

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(8): 1149-1155
www.biochemjournal.com
Received: 22-06-2024
Accepted: 28-07-2024

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Bio-efficacy of botanicals and insecticides against whitefly, *Dialeurodes kirkaldyi* Kotinsky (Aleyrodidae: Hemiptera) in jasmine, *Jasminum sambac*

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DOI: <https://doi.org/10.33545/26174693.2024.v8.i8So.2005>

Abstract

Field experiments were conducted to evaluate the efficacy of botanicals and newer insecticide molecules against whiteflies in jasmine. In the present study, *pungam* oil @ 2.0 per cent stood first effectively reducing the incidence of whitefly with 51.30 per cent reduction in jasmine. Among the insecticides, Imidacloprid 17.8 SL @ 0.30 ml /lit, Acetamiprid 20 SP @ 0.10 g /lit were found to be effective against whitefly with 82.63 and 79.44 per cent reduction, respectively. The results from the present investigation can provide valuable information towards the development of IPM module in jasmine.

Keywords: Bio-efficacy, botanicals, insecticides, whiteflies, jasmine

Introduction

Jasmine (*Jasminum sambac* L.) is one of the oldest traditional perfumed flowers cultivated by man and is considered as the 'Queen of fragrance' which belongs to the family Oleaceae (Kiran *et al.*, 2017) [7]. It is an important flowering plants which are commercially grown for their scented flowers and used for oil production (El-Amir *et al.*, 2020) [3], perfumes and attars (Arumugam *et al.*, 2002) [1]. India trades jasmine flowers to the adjoining countries like Sri Lanka, Singapore, Malaysia and Gulf countries. In South India, huge quantities of jasmine flowers are used by women folk for beautifying their hairs. Tamil Nadu is the leading state in jasmine production in the country. The least yield of jasmine flower production might be due to various reasons, among which the menace by insect pests is of fundamental consequence. There are about 50 diverse insect species belonging to more than eight orders harbouring fluctuated microhabitats of jasmine plants.

The jasmine whitefly, *Dialeurodes kirkaldyi* (Kotinsky) (Aleyrodidae: Hemiptera) is one of the most significant pest of jasmine all over the world. It was first described on *Jasminum grandifolium* in 1907 from Hawaii (Kotinsky, 1907) [8]. The nymphs and adults of whitefly suck the sap from lower surface of the leaves and cause yellowing thereby minimizing the vitality of the plant. It invites sooty mould fungus thus photosynthesis will be affected and yield reduction occurs (Rabeena *et al.*, 2020) [13]. Farmers depend mostly on insecticides for controlling whiteflies in jasmine. The decreased efficacy of pesticides and increased worries over their use in jasmine ecosystem have highlighted the need for identifying safer, more effective botanical and newer insecticide molecules for the management of whiteflies in jasmine. Hence, the present study was carried out to assess the efficacy of botanicals and newer insecticide molecules against whiteflies in jasmine.

Materials and Methods

A field trial was conducted in a farmer's field near Vallanad village, Thoothukudi district, Tamil Nadu, India. The experiment was conducted on existing jasmine crop of 1 ½ years old plant. Three rounds of foliar sprays were given at fortnight interval using battery operated knapsack sprayer. Pre-treatment observations on the incidence of whiteflies were recorded in each botanicals / synthetic insecticides treated plants. Post treatment counts were recorded on 1st, 3rd, 7th and 14th day after imposing treatment. Whiteflies population were recorded from 21 randomly selected leaves from top, middle and bottom of the bush and expressed as

number of whitefly adults per leaf (Hemalatha, 2009) [4]. Randomized Block Design was adopted in each treatment, three plants and three replications were maintained for observation.

Preparation of botanical leaf and kernel extracts

i. Notchi (*Vitex negundo*) leaf extract

The fresh leaves of Notchi, *V. negundo* were collected and dried under room temperature (25 ± 2 °C) and then powdered. A total of 100 gram powdered leaves were soaked in 1.0 litre of petroleum ether (boiling range 60–80 °C) was shaken for 24 hours and kept under room temperature for 10 days. After 10 days, the extract was made upto 1000 ml and maintained as standard solution. At the time of spray, 50 ml of standard solution was added in 1000 ml of water and used for spraying (Karunamoorthi *et al.*, 2008) [6].

ii. Neem Seed Kernel Extract (NSKE)

A quantity of 50 g dried neem seed kernel was powdered and it was tied in a small muslin cloth bag and dipped in 100 ml of water and kept overnight for 12 hours and the

suspension was separated. Then, 900 ml water was added to it and stirred well. The filtrate was used for spraying (Sathyan, 2015) [14].

iii. Pungam (*Pongamia pinnata*) (Karanj oil)

Pungam oil was purchased from the market and sprayed at the rate of 20 ml per litre after thorough mixing with the surfactant.

iv. Sweet flag, *Acorus calamus* (AC 10% D)

Rhizome powder of 300 g was added into 1000 ml of distilled water and kept for 24 hours. Then the solvent was filtered. At the time of spray, 50 ml of solvent was used (Shinhiya and Razak, 2017) [15].

v. Wild sage (*Lantana camara*) leaf extract

One kg fresh leaves of wild sage, *L. camara* was dried at room temperature and then powdered. One litre of petroleum ether was added to the dried leaves under kept in shaker for 8 hrs. Then, the extract was filtered. The filtrate thus obtained was used for spraying (Deshmukhe *et al.*, 2011) [2].

The list of botanicals evaluated in the field experiments are furnished below.

	Common Name	Botanical Name	Conc. (%)
T ₁ -	Notchi leaf extract	<i>Vitex negundo</i>	5.00
T ₂ -	NSKE	<i>Azadirachta indica</i>	5.00
T ₃ -	Pungam oil	<i>Pongamia pinnata</i>	2.00
T ₄ -	Sweet flag	<i>Acorus calamus</i>	5.00
T ₅ -	Wild sage leaf extract	<i>Lantana camara</i>	5.00
T ₆ -	Profenophos 50 EC (Std. check)	-	2 ml / lit
T ₇ -	Untreated check	-	-

The list of newer insecticides evaluated in the field experiments are furnished below.

Treatment	Insecticides	Formulation	Dose
T ₁	Acetamiprid	20 SP	0.10 g/lit
T ₂	Chlorantraniliprole	18.5 SC	0.10 ml/lit
T ₃	Dimethoate	30 EC	2.00 ml/lit
T ₄	Fipronil	5 SC	1.50 ml/lit
T ₅	Flubendiamide	39.35 SC	0.75 ml/lit
T ₆	Imidacloprid	17.8 SL	0.30 ml/lit
T ₇	Indoxacarb	14.5 SC	0.35 ml/lit
T ₈	Novaluron	10 EC	1.00 ml/lit
T ₉	Spinosad	45 SC	0.32 ml/lit
T ₁₀	Thiacloprid	21.7 SC	0.60 ml/lit
T ₁₁	Thiamethoxam	25 WG	0.40 g/lit
T ₁₂	Untreated check	--	--

Results and Discussion

i. Bio-efficacy of botanicals against whitefly, *D. kirkaldyi* in jasmine

The results stated that the influence of the treatments, spray rounds and period of observations; interaction effectiveness was also significant (Table 1a-1c). The incidence of whitefly ranged from 2.00 (at 7th day of 3rd spray round on pungam oil treated plant) to 6.00 (at 14th day of 1st spray round in untreated check). Mean population of whitefly over spray rounds as well as period of observations confirm the most effectiveness of pungam oil 2 per cent recording the least population (2.44/ leaf) than all other treatments except the standard check, Profenophos 50 EC; able to reduce the whitefly population more than 50 per cent over untreated check. All other treatments including the standard check brought down the population by 31.94 to 48.01 per cent. The trend was almost similar at each round of spray, period of observations. All the treatments were able to reduce the low population of whitefly even after 7th and 14th day after 3rd round of spray including untreated check.

Kumar (2007) [9] reported that pungam oil @ 2.0 per cent was effective in reducing the whitefly population followed by *V. negundo* leaf extract @ 5 per cent and NSKE @ 5.0 per cent (Fig. 1). The effectiveness of pungam oil @ 2.0 per cent for the control of jasmine pests revealed in the present study is confirmed by Ponsekha and Muthusamy (2016) [12], with their laboratory bioassay as well as by the field studies reported by Merlin Kamla (2017) [10] in jasmine.

ii. Bio-efficacy of insecticides against whitefly, *D. kirkaldyi* in jasmine

The data on the bio-efficacy of insecticides against whitefly presented in Table 2a-2c. The statistical analysis revealed that the significant influence of the treatments, spray rounds as well as period of observations; the interaction effect was desirable. The mean population of whitefly over spray rounds as well as period of observations shown the most effectiveness of Imidacloprid 17.8 SL; recording the least population (0.87/ leaf). Acetamiprid 20 SP (1.03/ leaf) stood next followed by Flubendiamide 39.35 SC (1.12/ leaf) and

Chlorantraniliprole 18.5 SC (1.18/ leaf). Imidacloprid 17.8 SL (0.30 ml/ lit) was found to be most effective treatment against whitefly with 82.63 per cent reduction in jasmine. Acetamiprid 20 SP (79.44%), Chlorantraniliprole 18.5 SC (78.24%), Flubendiamide 39.35 SC (77.64%) and Dimethoate 30 EC (70.86%) were found to be effective with more than 70 per cent reduction in population compared to untreated check. Thiacloprid 21.7 SC (69.10%) and Thiamethoxam 25 WG (62.04%) were found to be inferior to the above treatments but significantly superior than other treatments viz., Indoxacarb 14.5 SC (52.50%), Fipronil 5 SC (50.10%), Novaluron 10 EC (49.10%) and Spinosad 45 SC (48.10%). All other treatments were less effective recording reduction of less than 52.50 per cent. Identical trend was

apparent at each round of spray as well as each period of observations.

The insecticide application provides an immediate solution to control the insect pests and seems to be the most important pest management tool in enhancing agricultural production. The study brought out the superiority of Imidacloprid 17.8 SL @ 0.30 ml/lit followed by Acetamiprid 20 SP @ 0.10 g/lit against whitefly on jasmine (Fig. 2). Imidacloprid 17.8 SL @ 0.30 ml/lit and acetamiprid 20 SP @ 0.10 g/lit belongs to the main group of nicotinic acetylcholine receptor (nAChR) agonists and exemplifying Active Ingredient of neonicotinoids. They inhibit synaptic transmission in insects (IRAC, 2009) [5]. Chloronicotiny compound has good xylem mobility and it is found effective against sucking pests (Omkar Gavkare *et al.*, 2013) [11].

Table 1a: Bio-efficacy of botanicals against whitefly, *D. kirkaldyi* in jasmine

Treatment	Conc. (%)	No of adult per leaf												Overall Mean	Reduction over untreated check (%)
		1 st Spray				2 nd Spray				3 rd Spray					
		DAS				DAS				DAS					
		1	3	7	14	1	3	7	14	1	3	7	14		
Notchi (V. negundo) leaf extract	5.00	2.85	2.94	3.06	3.14	2.84	2.76	2.55	2.50	2.41	2.35	2.26	2.10	2.64	47.30
		(1.69)ab	(1.71)b	(1.75)abc	(1.77)ab	(1.96)b	(1.66)c	(1.60)a	(1.58)a	(1.55)a	(1.52)a	(1.50)ab	(1.45)a	(1.63)b	
NSKE	5.00	2.89	3.05	3.26	3.34	2.95	2.84	2.76	2.16	2.52	2.60	2.20	2.31	2.78	44.51
		(1.70)ab	(1.75)b	(1.81)abc	(1.83)abc	(1.72)a	(1.69)a	(1.66)a	(1.62)a	(1.58)a	(1.61)a	(1.48)ab	(1.52)a	(1.67)bc	
Pungam oil	2.00	2.49	2.75	2.85	3.02	2.54	2.48	2.39	2.31	2.24	2.11	2.00	2.22	2.44	51.30
		(1.58)a	(1.66)a	(1.69)a	(1.74)a	(1.59)a	(1.57)a	(1.55)a	(1.52)a	(1.48)a	(1.45)a	(1.41)a	(1.48)a	(1.56)a	
Sweet flag (A. calamus) rhizome extract	5.00	3.10	3.25	3.66	3.84	2.84	2.65	2.59	2.68	2.51	2.74	2.63	2.51	2.91	41.92
		(1.76)ab	(1.80)b	(1.91)bc	(1.96)bc	(1.69)a	(1.63)a	(1.61)a	(1.64)a	(1.58)a	(1.64)bc	(1.61)ab	(1.58)a	(1.71)c	
Wild sage (L. camara) leaf extract	5.00	3.26	3.40	3.68	4.06	3.94	3.76	3.61	3.48	3.20	3.01	2.84	2.70	3.41	31.94
		(1.81)b	(1.84)b	(1.92)c	(2.01)c	(1.98)b	(1.94)b	(1.90)b	(1.87)b	(1.79)b	(1.73)b	(1.67)b	(1.64)a	(1.85)d	
Profenophos 50 EC (Std check)	2.00 ml/lit	3.06	3.00	2.96	2.74	2.65	2.84	2.76	2.51	2.40	2.20	2.00	2.10	2.60	48.01
		(1.75)ab	(1.73)b	(1.72)ab	(1.66)a	(1.63)a	(1.69)a	(1.66)a	(1.58)a	(1.55)a	(1.48)a	(1.41)a	(1.45)a	(1.61)ab	
Untreated check	-	5.10	5.60	5.84	6.00	5.43	5.01	4.86	4.65	4.60	4.49	4.32	4.21	5.01	0.00
		(2.26)c	(2.37)c	(2.42)d	(2.45)d	(2.33)c	(2.24)c	(2.20)c	(2.16)c	(2.14)c	(2.12)c	(2.08)c	(2.05)b	(2.24)e	
Mean		3.25	3.43	3.62	3.73	3.31	3.19	3.07	2.96	2.83	2.77	2.60	2.59		-
		(1.80)CDE	(1.85)EFG	(1.90)FG	(1.93)G	(1.82)DEF	(1.79)CDE	(1.75)BCD	(1.72)BC	(1.68)AB	(1.66)A	(1.61)A	(1.61)A		

Mean of three replications.

Figures in parentheses are square root transformed values.

In a column/row, means followed by a common letter are not significantly different at 5% level (LSD).

	T	S	D	S x D	T x S x D
Significance	0.01	0.01	0.01	0.01	0.01
CD (P=0.05)	0.06	0.04	0.05	0.08	0.22

Table 1b: Bio-efficacy of botanicals against whitefly, *D. kirkaldyi* (on spray basis)

Treatment	Conc. (%)	No of adult per leaf			Overall Mean	Reduction over untreated check (%)
		Spray				
		1	2	3		
Notchi (<i>V. negundo</i>) leaf extract	5.00	3.00 C	2.66 B	2.27 A	2.64	47.30
		(1.73) a	(1.63) a	(1.50) a	(1.63) b	
NSKE	5.00	3.14 C	2.79 B	2.40 A	2.78	44.51
		(1.77) ab	(1.67) a	(1.55) a	(1.67) bc	
Pungam oil	2.00	2.78 C	2.43 B	2.13 A	2.44	51.30
		(1.67) a	(1.56) a	(1.46) a	(1.56) a	
Sweet flag (<i>A. calamus</i>) rhizome extract	5.00	3.46 C	2.69 B	2.58 A	2.91	41.92
		(1.86) ab	(1.64) a	(1.60) bc	(1.71) c	
Wild sage (<i>L. camara</i>) leaf extract	5.00	3.60 C	3.70 C	2.93 A	3.41	31.94
		(1.90) bc	(1.92) b	(1.71) c	(1.85) d	
Profenophos 50 EC (Std check)	2.00 ml/lit	2.94 C	2.69 B	2.18 A	2.60	48.01
		(1.71) a	(1.64) a	(1.47) a	(1.61) ab	
Untreated check	-	5.64 C	4.99 B	4.41 A	5.01	0.00
		(2.37) d	(2.23) c	(2.10) d	(2.24) e	
Mean		3.51	3.14	2.70		-
		(1.87) C	(1.77) B	(1.64) A		

Mean of three replications.

Figures in parentheses are square root transformed values.

In a column/row, means followed by a common letter are not significantly different at 5% level (LSD).

	T	S	D	T x S
Significance	0.01	0.01	0.01	0.01
CD (P=0.05)	0.06	0.04	0.05	0.11

Table 1c: Bio-efficacy of botanicals against whitefly, *D. kirkaldyi* (on day basis)

Treatment	Conc. (%)	No of adult per leaf					Reduction over untreated check (%)
		Day				Overall Mean	
		1	3	7	14		
Notchi (V. negundo) leaf extract	5.00	2.70 D	2.67 C	2.62 B	2.58A	2.64	47.30
		(1.64) a	(1.63) a	(1.62) a	(1.61) a	(1.63) b	
NSKE	5.00	2.78 B	2.83 C	2.74 A	2.75 A	2.78	44.51
		(1.67) a	(1.68) a	(1.66) a	(1.66) a	(1.67) bc	
Pungam oil	2.00	2.41 A	2.44 B	2.41 A	2.51 C	2.44	51.30
		(1.55) a	(1.56) a	(1.55) a	(1.58) a	(1.56) a	
Sweet flag (A. calamus) rhizome extract	5.00	2.81 A	2.87 B	2.95 C	3.01 D	2.91	41.92
		(1.68) ab	(1.69) ab	(1.72) ab	(1.73) ab	(1.71) c	
Wild sage (L. camara) leaf extract	5.00	3.47 D	3.39 B	3.36 A	3.41 C	3.41	31.94
		(1.86) c	(1.84) c	(1.83) b	(1.85) bc	(1.85) d	
Profenophos 50 EC (Std check)	2.00 ml/lit	2.70 C	2.68 C	2.57 B	2.45 A	2.60	48.01
		(1.64) a	(1.64) a	(1.60) a	(1.57) a	(1.61) ab	
Untreated check	-	5.04 C	5.03 B	5.01 B	4.95 A	5.01	0.00
		(2.25) d	(2.24) d	(2.24) d	(2.23) d	(2.24) e	
Mean		3.13 B	3.13 B	3.10 A	3.09 A		-
		(1.77)	(1.77)	(1.76)	(1.76)		

Mean of three replications.

Figures in parentheses are square root transformed values.

In a column/row, means followed by a common letter are not significantly different at 5% level (LSD).

	T	S	D	T x D
Significance	0.01	0.01	0.01	0.01
CD (P=0.05)	0.06	0.04	0.05	0.12

Table 2a: Bio-efficacy of insecticides against whitefly, *D. kirkaldyi* in Jasmine

Treatment	Dose	No of adult per leaf												Overall Mean	Reduction over untreated check (%)
		1 st Spray				2 nd Spray				3 rd Spray					
		DAS				DAS				DAS					
		1	3	7	14	1	3	7	14	1	3	7	14		
Acetamiprid 20 SP	0.10 g / lit	1.42 (1.19)b	1.60 (1.26)b	1.38 (1.17)a	1.30 (1.14)b	1.26 (1.12)b	1.15 (1.07)a	1.09 (1.04)b	1.04 (1.02)b	0.80 (0.89)b	0.60 (0.77)b	0.50 (0.71)c	0.20 (0.45)b	1.03 (1.01) b	79.44
Chlorantraniliprole 18.5 SC	0.10 ml / lit	1.56 (1.25)c	1.45 (1.20)a	1.42 (1.19)a	1.39 (1.18)c	1.33 (1.15)b	1.23 (1.11)b	1.18 (1.09)c	1.10 (1.05)b	1.06 (1.03)c	1.05 (1.02)d	0.80 (0.89)d	0.60 (0.77)d	1.18 (1.09) d	78.24
Dimethoate 30 EC	2.00 ml / lit	2.03 (1.42)d	2.00 (1.41)c	1.84 (1.36)b	1.56 (1.25)d	1.46 (1.21)c	1.30 (1.14)b	1.29 (1.14)d	1.20 (1.10)c	1.60 (1.26)e	1.40 (1.18)f	1.08 (1.04)f	0.70 (0.84)e	1.46 (1.21) e	70.86
Fipronil 5 SC	1.50 ml / lit	3.02 (1.72)g	2.86 (1.69)e	2.96 (1.72)e	3.00 (1.73)i	2.64 (1.62)fg	2.51 (1.58)e	2.49 (1.58)g	2.34 (1.53)f	2.20 (1.48)g	2.10 (1.45)hi	2.00 (1.41)i	1.90 (1.38)i	2.50 (1.58) i	50.10
Flubendiamide 39.35 SC	0.75 ml / lit	1.50 (1.22)bc	1.64 (1.28)b	1.40 (1.18)a	1.37 (1.17)bc	1.29 (1.14)b	1.24 (1.11)b	1.19 (1.09)c	1.10 (1.05)b	1.05 (1.02)c	0.95 (0.97)c	0.40 (0.63)b	0.30 (0.55)c	1.12 (1.06) c	77.64
Imidacloprid 17.8 SL	0.30 ml / lit	1.23 (1.11)a	1.45 (1.20)a	1.36 (1.17)a	1.20 (1.10)a	1.12 (1.06)a	1.06 (1.03)a	0.96 (0.98)a	0.75 (0.87)a	0.63 (0.79)a	0.43 (0.66)a	0.20 (0.45)a	0.10 (0.32)a	0.87 (0.93) a	82.63
Indoxacarb 14.5 SC	0.35 ml / lit	2.89 (1.70)g	3.05 (1.75)f	2.86 (1.69)e	2.64 (1.62)g	2.53 (1.59)f	2.46 (1.57)e	2.31 (1.52)f	2.20 (1.48)e	2.10 (1.45)g	2.01 (1.42)h	1.86 (1.36)h	1.70 (1.30)h	2.38 (1.54) h	52.50
Novaluron 10 EC	1.00 ml / lit	3.10 (1.76)h	2.74 (1.66)e	2.85 (1.69)e	2.91 (1.71)i	2.76 (1.66)h	2.64 (1.62)f	2.52 (1.59)g	2.34 (1.53)f	2.30 (1.52)h	2.20 (1.48)i	2.10 (1.45)j	2.10 (1.45)j	2.55 (1.60) j	49.10
Spinosad 45 SC	0.32 ml / lit	3.06 (1.75)h	3.00 (1.73)f	2.96 (1.72)e	2.74 (1.66)h	2.65 (1.63)gh	2.84 (1.69)g	2.76 (1.66)h	2.51 (1.58)g	2.40 (1.55)h	2.20 (1.48)i	2.00 (1.41)i	2.10 (1.45)j	2.60 (1.61) j	48.10
Thiacloprid 21.7 SC	0.60 ml / lit	2.13 (1.46)e	2.08 (1.44)c	2.02 (1.42)c	1.86 (1.36)e	1.65 (1.28)d	1.42 (1.19)c	1.28 (1.13)d	1.22 (1.10)c	1.46 (1.21)d	1.26 (1.12)e	1.01 (1.00)e	1.20 (1.10)f	1.55 (1.24) f	69.10
Thiamethoxam 25 WG	0.40 g / lit	2.26 (1.50)f	2.20 (1.48)d	2.15 (1.47)d	2.11 (1.45)f	2.08 (1.44)e	2.03 (1.42)d	2.00 (1.41)e	1.86 (1.36)d	1.76 (1.33)f	1.60 (1.26)g	1.20 (1.10)g	1.60 (1.26)g	1.90 (1.38) g	62.04
Untreated check	-	5.10 (2.26)i	5.60 (2.37)g	5.84 (2.24)f	6.00 (2.45)j	5.43 (2.33)i	5.01 (2.24)h	4.86 (2.20)i	4.65 (2.16)h	4.60 (2.14)i	4.49 (2.12)j	4.32 (2.08)k	4.21 (2.05)k	5.01 (2.24) k	0.00
Mean		2.44 (1.56)H	2.47 (1.57) HI	2.42 (1.56) H	2.34 (1.53) G	2.18 (1.48) F	2.07 (1.44) E	1.99 (1.41) E	1.86 (1.36) D	1.83 (1.35) D	1.69 (1.30) C	1.46 (1.21) B	1.39 (1.18) A		-

Mean of three replications. Figures in parentheses are square root transformed values.

In a column/row, means followed by a common letter are not significantly different at 5% level (LSD).

	T	S	D	S x D	T x S x D
Significance	0.01	0.01	0.01	0.01	0.01
CD (P=0.05)	0.00	0.01	0.01	0.01	0.03

Table 2b: Bio-efficacy of insecticides against whitefly, *D. kirkaldyi* (on spray basis)

Treatment	Dose	No of adult per leaf				Reduction over untreated check (%)
		Spray			Overall Mean	
		1	2	3		
Acetamiprid 20 SP	0.10 g / lit	1.43 C	1.14 B	0.53A	1.03	79.44
		(1.19) b	(1.07) b	(0.72) b	(1.01) b	
Chlorantraniliprole 18.5 SC	0.10 ml / lit	1.46 C	1.21 B	0.88 A	1.18	78.24
		(1.21) c	(1.10) c	(0.94) d	(1.09) d	
Dimethoate 30 EC	2.00 ml / lit	1.86 C	1.31 B	1.20 A	1.46	70.86
		(1.36)d	(1.15) d	(1.09) e	(1.21) e	
Fipronil 5 SC	1.50 ml / lit	2.96 C	2.50 B	2.05 A	2.50	50.10
		(1.72) gh	(1.58) h	(1.43) i	(1.58) i	
Flubendiamide 39.35 SC	0.75 ml / lit	1.48 C	1.21 B	0.68 A	1.12	77.64
		(1.22) c	(1.10) c	(0.82) c	(1.06) c	
Imidacloprid 17.8 SL	0.30 ml / lit	1.31 C	0.97 B	0.34 A	0.87	82.63
		(1.14) a	(0.99) a	(0.58) a	(0.93) a	
Indoxacarb 14.5 SC	0.35 ml / lit	2.86 C	2.38 B	1.92 A	2.38	52.50
		(1.69) g	(1.54) g	(1.38) h	(1.54) h	
Novaluron 10 EC	1.00 ml / lit	2.90 C	2.57 B	2.18 A	2.55	49.10
		(1.70) g	(1.60) i	(1.47) j	(1.60) j	
Spinosad 45 SC	0.32 ml / lit	2.94 C	2.69 B	2.18 A	2.60	48.10
		(1.71) g	(1.64) j	(1.47) j	(1.61) j	
Thiacloprid 21.7 SC	0.60 ml / lit	2.02 C	1.39 B	1.23 A	1.55	69.10
		(1.42) d	(1.18)e	(1.11) f	(1.24) f	
Thiamethoxam 25 WG	0.40 g / lit	2.18 C	1.99 B	1.54 A	1.90	62.04
		(1.48) f	(1.41) f	(1.24) g	(1.38) g	
Untreated check	-	5.64	4.99 B	4.41 A	5.01	0.00
		(2.37) i	(2.23) k	(2.10) k	(2.24) k	
Mean		2.42 C	2.03 B	1.59 A		-
		(1.56)	(1.42)	(1.26)		

Mean of three replications. Figures in parentheses are square root transformed values.

In a column/row, means followed by a common letter are not significantly different at 5% level (LSD).

	T	S	D	T x S
Significance	0.01	0.01	0.01	0.01
CD (P=0.05)	0.00	0.01	0.01	0.02

Table 2c: Bio-efficacy of insecticides against whitefly, *D. kirkaldyi* (on day basis)

Treatment	Dose	No of adult per leaf					Reduction over untreated check (%)
		Day				Overall Mean	
		1	3	7	14		
Acetamiprid 20 SP	0.10 g / lit	1.16 D	1.12 C	1.00 B	0.85 A	1.03	79.44
		(1.08) b	(1.06) b	(0.99) b	(0.92) b	(1.01) b	
Chlorantraniliprole 18.5 SC	0.10 ml / lit	1.32 D	1.24 C	1.13 B	1.03 A	1.18	78.24
		(1.15) c	(1.12) c	(1.06) c	(1.01) d	(1.09) d	
Dimethoate 30 EC	2.00 ml / lit	1.70 D	1.57C	1.40 B	1.15 A	1.46	70.86
		(1.30) d	(1.25) d	(1.18) d	(1.07) e	(1.21) e	
Fipronil 5 SC	1.50 ml / lit	2.62 C	2.49 B	2.48 B	2.41 A	2.50	50.10
		(1.62) g	(1.58) g	(1.58) g	(1.55) i	(1.58) i	
Flubendiamide 39.35 SC	0.75 ml / lit	1.28 C	1.28 C	1.00 B	0.92 A	1.12	77.64
		(1.13) c	(1.13) c	(1.00) b	(0.96) c	(1.06) c	
Imidacloprid 17.8 SL	0.30 ml / lit	0.99 D	0.98 C	0.84 B	0.68 A	0.87	82.63
		(1.00) a	(0.99) a	(0.92) a	(0.83) a	(0.93) a	
Indoxacarb 14.5 SC	0.35 ml / lit	2.51 C	2.51C	2.34 B	2.18 A	2.38	52.50
		(1.58) f	(1.58) f	(1.53) f	(1.48) h	(1.54) h	
Novaluron 10 EC	1.00 ml / lit	2.72 D	2.53 C	2.49 B	2.45 A	2.55	49.10
		(1.65) f	(1.59) f	(1.58) g	(1.57) i	(1.60) j	
Spinosad 45 SC	0.32 ml / lit	2.70 C	2.68C	2.57 B	2.45 A	2.60	48.10
		(1.64) h	(1.64) h	(1.60) g	(1.57) j	(1.61) j	
Thiacloprid 21.7 SC	0.60 ml / lit	1.75 D	1.59 C	1.44 B	1.43 A	1.55	69.10
		(1.32) d	(1.26) d	(1.2 d0)	(1.19) f	(1.24) f	
Thiamethoxam 25 WG	0.40 g / lit	2.03 D	1.94C	1.78 B	1.86 A	1.90	62.04
		(1.43) e	(1.39) e	(1.34 e)	(1.36) g	(1.38) g	
Untreated check	-	5.04 D	5.03C	5.01 B	4.95 A	5.01	0.00
		(2.25) i	(2.24) i	(2.24) b	(2.23) j	(2.24) k	
Mean		2.15 D	2.08 C	1.96 B	1.86 A		-
		(1.47)	(1.44)	(1.40)	(1.37)		

Mean of three replications. Figures in parentheses are square root transformed values.

In a column/row, means followed by a common letter are not significantly different at 5% level (LSD).

	T	S	D	T x D
Significance	0.01	0.01	0.01	0.01
CD (P=0.05)	0.00	0.01	0.01	0.02

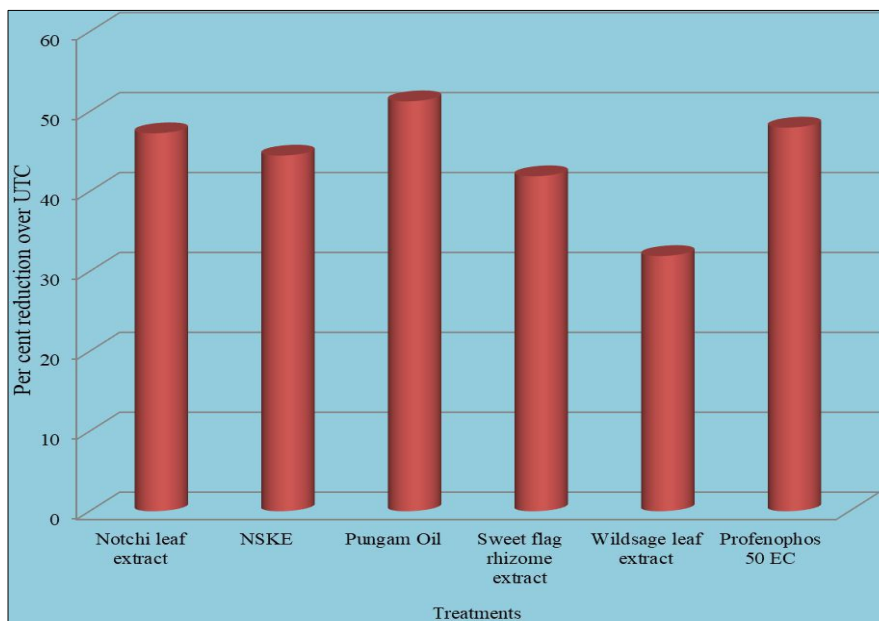


Fig 1: Bio-efficacy of botanicals against whitefly, *D. kirkaldyi* in jasmine

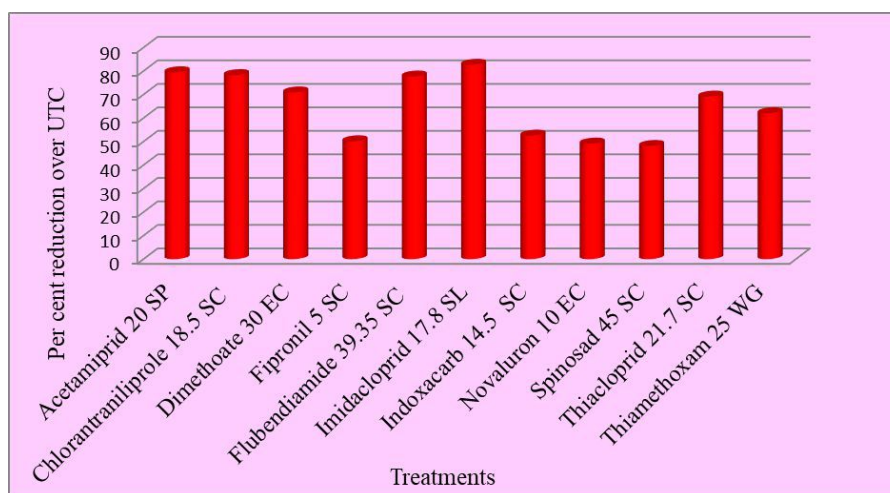


Fig 2: Bio-efficacy of insecticides against whitefly, *D. kirkaldyi* in jasmine

Conclusion

Considering the efficacy of different botanicals against whitefly, *D. kirkaldyi* in jasmine, *pungam* oil @ 2.0 per cent stood first effectively reducing the incidence of whitefly with 51.30 per cent reduction was followed by *notchi* (*V. negundo*) leaf extract @ 5.0 per cent and NSKE @ 5 per cent. Among the insecticides, Imidacloprid 17.8 SL @ 0.30 ml /lit, Acetamiprid 20 SP @ 0.10 g /lit were found to be effective against whitefly with 82.63 and 79.44 per cent reduction, respectively. The results from the present investigation can provide valuable information with special emphasis on selection of insecticides as well as development of pest forecast models towards the development in IPM module in jasmine.

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