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Survey for the occurrence of spiralling whitefly, *Aleurodicus dispersus* (Russell) under high density planting systems of guava in Karnataka, India

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ABSTRACT: Systematic surveys were conducted to document the incidence of spiralling whitefly, *Alerodicus dispersus* (Rssell) in seven districts of Karnataka *viz.*, Bidar, Bagalkot, Gadag, Dharwad, Haveri, Chikkamangaluru and Bengaluru during 2017 and 2018. Spiralling whitefly incidence in all the districts was categorized as low, medium, high and very high. Incidence was very high (>75%) in Bidar and Bengaluru while Gadag showed high incidence (51-75%) during both the years of study. The incidence of spiralling whitefly was high in 2017 in Bengaluru and Bidar districts. The district which showed high level of incidence of spiralling whitefly in 2017 turned to medium level of infestation in 2018. Dharwad and Bagalkot districts showed medium level (26-50%) of infestation. Haveri and Chikkamagaluru showed low level (1-25%) of infestation both the years.

Keywords: *Aleurodicus disperses,* guava, Karnataka, spiralling whitefly, survey

INTRODUCTION

Guava *(Psidium guajava* L.), a member of family Myrtaceae, popularly known as the "Apple of the Tropics", is one of the most common fruits grown in India. It is claimed to be the fourth most important fruit, in terms of area and production after mango, banana and citrus and presently it occupies nearly 2.76 lakh hectares of area with a production of 42.36 metric tonnes and productivity of 13.94 tonnes per hectare. Though it is successfully grown all over the country, the leading guava growing states are Maharashtra, Uttar Pradesh, Bihar, Madhya Pradesh and Karnataka. The state of Karnataka has 6740 ha with 1.31 lakh metric tonnes of production and productivity of 19.39 tonne per ha (Anon., 2019). The traditional system of cultivation has often been posed with problem in attaining desired levels of productivity and partly due to large tree canopy. Hence, the need arises across to improve the existing production system and to improve productivity. The high-density meadow orcharding facilitated enhanced production and quality of fruits. The meadow orchard system of guava accommodates more number of plants per ha as compared to conventional planting system. Though guava is a hardy plant, many insect pests are reported to attack and cause considerable damage. Insects like spiralling whitefly, tea mosquito bug, scale insects, mealy bugs, aphids, thrips, coreid bug, fruit fly, fruit borer, stem borer, hairy caterpillar and leaf weevil are affecting guava in south India (Nair and Visalakshi, 1999). Spiralling whitefly, *Aleurodicus dispersus* (Russell) has become a severe pest in recent years which causes 64 per cent leaf infestation with 80 per cent fruit loss in guava. Hence a survey was conducted to know the incidence of spiralling whitefly under high density planting systems of guava in various regions of Karnataka.

MATERIALS AND METHODS

Intensive roving surveys were under taken in guava orchards across seven districts of Karnataka i.e Bidar, Bagalkot, Gadag, Dharwad, Haveri, Chikkamagaluru and Bengaluru for two years (2017 and 2018) to understand the distribution pattern and extent of infestation by *Aleurodicus dispersus* (Russell) on guava. Observations on incidence pattern of spiralling whitefly were recorded across ten orchards in different places of each district. The orchards comprised of different spacings, where in ten plants were selected randomly. The sample involved two leaves from twelve shoots in a tree selected from all directions representing top, middle and bottom portion of the canopy. The data from these 24 leaves collected from top, middle and bottom portion of the ten plants were pooled and average was worked out. Adults were counted in the field and immatures were counted under microscope in laboratory. Assessment of pest infestation was recorded in five grade basis as given by Vennila *et al.* (2010) as follows. Nil-No pest incidence on a plant, Low (1-25%) Scattered appearance of few insect pests on the plant, Medium (26-50%) severe incidence of the pest on only one branch, High (51-75%) severe incidence of insect pest on more than one branch and Very high (>75%) Severe incidence of insect pest on entire plant.

Table 1.: Distribution of spiralling whitefly on guava at different districts of Karnataka during 2017 and 2018

District	Number of spiralling whiteflies per 24 leaves								
	2017				2018				
	Egg	Nymph	Adult	Total	Egg	Nymph	Adult	Total	Damage Level
Gadag	24.06	29.69	18.08	71.84	23.02	27.71	16.15	66.88	High
Bidar	29.29	39.36	22.07	90.72	27.79	37.95	21.88	87.62	Very high
Bengaluru	28.70	39.80	26.01	94.51	28.18	37.80	23.86	89.84	Very high
Dharwad	26.12	36.98	22.12	85.21	27.36	37.63	21.03	86.02	Medium
Bagalkot	20.88	31.42	18.19	70.50	21.35	31.95	18.05	71.35	Medium
Chikkamagaluru	13.54	19.35	12.42	45.31	12.92	17.43	12.05	42.40	Low
Haveri	14.51	19.36	13.26	47.13	14.05	17.48	11.94	43.47	Low
SEm ±	1.05	1.39	1.07	3.17	1.03	1.37	1.05	3.11	
CD @ 5%	2.92	3.88	2.98	8.85	2.88	3.83	2.94	8.68	

RESULTS AND DISCUSSION

Surveys were carried out in all the 7 districts of Karnataka i.e Bidar, Bagalkot, Gadag, Dharwad, Haveri, Chikkamagaluru and Bengaluru to know the distribution of *Aleurodicus dispersus* (Russell) during 2017 and 2018. Spiralling whitefly incidence in all the districts was categorized as low, medium, high and very high Table 1. The districts like Bidar and Bengaluru showed very high level of incidence (>75%) and Gadag showed high incidence (51-75%) during both the years of study. The incidence of spiralling whitefly was high in 2017 in Bangaluru and Bidar districts. The district which showed high level of incidence of spiralling whitefly in 2017 turned to medium level of infestation in 2018. Dharwad and Bagalkot districts showed medium level of infestation (26-50%). Haveri and chikkamagaluru showed low level of infestation (1-25%) both the years. Possibly this could due to variation of climatic factor like temperature, relative humidity and rainfall and also due to effect of natural enemies. Geetha (2000) reported similar results on incidence of spiralling whitefly in all the districts of Tamil Nadu except Udhagamandalam and also Dinesh (2004) in all the districts of Karnataka.

In India, its first occurrence was recorded in Kerala in 1993-1994 on cassava by Palaniswami *et al.* (1995), wild rubber in parts of Kerala and Tamil Nadu by David and Regu. (1995). However, the incidence of spiralling whitefly on guava in Karnataka was first reported by Mani and Krishnamoorthy (1996). The heavy incidence of this pest in Bidar, Gulberga, Raichur, Bellary, Belgaum, Dharwad and Gadag districts might be due to spread or migration of whitefly populaion from adjoining states like Maharashtra and Andhra Pradesh. Sathe (1999) reported heavy incidence of spiralling whitefly in Maharashtra. Reddy and Chandurkar (1999) reported the spiralling whitefly incidence in Andhra Pradesh. In India, though its occurrence is found in all southern states *viz.,* Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and Maharashtra, it is likely to spread to northern parts rapidly if left unchecked. Spiralling whitefly was also reported from several countries in the world. It was first reported in Carribean region and Central America (Russell, 1965), Hawaii and Canary Islands (Paulson & Kumashiro,1985), American Samoa and Gaum (Firman, 1982), in most of the Pacific islands (Waterhouse and Norris,1989), Africa (Akinlosotu *et al*., 1993; Boob and Oers, 1994; Neuenschwander, 1994), Asia (Anon.,1981; Wijesekera and Kudagamage,1990; Kajita *et al*., 1991;

Table 2.: Distribution of spiralling whitefly population across canopy levels with different plant spacings during 2017

Treatment	Number of spiralling whitefly per 24 leaves			
	Egg	Nymph	Adult	Total
		Spacing (S)		
S1: 2 m×2 m	30.74	42.55	24.96	98.26
S2: 3 m×2.5 m	26.48	36.44	25.96	88.88
S3: 3 m×3 m	25.83	37.75	22.55	86.14
S4: 5 m×2 m	26.24	37.70	23.23	87.18
S5: 5 m×2.5 m	26.23	34.38	20.70	81.32
S6: 5 m×4m	26.41	33.51	20.87	80.79
S7: 5 m×5 m	25.30	33.99	20.31	79.60
S8: 6 m×3 m	22.46	29.60	20.61	72.66
S9: 6 m×6 m	21.13	29.57	18.18	68.88
S10: 10 m×10 m	17.77	27.32	17.37	62.46
SEm ±	3.98	5.65	3.57	13.11
CD @ 5%	11.05	15.70	9.93	36.44
		Canopy levels (C)		
C_1: Upper	28.04	38.83	24.87	91.75
C_2: Middle	27.17	37.51	23.79	88.47
C_3: Lower	19.37	26.50	15.76	61.63
SEm ±	2.18	3.09	1.96	7.18
CD @ 5%	6.05	8.60	5.44	19.96
		Interactions (Spacing x Canopy level)		
S_1C_1	20.80	22.29	13.29	56.38
S_1C_2	38.17	56.68	33.79	128.63
S_1C_3	28.16	41.10	27.90	97.16
S_2C_1	30.05	24.00	10.40	64.45
S_2C_2	36.45	59.75	34.50	130.70
S_2C_3	27.80	40.75	35.20	103.75
S_3C_1	6.98	12.18	7.38	26.53
S_3C_2	21.45	33.98	22.38	77.80
S_3C_3	17.68	22.75	14.18	54.60
S_4C_1	16.16	14.37	9.18	39.71
S_4C_2	29.93	48.56	26.23	104.72
S_4C_3	20.09	31.91	20.25	72.26

S_5C_1	18.30	22.95	14.40	55.65
S_5C_2	35.95	55.65	34.50	126.10
S_5C_3	30.60	42.65	25.40	98.65
S_6C_1	20.95	21.60	12.90	55.45
S_6C_2	37.75	54.35	32.55	124.65
S_6C_3	26.15	36.30	30.25	92.70
S_7C_1	23.85	25.35	13.15	62.35
S_7C_2	45.40	63.40	39.25	148.05
S_7C_3	32.25	55.10	38.25	125.60
S_8C_1	15.40	14.33	9.53	39.27
S_8C_2	36.50	54.10	31.90	122.50
S_8C_3	32.11	46.86	30.93	109.89
S_9C_1	13.90	14.22	10.12	38.24
S_9C_2	25.82	38.16	22.05	86.03
S_9C_3	21.40	26.76	16.91	65.07
$S_{10}C_1$	8.46	9.57	4.97	23.00
$S_{10}C_2$	16.93	24.66	12.24	53.83
$S_{10}C_3$	10.37	14.14	10.24	34.76
SEm ±	6.89	9.78	6.18	22.70
CD @ 5%	19.14	27.19	17.19	63.12

Wen *et al*., 1994; Palaniswami *et al*., 1995) and Australia (Lambkin, 1999).

Distribution of whitefly population on guava plant in various districts during the year 2017 and 2018

The mean egg population was documented highest (29.29 /24 leaves) in Bidar district followed by Bengaluru (28.70 per 24 leaves) indicating an insignificant difference between them. On the contrary,lowest number of egg population was recorded in Chikkamagaluru district (13.54 per 24 leaves) followed by Haveri district (14.51 per 24 leaves) (Table 1). The population of nymphs was found to vary significantly in different canopy level. The districts also exhibited significant variation in mean nymph population with highest mean population observed in Bengaluru (39.80 per 24 leaves) followed by Bidar (39.36 per 24 leaves) and Dharwad (36.98 per 24 leaves). The least mean nymph population was reocorded in Chikkamagaluru (19.35 per 24 leaves) followed by Haveri (19.36 per 24 leaves) districts (Table2). Significantly, highest adult total population mean was recorded in Bengaluru (94.51 per 24 leaves) and Bidar (90.72 per 24 leaves) districts compared to other districts and significantly lower mean total population was documented in Chikkamagaluru (45.31 per 24 leaves) followed by Haveri (47.13 per 24 leaves) districts.

In 2018 distribution of whitefly population across different districts revealed that, number of eggs was significantly highest in Bengaluru (28.18) followed by Bidar (27.79) and Dharwad (27.36) but was lowest in Chikkamagaluru (12.92). With respect to nymph population, highest was observed in Bidar (37.95) followed by Bengaluru (37.80) and Dharwad (37.63) but lowest was observed in Chikkamagaluru (17.43). Adult population was found to be significantly higher in Bengaluru (23.86) followed by Bidar (21.88) and Dharwad (21.03) but lowest was observed in Haveri (11.94). Hence the total whitefly population was found to be significantly higher in Bengaluru (89.84) followed by Bidar (87.62) and Dharwad (86.02) but lowest was observed in Chikkamagaluru (42.40) (Table 2). The whitefly always preferred to lay eggs on lower surface of young leaves. Geetha (2000) reported similar results

on incidence of spiralling whitefly in all the districts of Tamil Nadu except Udhagamandalam and also Dinesh (2004) carried out surveys in 27 districts of Karnataka to know the distribution of *A. dispersus* during 2001 to 2002. Incidence of spiralling whitefly was seen in all the districts like Bidar and Gadag which showed high level of incidence during both the years of the study.

Distribution of spiralling whitefly population across canopy levels with different plant spacings during 2017 and 2018

The study was conducted to know the distribution of mean whitefly population across canopy levels and also across different plant density or plant spacing. The results showed that, the mean egg population was found to vary significantly across different spacing and highest mean egg population was recorded in plot with spacing of 2 m x 2 m (S_1=30.74) followed by S_2 with a mean of 26.48 and lowest was documented in S_{10} with a mean of 17.77 eggs per 24 leaves. The mean egg population also varied significantly across canopy levels with highest mean at upper (28.04) followed by middle (27.17) and lowest was on lower canopy (19.37). The mean nymphal population varied significantly across different spacing with highest mean (42.55) recorded in plot with spacing of 2 m x 2 m (S_1) followed by S_3 with a mean of 37.75 and lowest was documented in S_{10} with a mean of 27.32 nymphs per 24 leaves followed by S_9 (29.57). The means also varied significantly across canopy levels with highest mean at upper (38.83) followed by middle (37.51) and lowest on lower canopy (26.50). The mean adult population varied significantly across different spacing with a highest mean of 25.96 recorded in plot with spacing of 3 m x 2.5m m (S_2) followed by S_1 with a mean of 24.96 and lowest was documented in S_{10} with a mean of 17.37 adults per 24 leaves followed by S_9 (18.18). The means differed significantly across canopy levels with highest mean at upper level (24.87) followed by middle (23.79) and lowest on lower canopy (15.76). Similar trend was observed for total population, the means of total population were varied significantly across different spacing, canopy levels and also across interactions of spacing and canopy levels. Significantly, highest mean total population was recorded in plot with spacing of 2 m x 2 m (S_1=98.26) followed by S_2 with a mean of 86.14 and lowest was documented in S_{10} with a mean of 62.46 adults per 24 leaves followed by S_9 (68.88). The means of total population also varied significantly across canopy levels with highest mean at upper (91.75) followed by middle (88.47) and lowest on lower canopy (61.63). The interaction means of adult population between different spacings and canopy levels also varied significantly. The means of interactions of spacing and canopy levels for eggs, nymphs, adults and for total population differed significantly (Table 2).

Same trend followed by 2018 the results showed that, the mean egg population was found to vary significantly across different spacing, the highest number of eggs was recorded in plot with spacing of 2 m x 2 m (S_1=31.75) followed by S_6 (27.75), S_2 (26.56) and lowest was documented in S_{10} with a mean of 17.99 eggs per 24 leaves. The mean egg population also varied significantly across canopy levels with highest mean at upper (28.08) followed by middle (25.70) and lowest on lower canopy (19.34). The number of nymphs was found to vary significantly across different spacing with

Table 3. Distribution of spiralling whitefly population across canopy levels on guava and with plant spacings during 2018

Treatment	Number of spiralling whitefly per 24 leaves			
	Egg	Nymph	Adult	Total
	Spacings (S)			
S_1: 2 m×2 m	31.75	40.53	22.87	95.15
S_2: 3 m×2.5 m	26.56	38.95	25.37	90.88
S_3: 3 m×3 m	25.75	37.81	21.78	85.34
S_4: 5 m×2 m	22.53	29.22	18.38	70.13
S_5: 5 m×2.5 m	24.57	29.10	18.87	72.54
S_6: 5 m×4m	27.75	30.59	19.48	77.82
S_7: 5 m×5 m	25.01	31.90	18.83	75.73
S_8: 6 m×3 m	21.05	29.03	20.39	70.47

S_9: 6 m×6 m	20.74	27.87	16.50	65.11
S_{10}: 10 m×10 m	17.99	26.11	16.48	60.58
SEm ±	3.92	5.29	3.31	12.43
CD @ 5%	10.89	14.71	9.21 (NS)	34.57
		Canopy level (C)		
C_1: Upper	28.08	36.01	23.11	87.20
C_2: Middle	25.70	34.72	21.37	81.79
C_3: Lower	19.34	25.60	15.20	60.14
SEm ±	2.15	2.90	1.81	6.81
CD @ 5%	5.97	8.05	5.04	18.93
		Interactions (Spacings x Canopy levels)		
S_1C_1	20.96	21.13	13.38	55.47
S_1C_2	36.79	51.92	31.49	120.2
S_1C_3	27.26	38.47	26.01	91.73
S_2C_1	30.35	26.15	10.15	66.65
S_2C_2	38.75	62.25	35.10	136.1
S_2C_3	28.40	49.15	35.00	112.55
S_3C_1	7.18	10.73	6.38	24.28
S_3C_2	20.88	30.85	20.43	72.15
S_3C_3	17.50	21.75	13.03	52.28
S_4C_1	15.36	13.62	8.05	37.03
S_4C_2	29.41	45.54	25.11	100.06
S_4C_3	19.55	31.58	19.08	70.21
S_5C_1	18.90	22.90	12.30	54.10
S_5C_2	36.50	54.70	33.45	124.65
S_5C_3	30.30	39.50	22.90	92.70
S_6C_1	18.95	19.60	11.15	49.70
S_6C_2	35.75	52.35	30.55	118.65
S_6C_3	24.15	34.30	28.25	86.70
S_7C_1	23.85	25.35	13.15	62.35
S_7C_2	50.40	56.40	37.35	144.15
S_7C_3	35.50	49.90	33.35	118.75
S_8C_1	12.05	13.30	9.50	34.85
S_8C_2	30.65	38.35	24.85	93.85
S_8C_3	23.00	27.80	19.90	70.70
S_9C_1	15.53	15.36	10.56	41.44

S_9C_2	26.95	39.49	23.43	89.87
S_9C_3	22.11	27.82	18.37	68.31
$S_{10}C_1$	7.81	7.94	3.74	19.50
$S_{10}C_2$	16.07	22.24	11.19	49.50
$S_{10}C_3$	10.29	12.90	9.61	32.80
SEm ±	6.79	9.16	5.74	21.54
CD @ 5%	18.87	25.47	15.95	59.88

highest mean (40.53) recorded in plot with spacing of 2 m x 2 m (S_1) followed by S_2 (38.95), S_3 (37.81) and lowest was documented in S_{10} with a mean of 26.11 nymphs per 24 leaves followed by S_9 (27.87). The means were also varied significantly across canopy levels with highest mean at upper (36.01) followed by middle (34.72) and lowest on lower canopy (25.60). There was no significant variations with respect to adult population across different spacings with a highest mean of 25.37 was recorded in plot with spacing of 3 m x 2.5 m (S_2) and lowest was documented in S_{10} with a mean of 16.48 adults per 24 leaves. However, the means varied significantly across canopy levels with highest mean at upper (23.11) followed by middle (21.37) and lowest on lower canopy (15.20). The means of total population also varied significantly across different spacing, canopy levels and also across interactions of spacings and canopy levels. Significantly, highest population was recorded in plot with spacing of 2 m x 2 m (S_1=95.15) followed by S_2 (90.88) and lowest was documented in S_{10} with a mean of 60.58 adults per 24 leaves followed by S_9 (65.11). The means of total population also varied significantly across canopy levels with highest mean at upper (87.20) followed by middle (81.79) and lowest on lower canopy (60.14). The interaction means of adult population between different spacing and canopy levels also varied significantly. The means of interactions of spacing and canopy levels for eggs spirals, nymphs, adults and for total population varied significantly (Table 3). The present study is in agreement with (Jadhav, 2015) who reported guava plants with 6.0 m x 6.0 m and 2.0 m x 2.0 m spacing recorded significantly less incidence of thrips, spiralling whiteflies and mealy bugs. The maximum pest population was recorded in the spacing of 1.0 mx 1.0 m followed by 1.5 mx 1.5 m plant spacing. Mahesh (2014) also reported variation in incidence of spiralling white fly in different months among various spacing. Maximum incidence of spiralling whitefly (1.89, 2.34, 2.48, 2.55 and 3.51) was recorded in September, October, November, December and January, whereas lower incidence of spiralling whitefly (0.45, 1.54, 1.66, 1.75 and 2.39) was noted in September, October, November, December and January, respectively in plants at 6 x 6 m. (Scoring: 1-2: 20 per cent pest incidence, 2-3: 40 per cent pest incidence, 3-4: 60 per cent pest incidence, 4-5: 80 per cent pest incidence, 5-100 per cent pest incidence)

The surveys indicated the presence of infestation by *A. dispersus* in seven districts of Karnataka. There was severity in the incidence of spiralling whitefly in Bengaluru, Bidar, Dharwad and Gadag districts of Karnataka. The districts like Bengaluru and Bidar showed very high level of incidence on upper canopy in high density planting systems (close spacing of 2 m x 2 m) during both the years. The incidence of spiralling whitefly was very high in Bengaluru, Bidar and Gadag districts during 2017. Bagalkot and Dharwad districts showed medium level of infestation in 2017. Except Bengaluru and Bidar, the remaining districts showed medium level of infestation in 2018.

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