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Effect of different insecticides against leaf miner, *Phyllocnistis citrella* Stainton infesting kagzi lime

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Abstract
Field experiments on effect of different insecticides against leaf miner, *Phyllocnistis citrella* (Stainton) infesting Kagzi lime was carried out at Horticulture farm, Junagadh Agricultural University, Junagadh during 2015-16 and 2016-17. All the treatments were significantly superior over untreated check. Results of the experiment indicated that the lowest leaf damage percentage was observed in the treatment of spinosad 45 SC 0.0135%, it was statistically at par with difenthiuron 50 WP 0.05% and imidacloprid 17.8 SL 0.0072% after seven and fifteen days of first spray and second spray of the both the season. The treatments of thiamethoxam 25 WG 0.0125%, profenophos 40 + cypermethrin 4 EC 0.044% and profenophos 50 EC 0.05% as mediocre, whereas buprofezin 25 EC 0.025% and nuvaluron 10 EC 0.01% found the least effective.

Keywords: Kagzi lime, insecticides, citrus, leaf miner and *Phyllocnistis citrella*

Introduction
The citrus, *Citrusa urantifolia* Swingle belongs to family Rutaceae. Citrus fruits possess greater adaptability to different climatic conditions, so are grown with equal success in tropical, subtropical and even in some favorable parts of the temperate regions of the world. The productivity and quality of citrus are severely affected by several factors; insect pests being one of them (Rao and Shivankar, 2011) [9]. The citrus leaf minor, *Phyllocnistis citrella* Stainton (Lepidoptetra : Gracillariidae), is an important pest of citrus and related rutaceae and ornamental plants almost worldwide (Achor *et al*., 1997) [1]. It mines leaves, surface tissue of young shoots and stems and less frequently the fruit (Sponagel and Diaz, 1994) [10]. Although citrus leaf minor causes indirect damage to young leaves which predisposes them to infection by canker so, controlling citrus leaf minor is a vital component of canker management (Pena *et al*., 1996 and Belaque *et al*., 2005) [8, 3]. It is a small lepidopteron pest of citrus. Damage is caused by the larvae as they mine immature foliage. Twisted and culed leaves are generally the first symptoms in Severe infestations (average of two or more mines per leaf) can retard the growth and yield of nursery and newly planted trees, but their effect on mature trees is less serious. It has high migration ability from outside of orchards and high fertility. It present in epidermis of citrus leaf and get substantial protection, therefore, it get difficult to direct contract of chemical to the larval body. Commonly used pesticides are not able to manage the infestation of leaf minor in nursery and field. Therefore, it is very important to test different chemical pesticides against citrus leaf minor. Hence, present investigation was carried out on effect of different insecticides against leaf miner, *P. citrella* infesting kagzi lime.

Materials and Methods
With a view to effect of different insecticides against leaf miner, *P. citrella* infesting kagzi lime, a field experiment was conducted in completely randomized block design with three repetitions at Horticulture Farm, Junagadh Agricultural University, Junagadh during 2015-16 and 2016-17. The kagzi lime trees having uniform size, growth and age with a spacing of 6 m between two trees were selected and used for the study. Spraying of insecticides was applied after initiation of the pest population. The observations for infestation of leaf miner on citrus trees were made on sprouting of young leaves of the crop before application of respective insecticides. For recording observations ten twig from each trees were randomly selected and number of young leaves out of total number of leaves, infested by leaf miner were recorded before one and after 3,7 and 15 days of spraying. Second & subsequent spraying of insecticides was applied on need base. Data were subjected to ANOVA after following angular transformation of *P. citrella* damaged leaves.

Results and Discussion

Population of leaf miner was found non-significant before spray but after first and second spray, it was found significantly differ in all the treatments over control.

Pooled data of two years (2015-16 and 2016-17) after first spray (Table 1) showed that the lowest per cent damage of leaf miner was recorded in the treatment of spinosad 45 SC 0.0135% (3.06%) and it was statistically at par with difenthiuron 50 WP 0.05% (3.51%) and imidacloprid 17.8 SL 0.0072% (3.67%). The next better treatments were thiamethoxam 25 WG 0.0125% and profenophos 40% + cypermethrin 4 EC 0.044% and profenophos 50 EC 0.05% and it showed 12.41, 13.43 and 14.89 per cent leaf damage after three days of first spray. More or less similar trend was also observed after seven and fifteen days of first spray.

The lowest percent leaf damage (Table 2) was observed in treatments of spinosad 45 SC 0.0135%, difenthiuron 50 WP 0.05% and imidacloprid 17.8 SL 0.0072% it showed 3.24, 4.0 and 4.01 per cent leaf damage, respectively after three days of second spray. The highest leaf damage was observed in treatments of buprofezin 25 EC 0.025% (9.05%) and nuvaluron 10% EC 0.01% (9.01%). The treatment of spinosad 45 SC 0.0135%, difenthiuron 50 WP 0.05% and imidacloprid 17.8 SL 0.0072% also prove effectiveness after seven and fifteen days of second spray it showed 3.42 & 5.42, 4.23 & 6.25, 4.99 & 7.72 percent damage, respectively.

The findings of present studies are in conformity with the results obtained by Anon., 2010 [2, 4] who reported imidacloprid 17.8 SL (0.003%), trizophos 40 EC (0.03%) and chlorpyriphos 20 EC (0.03%) were effective for the control of citrus leaf miner on citrus. Mane *et. al* (2016) [6] reported In overall, cumulative effect of 3 applications of all the treatments Abamectin 1.8 EC (0.003%) recorded lowest (7.66%) leaves infestation of leaf minor and found at par with spinosad 45 SC (0.03%) i.e.8.42 per cent leaf infested. The spinosad 480 SC proved the best significant results on to reduce damage percentage of leaf miner after two weeks of spray followed by lambda cyhalothrin reported by Ensaf *et al.* (2015) [5]. Parekh and Virani (2015) [7] from Gujarat reported that the thiamethoxam 0.0125, spinosad 0.018 and imidacloprid 0.00725 were most effective against citrus leaf miner over control under field condition. Tarate *et al.* (2016) [11] reported the treatment with emamectin benzoate 5 SG @ 9.5 g a.i/ha (11.85%) was at par with
spinosad 45 SC @ 75 g a.i/ha (12.10%), lambda cyhalothrin 5 EC @ 50 g a.i/ha (12.95%) in reducing leaf miner infestation in tomato crop. According to Variya and Patel (2012) revealed that the lowest leaf damage percentage were recorded in treatment of diafenthiuron, emmamectin benzoate and spinosad followed by clothianidin and thiamethoxam in tomato crop.

Table 1: Efficacy of different insecticides against leaf miner in citrus first spray (Year 2015-16 and 2016-17)

Treat.	Before Spray			3rd Day after spraying			7th Day after spraying			15th Day after spraying		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Profenophos 40% + cypermethrin 4 EC 0.044%	15.27 (6.94)	15.66 (7.29)	15.47 (7.11)	11.33 (3.86)	15.53 (7.17)	13.43 (5.39)	10.98 (3.63)	12.55 (4.72)	12.09 (4.38)	16.43 (8.00)	15.53 (7.17)	15.98 (7.58)
Nuvaluron 10 EC 0.01%	16.89 (8.45)	18.88 (10.48)	17.89 (9.44)	14.47 (6.24)	19.22 (10.83)	17.03 (8.58)	13.53 (5.47)	17.09 (8.64)	16.04 (7.64)	19.40 (11.03)	21.69 (13.66)	20.55 (12.32)
Spinosad 45 SC 0.0135%	15.93 (7.53)	17.13 (8.67)	16.53 (8.09)	7.40 (1.66)	12.74 (4.86)	10.07 (3.06)	9.18 (2.54)	10.52 (3.33)	9.36 (2.64)	12.01 (4.33)	13.22 (5.23)	12.62 (4.77)
Imidacloprid 17.8 SL 0.0072%	16.46 (8.03)	16.54 (8.11)	16.50 (8.07)	8.34 (2.10)	13.50 (5.45)	11.04 (3.67)	10.78 (3.50)	10.53 (3.34)	10.63 (3.40)	15.19 (6.87)	13.56 (5.50)	14.38 (6.16)
Acetamiprid 20 SP 0.01%	18.15 (9.70)	17.24 (8.78)	17.69 (9.24)	13.25 (5.25)	16.50 (8.07)	14.95 (6.65)	12.90 (4.98)	15.68 (7.31)	14.70 (6.44)	18.31 (9.87)	17.72 (9.27)	18.01 (9.56)
Thiamethoxam 25 WG 0.0125%	17.52 (9.07)	17.08 (8.62)	17.30 (8.84)	10.08 (3.07)	14.51 (6.28)	12.41 (4.62)	10.25 (3.17)	13.35 (5.33)	11.88 (4.23)	15.42 (7.07)	14.89 (6.60)	15.15 (6.83)
Profenophos 50 EC 0.05%	14.74 (6.48)	16.10 (7.69)	15.42 (7.07)	11.77 (4.16)	17.20 (8.75)	14.89 (6.60)	12.09 (4.39)	14.16 (5.98)	13.19 (5.20)	16.98 (8.53)	16.60 (8.17)	16.79 (8.35)
Difenthiuron 50 WP 0.05%	16.63 (8.19)	16.79 (8.34)	16.71 (8.27)	8.20 (2.03)	13.14 (5.17)	10.80 (3.51)	10.16 (3.11)	10.91 (3.58)	10.21 (3.14)	13.18 (5.20)	13.69 (5.60)	13.44 (5.40)
Buprofezin 25 EC 0.025%	18.46 (10.03)	16.74 (8.29)	17.60 (9.14)	17.77 (9.31)	18.90 (10.50)	17.12 (8.67)	14.07 (5.91)	16.43 (8.00)	15.92 (7.53)	20.05 (11.76)	19.10 (10.71)	19.58 (11.23)
Control	18.07 (9.62)	14.31 (6.11)	16.19 (7.77)	23.42 (15.80)	22.04 (14.09)	21.57 (13.51)	18.17 (9.73)	23.04 (15.31)	21.79 (13.78)	21.39 (13.30)	22.81 (15.03)	22.11 (14.16)
S.Em.±	1.94	1.00	1.56	1.00	0.75	0.50	0.70	0.68	0.49	0.84	0.89	0.61
C.D. at 5%	NS	NS	NS	2.96	2.21	1.44	2.05	2.00	1.39	2.47	2.64	1.75
C.V.%	15.05	10.35	17.32	13.77	7.95	8.62	9.52	8.11	8.77	8.62	9.18	8.90
Y												
S.Em.±			0.70			0.23			0.22			0.27
C.D. at 5%			NS			0.64			0.62			NS
YXT												
S.Em.±			2.21			0.71			0.69			0.87
C.D. at 5%			NS			NS			NS			NS

Table 2: Efficacy of different insecticides against leaf miner in citrus after second spray (Year 2015-16 and 2016-17)

Treat.	3rd Day after spraying			7th Day after spraying			15th Day after spraying		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Profenophos 40% + cypermethrin 4 EC 0.044%	11.52 (3.99)	16.53 (8.10)	14.03 (5.88)	11.77 (4.16)	16.53 (8.09)	14.15 (5.98)	16.50 (8.07)	19.15 (10.76)	17.82 (9.37)
Nuvaluron 10 EC 0.01%	14.77 (6.50)	20.16 (11.88)	17.47 (9.01)	15.30 (6.97)	20.99 (12.83)	18.15 (9.70)	19.55 (11.20)	23.08 (15.37)	21.32 (13.21)
Spinosad 45 SC 0.0135%	7.53 (1.72)	13.22 (5.23)	10.38 (3.24)	8.45 (2.16)	12.88 (4.97)	10.67 (3.42)	12.20 (4.46)	14.73 (6.47)	13.47 (5.42)
Imidacloprid 17.8 SL 0.0072%	8.89 (2.39)	14.18 (6.00)	11.53 (4.00)	11.23 (3.79)	14.58 (6.33)	12.90 (4.99)	15.45 (7.10)	16.81 (8.36)	16.13 (7.72)
Acetamiprid 20 SP 0.01%	13.31 (5.30)	18.72 (10.30)	16.01 (7.61)	14.46 (6.23)	19.19 (10.80)	16.82 (8.37)	18.47 (10.03)	20.84 (12.66)	19.65 (11.31)
Thiamethoxam 25 WG 0.0125%	10.41 (3.27)	14.96 (6.67)	12.69 (4.82)	11.18 (3.76)	14.77 (6.50)	12.98 (5.04)	15.64 (7.27)	17.75 (9.30)	16.69 (8.25)
Profenophos 50 EC 0.05%	12.52 (4.70)	17.66 (9.20)	15.09 (6.78)	13.13 (5.16)	17.49 (9.03)	15.31 (6.97)	17.22 (8.77)	19.76 (11.43)	18.49 (10.06)
Difenthiuron 50 WP 0.05%	8.65 (2.26)	14.46 (6.23)	11.55 (4.01)	9.67 (2.82)	14.06 (5.90)	11.86 (4.23)	13.39 (5.37)	15.56 (7.20)	14.48 (6.25)
Buprofezin 25 EC 0.025%	15.52 (7.16)	19.49 (11.13)	17.51 (9.05)	15.60 (7.23)	20.59 (12.36)	18.09 (9.64)	20.31 (12.05)	22.62 (14.79)	21.47 (13.39)
Control	20.65 (12.44)	20.81 (12.62)	20.73 (12.53)	19.89 (11.58)	20.82 (12.63)	20.36 (12.10)	20.84 (12.65)	21.97 (14.00)	21.40 (13.32)
S.Em.±	0.72	0.72	0.83	0.79	0.92	0.61	0.85	0.96	0.64
C.D. at 5%	2.12	2.12	2.66	2.34	2.71	1.74	2.51	2.85	1.84
C.V.%	10.08	7.31	8.48	10.53	9.27	9.84	8.70	8.69	8.71
Y									
S.Em.±			0.37			0.27			0.29
C.D. at 5%			1.19			0.78			0.82
YXT									
S.Em.±			0.72			0.86			0.91
C.D. at 5%			NS			NS			NS

Data in parenthesis are retransformed values, while outsides were angular transformed values

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