



RESEARCH ARTICLE

Host plant resistance in onion (*Allium cepa* L.) genotypes against onion thrips (*Thrips tabaci* Lindeman) in relation to morphological traits and bulb yield performance

Susanta Kumar Das^{1*}, Arundhati Sasmal¹, Pradyumna Tripathy², Jayaraj Padhi², Kailash Chandra Samal³,
Prajna Prakash Mishra³ & Meenakshi Mohanty³

¹Department of Entomology, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar 751 003, Odisha India

²Department of Vegetable Science, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar 751 003, Odisha India

³Department of Agricultural Biotechnology, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar 751 003, Odisha India

*Correspondence email - skdas.ento@ouat.ac.in

Received: 20 March 2026; Accepted: 09 May 2026; Available online: Version 1.0: 20 June 2026

Cite this article: Susanta KD, Arundhati S, Pradyumna T, Jayaraj P, Kailash CS, Prajna PM, Meenakshi M. Host plant resistance in onion (*Allium cepa* L.) genotypes against onion thrips (*Thrips tabaci* Lindeman) in relation to morphological traits and bulb yield performance. Plant Science Today. 2026; 13(sp2): 1-9. <https://doi.org/10.14719/pst.14622>

Abstract

Onion thrips (*Thrips tabaci* Lindeman) is a major pest of onion, capable of causing substantial yield losses (up to 90 %) through foliar damage and transmission of Iris yellow spot virus, while also predisposing plants to secondary infections such as purple blotch. Host plant resistance, mediated through antixenosis, antibiosis and tolerance mechanisms, represents a durable and sustainable management approach. A field experiment was conducted during rabi 2021–22 to screen 70 onion genotypes against *T. tabaci* using a randomised block design (RBD) at Bhubaneswar, Odisha, India. Among the 70 genotypes evaluated, 13, 25, 22 and 10 genotypes were classified as highly resistant, resistant, susceptible and highly susceptible, respectively. Genotypes DOGR-1796, DOGR-1814 and DOGR-1771 recorded the lowest onion thrips population (6.11 to 10.65 thrips plant⁻¹), indicating strong resistance. Thrips population was related to morphological traits, genotypes such as DOGR-1796, DOGR-1814 and DOGR-1771, characterised by balanced vegetative growth and moderate leaf number, supported lower infestation. The highest bulb yields were recorded in genotypes such as DOGR-1771, Bhima Kiran, Bhima Shakti, Bhima Safed, Bhima Subhra, Bhima Sweta, Bhima Super, Bhima Dark Red and Bhima Light Red, indicating their superior productivity.

Keywords: *Allium cepa*; bulb yield; host plant resistance; morphological character; onion genotypes; onion thrips; *Thrips tabaci*

Introduction

Onion thrips (*Thrips tabaci* Lindeman) (Thysanoptera: Thripidae) is a major insect pest that damages both bulb and seed crops of onion (1, 2). Onion thrips emerge as a major biotic stress, causing about 50 % reduction in bulb yield under normal field conditions and may cause as high as 90 % loss in yield and quality in case of severe infestation (3, 4). Due to its short life cycle and high reproductive potential, populations increase rapidly under hot, dry conditions, often coinciding with the bulb formation stage (5). Larvae and adult thrips cause direct damage by destroying epidermal cells through piercing surface tissues and sucking exudate cellular contents (6). The damaged cells on attacked plants create silvery-white patches that reduce the photosynthetic area, resulting in low yield and susceptibility of the plant to pathogens (7, 8). Besides, onion thrips predisposes the onion plant to purple blotch and transmits Iris yellow spot virus (IYSV) diseases in hot, dry climatic conditions (9). The IYSV infection significantly reduces bulb size and poses a major threat to global onion production (7).

Repeated application of chemical insecticides for the management of onion thrips leads to the development of

resistance, pest outbreaks and contamination of the environment (10, 11). The habit of thrips hiding within leaf sheaths reduces the effectiveness of contact insecticides. Biological control, botanical pesticides and cultural practices exhibit inconsistent effectiveness under field conditions (12).

Host plant resistance (HPR) offers an eco-friendly, cost-effective approach for managing onion thrips. It operates through antixenosis (non-preference), antibiosis (adverse effects on insect biology) and tolerance (ability to withstand or recover from damage) (13). Several studies have documented considerable variation in thrips resistance among onion genotypes (2, 14).

Onion production is constrained by several biotic stresses, including insect pests and diseases such as thrips, purple blotch and IYSV, which pose significant productivity challenges worldwide (15). For example, Bhima Super and related lines have shown tolerance to both thrips and purple blotch, while traits such as leaf colour, canopy structure and leaf angle have been associated with reduced infestation levels (16–21).

Despite advances in developing HPR to *T. tabaci*, comprehensive and in-depth research is required, particularly in

view of the growing global significance (9). The HPR provide a key cornerstone of integrated pest management (IPM), as described by several scientists (22, 23). Considering the economic importance of onion and persistent infestation of *T. tabaci* and the drawbacks of chemical control, identification of resistant onion genotypes is very crucial. Keeping all the above-cited facts in view, the primary objective of the present investigation was to identify onion lines resistant to *T. tabaci* through systematic field screening.

Materials and Methods

Onion seed materials

In the present study, a total of 70 onion genotypes/varieties were evaluated. Sixty-eight onion genotypes/varieties were collected from the Directorate of Onion and Garlic Research (DOGR), Rajgurunagar, Pune, Maharashtra, India, while two varieties were collected from the local market.

Field preparation, experimental design and onion seedling plantation

The field experiment was conducted with 70 onion genotypes including resistant and susceptible check for screening against onion thrips, *T. tabaci* at research field of Department of Entomology, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India during rabi, 2021–22. The nursery bed was prepared thoroughly to fine soil structure with a bed size of 15 m in length and 2 m in width, following the raised bed method. Onion seedling (49 days old) was transplanted in the main field in a plot size ($2 \times 1 \text{ m}^2$), with a spacing of 15 cm between the rows and 10 cm between the plants, as recommended by the Directorate of Onion and Garlic Research, Rajgurunagar, Pune, Maharashtra, India. Each plot was adjusted to arrange 13 rows, each row contained 10 onion plants, resulting in a total of 130 plants planted in each plot in each replication. All the genotypes were arranged in a randomised block design (RBD) with 3 replications. A fertiliser dose of 75 : 40 : 40 : 40 kg N : P : K : S per hectare was applied. All the recommended agronomic practices were followed in the experimental plot, except for plant protection measures; no insecticides were applied during the cropping season.

Assessment of *Thrips tabaci* populations on onion plants

The performance of onion genotypes along with the standard resistant and susceptible checks was evaluated under main field conditions for screening against onion thrips, following methodologies described by previous researchers (19). The observations on thrips infestation were recorded starting from 30 days after transplanting (DAT) continued up to crop reached maturity. The number of thrips per plant was recorded at a weekly interval by counting individuals with visible inspection using a $10\times$ hand lens on 10 randomly selected plants from each genotype of each replication. The morphological character, viz., plant height (cm), number of leaves/plants, collar thickness (cm) and neck thickness (cm) were recorded from the same set of randomly

selected plants from each genotype of all three replications. The total bulb yield was also recorded for all 70 genotypes of each replication.

Categorisation of onion genotypes

Thrips population data were averaged on a per-plant basis and subjected to square root transformation ($\sqrt{x + 0.5}$). Based on the thrips population on the genotypes, they were categorised into 4 groups, viz., highly resistant, resistant, susceptible and highly susceptible for their susceptibility. For this purpose, the mean value of each genotype (X_i) was compared with the overall mean (X) and standard deviation (SD) using a modified scale; transformed data were used for computing X , X_i and SD. The scale was used for categorising genotypes presented in Table 1 as per the procedure adopted by several authors (24–26).

Statistical analysis

The data underwent appropriate transformations and analysis of variance (ANOVA) was conducted using OPSTAT and GRAPES Statistical Software. Duncan multiple range test (DMRT) was done through GRAPES statistical software (SmartQ version) to compare multiple means, identifying which groups are significantly different across genotypes. Field experiment data were analysed using RBD.

Results

Field evaluation of onion genotypes (Rabi 2021–22)

Onion thrips population

Significant differences in mean thrips population were observed among the 70 onion genotypes (ANOVA, $p < 0.05$; Table 2). The mean thrips population in the tested genotypes ranged from 6.11 to 65.31 thrips per plant ($F = 92.227$, $df = 69, 138$; $p < 0.05$). Relatively lower population of onion thrips (6.11 to 10.65 thrips plant⁻¹) were recorded in DOGR-1796, DOGR-1814 and DOGR-1771. The genotypes viz., W-078, W-218, W-136, W-217, W-141, W-210, W-458, DOGR-1770, DOGR-1769 and Bhima Shakti harboured fewer than 20 thrips per plant. Moderate population of thrips (24.45 to 30.00 thrips plant⁻¹) was counted in genotypes viz, W-143, W-119, W-253, W-534, W-455 and W-405. The remaining genotypes were infested by a large population build-up ranging from 31.00 to 65.30 thrips per plant.

Yield

Bulb yield differed significantly among genotypes, ranging from 17.23 to 35.10 t ha⁻¹ (Table 2). In the genotypes viz., DOGR-1771, Bhima Kiran, Bhima Shakti, Bhima Safed, Bhima Subhra, Bhima Sweta, Bhima Super, Bhima Dark Red, W-498, DOGR-1769, DOGR-1796, W-458, W-203, Bhima Light Red, W-353, W-405, W-055, W-455, W-143, W-078 and Bhima Red were recorded higher onion bulb yield (31.03 to 35.10 t ha⁻¹). The yield in the genotypes viz, W-567, W-172, W182, DOGR-1814, W-218, W-136, W-210, W-385, W-217, W-119, W-141, W-444, W-253, W-534, W-097 and DOGR-1770 were ranged between 29.64 to 30.95 t ha⁻¹. Relatively lesser yield, viz., 17.23

Table 1. Categorisation of onion genotypes

Category of resistance	Scale for resistance
Highly resistant (HR)	$X_i < X - sd$
Resistant (R)	$X_i > X - sd < X$
Susceptible (S)	$X_i > X < (X + sd)$
Highly susceptible (HS)	$X_i > (X + sd) < (X + 2 sd)$

Where, X_i : Mean value of individual genotype; X : Mean value of all genotypes; sd : Standard deviation.

Table 2. Field screening of onion genotypes against onion thrips (*Thrips tabaci* Lindeman) and bulb yield (Rabi, 2021–22)

Sl. No.	Genotypes	Thrips plant ⁻¹ (Mean ± S E)	Yield t. ha. ⁻¹ (Mean ± S E)
1	DOGR-1696	55.09 ± 1.646 ^c	18.62 ± 0.739 ^{klm}
2	DOGR-1736	54.68 ± 1.522 ^{cd}	18.43 ± 0.889 ^{klm}
3	DOGR-1742	33.56 ± 1.392 ^p	23.62 ± 0.907 ⁱ
4	DOGR-1761	43.24 ± 1.591 ^{ghijkl}	19.69 ± 0.904 ^{klm}
5	DOGR-1768	42.00 ± 1.936 ^{ijklmn}	18.32 ± 0.909 ^{klm}
6	DOGR-1769	19.90 ± 1.783 ^t	31.90 ± 1.017 ^{cdefgh}
7	DOGR-1770	19.24 ± 1.971 ^t	29.65 ± 0.352 ^h
8	DOGR-1771	10.65 ± 1.259 ^w	35.11 ± 1.942 ^a
9	DOGR-1772	41.27 ± 1.817 ^{jklmn}	19.85 ± 0.904 ^{kl}
10	DOGR-1773	38.15 ± 1.221 ⁿ	20.11 ± 0.390 ^{kl}
11	DOGR-1774	41.37 ± 1.173 ^{jklmn}	19.46 ± 0.352 ^{klm}
12	DOGR-1784	46.29 ± 1.187 ^{fghi}	20.65 ± 0.459 ^{jk}
13	DOGR-1785	40.89 ± 1.703 ^{jklmn}	18.93 ± 0.903 ^{klm}
14	DOGR-1786	52.13 ± 0.938 ^{cd}	18.07 ± 0.486 ^{lm}
15	DOGR-1787	50.47 ± 1.430 ^{def}	18.40 ± 0.895 ^{klm}
16	DOGR-1789	39.01 ± 1.023 ^{lmn}	19.57 ± 0.904 ^{klm}
17	DOGR-1796	6.11 ± 0.941 ^x	31.65 ± 0.904 ^{cdefgh}
18	DOGR-1814	9.35 ± 1.202 ^{wx}	30.85 ± 0.387 ^{cdefgh}
19	Bhuma Shubhra	33.45 ± 1.895 ^p	32.73 ± 0.904 ^{bcde}
20	Bhima Sweta	33.12 ± 1.502 ^p	32.68 ± 0.205 ^{bcde}
21	Bhima Safed	33.23 ± 1.113 ^p	32.84 ± 0.393 ^{bcd}
22	Bhima Shakti	20.18 ± 1.890 ^t	33.17 ± 2.053 ^{abc}
23	Bhima Dark Red	33.18 ± 1.905 ^p	32.20 ± 0.904 ^{bcdefg}
24	Bhima Light Red	32.89 ± 1.471 ^p	31.47 ± 0.904 ^{cdefgh}
25	Agri Found Dark Red	53.49 ± 1.905 ^{cd}	22.76 ± 1.034 ⁱ
26	N-53	65.31 ± 2.382 ^a	19.87 ± 0.903 ^{kl}
27	Bhima Kiran	31.24 ± 1.715 ^p	34.25 ± 0.904 ^{ab}
28	Bhima Red	33.43 ± 1.715 ^p	31.03 ± 0.443 ^{cdefgh}
29	Bhima Raj	42.93 ± 1.715 ^{hijklm}	19.84 ± 0.903 ^{kl}
30	W-055	31.93 ± 1.703 ^p	31.28 ± 0.904 ^{cdefgh}
31	W-078	11.71 ± 1.178 ^{vw}	31.10 ± 0.904 ^{cdefgh}
32	W-097	32.33 ± 1.665 ^p	29.65 ± 0.272 ^h
33	W-119	25.70 ± 1.715 ^{rs}	30.17 ± 0.551 ^{fgh}
34	W-125	37.75 ± 1.715 ^{no}	19.66 ± 0.330 ^{klm}
35	W-136	14.99 ± 1.513 ^{uv}	30.58 ± 0.393 ^{defgh}
36	W-141	16.21 ± 0.887 ^{tu}	30.16 ± 0.119 ^{fgh}
37	W-143	24.46 ± 1.142 ^s	31.24 ± 0.904 ^{cdefgh}
38	W-146	43.23 ± 1.715 ^{ghijkl}	18.46 ± 0.904 ^{klm}
39	W-160	39.89 ± 1.715 ^{klmn}	19.31 ± 0.903 ^{klm}
40	W-172	31.05 ± 1.703 ^p	30.93 ± 0.904 ^{cdefgh}
41	W-177	47.42 ± 1.706 ^{efg}	18.25 ± 0.904 ^{klm}
42	W-182	33.31 ± 1.480 ^p	30.86 ± 0.904 ^{cdefgh}
43	W-203	32.18 ± 1.715 ^p	31.55 ± 0.903 ^{cdefgh}
44	W-210	16.30 ± 1.715 ^{tu}	30.57 ± 0.305 ^{defgh}
45	W-217	15.01 ± 1.703 ^{uv}	30.35 ± 0.352 ^{efgh}
46	W-218	14.74 ± 1.450 ^{uv}	30.85 ± 0.904 ^{cdefgh}
47	W-226	44.88 ± 2.290 ^{ghij}	18.35 ± 0.904 ^{klm}
48	W-253	26.82 ± 1.706 ^{qrs}	29.92 ± 0.904 ^{gh}
49	W-285	52.28 ± 2.014 ^{cd}	18.05 ± 0.390 ^{lm}
50	W-353	34.00 ± 2.004 ^{op}	31.41 ± 0.903 ^{cdefgh}
51	W-361	42.64 ± 2.894 ^{hijklm}	18.33 ± 1.481 ^{klm}
52	W-385	33.57 ± 1.715 ^p	30.36 ± 0.904 ^{efgh}
53	W-398	46.98 ± 1.816 ^{efgh}	18.63 ± 0.904 ^{klm}
54	W-401	38.71 ± 1.715 ^{mn}	18.81 ± 0.904 ^{klm}
55	W-405	30.01 ± 1.454 ^p	31.31 ± 0.903 ^{cdefgh}
56	W-418	43.58 ± 1.170 ^{ghijk}	18.82 ± 0.903 ^{klm}
57	W-439	44.77 ± 1.447 ^{ghij}	18.48 ± 0.903 ^{klm}
58	W-444	33.70 ± 1.715 ^p	30.05 ± 0.904 ^{gh}
59	W-455	29.79 ± 1.454 ^{pq}	31.25 ± 0.595 ^{cdefgh}
60	W-458	18.46 ± 1.690 ^{tu}	31.58 ± 0.904 ^{cdefgh}

61	W-464	52.39 ± 2.024 ^{cde}	17.23 ± 0.903 ^{lm}
62	W-498	32.11 ± 1.312 ^p	32.05 ± 0.903 ^{bcdefgh}
63	W-500	40.81 ± 1.612 ^{ijklmn}	19.48 ± 0.903 ^{klm}
64	W-507	47.46 ± 1.448 ^{efg}	19.06 ± 0.904 ^{klm}
65	W-519	44.24 ± 1.612 ^{ghijk}	18.29 ± 0.331 ^{klm}
66	W-523	59.12 ± 1.760 ^b	17.88 ± 0.531 ^{lm}
67	W-534	29.53 ± 1.539 ^{pqr}	29.85 ± 0.904 ^{gh}
68	W-567	32.45 ± 1.420 ^p	30.95 ± 0.537 ^{cdefgh}
69	Bhima Super (RC)	32.21 ± 1.551 ^p	32.55 ± 0.903 ^{bcdef}
70	Agri found light red (SC)	54.32 ± 1.239 ^{cd}	21.96 ± 0.903 ^{ij}
F-value		92.227	77.604
p-value		< 0.05	< 0.05
SE(m) ±		1.345	0.706
SE(d) ±		1.902	0.999

* *p*-value in ANOVA table is < 0.05; ** Treatments with same letters are not significantly different; *** Within a column, means of 3 replications followed by different letters are significantly different (*p* = 0.05; DMRT test); RC : Resistant check, SC : Susceptible check.

to 23.62 t ha⁻¹ was recorded in the rest of the onion genotypes.

Plant height

Plant height varied significantly among genotypes, ranging from 44.21 to 57.32 cm (Table 3). The genotypes like W-534, W-458 and W-353 were observed to be dwarf (< 45cm), also statistically at par compared to the taller genotypes viz., N-53, Agri Found Light Red and W-464 (56.72–57.32 cm). In other genotypes, height ranged from 44.33 to 55.88 cm.

Number of leaves, collar and neck thickness

The number of leaves per plant at 60 DAT differed significantly among genotypes (Table 3). The number of leaves per plant varied from 6.24 to 9.84 in different genotypes. Genotypes N-53 and W-523 recorded the highest number of leaves per plant (9.84 each). On the other hand, the lowest number (6.24 to 6.35) of leaves per plant was recorded from Bhima Dark Red and Bhima Light Red. Neck thickness ranged from 1.10 to 2.40 cm, while collar thickness ranged from 1.13 to 2.89 cm.

Categorisation of onion genotypes

The 70 onion genotypes were categorised into four distinct groups, viz., highly resistant, resistant, susceptible and highly susceptible based on the mean number of thrips per plant (Table 4). Based on the mean onion thrips per plant, 13 genotypes, viz., DOGR-1769, DOGR-1770M, DOGR-1771M, DOGR-1796, DOGR-1814, Bhima Shakti, W-078, W-136, W-141, W-210, W-217, W-218, W-458 were categorised as highly resistant against onion thrips. However, 25 genotypes viz., DOGR-1742, Bhima Shubhra, Bhima Sweta, Bhima Super (RC), Bhima Safed, Bhima Dark Red, Bhima Light Red, Bhima Kiran, Bhima Red, W-055, W-097, W-119, W-143, W-172, W-182, W-203, W-253, W-353, W-385, W-405, W-444, W-455, W-498, W-534 and W-567 were found to be resistant. Twenty-two genotypes viz., DOGR-1761, DOGR-1768, DOGR-1772, DOGR-1773, DOGR-1774, DOGR-1784, DOGR-1785, DOGR-1789, Bhima Raj, W-125, W-146, W-160, W-177, W-226, W-361, W-398, W-401, W-418, W-439, W-500, W-507 and W-519 were classified under susceptible. Ten genotypes categorised under the highly susceptible group, viz., DOGR-1696, DOGR-1736, DOGR-1786, DOGR-1787, Agri Found Light Red, Agri Found Dark Red, N-53, W-285, W-464 and W-523.

Discussion

Screening of onion genotypes against onion thrips (*Thrips tabaci*)

Effective and sustainable management of onion thrips (*T. tabaci*) relies heavily on the identification of genotypes possessing

inherent resistance. Systematic and continuous screening of a wide range of onion germplasm is essential to identify and utilise genotypes exhibiting stable resistance. Such resistant genotypes serve as a foundation for breeding programmes and play a crucial role in IPM strategies, reducing reliance on chemical insecticides and promoting sustainable onion production. In this study, 70 onion genotypes, including a resistant check (Bhima Super) and a susceptible check (Agri Found Light Red), were evaluated under field conditions using standard screening methods. Based on field screening during rabi, 2021–22, out of 70 onion genotypes, 13, 25, 22 and 10 genotypes were found highly resistant, resistant, susceptible and highly susceptible, respectively. Substantial variation in thrips infestation was observed among the evaluated genotypes (Fig. 1). Some genotypes maintained comparatively low-level infestation, indicating relative resistance, while several others exhibited higher and variable infestations, suggesting susceptibility under prevailing field conditions. This highlights the potential of identifying and selecting low-infested genotypes in resistance breeding programmes against onion thrips.

The findings of the present study are in agreement with earlier reports, which screened several onion genotypes against onion thrips and identified the variety Bhima Super as moderately resistant against onion thrips (27). The present results are also corroborated by previous studies (28–30). Such resistance was likely associated with the intrinsic ability of these genotypes to deter the onion thrips feeding and colonisation, which might be influenced by key morphological traits or biochemical factors that negatively impact thrips feeding and development. The study evaluated eight onion cultivars in Poland and reported significant genotypic variations, with Niagara F₁ and Bila exhibiting the highest thrips infestation, while Wenta was the least infested and classified as resistant (31). The Bhima Super, NRCWO-3, NRCRO-4 and Arka Niketan, maintaining lower thrips populations, exhibited tolerance to onion thrips and produced significantly higher total bulb yield among the genotypes (16).

The results of the present study conform with previous researchers, who reported that Bhima Kiran, Bhima Dark Red, Bhima Safed, Bhima Red and Bhima Super had the lower onion thrips population during rabi 2022–23 and 2023–24 grouped under moderately susceptible (32). Bhima Shakti had the lowest thrips population (9.25 thrips plant⁻¹) among the tested onion varieties (33). Similarly, another study emphasised that genotypes viz., RO-1 × Bhima Kiran, RO-59 × Pusa Red, Bhima Shakti × Kashi No. 1, Pusa Shobha × Pusa Madhavi and Pusa Madhavi × Pusa Red were grouped into resistant to onion thrips (34). Significant variation in the mean number of onion thrips per plant was observed among

Table 3. Evaluation of morphological character of onion genotypes against onion thrips (*Thrips tabaci* Lindeman) during (Rabi, 2021–22)

Sl. No.	Genotypes	Plant height (cm) (Mean ± S E)	No. of leaf plant ⁻¹ (Mean ± S E)	Neck thickness (cm) (Mean ± S E)	Collar thickness (cm) (Mean ± S E)
1	DOGR-1696	55.36 ± 1.434 ^{abcd}	9.23 ± 0.128 ^c	2.24 ± 0.136 ^{ab}	2.54 ± 0.072 ^{bcdefg}
2	DOGR-1736	54.21 ± 1.577 ^{abcdef}	8.98 ± 0.093 ^{cd}	2.19 ± 0.066 ^{abc}	2.49 ± 0.079 ^{bcdefg}
3	DOGR-1742	47.78 ± 1.577 ^{klmnopqrs}	6.33 ± 0.093 ^w	1.56 ± 0.043 ^{ijklmnopqrstu}	1.62 ± 0.123 ^{ijklmnop}
4	DOGR-1761	53.36 ± 1.412 ^{abcdefg}	7.62 ± 0.093 ^{ijkl}	1.91 ± 0.069 ^{def}	2.32 ± 0.070 ^{cdefgh}
5	DOGR-1768	53.12 ± 0.952 ^{bcdefg}	7.58 ± 0.150 ^{ijklm}	1.59 ± 0.064 ^{ijklmnopqrstu}	2.29 ± 0.120 ^{defgh}
6	DOGR-1769	46.24 ± 1.959 ^{opqrs}	7.11 ± 0.090 ^{pqrstu}	1.36 ± 0.144 ^{tuvwxzyA}	1.25 ± 0.135 ^{qrs}
7	DOGR-1770	46.13 ± 2.869 ^{opqrs}	7.16 ± 0.165 ^{opqrst}	1.35 ± 0.084 ^{tuvwxzyA}	1.27 ± 0.095 ^{qrs}
8	DOGR-1771	44.33 ± 1.577 ^{rs}	7.08 ± 0.104 ^{pqrstu}	1.28 ± 0.095 ^{wxyzAB}	1.19 ± 0.135 ^{rs}
9	DOGR-1772	51.69 ± 1.046 ^{cdefghijkl}	7.23 ± 0.096 ^{nopqr}	1.80 ± 0.098 ^{efghij}	2.27 ± 0.099 ^{defgh}
10	DOGR-1773	51.74 ± 0.522 ^{cdefghijk}	7.53 ± 0.115 ^{ijklmn}	1.75 ± 0.139 ^{efghijklm}	2.28 ± 0.021 ^{defgh}
11	DOGR-1774	52.74 ± 1.003 ^{bcdefghi}	7.56 ± 0.108 ^{ijklm}	1.79 ± 0.103 ^{efghijk}	2.33 ± 0.090 ^{cdefgh}
12	DOGR-1784	53.43 ± 1.839 ^{abcdefg}	7.38 ± 0.096 ^{lmnop}	1.84 ± 0.110 ^{efghi}	2.41 ± 0.091 ^{cdefgh}
13	DOGR-1785	51.33 ± 1.611 ^{defghijkl}	7.45 ± 0.175 ^{klmno}	1.76 ± 0.110 ^{efghijkl}	2.35 ± 0.120 ^{cdefgh}
14	DOGR-1786	54.53 ± 1.581 ^{abcdef}	8.83 ± 0.091 ^d	2.18 ± 0.091 ^{abc}	2.63 ± 0.103 ^{abc}
15	DOGR-1787	54.57 ± 1.214 ^{abcdef}	8.76 ± 0.085 ^d	2.10 ± 0.090 ^{bcd}	2.59 ± 0.065 ^{bcd}
16	DOGR-1789	52.37 ± 2.141 ^{cdefghij}	7.74 ± 0.075 ^{hijk}	1.71 ± 0.107 ^{fghijklmno}	2.31 ± 0.091 ^{defgh}
17	DOGR-1796	44.83 ± 1.577 ^{qrs}	7.18 ± 0.101 ^{opqrs}	1.25 ± 0.042 ^{xyzAB}	1.16 ± 0.099 ^s
18	DOGR-1814	45.27 ± 1.512 ^{pqrs}	6.98 ± 0.084 ^{qrstuv}	1.29 ± 0.072 ^{vwxyzAB}	1.13 ± 0.083 ^s
19	Bhuma Shubhra	48.56 ± 1.894 ^{ijklmnopqr}	6.84 ± 0.106 ^{uv}	1.64 ± 0.046 ^{ghijklmnopqrs}	1.74 ± 0.099 ^{ijklmn}
20	Bhima Sweta	48.52 ± 0.791 ^{ijklmnopqr}	7.23 ± 0.067 ^{nopqr}	1.68 ± 0.046 ^{fghijklmnop}	1.69 ± 0.148 ^{ijklmno}
21	Bhima Safed	48.65 ± 0.438 ^{hijklmnopq}	7.11 ± 0.134 ^{pqrstu}	1.57 ± 0.078 ^{ijklmnopqrstu}	1.71 ± 0.116 ^{ijklmno}
22	Bhima Shakti	46.83 ± 2.995 ^{mnoqrstu}	7.12 ± 0.120 ^{pqrstu}	1.39 ± 0.038 ^{stuvwxyz}	1.28 ± 0.120 ^{qrs}
23	Bhima Dark Red	47.81 ± 0.952 ^{klmnopqrs}	6.24 ± 0.134 ^w	1.61 ± 0.056 ^{hijklmnopqrst}	1.69 ± 0.124 ^{ijklmno}
24	Bhima Light Red	46.22 ± 1.859 ^{opqrs}	6.35 ± 0.134 ^w	1.59 ± 0.049 ^{ijklmnopqrstu}	1.73 ± 0.108 ^{ijklmn}
25	Agri Found Dark Red	54.53 ± 1.039 ^{abcdef}	8.86 ± 0.168 ^d	2.37 ± 0.161 ^a	2.77 ± 0.125 ^{ab}
26	N-53	57.32 ± 1.897 ^a	9.84 ± 0.106 ^a	2.41 ± 0.130 ^a	2.89 ± 0.131 ^a
27	Bhima Kiran	48.94 ± 2.463 ^{hijklmnopq}	7.14 ± 0.134 ^{opqrstu}	1.53 ± 0.054 ^{klmnopqrstuv}	1.75 ± 0.091 ^{ijklmn}
28	Bhima Red	49.53 ± 2.463 ^{hijklmnop}	6.94 ± 0.134 ^{rstuv}	1.61 ± 0.046 ^{hijklmnopqrst}	1.78 ± 0.123 ^{ijklm}
29	Bhima Raj	51.23 ± 1.577 ^{defghijkl}	7.45 ± 0.134 ^{klmno}	1.79 ± 0.097 ^{efghijk}	2.35 ± 0.100 ^{cdefgh}
30	W-055	47.74 ± 1.331	7.21 ± 0.134 ^{opqr}	1.50 ± 0.064 ^{mnoqrstuvwxy}	1.85 ± 0.129 ^{jk}
31	W-078	45.82 ± 1.331 ^{opqrs}	6.98 ± 0.078 ^{qrstuv}	1.23 ± 0.032 ^{yzAB}	1.36 ± 0.119 ^{pqrs}
32	W-097	47.64 ± 1.003 ^{klmnopqrs}	7.21 ± 0.078 ^{opqr}	1.65 ± 0.046 ^{ghijklmnopqr}	1.76 ± 0.116 ^{ijklm}
33	W-119	46.83 ± 1.506 ^{mnoqrstu}	7.21 ± 0.058 ^{opqr}	1.51 ± 0.043 ^{lmnopqrstuvw}	1.63 ± 0.108 ^{ijklmnop}
34	W-125	49.71 ± 1.000 ^{ghijklmno}	7.56 ± 0.134 ^{ijklm}	1.70 ± 0.059 ^{fghijklmno}	2.37 ± 0.148 ^{cdefgh}
35	W-136	46.13 ± 0.844 ^{opqrs}	6.84 ± 0.103 ^{tuv}	1.38 ± 0.066 ^{tuvwxyz}	1.44 ± 0.146 ^{mnopqrs}
36	W-141	47.48 ± 1.000 ^{lmnopqrs}	6.92 ± 0.134 ^{rstuv}	1.40 ± 0.040 ^{rstuvwxyz}	1.49 ± 0.140 ^{mnoqrstu}
37	W-143	48.86 ± 1.097 ^{hijklmnopq}	7.28 ± 0.111 ^{mnoqr}	1.58 ± 0.046 ^{ijklmnopqrstu}	1.69 ± 0.166 ^{ijklmno}
38	W-146	50.49 ± 0.439 ^{fghijklmn}	7.34 ± 0.131 ^{lmnop}	1.85 ± 0.110 ^{efgh}	2.34 ± 0.112 ^{cdefgh}
39	W-160	51.41 ± 1.894 ^{defghijkl}	7.58 ± 0.078 ^{ijklm}	1.73 ± 0.069 ^{efghijklmn}	2.25 ± 0.084 ^{efgh}
40	W-172	48.76 ± 1.577 ^{hijklmnopq}	7.28 ± 0.044 ^{mnoqr}	1.46 ± 0.072 ^{opqrstuvwxyz}	1.78 ± 0.191 ^{ijklm}
41	W-177	52.79 ± 2.152 ^{bcdefgh}	8.29 ± 0.103 ^{ef}	1.88 ± 0.055 ^{defg}	2.24 ± 0.180 ^{efg}
42	W-182	47.56 ± 0.439 ^{klmnopqrs}	7.33 ± 0.134 ^{lmnop}	1.45 ± 0.099 ^{pqrstuvwxyz}	1.52 ± 0.111 ^{lmnopq}
43	W-203	46.82 ± 0.996 ^{mnoqrstu}	7.31 ± 0.120 ^{lmnop}	1.39 ± 0.055 ^{stuvwxyz}	1.53 ± 0.148 ^{klmnopq}
44	W-210	45.38 ± 1.331 ^{pqrs}	6.87 ± 0.089 ^{stuv}	1.11 ± 0.038 ^B	1.21 ± 0.067 ^{rs}
45	W-217	45.23 ± 1.577 ^{qrs}	7.15 ± 0.078 ^{opqrstu}	1.13 ± 0.032 ^{AB}	1.23 ± 0.078 ^{rs}
46	W-218	45.76 ± 0.509 ^{opqrs}	7.22 ± 0.064 ^{nopqr}	1.21 ± 0.043 ^{ZAB}	1.20 ± 0.019 ^{rs}
47	W-226	52.82 ± 0.962 ^{bcdefgh}	8.17 ± 0.134 ^{fg}	1.74 ± 0.081 ^{efghijklm}	2.16 ± 0.088 ^{hi}
48	W-253	47.82 ± 1.003 ^{klmnopqrs}	7.23 ± 0.114 ^{nopqr}	1.42 ± 0.052 ^{qrstuvwxyz}	1.74 ± 0.099 ^{ijklmn}
49	W-285	54.78 ± 0.799 ^{abcde}	8.23 ± 0.061 ^{efg}	2.35 ± 0.083 ^a	2.63 ± 0.114 ^{abc}
50	W-353	44.23 ± 1.213 ^s	6.89 ± 0.114 ^{stuv}	1.50 ± 0.118 ^{mnoqrstuvwxy}	1.92 ± 0.101 ^{ij}
51	W-361	55.87 ± 1.003 ^{abc}	7.89 ± 0.081 ^{hi}	1.86 ± 0.076 ^{efgh}	2.35 ± 0.037 ^{cdefgh}
52	W-385	46.58 ± 1.577 ^{nopqrs}	6.94 ± 0.081 ^{rstuv}	1.51 ± 0.046 ^{lmnopqrstuvw}	1.61 ± 0.091 ^{ijklmno}
53	W-398	53.67 ± 1.213 ^{abcdefg}	8.33 ± 0.120 ^{ef}	1.98 ± 0.126 ^{cde}	2.35 ± 0.126 ^{cdefgh}
54	W-401	52.81 ± 1.512 ^{bcdefgh}	8.43 ± 0.100 ^{ef}	1.73 ± 0.052 ^{efghijklmn}	2.31 ± 0.076 ^{defgh}
55	W-405	45.63 ± 1.003 ^{opqrs}	7.13 ± 0.100 ^{pqrstu}	1.48 ± 0.058 ^{nopqrstuvwxy}	1.62 ± 0.114 ^{ijklmnop}
56	W-418	55.89 ± 1.318 ^{abc}	7.79 ± 0.137 ^{hij}	1.88 ± 0.055 ^{defg}	2.41 ± 0.113 ^{cdefgh}
57	W-439	52.66 ± 1.003 ^{bcdefghij}	8.23 ± 0.140 ^{efg}	1.79 ± 0.119 ^{efghijk}	2.55 ± 0.091 ^{bcdef}
58	W-444	48.86 ± 1.106 ^{hijklmnopq}	7.12 ± 0.143 ^{pqrstu}	1.42 ± 0.038 ^{qrstuvwxyz}	1.78 ± 0.171 ^{ijklm}
59	W-455	46.54 ± 1.331 ^{nopqrs}	6.89 ± 0.140 ^{stuv}	1.38 ± 0.068 ^{tuvwxyz}	1.68 ± 0.104 ^{ijklmno}
60	W-458	44.23 ± 1.003 ^s	6.89 ± 0.140 ^{stuv}	1.28 ± 0.052 ^{vwxyzAB}	1.28 ± 0.090 ^{qrs}
61	W-464	56.72 ± 1.966 ^{ab}	8.88 ± 0.118 ^d	2.21 ± 0.077 ^{abc}	2.59 ± 0.108 ^{bcd}
62	W-498	48.57 ± 0.439 ^{ijklmnopqr}	7.12 ± 0.140 ^{pqrstu}	1.48 ± 0.058 ^{nopqrstuvwxy}	1.81 ± 0.085 ^{kl}
63	W-500	50.86 ± 1.490 ^{efghijklm}	7.97 ± 0.099 ^{gh}	1.67 ± 0.098 ^{fghijklmnopq}	2.23 ± 0.136 ^{gh}
64	W-507	52.64 ± 1.969 ^{bcdefghij}	8.78 ± 0.140 ^d	1.98 ± 0.090 ^{cde}	2.24 ± 0.148 ^{efg}
65	W-519	51.48 ± 0.528 ^{defghijkl}	8.47 ± 0.114 ^e	1.85 ± 0.052 ^{efgh}	2.33 ± 0.143 ^{cdefgh}

* p -value in ANOVA table is < 0.05 . *** Treatments with same letters are not significantly different; **** Within a column, means of 3 replications followed by different letters are significantly different ($p = 0.05$; DMRT test); RC: Resistant check, SC: Susceptible check.

Category of resistance (*)	Scale	Genotypes (X)	No.
Highly resistant	$X_i < 4.7$	DOGR-1769, DOGR-1770M DOGR-1771M DOGR-1796, DOGR-1814, Bhima Shakti, W-078, W-136, W-141, W-210, W-217, W-218, W-458	13
Resistant	$X_i > 4.7 < 5.87$	DOGR-1742, Bhima Shubhra, Bhima Sweta, Bhima Super (RC), Bhima Safed, Bhima Dark Red, Bhima Light Red, Bhima Kiran, Bhima Red, W-055, W-097, W-119, W-143, W-172, W-182, W-203, W-253, W-353, W-385, W-405, W-444, W-455, W-498, W-534, W-567	25
Susceptible	$X_i > 5.87 < 7.04$	DOGR-1761, DOGR-1768, DOGR-1772, DOGR-1773, DOGR-1774, DOGR-1784, DOGR-1785, DOGR-1789, Bhima Raj, W-125, W-146, W-160, W-177, W-226, W-361, W-398, W-401, W-418, W-439, W-500, W-507, W-519	22
Highly susceptible	$X_i > 7.04 < 8.21$	DOGR-1696, DOGR-1736, DOGR-1786, DOGR-1787, Agri Found Light Red, Agri Found Dark Red, N-53, W-285, W-464, W-523	10
Total			70

[illegible]

<https://plantsciencetoday.online>

the 15 Iranian onion genotypes (35). The characters like shorter plant height in certain genotypes reduce accessibility for thrips colonisation, whereas taller plants in susceptible genotypes provide a favourable canopy that promotes thrips multiplication and damage. This is consistent with the present finding, where significant variations in plant height were observed among the susceptible and resistant genotypes (36).

DOGR-1771 and Bhima Shakti recorded the least thrips incidence. The findings validate earlier reports, which also observed considerable variation among onion genotypes and categorised them into four groups as resistant, moderately resistant, susceptible and highly susceptible types (37, 38).

In contrast to earlier reports, Agri Found Light Red was classified as highly susceptible in the present study, indicating variability in resistance expression across environments (24). Similarly, other authors observed a high incidence of onion thrips infestations (9.90 thrips per plant) in onion variety Bhima Shakti (39). This discrepancy may be attributed to environmental factors, as the incidence of thrips is strongly influenced by weather conditions like high temperature, which can accelerate thrips development and lower relative humidity can suppress natural enemy activity, thereby increasing the pest pressure. Out of 49 cultivars, 11 were identified as resistant to onion thrips and significant differences were observed in the cumulative number of larvae among cultivars, indicating that all resistant cultivars possessed yellow-green foliage, whereas others exhibited blue-green foliage, which aligns with the present findings (18).

Thirteen genotypes were categorised as highly resistant and 25 onion genotypes were identified as resistant among the 70 onion genotypes evaluated. This indicates the presence of strong antibiosis, antixenosis or both as a mechanism of resistance against onion thrips. This result also corroborates the earlier findings (40). Variations in susceptibility to thrips infestation among onion varieties and accessions have also been reported by several researchers (15, 41–43). The variety, NIKSP categorised as highly resistant, T-821 and Ceylon were resistant, Punjab Naroya was grouped under susceptible and Onion Rob and DeepSS-11 grouped highly susceptible among the tested varieties, which aligns with the present results (44). The current result also aligns with the results of previous studies, which evaluated 22 onion genotypes and revealed that BKHO 1018, which had the lowest thrips per plant, was the most tolerant to the onion thrips population (45). Further, they observed a significantly positive correlation with the maximum and minimum temperature as well as sunshine hours, but a significantly negative correlation with morning relative humidity. A similar type of result was reported by several scientists in onion (15, 35, 46).

Conclusion

The present study revealed substantial variability among onion genotypes in response to onion thrips infestation and bulb yield under field conditions. Genotypes DOGR-1796, DOGR-1814 and DOGR-1771 recorded the lowest thrips populations, indicating strong resistance against onion thrips. Several genotypes, including W-078, W-218, W-136, W-217, W-141, W-210, W-458, DOGR-1770, DOGR-1769 and Bhima Shakti also maintained relatively low thrips populations (< 20 onion thrips per plant). Genotypes such as DOGR-1796, DOGR-1814 and DOGR-1771 with

balanced vegetative growth and moderate leaf production, which appeared to be associated with reduced thrips infestation. Higher bulb yields were recorded in genotypes such as DOGR-1771 and several Bhima series cultivars, indicating superior productivity and suitability for cultivation under Odisha conditions. Overall, the study identifies promising onion genotypes combining low thrips infestation and high bulb yield, highlighting their potential as genetic resources for breeding thrips-tolerant and high-yielding onion varieties.

Acknowledgements

The authors gratefully acknowledge Odisha University of Agriculture and Technology, Odisha, India, for providing the research facilities and the Directorate of Onion and Garlic Research for providing the onion seed materials to conduct this experiment.

Authors' contributions

PT and AS conceptualised and supervised the research design and experimental planning. SKD experimented and performed the analysis. KCS, JP, PPM and MM participated in the statistical analysis. All authors read and approved the final manuscript.

Compliance with ethical standards

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

Ethical issues: None

References

- Lewis T. Pest thrips in perspective. In: Lewis T, editor. Thrips as crop pests. New York (NY): CAB International; 1997. p. 1–13. <https://doi.org/10.1079/9780851991784.0001>
- Montano JD, Fuchs M, Nault BA, Fail J, Shelton AM. Onion thrips (*Thrips tabaci*): a global pest of increasing concern. J Econ Entomol. 2011;103(4):1130–42. <https://doi.org/10.1603/EC10269>
- Khoso AR, Kalhor SA, Kalhor FA. Impact of thrips on onion yield. Pak J Agric Sci. 2017;54(2):409–15.
- Gupta RP, Srivastava PK, Srivastava RC. Losses caused by onion thrips. Indian J Entomol. 1984;46:142–7. [https://doi.org/10.1016/0020-0190\(84\)90094-2](https://doi.org/10.1016/0020-0190(84)90094-2)
- Jacobson AL, Kennedy GG, Hoyt GD. Ecology and management of onion thrips in agroecosystems. Annu Rev Entomol. 2022;67:171–90. <https://doi.org/10.1146/annurev-ento-020821-060252>
- Koschier EH, De Kogel WJ, Visser JH. Assessing the attractiveness of host plant odours to western flower thrips (*Frankliniella occidentalis*). Entomol Exp Appl. 2002;103(2):131–42. <https://doi.org/10.1046/j.1570-7458.2002.00965.x>
- Gent DH, Schwartz HF, Khosla R. Distribution and incidence of Iris yellow spot virus in Colorado and its relation to onion plant population and yield. Plant Dis. 2004;88:446–52. <https://doi.org/10.1094/PDIS.2004.88.4.446>
- Pappu HR, Jones RAC, Jain RK. Global status of tospoviruses. Annu Rev Phytopathol. 2009;47:275–97. <https://doi.org/10.1146/annurev-phyto-080508-081839>
- Gent DH, du Toit LJ, Fichtner SF, Mohan SK, Pappu HR, Schwartz HF. Iris yellow spot virus: an emerging threat to onion bulb and seed production. Plant Dis. 2006;90:1468–80. <https://doi.org/10.1094/PD-90-1468>

10. Shelton AM, Nault BA, Plate J. Onion thrips resistance to insecticides. *Pest Manag Sci.* 2006;62(12):1189–97. <https://doi.org/10.1002/ps.1304>
11. Ullah F, Gul H, Shah ST. Insecticide resistance in thrips: current challenges. *Crop Prot.* 2020;136:105212. <https://doi.org/10.1016/j.cropro.2020.105212>
12. Trdan S, Valic N, Zezlina I, Bergant K, Znidarcic D. Light blue sticky boards for mass trapping of onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae), in onion crops: fact or fantasy? *J Plant Dis Prot.* 2005;112(2):173–80.
13. Smith CM. Plant resistance to arthropods: molecular and conventional approaches. Dordrecht: Springer; 2005. <https://doi.org/10.1007/1-4020-3702-3>
14. Damon SJ, Groves RL, Havey MJ. Variation for resistance to onion thrips in onion (*Allium cepa* L.) populations. *Euphytica.* 2014;195:181–9. <https://doi.org/10.1007/s10681-013-0997-9>
15. Cramer CS, Kamal AM, Shock CC. Iris yellow spot virus in onion: a global threat to onion production. *Plant Dis.* 2014;98(5):1–12. <https://doi.org/10.1094/PDIS-09-13-0957-FE>
16. Tripathy P, Priyadarshini SK, Das BB, Sahoo, Dash DK. Evaluation of onion genotypes for tolerance to thrips and purple blotch. *Int J Bio-resour Stress Manag.* 2013;4(4):561–4. <https://www.researchgate.net/publication/271214954>
17. Jones HA, Bailey SF, Emsweller SL. Field studies of *Thrips tabaci* Lind. with special reference to resistance in onions. *J Econ Entomol.* 1935;28:678–680. <https://doi.org/10.1093/jee/28.4.678>
18. Montano JD, Fuchs M, Nault BA, Shelton AM. Resistance to onion thrips in onion germplasm. *J Econ Entomol.* 2010;103:197–204. <https://doi.org/10.1603/EC09270>
19. Tripathy P, Sahoo BB, Dash DK. Evaluation of rabi onion (*Allium cepa* L.) genotypes under Western Table Land Zone of Odisha. *Int J Farm Sci.* 2016;6(3):216–22. <https://www.researchgate.net/publication/311274148>
20. Satyanarayana P, Singh PP, Prasad R, Kumar J. Screening of onion genotypes in order to identify tolerant or resistant against thrips (*Thrips tabaci* Lindeman). *J Exp Zool India.* 2017;20(1):333–7.
21. Loges V, Lemos MA, Resende LV, Menezes D, Candeia JA, Santos VF. Resistência de cultivares e híbridos de cebola a tripes. *Hortic Bras.* 2004;22:222–5. <https://doi.org/10.1590/S0102-05362004000200019>
22. Kennedy GG. Integration of insect-resistant genetically modified crops within IPM programs. In: Romeis J, Shelton AM, Kennedy GG, editors. *Integration of insect-resistant genetically modified crops within IPM programs.* Dordrecht: Springer; 2008. p. 1–26. https://doi.org/10.1007/978-1-4020-8373-0_1
23. Panda N, Khush GS. Host plant resistance to insects. Wallingford, UK: CAB International; 1995. <https://doi.org/10.1079/9780851989330.0000>
24. Shaikh RR, Acharya MF, Rode NS. Screening of onion varieties against onion thrips, *Thrips tabaci* Lind. *J Entomol Zool Stud.* 2014;2(5):91–6.
25. Shonga E, Getu E. Evaluation of shallot cultivars against onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) in Bishoftu, Ethiopia. *SINET Ethiop J Sci.* 2018;41(1):8–14.
26. Kumar A, Deole S, Nirmal A, Taram SK. Evaluation of onion genotypes against *Thrips tabaci* Lindeman. *Int J Chem Stud.* 2019;7(1):1007–11.
27. Manjunathagowd DC, Anjanappa M, Shankarappa KS. Identification of purple blotch and thrips resistant lines of onion (*Allium cepa* L.). *Veg Sci.* 2020;47(1):121–3. <https://doi.org/10.61180/vegsci.2020.v47.i1.21>
28. Gupta RP, Srivastava KJ, Pandey UB. Diseases and insect pests of onion in India. *Acta Hort.* 1994;358:265–9. <https://doi.org/10.17660/ActaHortic.1994.358.30>
29. Chhalrola DP, Vyas HJ, Boraiya KP. Influence of abiotic factors on population build-up of the thrips (*Thrips tabaci* Lindeman) in garlic. *Indian J Plant Prot.* 2003;31(2):98–100.
30. Salas J. Biology and life habits of the onion thrips (*Thrips tabaci* Lindeman). *Acta Hort.* 1994;358:383–388. <https://doi.org/10.17660/ActaHortic.1994.358.43>
31. Pobożniak M. Relationship between colonisation by onion thrips and leaf colour parameters. *Agronomy.* 2021;11(5):963. <https://doi.org/10.3390/agronomy11050963>
32. Seervi S, Singh P, Sasode RS, Bhadauria NS, Naveen, Saxena S, Suman S. Evaluation of onion varieties for their susceptibility to thrips (*Thrips tabaci* Lindman) in Madhya Pradesh, India. *J Adv Biol Biotechnol.* 2024;27(8):300–5. <https://doi.org/10.9734/jabb/2024/v27i8794>
33. Goud RP, Mamatha A, Lavanya AVN, Anitha Kumari D, Suresh V, Krishnaveni V. Performance of red onion varieties during late kharif in Telangana. *Pharma Innov J.* 2023;12(3):585–7.
34. Mahala K, Yadav DK, Gupta D, Choudhary MR, Ujjainiya P, Goswami M. Study about identification of purple blotch and thrips resistant lines of onion (*Allium cepa* L.). *J Exp Agric Int.* 2024;46(10):304–310. <https://doi.org/10.9734/jaei/2024/v46i102951>
35. Alimousavi SA, Hassandokht MR, Moharramipour SA. Evaluation of Iranian onion germplasm for resistance to thrips. *Int J Agric Biol.* 2007;9(3):455–8. <http://www.fspublishers.org>
36. Patel HC, Patel JJ, Patel PB. Screening of onion genotypes/cultivars for susceptibility to thrips, *Thrips tabaci* Lindeman. *AGRES Int E-J.* 2012;1(4):492–6.
37. Hosamani V, Kulkarni SR, Sreenivas AG. Biochemical constituents influencing resistance to onion thrips (*Thrips tabaci* Lind.) in onion (*Allium cepa* L.). *Karnataka J Agric Sci.* 2011;24(2):220–3.
38. Patil AP. Field screening of onion cultivars for reaction to thrips. M.Sc. (Agri.) Thesis. Rahuri (India): Mahatma Phule Krishi Vidyapeeth; 1983.
39. Balachandra H, Suneetha C, Sunitha TR, Kavitha TR, Krishnamma PN. Evaluation of onion (*Allium cepa* L.) genotypes for thrips resistance. *Int J Res Agron.* 2024;7(8):763–6. <https://doi.org/10.33545/2618060X.2024.v7.i8j.1377>
40. Rueda A, Badenes-Perez FR, Shelton AM. Developing economic thresholds for onion thrips in Honduras. *Crop Prot.* 2007;26(8):1099–107. <https://doi.org/10.1016/j.cropro.2006.09.003>
41. Birithia RK, Subramanian S, Muthomi JW, Narla RD. Resistance to Iris yellow spot virus and onion thrips among onion varieties in Kenya. *Int J Trop Insect Sci.* 2014;34:73–9. <https://doi.org/10.1017/S1742758414000289>
42. Njau GM, Nyomora AM, Dinssa FF, Chang JC, Malini P, Subramanian S, Srinivasan R. Evaluation of onion germplasm for resistance to onion thrips in Tanzania. *Int J Trop Insect Sci.* 2017;37(2):98–113. <https://doi.org/10.1017/S1742758417000033>
43. Singh N, Cramer CS. Improved tolerance for onion thrips and Iris yellow spot in onion plant introductions after two selection cycles. *Horticulturae.* 2019;5:18. <https://doi.org/10.3390/horticulturae5010018>
44. Rout ND, Singh A, Singh R. Onion cultivation in India: status and constraints. *Indian J Agric Sci.* 2020;90(6):1071–8. <https://doi.org/10.56093/ijas.v90i6.104226>
45. Engla P, Thakur AS, Thomas M, Bhowmick AK, Sharma HL. Screening of onion genotypes against *Thrips tabaci* Lind. in Central India. *Int J Biodivers Conserv.* 2014;6(12):806–13. <https://doi.org/10.5897/IJBC2014.0743>
46. Boateng CO, Schwartz HF, Havey MJ, Otto K. Evaluation of onion germplasm for resistance to Iris yellow spot (Iris yellow spot virus) and onion thrips, *Thrips tabaci*. *Southwest Entomol.* 2014;39(2):237–60. <https://doi.org/10.3958/059.039.0206>

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonpublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc
See https://horizonpublishing.com/journals/index.php/PST/indexing_abstracting

Copyright: © The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited (<https://creativecommons.org/licenses/by/4.0/>)

Publisher information: Plant Science Today is published by HORIZON e-Publishing Group with support from Empirion Publishers Private Limited, Thiruvananthapuram, India.