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EFFECT OF CYCOCYL AND CULTAR ON INFESTATION OF CITRUS LEAFMINERS AND CERTAN CHEMICAL CONSTITUENTS OF NAVEL ORANGE LEAVES

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ABSTRACT

Washington Navel orange transplants were sprayed at the beginning of each three growth flushes; i.e., spring, summer and autumn with CCC (cycocyl) or PP_{333} (cultar) at 1000 or 2000 ppm. All tested treatments reduced number and percentage of leaf infestation by citrus leafminers (*Phyllocnistis citrlla Station*). The highest infestation was recorded in summer flush and reduced in in autumn and spring flushes. PP^{333} cultar at 1000 ppm increased leaf pigments content compared with untreated control, while the higher level (2000 ppm) increased the percentages of foliar contents of N, K, Ca and Mg. In addition, the healthy leaves always had higher contents from carbohydrates, pigments, as well as N, P, Ca and Mg than infected ones.

INTRODUCTION

The citrus leafminer *(Phyllocnistis citrella)* is one of the major constraints to citrus production in southeastern Asia area assumed to fall within the area origin of the species in connection with its natural host plants *(citrus species* and other *Rutaceae.* In addition, citrus leafminer has been reported to infest citrus in the Middle East, Africa, Australia and North America. The citrus leafminer, *Phyllocnistis. citrella* invasion was recorded in Egypt at the end of 1994, when reported in newly reclaimed areas; by then, over 90% of newly replanted citrus species and much of the citrus orchards were already infested. Within few months, all citrus groves all over the country were infested. The citrus leafminer is one of exotic pests that it was introduced with plant materials from those regions; especially Southeast Asia. All citrus cultivars are attacked, small eggs are laid individually on young leaves *(*1-25 days old) (Knapp *el al*., 1995), then the hatched larvae produce serpentine mines beneath the leaf epidermis, where they feed upon the juice of the leaf cells. The damaged areas turns into colortic patch which may become necrotic. Number of mines in heavy infestation ranged between 2 to 3 mines/ leaf or more. The larvae consume about 1-7 cm^2 (40-50%) of the leaf area, thus adversely affect photosynthesis. The mature larvae forms a pupation cell on the leaf edge by the prepupa, from which the adult emerges to continue the life cycle. The injury is particularly severe in nursery plants and new plantations. Young trees (less than 3 years old) show growth reduction, if the leaves are left unprotected. Control of citrus leafminer could achieved through combination among many methods which include; i.e., cultural and chemical pesticides for the short term and biological and environmentally solutions for the long term.

Some cultural, chemical and other control tactics should be practiced to protect the main growth flushes, which contribute to tree health and fruit production. Some cultural methods might be useful to decrease citrus leafminer population which include manual removal of early and late-growing flushes, pre-flush pruning to promote uniform flushing application of fertilizers during the winter to promote rapid growth of spring flushes , when leafminer infestations are lowest (over-wintering population in pupal resting stage), and discouraged summer and autumn growth by reducing fertilizer and irrigation to maintenance levels (Knapp *el al.,* 1995).

Paclobutrazol (pp_{333}) is one of the triazole compounds, which are a highly active group of plant growth retardat chemicals (Arteca, 2013). Triazole compounds have been shown to reduce insect population densities; however, it is unclear how this is achieved (Campbell *et al,* 1989).

Also it was reported that onium compounds, including chlorequate chloride (cycocel, CCC), can enhance net photosynthesis. In addition, in the leaf area caused by onium compounds reduces the transpiration surface. which in turn reduces water loss (Davis and Jones 1991). Plant treated with onium compounds have thicker and greener leaves than untreated control. Onium-treated plants have also been shown to tolerate biotic stresses such as insects (Zummo *et al.,* I984 Dreyer *et al*., 1983), diseases and nematodes (Erwin *et. al.,* 1979).

The purpose of this study is to reduce the rate of Washington navel orange transplant flushes production using two growth retardants; i.e., CCC and PP_{333} at two concentrations 1000 and 2000 ppm during two growth flushes (summer and autumn). Moreover, to study the effect of these treatments on leafminer infestation and leaf contents of carbohydrates, pigments and major nutrient elements.

MATERIALS AND METHODS

This investigation was carried out during the two successive seasons of 2013 and 2014, in the nursery of the Depart of Hortic., International Company Abo Rawsh Giza Governorate. Hundred thirty five (five treatments x three replicates x nine plants in each replicate) of Washington navel orange *(Citrus sinensis* (L.) Osbeck) transplants were used in this study. The transplants were planted in plastic pots 30-cm diameter filled with sandy soil in February 2013 and received the same cultural practices, without any chemical pest control throughout the whole period of study.

Five groups of transplants were chosen randomly, each one received one of the following treatments:

1- Untreated control.

2- Cycocyl (chfromequat-CCC) at 1000 ppm.

3- CCC at 2000 ppm.

4) Paclobutrazol (cultar - pp_{333}) at 1000 ppm.

5- p_{333} at 2000 ppm.

Transplants of each treatment were sprayed with the respective growth retardant solution at the beginning of each growth flush; i.e., 5 April for spring flush,15 June for summer flush, and 10 Sept. for autumn flush in both seasons (2013 and 2014).

The following parameters were estimated:

1. Number of infested leaves is counted at the end of each flush by tagging the new shoots and counting both the infested leaves and the total number of leaves produced during every flush. The relative percentage of infestation was calculated.

2. Determination of leaf chemical constituents

At, the end of October of each season, when the leaves of spring shoots were about seven months old and those of summer shoots were about five months old. Samples were taken for the leaf necessary determinations from the medium position of shoots. Autumn leaves were still immature and were not represented in leaf sampling.

Total carbohydrates were determined in dry leaf samples according to |(Dubois *et al.,*1956).

Leaf pigments; Chlorophyll a, b and carotenoides, were determined in fresh leaf samples according to (Westtestein 1957) as mg/g fresh weight.

2.3. Leaf mineral contents Leaf samples were dried till constant weight at 70°C, then finely ground. The following methods were used for N, P, K, Ca and Mg determinations: N and P were determined colorimetrically according to (Kitson and Mellon 1964) also, Safaa A. and El-Deeb 2000), respectively. Potassium was estimated flame photometrically as reported by (Brown and Lilleland ,1946). Calcium and Mg were determined according to the versinate titration method, as described by (Barrows and Simpson 1962).

The obtained data were statistically analysed according to the complete randomized block design with three replicates (Snedecor and Cochran, 1980). The LSD method at 0.05 was used to compare the means. The values representing the means of each major factor and their interaction were tabulated.

RESULTS AND DISCUSSION

1. Temperature conditions in experimental seasons:

Data in table (1), demonstrated that average temperature in winter months (Dec., Jan. and Feb.) in 2013, were 18.2, 17.05, and 17.5°C, respectively, and were 23.0, 16.35, and 16.20°C in 2014, respectively. The maximum temperature in winter months ranged from 22.4 to 24.1°C in 2013 and from 22.1 to 29.1°C in 2014. According to (Singh and Azani 1980), the population of citrus leafminer was building up when the maximum temperature was in between 32 to 25°C and as soon as the temperature risen to 37ºC the pest population declined. Also, (O'leary and Quarles 1994) mentioned that the generation of citrus leafminer requires 13-15 days under average temperature of 26-29°C, while requires 42 days under 16.6°C, the number of pest generations ranging between 9-15 a year depending on its location. In addition, (Abo-Sheaesha ,1997) mentioned that the lowest level of larval infestation of citrus leafminer was recorded during winter months, while a sudden increase in the population and infestation rate took place during the end of May and early summer

2. Number of leafminer infested leaves / plant:

Data recorded in table (2) showed that the average number of infested leaves / plant during the whole season ranged 22.31 - 49.73 and 34.68-120.17 during the two seasons, respectively. While, the total numbers of new leaves / plant /season ranged 112.65- 171.42 and 131.69 - 266.05 during the first and second seasons respectively.

The untreated plants (control) were higher in total number of infested leaves (49.73 and 120.17 in the two seasons, respectively), while the tested treatments recorded much lower values ranged between 22.31 - 30.13 and 34.68 - 55.39 leaves for the two seasons, respectively). However, no significant differences among the tested CCC and PP_{333} treatments were observed in the second season.

Significant differences were observed between the average number of infested leaves in different flushes during the successive seasons, where the average numbers of infested leaves were highest during summer flush (15.64 and 28.32 leaves/plant in the two seasons, respectively). While, the least average numbers were recorded during autumn of the first season (2.55 leaves / plant) and spring of the second season (2.29 leaves / plant). These results apparently may be due to some weather factor effects, especially temperature, where the cool temperature during spring usually delays leafminer infestation as discussed in Table (1).

Significant effects were observed also in the interaction (treatment x flush) in both seasons, where the highest infestation was recorded for the interaction between (control x summer flush), while the lowest were observed for all treatments x autumn flush/2013, and all treatments x spring flush/ 2014

3. Percentage of infested new leaves / plant:

The percentage of infested leaves all over the season ranged between 19.13 - 28.54% and 24.41 - 44.05% during the two seasons, respectively. The highest infestation percentage always was recorded in control plants 28.54 and 44.05% in the two seasons, respectively. Meanwhile, infestation percentages were reduced in the tested treatments and ranged between 19.13 -21.29 and24.41-25.81% in the two seasons, with no significant differences. The depressing effects of growth inhibitors treatments on insect infestation in sorghum, cotton and pears plants were previously reported by (Dreyer *el al*., 1983 and Zummo *et al.,* 1984 also Campbell *et al.,* 1985). Significant differences were found between growth flushes in both seasons, where the highest values were 38.88 and 44.87% in summer flush in the two seasons and the lowest value was recorded in autumn flush in the first season (8.25%) and in the spring flush in the second one (3.55%). Previous reports on the effect of growth retardants on citrus leafminer infestation are not available.

4. Total carbohydrates percentage:

Data presented in table (3) show the percentages .of total carbohydrates in both healthy and infested leaves of spring and summer growth flushes. The effect of tested treatments on total carbohydrates percentage was nonsignificant with the older leaves (spring flush). However, summer leaves indicated higher carbohydrates percentage with control and CCC treatments as compared with pp_{333} ones.

The effect of growth retardant on total carbohydrate content in the leaves was discussed in many previous studies, but without any constant trend. Some reports showed that, P_{333} application usually reduced photosynthetic rate and carboxylase activity (Vu and Yelenosky, 1988; Yelenosky *et al*., 1994 and Safaa and El Deeb , 2000) on Valencia orange. Meanwhile, Melouachi *el al.* (2013) on citrange rootstock seedlings indicated that PP_{333} delayed growth, reduced sucrose and increased starch storage in citrange seedlings.(Deng *et at.,* 1990) painted shoots of Satsuma mandarin with pp_{333} and concluded that, it increased photosynthetic rate, leaf starch and reducing sugars contents, while decreased leaf dark respiration. It seems necessary however, to take into consideration the save in carbohydrate utilization due to growth depression by growth retardant, which was reported in many previous studies on different citrus species and cultivars (Aron *et al,* 1985, Monselise, 1986; Swietlik, 1986 Swietlik and Fucik, 1988; Mikaberidze and Mardaleishvili, 1990; and Vu and Yelenosky, 1988).

Generally, healthy leaves always showed higher carbohydrates percentage as compared with infested ones. However, the differences were significant only in spring flush in the first season. Similar significant result was also obtained by the interaction (treatment x infestation). The highest total carbohydrates percentage came from control and CCC at 1000 ppm in healthy leaves, while the total carbohydrates percentage were significantly reduced in infested leaves both in treated or untreated ones.

5. Leaf pigments contents:

The effects of both CCC and PP_{333}, in healthy and infested leaves, on chlorophyll a, b and carotenoides contents in spring and summer flushes are shown in Tables 3 and 4. Generally P333 at 1000 ppm increased leaf pigments contents as compared with the control. This result was obtained in most cases during spring and summer flushes in both seasons. Similar results were previously reported by (He *et al.* (1988) on *Cirrus unshiu* trees sprayed with pp_{333}; Thurkral *et al.* (1994) on lemon trees sprayed with CCC, (Deng *et at*.,1990) on Satsuma mandarin trees sprayed with PP_{333} and (Yelenosk *et al*.,1994) on Valencia orange trees sprayed with $PP_{333.}$

Also, in most cases, healthy leaves had higher, concentrations of pigments as compared with infested ones. Carotenoids content were not affected by infestation, where it recorded the same concentration in spring flushes for healthy and infested leaves. This was apparently due to damaged leaf area by leafminer, which turns into a chorionic patch and may become necrotic; such damaged area / leaf may reach 1-7 cm2 (Kanapp *et al.,* 1995*).*

The interactions (treatments x leafrniner infestation) were significant. except with chlorophyll and carotenoides in spring leaves of both seasons as well as with carotenoides in summer leaves in the first season. The significant interactions indicated that the combination (pp_{333} at 1 1000 ppm x healthy leaves) was always among those resulting in relatively higher.

6. Major elements content in the leaves:

Tables 5 and 6 show the effect of CCC and PP333 treatments on N. P. K, Ca and Mg percentages in healthy and infested leaves of Washington navel orange transplants during the experimental seasons.

The obtained data revealed that the higher level (2000 ppm) of both CCC and pp333 increased N, K, Ca and Mg percentages in the leaves, which was clear in spring and summer flushes in both seasons. In addition, P percentage was increased with pp333 at 2000 ppm in summer flushes in the first season and with CCC at 2000 ppm in spring leaves in the second one. Meanwhile, all tested treatments caused insignificant effect on P percentage concerning spring leaves in the first season and summer leaves in the second season.

Such promotion in leaf major mineral contents with the higher levels (2000 ppm) of both CCC and PP333 might be due to the growth inhibiting effect of these regulators. Where by the uptake of the considered that was in harmony with (Safaa, and El Deeb, 2000). Nutrients will be sufficient for the limited new growth.

The increased foliar N content with PP333 treatment was in line with He *et al.* (1988) working on Citrus unshi. However, Thurkral *et at.* (1994) found that CCC at 2000 ppm did not affect N or contents, while increased Mg content in leaves of Pant lemon trees.

The leafminer infestation also affected the leaf major mineral contents. The percentages of N, P, Ca and Mg in healthy leaves were generally, higher than in infested ones. The differences were mostly statistically significant. However, differences between healthy and infested leaves in K percentage were always insignificant.

The interactions (treatment x infestation) were insignificant for N, P and Ca percentages, but were always significant with K and Mg percentages. The combinations which indicated constant higher Mg percentages through all flushes and seasons were (healthy leaves x CCC and P333 at the higher level, 2000 ppm).

On the other hand, no actual trend was detected through the interaction values of K foliar percentages.

Table (1). Average monthly temperature (°C) in nursery at study region, Giza Governorate (2013 and 2014 seasons).

Months		**2013 season**			**2014 season**	
	Min.	**Max.**	**Av.**	**Min.**	**Max.**	**Av.**
January	11.7	22.4	17.05	10.2	22.5	16.35
February	12.3	22.7	17.5	10.3	22.1	16.2
March	12	23.6	17.8	10.8	22.5	16.65
April	13.5	26.9	20.2	14.4	27.7	21.05
May	18.2	33.9	26.05	18.09	35.4	26.75
June .	21.4	36.1	28.75	22.4	35.9	29.15
July	23.6	35.8	29.7	24.3	36.9	30.6
August	23.5	35.6	29.55	23.6	35	29.3
September	21.5	35.2	28.35	20.4	35.3	27.85
October	20.5	32.7	26.6	19.1	31.2	25.15
November	16.9	29.1	23.0	2.7	24.3	18.5
December	12.3	24.1	18.2	16.9	29.1	23

- According to the General Meteorological Authority, Giza Governorate.

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تاثير الرش بالسيكوسيل والكلتار علي الاصابة بحشرة صانعات الانفاق والمحتوي الكيمائي للاوراق البرتقال ابوسرة

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أجريت هذه الدراسة خلال عامي ٢٠١٣ و ٢٠١٤ على شتلات البرتقال بسرة واشنجطن بمشتل الشركة الدولية بابورواش محافظة الجيزة داخل الصوبة بهدف تقليل الإصابة بحشرة صانعة إنفاق أوراق الموالح والتي عادة ما تصيب الأوراق الحديثة فقط، ومثل هذه الأوراق تتكون بكمية اكبر كثيرا في الشتلات والأشجار حديثة الزراعة مقارنة بالأشجار البالغة. ولهذا العرض تم رش الشتلات بكل من السيكوسيل والكلتار بتركيز ١٠٠٠ أو ٢٠٠٠ جزء في المليون في بداية كل من دورات النمو الرئيسية الثلاث وهي الربيع والصيف والخريف. ولقد أوضحت النتائج أن معاملات السيكوسيل والكلتار أدت إلى تقليل عدد الأوراق المصابة بحشرة صانعات إنفاق أوراق الموالح والنسبة المئوية لها بدرجة معنوية. وقد تبين أن دورة نمو الصيف كانت أعلى في العدد والنسبة المئوية للأوراق المصابة مقارنة بدورتي الربيع والخريف. وبالاضافة إلى ذلك فقد ادت المعاملة بالكلتار بتركيز ١٠٠٠ جزء في المليون زيادة محتوى الأوراق من الصبغات مقارنة بالكنترول. كما نتج عن استخدام تركيز ٢٠٠٠ جزء في المليون زيادة محتوى الأوراق من عناصر الازوت والبوتاسيوم والكالسيوم والماغنسيوم، ومن جهة أخرى فقد احتوت الأوراق السليمة على تركيزات أعلى من الكربوهيدرات والصبغات وكذلك الأزوت والفوسفور والماغنسيوم بالمقارنة بالأوراق المصابة.

Table 2. Effect of some CCC and PP_{333} treatments on number and percentage of leafminer infestation on Washington navel orange transplants (2013 and 2014).

Treatments (ppm)	Number of infested new leaves/ Plant					Total number of new leaves/plant in the season	Percentage of infested new leaves/plant				Total percentage in
	Spring flush	Summer flush	Autumn flush	Treat, av.	Total number of infested leaves		Spring flush	Summer flush	Autumn flush	Treat. av.	The season
2013											
Control	16.27	28.60	4.87	16.58	49.73	171.42	19.92	50.91	14.79	28.54	29.19
CCC 1000	12.60	13.23	2.10	9.31	27.93	142.67	16.79	35.70	8.25	20.24	19.60
CCC 2000	10.33	13.39	2.00	8.57	25.72	133.02	13.73	36.64	9.41	19.93	19.33
PP_{333} 1000	10.37	12.61	2.01	8.33	24.98	129.18	15.08	32.80	9.52	19.13	19.34
PP_{333} 2000	10.20	10.35	1.75	7.44	22.31	112.65	14.97	38.88	10.02	21.29	19.79
Flush av.	11.95	15.64	2.55	-	30.13	137.79	16.10	38.99	10.40	-	21.45
$LSD_{0.05}$	Treat. = 1.95; Flu. = 1.51; Treat x Flu. = 3.37				4.86	12.02	Treat. = 3.14; Flu. = 2.43; Treat x Flu. = 5.43				8.26
2014											
Control	4.55	68.61	47.83	40.06	120.17	266.05	9.43	89.60	33.11	44.05	45.05
CCC 1000	2.22	17.72	20.50	12.99	38.97	145.53	5.44	40.52	31.46	25.81	26.78
CCC 2000	1.75	16.59	19.77	14.33	43.00	156.44	5.94	38.73	28.55	24.41	27.69
PP_{333} 1000	1.66	18.33	20.11	13.37	40.11	157.11	4.54	44.87	25.61	25.01	25.65
PP_{333} 2000	1.26	20.33	13.08	11.56	34.68	131.69	3.55	43.01	27.48	24.68	26.44
Flush av.	2.29	28.32	24.26	-	55.39	171.36	5.78	51.35	29.24	-	30.32
$LSD_{0.05}$	Treat. 3.23; Flu. = 2.50; Treat x Flu.=5.60				11.36	13.26	Treat. = 4.10; Flu. = 3.18; Treat x Flu.=7.11				8.76

Spraying dates in 2013 and 2014 seasons: 5 April, 15 June & 10 Sept.

Table 3. Effect of some CCC and P_{333} treatments on total carbohydrates percentage and chlorophyll a content (mg/g. F.W.) in healthy and leafminer infested leaves of Washington navel orange transplants (2013 and 2014).

Treatments (ppm)	Leaf total carbohydrate (%)						Leaf chlorophyll-a content (mg/g. F.W.)					
	Spring flush leaves			Summer flush leaves			Spring flush leaves			Summer flush leaves		
	Healthy	Infested	Treat. av.	Healthy	Infested	Treat. av.	Healthy	Infested	Treat. av.	Healthy	Infested	Treat. av.
						2013						
Control	26.35	17.69	22.02	24.02	22.24	23.13	0.71	0.60	0.66	0.72	0.52	0.62
CCC 1000	25.58	17.65	21.62	23.87	22.02	22.94	0.59	0.54	0.57	0.77	0.54	0.66
CCC 2000	25.43	19.93	22.68	23.79	21.65	22.72	0.69	0.60	0.65	0.79	0.47	0.63
PP_{333} 1000	24.36	19.67	22.02	18.38	18.24	18.31	0.75	0.70	0.73	0.84	0.69	0.76
PP_{333} 2000	19.28	19.98	19.63	20.94	19.47	20.21	0.69	0.67	0.68	0.76	0.37	0.57
Infestation av.	24.20	18.98	-	22.20	20.72	-	0.69	0.62	-	0.78	0.52	-
$LSD_{0.05}$	Treat. NS; Infest. 1.73, Treat. x Infet. = 3.87			Treat =3.17; Infest. =NS, Treat. x Infest. NS			Treat. = 0.89; Infest. = 0.056, Treat. x Infest NS			Treat. 0.069; Infest. = 0.044, Treat x Infest. = 0.098		
2014												
Control	29.25	19.80	24.53	26.32	22.82	24.57	0.90	0.77	0.84	0.89	0.66	0.78
CCC 1000	28.27	20.56	24.42	24.03	23.33	23.68	0.85	0.78	0.82	0.96	0.69	0.83
CCC 2000	22.72	28.06	25.39	26.09	28.30	27.20	0.90	0.79	0.85	0.98	0.60	0.79
PP_{333} 1000	18.01	24.56	21.29	20.68	23.57	22.13	0.97	0.92	0.95	0.103	0.86	0.95
PP_{333} 2000	23.51	25.00	24.26	23.24	19.96	21.60	0.88	0.85	0.87	0.89	0.46	0.68
Infestation av.	24.35	23.60	-	24.07	23.60	-	0.90	0.82	-	0.95	0.65	-
$LSD_{0.05}$	Treat. NS; Infest. "NS, Treat. x Infest. 4.75			Treat. = 3.73; Infest. NS, Treat. x Infest. NS			Treat = 0.068; Infest. = 0.043, Treat. x Infest. =NS			Treat. = 0.064; Infest. = 0.040, Treat. x Infest. 0.091		

Spraying dates in 2013 and 2014 seasons: 5 April, 15 June & 10 Sept.

Table 4. Effect of some CCC and PP333 treatments on chlorophyll b and carotenoides content (mg/g. F.W.) in healthy and leafminer infested leaves of Washington navel orange transplants (2013 and 2014).

Treatments (ppm)	Leaf chlorophyll b content (mg/g. F.W.)						Leaf carotenoides content (mg/g.F.W.)					
	Spring flush leaves			Summer flush leaves			Spring flush			Summer flush		
	Healthy	Infested	Treat. av.	Healthy	Infested	Treat. av.	Healthy	Infested	Treat. av.	Healthy	Infested	Treat. av.
						2013						
Control	0.57	0.34	0.46	0.51	0.34	0.43	0.30	0.28	0.29	0.35	0.30	0.33
CCC 1000	0.26	0.16	0.21	0.62	0.42	0.52	0.32	0.35	0.34	0.45	0.32	0.39
CCC 2000	0.64	0.43	0.53	0.62	0.28	0.45	0.40	0.37	0.39	0.48	0.25	0.37
PP_{333} 1000	0.60	0.55	0.58	0.64	044	0.54	0.33	0.34	0.34	0.53	0.44	0.48
PP_{333} 2000	0.50	0.41	0.46	0.74	0.38	0.56	0.30	0.29	0.30	0.33	0.18	0.26
Infestation av.	0.51	0.38	-	0.63	0.37	-	0.33	0.33	-	0.43	0.30	-
$LSD_{0.05}$	Treat. = 0.032; Infest. = 0.020, Treat. x Infest. = 0.045			Treat. = 0.036: Infest. = 0.023, Treat. x Infest. 0.05 1			Treat. 0.045; Infest. NS, Treat. x Infest. =NS			Treat. = 0.086; Infest. = 0.055, Treat. x Infest. = NS		
					2014							
Control	0.76	0.51	0.64	0.70	0.48	0.59	0.49	0.46	0.48	0.54	0.46	0.50
CCC 1000	0.73	0.45	0.59	0.81	0.56	0.69	0.51	0.57	0.54	0.64	0.46	0.55
CCC 2000	0.83	0.52	0.68	0.81	0.37	0.59	0.62	0.58	0.60	0.67	0.35	0.51
PP_{333} 1000	0.79	0.73	0.76	0.83	0.59	0.71	0.52	0.54	0.53	0.72	0.61	0.67
PP_{333} 2000	0.82	0.69	0.75	0.93	0.49	0.71	0.49	0.46	0.48	0.49	0.27	0.38
Infestation av.	0.79	0.58	-	0.82	0.50	-	0.53	0.53	-	0.61	0.43	-
$LSD_{0.05}$	Treat. 0.069; Infest. = 0.044, Treat. x Infest. = 0.097			Treat. q.056; Infest. = 0.035, Treat. x Tnfeat.. = 0.079			Treat. = 0.050; Infest. ‘NS, Treat. x Infest. ‘NS			Treat. =0.082; Infest. =0.052, Treat, x Infest. 0.116		

Table 5. Effect of some CCC and PP333 treatments on N, P and K percentages in healthy and leafminer infested leaves of Washing navel orange transpla its (2013 and 2014).

Treatment	N %						P %						K %					
(ppm)	Spring flush			Summer flush			Spring flush			Summer flush			Spring flush			Summer flush		
	Healthy	Infested	Trea.av.	Healthy	Infested	Trea.av.	Heal thy	Infested	Trea. av.	Heal thy	Infested	Trea .av.	Heal thy	Infested	Trea. av.	Healthy	Infested	Trea. av.
2013																		
Control	2.01	1.67	1.84	2.29	1.71	2.00	0.064	0.055	0.060	0.073	0.061	0.067	1.67	1.86	1.76	1.43	1.44	1.43
CCC 1000	2.29	1.91	2.10	2.32	1.90	2.11	0.066	0.064	0.065	0.077	0.073	0.075	1.65	1.93	1.79	1.59	1.95	1.77
CCC 2000	2.30	1.92	2.11	3.15	2.71	2.93	0.067	0.054	0.060	0.076	0.074	0.075	1.67	2.26	1.96	1.98	1.92	1.95
PP_{333} 100	2.17	1.67	1.92	2.57	1.81	2.19	0.079	0.063	0.071	0.084	0.064	0.074	1.64	1.37	1.51	1.96	1.92	1.94
PP_{333} 2000	2.51	1.85	2.18	3.09	2.27	2.68	0.071	0.059	0.065	0.088	0.077	0.082	1.74	1.70	1.72	1.91	1.98	1.94
Infestation	2.26	1.80	-	2.68	2.08	-	0.069	0.059	-	0.080	0.070	-	1.67	1.82	-	1.77	1.84	-
LSD $_{0.05}$	Treat. =NS; Infest = 0.223, Treat. x Infest. = NS			Treat. = 0.433; Infest. = 0.274. Treat. x Infest. NS			Treat. =NS; Infest.=NS, Treat. x Infest. = NS			Treat. = 0.0.007; Infest.= 0.005 Treat. x Infest. = NS			Treat. = 0.222; Infest.= NS Treat. x Infest. = 0.314			Treat. = 0,130; Tn1es.= NS Treat. x Infest. = 0.184		
2014																		
Control	1.54	129	1.42	2.39	1.75	2.07	0.016	0.061	0.066	0.083	0,067	0.075	1.73	1.91	1.82	1.51	1.47	1.51
CCC 1000	1.59	1.29	1.44	2.40	1.89	2.15	0.075	0.071	0.073	0.085	0.080	0.083	1.35	1.59	1.47	1.67	2.13	1.90
CCC 2000	2.49	2.10	2.29	3.17	2.87	3.02	0.086	0.076	0,079	0.077	0.080	0.079	1.54	2.06	1.80	2.73	2.30	2.52
PP_{333} 100	2.08	1.58	1.83	2.53	1.83	2.18	0.075	0.65	0.070	0.092	0.068	0.080	1.61	1.34	1.48	2.06	2.20	2.13
PP_{333} 2000	2.30	1.95	2.13	2.81	2.37	2.59	0.072	0.061	0.067	0.088	0.87	0.088	1.13	1.11	1.12	1.73	2.03	1.88
Infestation	2.00	1.61	-	2.66	2.14	-	0.076	0.067	-	0.085	0.076	-	1.47	1.60	-	1.95	2.03	-
LSD $_{0.05}$	Treat. = 0.262; Infest = 0.166 Trent x infest = NS			Treat. = 0.387 Infest.= 0,24, Trent x infest = NS			Treat. = ٠.٠٠٩ Infest.= 0.005 Trent x infest = NS			Treat = NS; Infest = NS Trent x infest = NS			Treat. = 0.180; Infest = NS Trent x infest = 0.255			Treat = 0.141 Infest = NS Trent x infest = 0.200		

Spraying dates in 2013 and 2014 seasons: 7 5 April,15 June & 10 Sept.

Table 6. Effect of some CCC and treatments on Ca and Mg percentages in healthy and leafminer infested leaves of Washington navel orange transplants (2013 and 2014).

Treatments	Ca (%)						Mg %					
(ppm)	Spring flush			Summer flush			Spring flush			Summer flush		
	Healthy	Infested	Treat. av.	Healthy	Infested	Treat. av.	Healthy	Infested	Treat. av.	Healthy	Infested	Treat. av.
2013												
Control	2.22	1.58	1.90	2.21	1.78	1.99	0.21	0.13	0.17	0.28	0.19	0.23
CCC 1000	2.14	1.74	1.94	3.38	2.61	2.99	0.31	0.19	0.25	0.45	0.22	0.33
CCC 2000	2.25	2.05	2.15	2.38	2.18	2.28	0.31	0.25	0.28	0.49	0.38	0.43
PP_{333} 1000	2.42	1.73	2.07	2.63	2.22	2.42	0.32	0.23	0.27	0.46	0.31	0.38
PP_{333} 2000	2.50	2.28	2.39	3.06	2.71	2.88	0.39	0.20	0.29	0.55	0.35	0.45
Infestation av.	2.31	1.88	-	2.73	2.30	-	0.31	0.20	-	0.45	0.29	-
$LSD_{0.05}$	Treat. 0.318;Infest. 0.201, Treat x Infest.' NS			Treat. = 0.191; Infest. =0.121, Treat.xInfest.=NS			Treat. = 0.019; Infest. = 0.012, Treat.xInfest.'0.026			Treat. = 0.017; Infest. = 0.011, TreafxInfest.'0.025		
2014												
Control	2.64	1.83	2.24	2.23	1.83	2.03	0.45	0.36	0.40	0.47	0.21	0.57
CCC 1000	3.04	2.62	2.83	3.53	2.78	3.16	0.60	0.40	0.50	0.54	0.47	0.50
CCC 2000	2.72	2.77	2.75	2.41	2.29	2.35	0.55	0.43	0.49	0.55	0.46	0.50
PP_{333} 1000	2.71	1.94	2.33	2.64	2.23	2.44	0.35	0.39	0.37	0.47	0.34	0.40
PP_{333} 2000	2.95	2.69	2.82	2.93	2.1	2.92	0.50	0.49	0.49	0.57	0.42	0.49
Infestation av.	2.81	2.37	-	2.75	2.41	-	0.49	0.41	-	0.52	0.38	-
$LSD_{0.05}$	Treat. 0.383; Infest. 0.242, Treat. x Infest. NS			Treat. = 0.495; Infest. 0.3 13, Treat. x Infest. NS			Treat. = 0.035; Infest. 0,022, Treat. x Infest. = 0.049			Treat. = 0.026; Infest. 0.016, Treat. x Infest. 0.036		

Spraying dates in 2013 and 2014 seasons: 5 April, 15 June & 10 Sept.