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Full Length Research Paper

The Effects of Girdling and Bio-Stimulants on Persian Lime (*Citrus Latifolia* Tan.) Bloom, Production and Quality for Winter

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In Mexico, 61.000 hectares of land are used top lant Persian lime trees (Citruslatifolia Tan.) whose average yield is of14 t ha^{-1} (SIAP, 2013) and production occurs from May to October. Yet their prices in themarket are low. On this basis, the trial consistedon carry out some evaluations on the cultural practices and applications of bio-stimulants as a way to induce bloom, production, and fruit quality for winter. Through August 2013 and April 2014, in a Persian lime orchard in Tlaltizapán, Morelos, México, combinations in pruning, girdling, and applications of urea and Biofol® were assessed. These were conducted in August, September and October, they determined the effects on trees, the content of leaves' macronutrients as well as micronutrients; and the determination of the physical-biochemical quality of fruit. With September pruning + urea + girdling, a greater bloom and yield of 20.3 t ha^{-1} were obtained that exceeded the rest of the other treatments by 50-400 percent. It also showed a higher specific weight, protein content, and presence of N, P, Mg and Zn in leaves. Fruit displayed some physical-biochemical qualities, as well. As a result, this treatment promotes budding, blooming, setting, and the quality-yield of Persian lime for winter.

Keywords: *Citrus latifolia Tan.*, blooming, urea production, girdling and quality.

INTRODUCTION

Citriculture represent a significant activity for domestic fruit growth. The main cultivated citrus fruits in Mexico are: orange, Mexican lime, Persian lime, grape fruit, and tangerine (SIAP, 2013). Persian lime contributes to 61.822 ha, has an annual yield of 14 t ha^{-1}and the price paid is of 2.000 Mexican pesos per ton of fruit. Among citrus species, it's the country's number-one income generator because 80% of its production is mainly exported to the United States (Contreras et al., 2008). Japan is a big importing country but France, England and Holland are within the European Economic Union. So, Mexico is the biggest producer and exporter of Persian lime worldwide (Castellanos, 2009).

In the state of Morelos, of the 937 haplanted with citrus fruits, 60% belong to Persian lime, 30% to Valencia orange; and 10% to Mexican lime, tangerine, and

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grapefruit. In this state, plantings are quite new, being in production and expanded; therefore they represent, within the productive conversion diagram, a suitable economic alternative for Morelos producers to export (Lugo et al., 2009; Alia et al., 2011 a).

Persian lime production in Mexico occurs from May to October; its national and international low prices in the market coincides with these periods (Curti et al., 1996; Puente, 2002).Production is limited through December to April, but prices go high and crops become profitable (Ariza et al., 2004). In this context, the use of cultural practices could control bloom period as it is a technique that improves crops' profitability (Ruiz, 2001); among these techniques there's: pruning, ringing, and the application of some chemical substances (Ariza et al., 2004).

Pruning in Persian lime plantings attempts to regulate bloom period and to obtain a more uniform production during the year, but results are incipient and there's still much to investigate (Curti et al., 2000).Girdling can influence bloom and favor the accumulation of carbohydrates upward the ring and growth interruption. (Erner, 1986); Ariza et al. (2004) pointed out that girdling and hydric stress facilitate Mexican lime blooming for Winter production; they also generate a yield higher than 500 percent, increasefruit quality weight and green-colorfor about 20-40 percent; and improve soluble solids/titratable acidity ratios.

The use of some chemical substances promote bloom inducement, which is one of the most practiced agronomics activities (Ruiz, 2001).Lugo et al. (2009) have observed that applications with naphthalene acid help bloomoccurring in the orchard located in Morelos, but they still haven't quantified the effect these applications will have when using them at different production stages. Ariza et al. (2004) mentioned that application of urea at 4% promotes Mexican lime blooming; Almaguer et al. (2011) however, did not find any differences in the quality of Persian lime while applying urea at 5% and foliar fertilizer at 2%. Pruning and cutting of productive branches were used to arouse mismatching in the production harvesting in Veracruz, Mexico. For this reason, evaluating the effects and combinations on when to apply pruning, girdling, and applyingchemical substances onto Persian limecrops and its final quality in the fruit for winter, were considerately important.

MATERIALS AND METHODS

Trials were carried out in the municipalities of Ticumán and Tlaltizapán in Morelos onto a 4.5-year-old Persian lime orchard. The climate is hot-dry, it's located at 1000 mheight above sea level; it possess a rainfall of 800 mm, an annual average temperature of 24°C (75.2°F); and a Feozem soil.

Setting up the experimental. The following treatments and application periods were evaluated(from February to April): 1. Grafting trees (with no applications of practices nor substances), 2. Pruning in August, 3. Pruning and girdlingin September, 4. Pruning, urea by 6% and girdlingin September; 5. Pruning with Biofol® and girdlingin September; 6. Pruning in September, 7. Pruning and girdlingin October, 8. Pruning and girdlingin August; and 9. Pruning, urea at 6% and girdlingin October.

From trees in which pruning was done, 30 cm of their crown was eliminated just to carry out girdlingor to apply chemical substances. By using a mini-hacksaw 6" (152 mm), girdlingwas executed above the scion area in two or three main branches; subsequently, that section was sealed with aerosol spray. Applications of urea at 6% and Biofol® to 3 L $ha^{-1}$are sprayedonto the foliage; in both cases, Inex-A® adherent is used in doses of 2 ml per literof water.

Agronomic management. The Persian lime orchard received 180- 40-75 (N-P-K) of chemical fertilization and 20 kg of vermicomposting per tree; their foliage had a dose of 3 L ha^{-1} of Poliquel® Multi. Applications with imidacloprid + cyfluthrin (300 ml ha^{-1}) + thiamethoxam + citrolin (200 ml ha^{-1}) + mineral oil (2 L ha^{-1}) were implemented for insect pest control: leafminers (*Phyllosnictiscitrella* Stainton), aphids (*Aphysgossypi* y *A. spiraecola*) and diaphorina (*Diaphorinacitri* Kuwayama). The presence of gummosis (*Phytophthora*sp.) was brought under control through 500 g of fosethylaluminium in 200 L of water. A micro-spray irrigation system, with a water consumption of 100 to 120 L d^{-1}, was utilized for irrigating.

Evaluated variables. The effects that treatments had on Persian lime trees was determined at 3.0 m height and 3.0 m-diameter from their top; just like the number of flowers and fruit setting selected from a 75 cm-length and 1.6 m-height branch from soil level in each of the trees' cardinal point. These evaluations took place every 15 days but, after treatment applications, these were carried out from October to December 2011. The number of buds was established in four branches per tree that were obtained from September to November 2011.

A chlorophyll concentration could be determined with a SPAD 502 (Minolta®, Japan), a colorimetric method defined the total sugar content in mature leaves (Witham et al., 1971).The total protein content in leaves was defined through the colorimetric method to which amido black staining has been added (Höfneret al., 1989).From each experimental unit, 12 samples of 3.14 cm^2 leaveswere obtained, they dried out inside a stove for about 48 hours at 50°C (125.6°F) and weighed in an analytical balance (Scientech®, USA).Their specific weight was calculated in which dry weight (mg) had to be divided between foliage areas (cm^2), as a result of the collected data (Reyes et al., 1999).

Fruit yielding per treeis defined withthe January and April crops.The total production weight from each tree was obtained by using a mechanical scale with a capacity of 10 kg and a sensitivity of 0.025 kg; they were determined into kilograms per hectare (kg ha^{-1}).

Content of N, P, K, Ca, Mg, Cu, Fe, Mn and Zn were obtained from terminal buds samples with flowers. To do so, a bud was collected randomly from each tree cardinal point per treatment, a three-repetition method was carried out. They werelater transported into the lab, washed with distilled water so any excess of it could have beenremoved with sterile tissues®. Subsequently, they were put in brown paper bags and put to dry in a mechanical ventilation oven at 70°C (158°F) for three days. The semi-micro Kjeldahl method for the determination of N was used; while P, K, Ca, Mg-Cu, Fe, Mn and Zn concentrations have been obtained through dry material's wet digestion with a compound of perchloric and nitric acids. Extract readings were conducted by means of atomic emission spectroscopy and inductively coupled plasma ICP-AES VARIAN™ Liberty II model (Gómez et al., 2011a,b).

To a sample containing six harvested fruit and coming from each treatment, fruit mass is determined by utilizing both a digital weighing scale (OHAUS®, USA) and a digital caliper (Mitutoyo®, Japan) for polar as well as equatorial fruit diameters. Components of luminous color (L*), chromaticity (C*); and shade (h) have been established throughout a portable spectrophotometer (X-rite®, Mo. 3290, USA) (McGuire, 1992.)

In order to know the juice percentage (that has been extracted from each fruit), rind has been weighed separately from the juice. Giving the equation proposed by Ladaniya (2008), titratable acidity is calculated in a 5 mL aliquot of juice; this equation is shown as follows:

$$\text{Titratable acidity (\% of citric acid)} = \frac{(\text{mL of NaOH spent}) \times (\text{N of NaOH}) \times (\text{final volume}) \times (\text{Meq citric acid 64}) \times 100}{(\text{Titratable total volume}) \times (\text{juice volume}) \times 1000}$$

When putting one and three drops of juice in a refract meter (PAL-1, Atago®, Japan), total soluble solids are established and expressed the values in °Brix (°B).Soluble solids total values alongside titratable acidity could determine both variable ratios that indicate either fruit sweetness or acidity (Ladaniya, 2008).

Statistical analyses. Results from each variable have been analyzed with ANOVA; some median separation tests have been applied through a LSD test with a probability of 5% when SAS V9.2 program was used (Castillo, 2011).

RESULTS AND DISCUSSION

Plants, buds and flowers formation in Persian lime. Pruning in Persian lime trees were of great importance for their production because they were kept to a height of 3.0 m; nonetheless, grafting trees were to a 4.1 m (Table1). Curti et al.(2012) quantified an average height between 2.6-3.4 m while evaluating Persian lime behavior within four rootstocks (reed, rough, *swingle* and *volkameriana*). Yet, with the volkameriana root stock, they've reached an average height of 2.8 m, which is lower compared to those achieved in the current study.

The diameter of the crown was between 3.0 and 4.0 m, in which grafting trees showed a higher diameter (Table 1).Other authors indicate thatPersian lime trees' top's diameter,in different rootstocks, is between 4.0 to 4.5 m for 11-yearl-old trees; but in the *volkamerian*a rootstock, they reached a height of 4.5 m (Curti et al., 2012). Stenzel and Neves (2004) indicated a crown diameter of 6.6 m with the *volkameriana* rootstock. Evaluated differences are attributed to the soil characteristics from where they grow. In this trial, trees with pruning,girdling, and with applications of urea and Biofol® showed the lowest height and top diameter in September and October, in compared to those without pruning or with pruning done in August (Table1.) It is observed that tree's height and crown growth were greater than what Curti et al.(2012) reported.

There are some significant differences among treatments for buds number. It is seen that combinations in September pruning + 6% of urea + girdling gave three buds per branch; meanwhile, emerging of buds was little in grafting trees (without pruning) for Persian lime trees. The rest of the treatments produced one and two buds (Table 1).

Pruning in citrus is done to optimize trees' size, to facilitate their handling, to increase their production; and to expand crops' productive life (Amoros, 1989). When pruning, carbohydrates balance and nitrogen must be taken into consideration since this balance stimulate buds growth (which happens in higher amounts as they have little carbohydrates because of pruning); applications of nitrogen occur in parallel (Medina et al., 2004). There was a greater amount of buds in treatments with 6 % of urea application, this may be due to ratios first mentioned.

In trees with pruning + urea+ girdling and pruning + Biofol® applications, 38 and 28 flowers were respectively quantified during September harvest and presented a percentage of 50-80 more flowers in regards to other treatments (Table 1). It has been reported that applications of urea + light pruning onto Persian as well as on Mexican limes trees invigorate significantly to flowers formation; while applications of urea and Biofol® improve a higher production of flowers during winter (Ariza et al., 2004; Almaguer et al., 2011).An increase in blooming is due to conversion of urea to ammonia, which reduces growth by ethylene synthesis and induces bloom (Lovatt et al., 1988).

Effects on chlorophyll, total sugars and leaves specific weight. It was not able to determine the effects from the different treatments within chlorophyll relative

Table 1. Persian lime trees morphological characteristics in winter.

Treatment	Height (m)	Diameter (m)	Buds per branch (no.)	Total flowers (no.)
Control	4.1 a[z]	4.0 a	0.0 c	13.0 bc
P in August	3.0 b	3.3 ab	1.6 b	7.0 c
P + Gin September	3.0 b	3.0 c	1.4 b	10.0 c
P + U + G in September	3.0 b	3.0 c	3.4 a	38.0 a
P + B + G in September	3.0 b	3.0 c	2.2 b	28.0 ab
P in September	3.0 b	3.0 c	1.9 b	14.0 bc
P + Gin October	3.0 b	3.0 c	1.3 b	14.0 bc
P + G in August	3.0 b	3.0 c	2.4 ab	7.0 c
P + U + G in October	3.0 b	3.0 c	2.3 b	9.0 c
DMS	0.1	0.2	1.1	15.5
C.V.	2.1	4.5	34.9	17.0
Significance	***	***	***	*

Averages with different letters along the lines of the columns indicate some significant statistical differences according to the Least Significant Difference test (LSD 0.05)CV: Coefficient of variation, significant to<0.05, <0.01, <0.0001: *, **, ***.
P (pruning), U (urea), G (Girdling), B (Biofol®).

Table 2. Persian lime trees physical, biochemical and yielding analyses.

Treatment	Chlorophyll (Units SPAD)	Specificweigth (mg cm^2)	Total sugar (mg g fresh weight^{-1})	Total protein (mg g^{-1}fresh weight^{-1})	Yield per tree (kg tree^{-1})	Yield (t ha^{-1})
Control	56.8	6.3 bcd	44.9	1.8 c	24.6 c	8.8 c
P in August	53.7	5.6 d	33.5	1.9 bc	9.2 d	3.3 d
P + A in September	54.1	6.0 cd	46.4	2.1 bc	9.5 d	3.4 d
P + U + Gin S	59.9	7.5 a	54.4	3.3 a	57.1 a	20.3 a
P + B + Gin S	56.5	5.8 cd	45.7	2.3 bc	40.1 b	14.4 b
P in September	55.3	6.7 abc	34.5	1.9 c	10.1 d	3.6 d
P + Gin october	57.9	6.0 bcd	41.5	2.3 bc	9.7 d	3.5 d
P + Gin August	59.3	6.2 bcd	26.5	2.4 bc	14.5 cd	5.1 cd
P + U + G in October	57.2	7.0 ab	43.5	2.8 ab	9.1 d	3.3 d
DMS	7.1	1.0	20.2	0.9	10.4	3.7
C.V.	7.6	9.2	28.6	21.2	29.7	29.7
Significance	n s	*	n s	**	***	***

Averages with different letters along the lines of the columns indicate some significant statistical differences according to the Least Significant Difference test (LSD 0.05) C.V. = Coefficient of variation. Significant to <0.05, <0.01, <0.0001: *, **, ***. NS= non-significant. P = pruning, U = urea, G = Girdling, S = september.

concentration (SPAD units) and the total sugars concentration in leaves (Table 2).

We detected significant differences in leaves specific weight due to treatments. The Persian lime trees in which September pruning + urea at 6 % + girdling combined with October pruning + urea + girdling had the highest values of 7.0 and 7.5 mg cm^{-2} (Table 2). Specific weight is an indirect way for photosynthesis estimation (Secor et al., 1982) that indicates, along with high values, a greater accumulation of carbohydrates per foliage area. Therefore, it's possible to explain some citrus physiological relations occurring in the photosynthesis process and increasing fruit setting by obstructing flow through the phloem (Reyes et al., 1999; Iglesias et al., 2007).

Girdling reduces photosynthesis in growing vegetative buds, yet it invigorates fruition bud's formation (Rivas et al., 2007). The results achieved, indicate that application of urea and girdling stimulate a higher specific weight in

Table 3. Content of macronutrients in Persian lime buds.

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Control	1.70	0.13	0.66	2.60	0.20 b
P + U + G in September	1.78	0.16	0.61	2.35	0.26 a
P in September	1.69	0.13	0.60	2.76	0.18 b
DMS	0.32	0.14	0.39	1.35	0.2
C.V.	9.53	15.85	31.18	26.3	6.4
Significance	n. s.	n. s.	n. s.	n. s.	**

[z]: Averages with different letters along the lines of the columns indicate some significant statistical differences according to the Least Significant Difference test (LSD 0.05) C.V. = Coefficient of variation. Significant to <0.05, <0.01, <0.0001: *, **, ***. NS= non-significant. P = pruning, U = urea, G = girdling.

Persian lime leaves. Girdling, on one hand, promotes the accumulation of carbohydrates in the canopy and provides a rich source of nutrients for blooming, setting, growing, and fruit maturity (Goren et al., 2004). This is confirmed, in regards to other treatments, by a concentration of 54 mg g^{-1} of total sugars in leaves with September pruning + urea + girdling (Table 2).

Protein content in Persian lime leaves that had pruning + urea + Girdling during September, combined with pruning + urea + Girdling in October, obtained concentrations of 3.3 to 2.8 mg $g^{-1}$of fresh weight; but the rest of the treatments showed concentrations of 1.9 to 2.4 mg $g^{-1}$of fresh weight. It's shown that grafting trees had the lowest concentration of 1.8 mg g^{-1} of fresh weight (Table 2). A high content of nitrogen in leaves, indicate a greater rate of photosynthesis (Calderón et al., 1997) and therefore, a higher concentration of carbohydrates. Consequently, an adequate concentration of nitrogen and carbohydrates grant to the Mexican lime, a moderated growth and high fruition (Medina et al., 2004).

Yielding. In relation to yield, highly significant differences of it, are proven among treatments. In Persian lime trees with applications of pruning + urea+ Girdling during September, and with pruning +Biofol® + girdling in the same month, fruit yielding per tree was of 57.1 y 40.1 kg; but for the other treatments, fruit yielding was of 9.1 to 24.4 kg $tree^{-1}$ (Table 2).

Yielding per hectare showed the same pattern because it obtained values of 20.3 to 14.4 t ha^{-1} from Persian lime trees with applications of pruning + urea + Girdling during September; and with pruning +Biofol® + Girdling during the same month (Table2).In Mexico, national yielding average is of 14 t ha^{-1}, although in some states like Yucatan and Colima, yielding is above 20 t ha^{-1}. In this trial, only similar yielding to those in the January-April harvest were obtained. By using Girdling and pruning, Mexican lime production went higher (Ariza et al., 2004) and application of bio-stimulants induced onto Mexican lime, its blooming and production as well (Ariza et al., 2015).

Generally, carrying out these activities during August had zero benefits.

Buds nourishment analyses. Nourishment analyses in reproductive buds from each of the assessed treatments, have proven a greater content of N and P in trees that had applications of pruning + urea + girdling. These were not significantly different in trees with pruning and grafting trees(Table3). N (ammonia) promotes bloom to increase, but in general, it alters blooming and leaves when applying it in winter (Lovatt et al., 1988; Menino et al., 2003). Hence its accumulation must be related; also, there were not differences found in K and Ca contents. Content of Mg was higher in trees with applications of pruning + urea + girdling, during September (Table 3).

In trees with applications of pruning + urea + girdling, micronutrients of Cu, Fe, and Zn presented the highest values; consequently, only significant differences were found in Zn (Table 4).

In trees, maximum contents of Mg and Zn are presented due to some cultural practices (pruning and girdling) and applications of urea, which apparently, are related to chlorophyll metabolism and carbohydrates in leaves (Lavon et al., 1995; Patil, 2013). Mechanisms are still unknown.

Physical and biochemical quality in fruit. Persian lime fruit presented a weight between 77.7 and 125.7g (Table5), they also showed highly significant differences among treatments. De Souza et al. (2003) reported a fruit average mass of 64-82g; while Stuchi et al. (2009) stated a fruit average mass of 81.3-96.7g. In addition, evaluated fruits expressed an average weight higher than 97.0 g; fruits in trees with pruning + urea + girdlinghad a weight lower than 80 g (Table 5) in October. Most of fruit mass is related to a more retention time in the tree, since it's been observed an increasing gradient in mass when carrying out

Table 4. Content of micronutrients in Persian lime buds.

Treatment	Cu mg kg^{-1}	Fe mg kg^{-1}	Mn mg kg^{-1}	Zn mg kg^{-1}
Control	30.4	54.9	3580.0	22.70 b
P + U + Gin September	93.8	116.2	4218.0	94.96 a
P in September	73.1	75.35	3512.0	88.46 a
DMS^z	54.58	67.61	1563.0	48.8
C.V.	41.52	41.17	20.7	21.2
Significance	n. s.	n. s.	n. s.	**

^{z}: Averages with different letters along the lines of the columns indicate some significant statistical differences according to the Least Significant Difference test (LSD 0.05) C.V. = Coefficient of variation. Significant to <0.05, <0.01, <0.0001: *, **, ***. NS= non-significant. P = pruning, U = urea, G = Girdling.

Table 5. Persian lime fruit quality (physic and biochemical) with cultural practices and bio-stimulants.

Treatment	Mass of the fruit (g)^z	Polar diameter (mm)	Equatorial diameter (mm)	Juice (%)	Titratable acidity(%)
Control	109.4 ab	68.2	55.9 b	50.9	5.9 c
Pin August	111.8 ab	68.3	56.6 ab	50.1	6.3 bc
P + g in September	110.8 ab	68.5	56.0 b	46.9	6.3 bc
P + U + Gin September	107.7 ab	74.0	56.0 b	50.5	6.0 bc
P + B + G in September	110.5 ab	67.7	56.3 b	51.3	6.0 c
P in September	97.8 b	65.5	53.9 b	53.3	6.1 bc
P + G in October	99.5 b	64.9	54.6 b	48.7	6.5 b
P + G in August	125.7 a	74.9	59.8 a	50.1	6.0 bc
P + U + G in October	77.7 c	59.2	50.5 c	46.8	6.9 a
DMS^z	105.6	7.9	3.2	6.1	0.4
C.V.	19.5	6.9	3.4	7.1	4.0
Significance	**	n. s.	**	n. s.	**

^{z}: Averages with different letters along the lines of the columns indicate some significant statistical differences according to the Least Significant Difference test (LSD 0.05) C.V. = Coefficient of variation. Significant to <0.05, <0.01, <0.0001: *, **, ***. NS= non-significant, . P = pruning, U = urea, G = Girdling

treatments practices in August>September>October (Table 5).

No significant differences were detected in the polar diameter but they did show, for the equatorial diameter, highly significant differences among treatments (Table5).It proved values between 50.5 to 59.8 mm that are classified as 230 gauge (Curti et al., 2012).No differences were detected as a result of the assessed treatments containing 50.5 and 59.8 percent juice (Table5); this is why, it's advised to harvest Persian lime trees with 45% juice or more (Alía et al., 2011 b; Ladaniya, 2008).

In fruit juice titratable acidity, significant differences were detected. That being said, grafting trees presented a lower acidity of 5.9% in comparison to fruits of trees that gave the highest titratable acidity of 6.9% because they were, during October, applied with pruning + urea + girdling (Table5). Various trials describe values of 5.7 to 6.4% (Stuchi et al., 2003) and 5.25 to 6.98 % (Lye et al., 2003) as titratable acidity. Results suggest that, despite any treatment affected titratable acidity, values in Persian lime turned out to be similar to those reported by other authors.

Total soluble solids and titratable acid (TSS/TA) relation, and color components were not affected by assessed treatments (Table6). However, soluble solids were in concentrations of 7.6 to 8.7°Brix, which are within the values of 7.3 and 8.9 °Brix that other researchers reported (Stuchi et al., 2003; Lye et al., 2003; Stuchi et al., 2009).TSS/TA relation showed values of 1.1 to 1.3 which are similar to those given by Stuchi et al.(2003).

Color components (Table 6) point out that Persian lime fruit tend to be colored-green (h= entre103.2 y 106.7), pure (C*= entre 39.5 y 44.7), and moderately shiny (L*= entre

Table 6. Persian lime fruit quality with cultural practices and bio-stimulants.

Tratamiento	Total soluble solids(°B)	Relation SST/AT	L*	C*	h
Control	7.6	1.2	52.9	42.0	106.7
Pin August	7.6	1.2	53.1	42.7	106.6
P + G in September	7.6	1.2	54.5	41.2	104.2
P + U + G in September	8.1	1.3	54.0	41.6	106.0
P + Biofol® + G in September	7.8	1.3	52.0	39.5	106.6
P in September	7.7	1.2	55.8	41.7	103.2
P + Gin October	7.6	1.1	51.5	40.2	107.8
P + G in August	6.7	1.1	54.5	44.7	106.2
P + U + G in October	8.7	1.2	51.6	40.8	106.2
DMS	1.0	0.16	5.5	5.5	2.4
C.V.	8.1	7.5	7.7	7.7	1.3
Significance	n. s.	n. s.	n. s.	n. s.	n. s.

NS= these were not statistical significant to results from obtained values. P = pruning, U = urea, G = Girdling

51.5 y 55.8).These values are lower than those given by Lye et al.(2003) in Persian lime from Brazil because this green-color indicates a more opaque one (h= 120 y C*= 31.5).

CONCLUSION

Pruning, application of urea and girdling, invigorate flowers' budding and fruit setting in Persian limeduring September. Under environmental conditions and soil, they favor winter production in Morelos as well as the accumulation of N, P, Mg and Zn. Pruning, application of urea, and girdling, invigorate quality in Persian lime produced in winter.

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