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Effect of Foliar Applications with Urea and Yeast Extract on the Vegetative and Floral Buds, Leaf Ammonium Content, Flowering Behavior, Fruiting and Fruit Quality of Washington Navel Orange Trees.

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THE PRESENT investigation was conducted during 2014 and 2015 seasons to study the influence of foliar sprays with urea and yeast extract on vegetative and floral buds , leaf ammonium, fruit set, yield and fruit quality of 35- years old Washington navel orange trees on sour orange rootstock. Results revealed that a combination of urea plus yeast on Jan.,15, achieved the highest number of vegetative buds per branch and produced significantly the highest number of fruit set / branch and achieving an increase in fruit number per tree, average fruit weights and fruit yield compared with other treatments. Single foliar application of urea in mid-January, significantly increased leaf ammonium concentrations and the total number of inflorescences (leafy had more flowers, one or two flowers) and leafless inflorescences. Trees sprayed with urea plus yeast on Feb., 15 and these sprayed with urea on Feb. , 15 have improved fruit size. Moreover, spraying trees with the two compounds, in mid-Jan. and mid-Feb. increased fruit and pulp weights, whereas , those sprayed with a mixture of urea plus yeast extract in mid-Jan. or urea in mid-Feb., produced fruits with significantly higher juice percent and almost improved chemical fruit properties. Fruit nitrate and nitrite contents were in permitted limits due to foliar urea and yeast application. In addition, urea plus yeast extract, in mid-January and mid-February resulted in fruits having the lowest contents of nitrate and nitrite and similarly as the control.

Keywords: Inflorescences (leafy & leafless), Washington navel orange, Leaf ammonium, Fruit nitrate ($NO3^{-}$) and nitrite ($NO2^{-}$) contents.

Introduction

Citrus production, nowadays, occupies a key position in the prominent economic importance of world fruit industry. No doubt, Washington navel oranges play an important role in agricultural production and world›s economy. In Egypt, both navel and Valencia oranges are considered as the most wide spread varieties planted especially in the newly reclaimed area. The total area occupied by citrus in 2015 accounted to 533835 with a total production of 4646579 tons of fruits. From such area , that Washington navel orange trees, representing about 33.70% of total citrus area and about 36.53% of the total production of citrus (Annual Book of Agricultural Statistics,2015).

Noteworthy, the enormous demands of citrus fruit for both local consumption and exportation implies a great interest for increasing trees yield, orchards productivity and fruit quality, with reduced fruit contents of the chemical residues. Certainly, the true challenge seemed to be in finding out and experimenting a new cultural practice which is easy, economical , safe and promising through foliar applications of urea and dry yeast extract at proper time of flower bud induction and initiation which might participate in the fulfillment of this goal. Pre -bloom (January or February) foliar application of nitrogen as low-biuret urea at flower bud physiological initiation and morphological differentiation significantly increased fruit yield per tree for each of three consecutive years of Satsuma mandarin, Washington navel orange, Balady mandarin and Valencia orange trees (Liu & Liu 1998, Lovatt 1999 a, El-Tanany 2003 and El-Tanany & Abdel Messih 2009), respectively.

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Numerous investigators have been conducted over the last years to determine the physiological factors controlling induction, initiation and differentiation of flower buds in citrus. Davis and Albrigo (1994) pointed out that among the most likely controlling factors are nutrition, carbohydrates, hormones, temperature and water relation. They also reported that nitrogen, as ammonium obtained from urea foliar sprays, may directly affect flowering in citrus trees via biosynthesis of polyamines levels. Ali and Lovatt (1994) and Lovatt (1999a) agreed that elevating the leaf ammonium levels in citrus trees artificially by winter urea foliar application stimulate specific physiological processes affecting induction and initiation and causing an increase in flowering, fruit set and yield.

Moreover, the various positive effects and benefits of applying active dry yeast as a bio-fertilizer or bio stimulant were attributed to its own different nutrients, great amounts of vitamin B1, B2, and B6 and cytokinin as a natural plant hormone (Kafagy et al., 2010 and Thanaa et al., 2015). Undoubtly, foliar applications of urea solution (as a source of ammonium) with dry yeast extract (as a source of natural cytokinin) prior to and / or during floral induction and initiation might help in increasing the flowering and yield productivity of the citrus trees.

Therefore, the present study aimed mainly to evaluate the influence of foliar sprays of urea and dry yeast extract either alone or in combinations on flowering behavior, fruiting , leaf chemical composition and fruit quality of Washington navel orange trees. Also, to produce fruits with minimum health hazards safe from nitrate (NO_3) and nitrite (NO_2) valid for exportation.

Materials and Methods

The present study was carried out during 2014 and 2015 growing seasons on thirty five years old Washington navel orange trees (*Citrus sinensis, Osbeck*) budded on sour orange rootstock grown sandy soil in a private orchard located at Zaweit Hamour village, Boustan area, El-Behira governorate, Egypt. The selected trees were nearly uniform in vigor and size, spaced at 5x5 m a part and receiving the same horticultural practice usually adopted for this area according to the Horticulture Research Institute recommendations. Drip irrigation system is used in the orchard. The foliar sprays were as follow:

- Control (sprayed with water).
- Urea at 2% on January,15.
- Yeast extract at 0.4% on January, 15.
- Urea at 2% plus yeast extract at 0.4% on January, 15.
- Urea at 2% on February, 15.
- Yeast extract at 0.4% on February,15.
- Urea at 2% plus yeast extract at 0.4% on February,15.
- Urea at 2% plus yeast extract at 0.4% on January, 15 and February.

Four trees per replicate were selected to represent each treatment. Different treatments were applied using a 20 liters hand sprayer on the foliage until drip point of the solution. Each tree received (6 liters i.e 120 gm. commercial urea with low-biuret 46.5 N% and 24 gm. active dry yeast) per tree. Active dry pure yeast powder was activated by using source of carbon and nitrogen with the ratio 6:1 according to Barnett et al (1990). This ratio is suitable to get the highest vegetative production of yeast (each ml yeast contained about 12000 of yeast cells), and then the media was frozen and thawed directly before using. Tween 20 was added as spreading agent. Guard rows were left around the trees of each spray treatment.

Leaf analysis

Leaf samples of 20-30 full-expanded mature leaves were taken from non-fruiting shoots of the previous spring growth flushes. The leaves were collected from all over the circumference of each tree. Leaf samples were taken at fruit ripening, in September of 6 months of each season. The samples were used for ammonium and total nitrogen determination. Ammonium was extracted from 0.5gm.ground dry material using the procedure suggested by Ali and Lovatt (1995) and calorimetrically determined by Neslar method according to A.O.A.C. (1995). For total nitrogen determination, 0.3gm.ground dry material was digested according to Evenhunis and DeWaard (1980). Nitrogen in the digested solution was calorimetrically determined according to Evenhunis (1976).

The number of floral and vegetative buds

At March, 9 of 2014 and 2015 seasons, two branches (4-5cm circumference) located at two different directions (in north east and south west) were tagged from the selected trees. The number of floral and vegetative buds born on each branch on each season was counted and recorded.

Flowering and fruit setting

During March and April of 2014 and 2015 seasons, the number of both leafy inflorescences (with more flowers and with either one or two flowers) and leafless inflorescences born on each branch in each season was recorded.

During both seasons of investigation, number of fruit set of each inflorescence was recorded for each season in the three different counting dates i.e May, 20th , 13 and 25th of June.

Number of Fruits and yield

On October, 25 of 2014 and 2015 seasons, number of fruits of each tree was recorded and on December, 21, average fruit weight, of 10 randomly selected mature fruit was estimated for each tree. Fruit yield of each experimental tree was then calculated as kg per tree.

Fruit quality

At harvest time (on December, 21) of seasons, fruit length, diameter, peel percentage, pulp and fruit weights of eight fruits, randomly taken from each experimental tree, were measured. Soluble solids contents (SSC) in fruit juice were determined by hand refractometer. Fruit juice percentage was also calculated. Acidity, as citric acid percent and vitamin C content in the juice were determined according to (A.O.A.C, 2005). In addition, at harvest time leaf samples were collected for leaf ammonium content determination. Besides, the nitrate (NO_3) and nitrite (NO_2) in fruit juice were determined according to Okafor and Nwogbo (2005). The data were statistically analyzed using a Complete Randomized Block Design (C.R.B.D) according to Snedecor and Cochran (1990). The means were differentiated using new LSD method at 0.05 level by Gomez and Gomez (1984).

Results and Discussion

Effect of foliar winter with urea and yeast extract sprays on the number of vegetative, floral buds / branch and leaf ammonium content:

It is evident from data in Table 1 that spraying trees with urea plus yeast extract on January, 15 resulted in the highest number of vegetative buds per branch in both seasons with statistical significance. Besides, trees sprayed with urea plus yeast extract on February, 15, in both seasons, as well as urea spraying treatment in mid-Feb. in the second one also significantly produced a higher number of vegetative buds / branch and followed by urea plus yeast extract spraying treatment in mid-January and the differences were significant.

Concerning the number of floral buds per branch, the data in Table 1, also revealed that trees sprayed twice with urea plus yeast extract on January, 15 and Feb., 15 produced significantly the highest number of floral buds per branch compared to the other treatments including the control trees, followed in a descending order by trees sprayed with urea only once in mid-January which gave significantly a higher number of flower buds per branch when compared with the control treatment during both seasons of the study.

Regarding leaf ammonium concentrations the results in Table 1 indicated that foliar application with urea on Jan., 15, in both seasons, achieved with a significant difference the highest leaf ammonium content as compared with other treatments. On the other hand, urea plus yeast extract spraying treatment twice, on January, 15 and February, 15, in both seasons, inclined to achieve the lowest values of leaf ammonium concentrations and similar to that of the control , yet without significance (Table 1). Results seem to be in agreement with those reported by numerous other investigators, Mustafa and El-Shazly (2015) reported that foliar spray of active dry yeast extract at either 0.2 or 0.4% alone or with some bio stimulant substances to Washington navel orange trees gave the highest values of vegetative buds number and vegetative growth. In the meantime, Thanaa *et al.* (2015) found that dry yeast extract significantly increased the number of vegetative buds and vegetative growth characteristics when sprayed at 40 g/L to the foliage of Manzanillo olive. Moreover, Lovatt *et al.* (1994) reported that foliar application of urea during flower bud initiation raised the number of floral shoots and flowers / shoot bud did not influence the number of vegetative shoots. They also added that urea application raised the leaf ammonia content which was significantly correlated with flower number. Curti-Diaz (1994) on Valencia orange trees found that foliar sprays with low-biuret urea (170 g N/tree) increased vegetative shoot numbers but urea treatment scorched 8-10% of the foliage. Ali and lovatt (1992) and Davis and Albrigo (1994) suggested a foliar winter application of urea to citrus trees to augment ammonium accumulation and hence increasing their flowering intensity.

TABLE 1. Effect of foliar application with urea and yeast extract on number of vegetative and floral buds/branch of Washington navel orange trees during 2014 and 2015 seasons .

Treatments	First season (2014)			Second season (2015)		
	Number of vegetative buds	Number of floral buds	Leaf ammonium +(NH_4ppm)	Number of vegetative buds	Number of floral buds	Leaf ammonium +(NH_4ppm)
Control (water spray)	47.00 d	212.63 ef	48.38 e	33.75 c	218.25 e	51.82 e
Urea on Jan.,15	39.00 e	315.13 b	89.28 a	35.38 c	326.50 b	72.97 a
Yeast on Jan.,15	31.63 f	292.30 bc	75.57 b	30.25 c	268.50 d	66.23 b
Urea+ Yeast on Jan.,15	71.38 a	192.50 f	60.41 d	69.25 a	304.00 c	60.27 c
Urea on Feb.,15	56.00 c	255.30 cd	60.56 d	51.88 b	316.13 bc	68.42 b
Yeast on Feb.,15	40.13 e	312.00 b	59.85 d	34.50 c	318.88 bc	56.61 d
Urea+ Yeast on Feb.,15	60.00 b	237.13 de	67.63 c	45.75 b	259.00 d	69.05 b
Urea+ Yeast on Jan.,15 and Feb.,15	32.00 f	411.00 a	49.27 e	45.75 b	350.00 a	49.07 e
L.S.D. at 0.05	3.08	37.22	6.15	7.18	20.15	3.44

Means within each column with the same latter are not significantly different at p= 0.05

Effect of foliar winter with urea and yeast extract sprays on flowering behavior

The effect of different winter urea and yeast extract sprays on number of leafy floral inflorescences / branch showed that spraying Washington navel orange trees only once with urea in mid-January produced the highest significant number of leafy inflorescences / branch in both seasons, followed by in a descending order by yeast extract treatment on January, 15 and then urea spray on February, 15 compared with other treatments including control (Table 2).

Concerning the influence of urea and yeast extract sprays on number of leafy floral inflorescences / branch, the data in Table 2 indicated that, in both seasons, trees sprayed twice with a mixture of urea plus dry yeast extract in mid-January and mid-February scored with a significant difference the highest number of leafy inflorescence which had one or two flowers per branch compared to other treatments. Meanwhile, trees sprayed once with urea in mid-February, in the first season, was significantly higher in this respect compared with the control treatment (Table 2).

With regard to the influence of different urea and dry yeast spraying treatments on the total number of leafy floral inflorescences (with more number of flowers plus either one or two flowers) / branch data in Table 2, in general, revealed that trees sprayed only once with urea, also, sprayed with dry yeast extract in mid-January, in both seasons, had significantly higher number of total leafy inflorescences / branch (had more flowers + one or two flowers compared to the control treatment. Similar results were also obtained when urea was sprayed only once on February, 15, in the first season and sprayed with urea plus yeast extract twice in mid-January and mid-February, in the second one, by attaining a higher number of leafy inflorescences (more flowers + one or two flowers) compared with that of the control and the differences were high enough to be significant (Table 2).

Table 2. Effect of foliar application with urea and yeast extract on the number of leafy inflorescences (with more flowers and one or two flowers), leafless inflorescences and total number of inflorescences / branch of Washington naval orange trees during 2014 and 2015 seasons

Treatments	First season (2014)					Second season (2015)				
	Leafy inflo. with more flowers	Leafy inflo. with one or two flowers	Total.No.of inflo.(more +one or two flowers)	Leafless inflo. number	Tot. No. of inflo. (leafy+ leafless)	Leafy inflo. with more flowers	Leafy inflo. with one or two flowers	Tot. No. of inflo.(more +one or two flowers)	Leafless inflo. number	Tot.No.of inflo. (leafy+ leafless)
Control (water spray)	42.90 cd	18.63 e	61.53 c	5.63 d	67.16 c	34.38 d	23.50 de	57.90 d	6.63 c	64.53 d
Urea on Jan.,15	75.00 a	34.00 bc	109.00 a	8.25 a	117.25 a	73.13 a	35.75 c	1.08.88 ab	8.75 b	117.63 ab
Yeast onJan.,15	65.00 b	29.00 cd	94.00 b	7.63 abc	101.63 b	69.00 ab	45.63 b	114.50 a	10.75 a	125.25 a
Urea+ Yeast on Jan.,15	37.40 d	34.50 bc	71.88 c	5.13 d	77.00 c	65.25 b	38.50 c	99.88 b	7.13 c	107.00 b
Urea on Feb.,15	59.13 b	40.88 ab	100.00 ab	6.38 cd	106.38 ab	61.38 b	28.00 d	76.25 c	3.75 d	79.90 c
Yeast on Feb.,15	41.25 cd	25.13 de	66.25 c	6.50 bcd	73.00 c	37.13 d	21.50 e	58.63 d	7.25 c	65.90 cd
Urea+ Yeast on Feb.,15	35.25 d	36.13 bc	71.38 c	5.50 d	76.88 c	33.50 d	19.60 e	53.13 d	4.00 d	57.13 d
Urea+ Yeast on Jan.,15 and Feb.,15	46.80 c	46.63 a	93.38 b	8.13 ab	101.5 b	48.13 c	56.63 a	104.75 ab	9.35 b	114.10 ab
L.S.D. at 0.05	8.07	7.27	13.07	1.68	13.94	7.67	5.56	11.42	1.36	15.13

Means within each column with the same latter are not significantly different at p= 0.05 *- inflo.= inflorescences

As for the influence of foliar sprays with urea and dry yeast on number of leafless floral inflorescences, the date listed in Table 2 generally indicated that spraying trees with urea once on January, 15,in the first season, and yeast extract on Feb.,15 in the second one, resulted in the highest number of leafless inflorescences when compared with the other treatments including the control and the differences were significant, followed by spray treatment with a mixture of urea plus yeast twice, in mid Jan. and mid-Feb. . This result held true during both seasons of study.

The date in Table 2 concerning the influence of different urea and yeast sprays on the total number of inflorescences (leafy plus leafless floral inflorescences), the obtained data revealed that, in general, either urea foliar sprays or yeast extract treatment only once in mid-January achieved significantly an increase in total number of floral inflorescences (leafy and leafless) per branch compared with that of the control. This result was valid during both experimental seasons. Magnitude , that trees sprayed with urea once on February,15, in the first season, and spraying trees with urea solution on Jan., 15 in the second one, also, produced a higher number of total inflorescence per branch (leafy plus leafless) compared to the control treatment (Table 2).

These results are in agreement with those reported by Thanaa et al. (2015) who found that application of dry yeast extract at 40g/L / tree increased flowering density (number of inflorescences/m) than the control which had the lowest number of inflorescences /m in both seasons of study. They added that the highest significant perfect flowers percentages of olive trees was obtained by the application of dry yeast at 40g/L/tree compared to the control treatment. Moreover, El-Tanany and Abdel Messih (2009) on Valencia orange trees, revealed that spraying trees with 1.5% urea in mid-Jan. resulted in the highest number of flowers /branch in both seasons when compared with the control and the differences were significant. Similarly, Albrigo (2000) on Valencia orange trees, reported that urea or Nutriphite applied between 25 December and 11 January increased the number of flowers when applied in winter. He concluded that winter urea sprays for 4 consecutive years also significantly increased yield. Kim-Yong et al (1997) on Satsuma mandarin concluded that foliar sprays of 1% urea applied one week before and after harvest, improved the nutrition status of trees, resulting in better reproductive growth. Dai et al. (1995), using Punkan mandarin reported that results of 10 years showed that a high leaf N content prior to physiological differentiation stage which was a key factor for flowers bud formation. Lovatt et al. (1992), reported that raising the ammonia content with the application of low-biuret urea raised the number of floral shoots and flowers /shoots but did not influence on the number of vegetative shoots.

Effect of foliar winter with urea and yeast extract sprays on number of fruit set in each inflorescence / branch

Data in Table 3 clearly indicated that, in both seasons, trees sprayed with a combination of urea plus yeast extract on Jan. , 15 only once attained significantly the highest number of fruit set in each inflorescence type per branch, compared with other treatments. This result held true through the three dates used for fruit set counts, on 20th May, on 13th and 25th of June, during both seasons of study. Consecutively, spraying trees with urea only once on February, 15, also caused the highest number of fruit set in leafy floral inflorescence and followed the superior treatment. This result held true in both seasons and through the three dates used for set counts (Table 3).

The present results are in a general harmony with those of El-Tanany and Shaimaa (2016) who found that Valencia orange trees sprayed with dry yeast extract at 0.2% or in combination with benzyl adenine and potassium solution raised the number of fruit set / branch during both April and May in both seasons of study. Moreover, Khafagy et al. (2010) on navel orange trees, reported that trees prayed with a mixture of 0.5% zinc sulphate plus yeast extract at 0.4% yielded significantly the highest number of setting fruits and highest number of fruits per tree. Similarly, Thanaa et al. (2015) on Manzanillo olive trees, found that foliar application with dry yeast extract at 40g/L/tree alone or combined with benzyl adenine at 60 ppm /tree recorded the highest significant values of percentage of fruit set. Whereas, control treatment recorded the lowest percentage of fruit set during both seasons of study.

The surge in fruit set number on both leafy and leafless inflorescence due to urea solution sprays was reported by El-Tanany and Abdel Messih (2009) on Valencia orange trees, who found that spraying urea at 1.5% in mid-January, in both seasons brought about the highest number

of fruit set. On the other hand, control trees, had lower fruit set. Moreover, El-Tanany (2003) on Washington navel orange found that the average fruit set percentages in leafy and leafless inflorescences obtained from spraying trees with urea only once in December or thrice in November plus December plus January was significantly the highest fruit set percentage, in comparison with all the other urea spray treatment and control. He also noticed that this result was valid in the four individual fruit set counting dates, namely: the 7th and the 26th of May and June during both seasons of the study. Meanwhile, Ali and Lovatt (1994) found that winter foliar application of low-buret urea to Washington navel orange trees in mid-January or mid-February had significantly greater fruit setting, fruit number /tree and yield than that of the control trees.

In 2- year trials with 10- years – old lime (*Citrus aurantifolia*) trees Singh and Prasad (1981), in India, stated that fruit set was highest in trees which received the highest N (as urea) via the foliage of the trees.

Effect of foliar winter with urea and yeast extract sprays on number of fruits /tree, average fruit weight and yield:

The results concerning the effect of different foliar urea and yeast extract spraying treatment on fruit yield, expressed as number of fruits and fruit weight, in both seasons, showed that trees sprayed with a combination of urea plus yeast extract only once, on January, 15 produced significantly the highest fruit yield expressed as number of fruits or weight compared with the other treatments and the control (Table, 4). The fruit yield obtained from this treatment was as high as 2.0 and 1.96 folds that obtained from water spray control trees, in the first and second seasons, respectively. Conversely, spraying trees with a mixture of urea plus dry yeast twice, on January , 15 and February, 15, in both seasons, resulted in the lowest values of fruit yield, either weight or number and similar to that of the control trees and the differences were not significant. Our results proved that, the same treatments which increased the number of fruit set per branch (urea plus yeast spray treatment in mid-January), also brought about the highest fruit yield to the trees. These results agree with those of Gonzalez *et al* (2010) who reported winter pre bloom foliar application of low-biuret urea to *C. reticulata* and 'Nules' Clementin mandarin increased 2-years cumulative yield as both Kilogram and number of fruits per tree with no effect on fruit quality. Moreover, El-Shazly and Mustafa (2015) found that foliar application of yeast extract at 0.2 and 0.4% and amino green at 0.25 and 0.5% to Washington navel orange trees increased number of fruits and total yield compared to control. They added that active dry yeast at 0.4% and potassium humate at 20 g/tree were considered the promising treatments. Khafagy *et al* (2010) reported that tree sprayed with yeast at 0.4% alone or combined with zinc sulphate at 0.5% or 1% gave significantly the highest number of fruits per tree compared with other treatments as well as control. Similarly, Bakry (2007) on Jaffa orange stated that the maximum number of fruits and yield /tree were noticed when trees were sprayed with yeast extract. El-Tanany and Abdel Messih (2009) on Valencia orange trees, showed that all the trees which received winter urea sprays produced a higher number of fruits per tree than the control. Likewise, El-Tanany (2003) on Washington navel orange and mandarin trees, found that when both species were sprayed with urea in mid-Jan. once, or thrice in mid-November plus December plus January produced significantly the highest number of fruits / tree during both experimental seasons. While, water sprayed orange and mandarin control trees produced the least fruit yield, expresses as weight or number. Similarly, Lovatt (1999a).reported that a single winter pre bloom foliar application of low-biuret urea to Washington navel orange trees significantly increased number of fruits and yield per tree for each of 3 consecutive years. In the meantime, Lovatt (1999b) on Washington navel orange trees, found that a single winter pre bloom (January or February) foliar application of nitrogen as low-biuret urea (0.16 Kg N/tree) at flower initiation increased net cumulative yield and the number of commercially valuable large-size fruits. Similar results were also obtained by Ali and Lovatt (1994).

Again, the data in Table 4 clearly indicated that all different urea and dry yeast extract spray treatments seem to be participated to augment fruit yield without any reduction in average fruit weight or its size. In This concern, EL-Tanany and Abdel Mesih (2009) on Valencia orange trees indicated that trees sprayed with urea on January. 15 produced heavier fruits than the control and concluded that this previous treatment increased yield of trees without any reduction in fruit size

TABLE 3. Effect of foliar application with urea and yeast extract on number of fruit set in each floral inflorescences / branch of Washington naval orange trees during 2014 and 2015 seasons.

Treatments	First season (2014).						Second season (2015)					
	Fruit set counting dates.						Fruit set counting dates.					
	In leafy inflorescences			In leafless inflorescences			In leafy inflorescences			In leafless inflorescences		
	May,20	June,13	June,25	May,20	June,13	June,25	May,20	June,13	June,25	May,20	June,13	June,25
Control (water spray)	15.13de	6.50 c	5.75 c	2.40 c	1.63 b	1.13 b	15.50 d	3.63 c	3.25 c	6.50 e	0.25 cd	0.00 d
Urea on Jan.,15	18.30cd	7.50 bc	7.13 b	4.50 b	1.00 c	0.88 b	25.50 ab	10.40 a	9.50 a	3.38 f	1.80 a	1.00 a
Yeast onJan.,15	12.00 e	3.80 d	3.38 d	5.63 a	1.13 c	0.75 c	19.13 c	7.90 b	6.88 b	3.38 f	0.90 b	0.75 b
Urea+ Yeast on Jan.,15	30.40 a	9.63 a	8.88 a	5.50 a	2.25 a	1.75 a	27.13 a	10.13 a	9.63 a	23.30 a	1.80 a	1.00 a
Urea on Feb.,15	26.63 b	7.90 b	7.25 b	5.90 a	1.00 c	0.00 e	23.30 b	8.00 b	7.00 b	20.90 b	0.25 cd	0.25 c
Yeast on Feb.,15	16.50 d	7.50 bc	7.25 b	4.00 b	0.50 de	0.75 c	12.00 d	3.80 c	3.38 c	12.00 d	0.38 cd	0.25 c
Urea+ Yeast on Feb.,15	12.13 e	4.63 d	4.25 d	2.13 c	0.25 ef	0.38 d	15.75 d	3.50 c	3.25 c	15.75 c	0.13 d	0.00 d
Urea+ Yeast on Jan.,15 and Feb.,15	20.90 c	4.13 d	3.88 d	1.90 c	0.13 f	0.13 de	20.90 c	8.00 b	7.25 b	3.75 f	0.50 c	0.38 c
L.S.D. at 0.05	3.44	1.06	0.94	0.74	0.36	0.28	2.26	1.02	0.90	1.22	0.34	0.21

Means within each column with the same latter are not significantly different at p= 0.05

TABLE 4. Effect of foliar application with urea and yeast extract on the number of fruits / tree, average fruit weight and fruit weight and fruit yield (as Kg/ tree) of Washington naval orange trees during 2014 and 2015 seasons.

Treatments	First season (2014).			Second season (2015).		
	Number of fruits / tree	Average fruit weight (gm.).	Fruit yield (Kg/ tree).	Number of fruits / tree	Average fruit weight (gm.).	Fruit yield (Kg/ tree).
Control (water spray)	185.00 c	212..00 b	39.22 f	183.50 cd	211.00 e	38.72 d
Urea on Jan.,15	236.00 b	213.00 b	50.27 cde	267.50 a	245.00 c	65.54 b
Yeast onJan.,15	231.00 b	242.25 ab	55.96 bcd	260.25 a	289.00 b	75.21 a
Urea+ Yeast on Jan.,15	298.75 a	262.50 a	78.42 a	261.00 a	291.00 b	75.95 a
Urea on Feb.,15	233.50 b	243.50 ab	56.86 bc	186.25 cd	285.00 b	53.08 c
Yeast on Feb.,15	195.00 c	240.50 ab	46.90 def	204.50 bc	293.00 b	59.92 b
Urea+ Yeast on Feb.,15	249.50 b	261.00 a	65.12 b	212.75 b	306.25 a	65.15 b
Urea+ Yeast on Jan.,15 and Feb.,15	194.00 c	220.75 b	42.83 ef	176.00 d	227.00 d	39.95 d
L.S.D. at 0.05	23.92	37.93	9.84	21.29	13.19	5.85

Means within each column with the same latter are not significantly different at p= 0.05

TABLE 5 . Effect of foliar application with urea and yeast extract on physical fruit properties of Washington naval orange trees during 2014 and 2015 seasons.

Treatments	First season (2014).						Second season (2015).					
	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (gm)	Pulp weight (gm)	Rind percent (%)	Juice percent (%)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (gm)	Pulp weight (gm)	Rind percent (%)	Juice percent (%)
Control (water spray)	6.90 d	7.03 e	209.38 e	150.63 d	28.18 a	26.41 c	7.07 cd	6.84 e	225.00c	163.44 c	27.48 a	27.94 cd
Urea on Jan.,15	8.10 b	7.38 c	265.63 c	2.03.44 c	23.78 b	30.65 b	7.25 c	7.08 cd	268.75 b	206.25 b	23.87cd	29.95 bcd
Yeast onJan.,15	7.61 c	7.19 d	228.13 d	165.63d	27.67 a	33.77 a	7.21 c	6.97 de	237.51 c	178.13 c	24.99bc	30.00 bcd
Urea+ Yeast on Jan.,15	7.62 c	7.66 b	281.25 b	219.38bc	22.52 b	35.73 a	7.44 b	7.42 b	268.75 b	209.69 b	24.10cd	33.80 a
Urea on Feb.,15	8.13 ab	7.90 a	230.31 d	169.06 d	26.66 a	33.39 a	7.56 b	7.90 a	231.25 c	169.06 c	26.90ab	32.85ab
Yeast on Feb.,15	7.57 c	7.28 cd	285.63 b	223.13 b	22.21 b	29.35 b	7.00 d	7.41 b	258.13 b	200.00 b	22.52de	26.64 d
Urea+ Yeast on Feb.,15	8.45 a	7.69 b	271.63 bc	209.38bc	23.13 b	33.19 a	8.31 a	7.53 b	259.38 b	197.19 b	24.14cd	29.05 bcd
Urea+ Yeast on Jan.,15 and Feb.,15	7.03 d	6.86 f	301.95 a	242.81 a	19.57 c	29.93 b	7.13 cd	7.22 c	300.00 a	237.81 a	21.33 e	30.47 abc
L.S.D. at 0.05	0.29	0.14	14.97	18.58	1.46	2.61	0.18	0.15	18.52	17.73	2.13	3.68

Means within each column with the same latter are not significantly different at p= 0.05

or weight. Moreover Singh and Prasad (1981) reported that applying urea via the foliage of acid lime (*Citrus aurantifolia*) produced heavier fruits than those of the control.

Increasing yield of citrus trees due to winter pre bloom foliar application of urea solution and / or yeast extract was reported by many investigators El-Tanany and Shaimaa (2016) , Mustafa and El-Shazly (2015), El-Shazly and Mustafa (2015), Khafagy et al. (2010), Gonzalez et al. (2010), El-Tanany and Abdel Messih (2009), Mahmoud (2008), Bakry (2007), El-Tanany (2003), Lovatt (1999b), Albrigo (2000), Lui and lui (1998), Ali and Lovatt (1994), Lovatt et al. (1992), Kumar et al. (1988) and Singh and Prasad (1981).

Effect of foliar winter with urea and active dry yeast sprays on physical fruit properties of Washington navel orange trees:

As for fruit length , the results in Table 5 revealed that, in both season, trees sprayed with a mixture of urea solution plus yeast extract only once, on Feb., 15 significantly increased average fruit length when compared with that of the control followed by urea spraying treatment on Febraury,15. This result was valid during both experimental seasons and the differences were statistically significant. On the contrary, spraying trees with a combination of urea plus yeast extract twice , on Jan, 15 and Feb.,15, in both seasons, markedly reduced fruit length and produced fruits of about equal length as that of the control,. The data concerning fruit diameter, in both seasons, trees sprayed with a single urea solution on Feb.,15, gave the highest fruit diameter than that of the control and the differences were significant (Table, 5). Moreover, urea plus yeast extract spraying treatment in mid-Feb., also increased fruit diameter and followed by urea spraying treatment which previously mentioned during both season of study. On the contrary, trees sprayed with urea plus yeast extract twice, on Jan., 15 and Feb., 15, was inferior treatment in this respect and tended to resemble the control treatment (Table 5).

This result partially agreed with the findings of Khafagy et al. (2010) who found that dry yeast extract alone or combined with Zn So4was the most efficient treatment in improving fruit length and also increased fruit size (length & diameter) over other treatments including control. Likewise, Bakry (2007) indicated that spray Jaffa orange trees with yeast extract at 0.4% concentration improved fruit physical properties. Moreover, Thanaa et al. (2015) on olive trees, reported that foliar application with yeast extract at 40 g/L leads to an increase in fruit physical properties including fruit size, expressed as fruit length and its diameter compared to the control. Furthermore, Ali and Lovatt (1994) on Washington navel orange trees, found that an increase in the number of fruit with diameter of 6.1- 8.0 cm, due to foliar applied urea in mid-January or mid-February. In this respect, Lovatt (1999) reported that a single winter urea spray applied to Washington navel orange trees, increased the commercially valuable large-size fruit with an increment of yield. Ahmed and Abo-Shelbaya (1988), reported that fruit dimensions of Balady mandarin were increased by all urea and micro-nutrients treatments.

The effect of different urea and yeast extract spraying treatments on fruit and pulp weights are shown in Table 5. The results, in both seasons, indicated that trees sprayed with a mixture of urea and yeast extract twice in mid-January and mid-February produced fruit were the heaviest compared with the other treatments including the control and the differences were highly significant. Besides, trees sprayed with dry yeast extract on Feb. , 15in first season, also sprayed with a combination of urea plus yeast on January,15, also participated to augment both fruit and pulp weights especially in second one when compared to the control treatment and the differences were significant. Conversely, trees sprayed with yeast extract in mid-January and those sprayed with urea in mid-February, in both seasons, produced fruits that had significantly lowest contents in either fruit or pulp weight and were similar to those of the control (Table 5).

With regard to peel percent, data in Table 5 revealed that all urea and yeast spray treatments participated to reduce the rind percentage of Washington navel orange fruits when compared with the control which produced fruits, in both seasons, had significantly the highest content. The only exceptional cases, were spraying trees with urea on Feb., 15, in both seasons, and spraying trees with yeast on Jan., 15 in first one, achieved with a significant difference the highest fruit peel percent and resembled with the control fruits in rind percentage (Table 5).

The increment in fruit and pulp weights and peel percentage due to urea and/or yeast extract spraying treatments was reported by numerous investigators. Thanaa et al. (2015) on olive trees found that dry yeast extract at 40 g/L leads to increase in fruit physical properties (fruit and flesh weights, fruit length and diameter) compared to the control. They attributed this response to the role of these materials as a stimulant for dry mass

production through enhancement of cell division. Moreover, Khafagy et al (2010) on Washington navel orange trees, concluded that spraying trees with 0.4% yeast extract alone or combined with 1.0% Zn So4 was more effective in increasing fruit, pulp weights and fruit volume. Similarly, Bakry (2007) indicated that spraying Jaffa orange trees with yeast extract improved physical properties. El-Shazly and Mustafa (2015) stated that all bio stimulants including active dry yeast markedly increased fruit weight and other fruit quality compared to control. Addition EL-Tanany and Abdel Messih (2009) found that spraying urea at 1.5% on Valencia orange trees on January, 15, in both seasons, had pronounce effect by significantly attaining the highest fruit weight compared to the control treatment.

Concerning the effect of foliar sprays of urea and dry yeast extract on fruit Juice percentages, data in Table 5 revealed that all spraying treatments almost markedly increased fruit Juice percent when compared with the control fruits, especially in the first season. Moreover, trees sprayed with urea plus yeast extract once, in mid-January as well as spraying trees with urea in mid-February, in both seasons, achieved with a significant difference the highest fruit juice percent as compared with the control fruits.

These results partially agreed with the findings of El-Tanany et al. (2011) who found that foliar application of urea on lime trees, once gave the highest Juice percent compared with other treatments including the control. Likewise, El-Shazly and Mustafa (2015) reported that foliar applications of bio-stimulants including 0.4% yeast extract markedly increased fruit juice percent of Washington navel orange. They added that active dry yeast at 0.4% and potassium humate at 20 g/ tree were considered as the promising treatments.

The influence of foliar application of urea and yeast extract on chemical fruit properties

The results shown in Table 6 indicated that, in both seasons, Washington navel orange trees sprayed with urea in mid-February, was the most pronounced treatment in all chemical fruit properties including (Total soluble solids, acidity percentages and vitamin C content in fruit juice). This result was supported by significant differences when compared with that of other treatments including control trees. Besides, when foliar application with a mixture of urea plus yeast extract only once, on February, 15, greatly increased fruit total soluble solids content during both seasons of study. On the other hand, spraying trees with urea plus yeast twice on Jan. 15 and Feb., 15 greatly reduced either acidity and vitamin C content in their fruit juice and tended to approach of the control, however.

These results were concomitant with those obtained by El-Tanany and Abdel Messih (2009) who found that trees sprayed with urea twice on December, 15 and January, 15, whether urea concentration at 1.5% or 3% to Valencia orange trees achieved markedly increased juice total soluble solids and vitamin C content in their fruit juice when compared with that of the control, while that of other treatments were almost similar to that of the control trees. In addition, foliar urea treatments caused a slight increase in juice acidity, but higher acidity percentage was found in fruits of trees sprayed with urea at 1.5%on January, 15 or those sprayed with 3% urea solution on December, 15 comparing with the control. Albrigo (2000), on Valencia orange trees, found that winter urea sprays for 4 consecutive years increased orange juice soluble solids. Moreover, El-Shazly and Mustafa (2015), using Washington navel orange trees, reported that active dry yeast at 0.4% as bio-stimulants markedly increased total soluble solids (TSS), total sugars and vitamin C content in the fruit juice compared to control. Similarly, El-Tanany and Shaimaa (2016) indicated that spraying Valencia orange trees with active dry yeast extract at 0.2% significantly increased total soluble solids content in fruit juice as comparing with control. Khafagy *et al* (2010) found that spraying trees with yeast extract at 0.4 or 0.2% alone or combined with 1.0% zinc sulphate, recorded the highest value of fruit quality resembled by increasing total soluble solids of Washington navel orange .Besides, Mohamed (2008) and Bakry (2007) found that spraying yeast extract increased TSS and TSS/acid ratio of Balady mandarin and Jaffa orange, respectively.

As for the effect of foliar sprays of urea and yeast extract on fruit nitrate (NO3) and nitrite (NO2) contents, the results in Table 6 generally indicated that most different urea and yeast extract treatments achieved slightly increased in fruit nitrate content (NO3). This result held true in both seasons. The only exceptional case, was observed in the trees sprayed with urea only once, in mid-February which brought about the highest values for fruits nitrate concentrations when compared to other treatments. This result was hed true during both seasons of study.

Concerning fruit nitrite (NO2) content, the results shown in Table 6 generally, most treatments, in both seasons, gave the same trend as that of fruit nitrate (NO3). Nevertheless, spraying trees only once with urea plus yeast extract in mid-January, in both season. Produced fruits were significantly higher fruit nitrite content compared to the control fruit, followed by in a descending order by those sprayed with urea on February, 15. Conversely, trees sprayed with yeast extract either on January, 15or February, 15 as well as which sprayed with urea plus yeast extract twice, in mid-Jan. and mid-Feb., in

TABLE 6. Effect of foliar application with urea and yeast extract on chemical fruit properties of Washington naval orange trees during 2014 and 2015 seasons.

Treatments	First season (2014).					Second season (2015).				
	Total soluble solids (%)	Acidity (%)	Vitamin C (mg/L) juice	Fruit nitrate (ppm)	Fruit nitrite (ppm)	Total soluble solids (%)	Acidity (%)	Vitamin C (mg/L) juice	Fruit nitrate (ppm)	Fruit nitrite (ppm)
Control (water spray)	11.50 d	0.82 f	34.18 e	19.21 bc	2.22 f	12.63 bc	0.75 f	38.58 e	18.99 d	2.61 c
Urea on Jan.,15	13.00 b	0.83 f	44.06 b	21.86 a	3.73 bc	12.90 ab	0.92 c	38.11 e	21.32 bc	4.11 b
Yeast onJan.,15	13.00 b	0.95 cd	41.08 c	22.00 a	2.99 d	12.50 c	0.81 e	43.01 c	22.33 ab	2.87 c
Urea+ Yeast on Jan.,15	12.90 bc	1.05 b	40.71 c	21.55 ab	4.84 a	12.50 c	1.07 b	41.65 d	22.13 ab	4.87 a
Urea on Feb.,15	13.38 a	1.24 a	46.91 a	23.78 a	3.96 b	13.13 a	1.12 a	46.39 a	22.74 a	4.15 b
Yeast on Feb.,15	12.63 c	0.91 de	43.60 b	21.50 ab	2.68 e	12.50 c	0.87 d	45.02 b	22.65 a	2.73 c
Urea+ Yeast on Feb.,15	13.13 ab	0.99 c	44.20 b	19..21 bc	3.50 c	13.00 a	0.95 c	46.14 ab	20.24 c	3.75 b
Urea+ Yeast on Jan.,15 and Feb.,15	12.90 bc	0.86 ef	37.17 d	18.96 c	1.64 g	12.88 ab	0.82 e	40.77 d	16.82 e	1.62 d
L.S.D. at 0.05	0.30	0.05	1.76	2.50	0.24	0.27	0.04	1.13	1.14	0.45

Means within each column with the same latter are not significantly different at p= 0.05

both season, contained markedly the lowest values of fruit nitrite content (Table 6). Our results proved that both two substances nitrate (NO3) and nitrite (NO2)in Washington navel orange fruits juice due to foliar urea application were in permittable limits, in this respect, Okafor and Nwogbo (2005) and ÖzgÜl and Üren (2012) reported that the mean values of nitrate in fruit juice ranged from 2.29 AA± 0.05 to 17.50± 1.21 mg/L, while nitrite ranged from 6.84± 0.47 to 12.03± 1.07.

Similarly, Mohammadi and Ziarati (2016) reported that the most source of these ions (nitrate NO3 and nitrite NO2)are nitrogen fertilizer in agriculture for production of fruits and vegetables . They found that the mean nitrate and nitrite levels in orange juice ranged from 13.29 to 29.63 mg/L and from 3.78 to 10.46 mg/L, respectively. They also mentioned that nitrate ions have a low toxin but they would be converted to nitrites when consumed which have a higher toxic effect that nitrates, and converted to N-nitrose or nitrosamines compounds in stomach (where the PH < 7). Nitrites can interact with haemoglobin by oxidation of ferrous ion (Fe2+) to ferric state (Fe3+) preventing or reducing the ability of blood to transport oxygen a condition known as methaemoglbenaemia . Nitrites can also reacting with secondry amines which might also be present in the digested food. They also added that nitrite (NO2) is known to be a precursor of toxic and carcinogenic N-nitrosamines and induced concern.

Conclusion

It can be concluded that foliar application with urea plus yeast extract twice, in mid-January and mid-February was the efficient treatment to achieve significantly the highest number of floral buds and inflorescences (had one or two flowers) when compared with other treatments and control. Also, this treatment increased fruit and pulp weights and significantly reduced fruit content of both nitrate (NO_3) and nitrite ($NO_{2)}$. Urea spray treatment on Jan., 15 elevated leaf ammonium content, consequently increased the number of floral inflorescence as (leafy plus leafless) born per branch.

Foliar application with urea plus yeast extract once, in mid-January produced significantly the highest number of fruit set in each type of inflorescences through the different dates of set counting. This treatment also increased fruit yield expressed as weight or number and markedly augment fruit juice percent. Foliar application of urea on February, 15 lead to improve chemical fruit properties. All urea and dry yeast spraying treatments alone or in combination produced fruits were significantly lowest in rind percent.

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تاثير الرش الورقي باليوريا مع مستخلص الخميرة الجافة علي البراعم الخضرية والزهرية ومحتوي الاوراق من الامونيوم وسلوك الازهار والاثمار وصفات جودة الثمار لأشجار البرتقال ابوسرة واشنطن.

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أجريت هذه الدراسة خلال موسمي 2014 و 2015 بهدف دراسة تأثير الرش الورقي باليوريا مع مستخلص الخميرة الجافة علي عدد البراعم ومحتوي الاوراق من الامونيوم وعقد الثمار والمحصول وجودة الثمار لأشجار البرتقال ابوسرة واشنطن – عمرها 35 سنة مطعومة علي اصل النارنج.

ولقد أظهرت النتائج مايلي :

- أعطت معاملة الرش بمخلوط اليوريا مع مستخلص الخميرة في 15 يناير اعلي عدد من البراعم الخضرية علي الفرع. فضلا عنى ان معاملة الرش مرتين بمخلوط اليوريا مع الخميرة في 15 يناير و 15فبراير قد اعطت اعلي عدد من البراعم الزهرية مقارنة باشجار الكنترول (المرشوشه بالماء).
- أدت معاملة الرش الورقي باليوريا بمفرده في منتصف شهر يناير الي زيادة معنوية في محتوى الورقة من الامونيوم اثناء موسمي الدراسة مقارنة بالكنترول وايضا هذه المعاملة أدت الي زياده العدد الكلي للنورات (الورقيه التي لها عدد كبير من الازهار والتي لها زهره او زهرتين) والنورات الغير ورقيه بالاضافه الي ان معامله الرش بمستخلص الخميرة في 15 يناير أعطت اعلي عدد من النورات الكلية (ورقية وغير ورقيه) خلال الموسم الثاني من الدراسه .
- كانت معامله الرش الورقي باليوريا مع مستخلص الخميرة هي المعامله الاكثر كفاءه لانتاج العدد الاعلي معنويا من الثمار العاقدة / الفرع في كل نوع من النورات خلال المواعيد التي تم فيها عد الثمار العاقده وبالمثل حققت هذه المعامله الزياده في عدد الثمار / الشجرة ومتوسط وزن الثمرة والمحصول بالمقارنه بالمعاملات الأخري.
- أكد نتائجنا بأن الاشجار التي تم رشها باليوريا مع الخميرة في منتصف شهر فبراير وتلك التي تم رشها باليوريا مره واحده في 15 فبراير قد حسنت من حجم الثمار.
- أدت معامله الرش مرتين باليوريا مع مستخلص الخميره في 15 يناير و 15 فبراير الي زيادة مؤكده في كلا من أوراق ولب الثمار.
- أنتجت معاملة الرش بمخلوط اليوريا مع مستخلص الخميرة منتصف يناير او الرش باليوريا في منتصف فبراير ثمارا كانت اعلي معنويا في نسبه عصير الثمار عن الكنترول .
- أدت معاملة الرش باليوريا في 15 فبراير الي تحسين صفات الثمار الكيمائية وكان محتوي الثمار من النترات والنتريت في الحدود المسموح بها نتيجة لمعاملات الرش باليوريا والخميره.
- أعطت معاملة الرش مرتين بمخلوط اليوريا مع مستخلص الخميره في منتصف يناير ومنتصف فبراير ثمارا كانت منخفضه في محتواها من النترات والنتريت وكانت مثل معامله الكنترول.