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EVALUATION OF GARLIC GENOTYPES FOR RESISTANCE TO *THRIPS TABACI* LINDEMAN

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ABSTRACT

Nine genotypes of garlic were evaluated for their reaction to *Thrips tabaci* Lindeman under natural infestation and for host plant traits. Amongst genotypes, UHF G12-2 exhibited resistant reaction; G-282 and PGS-204 were found to be moderately resistant and G- 384, G-189, Bhima purple, PGVK-07 and G-304 were susceptible. The relationship between infestation and among leaf angle (*r* = -0.897) and total phenol content (*r*= -0.836**) showed a significant negative correlation. Leaf damage revealed a weak negative correlation with leaf angle (*r*= -0.483) and total phenol content (*r*= -0.303). The plant height and number of leaves revealed a significant negative correlation with thrips damage (*r*= -0.796*) and non-significant negative one with thrips density. Total chlorophyll content showed a non-significant negative correlation with thrips density (r= -0.278) and damage (r= -0.597). Thus, the garlic cultivar UHF G 12-2 could be a promising genotype with resistance/ tolerance, having higher phenol content, total chlorophyll and bulb yield.**

Key words: *Thrips tabaci*, *Allium sativum*, varietal resistance, biochemical resistance, biophysical traits, antixenosis, antibiosis, tolerance, susceptible, phenol, chlorophyll, bulb yield

Garlic (*Allium sativam* L.) is the second important member of *Alliaceae* family after onion grown in India (Lawande et al., 2009), and India is the second largest producer (FAOSTAT, 2017). The crop is famous for its medicinal properties, flavour, minerals, vitamins and nutrition (Ferruci et al., 2010; Bayan et al., 2014). In India, it is mainly cultivated in rabi season and harvested in March-April (Karuppaiah et al., 2018). The states including Madhya Pradesh, Gujarat, Rajasthan, Uttar Pradesh and Maharashtra occupy major area, with the productivity being lower (5.67t/ ha) (Malik et al., 2017), and insect pests are the major constraints. Onion thrips *Thrips tabaci* Lindeman, (Thripidae: Thysanoptera) is one of the major pests (Patel and Patel, 2012; Arantha, 1980; Butani and Verma, 1976). In India, yield losses due to thrips has been observed to be 15.35 to 46.82% (Changela, 1993). To minimize the losses due to *T. tabaci*, numerous approaches are used, of which the most common is the use insecticides, but these are often ineffective due to thrips feeding behavior, fast multiplication, overlapping generation and insecticide resistance (Gill et al., 2015). In this context, integrating tolerant/ resistant genotypes in IPM is an effective approach (Ferreria et al., 2017). Cultivar resistance to *T. tabaci* is connected to plant morphology and biochemical/ nutritional compositions (Alimousavil et al., 2007). Plant architecture characteristics such as leaf structure, leaf angle, number of leaf, leaf colour, epicuticular wax, bulb diameter and plant height are some of these traits associated with plant resistance to onion thrips (Coudriet et al., 1979; Diaz Montano et al., 2010). Biochemical and nutrition components affect the growth and development of thrips (Frei et al., 2003; Mollema and Cole, 1996; Srinivasan et al., 2018; Kandakoor et al., 2014). This study evaluates nine advanced garlic genotypes for their field reaction against *T. tabaci* and their plant biophysical and biochemical parameters towards resistance.

MATERIALS AND METHODS

The garlic genotypes were evaluated in 2017-18 and 2018-19 at the research farm of Directorate of Onion and Garlic Research (DOGR), Pune, Maharashtra, India (18.320 N,73.510 E, 553.8 masl, annual rainfall 574 mm). Genotypes- G-384, G-189, G-282, Bhima purple, PKVG-07, PGS-204, G-304, G-363 and UHF G12-2 available at DOGR were used. For each season, in October (2017-18), the cloves were planted in a randomized complete block design with the spacing of 10 cm (plant to plant) about 15 cm (row to row). Each genotype had 30 plants/ plot of 1 m^2, and two such replications were maintained, and were kept free of insecticides. The genotypes were scored for *T. tabaci* damage at 75 days after garlic dibbling based on %

leaf/ foliage damage. In each genotype, five plants were selected and observed for foliage damage and scored for thrips damage using 1-5 scale: 1= 1-20% leaf area damaged; 2= 21-40% leaf area damages; 3= 41-60% leaf area damaged; 4= 61-80% leaf area damaged; 5= 81-100% leaf area damaged (AINRPOG, 2015). The mean score of these were further taken for categorizing the genotypes as 0-1= highly resistant (HR), 1.1-2= resistant (R), 2.1-3= moderately resistant (MR), 3.1-4= Susceptible (S), 4.1-5= Highly Susceptible (HS). The population density of thrips (nymphs and adults) for each genotype was recorded at 30, 45, 60 and 75 days after dibbling (Karuppaiah et al., 2018).

The leaf angle was recorded using a protractor by measuring the angle between two completely matured leaves (da Silva et al., 2015). The plant height was measured with measuring scale from bottom region to tip of the leaf; number of leaves/ plant, and cloves/ bulb were observed for from five plants and cloves. Measurements of all the plant characteristics were taken in 75 days old plants. Biochemical parameters viz., total phenol content was estimated in the leaf- from fresh sample collected at 75 days old plants and cloves that are separated from bulbs collected immediate after crop harvest, respectively. Total phenols were determined calorimetrically using a folin-ciocalteu reagent (Pinelo et al., 2004). The samples were extracted using 1 g of leaf sample crushed in 10 ml of 80% methanol. Then, the extracts were filtered with cheesecloth to remove the solid debris. Tenfold diluted folin-ciocalteu reagent (1 ml) and 7.5% sodium carbonate (0.8 ml) and methanolic extract (0.2 ml) were mixed and after heating at 45°C for 15 min in water bath, the absorbance was measured at 765 nm against a blank. The phenolic content was reported as gallic acid equivalent/ g fresh weight. The total chlorophyll was measured in 0.05g (w) of leaf sample in 10 ml (V) DMSO (dimethyl sulfoxide) by non-maceration method (Hiscox and Israelstam, 1979). Absorbance was recorded at 645 and 665 nm, and then total chlorophyll was estimated after Arnon (1949). The harvested bulbs were subjected to field curing for three days followed neck cutting for the separation from foliage. The total bulb yields (kg/ plot) were estimated and expressed in t/ ha. The data on thrips numbers, leaf angle, number of leaves, plant height, numbers of clove, leaf phenol content and bulb yield were subjected to square root transformation before analysis. Further, data were analyzed by one-way ANOVA using SPSS v.16 software followed by mean comparison using Tukey's HSD test (p=0.05). Correlation coefficients between thrips density and plant physical and biochemical constituents in genotypes were also determined.

RESULTS AND DISCUSSION

The data on thrips infestation in garlic genotypes presented in Table 1 reveals that regardless of the year, more density was observed in 2017-18 compared to 2018-19. The pooled data on damage, and thrips incidence revealed that genotype Bhima purple (56.3 thrips/ plant) followed UHF G12-2 (59.4 thrips/ plant) were the least affected; UHF G12-2 is the least damaged (score of 1.8), and thus categorized as resistant, and PGS-204 as moderately resistant. Genotype G-363 was categorized as highly susceptible; and G-384, G-189, G-282, Bhima purple, PKVG-07 and G 304 and were grouped as susceptible. The leaf angle, number of leaves and cloves, and the total phenol and chlorophyll contents in genotypes revealed significant differences- Bhima purple (23.2°) and UHF G12-2 (21.8°) revealed broader leaf angle; and maximum number of cloves (16.3/ bulb) was observed in G-189 and the least was in genotypes G-384 and G-304. The phenol content was maximum with Bhima purple (107.7 mg/ g of GE/ g fresh weight) followed by UHF G12-2 (92.2 mg/ g of GE/ g fresh weight); and total chlorophyll content was maximum with UHF G12-2 (2.62 mg/ g) followed by G-282 (1.91 mg/ g).

The correlation coefficient between the leaf angle and the thrips density showed a highly significant negative relation (r= -0.897 p<0.001). The phenol content showed a highly significant negative correlation (r= -0.836 p<0.001) with thrips density. Thrips damage showed a non-significant negative correlation with all the parameters except plant height. Total chlorophyll content showed a non-significant negative correlation with thrips density and damage. Genotype UHF G 12-2 gave the maximum bulb yield (6.7 t/ ha) (Table 1). Maximum bulb yield observed in the resistant/ tolerant genotypes is probably be due to foliage compensation mechanism. The higher chlorophyll content, phenol content and a wider leaf angle determined in UHFG 12-2 appears to be important in determining field tolerance to thrips. An adverse impact of wider leaf angle and the phenol content on thrips density had been earlier reported. These present results corroborate with the earlier reports (Alimousavi et al., 2007; Gadad et al., 2014; Kandakoor et al., 2014). Thus, the genotype, UHF G 12-2 found to be tolerant under natural infestation, could be used in future garlic improvement. The traits, leaf angle, phenol content and chlorophyll content are well correlated with plant resistance to *T. tabaci*.

Table 1. Population density and damage rating of *T. tabaci*, and plant physical, biochemical traits and yield in garlic genotypes

Genotype	2017-18		2018-19		Pooled		Plant physical traits				Biochemical traits		Reaction based on mean damage score	Yield t/ ha
	Thrips/ plant	Damage score	Thrips/ plant	Damage score	Thrips/ plant	Damage score	Leaf angle (°)	Plant height (cm)	No. of leaves	No. of cloves	Phenol content (Leaf)*	Total chlorophyll mg/ g dry weight		
G-384	48.3^{ab}	3.4	84.0^{d}	4.6	66.2^{cd}	4.0	17.7^{a}	30.8^{ab}	6.7^{b}	5.4^{a}	61.5^{a}	1.41^{d}	S	1.4^{ab}
G-189	52.1^{b}	3.0	81.4^{d}	4.8	66.7^{d}	3.9	17.7^{a}	31.8^{ab}	6.5^{b}	16.3^{b}	65.5^{ab}	1.91^{b}	S	1.4^{ab}
G-282	43.5^{a}	2.6	78.0c^{d}	3.4	60.4^{ab}	3.0	20.3^{bc}	29.8^{b}	6.4^{b}	13.3^{b}	75.5^{abc}	1.74^{c}	MR	1.2^{ab}
B. Purple	48.8^{ab}	3.8	63.7^{a}	2.6	56.3^{a}	3.2	23.2^{d}	27.9^{bc}	6.3^{b}	12.7^{b}	107.7^{c}	1.42^{d}	S	1.6^{ab}
PKVG-07	53.3^{b}	2.6	82.0^{d}	4.2	67.7^{d}	3.4	18.6^{ab}	27.8^{bc}	6.2^{b}	15.7^{b}	86.0^{bc}	1.12^{e}	S	0.4^{b}
PGS-204	50.9^{bc}	2.2	71.5^{bc}	3.8	61.2^{abc}	3.0	18.8^{ab}	31.5^{ab}	6.8^{b}	13.4^{b}	67.5^{a}	1.13^{e}	MR	0.9^{ab}
G-304	47.4^{ab}	2.4	72.1^{bc}	4.8	64.4^{bcde}	3.6	18.4^{ab}	29.9^{b}	6.0^{ab}	5.4^{a}	72.5^{ab}	1.36^{d}	S	1.0^{ab}
G-363	43.1^{a}	5.0	82.1^{d}	4.4	62.6^{bcd}	4.7	18.5^{ab}	24.7^{c}	5.4^{a}	6.6^{a}	77.5^{abc}	1.32^{d}	HS	0.4^{b}
UHFG12-2	51.6^{b}	1.8	67.2^{ab}	1.8	59.4^{ab}	1.8	21.8^{cd}	35.6^{a}	6.8^{b}	14.6^{b}	92.2^{bc}	2.62^{a}	R	6.7^{a}
Correlation co-efficient between thrips damage, density and plant physical & biochemical parameters														
Thrips damage							-0.483^{ns}	-0.796*	-0.490^{ns}	-0.444^{ns}	-0.303^{ns}	-0.278^{ns}		
Thrips density							-0.897**	0.080^{ns}	0.192^{ns}	-0.060^{ns}	-0.836**	-0.597^{ns}		

R-Resistant, MR-Moderately resistant, S-Susceptible, HS-Highly susceptible; Value following different letter down the column significantly different using Turkey's HSD test; ** Significant at p=0.01; ns-non-significant; *mg/ g of GE/ g fresh weight

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