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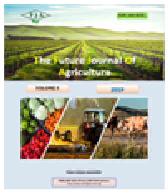

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EFFECT OF PURE UREA AND LISOPHOSPHATIDYLETHANOLAMINE ON MITIGATING THE ADVERSE CONSEQUENCES OF DELAYING HARVEST OF "VALENCIA" ORANGES

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ABSTRACT: Harvest delay of "Valencia" orange fruits has been a common practice of many citrus growers and producers. Late harvest of ripe oranges may extend to May or June. Many problems are associated with such delay, which reflect on reducing flowering and fruit set of the next season's crop. There is a possibility of regreening, in addition to the change in the taste due to the change in the TSS to acidity ratio. This study was conducted during the two successive seasons 2017 and 2018 in Badr district, Al-Buhaira Governorate, Egypt to deal with the consequence of harvest delay. Trees were sprayed to the run off by using pure urea of 0.5 or 1% (w/v), Lysophosphatidylethanolamine (LPE) at 50 or 100 ppm and their combinations the surfactant Top film was added to all treatments (at 1% v/v). Spray was done on the first week of December with a second spray on the first week of January in both seasons. Briefly, the data indicated to a significant increase in fruit set, especially with the application of LPE at 100 ppm combined with urea at 1%. Meanwhile, the least fruit abscission was obtained with the same mentioned combination as well as the greatest fruit retention. Fruit physical characteristics were enhanced in terms of fruit weight and size as well as the pulp weight by the combinations of LPE at 50 or 100 ppm plus urea at 1%. Furthermore, the mentioned combinations were effective on enhancing many chemical characteristics at harvest such as TSS and reduced acidity, as well as the carotene content in the rind and the juice. Thus, this study provided some feasible treatments that could be adopted on afield scale to deal with the consequences of delaying harvest of "Valencia" oranges.

Key words: Valencia, Lysophosphatidylethanolamine (LPE), urea, fruit set, quality

INTRODUCTION

Valencia" oranges have been considered as one of the main citrus varieties in Egypt. The fruit is demanded by consumers in Egypt and in many countries around the world. The rare- ripe citrus fruits during the marketing season especially during May and June attract consumers. It is also called the summer oranges due to their late appearance in the market. Moreover, the fruit is juicy, contains few seeds, with appealing taste and color, in addition to its high soluble solids content that ranges between 12.5 to 19.5% **(Matthews,1994).** The Egyptian "Valencia" orange fruit production was estimated to be 3197046 tone **(FAO, 2019).**

Due to the low risk of fruit abscission, most producers delay the harvest of "Valencia" oranges by storing the fruits on the tree. later harvest of "Valencia" fruits lead to better volatiles profile as a result of the concentration of a number of key secondary metabolites appearing at higher levels. Glucose is increasing, but other sugars are constant from March to May in "Valencia" pulp **(Watkins *et al*., 2005).** Citrus harvested at the optimum maturity stage have higher quality and higher demand **(Caixeta-Filho, 2006).**

In spite of the drawbacks of delaying harvest of "Valencia"oranges such as changing the TSS to acidity ratio, reducing the subsequent year's yield due to the competition of more sinks on the tree, such as the new leaves (new flush) nutrition stress and increasing the competition between mature and developing fruits (sinks). The total seed content of delayed harvested- fruits means more gibberellin content, which can adversely affect floral induction of the next season as well as the increased competition for carbohydrate among various sinks. Some evidence has been provided **(Al- Hassan, 2013)** in favor of late harvest thinking that improved fruit weight as compared with mature fruits. Furthermore, **(Hilgeman *et al*., 1967)** declared that the percentage of No.1 grade fruits was always higher in fruits harvested on February than May. The scientific debate around the convenient time of harvest lead us to find a new approach to alleviate the negative impacts of late harvest of "Valencia" oranges. Since Lysophosphatidylamine has been reported to delay tissue senescence and to maintain the integrity of the plasma membrane **(Farag *et al*., 2019)** and to reduce the injuries of abiotic stresses **(Farag and Palta, 1993).**

Meanwhile, pure urea by the end of stressful season was reported to compensate the nutritional status, so the objectives of this research could be summarized in the following points:

1- To assess the drawbacks of harvest delay of "Valencia" oranges quality and fruit set of the next season.
2- To provide citrus growers, especially "Valencia"oranges with safe and applicable treatments to enhance, quality in spite of the delay.
3- To provide the farmers with a production system that could be adopted on a commercial scale by "Valencia" orange producers.

MATERIALS AND METHODS

The present study was performed during the two successive seasons 2017 and 2018 using "Valencia" orange trees (*Citrus sinensis* L.). Trees were 8 years old spaced at 5×6 m and budded on "Volkamer" lemon rootstock (*Citrus volkamariana*). The trees were grown in Elbana farm at Badr district, Al-buhaira governorate, Egypt. Soil texture was sandy and drip irrigation system was adopted. In order to pursuance this investigation, thirty-six uniform trees have been receiving standard agricultural practices and free as possible from physiological disorders or visible pathological problems were selected.

At field work: Nine treatments were applied to 36 trees randomly selected and four replications were used for each treatment. These treatments included: Water as the control; Urea 0.5%; Urea 1%; Lisophosphatidylethanolamine (LPE) 50 ppm; LPE 100 ppm; LPE 50 ppm + urea 0.5%; LPE 50ppm + urea 1%; LPE 100 ppm + urea 0.5% and LPE 100ppm + urea 1%. Trees were sprayed to the run off point in December 1st 2016, 2017 and January 1st 2017 and 2018 during the two seasons, respectively. The non-ionic surfactant Top Film at 0.05% (v/v) was added to all treatments to reduce the surface tension and increase the contact angle using a hand sprayer.

Assessment of fruit set, abscission rate and retained fruits

The number of flowers on five branches (1.5 cm in diameter) located at the northern half of each tree was counted on April 1st, the number of fruit set on May 1st, and the number of retained fruits on June 10th, then the fruit set and abscission rate were calculated as percentage of the initial number of fruit set using the following equation:

$$\text{Fruit set \%} = \frac{\text{Number of fruit set on May}}{\text{Number of flowers on April 1 st}} \times 100$$

$$\text{Abscission rate \%} = \frac{\text{Number of fruit set on May} - \text{number of retained fruits on June}}{\text{Number of fruit set on May}} \times 100$$

At laboratory work

Fruit quality parameters

Five fruits per each replicate were randomly picked on April 28, and exposed to the following physical and chemical assessments.

Physical characteristics

The average weight of five fruits was utilized as representative sample for each replication (tree) by using a digital analytical balance to determine fruit weight (g). Fruit size (cm^3) was measured by using a graduated cylinder and average volume of five fruits was recorded. Pulp weight (g) was measured by utilizing a digital analytical balance. Moreover, the average juice volume of five fruits (cm^3) was measured by using a graduated cylinder.

Chemical characteristics

- Total soluble solids content (TSS as Brix) was estimated using Galli 110 refractometer according to **A.O.A.C. (2000).**

- The titratable acidity in the fruits juice was assessed as citric acid by titration with 0.1 N sodium hydroxide after adding a few drops of phenolphthalein as an indicator according to **A.O.A.C. (2000).**

- TSS to acidity ratio was calculated.

- Carotenes of the rind and juice were extracted with acetone-hexane mixture and determined with a spectrophotometer at wavelength 440 n.M as described by **Dubois *et al. (*1956).**

- Total carbohydrates content of leaves was extracted and measured according to the method described by **Sadasivam and Manickam (1996).**

Statistical analysis

The data of this study were arranged in a randomized complete blocks design (RCBD). All obtained data of the measured parameters were subjected to computerized statistical analysis using **Costat (2006)** program for analysis of variance (ANOVA) and means of treatments were compared using LSD at 0.05 level of possibility **(Snedecor and Cochran, 1980).**

RESULTS

Fruit set

The effect of various applied treatments on "Valencia" orange fruit set percentage was determined during June of the two seasons. The data in Table 1 showed that the least fruit set % occurred in the control in a consistent manner in both seasons. Meanwhile, the highest percentage of fruit set was achieved by the combination of LPE at 100ppm plus urea at 1%. In addition, there were other effective treatments that resulted in significant increases in fruit set % as compared with the control in both seasons such as the combinations of LPE (100 ppm) plus urea (0.5%) as well as LPE (50ppm) plus urea (1%). Furthermore, the individual application of LPE at 100ppm or 50ppm was able to increase fruit set non significantly in both seasons than the control. On the other hand, the application of urea led to a significant increase in fruit set in both seasons.

Fruit abscission and remaining fruits

The data in Table 2 indicated the responses to applied treatments in terms of the magnitude of fruit abscission and the percentage of "Valencia" oranges retention during 2017 and 2018 seasons. It was obvious that the greatest fruit abscission occurred in the control trees ranging approximately between 80 and 90%. Moreover, the two used concentrations of LPE were equally effective in reducing fruit abscission during both seasons. The magnitude of the fruit abscission did not significantly vary when comparing the effectiveness of urea alone and LPE alone of the used concentrations except with urea at 1% in the first season that resulted in less abscission than other individual treatments. Meanwhile, the least abscission occurred with the application of the combination LPE at 100ppm plus urea at 1% or the combination of LPE at 50ppm plus urea at 1%. However, both mentioned combinations were similar in both seasons on their influence on the percentage of abscission rate. When urea at 0.5% replaced urea at 1% in the last two mentioned combinations, there were still a significant reduction in fruit abscission specialty with LPE at 100ppm plus urea at 0.5% in the first season. Thus, it could be concluded that all applied treatments were able to reduce "Valencia" orange abscission when compared with the control with varying magnitude of reduction.

Table 1. The effect of pure urea, lysophosphatidylethanolamine (LPE) and their combinations on fruit set of "Valencia" orange fruits in the two successive seasons 2017 and 2018

Treatments	Fruit set (%)	
	2017	2018
Control	7.74e*	7.44d
Urea(0.5%)	10.10cd	11.45bc
Urea(1%)	9.09cde	10.74bcd
LPE (50ppm)	7.55e	9.11bcd
LPE (100ppm)	8.38de	8.43cd
LPE (50ppm) +Urea (0.5%)	9.09cde	9.27bcd
LPE (50ppm) +Urea (1%)	10.83c	12.21ab
LPE (100ppm) +Urea (0.5%)	12.66b	12.48ab
LPE (100ppm) +Urea (1%)	17.67a	15.08a

* Comparison of the means of various treatments, within each season, was done based on the Least Significant Difference (LSD) at 0.05 levels.

On the other hand, fruit retention percentage (Table 2) showed that the greatest fruit retention was achieved by the application of the combination of LPE (at 100 ppm) plus urea (at 1%). Meanwhile, fruit retention of the control ranged between 1-2%. Even when LPE concentration was reduced to 50ppm, it was able to significantly increase fruit retention when urea 1% was combined with it in both seasons.

However, urea alone at 0.5% did not result in any significant difference than the control. That was the case with other individual treatments except LPE alone at 100 ppm and urea at (1 %) in the first season which increased fruit retention as compared with the control. The combinations of LPE at 100ppm or 50ppm plus urea at 0.5% in both seasons resulted in inconsistent increase of fruit retention as compared with the control.

Table 2. The effect of pure urea, lisophosphatidylethanolamine (LPE) and their combinations on abscission rate and remaining fruits of "Valencia" orange in the two successive seasons 2017 and 2018

Treatments	Abscission rate (%)		Remaining fruits(%)	
	2017	2018	2017	2018
Control	93.15a*	82.71a	1.00 d	1.25c
Urea(0.5%)	79.40b	78.44ab	3.00 cd	3.00 c
Urea(1%)	60.72c	74.15b	9.50 ab	3.25c
LPE (50ppm)	79.64b	80.38ab	5.75bcd	2.75c
LPE (100ppm)	74.79b	75.47ab	6.75bc	5.75bc
LPE (50ppm) +Urea (0.5%)	71.75b	64.69c	6.00 bdc	12.25b
LPE (50ppm) +Urea (1%)	58.68c	54.66d	8.00 bc	7.50 bc
LPE (100ppm) +Urea (0.5%)	53.91c	63.31c	13.25a	6.75bc
LPE (100ppm) +Urea (1%)	54.24c	54.57d	13.75a	20.75a

* Comparison of the means of various treatments, within each season, was done based on the Least Significant Difference (LSD) at 0.05 levels.

Physical characteristics

Fruit weight

The data in Table 3 revealed the response of fruit weight, at harvest to various treatments in the two seasons. It was evident that there was a significant increase in fruit weight by some treatments as compared with the control. The greatest increase in fruit weight was obtained with the combination of LPE at 100 ppm plus urea at 1%, followed by combination of LPE (at 50ppm) plus urea (1%). The individual applications of urea (at0.5 or at 1% w/v) resulted in greater fruit weight than the control, especially in the second season. Even though, the combination of LPE (100ppm) plus urea at 0.5% resulted in greater fruit weight than the control in both seasons. With regard to the effect of LPE at 50ppm plus urea at 0.5%, there was noticeable increase in fruit weight especially in the second season when compared with the control.

Fruit size

The response of fruit size of "Valencia" oranges to urea and LPE treatments

was reported in Table 3. The data indicated to a significant increase in fruit size by the applications of the formulations containing LPE plus urea, especially the combination of LPE (100 ppm) plus urea at 1%. Similar trend of results was obtained with the combination of LPE at 50ppm and urea at 1%and the combination of LPE (at 50 ppm) plus urea (at 0.5%). However, the increase of fruit size was significant only in the second season with the individual application of LPE either at 100ppm or at 50ppm. Urea, on the other hand, resulted in a significant increase in fruit size relative to the control in both seasons. Meanwhile, the greatest and most consistent increase in fruit size was achieved by the combination of LPE (at 100 ppm) plus urea (at 1%).

Pulp weight

With regard to the changes in pulp weight in response to different urea and LPE treatments, the data in Table 3 showed that all used treatments in the first season had similar pulp weight except the combination of LPE (100 ppm) plus urea (1%) that resulted in significantly greater pulp weight than that of the control treatment. However, in the second season, all treated fruits had a significant increase in pulp weight as compared with the control. However, the greatest magnitude of increase was still obtained with the combination of LPE (at 100ppm) plus urea (at 1%). If we compare the variations among used treatments in the second season, it was obvious that the sole application of a compound was less effective than the combination treatments.

Juice volume

Changes in juice volume in "Valencia" oranges as influenced by various applied treatments during the two seasons 2017 and 2018 were reported in Table 3. The data revealed that there was a superior influence of the combination of LPE (100 ppm) plus urea (at 1%) on increasing juice volume relative to the control and to all other used treatments in the two studied seasons. This desired effect was also obtained by the application of LPE(50ppm) plus urea (1%) but was still less than that obtained with the former combination in a consistent manner in both seasons. However, LPE or urea were used singly, there was no significant difference between juice volume of LPE at 100 or 50 ppm or urea at 0.5 % and the control in the first season. However, urea at 1%resulted in a significant increase in such volume as compared with the control during the two seasons (Table3). In addition, the combination of LPE (at 100 ppm) plus urea (at 0.5%) was also effective on increasing juice volume but to less extend than that found LPE (at 100 ppm) plus urea (at 1%) and less than LPE (50 ppm) plus urea (1%) in the two seasons.

Chemical characteristics

Total soluble solids (TSS)

The effect of various applications on the total soluble solids of "Valencia" oranges at harvest was shown in Table 4. The data indicated to a significant increase in TSS by the application of the combination containing LPE (at 100ppm) plus urea (at1%)in both seasons compared to the control and all other used treatments. Moreover, in a similar trend, the combinations of LPE at 50 ppm plus urea at 0.5or1% and LPE at 100 ppm plus urea at 0.05 %, respectively resulted in a significant increase of the TSS of "Valencia" oranges but to lesser magnitude when compared with LPE at 100 ppm plus urea at 1%. Meanwhile, when LPE was used alone failed to increase TSS% significantly during the first season, in the first season as compared with the control. However, spraying urea alone resulted in a significant increase in TSS, whether at0.5% or at1%. Thus, it is preferred to use LPE in combination with urea to increase the TSS in "Valencia" oranges since they all resulted in greater TSS values relative to the control.

Table 3. The effect of pure urea, lysophosphatidylethanolamine (LPE) and their combinations on some physical characteristics of "Valencia" orange fruits in the two successive seasons 2017 and 2018

Treatments	Fruit weight (g)		Fruit size (cm^3)		Pulp weight (g)		Juice volume(cm^3)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	168.50c*	213.80i	150.00e	153.05i	113.75b	152.81i	69.75f	91.18i
Urea (0.5%)	179.50c	234.54f	200.00cd	180.96f	173.00ab	179.21f	78.50ef	107.18f
Urea (1%)	182.75c	243.65e	220.00bc	187.61a	180.5ab	187.47e	80.00de	112.77e
LPE(50ppm)	169.25c	221.04h	160.00de	163.05h	119.17b	161.93h	72.25ef	96.52h
LPE(100ppm)	179.25c	227.61g	176.25de	171.96f	149.75b	171.04g	73.25ef	100.56g
LPE(50ppm)+Urea(0.5%)	191.75c	247.99d	236.25bc	197.13d	191.50ab	198.20d	86.50cd	117.40d
LPE(50ppm)+Urea (1%)	236.70b	261.90b	303.75a	216.06b	208.00ab	215.28b	107.50b	128.07b
LPE(100ppm)+Urea(0.5%)	219.75b	254.40c	257.50b	206.70c	193.75ab	205.02c	91.75c	122.96c
LPE(100ppm)+Urea(1%)	299.25a	268.07a	313.75a	223.91a	262.00a	224.68a	127.75a	133.93a

* Comparison of the means of various treatments, within each season, was done based on the Least Significant difference (LSD) at 0.05 levels.

Titratable acidity

The response of juice acidity of "Valencia" oranges to used treatments was reported in Table 4. The results revealed that the trees received LPE at100 ppm and urea at1%in combination present the highest total acidity in fruit juice, the data were true during the two seasons. Similar trend but with less magnitude was obtained with the formulation of LPE at 50ppm plus urea at1%. Furthermore, LPE alone at 50 and 100ppm had similar influence on fruit acidity since they resulted in similar effect to the control in the first season while they were able to increase acidity in a significant way in 2018 season when compared with the control. However, urea alone either at 1% was able to increase fruit acidity consistently in both seasons relative to the control.

TSS / acidity ratio

The effect of various applied treatments on the TSS to acidity ratio of "Valencia" oranges juice was reported in Table 4. The data revealed that there was a significant increase in such ratio by the application of LPE (at100ppm) plus urea (at1%) which was followed by the application of LPE (at 50ppm) plus urea (at1%). However, the difference between the two formulas was significant in both seasons. Moreover, the two individual treatments of urea at 0.5% or1% resulted in similar influence on the ratio of TSS to acidity in the two seasons .Meanwhile, the two LPE individual treatments at 50ppm or at 100ppm in the first season did not vary in their influence on the TSS to acidity ratio while in the second season, LPE at 100ppm caused a significant increase more than that of LPE at 50ppm.However the formulation containing LPE at50ppm plus urea at 0.5% was still effective on increasing TSS/acidity ratio more than the control.

Carotenes content in the rind

Regarding to the effect of various applications on the content of carotenes in the rind during the two studied seasons, the data in Table 5 indicated that all treatments resulted in a significant increase in carotene of the rind except with LPE at 50 ppm as compared with control. The greatest increase in rind carotene was found with the combination treatment that contained either LPE at 100ppm or at 50ppm, each plus urea at 1% followed by LPE at 50 ppm plus urea at 0.5%. Meanwhile, LPE at 100ppm alone, urea at 0.5% or urea alone at1%each of them was able to cause a significant increase in rind carotene in both seasons as compared with the control. Furthermore, all applied combinations of LPE plus urea were equally effective on rind carotenes except with application of LPE at50ppm plus urea at 0.5% that resulted in less magnitude of increase than those reported for other combinations.

Table 4. The effect of pure urea, lysophosphatidylethanolamine (LPE) and their combinations on TSS, acidity and their ratio of "Valencia" orange fruits in the two successive seasons 2017 and 2018

Treatments	TSS(%)		Acidity(%)		TSS/acidity (ratio)	
	2017	2018	2017	2018	2017	2018
Control	9.32d*	11.57i	0.98e	1.07f	7.74e	8.16g
Urea (0.5%)	9.92c	12.16f	1.05cde	1.18e	9.27c	9.61d
Urea (1%)	10.00c	12.36e	1.07cd	1.24d	9.28c	9.93d
LPE(50ppm)	9.52cd	11.74h	1.01de	1.13e	8.35de	8.77f
LPE(100ppm)	9.75cd	11.95g	1.04cde	1.13e	8.79cd	9.17e
LPE (50ppm) +Urea (0.5%)	10.02c	12.59d	1.08cd	1.26cd	9.32c	10.65c
LPE (50ppm) +Urea (1%)	11.05b	12.96b	1.20b	1.34b	10.56b	11.45b
LPE (100ppm) +Urea (0.5%)	10.02c	12.75c	1.11c	1.30bc	9.67c	11.21b
LPE (100ppm) +Urea (1%)	11.85a	13.22a	1.29 a	1.41a	11.28a	12.33a

* Comparison of the means of various treatment, within each season, was done based on the Least Significant Difference (LSD) at 0.05 levels.

Carotenes content in the juice

The response of carotene content in the juice to various applied treatments is shown in Table 5. It was obvious that almost all treatments were able to significantly increase these carotenes except only LPE alone at 50 ppm that resulted in similar content to that found in the control. Moreover, the individual treatments were also able to increase carotene of the juice whether urea at 0.5% or at 1% or LPE at 100 ppm. In addition, the combination of LPE at 100ppm plus urea at 1% resulted in the greatest increase in juice carotenes.

Leaf carbohydrate content (%)

The influence of various used treatments on leaf content of carbohydrates at harvest of "Valencia" orange trees was show in Table 5. The data revealed that most treatments were able to significantly increase carbohydrate content in the leaf in both seasons. However, the greatest increase was found with the application of LPE at either 50 or 100 ppm combined with urea at 1% in both cases. Furthermore, the individual treatments of LPE or urea were also effective on increasing carbohydrate content except with LPE at 50 ppm that had similar influence to that obtained by the control. Urea at 1% was more effective than urea at 0.5% in a significant manner in both seasons.

Table 5. The effect of pure urea, lysophosphatidylethanolamine (LPE) and their combinations on carotenes in rind and juice as well as carbohydrate in leaves of "Valencia " oranges during the two seasons 2017 and 2018

Treatments	Carotene in rind (mg/100g)		Carotene in juice (mg/100g)		Carbohydrate in leaves (%)	
	2017	2018	2017	2018	2017	2018
Control	3.86 d*	4.25 d	1.41d	1.73 e	28.14 d	30.03 e
Urea(0.5%)	4.39 c	4.80 c	1.87 c	2.18 d	29.34 bc	31.21d
Urea (1%)	4.53 bc	5.03 bc	2.08 bc	2.36 cd	30.72 a	32.16 bc
LPE(50ppm)	4.05 d	4.43 d	1.58 d	1.88 e	28.55 cd	30.03 e
LPE(100ppm)	4.49 bc	4.99 bc	2.06 bc	2.32 cd	30.13 ab	32.00 cd
LPE (50ppm) +Urea (0.5%)	4.69 b	5.19 b	2.32 b	2.46 cd	30.14 ab	31.95 cd
LPE (50ppm) +Urea (1%)	5.06 a	5.54 a	2.53 a	2.58 bc	31.19 a	32.93ab
LPE (100ppm) +Urea (0.5%)	5.05 a	5.59 a	2.56 a	2.78 ab	30.54 ab	32.30 bc
LPE (100ppm) +Urea (1%)	5.25 a	5.78 a	2.70 a	2.91 a	31.43 a	33.16 a

*Comparison of the means of various treatment, within each season, was done based on the Least Significant Difference (LSD) at 0.05 levels.

DISCUSSION

Since harvest delay of "Valencia" oranges became a common practice by many citrus growers on a large scale especially in the Egyptian farms, it was necessary to assess the benefits and drawbacks of this delay. Farmers and producers keep the ripe "Valencia" orange fruits on the tree for many months to gain higher prices in the market and hoping for an increased fruit quality without worrying about the abscission of ripe fruits from trees. This producer practice is based on their observations. However, it was evident that the abscission of citrus fruits represents a problem after fruit set and through the period until June drop, preharvest fruit drop is not a problem for growers as it is the case with apple or pear fruits.

Moreover, the concept of taste life is not a well comprehended concept which means the changes of some acids in the rind or the segments to sugars by the gluconeogenesis process is not taken into consideration by "Valencia" growers.

In addition, since the process of floral induction in "Valencia" orange tree especially in arid agriculture in the Egyptian desert starts early in November of the previous season while the main crop still under the ripening processes. That reflect on excreting a nutritive stress in the tree that is carrying mature and ripe fruits of the previous season, flower buds either at the induction or at the differentiation stages, in addition to the new vegetative growth and new roots of the new season.

It results a very stressful- nutritive conditions that reflect on the greater nutritive load on all types of loaded fruits. Thus, it was logic to find a positive influence of pure urea in this study since it is required to compensate for the deprivation of the tree. This compensation was reported to occur by the application of urea alone **(Albrigo, 1999)** or by the addition of the NPK before the flowering of the season **(EL-Otmani *et al.* 2000).** The addition of urea to the heavily loaded tree was also evident in olive trees, especially by the end of the “ON” season **(Cuevas *et al.*, 1994).**

On the other hand, the use of lysophosphatidylethanolamine (LPE) as the compound of vigor enhancement has been utilized in the relatively new years since its discovery in the USA by **Farag and palta (1992 and 1993)** and **Farag *et al*. (2003)** as it provided evidences for the delay of plant tissue senescence and enhancement of plant vigor and even delaying flowering, ageing and retarding fruit abscission. It was also reported that was able to inhibit phospholipase D that is responsible for the degradation of the plasma membrane **(Ryu *et al*., 1995).**

Aforementioned provided further evidence for the wise use of urea and LPE to mitigate the adverse consequences of harvest delay of “Valencia” oranges to face the reduction of tree vigor ascribed to the heavy load and late picking.

Such positive effects of this research treatments were indicated by the significant increase of fruit set by LPE (100ppm) plus urea (1% w/v) and by increased fruitlet retention and reduced abscission as compared with the control. Fruit quality was improved by the same combination such as fruit size and juice volume even at LPE at 50 ppm plus urea at 1% even the individual treatments of pure urea or LPE (at 50 or 100 ppm), each was effective on increasing fruit size and juice volume by urea at 1% or the increase in the TSS/acidity by LPE (at100 ppm). The combination of LPE plus urea was even more effective on enhancing TSS to acidity and juice carotenes. Moreover, carbohydrate content in the lab was increased by either LPE at 50 or at 100 ppm/plus urea, at 1%. All the aforementioned examples are explained by the enhanced real vigor and by increased source vigor as a result of LPE applications.

The increase in many other nutrients by the combination treatments, especially LPE (at 50 or 100 ppm) plus urea (at 1%) such as potassium and phosphorus further explain the increase in carbohydrates, the carotenes in the rind and the juice.

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