Factors influencing the varietal preference of onion thrips, *Thrips tabaci* under storage conditions

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Onion thrips, *Thrips tabaci* (Lindeman) (Thripidae: Thysanoptera) is a key pest and known to reduce onion yields up to 50% on standing onion crop (Diaz Montano *et al*. 2011). Their feeding on foliage causes silvery blotches, downward curling and drying. This pest can become devastating as it transmits *Iris yellow spot virus* (IYSV) in seed crop. In addition to the damage caused in the field, it is now emerging as a potential storage pest on onion.

Onion is harvested during different cropping seasons *viz., Kharif* (Oct-Nov; 20% of total production), late *Kharif* (Feb-March; 20% of total production) and *Rabi* (April-May; 60% of total production) in Maharashtra, India. Usually, *Rabi* harvest is in high quantity and the bulbs are available across the country in abundance. These bulbs need storage not only to ensure the onion availability till next Oct-Nov, but also to have assured profits for farmers. Thus, *Rabi* onion crop is stored for long period (~4-6 months) and several factors play a role in causing significant storage losses in onion such as rotting due to fungal/bacterial infections, sprouting, physiological loss of weight, etc. In addition to these losses, in recent past, thrips are contributing to the post-harvest losses significantly during storage. During harvest, farmers usually cut the bulb tops leaving substantial portion of neck length (~2cm) that facilitate thrips to be carried from field to storage along with the bulbs. These thrips multiply and cause damage to the onion bulbs during storage affecting the bulb quality.

The present study was taken up to understand the varietal preference by the thrips and to identify the varietal traits that are influencing the *T. tabaci* preference under storage conditions. The experiment was carried out in the storage structures of Directorate of Onion and Garlic Research, Rajgurunagar, Pune, Maharashtra, India during the *Rabi* season of 2012. Five varieties of onion were selected for the study. Red coloured bulb onions varities Bhima Shakti, N-2-4-1, and Bhima Kiran with a storability of 5-6 months and white coloured bulb varities Bhima Shubra and Bhima Shwetha with storability of 3 months were selected. Bhima Shakti, N-2-4-1 and Bhima shubra were grown both in *Rabi* and *Kharif* seasons whereas Bhima Kiran and Bhima shwetha were grown in *Rabi* season. All the varieties were harvested in the month of May, 2012 and shifted to storage structures. One month after harvesting, observations were recorded at monthly intervals till September, 2012. A total of four observations was taken during the study period. The sample size during each sampling varied between 25-125 bulbs per variety, depending upon the availability of bulbs.

Destructive sampling was carried out and observations were made on different parameters. Thrips counts were taken on the number of nymphs/adults present within the bulb recorded as total thrips; bulb damage (%) recorded as bulb area damaged by thrips visually graded on scale 0-100; sooty mould (%) to understand the correlation between sooty mould occurrence and thrips survival within the bulb; neck length (cm) to understand whether neck length supports thrips survival; neck thickness of the bulb (mm); extent of outer bulb layers infested by thrips (no.), infested bulb layers were peeled and the number of layers infested with thrips were counted; type of bulb skin (loose/compact) was categorized whether loose or compact (ranked 1 and 2, respectively), as loose skin can encourage thrips entry at the field level during harvest. The data were subjected to ANOVA, correlation and regression analyses to understand the differences between varieties and to identify significant parameters contributing to thrips preference (Little and Hills, 1978).

The mean number of total thrips per bulb among different varieties was significantly different (P=0.05). The mean thrips incidence was significantly highest in Bhima Shubra (9.3/bulb) followed by Bhima Kiran (6.53/bulb), Bhima Shwetha (5.2 /bulb) and N-2-4-1 (3.4 /bulb). Significantly lowest numbers of thrips were recorded in Bhima Shakti

(2.6/bulb) (Table 1). The bulb damage also differed significantly among the varieties (Table 1). It was highest in Bhima Shubra (63.7%) followed by Bhima Shwetha (48.9%), (Table.1). The neck length (cm) of bulbs differed significantly among the varieties *viz.,* Bhima Shakti (1.11cm), N-2-4-1 (1.89 cm) and Bhima Shubra (1.62 cm). However, Bhima Kiran (~~1.42~~ cm) and Bhima Shwetha (~~1.38~~ cm) were not significantly different with each other with respect to neck length. With respect to bulb neck thickness (mm), varieties Bhima Shubra (4.64 mm) and N-2-4-1 (7.74 mm) were significantly (*P*=0.05) different from other varieties. The varieties Bhima Kiran (5.49 mm), Bhima Shakti (5.63 mm) and Bhima Shwetha (6.19 mm) were not significantly different with each other for bulb neck thickness (Table 1). The sooty mould occurrence in different varieties was also not statistically significant. The highest sooty mould occurrence was observed in the variety Bhima Shwetha (17.6%) followed by Bhima Kiran (16.6%), Bhima Shakti (10.6%), N-2-4-1 (10.6%) and Bhima Shubra (10.2%).

In order to understand to what extent thrips can penetrate the layers of onion bulbs, the number of outer bulb layers in to which thrips could make entry was observed among the varieties. Maximum layers infested by thrips were observed in the variety N-2-4-1 (2.6). The lowest number of layers were found infested in Bhima Shwetha (2.2) and it was found to be significantly (P=0.05) different with rest of the varieties (Table 1). The onion bulb skin type (loose/ compact) varied with variety. The varieties, N-2-4-1 (1.5) and Bhima Shakti (1.7) were significantly different from other varieties and were found to have loose skin type. However, varieties Bhima Kiran (1.8), Bhima Shubra and Bhima Shwetha (1.9) were not significantly different with each other. These varieties recorded a higher compactness in bulb layers.

Significant positive correlation was observed between number of thrips recorded and bulb damage across the varieties *viz.,* Bhima Shakti (r = 0.66), N-2-4-1 (r = 0.72), Bhima Kiran (r = 0.42), Bhima Shubra (r = 0.33), Bhima Shwetha (r = 0.42) indicating that the thrips are the major reason for bulb damage during storage conditions. Overall correlation across varieties also yielded similar relationship (r=0.41) (Table 2). Irrespective of the varieties, of all the parameters, sooty mould, number of layers and skin type were significantly related to the thrips incidence. The variability in the thrips incidence is explained to the tune of 2% by the per cent sooty mould ($Y=7.45-0.069\ x_1$; $R^2=0.02$) and 7% by the number of layers ($Y=-2.96+3.83\ x_2$; $R^2=0.07$). The multiple regression could explain to the tune of 11% variability in the number of thrips ($Y=5.14-0.071x_1+3.54x_2-3.49x_3$; $R^2=0.11$). The neck length was found to be significantly and positively correlated with thrips incidence in N-2-4-1. Further, compact skin types onion discouraged the thrips development that was evident by its significant negative correlation with thrips occurrence and bulb damage as observed in the varieties N-2-4-1 and Bhima Kiran. In the variety, N-2-4-1, neck length alone could explain the bulb damage to the tune of 27% (Y=-

Table 1. Reaction of onion varieties screened against thrips under storage condition

Onion varieties	Mean thrips/ bulb (No)	Bulb damage (%)	Bulb neck length (cm)	Bulb neck thickness (mm)	Sooty mould (%)	No of bulb layers thrips infested	Bulb layer skin type (loose/ compact)
Bhima Shakti (n=25)	2.60 (1.65)^{a}	25.2 (26.44)^{ab}	1.11 (1.26)^{a}	5.63 (2.46)^{bc}	10.6 (14.07)^{a}	2.5 (1.73)^{bc}	1.7 (1.47)^{b}
N-2-4-1 (n=25)	3.44 (1.70)^{ac}	20.4 (22.20)	1.89 (1.54)^{e}	7.74 (2.84)^{e}	10.6 (13.29)^{a}	2.6 (1.76)^{bd}	1.5 (1.41)^{a}
Bhima Kiran (n=125)	6.53 (2.12)^{ab}	37.4 (35.32)	1.37 (1.36)^{b}	5.49 (2.42)^{b}	16.6 (17.16)^{a}	2.6 (1.76)^{be}	1.8 (1.53)^{c}
Bhima Shubra (n=100)	9.31 (2.66)^{b}	63.7 (55.24)	1.62 (1.45)^{d}	4.64 (2.25)^{a}	10.2 (9.39)^{a}	2.4 (1.70)^{b}	1.9 (1.53)^{cd}
Bhima Shwetha (n=100)	5.20 (1.99)^{ab}	48.9 (43.85)	1.42 (1.38)^{bc}	6.19 (2.57)^{bd}	17.6 (16.31)^{a}	2.2 (1.62)^{a}	1.9 (1.53)^{ce}
CD n=25 × 125	0.358	11.92	0.075	0.162	10.39	0.107	0.063

Figures in the parentheses are square root (X+0.5) transformed values.

Means followed by the same letter in each column are not significantly different at p≤0.05

Table 2. Correlation analysis for different traits of onion varieties with thrips infestation and bulb damage

Varieties	Independent variables	Neck length (cm)	Neck thickness (mm)	Skin type (L/C)#	Sooty mould (%)	Layers infested (No)
Bhima Shakti (r=0.66)	Total thrips	-	-		0.46*	0.42*
	Bulb damage					
N-2-4-1 (r=0.72)	Total thrips			-0.45*		
	Bulb damage	0.52*		-0.48*		
Bhima Kiran (r=0.42)	Total thrips			-0.39*	-0.26*	
	Bulb damage		-0.26*			
Bhima Shubra (r=0.33)	Total thrips					0.58*
	Bulb damage			-0.22*		0.23*
Bhima Shwetha (r=0.42)	Total thrips			-0.25*		0.29*
	Bulb damage			-0.21*	0.22*	0.21*
Overall (r=0.41)	Total thrips			-0.18*	-0.17*	0.27*
	Bulb damage		-0.25*			

Figures in the parentheses are correlation coefficient (r) of No of thrips with respect to per cent bulb damage.

*Significant at P=0.05; # L= loose; C=Compact

53.71+39.25 x_1; R^2=0.27) and skin type to the tune of 23% (Y=52.11-20.86 x_2; R^2=0.23). These two variables *viz*., neck length and skin type together can explain the variability in the bulb damage to the tune of 44% conveying both neck length and skin type of bulbs are crucial factors deciding the thrips incidence under storage conditions. However, in other varieties *viz.,* Bhima Shubra, Bhima Shakti, Bhima Kiran, the skin type could not explain the variability in the bulb damage beyond 11% indicating the need to study additional variables responsible for bulb damage.

The present study is first of its kind to correlate the onion bulb traits with thrips infestation under storage conditions. Nevertheless, in depth studies taking more traits in to consideration are needed to pin point the important onion bulb traits that are influencing the thrips incidence under storage conditions and this knowledge will help in formulating the post-harvest management of thrips in storage onions.

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