International Journal of Agricultural Sciences ☞DOI:10.15740/HAS/IJAS/18.2/815-820
Volume 18 | Issue 2 | June, 2022 | 815-820 ■ ISSN : 0973-130X Visit us : *www.researchjournal.co.in*

RESEARCH PAPER

A study on solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) against leaf minors (*Phyllocnistis citrella stainton*) on kinnow plants

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Abstract : The study trial was conducted on kinnow 2 trees per treatment/ replicationat Agricultural Research Station, Sriganganagar during 2016-2017. Eight treatments including control were evaluated and each treatment was replicated three times and using RBD. Observations were also taken on number of leaves and infested leaves per twigs from 5 randomly selected twigs. The first application of each treatment was made at according to need based using a water volume of 10 liters per treatment and second application was imposed on a need basis at an interval. The population of leaf infested with leaf minors per 20 leaves were made from a tree before as well as 3, 7, 10 and 15 days after each spray and one day before spray to work out leafs infestation using formula and observed the combination of both @ 7.0 ml / 10 lit was best for the control of leaf minor of kinnow and on at par in comparision to other treatments. The yield of fruit was recorded after harvesting the kinnow.

Key Words : Solomon 300 OD, Leaf minors, Kinnow plants

View Point Article : Singh, Harjindra, Meena, Roop Singh and Kumar, Pradeep (2022). A study on solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) against leaf minors (*Phyllocnistis citrella stainton*) on kinnow plants. *Internat. J. agric. Sci.*, **18** (2) : 815-820, **DOI:10.15740/HAS/IJAS/18.2/815-820.**

Article History : Received : 06.04.2022**; Revised :** 15.04.2022**; Accepted :** 18.05.2022

INTRODUCTION

The area under kinnow cultivation in India is about 67000 hectares which produce 412000 Metric ton (2018-19). Kinnow contribute 6.23 per cent share of India from Sriganganagar and Hanumangarh district of Rajasthan. Kinnow produces good tasty (good blend of sugars/acid ratio), yield of orange coloured and very juicy in Sriganganagar and Hanumangarh agro-ecological conditions. It has grown in the agro-ecological conditions in Sriganganagar (Rajasthan) India. Kinnow was developed through hybridization between king mandarin x Willow leaf orange produced by H.B. Frost in 1915 and released in 1935 was introduced by Dr. J.C. Bakhshi at Abohar research station during 1954. Kinnow belongs to family Rutaceae and sub-family Aurantioedae. Kinnow has rich source of vitamins and have highly nutritional value. 85 g of fruits per capita per day according to the Indian council of medical Research has recommended balance diet. One of the reasons for the lower production is the attack of citrus crop by many diseases and insect pests. One of the major insect pests of citrus is citrus

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leaf-miner (CLM). The citrus leaf-miner is originated from Eastern and Southern parts of Asia. After 1993, it was rapidly spread to all citrus growing areas of America and also in the Mediterranean basin. Citrus leaf-miner is one of the major pests that have very deleterious effects on Citrus and related species worldwide. According to Ujiye (2000), citrus leaf-miner is a destructive pest of citrus crops. Generally one larva makes one mine but in case of heavy infestation two to three mines may be formed per leaf by the same larva. The active period of infestation of leaf minor on leafs continues to inflict serious damage even after transplanting. It generally occurs during spring March-April and autumn September-October. Eggs are laid singly generally on the underside of leave near the midrib. The eggs look like tiny water droplets and hatchs within the period of 4-5 days. The young have pale yellow color and young larvae immediately start feeding between epidermal layers of the leaf. The larvae of citrus leaf miner have four instars and development of the larvae takes 5 to 20 days. Pupation of leaf -minor occurs in a particular type of pupal cell which is formed by larva at the leaf edge within the mine under a simple leaf curve. They pupate, when full grown, near the margin of the mined leaf. The citrus leaf miner adult is a tiny silvery-white moth about 2 mm long with fringed wings. Fore wings have brown stripes and a prominent black spot near the apical margin while hind wings are pure white with a wing spread of 4-5 mm. Total life cycle of the pest is about 3 weeks in summer and may prolong to 2 months in winter season. Leaf miner's infestation has been a constant threat to young citrus nurseries and spring sprouting are highly prone to be attacked by citrus leaf-miners. A wide range of insecticides are being evaluated against these deleterious insect pests. For instance, Bhatia and Joshi (1991) evaluated dimethoate, monocrotophos, phosphamidon, fenvalerate, parathion-methyl, quinalphos, cypermethrin, (all at 0.05%) and deltamethrin (at 0.0017%) for the management of *P. citrella* on kinnow mandarin nursery in Rajasthan, India. They found deltamethrin, fenvalerate, monocrotophos and quinaphos as the most effective ones against citrus leafminers. Similarly, Johi *et al.* (1993) evaluated the toxicity of *Neem,* mahua and pongamia oil (2 and 4%) and seed extract (2%) of *Neem* and pongamia against citrus leaf miner on citrus line in Karnataka, India. All the treatments reduced the population of *P. citrella*, but combination of (Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)) insecticides against infestation of leaf minor. Damage by this pest predisposes the plant for development of canker disease. So, therefore due to causes of canker in kinnow its proper control should be have. So, keeping in view Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) combination with different doses against infestation of leaf minors

MATERIAL AND METHODS

The study was conducted on kinnow 2 trees per treatment/ replicationat Agricultural Research Station, Sriganganagar during 2016 and 2017. Eight treatments including control were evaluated and each treatment was replicated three times and using RBD. All the agronomic practices were followed as per the recommended package of practices. The first application was made on (23 and 26 February 2016 and 2017, respectively) using 10 liters of water per treatment. Second application (14 and 18 March 2016 and 2017, respectively) was imposed. The infestation of leaf minor per 20 leaves was made from a tree before spray and as well as 3, 7, 10 and 15 days after spray. Observation was also taken on number of leaves and infested leaves per twigs form 5 randomly selected twigs after spray to work out leaf infestation. The infestation percentage of leaves was calculated by using below mentioned formula:

$$\text{Percentage of infestation leaves} = 100\left(\frac{X_1 - X_2}{X_1}\right)$$

where,
$X_{1=}$ Number of leaves
$X_{2=}$ Number of healthy leaves

The data obtained from field experiments in a Randomized Block Design were statistically analyzed after converting it into count data into square root and percentage data into arc sin transformed values.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Leaf-miner (*Phyllocnistis citrella* stainton) :

The study data of two sprays in respect of leaf infestation caused by citrus leaf miner in kinnow are presented in table 3a and 3b, revealed that all treatments significantly recorded less-infestation (35.10-48.25,

26.97-40.59, 24.29-37.24 and 20.68-35.55 and 34.18-46.40,25.16-38.97, 22.48-36.36 and 18.93-33.84 %) over untreated control (62.62, 65.97, 67.73 and 69.46 and 63.49, 66.85, 68.54 and 71.19 %) on 3rd, 7th, 10th and 14th days after 1st and 2nd spray, respectively during 2016 and almost similar data obtained during 2017, 36.73-49.08, 27.94-40.23, 25.25-36.94 and 21.00-35.50 and 33.62-47.26,25.65-38.71, 23.87-36.61 and 19.46-33.27 %) over untreated control (63.32, 66.63, 68.30 and 70.80 and 64.06, 67.36, 69.03 and 69.95%) on 3rd, 7th, 10th and 14th days after 1st and 2nd spray, respectively. Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) @ 7.0 ml/ 10 litter of water was recorded minimum infestation of leaves (35.10, 26.97, 24.29 and 20.68 and 34.18, 25.16, 22.48 and 18.93%) during 2016 and similarly obtained during 2017 that was 36.73, 27.94, 25.25 and 21.00 and 33.62, 25.65, 23.87 and19.46 per cent followed by solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) @ 5.0 ml/10 litter of water (37.78, 28.82, 26.14 and 22.51 and 36.01, 27.02, 24.36 and 21.61 per cent during 2016 and 39.87, 30.44, 27.76 and 23.39 and 36.26, 28.26, 25.70 and 21.12 per cent during 2017 and solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) @ 5.0 ml/10 litter of water (41.80, 34.63, 30.13 and 26.57 and 39.97, 32.08, 28.40 and 24.84 %) recorded during 2016 and (42.93, 35.06, 30.65 and 26.30 and 41.67, 33.84, 29.48 and 25.16%) recorded during 2017 on 3rd, 7th, 10th and 14th days after 1st and 2nd spray, respectively and it was at par with solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) @ 7.0 ml/10 litter of water during both the years.

The rest of the treatments *viz.,* Imidacloprid 200 SL (imidacloprid 17.8% w/w SL) @ 7.50 ml, 5.00 ml, Quinalphos 25 % EC @ 28.0 ml and Betacyfluthrin 25 SC (Betacyfluthrin 2.45% w/w SC) @ 25.50 ml/10 litter of water also reduced the leaf miner population and it was 43.43, 36.56, 33.95 and 32.17 and 45.28, 38.37, 35.80 and 34.09 and 48.15, 39.50, 36.91 and 34.32 and 47.37, 40.59, 37.24 and 35.55 per cent on after 1st spray and 41.67, 34.78, 32.17 and 30.44 and 44.44, 36.66, 34.09 and 32.41 and 46.40, 38.60, 36.10 and 33.44 and 45.74, 38.97, 36.36 and 33.84 per cent after 2nd spray on 3rd, 7th, 10th and 14th days, respectively during 2016. Similarly during 2017 the data obtained 44.91, 36.45, 33.91 and 31.53 and 46.17, 38.54, 35.20 and 33.47 and 49.08, 39.74, 36.31 and 35.50 and 47.84, 40.23, 36.94 and 34.38 per

Table 1a : Bio-efficacy of solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) against leaf-miner, *Phyllocnistis citrella* stainton,2016 (first spray)

Sr. No.	Treatments	Dose (ml/10 lit. water)	Percentage of infested leaves					
			B.S.	3 DAS	7 DAS	10 DAS	14 DAS	Mean
1.	Control	-	59.22 (50.30*)	62.62 (52.30*)	65.97 (54.29*)	67.73 (55.37*)	69.46 (56.43*)	66.45 (54.60*)
2.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	3.00	57.93 (49.55)	41.80 (40.25)	34.63 (36.02)	30.13 (33.27)	26.57 (30.92)	33.28 (35.21)
3.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	5.00	60.34 (50.95)	37.78 (37.90)	28.82 (32.45)	26.14 (30.73)	22.51 (28.31)	28.81 (32.35)
4.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	7.00	61.29 (51.58)	35.10 (36.31)	26.97 (31.23)	24.29 (29.50)	20.68 (27.01)	26.76 (31.02)
5.	Betacyfluthrin 25 SC (Betacyfluthrin 2.45% w/w SC)	25.50	61.76 (51.80)	47.37 (43.47)	40.59 (39.56)	37.24 (37.59)	35.55 (36.58)	40.19 (39.30)
6.	Imidacloprid 200 SL (imidacloprid 17.8% w/w SL)	7.50	58.11 (49.67)	43.43 (41.20)	36.56 (37.19)	33.95 (35.62)	32.17 (34.54)	36.53 (37.14)
7.	Imidacloprid 200 SL (imidacloprid 17.8% w/w SL)	5.00	61.50 (51.64)	45.28 (42.27)	38.37 (38.23)	35.80 (36.70)	34.09 (35.67)	38.39 (38.22)
8.	Quinalphos 25 % EC	28.00	57.77 (49.47)	48.15 (43.92)	39.50 (38.91)	36.91 (37.38)	34.32 (35.85)	39.72 (39.01)
	CV %		5.91	5.21	5.27	5.45	5.55	5.38
	S.E.±		2.45	1.73	1.56	1.53	1.48	1.45
	C.D. (P=0.05)		7.42	5.25	4.72	4.64	4.49	4.37

*Figures in parentheses are arc sin values; B.S.- Before Spray; DAS – Days after spray

Table 1b : Bio-efficacy of solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) against leaf-miner, *Phyllocnistis citrella* stainton, 2016 (Second spray)

Sr. No.	Treatments	Dose (ml/10 lit. water)	Percentage of infested leaves					
			B.S.	3 DAS	7 DAS	10 DAS	14 DAS	Mean
1.	Control	-	62.20 (52.06)	63.49 (52.82)	66.85 (54.85)	68.54 (55.89)	71.19 (57.52)	67.52 (55.27)
2.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	3.00	55.34 (48.05*)	39.97 (39.17*)	32.80 (34.92*)	28.40 (32.17*)	24.84 (29.82*)	31.50 (34.02*)
3.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	5.00	55.83 (48.33)	36.01 (36.84)	27.02 (31.29)	24.36 (29.53)	21.61 (27.67)	27.25 (31.33)
4.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	7.00	55.86 (48.35)	34.18 (35.75)	25.16 (30.06)	22.48 (28.27)	18.93 (25.78)	25.19 (29.96)
5.	Betacyfluthrin 25 SC (Betacyfluthrin 2.45% w/w SC)	25.50	56.78 (48.88)	45.74 (42.54)	38.97 (38.61)	36.36 (37.07)	33.84 (35.54)	38.73 (38.44)
6.	Imidacloprid 200 SL (imidacloprid 17.8% w/w SL)	7.50	56.37 (48.66)	41.67 (40.18)	34.78 (36.13)	32.17 (34.54)	30.44 (33.47)	34.76 (36.08)
7.	Imidacloprid 200 SL (imidacloprid 17.8% w/w SL)	5.00	58.96 (50.23)	44.44 (41.79)	36.66 (37.21)	34.09 (35.71)	32.41 (34.68)	36.90 (37.35)
8.	Quinalphos 25 % EC	28.00	54.24 (47.41)	46.40 (42.91)	38.60 (38.40)	36.10 (36.90)	33.44 (35.28)	38.64 (38.37)
	C.V. %		5.00	5.36	5.36	5.20	5.67	5.43
	S.E.±		1.98	1.75	1.54	1.42	1.47	1.44
	C.D. (P=0.05)		6.02	5.30	4.68	4.31	4.46	4.32

*Figures in parentheses are arc sin values; B.S.- Before spray; DAS – Days after spray

Table 1c : Bio-efficacy of solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) against leaf-miner, *Phyllocnistis citrella* stainton, 2017 (first spray)

Sr. No.	Treatments	Dose (ml/10 lit. water)	Percentage of infested leaves					
			B.S.	3 DAS	7 DAS	10 DAS	14 DAS	Mean
1.	Control	-	58.32 (48.80)	63.32 (52.74)	66.63 (54.71)	68.30 (55.72)	70.80 (57.28)	67.26 (55.11)
2.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	3.00	62.24 (52.07*)	42.93 (40.92*)	35.06 (36.28*)	30.65 (33.58*)	26.30 (30.83*)	33.74 (35.40*)
3.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	5.00	59.95 (50.72)	39.87 (39.12)	30.44 (33.47)	27.76 (31.76)	23.39 (28.87)	30.36 (33.30)
4.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	7.00	62.31 (52.11)	36.73 (37.27)	27.94 (31.86)	25.25 (30.07)	21.00 (27.25)	27.73 (31.61)
5.	Betacyfluthrin 25 SC (Betacyfluthrin 2.45% w/w SC)	25.50	61.27 (51.59)	47.84 (43.74)	40.23 (39.32)	36.94 (37.38)	34.38 (35.86)	39.85 (39.07)
6.	Imidacloprid 200 SL (imidacloprid 17.8% w/w SL)	7.50	62.69 (52.34)	44.91 (42.06)	36.45 (37.12)	33.91 (35.60)	31.35 (34.03)	36.66 (37.20)
7.	Imidacloprid 200 SL (imidacloprid 17.8% w/w SL)	5.00	62.10 (52.00)	46.17 (42.79)	38.54 (38.35)	35.20 (36.36)	33.47 (35.32)	38.35 (38.20)
8.	Quinalphos 25 % EC	28.00	58.49 (49.88)	49.08 (44.45)	39.74 (39.06)	36.31 (37.04)	35.50 (36.56)	40.16 (39.28)
	CV %		5.12	5.17	5.33	5.21	5.18	5.24
	S.E.±		2.15	1.75	1.59	1.47	1.38	1.43
	C.D. (P=0.05)		6.53	5.32	4.82	4.45	4.19	4.29

*Figures in parentheses are arc sin values; B.S.- Before spray; DAS – Days after spray

Table 1d : Bio-efficacy of solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) against leaf-miner, *Phyllocnistis citrella* stainton, 2017 (Second spray)

Sr. No.	Treatments	Dose (ml/10 lit. water)	Percentage of infested leaves					
			B.S.	3 DAS	7 DAS	10 DAS	14 DAS	Mean
1.	Control	-	58.22 (49.84)	64.06 (53.20)	67.36 (55.16)	69.03 (56.20)	69.95 (56.74)	67.60 (55.33)
2.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	3.00	57.43 (49.26*)	41.67 (40.18*)	33.84 (35.54*)	29.48 (32.82*)	25.16 (30.06*)	32.54 (34.65*)
3.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	5.00	56.60 (48.77)	36.26 (37.01)	28.26 (32.08)	25.70 (30.44)	21.12 (27.27)	27.84 (31.70)
4.	Solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD)	7.00	55.76 (48.29)	33.62 (35.42)	25.65 (30.41)	23.87 (29.22)	19.46 (26.16)	25.65 (30.30)
5.	Betacyfluthrin 25 SC (Betacyfluthrin 2.45% w/w SC)	25.50	60.73 (51.18)	46.62 (43.04)	38.32 (38.22)	36.61 (37.21)	33.27 (35.21)	38.70 (38.42)
6.	Imidacloprid 200 SL (imidacloprid 17.8% w/w SL)	7.50	58.00 (49.59)	43.49 (41.24)	34.97 (36.23)	31.55 (34.15)	27.18 (31.41)	34.30 (35.76)
7.	Imidacloprid 200 SL (imidacloprid 17.8% w/w SL)	5.00	58.82 (50.06)	45.38 (42.33)	36.94 (37.40)	34.42 (35.91)	30.24 (33.34)	36.75 (37.25)
8.	Quinalphos 25 % EC	28.00	59.21 (50.29)	47.26 (43.41)	38.71 (38.46)	35.37 (36.48)	32.86 (34.96)	38.55 (38.33)
	C.V. %		5.29	5.16	5.39	5.38	5.41	5.34
	S.E. ±		2.15	1.70	1.56	1.48	1.38	1.52
	C.D. (P=0.05)		6.51	5.16	4.73	4.49	4.18	4.56

*Figures in parentheses are arc sin values; B.S.- Before spray; DAS – Days after spray

cent after 1st spray after 1st spray and 43.49, 34.97, 31.55 and 27.18 and 45.38, 36.94, 34.42 and 30.24 and 47.26, 38.71, 35.37 and 32.86 and 46.62, 38.32, 36.61 and 33.27 per cent on 3rd, 7th, 10th and 14th days after 2nd spray, respectively. These finding are supported by observations of Singh and Azam (1986) and Legaspi *et al*. (2001) worked on the seasonal occurrence and population dynamics of citrus leaf-miner, *P. citrella*, on different citrus cultivars and reported that population of citrus leaf-miner were at peak during February to April and July-October. However, Zeb *et al.* (2011) assessed population dynamics of citrus leaf-miner in Northern areas of Pakistan and found that the pest remains active throughout the year on new plant growth and young sprouting with peak populations in second fortnight of September and to first fortnight of October. Regarding effect of botanical extracts on citrus leaf-miner infestation, results reflected that, foliar application of datura and neem leaves extracts with 30% concentration gave upto 12% reduction in the population citrus leaf miner after 72 hrs. These results are in line with those of Borad *et al*. (2001) evaluated a wide range of botanicals against different insect pests and found that that 10% leaf extract of *Neem* (*A indica*) and morning glory (*I. fistulosa*) successfully managed the population of citrus leaf miner (*P. citrella*) and citrus psylla (*Diaphorina citri*). In this study, foliar application of *Neem* leaf extract reduced the population of citrus leaf miner by their direct toxicity and/or repellent actions and also there would antifeedant activity of kortuma causing about 6% reduction of leaf-miner and Muhammad *et al.* (2016) revealed on leaf minor population dynamics and infestation on citrus that peak infestation of leaf-miner appeared in end August to early October and foliar application of 30% *Neem* and kurtuma leaf extracts gave up to 12% reduction in the population infestation of citrus leaf miner at 72 hrs post application and Wale *et al.* (2013) studied on bioefficacy of evolved doses of solomon (Beta-cyfluthrin 9% + Imidacloprid 21%) 300 OD. Betacyfluthrin 2.5 SC, Imidacloprid 200 SL, Lamdacyhalothrin 5% + Thiamethoxam 25 WG, Monocrotophos 36 SL, Triazophos 40 EC and Endosulfan 35 EC were for comparison against aphids of brinjal and solomon (Beta-cyfluthrin 9% + Imidacloprid 21%) 300 OD @ 15.75 + 36.75 and 18 + 42 g.a.i./ha observed most superior for the control of aphids as well as fruit

borer and also obtaining good yield of brinjal.

Conclusion:

The result of the study conducted 2016 and 2017 pointed out that solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) @ 3.0, 5.0 and 7.0 ml/ha were found best and on par with each other in respect to leaf minor control. Therefore, application of solomon 300 OD (Betacyfluthrin 90 + Imidacloprid 210 OD) @ 7.0 ml/ 10 litter of water can be recommended for better control of leaf minor.

Acknowledgement :

The authors acknowledge ARS, Sriganganagar for conducting experimental trail for two consecutive years and helpful Dr. Roop Singh Meena (PI of trail) and Dr. Pradeepkumar (Co-PI) and I also help that time with PI and also prepared this research papper.

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