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Efficacy of imidacloprid (Confidor 200SL) and improved cultural practices in the control of the green date palm pit scale insect (*Asterolecanium phoenicis* Rao.) (*Palmapsis phoenicis*) (Homoptera: Asterolecaniidae) in Northern Sudan

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Experiments were undertaken in Elgaba scheme for two seasons (1999/2000 and 2000/2001) to evaluate the efficacy of imidacloprid (as Confidor 200SL) as part of a technical cultural practices package (earthing, pruning and regular irrigation) in the control of the date palm green pit scale insect *Asterolecanium phoenicis* (Rao). Four doses of Confidor 200SL (15, 20, 25 and 35 ml/palm) were compared with standard insecticide carbofuran (Furadan 5G (60g/palm) and untreated control. A Completely Randomized Design with six replicates (one palm = replicate) was used. The insects (all developing stages) were counted per cm^2 per leaflet. Eight leaflets, from each palm, were inspected biweekly. Date yield and quality were determined at harvest. Residue analysis was carried out twice on dates, soil and plants intercropped with date palms. Results indicated that percentage mortality of both adults and immature stages were significantly higher in the insecticides treatments than in untreated control after two weeks. All insecticides lost their efficacy after twelfth weeks. The efficacy of the treatments followed the order; Confidor (35 ml/palm), Furadan 5G (60 g/palm) and Confidor (25 ml/palm). No detectable residues of imidaclprid were found on dates, soil or intercropped plants even at the high dose of Confidor 200SL (35 ml/palm) used. Date palm treated with Confidor (25 ml/palm), developed normally and the dates reached maturity (ripening) normally compared to the untreated control. The percentage of unripe date (1.7) was significantly (p = 0.01) lower than in the untreated control (27.33). Confidor checked the activity of termites and many other pests. Partial budget analysis indicated the profitability of this package as estimated by the marginal rate of return of 29.8 and 201% over one and three year's period, respectively.

Key words: Sudan, date palms, *Aesterolecanium phoeniccis*, control measures, imidacloprid.

INTRODUCTION

The date palm (*Phoenix dactylifera*) is a very important plant throughout the world. It has high socioeconomic importance not only due to its food value, but also its capacity to provide many other products such as shelter, fiber, clothing, aesthetic beauty and furniture (Mousavi et al., 2009). It has high natural tolerance to very adverse growing conditions, including drought, salinity and high temperatures (Bakheet et al., 2008). The date palm is

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cultivated in the Northern Sudan along the banks of the River Nile over a distance of about 900 km. The total number of trees is in this area is estimated at 8 million. According to Food and Agriculture Organization (FAO, 2005) reports, the average annual production (2005) of dates is 328.2 metric tons. This makes Sudan as the 7th largest producer of dates among Arab countries. Date fruits constitute the most important agricultural crop in the area and provide food and are a primary source of income to the majority of the inhabitants. The tree and fruit by-products offer an extra income. Stems and fronds are widely used for thatching, buildings, barring and basketry (household utensils). The date palm industry is facing many serious problems, related to low yields, lack of appropriate packing and presentation and limited production of sound industrial date products etc (FAO, 2002). The low yields in Sudan, are due to soil salinity, poor fertility, insect and diseases infestations, lack of maintenance and care due to increasing cost of labour and to shortage of trained personnel to introduce improved cultural practices. As a result of high cost of production and low prices of the produce, farmers tend to neglect or even abandon their gardens. Although the commonly known, palm lethal insect pests and diseases like red weevil and Bayoud have not been reported in Sudan (Khairi et al., 2010), yet, yield of the date palm is affected by many biotic factors among which insects are the most important In Sudan, the date palm green pit scale insect is considered a key pest on date palm. This genus, a native of central Asia (Iran), (Ezz, 1973; Sherif, 1967) was not known in Sudan before 1986 when it was reported for the first time by Ali (1989) in Golid area.

The pest was first reported in Golid area through illegal introduction of some offshoots from Saudi Arabia in 1974. Later, the pest crossed the natural barrier of Baja desert to invade Elgaba scheme, (150 km south of Dongola, 400 km-north Khartoum) probably in 1995 to become a real threat to date palm cultivation in Northern Sudan. The infested area in Golid, Gaba and Old Dongola is about 5000 ha, extending over 60 and 50 km along the west and east bank of the river Nile respectively. The later reported infestation in Artigasha Island, Burgaig scheme and Orbi in Dongola area, Abuhamad in the River Nile State, and Khartoum State reached about 23000 infested palm trees constitute strong evident that the pest continues to spread. Studies have been conducted on the biology and population development of the pest, its seasonal abundance, susceptibility of date palm varieties, losses caused by the pest, and control method (Ali, 1989). The insect attacks the leaflets, leaf rachis and fruits. It causes chlorosis, degeneration of the leaves, malformation of fruits before maturity leading to losses in production ranging from 5 to 50 kg per tree (Ali et al., 1993). The losses may range between 85 and 90% according to infestation rate, variety infested and management conditions (Ahmed, 2001; 2004). The lack of indigenous knowledge of appropriate control measures led to the steady increase in the level of infestation. Studies have been conducted on the biology and population development of the pest, its seasonal abundance, susceptibility of date palm varieties, losses caused by the pest, and control method (Ali, 1989). An eradication program was attempted based on pruning, local Quarantine and aerial insecticide application. Various insecticides were tested (Ali and Tibin 1992). They include diazinon 60 EC (340 ml/100 L of water), dimethoate as Roger 32% EC (225 ml per 100 L of water), and Folimat 80% (200 ml per 100 L of water). Each of these treatments included 2 L of 80% Albolinium summer oil. About 96.4% control was achieved, thus lowering the infestation within the target area drastically to 3.6% and ended apparently the infiltration of the pest outside the hot area. The infestation had flared back to more than 50% in less than one year. Eradication of insect was doomed to failure. Attempts to locate a biological control agent failed when coccinellid beetle was introduced (Ali, 1989; Harten and Abdel Rhman 1996).

Based on the above, this study was initiated to seek a solution for the control of this pest using imidacloprid as Confidor 200 SL and improved cultural practices in the control of the green date palm pit scale insect. The study also covers related aspects of control measures such as residues on date fruits, intercropped-plants and soil as well as economic analysis of the incurred cost. Imidacloprid belongs to relatively new classes of insecticides, the neo-nicotinoids (also called chloronicotinyls, or nicotine mimics). Members of this group provide a useful alternative to the traditional foliar insecticides such as synthetic pyrethroids or carbonates' (Castle et al., 2005) having outstanding potency and systemic action for crop protection against piercing-sucking pests. About seven compounds or more were from this group were (Tomizaw and Casida, 2005). The group possesses several advantages including high potency against wide variety of pests, suitability to various types of cropping system and method of application as well as reduced mammalian toxicity. Because of their systemic activity when applied to soil or seed, these products are taken up through the roots and transported into new leaf tissue where they persist through the critical early plant stages. They can be applied in the furrow or as a surface band at planting, which simplifies control efforts especially in fields. Also they can be applied through drip irrigation, which allows application to be timed shortly in advance of the expected arrival of the pest. Further they can be applied as a transplant drench prior to setting out in the field and for a perimeter trap crop system which could dramatically reduces the cost of pest control (Tomizaw and Casida, 2005).

MATERIALS AND METHODS

Experiments were undertaken in Northern Sudan in Elgaba scheme, for two consecutive cropping seasons (1999/2000 to 2000/2001), to evaluate the efficacy of imidacloprid (as Confidor 200 SL) as a systemic insecticide as well as improved cultural practices against the green date palm pit scale insect.

Experimental sites

Two farms in the middle of Elgaba scheme were selected, (Elkhier farm (location1) and Issa farm (Locatin2)) (Table 2) their infestations dated back to four years ago and the estimated loss in date yield was more than 70 and 80% for Barakawi and Gondeila varieties, respectively. Palms in the test site were 10 to 15 m tall and approximately 15 to 20 years old, planted at a density of about 170 palms/ha. They were food irrigated from the Nile through open channels via the scheme's main canal at monthly interval. Supplementary irrigation was given from underground water using diesel pump. Urea was added in summer for intercropping fodder crops (maize, dura and legumes). No chemical control measures were used in the area before.

Cultural practices

The following cultural practices have been carried out prior to the experiment;

(a) Pruning by removal of dead leaves and the lowest row of the highly infested leaves.
(b) Raising earth around the palm to facilitate irrigation (every tree is irrigated individually).
(c) Pre-watering (24 h before application) was under taken using diesel pumps from underground water.

Soil application method

Four doses of imidacloprid as Confidor 200 SL; 15, 20, 25 and 35 ml product/tree (3, 4, 5 and7 g a.i./tree), were tested and compared to the standard insecticide carbufuran (as Furadan 5G, at 60g/tree) (Ali, 1989) and the untreated control in June 1999. The selected doses were diluted with 10 liter of water and applied to the soil around the trunk of the date palm tree and then irrigated directly after application. Following irrigations were scheduled at two weeks interval. Barakawi, the most dominant variety, was selected. A Completely Randomized Design with 6 replicates (one tree = replicate) was used. Residue analysis was carried out on dates, soil and intercropping twice. The experiment was repeated in the following season (2000/2001) but only the most effective doses of Confidor (25 and 35 ml/tree) were tested.

Insect counts

Samples of eight leaflets (two leaflets from each of the four main directions) were taken biweekly and examined under the binocular microscope.

The number of live and dead adult females and immature stages were recorded per 3 cm^2 of each leaflet (tip, top and bottom). An average per cm^2 of the number of dead insets (adult female and immature) was calculated. Pre-spray count was undertaken before insecticide application.

Residue analysis

Residue analysis was done at the Gezira Research Station, Agricultural Research Corporation (ARS). Samples contain date palm fruits, intercropped plants and soil were collected from sites treated with high doses; 35 ml product/tree (7 g. a.i.), Samples were collected early season, (unripe fruit stage) and at harvest.

For analysis, sub-sampls of 50 g date fruits were taken randomly from treated and untreated trees and intercropped plants, and then mixed with 300 ml of methanol/water mixture (3:1) and allowed to soak for 30 min. Then the sample was homogenized and filtered using 10 g celite as filter aid. The filterae was transferred into a graduated cylinder, filled up with methanol to total of 250 ml and homogenized by agitation. An aliquot (100 ml) was removed. Transferred into 1000 ml round-bottomed flask and concentrated to about 20 ml using rotary evaporator.

Clean up was carried out using 10 g Amberlite XAD 4 resin packed into a chromatography column having an inner diameter of 10 mm. the column was pre-wetted with methanol and water. All aqueous elutes were discarded. The residues were eluted with 100 ml methanol. This elute was collected and concentrated to dryness and the residues were taken into 0.5 ml acetone and kept for analysis.

Yield and yield components

At harvest, 50 date fruits were taken at random from each replicate, three times to estimate the percentage fruit maturity (ripening).

Sub samples of ten date fruits each were taken to the laboratory to determine the following yield parameters:

Average fruit weight (g)
Average fruit length (cm): (L)
Average fruit diameter (cm): (D)
The L/D ratio% seed/fruit weight.

Economics analysis of the control measures

This study was conducted to evaluate the profitability of the control measures. Partial budget analysis was done to evaluate the profitability of control measures of the green scale insect using the tested package which includes;

1. Raising earth around the tree to facilitate irrigation.
2. Removal of the dead and highly infested leaves. And,
3. Soil application of Confidor 200 SL 35 ml (7 g a.i.) / date palm tree.

Costs and benefits of the variable items were obtained from secondary sources including previous records of agricultural schemes and Crop Markets Administration in the Northern State. Calculations were done for irrigation cost per one tree according to the ruling rate of 3 Sudanese Pounds (SDG) / tree / year and were estimated to increase to 5 SDG / tree / year due to control measures. Price of Confidor 200SL is 500 SDG / liter (in year 2003), which is sufficient for about 28 palm date trees at the rate of 35 ml / tree (Mahdi, 2001). This dose was found effective for at least three years after first application if good cultural methods were followed. Costs of raising earth and removal of dead leaves are estimated at 3 SDG and 5 SDG / tree with and without control respectively. Average dates yield was estimated at 40 kg / tree and the estimated loss due to infestation ranges between 85 and 90% according to severity of infestation, variety grown and management conditions. Yields due to infestation can be as low as 5kg / tree (Mahdi, 2001). Average dates price was 76 SDG per 100 kg in 2003 (Crop Markets Administration in the Northern State Reports, 2003).

RESULTS AND DISCUSSION

Results of biweekly counts indicate that the higher doses of imidacloprid as Confidor 200SL (25 and 35 ml/tree) increased adult female and immature mortality (Table 1a). Effects are significantly different from control

Table 1. Mean biweekly mortality[a] of the green pit scale insect per cm^2/leaflet of date palm treated with different insecticides (season 1999/2000) for a) Total mortality (adult females + immature) b) Adult females and c) Immatures.

Dosage rate (ml/palm)	Weeks after application						
	0	2	4	6	8	10	12
a) Total mortality (adult females + immature)							
35 ml	1.05^{A}	2.67^{A}	1.92^{A}	1.87^{A}	1.76^{A}	1.5^{A}	1.27^{A}
25 ml	1.05^{A}	2.07^{B}	1.69^{AB}	1.7^{A}	1.48^{AB}	1.38^{AB}	1.18^{A}
20 ml	1.12^{A}	1.67^{BC}	1.66^{AB}	1.32^{B}	1.41^{AB}	1.03^{B}	0.94^{A}
15 ml	1.10^{A}	1.33^{CD}	1.17^{B}	1.2^{B}	1.27^{B}	1.18^{AB}	0.99^{A}
Control	1.1^{A}	0.97^{D}	1.14^{B}	1.2^{B}	1.13^{B}	1.11^{AB}	1.01^{A}
SE±	0.23	0.45	0.39	0.21	0.34	0.31	0.32
C.V.%	11.9	11.45	25.6	5.1	19.5	19.68	23.7
LSD (0.05)	0.21	0.45	0.61	0.25	0.44	0.44	0.41
b) Adult females							
35 ml	16.4 (23.9) ^{A}	77.2 (61.3)^{A}	53.2 (46.8)^{A}	38.8 (38.5)^{A}	37.8 (37.9)^{A}	31.5 (34.1)^{A}	26.4 (30.9)^{A}
25 ml	14.2 (22.1)^{A}	53.7 (47.1)^{A}	27.3 (37.6)^{A}	27.2 (31.4)^{B}	29.5 (32.9)^{A}	22.6 (28.4)^{B}	16.4 (23.9)^{AB}
20 ml	14.8 (22.7)^{A}	37.8 (37.9)^{C}	28.9 (32.5)^{BC}	21.2 (27.4)^{BC}	16.6 (24.0)^{B}	13.8 (21.8)^{C}	9.8 (18.3)^{B}
15 ml	16.8 (24.2)^{A}	31.5 (34.1)^{C}	21.6 (27.7)^{CD}	13.8 (21.8)^{C}	12.0 (20.3)^{B}	10.8 (19.2)^{C}	9.7 (18.2)^{B}
Control	14.6 (22.5)^{A}	13.8 (21.8)^{D}	17.4 (24.6)^{D}	16.6 (24.0)^{C}	13.1 (25.2)^{B}	17.1 (24.4)^{BC}	11.8 (20.1)^{B}
SE ±	1.51	1.52	1.31	1.26	1.17	1.19	1.36
LSD (0.05)	8.9	9.07	6.76	6.23	5.36	5.58	7.31
C.V.%	23.98	13.99	12.47	13.56	11.92	13.62	20.48
c) Immatures							
35 ml	23.8 (29.3)^{A}	98.6 (83.2)^{A}	96.9 (79.9)^{A}	97.2 (80.4)^{A}	93.1 (74.7)^{A}	90.0 (71.5)^{A}	84.7 (66.7)^{A}
25 ml	32.4 (34.8) ^{A}	96.5 (78.5)^{A}	92.1 (73.4)^{A}	88.2 (70.4)^{B}	85.1 (67.3)^{B}	69.2 (63.0)^{B}	73.7 (59.7)^{A}
20 ml	31.5 (34.3)^{A}	60.4 (51.1)^{B}	62.1 (52.0)^{B}	52.0 (46.1)^{C}	47.5 (43.6)^{C}	41.1 (39.9)^{C}	34.2 (35.7)^{B}
15 ml	22.7 (28.5)^{B}	35.1 (36.4)^{C}	28.0 (32.0)^{C}	25.6 (30.4)^{D}	20.5 (26.9)^{D}	17.8 (25.0)^{D}	14.9 (22.7)^{C}
Control	23.8 (29.3)^{AB}	22.3 (28.3)^{D}	21.7 (27.8)^{C}	22.9 (28.6)^{D}	20.4 (26.9)^{D}	22.1 (28.0)^{D}	15.9 (23.5)^{C}
SE±	1.4	1.32	1.37	1.38	1.33	1.4	1.43
LSD (0.05)	7.71	6.79	7.37	7.59	6.95	7.7	8.1
C.V.%	15.94	7.63	8.67	9.25	9.06	10.56	12.05

Data in brackets were arcsine transformed. Means with letter(s) in common are not significantly different at 5% level according to Duncan's Multiple Range Test. [a] Data transformed to √X+0.5.

(untreated) throughout the test period (twelve weeks after application). The percentage mortality of the adult females and immature stages significantly increased in trees treated with insecticides compared with untreated control. More than 77% of adult female's mortality was observed at the higher dose of Confidor (35 ml/tree) four weeks after application ,while more than 90% percentage of immature stages mortality for the same dose was observed only two weeks after application (Table 1a).

The most effective doses of Confidor 200SL (25 and 35 ml/tree) in season 1999/2000 were chosen and tested in comparison to the standard insecticide carbufuran as Furadan 5G (60 g/palm). The experiments were conducted in two locations. Results (Table 1b and c) indicated that the average number of dead insects (adults females and immature) were significantly higher in the insecticide treated trees than in untreated control after two weeks. The efficacy of tested insecticides followed the order; Confidor (35 ml/palm) > Furadan 5G (60 g/palm) > Confidor (25 ml/palm). A high percentage of adult female mortality was observed after four weeks, in the two location, for the higher dose of Confidor (35 ml) compared to Furadan and untreated control while a similar percentage mortality of immature stages was observed only two weeks after application of the higher dose of Confidor (35 ml) (Table 1b and c). The soil application of imidacloprid (Confidor 200SL) coupled with management package was found highly effective in controlling the green pit scale insect and other pests such as termites with no phytotoxicity observed on the treated plants. It proved to very effective as a protective measure against new infestation. Further the method of application is easy, relatively safe and do not require any machinery or intensive labour.

Table 2. Mean biweekly mortality[a] of the green pit scale insect (mature female + immature) per cm^2/leaflet of date palm treated with different insecticides (season 2000/2001).

Location	1 (Elkhier farm)					2 (Issa farm)			
weeks after application	**0**	**2**	**4**	**6**	**8**	**0**	**2**	**4**	**6**
insecticides									
Confidor 35ml/palm	1.23^{A}	2.5^{A}	2.37^{A}	2.76^{A}	2.2^{A}	1.58^{A}	2.27^{A}	1.95^{AB}	1.45^{BC}
Confidor 25ml/palm	1.24^{A}	1.95^{AB}	2.03^{A}	1.75^{AB}	0.76^{B}	1.45^{A}	1.93^{AB}	1.85^{AB}	1.46^{B}
Furadan 5G 60g/palm	1.01^{A}	1.86^{B}	1.84^{A}	1.92^{AB}	1.77^{A}	1.26^{A}	2.56^{A}	2.60^{A}	2.83^{A}
Control	1.2^{A}	1.26^{B}	1.03^{B}	1.15^{C}	0.9^{B}	1.55^{A}	1.56^{B}	1.43^{B}	1.83^{C}
SE±	0.25	0.4	0.36	0.4	0.33	0.55	0.37	0.36	0.28
LSD (0.05)	0.28	0.71	0.59	0.72	0.49	1.35	0.61	0.6	0.35
C.V.%	9.8	14.52	12.43	14.6	13.47	35.48	11.32	11.64	8.9

Means with letter(s) in common are not significantly different at 5% level according to Duncan's Multiple Range Test. [A] Data transformed to $\sqrt{X+0.5}$. CV: Coefficient of variation.

Table 3. Percentage of unripe dates and weight of fruits location 1 (Elkhier farm) season 2000/2001.

Insecticides	% unripe fruit	Fruit weight (g)
Confidor 35 ml/palm	1.7	59.08
Confidor 25 ml/palm	4.87	55.68
Furadan 5G 60 g/palm	3.63	59.22
Untreated control	15.37	53.44
Untreated control without pruning	27.33	47.7
SE±	1.59	2.59
C.V.%	41.5	22.7
Sig. Level	***	NS

CV: Coefficient of variation.

Data presented in Table 3 showed the effect of the different doses of Confidor and Furadan on the percentage of ripe fruits (% maturity) and fruit weight (g). Date palms treated with higher doses of Confidor (35 ml) showed a high percentage of ripe fruits. The percentage of unripe date was significantly ($p = 0.01$) lower in the treatments compared to the untreated control. (1.7 and 27.33), respectively. Treated trees also gave the highest fruit weight.

Results of residue analysis indicated that, the residues of imidacloprid and its metabolites were below the detection limit (0.09 µg) in all samples analyzed (dates, soil and intercropped plants (alfalfa, and grasses)) even at the highest dose applied (35 ml/palm) The Rf of imidacloprid was 0.53. This result indicated that the use of Confider 200 SL at the rate of 35 ml/ tree on the date palms is safe for human consumption (Abbas et al. 2002). Similar findings of absence of detectable residues of imidacloprid in dates harvested six months latter from treated trees were reported from Sudan and Dammam area in Saudi Arabia (Alawi, 1993).

Date palm treated with Confidor (35 ml / palm), developed normally and the dates reached maturity (ripening) normally compared with untreated control. Confidor checked the activity of termites and many other pests. Results of the partial budget analysis are summarized in Table 4 (Time unit is one year).

Profitability of control of the green scale insect using this package is evident by the marginal rate of return of 29.8% which indicates that every Sudanese Pound spent to control the insect generates an extra net benefit of SDG 0.298 indicating positive profitability of the package over one year period. Sensitivity analysis by increasing both Confidor's price and decreasing dates prices by 10% showed that the marginal rate of return may decrease by 7.6% indicating a reasonable stability of the package. However, if the efficacy of control by a single dose of Confidor 200SL per tree throughout the first three years is taken into account, the profitability and stability may even further improved as indicated in Table 5. The profitability of this control package over the three years period may lead to a marginal rate of return of 201%.Sensitivity analysis by both increasing Confidor and labour cost prices and decreasing date's prices by 10% showed that the marginal rate of return may decrease to 146% indicating a high stability of the

Table 4. Partial budget analysis of the package used for the control the green scale insect in the Northern State of Sudan using imidacloprid as Confidor 200SL (Time unit is one year).

Item	Package	Non-package	Difference
(A) Benefits			
Average yield (SDG /tree)	40	5	35
Average price (SDG /kg)	0.76	0.76	0.76
Gross benefits (SDG /tree)	30.40	3.80	26.60
(B) Variable costs			
Pesticide (SDG /tree)	17.50	-	17.50
Irrigation (SDG /tree)	5.00	3.00	2.00
Earthing and cleaning (SDG /tree)	3.00	2.00	1.00
Total variable costs (SDG /tree)	25.50	5.00	20.50
Net benefits (SDG /tree)	4.90	– 1.20	6.10
MRR% =29.8			

The analysis was done according to the prices in 2003.

Table 5. Partial budget analysis of the package used for the control of the green scale insect in the Northern State of Sudan using imidacloprid as Confidor 200SL (Time unit is three year).

Item	Package	Non-package	Difference
(A) Benefits			
Average yield (kg/tree/3 years)	120	15	105
Average price (SDG /kg)	0.76	0.76	0.76
Gross benefits (SDG /tree/3 years)	91.20	11.40	79.80
(B) Variable costs			
Pesticide (SDG /tree)	17.50	-	17.50
Irrigation (SDG /tree/3 years)	15.00	9.00	6.00
Earthing and cleaning (SDG /tree/3 years)	9.00	6.00	3.00
Total variable costs (SDG /tree)	41.50	15.00	26.50
Net benefits (SDG /tree)	49.70	--3.60	53.30
MRR% =201			

The analysis was done according to the prices in 2003.

package over the three years. Profitability and stability of the package during the one-year period can be improved through enhancement of date palms' productivity to increase the net benefits to farmers. It can also be improved by introducing new products which offer a wider choice for selection and thus lower the cost of control which alone may constitutes about 50% of the variable cost of control package.

The date palm is attacked by many pests other than the green date palm scale insect (FAO 1982). These include; the red palm weevil, the stem borer beetles and their larvae such as *Orycet eleans*, *Phonopate frontalis*, and *Pseudophilus testaces* and the principal sucking pest, the date palm cicada (*Ommatissus binotatus* libycus). All the above mentioned pests can be controlled very well with imidacloprid as Confidor 5 GR or 200 SL (Sharif, 1994). Two treatments using Confidor with 60 to 100 g /palm or 15 to 20 ml in 10 L water /palm applied to the soil around the trunk give adequate protection Experiments were undertaken in Sao Paulo, Brazil, (Coelho et al., 2005) to evaluate the efficiency of systemic insecticides, including imidacloprid, to control aphids and leafhoppers on young citrus plants following planting in the field by drench application, using 20 ml of solution/nursery tree of imidacloprid and compared with thiamethoxam. The insecticides were found effective in the control of the leafhopper *Oncometopia facialis* and the brown aphid *Toxoptera citricida* for 155 and 90 days, respectively. In a second experiment, the insecticides were applied in the field, by soil application (granulates) and by drench (50 ml of solution/plant). The control periods of *O. facialis* by aldicarb+imidacloprid was longer than aldicarb alone (15 g CP/nursery plant) which presented a shorter control period. For aphids, until 61 days protection was obtained.

The degree of control was over 95% in all treatments. No occurrence of this pest was found in further evaluations.

The efficacy of imidacloprid (0.35, 0.70 and 1.05 g a.i./plant) in controlling citrus leaf miner (*P. citrella*) infesting lemons was investigated in a field experiment conducted in Argentina. Application of 0.35 g a.i. imidacloprid/plant controlled citrus leaf miner for up to 100 days after planting (Salas and Goane, 2003.

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