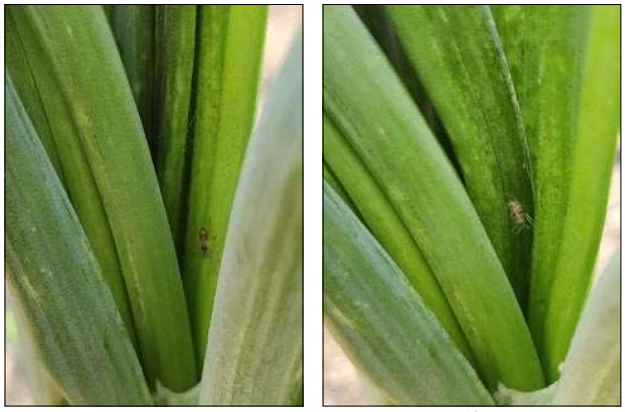


(a). *Coccinella septempunctata* (b) Coccinellid (unidentified)

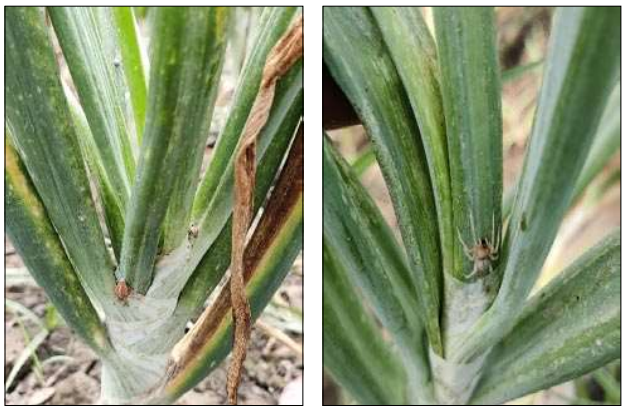


(c) Coccinellid (unidentified) (d) Pirate bug *(Orius spp.)*

Fig 1. Coccinellids and Orius bugs feeding on *T. tabaci*



(e) (f)



(g) (h)

Fig 2. Fig. (e), (f), (g) and (h): Different kind of spiders feeding on *T. tabaci*

unaffected by other meteorological variables. This aligns with Dhaka and Pareek (2007) findings, who observed a negative significant effect of evening relative humidity on the coccinellid population combating insect pests in cotton. Additionally, Begam et al. (2016) reported a significant positive correlation between coccinellid predators and maximum temperature.

Orius bug

The results presented in Table 3 demonstrate that both maximum and minimum temperatures (r = 0.78 in the first year, r = 0.69 in the second year) and (r = 0.31 in the first year, r = 0.43 in the second year), respectively, along with sunshine hours (r= 0.43 in the first year and r=0.42 in the second year), significantly positively influenced the Orius bug population. Conversely, morning relative humidity (r = -0.82 in the first year and r = -0.59 in the second year) and evening relative humidity (r = -0.71 in the first year and r = -0.78 in the second year) had a significant negative impact. Other weather variables had minimal effects on the bug population. Notably, these data cannot be compared or discussed due to the absence of existing research on the influence of abiotic factors on the incidence of Orius bugs on onions and other crops.

Based on the above results, it may be concluded that, in the onion crop, the population of natural enemies like spiders, coccinellids, Orius bugs, etc., has been active since the appearance of thrips and has continued till harvesting of the crop, which can play a major role in keeping the onion thrips population below the economic threshold level (ETL). More extensive research is needed to determine the seasonal incidence of these natural enemies of key insects, such as onion thrips and other onion pests, as well as the effect of weather factors on their population dynamics, which will aid researchers and other scientists in developing safe and environmentally friendly integrated pest management strategies.

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