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Response of Picual olive trees to urea winter sprays

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ABSTRACT

The objective of this experiment was to examine the effect of winter urea sprays on yield and fruit quality of Picual olive trees. The study was conducted during 2015/2016 – 2016/2017 seasons in a private orchard located at El Noubaria district belongs to El Behera governorate on thirty years old Picual olive trees planted on sandy soil. Urea was sprayed at two concentrations (0.5 and 1.0%) performed as follows: (1) Once at mid-December. (2) Twice at mid-December + mid-January. (3) Once at mid-January. The results showed that urea concentration and time of application had a positive effect on increasing yield (kg/tree), leaf mineral content and fruit properties comparing with the control. The obtained results indicated that urea sprays at 0.5 % twice at mid-December and Mid-January was more successful in improving mineral status, yield and fruit quality. It is recommended that such treatment is recommended for improving yield and fruit quality of Picual olive trees.

Key words: Urea winter sprays, Picual olive trees, yield, fruit quality, oil content.

Introduction

Olive (*Olea europea* L.) is considered as a one of the most important fruit crops in Egypt, which cultivated in a range area of 240,458 feddan with a total production of 541,790 ton/year (M.A.L.R., 2013). Increasing yield and improving fruit quality and oil content is considered the main target for olive growers. However, under new reclaimed soil conditions, foliar spray is being a high efficiency method to provide plant needs with nutrient elements, because of poor holding capacity for nutrients and water of such soils. Foliar fertilization is a rapid and effective method to provide the nutrient elements required for photosynthesis process and other important metabolic functions. However, nitrogen is one of the most important elements for tree growth and development. Application of nitrogen in urea form tended to increase the tree nitrogen storage and regulate N distribution also resulted in healthy and better flowering, consequently, increasing crop productivity (Mengel and Krikby, 1987). Moreover, the time of foliar fertilization provides is a tool for growers to reduce fertilizer use and expense in the same time increasing yield and revenue and protecting the environment. However, fertilizer foliar spray can result in an increase in grower income, even when the tree is not deficient in the nutrient. In this concern, foliar applied low-biuret urea during winter pre bloom increased total yield of both Navel and Valencia oranges (lovatt, 1999 and lovatt, 2013). Applying urea in autumn is rapidly mobilized back to the tree storage tissues and then utilized in next spring by growing tissues (Saleem *et al*., 2011).

The main target of the present study is identifying the proper time and concentration of urea spray as well as number of urea applications to meet nitrogen demand and stimulate a specific physiological process that improve mineral status, increase yield and fruit quality of Picual olive trees under sandy soil conditions.

Materials and Methods

This experiment was carried out during 2015/2016 and 2016/2017 seasons on 30 years old Picual olive trees. The selected trees were almost similar in vigor and size. Olive trees were grown in a private orchard in El Behera governorate, Egypt. The trees were planted at 6 × 6 meters, in sandy

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soil under drip irrigation system. The experimental trees received the same cultural practices according to Ministry of Agriculture and Land Reclamation recommendation.

Foliar applications of urea at 0.5 and 1.0% were sprayed once in December (Dec) or twice in December + January (Dec + Jan) or once in January (Jan). Nine treatments were arranged in three replicates on one tree plot as follows:-

- Urea 0.0 % at Mid Dec (water sprays only)
- Urea 0.5 % at Mid Dec
- Urea 1.0 % at Mid Dec
- Urea 0.0 % at Mid Dec+ Mid Jan (water sprays only)
- Urea 0.5 % at Mid Dec+ Mid Jan
- Urea 1.0 % at Mid Dec+ Mid Jan
- Urea 0.0 % at Mid Jan (water sprays only)
- Urea 0.5 % at Mid Jan
- Urea1.0 % at Mid Jan

The following measurements were carried as follows.

Yield and fruit quality:

At harvest time (late November), fruits of each replicate (tree) were separately harvested, weighed and yield as kg/tree was determined, then samples of 60 fruits from the sprayed trees (20 fruits from each replicate tree) were picked randomly around the tree to determine the following parameters:

Average fruit weight (gm), fresh and dry flesh weight (gm), seed weight (gm), fruit length (cm), fruit diameter (cm), fruit shape index, fruit moisture (%), oil percentage in dried flesh were measured as the methods described in A.O.A.C. (1985).

Leaf mineral content:

Leaf samples were picked from each replicate tree then washed and dried at 70^{o}C till a constant weight to determine nitrogen (N), phosphorus (P), and potassium (K) as percentage of dry weight basis as the method described by Cottenie *et al.* (1982).

Statistical Analysis:

Data were subjected to analysis of variance and the method of Duncan was used to differentiate means (Duncan, 1955).

Results

Results in Table (1) shows the effect of urea concentrations and time of applications on yield per tree, fruit weight, fresh flesh weight and seed weight of Picual olive trees.

As for yield as kg /tree, spraying urea at both concentrations were superior to control. In this concern, urea at 0.5% gave the best results compared with 1% urea. On the other hand, spraying urea once in Jan or twice in Dec and Jan recorded the same results and were more effective than spraying it in Dec solely. However, the interaction between urea concentrations and time of applications show that spraying urea at 0.5% twice in Dec and Jan produced the highest yield per tree (61.67 and 63.33 kg in the first and second seasons, respectively) compared with the other treatments under the study.

Regarding fruit weight, it's clear that spraying urea at 1% was the most effective treatment compared with 0.5% or the control. On the other side, spraying urea twice in Dec and Jan followed by spraying it once in Dec were better than Jan spray. However, the interaction show that 1% urea sprayed either once in Dec or twice in Dec and Jan gave higher value of fruit weight compared with the other treatments in both studied seasons.

Concerning fresh flesh weight, spraying urea at any concentration was more effective than the control; also no significant differences were detected between 0.5 or 1% urea treatments. The effect of

time of application show that spraying urea twice in Dec and Jan followed by spraying it once in Dec recorded higher values than Jan spray. The interaction results show that trees sprayed with 1% urea once in Dec recorded the heaviest fresh flesh weight followed without significance by spraying urea twice in Dec and Jan.

In respect to seed weight, results in Table (1) generally reveal that the untreated trees recoded the lowest seed weight compared with the two urea concentrations. As for time of spray, it is clear that spraying urea once in Jan recorded the smallest seed than the other times of spray. However, the interactions between urea concentrations and spray times clearly show that spraying urea at 1% in Jan scored the lowest seed weight in both studied seasons.

Table 1: Effect of urea foliar sprays on yield, fruit weight, fresh flesh weight and seed weight of Picual olive trees during 2015/2016 and 2016/2017 seasons.

	2016 season				2017 season			
Yield /tree (kg)								
	(Dec)	**(Dec+ Jan)**	**(Jan)**	**Means (A)**	**(Dec)**	**(Dec+ Jan)**	**(Jan)**	**Means**
Control (0)	44.00	44.00	44.00	44.00	46.67	46.33	46.50	46.50
Urea (0.5 %)	55.00	61.67	51.67	56.11	61.67	63.33	56.67	60.56
Urea (1 %)	48.33	48.33	58.33	51.67	50.00	55.00	58.33	54.44
Means (B)	49.11	51.33	51.33		52.78	54.89	53.83	
LSD $_{at\ 5\ \%}$ (A)	7.47				LSD $_{at\ 5\ \%}$ (A)	5.78		
LSD $_{at\ 5\ \%}$ (B)	7.47				LSD $_{at\ 5\ \%}$ (B)	5.78		
LSD $_{at\ 5\ \%}$ (A*b)	12.94				LSD $_{at\ 5\ \%}$ (A*b)	10.02		
Fruit weight (gm)								
Control (0)	5.01	4.61	4.81	4.81	5.090	4.86	4.98	4.98
Urea (0.5 %)	4.96	6.10	5.96	5.67	5.050	6.41	6.67	6.04
Urea (1 %)	6.91	6.80	5.61	6.44	6.910	6.57	4.97	6.15
Means (B)	5.63	5.84	5.46		5.680	5.95	5.54	
LSD $_{at\ 5\ \%}$ (A)	0.56				LSD $_{at\ 5\ \%}$ (A)	0.44		
LSD $_{at\ 5\ \%}$ (B)	0.56				LSD $_{at\ 5\ \%}$ (B)	0.44		
LSD $_{at\ 5\ \%}$ (A*b)	0.96				LSD $_{at\ 5\ \%}$ (A*b)	0.77		
Fresh flesh weight (gm)								
Control (0)	3.80	3.99	3.90	3.90	3.91	3.92	3.92	3.92
Urea (0.5 %)	3.91	4.56	4.67	4.38	4.07	4.62	4.45	4.38
Urea (1 %)	5.10	4.63	4.01	4.58	4.71	4.70	3.51	4.31
Means (B)	4.27	4.39	4.19		4.23	4.41	3.96	
LSD $_{at\ 5\ \%}$ (A)	0.29				LSD $_{at\ 5\ \%}$ (A)	0.39		
LSD $_{at\ 5\ \%}$ (B)	0.29				LSD $_{at\ 5\ \%}$ (B)	0.39		
LSD $_{at\ 5\ \%}$ (A*b)	0.51				LSD $_{at\ 5\ \%}$ (A*b)	0.67		
Seed weight (gm)								
Control (0)	0.93	0.88	0.91	0.91	0.88	0.86	0.87	0.87
Urea (0.5 %)	0.83	1.05	0.96	0.95	0.89	1.01	0.98	0.96
Urea (1 %)	1.15	1.19	0.81	1.05	1.13	1.29	0.79	1.07
Means (B)	0.97	1.04	0.89		0.96	1.05	0.88	
LSD $_{at\ 5\ \%}$ (A)	0.09				LSD $_{at\ 5\ \%}$ (A)	0.19		
LSD $_{at\ 5\ \%}$ (B)	0.09				LSD $_{at\ 5\ \%}$ (B)	0.19		
LSD $_{at\ 5\ \%}$ (A*b)	0.15				LSD $_{at\ 5\ \%}$ (A*b)	0.33		

Results in Table (2) show the effect of urea concentrations and time of applications on fruit length, fruit diameter and fruit shape index of Picual olive trees.

Regarding fruit length, it is clear that spraying urea at 1% recorded the highest value of fruit length in both seasons followed by 0.5% urea then the control treatment. Concerning time of applications, it is clear that two sprays of urea in Dec and Jan followed by one spray in Jan were more effective than Dec spray. However, the interaction between the treatments show that spraying urea at 1% twice in Dec and Jan lengthened the fruit and recorded the highest value comparing with the other treatments in both studied seasons.

Results of fruit diameter indicate that urea at both concentrations (0.5 or 1%) have a positive effect on fruit diameter compared to control. On the other side, spraying urea twice in Dec and Jan recorded the best result compared with the other times. Finally, the interaction results clear that the

highest fruit diameter value was obtained due to spraying urea at 1% either twice in Dec and Jan or once in Dec, in the first season. While, in the second one the highest value was recorded when 1% urea sprayed once in Dec followed by spraying urea at 0.5% in Dec and Jan, without significance.

As for fruit shape index, the obtained results show that, either urea concentrations or time of applications did not show any effect and no trends were observed for the treatments in the two studied seasons. Also, the interaction recorded the same results.

Table 2: Effect of urea foliar sprays on fruit length, fruit diameter and fruit shape index of Picual olive trees during 2015/2016 and 2016/2017 seasons.

	2016 season				2017 season			
Fruit length (cm)								
	(Dec)	**(Dec+ Jan)**	**(Jan)**	**Means (A)**	**(Dec)**	**(Dec+ Jan)**	**(Jan)**	**Means**
Control (0)	2.47	2.51	2.49	2.49	2.49	2.49	2.49	2.49
Urea (0.5 %)	2.57	2.63	2.67	2.62	2.50	2.67	2.73	2.63
Urea (1 %)	2.71	2.75	2.67	2.71	2.67	2.75	2.49	2.64
Means (B)	2.58	2.63	2.61		2.55	2.64	2.57	
LSD $_{at\ 5\ \%}$ (A)	0.09				LSD $_{at\ 5\ \%}$ (A)	0.09		
LSD $_{at\ 5\ \%}$ (B)	0.09				LSD $_{at\ 5\ \%}$ (B)	0.09		
LSD $_{at\ 5\ \%}$ (A*b)	0.16				LSD $_{at\ 5\ \%}$ (A*b)	0.16		
Fruit diameter (cm)								
Control (0)	1.90	1.85	1.88	1.88	1.89	2.03	1.96	1.96
Urea (0.5 %)	1.90	2.07	2.03	2.00	1.93	2.11	2.10	2.05
Urea (1 %)	2.11	2.13	1.97	2.07	2.13	2.08	1.92	2.04
Means (B)	1.97	2.02	1.96		1.99	2.07	1.99	
LSD $_{at\ 5\ \%}$ (A)	0.10				LSD $_{at\ 5\ \%}$ (A)	0.08		
LSD $_{at\ 5\ \%}$ (B)	0.10				LSD $_{at\ 5\ \%}$ (B)	0.08		
LSD $_{at\ 5\ \%}$ (A*b)	0.17				LSD $_{at\ 5\ \%}$ (A*b)	0.14		
Shape index								
Control (0)	1.31	1.36	1.33	1.33	1.32	1.23	1.27	1.27
Urea (0.5 %)	1.35	1.28	1.31	1.31	1.29	1.26	1.30	1.29
Urea (1 %)	1.29	1.30	1.36	1.31	1.25	1.32	1.29	1.29
Means (B)	1.32	1.31	1.33		1.29	1.27	1.29	
LSD $_{at\ 5\ \%}$ (A)	0.05				LSD $_{at\ 5\ \%}$ (A)	0.05		
LSD $_{at\ 5\ \%}$ (B)	0.05				LSD $_{at\ 5\ \%}$ (B)	0.05		
LSD $_{at\ 5\ \%}$ (A*b)	0.08				LSD $_{at\ 5\ \%}$ (A*b)	0.08		

Table (3) shows the effect of urea concentrations and time of applications on dry flesh weight, fruit moisture percentage and oil content in the dry flesh of Picual olive trees.

Concerning dry flesh weight, the obtained results clear that, both urea concentrations gave positive effects compared with the control. However, 1% urea was better than 0.5% in both seasons. On the other hand, no clear trends for the time of applications in both seasons when urea sprayed once in Dec or Jan or twice in both months. The interaction results show that spraying urea at 1% especially when sprayed once in Dec or twice in Dec and Jan gave better results without significance between them, while the lowest values were obtained generally from the untreated trees (control).

In respect to fruit moister percentage, the obtained results reveal that both urea concentrations had a positive effect on reducing fruit moisture, since 1% urea recorded the lowest value of fruit moisture, while the untreated trees (control) recorded the highest value in both seasons. On the other side, the time of applications had no effect on this parameter, since all applications gave more or less the same results. The interaction between urea concentrations and time of applications show that urea 1% spray scored low values of fruit moister and no constant trend was observed between the three application times. The same trend in both studied seasons.

Regarding oil percentage in dried flesh, in general, urea concentrations had no effect on this parameter. In this respect, the untreated trees recorded the highest oil percentage in the dry flesh comparing with the two urea concentrations. On the other hand, spraying urea once in Dec recorded the highest oil value compared with the other two applications. The interaction results show that the

untreated trees in the three application times gave higher values of oil percentage without significance among them.

Table 3: Effect of urea foliar sprays on dry flesh weight, fruit moisture and oil percentage in dried flesh of Picual olive trees during 2015/2016 and 2016/2017 seasons.

	2016 season				2017 season			
Dry flesh weight (gm)								
	(Dec)	**(Dec+ Jan)**	**(Jan)**	**Means (A)**	**(Dec)**	**(Dec+ Jan)**	**(Jan)**	**Means**
Control (0)	1.01	0.99	1.00	1.00	1.01	1.00	1.00	1.00
Urea (0.5 %)	1.15	1.27	1.34	1.25	1.23	1.29	1.23	1.25
Urea (1 %)	1.42	1.43	1.25	1.37	1.56	1.45	1.12	1.38
Means (B)	1.19	1.23	1.20		1.27	1.25	1.12	
LSD $_{at\ 5\ \%}$ (A)	0.07				LSD $_{at\ 5\ \%}$ (A)	0.14		
LSD $_{at\ 5\ \%}$ (B)	0.07				LSD $_{at\ 5\ \%}$ (B)	0.14		
LSD $_{at\ 5\ \%}$ (A*b)	0.12				LSD $_{at\ 5\ \%}$ (A*b)	0.24		
Fruit moisture (%)								
Control (0)	73.32	75.22	74.27	74.27	74.15	74.44	74.30	74.30
Urea (0.5 %)	70.50	72.06	71.23	71.27	69.73	71.96	72.25	71.31
Urea (1 %)	72.18	69.02	68.79	69.99	66.69	69.24	68.01	67.98
Means (B)	72.00	72.10	71.43		70.19	71.88	71.52	
LSD $_{at\ 5\ \%}$ (A)	0.93				LSD $_{at\ 5\ \%}$ (A)	2.41		
LSD $_{at\ 5\ \%}$ (B)	0.93				LSD $_{at\ 5\ \%}$ (B)	2.41		
LSD $_{at\ 5\ \%}$ (A*b)	1.60				LSD $_{at\ 5\ \%}$ (A*b)	4.17		
Oil percentage in dried flesh (%)								
Control (0)	44.78	43.66	44.08	44.17	43.52	44.38	44.80	44.23
Urea (0.5 %)	41.20	34.23	39.15	38.19	42.78	35.80	43.89	40.82
Urea (1 %)	40.85	41.49	38.60	40.31	41.34	42.61	30.03	37.99
Means (B)	42.27	39.79	40.61		42.54	40.93	39.58	
LSD $_{at\ 5\ \%}$ (A)	1.70				LSD $_{at\ 5\ \%}$ (A)	0.62		
LSD $_{at\ 5\ \%}$ (B)	1.70				LSD $_{at\ 5\ \%}$ (B)	0.62		
LSD $_{at\ 5\ \%}$ (A*b)	2.94				LSD $_{at\ 5\ \%}$ (A*b)	1.07		

Results in Table (4) shows the effect of urea concentrations and time of applications on nitrogen, phosphorus and potassium percentages in the leaves of Picual olive trees.

Results of leaf nitrogen percentage, clearly in general reveal that both urea concentrations had a highly significant effect on nitrogen percentage compared with the control. However, urea at 1% shows the best effect and recorded the highest significant value than 0.5 % or the control treatments. Concerning time of applications, it is clear that spraying urea once in Dec recorded the highest concentration of nitrogen in the leaves followed significantly by Dec + Jan spray then Jan treatment. The interaction between treatments show that spraying urea at 1% once in Dec was superior when compared with the other treatments, since it recorded the highest nitrogen percentage in the leaves, while the untreated trees (control) gave the lowest nitrogen percentage as one or two sprays.

Concerning phosphorus percentage in the leaves, it is clear that 1% urea was the most effective treatment than 0.5% or the control on phosphorus percentage. On the other hand spraying urea once in Jan recorded the highest phosphorus value than the other treatments. The result of the interaction show that both 1% urea sprayed in Dec or 0.5% urea sprayed in Jan, gave more or less the same values of leaf phosphorus percentage in both studied seasons.

As for potassium percentage in the leaves, it is clear from the obtained results that urea concentration especially at 1% was more effective in increasing potassium percentage in the leaves compared with 0.5% or the control. Time of application had high efficiency when urea sprayed once in Jan, comparing with the two other applications. However, the interaction between the treatments show that 1% urea spray once in Jan gave the highest significant potassium percentage in olive leaves compared with all other treatments including the control which recorded lower values. These results were observed in the two studied seasons.

Table 4: Effect of urea foliar sprays on nitrogen, phosphorus and potassium of Picual olive trees during 2015/2016 and 2016/2017 seasons.

	2016 season				2017 season			
Nitrogen (%)								
	(Dec)	**(Dec+ Jan)**	**(Jan)**	**Means (A)**	**(Dec)**	**(Dec+ Jan)**	**(Jan)**	**Means**
Control (0)	1.65	1.60	1.63	1.63	1.64	1.64	1.64	1.64
Urea (0.5 %)	1.81	1.90	1.70	1.80	1.80	1.90	1.70	1.80
Urea (1 %)	2.39	1.97	1.70	2.02	2.29	2.03	1.72	2.01
Means (B)	1.95	1.83	1.68		1.91	1.86	1.69	
LSD $_{at\ 5\ \%}$ (A)	0.05				LSD $_{at\ 5\ \%}$ (A)	0.08		
LSD $_{at\ 5\ \%}$ (B)	0.05				LSD $_{at\ 5\ \%}$ (B)	0.08		
LSD $_{at\ 5\ \%}$ (A*b)	0.09				LSD $_{at\ 5\ \%}$ (A*b)	0.13		
Phosphorus (%)								
Control (0)	0.137	0.138	0.138	0.138	0.136	0.139	0.138	0.138
Urea (0.5 %)	0.113	0.135	0.160	0.136	0.118	0.140	0.159	0.139
Urea (1 %)	0.157	0.133	0.144	0.144	0.160	0.135	0.139	0.145
Means (B)	0.136	0.135	0.147		0.138	0.138	0.145	
LSD $_{at\ 5\ \%}$ (A)	0.003				LSD $_{at\ 5\ \%}$ (A)	0.004		
LSD $_{at\ 5\ \%}$ (B)	0.003				LSD $_{at\ 5\ \%}$ (B)	0.004		
LSD $_{at\ 5\ \%}$ (A*b)	0.005				LSD $_{at\ 5\ \%}$ (A*b)	0.007		
Potassium (%)								
Control (0)	1.62	1.60	1.61	1.61	1.61	1.60	1.61	1.61
Urea (0.5 %)	1.82	1.67	1.72	1.74	1.85	1.69	1.74	1.76
Urea (1 %)	1.84	1.64	2.07	1.85	1.87	1.62	2.06	1.85
Means (B)	1.76	1.64	1.80		1.78	1.64	1.80	
LSD $_{at\ 5\ \%}$ (A)	0.03				LSD $_{at\ 5\ \%}$ (A)	0.04		
LSD $_{at\ 5\ \%}$ (B)	0.03				LSD $_{at\ 5\ \%}$ (B)	0.04		
LSD $_{at\ 5\ \%}$ (A*b)	0.05				LSD $_{at\ 5\ \%}$ (A*b)	0.06		

Discussion

From the above results, it's clear that, spraying urea either as concentration or time of appliocation had the superiority in improving leaf nutritional status, fruit characteristics, yield as kg/tree and oil contents (when calculated as oil yield per tree) than the control in both studied seasons.

Response of Picual olive trees to urea sprays at 0.5 or 1.0% was positively resulted in fruit quality improvement, yield and fruit oil yield parameters, Also time of urea application was very effective on yield per tree and fruit quality special when sprayed once in December or twice in December and January.However, this improvement in most olive studied parameters due to urea sprays may be explained due to tree needs of nitrogen during the phonological stage of tree growth cycle, which reflected in increasing nitrogen and potassium in the leaves.

This means more translocation to reproductive organs where the increase in fruit dimensions, flesh weight; that explain the increase in fruit weight over the control due to urea sprays, which finally increased most studied parameters.

The obtained results are in agreement with the findings by Lovatt (1999) who concluded that foliar fertilizer at the appropriate time in the phenology of the tree such as time when the demand for the nutrient is likely to be high to stimulate a specific physiological process that increases yield, fruit size, or fruit quality. He added that the application of fertilizers can result in a net increase in grower income, even when the tree is not deficient in the nutrient by standard leaf analysis.

Similar findings were reported by Lovatt (2013) who reported that foliar application of low-biuret urea during winter pre bloom increased total yield of both Navel and Valencia oranges.

Improving olive yield as kg/tree and fruit quality may be explained due to the positive effect of urea sprays on the leaves of the previous year (December). These are in harmony with Goldschmidt (1997) and Moss *et al.* (1972) in their studies on citrus since they reported that floral development

needed for anthesis and fruit set, require photosynthetic higher amount for organ growth to meet the respiratory requirements and to supply photo-assimilates during the emergence of the spring flush prior to full expansion of new leaves. Similarly, the present results are in somewhat agree with those of Ruan (1993) who reported that the assimilate supply to young leaves and fruitlets of Satsuma mandarin is mainly affected by photosynthesis of the current old leaves.

This means that the time of urea foliar spray as well as the phonology stage of the tree specially leaves age during the time of urea spray markedly affects the following year productivity. This may explain our present results for significant increase in yield, oil content and fruit quality of Picual olive trees sprayed with urea at 0.5% once in December or twice in December and January than those sprayed with urea once in January or unsprayed trees (control).

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