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Evaluation of citrus germplasm for resistance to Asian citrus psyllid, *Diaphorina citri* Kuwayama (Hemiptera:Psyllidae)

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ABSTRACT: Thirty two germplasm collections of *Citrus* spp. were screened for their relative resistance to Asian Citrus Psyllid (ACP), *Diaphorina citri* Kuwayama under field conditions at National Research Centre for Citrus, Nagpur during 2008-10. A significant variation was observed among the citrus germplasm in their response to infestation of ACP. Results revealed that Willits citrange, Trifolia, Rich 16-6, Flying dragon, Trifoliate Orange (Chethali, Gonicoppal), Carizzo Citrange (Chethali), Troyer Citrange (Gonicoppal) showed resistance to ACP. The identified resistance germplasm forms a basis for further studies on morphological and biochemical basis of resistance to understand the host plant resistance mechanism to the pest.

Keywords: Asian Citrus Psyllid, Citrus, *Diaphorina citri*, germplasm, host plant resistance

INTRODUCTION

Citrus is one of the important fruit crops in India with the production of 74.64 lakh tons from 8.46 lakh hectares with the productivity of 8.8 tons/ha at national level as compared to 25-30 tons/ha in advanced citrus producing countries (NHB, 2011). The productivity and quality of citrus is severely affected by several factors; insect pests being one of them. *Citrus* spp. is attacked by more than 823 and 250 insects in the world (Ebeling, 1959) and India (Nair, 1975, Srivastava and Butani, 1999), respectively right from nursery to harvesting stage. Among the insect pests attacking citrus, Asian Citrus Psyllid (ACP), *Diaphorina citri* Kuwayama, is one of the major insect pests of citrus cultivars attacking the new flush in all the three seasons *viz.* spring, summer and winter with its peak activity in spring season across India and is also known to transmit the Greening disease, which accelerates 'citrus decline' syndrome (Bove, 2006). Chemical control has been widely used to contain the pest, but the deleterious effects associated with its indiscriminate use results in insecticide resistance, pest resurgence. Among the safer and viable methods to combat insect pest attack, host plant resistance plays an important role in Integrated Pest Management. Evaluation of available indigenous/exotic citrus germplasm to ACP results in identification of resistant germplasm which further helps in the development of insect resistant rootstocks/scions which culminates in to development of rational pest management strategy for ACP. Keeping this in view, screening studies were carried out to know the relative resistance level among 32 germplasm collections of citrus against ACP.

MATERIALS AND METHODS

Field screening of citrus germplasm (32 Nos.) against ACP was conducted during 2008-2010 at Experimental Farm of National Research Centre for Citrus, Nagpur. The exotic gemplasm collections (21 Nos.) used for the study were Sunlix beneck S.C., Kusaic Rangpur, Shekwasha x Rough lemon, X-639, Benton citrange, Sun-chu-sha mandarin, Rangpur lime X Troyers, Willits citrange, Florida Rough lemon, Norneo Rangpur, Trifoliate hybrid, Trifolia, Rich 16-6, Flying Dragon, Schaub Rough lemon, Alemow, C-32 citrange, Smooth Flat Seuilli, (SFS), Dr. Knoor, Chase Rough lemon and Argentina Trifoliate orange. Indigenous gemplasm (11 Nos.) included Cleoptra mandarin (Tirupati), Cleopatra mandarin (Gonicoppal), Rough lemon (Tirupati), Rough lemon (Rahuri), Sour orange (Tirupati), Trifoliate orange (Chethali), Trifoliate orange (Gonicoppal), Troyer citrange (Gonicoppal), Troyer citrange (Chethali), Carizzo citrange (Chethali) and Rangpur lime (Gonicoppal). All the agronomic practices were carried out regularly and no insecticidal spray was carried out during the study period.

Observations on incidence of ACP (no. of nymphs/ 5cm twig) were taken during spring season. Four trees of each germplasm were selected for recording data. Nymphal count / 5cm twig covering four directions of each tree was taken. The data were transformed to square root values and subjected to ANOVA to test the significance of differences. Citrus germplasm were classified as resistant (< 5 nymphs / 5cm twig), moderately resistant (5.1 - 10 nymphs / 5cm twig), susceptible (10.1-25 nymphs / 5cm twig) and highly

Table 1. Infestation of Asian Citrus Psyllid, *Diaphorina citri* in different exotic and indigenous citrus germplasm during 2008, 2009 and 2010.

Citrus germplasm		Psylla population (nymphs/5 cm twig)			
		2008	2009	2010	Pooled Mean
Exotic					
1.	Sunlix beneck S.C.	7.4(2.72)^{def}	7.3 (2.70)^{ef}	8.6(2.93)^{cdefg}	7.7(2.78)
2.	Kusaic Rangpur	14.6(3.82)^{hi}	22.5 (4.74)^{mn}	21.7(4.66)^{j}	19.6(4.40)
3.	Shekwasha x Rough lemon	5.2(2.28)^{de}	6.8 (2.61)^{ef}	8.2(2.86)^{cdef}	6.7(2.58)
4.	X – 639	5.4(2.32)^{de}	7.0 (2.64)^{ef}	72(2.68)^{cd}	6.5(2.54)
5.	Benton Citrange	16.8(4.10)^{ij}	22.1 (4.70)^{lmn}	21.0(4.58)^{ij}	19.9(2.46)
6.	Sun-Chu-Sha Mandarin	5.4(2.32)^{de}	7.1 (2.66)^{ef}	7.6(2.76)^{cd}	6.7(2.58)
7.	Rangpur lime X Troyers	5.1(2.26)^{cd}	6.4 (2.53)^{def}	NR	5.7(1.59)
8.	Willits citrange	1.2(1.10)^{a}	0.2 (0.45)^{a}	NR	0.7(0.51)
9.	Florida Rough lemon	24.9(4.99)^{k}	25.8 (5.08)^{n}	12.6(3.55)^{defgh}	21.1(4.54)
10.	Norneo Rangpur	9.2(3.03)^{fg}	8.8 (2.97)^{fg}	7.5(2.74)^{cd}	8.5(2.91)
11.	Trifoliate Hybrid	8.8(2.97)^{fg}	9.4 (3.07)^{fgh}	7.9(2.81)^{cd}	8.7(2.95)
12.	Trifolia	2.4(1.55)^{ab}	2.2 (1.48)^{bc}	NR	2.3(1.01)
13.	Rich 16-6	2.5(1.58)^{ab}	0.8 (0.89)^{ab}	0.9(0.95)^{a}	1.4(1.15)
14.	Flying Dragon	2.4(1.55)^{ab}	1.5 (1.22)^{bc}	1.2(1.10)^{a}	1.7(1.29)
15.	Schaub Rough lemon	18.0(4.24)^{j}	20.4 (4.52)^{klmn}	3.9(3.73)^{fghi}	14.1(4.16)
16.	Alemow (*C. macrophylla*)	18.3(4.28)^{j}	24.3 (4.93)^{n}	13.7(3.70)^{efghi}	18.7(4.30)
17.	C – 32 Citrange	5.5(2.35)^{de}	6.5 (2.55)^{ef}	8.0(2.83)^{cde}	6.6(2.57)
18.	Smooth Flat Seuilli (SFS)*	13.7(3.65)^{hi}	16.4 (4.05)^{ijk}	16.3(4.04)^{hij}	15.5(3.91)
19.	Dr. Knoor*	13.3(3.65)^{hi}	16.8 (4.10)^{jkl}	18.9(4.35)^{hij}	16.3(4.03)
20.	Chase Rough lemon*	11.8(3.44)^{fgh}	13.1(3.62)^{hij}	14.4(3.79)^{ghij}	13.1(3.61)
21.	Argintina Trifoliate Orange*	5.4(2.32)^{de}	6.8 (2.61)^{ef}	5.7(2.39)^{bc}	6.0(2.42)
Indigenous					
22.	Cleoptra Mandarin (Tirupati)	5.1(2.26)^{cd}	6.9 (2.63)^{ef}	7.9(2.81)^{cd}	6.6(2.56)
23.	Cleoptra Mandarin (Gonicoppal)	5.0(2.24)^{cd}	7.2 (2.68)^{ef}	7.1(2.66)^{c}	6.4(2.52)
24.	Rough Lemon (Tirupati)	12.9(3.59)^{h}	17.0 (4.12)^{jklm}	15.8(3.97)^{hij}	15.2(3.89)
25.	Rough Lemon (Rahuri)	8.0(2.83)^{f}	12.3(3.51)^{ghi}	14.2(3.77)^{ghi}	11.5(3.37)
26.	Sour Orange (Tirupati)	2.0(1.41)^{a}	5.1 (2.26)^{de}	8.6(2.93)^{cdefg}	5.2(2.2)
27.	Trifoliate Orange (Chethali)	2.8(1.67)^{b}	2.0 (1.41)^{bc}	2.5(1.58)^{ab}	2.4(1.55)
28.	Trifoliate Orange (Gonicoppal)	3.2(1.79)^{bc}	2.5 (1.58)^{c}	2.6(1.61)^{ab}	2.8(1.66)
29.	Troyer Citrange (Gonicoppal)	2.4(1.55)^{ab}	3.0 (1.73)^{cd}	NR	2.7(1.09)
30.	Troyer Citrange (Chethali)	7.1(2.66)^{def}	7.9 (2.81)^{ef}	8.9(2.98)^{cdefg}	8.0(2.81)
31.	Carizzo Citrange (Chethali)	2.2(1.48)^{ab}	3.2 (1.79)^{cd}	2.2(1.48)^{a}	2.5(1.58)
32.	Rangpur lime (Gonicoppal)	7.6(2.76)^{ef}	13.0 3.61)^{hij}	NR	10.3(2.12)
	SED ±	0.234	0.310	0.432	—
	CD (5%)	0.48	0.63	0.88	—

Figures in parentheses are square root transformed values; NR = Not recorded
Values followed by same letter in a column are not significantly different (P=0.05).

Table 2. Response of different Citrus germplasm collections against Asian Citrus Psyllid during 2008, 2009 and 2010

Resistance category	Exotic	Indigenous
Resistant (< 5 nymph /5 cm twig)	Willitus Citrange, Trifoliate, Rich 16-6 Flying dragon	Trifoliate orange(Chethali) Trifoliate orange(Gonicoppal) Troyer citrange (Gonicoppal) Carizzo citrange (Chethali)
Moderately resistant (< 10 nymph/5 cm twig)	Sunlix beneck S.C. Shekwasha x Rough lemon X-639, Sun-cun-sha mandarin, Argentine Trifoliate, Rangpur lime x Troyers Norneo Rangpur Trifoliate Hybrid C-32 Citrange	Cleopatra mandarin (Tirupati) Cleopatra mandarin(Gonicoppal) Troyer Citrange (Chettalli) Sour Orange (Tirupati)
Susceptible (< 25 nymph/5 cm twig)	Kusaic Rangpur, Smooth Flat Seuilli (SFS) Benton citrange , Dr. Knoor Florida Rough lemon Alemow (*C. macrophylla*) Schaub Rough lemon, Chase Rough Lemon	Rough lemon (Tirupati) Rough lemon (Rahuri) Rangpur Lime (Gonicoppal)
Highly Susceptible (> 25 nymph/5 cm twig)	Nil	Nil

susceptible (>25 nymphs/ 5cm twig) based on the extent of damage was adopted.

RESULTS AND DISCUSSION

Among the 32 citrus germplasm collections, Willits Citrange (1.2 nymphs/ 5 cm twig) and Sour Orange (Tirupati) (2.0 nymphs/ 5 cm twig) recorded significantly low ACP incidence but were at par with Carrizo citrange (Chethali) (2.2 nymphs/ 5 cm twig), Trifeola (2.4 nymphs/ 5 cm twig), Flying dragon (2.4 nymphs/ 5 cm twig), Troyer citrange (Gonicoppal) (2.4 nymphs/ 5 cm twig) and Rich 16-6 (2.5 nymphs/ 5 cm twig) during 2008. Similarly in 2009, Willits citrange (0.2 nymphs/ 5 cm twig) recorded significantly low ACP incidence but was at par with Rich 16-6 (0.8 nymphs/ 5 cm twig). In 2010, Rich 16-6 (0.9 nymphs/ 5 cm twig), Flying dragon (1.2 nymphs/ 5 cm twig) and Carizzo Citrange (Chethali) (2.2 nymphs/ 5 cm twig) recorded significantly low ACP incidence but were at par with Trifoliate orange (Chethali) (2.5 nymphs/ 5 cm twig) and Trifoliate orange (Gonicoppal) (2.6 nymphs/ 5 cm twig) (Table 1).

According to germplasm classification based on three year mean data, Willits citrange, Trifolia, Rich 16-16, flying dragon in case of exotic germplasm and Trifoliate Orange (Chethali, Gonicopal), Carizzo Citrange (Chethali), Troyer Citrange (Gonicopal) in case indigenous germplasm were found resistant to ACP (Table 2).

The foregone results showed that a total of eight, thirteen and eleven germplasms were found resistance, moderately resistant and susceptible to ACP. Of the 32 citrus germplasm screened, none were found highly susceptible to ACP (Table 2). Bhagat and Nehru (2005) and Batra *et al.* (1970) reported the variation in different citrus cultivars/germplasm regarding their susceptibility to ACP.

The variation in resistance levels to ACP in different citrus germplasm may be due to time of availability of tender flushes and seasonal fluctuations in the populations of the ACP, ovipositional preferences and host suitability for growth and development of the ACP and presence of allelochemicals. Further, the presence of aromatic aminoacids in the flowers also plays a role in nutritional ecology (Broadbeck *et al.,* 2001). The identified germplasm resistance to ACP can be considered as potential resistance source in future citrus improvement programmes through breeding/ hybridization programmes to suit best in IPM strategies. The identified resistance germplasm may be further studied to know the mechanism of resistance for ACP.

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