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Impact of Organic Fertilization and Water Requirements on Olive Fruit Productivity and Some Mineral Concentration in Sandy Soil

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Abstract : An experiment was carried out in the experimental station of National Research Centre in El-Bostan area, Egypt, during the two successive seasons 2012 and 2013 to investigate the effect of partial replacement of mineral nitrogen fertilizers by organic fertilizer. Five different fertilization treatments were used (100% chemical fertilizer (F_1), 75% chemical fertilizer+25% organic fertilizer(F_2), 50% chemical fertilizer+50% organic fertilizer(F_3),25% chemical fertilizer +75% organic fertilizer(F_4)and100% organic fertilizer (F_5) were combined with three different levels of water requirements (according to estimated crop evapotranspiration) 100%, 66% and 33% of Etc on olive productivity and some macronutrients contents of fruits were investigated. The obtained results revealed that, application of 50% chemical N fertilizer + 50% organic fertilizer under all irrigation water levels gave the highest fruit yield compared with the other fertilization treatments. While, Fruits N, P concentration decreased by increasing organic fertilizer, potassium concentration increased. Raising the irrigation water levels causes an increase in fruits nitrogen, phosphorus, potassium and calcium concentration.

Key words : Olive cultivars, mineral and organic nitrogen fertilization, water requirements, fruits mineral contents.

Introduction

Reclamation of sandy soils have their own problems as single grain structure, susceptibility to erosion, low levels of nutrients, microorganisms and low water retention[1]. Therefore, adding organic manures such as farmyard manure to these soils would improve their physico-chemical and biological properties, increase soil organic matter, cation exchange capacity, available nutrients, and available water holding capacity and this in turn stimulates plant growth and productivity.

In Egypt almost 55% (29,700 ha) of the current area cultivated with olives are within new reclaimed desert locations. Olive cultivation has essential role in agricultural production. Since it increases the land value especially where soil is unsuitable for other fruit crops due to its capability to grow under several conditions. Olive is one of the fruit crops that can grow in sandy and newly reclaimed soils due to its capability to tolerate

drought, salinity and other soil stresses. The production of olive in these areas is generally low due to the poor soil fertility and low water holding capacity[2].

Olive trees (*Olea europaea* L.)is considered among the major fruit trees grown in the south countries of the Mediterranean Sea[3,4,5,6], and it must be fertilized properly to provide enough nutrients to form the fruit yield and to stay healthy and pest free[7,8,9,10,11].The needs of olive trees with respect to N, P, and K are comparable to the needs of other fruit. It is vital importance that, the loss of nutrients are replaced through appropriate fertilization. The integration of organic and inorganic sources of nutrients not only supplied essential elements but also some positive interaction with chemical fertilizers to increase their efficiency and thereby reduce environment hazards.

The limited water availability in the Mediterranean ecosystems and the current and predicted decrease of water resources are leading to the urgent need to reduce water use for irrigation in the arid and semi-arid regions. Since irrigation is essential to ensure optimal yield, it is imperative to develop sound and efficient irrigation methods for olive groves, with irrigation scheduling techniques based on the plant's actual need and optimal use of water.

Materials and Methods

A field experiment was conducted in the Agricultural Experimental Station of the National Research Centre at El-Bostan area, Egypt, during the two successive seasons of2012 and 2013.Sandy soil in texture(coarse sand 75.97, fine sand 21.64, silt 1.48 and clay 0.91) with 8.8pH, 0.4 dSm^{-1} EC was used. Two olive cultivars (*Olea europaea* L. cv. Picual as Dual Purpose, and Kronaki as olive oil production) were used. The trees were 6-year-old with planting distances of 5×5 m.(168 tree per fed.), which were irrigated with drip irrigation. (Six rows of the trees were used, each row contain 20 olive trees). The drip irrigation network consisted of two laterals for every row of trees. The laterals were situated 50 cm from the trunk on both sides of the tree. Six online emitters were devoted for each tree (3 emitters on each side). The emitter discharge was 8 L/h. treatments of irrigation requirement as 100% of estimated crop evapotranspiration in mm/ day (ETc.) during two years (as control), 66% and 33%, of ETc. Irrigation was carried out according to the methodology proposed by Allen *et al.*[12].

Five N fertilization treatments were applied as follow: 100% chemical fertilizers (F_1). 75% chemical fertilizers + 25% organic fertilizers (F_2).50% chemical fertilizers +50% organic fertilizers (F_3).25% chemical fertilizers +75% organic fertilizers (F_4) and 100% organic fertilizers (F_5). Organic amendments application rates were depend on the total N content of the farmyard manure (1.14%) followed the recommended fertilization for olive according to the recommendations of Ministry of Agriculture in Egypt for new reclaimed soils. The recommended doses of fertilizers for olive trees age 6 years are; 4 kg ammonium sulphate 20%N + 2 kg potassium sulphate 50% K_2O +1.5 kg mono supper phosphate 15.5% P_2O_5.Olive fruits were hand-picked and prepared for chemical analysis[13]**,**the fruits were harvested for determination the yield of each tree as Kg/ tree.

This experiment was conducted to study the influence of partial replacement of ammonium sulphate by FYM and the amount of irrigation water on olive fruits productivity and its content of some macronutrients.

Results and Discussion

Fruit yield

The data illustrated in Fig. (1) show that, the highest value record at 66% followed by 100% then 33% of ETc, there are 9.16, 8.20 and 5.65 Kg/tree respectively. Such results are in close agreement with Andria and Morelli[14]**,** stated that, fruit yield of five olive cultivars increased with increasing the irrigation water supply. Also, [15]compared the effect of three irrigation treatments 0, 33 and 66% of ETc on yield of Chemlali olive cultivar. They pointed out that, 66% ETc gave the highest yield (37 Kg /tree). compared with the other treatments. Also, [16]the increment of fruit yield was related to increasing the amount of irrigation water.

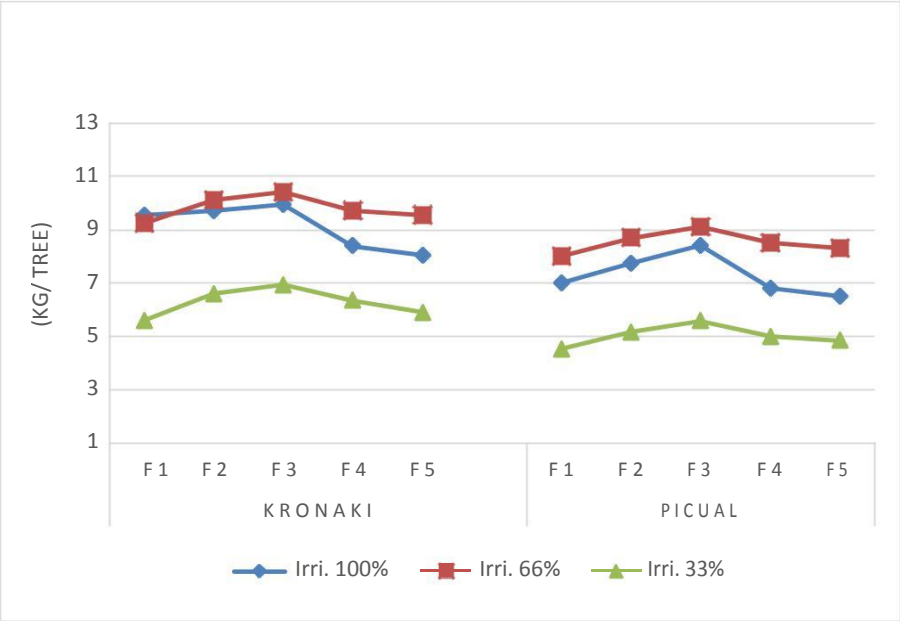


Fig. (1): Effect of irrigation and fertilization treatments on fruit yield of the two olive cultivars.

In case of fertilization treatments, data indicate that, the fertilization treatment F_3 (50% chemical + 50% organic fertilizers) give the highest yield 8.4 Kg/tree, These results are confirmed with the finding of Maksoud *et al.*[17] who found a positive close correlation between rate of ammonium sulphate application and yield of olive fruit. While, [18] indicated that, nitrogen fertilization as ammonium nitrate significantly decreased fruit weight and flesh weight of Picual and Chemlali trees, [19] noticed that, nitrogen fertilization improved yield of Picholine olive cultivar (35 year old), while the yield of Moroccan 9 years old cultivar and Arbequina 7 years old, don't affected by nitrogen applications. Maksoud *et al.*[20] added that, the application of 30% of different organic composts increased the fruit yield of olive cultivars.Abd-Alhamid et. al., [2] pointed out that, nitrogen fertilizer as ammonium sulphate combined with bio-fertilizer significantly increased total yield of Manzanillo olive trees compared with the control.

Data show also that, there is a significant difference between fruit yield of the two olive cultivars .the mean values of yield for Kronaki is 2.4 Kg/tree. while it 6.9 Kg/tree for Picual. These results was agreement with [21,22] reported that, Kronaki olive cultivar presented a highly significant yield per tree than Toffahi and Picual cultivars, this variance may be due to Kronaki cultivar had a higher percent of fruit set with lower fruit dropping compared with Toffahi and Picual olive cultivars.

Concerning the interaction effect between irrigation and fertilization treatments, data indicate that, irrigation treatment (I_2) record the highest yield under all fertilization treatments, it reach 8.625, 9.402, 9.750, 9.111 and 8.925 Kg/tree under the fertilization treatments of F_1, F_2, F_3, F_4 and F_5, respectively. Moharam and Zeen El- Deen[23] investigated the effect of the partial replacement of NPK mineral fertilizers by olive solid waste (OSW) under supplemental irrigation on yield of peaches. The obtained results indicated that, application of 50% NPK + 50% compost OSW of recommended doses under supplemental irrigation gave the best results for yield.

Fruit mineral contents:-

Nitrogen:

Data illustrated in Fig. (2) show that, in both seasons, gradually decrease of nitrogen concentration with increasing the ratio of organic fertilizer in the fertilization treatments. The treatment (F_5) 100% farmyard manure give the lowest value of nitrogen concentration which compared with the other treatments. It record 1.143, 1.015, 0.918, 0.817, and 0.688% in the first season, while it were 1.573, 1.432, 1.412, 1.295 and 1.163% in the second season under the fertilization treatments of F_1,F_2,F_3,F_4 and F_5, respectively.

Fig. (2) Effect of irrigation and fertilization treatments on fruits nitrogen concentration of the two olive cultivars in the two seasons.

The data generally show also that, fruit nitrogen concentration decreased with reducing irrigation water rates. Such results are in close agreement with Hussein[24]who found that, increasing irrigation levels from 25 to 35 m^3/tree / year significantly increased fruit nitrogen content of olive tree 7 years old, he attributed this increment to increasing water supply and improving the root function which enhanced the absorption of many nutrients. Also, El-Hassanin *et al.*, [25]added that, decreasing irrigation water levels reduced nitrogen concentration of olive leaves. Irrigation treatment I3 give the lowest nitrogen concentration under all fertilization treatments. The data indicates also that, the mean values of nitrogen concentration are higher in the second season than in the first one. Statistical analysis reveal that, increasing chemical fertilizers significantly increased fruit nitrogen concentration in both seasons. Tekaya *et al.*[26]studied the effects of nitrogen fertilization as foliar application on mineral elements of olive fruits of Picholine olive cultivar. Results pointed out that, nitrogen fertilization caused a significant increase of fruit nitrogen level.

With regard to the interaction effect between irrigation, fertilization treatments and olive cultivars on fruit nitrogen concentration, the highest value record in Kronaki cultivar under F_1 I_1 (1.155 %),while the treatment of F_1 I_2 record the highest nitrogen concentration (1.407%) in Picual cultivar. With regard to the

second season the highest nitrogen concentration for Kronaki and Picual was 1.795% and 1.799 under F_1 I_1treatment,while the lowest nitrogen concentration value is notice at F_5 I_3 1.078% and 0.930% for the two cultivars.

Phosphorus:-

Data in Table(1) show the effect of fertilization treatments on fruit phosphorus concentration, gradually the phosphorus concentration decrease with increasing the ratio of organic fertilizer in different fertilization treatments. The treatment (F_5) 100% farmyard manure give the lowest value of phosphorus concentration comparing with the other treatments in the both seasons. The data show also that, phosphorus concentration is higher in the second season than the first one. Statistical analysis show that, increasing nitrogen chemical fertilizer significantly increased fruit phosphorus concentration in both seasons. Heidari and Mohammad[27] evaluated the effect of three levels of nitrogen fertilization (75,150 and 225 Kg N /ha)on Kiwi (M. charantia) the results pointed out that ,increasing olive nitrogen fertilization levels from 75 to 225 Kg N/ha, increased the fruit phosphorus content. Also, [26] revealed that, a significant increase of fruit phosphorus concentration by adding nitrogen fertilizer as foliar application to Picholine olive cultivar. On the other hand, Malek and Mustapha[28]reported that, there was no effect of nitrogen fertilization on the phosphorus content of Arbequina olive cultivar.

Table. (1) Effect of irrigation and fertilization treatments on fruits phosphorus concentration of two olive cultivars in the two seasons.

Cultivars (Cv)	Fertilization (F)	2012 Irrigation (I) 100%	66%	33%	Mean	2013 Irrigation (I) 100%	66%	33%	Mean
Kronaki	F_1	0.034	0.025	0.022	**0.027**	0.105	0.093	0.092	**0.097**
	F_2	0.033	0.025	0.020	**0.026**	0.097	0.092	0.092	**0.094**
	F_3	0.032	0.024	0.021	**0.026**	0.096	0.088	0.088	**0.091**
	F_4	0.032	0.023	0.019	**0.025**	0.096	0.086	0.076	**0.086**
	F_5	0.029	0.022	0.019	**0.023**	0.095	0.084	0.072	**0.084**
Mean		**0.032**	**0.024**	**0.020**	**0.025**	**0.098**	**0.089**	**0.084**	**0.090**
Picual	F_1	0.031	0.029	0.022	**0.028**	0.104	0.093	0.093	**0.099**
	F_2	0.028	0.026	0.021	**0.025**	0.102	0.098	0.093	**0.097**
	F_3	0.027	0.026	0.021	**0.025**	0.098	0.093	0.092	**0.094**
	F_4	0.026	0.025	0.021	**0.024**	0.094	0.092	0.092	**0.093**
	F_5	0.026	0.021	0.021	**0.023**	0.092	0.095	0.084	**0.091**
Mean		**0.028**	**0.026**	**0.021**	**0.024**	**0.098**	**0.096**	**0.091**	**0.095**
	F_1	0.033	0.027	0.022	**0.027**	0.105	0.096	0.093	**0.098**
	F_2	0.031	0.025	0.021	**0.026**	0.099	0.095	0.092	**0.096**
	F_3	0.030	0.025	0.021	**0.025**	0.097	0.091	0.091	**0.093**
	F_4	0.029	0.024	0.020	**0.024**	0.095	0.089	0.084	**0.089**
	F_5	0.028	0.021	0.020	**0.023**	0.093	0.090	0.078	**0.087**
Irrigation mean		**0.030**	**0.025**	**0.021**		**0.098**	**0.092**	**0.088**	
L.S.D 0.05 2012		**I** =0.0003	**F**= 0.00032	**Cv**.=0.0002	**I*F**=0.0006				
		I*Cv=0.0004	**F*Cv**=0.0007		**I*F*Cv**=ns				
2013		**I** =0.00033	**F**=0.00035	**Cv**.=0.0003	**I*F**=0.028				
		I*Cv=0.0005	**F*Cv**=0.0005		**I*F*Cv**=ns				

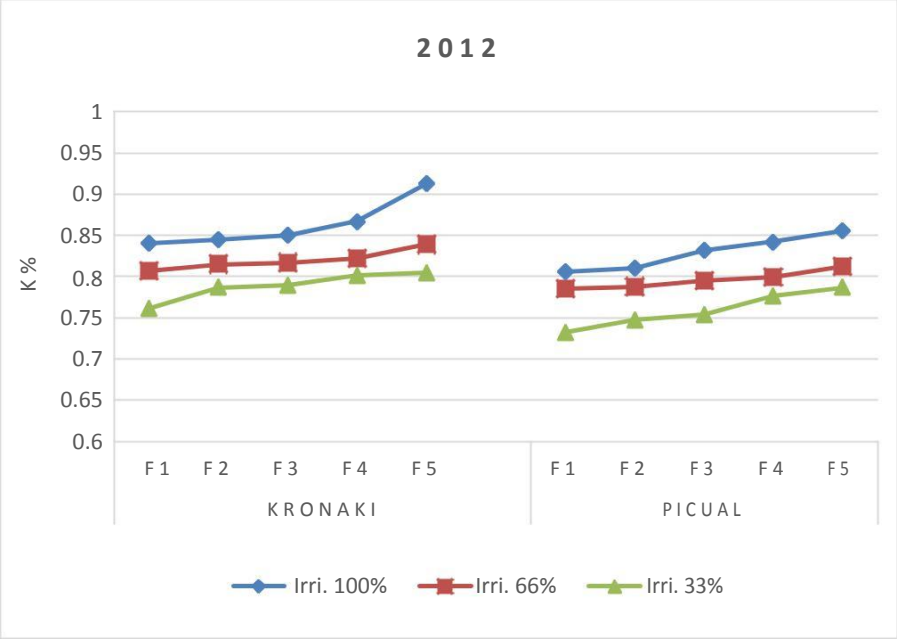
Concerning the irrigation treatments, data show a significant decrement of fruit phosphorus concentration with reducing the amount of irrigation water. Such results are in close agreement with Hussein [24]concluded that, increasing irrigation water level from 25 to 35m^3/tree/ year significantly increased phosphorus fruit content of olive tree 7 years old. Concerning olive cultivar, there is no clear difference between the two olive cultivars about their fruit phosphorus content. With regard to the interaction effect between irrigation, fertilization treatments and olive

cultivars, data show that, fruit phosphorus concentration of Kronaki and Picual cultivars record the highest value under F_1 I_1 (0.034 and 0.031%) in the first season and (0.105 and0.104%) in the second season, respectively, while the lowest phosphorus concentration values in the second season under F_5I_3 are 0.072 and 0.084 for Kronaki and Picual cultivars. Statistical analysis show that, the interaction between these factors have no significant effect on the fruit phosphorus concentration.

Potassium:-

With regard to fertilization treatments, Fig. (3)show that, fruit potassium concentrations are higher in the second season than in the first one. This attributed to increasing soil fertility after using the fertilization program. The mean values of potassium concentration significantly increased with increasing the ratio of organic fertilizer in the different fertilization treatments, in both seasons, there are 0.789, 0.799, 0.806, 0.818 and 0.835% in the first season, and, 1.777, 1.810, 1.838, 1.853 and 1.893% in the second season at the fertilization treatments of F_1, F_2, F_3, F_4, and F_5respectively. These results are confirmed with Heidari and Mohammad [27]who suggested that, increasing nitrogen levels from 75 to 225 Kg N/ ha. increased the fruit potassium content for Kiwi (M. charantia). Also, [26]pointed out that, nitrogen fertilization caused a significant increase of potassium fruit level. They suggested a direct association between the mineral nutrition during the vegetative growth of the olive trees and the mineral element composition of the fruits after harvesting.

Potassium concentration values of fruit significantly decreased with reducing the amount of irrigation water, they record 0.846, 0.808, and 0.774% in the first season, while there are 1.934, 1.819 and1.750% in the second season for irrigation treatment I_1, I_2 and I_3, respectively. This finding is in close agreement with those of [24]who found that**,** increasing the irrigation water levels significantly increased potassium fruit content of olive trees**.** El-Hassanin *et al.*,[25] pointed out that, decreasing irrigation water levels from 100% of ETc to 33% ETc reduced potassium concentration of olive leaves. Concerning the effect of cultivars on fruit potassium concentration, Kronaki olive cultivar contain high potassium concentration 0.824% comparing with Picual 0.795% in the first season, while in the second season the values are 1.804% and 1.864%for Kronaki and Picual, respectively. Statistically, there is a significant difference between the olive cultivars for their potassium concentration in the first season.



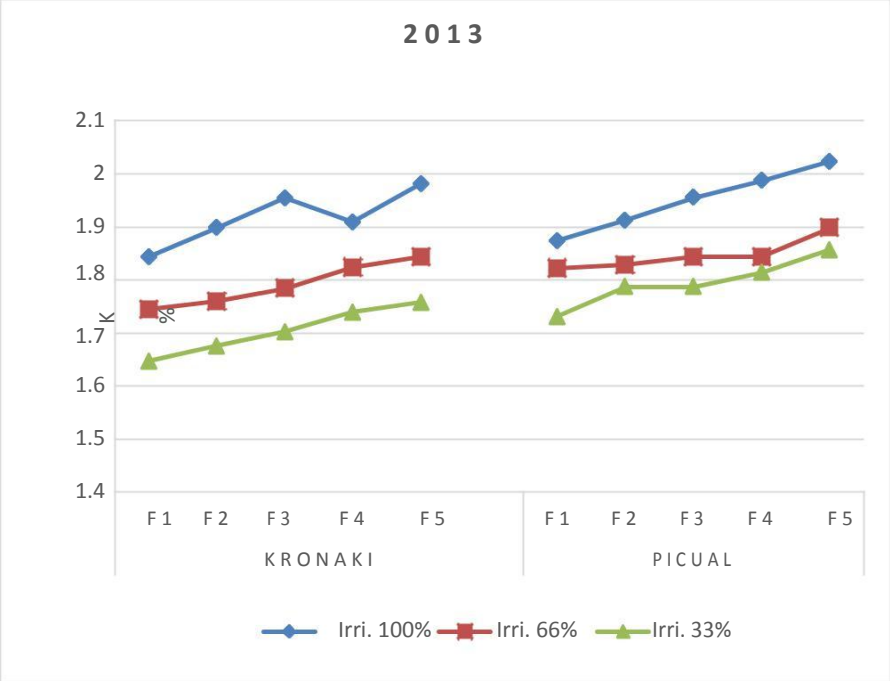


Fig.(3) Effect of irrigation and fertilization treatments on fruits potassium concentration of the two olive cultivars in the two seasons.

About the interaction effect between irrigation, fertilization and olive cultivars on fruit potassium concentration, statistical analysis indicate that, potassium concentration significantly affected by the interaction between these factors in both seasons. Kronaki and Picual cultivars give the highest potassium concentration underF_5I_1 in both seasons, while the treatment F_1I_3 register the lowest value in the first and second seasons.

Calcium:-

Concerning the effect of various irrigation water levels on calcium concentration of fruit olive cultivars. Illustrated data in Table (2) show that, increasing the amount of irrigation water significantly increase calcium concentration of olive fruit in the two seasons, they record 0.542, 0.507and 0.488% in the first season, while they are 0.778, 0.754 and 0.723%in the second season at the treatments of I_1, I_2 and I_3, respectively. These results are quite agreement with the finding of Hussein[24]who stated that, increasing irrigation level from 25-35 m^3/tree / fed. significantly increased fruit calcium content, this increment may be due to increasing of water supply, which improve the root function and vegetative growth, consequently improvement of water and nutrients absorption.

Data show also that, fruit calcium concentration significantly affected by the different fertilization treatments. It is noticeable that, the highest values of calcium concentration are register at the treatment of F_3 (0.524%) and F_4 (0.778%) in the first and second season, respectively. However, the treatment of F_1 record the lowest values in the first season (0.496%) and in the second season (0.712%). Heidari and Mohammad [27]confirmed that, increasing nitrogen fertilization increase the fruit calcium content and various nitrogen levels had significantly affected on the amounts of calcium. With respect to the effect of cultivars on fruit calcium concentration, data indicate that, calcium concentration of Kronaki olive cultivar slightly higher than Picual.

Table. (2) Effect of irrigation and fertilization treatments on fruits calcium concentration of two olive cultivars in the two seasons

Cultivars (Cv)	Fertilization (F)	2012 Irrigation (I) 100%	66%	33%	Mean	2013 Irrigation (I) 100%	66%	33%	Mean
Kronaki	F_1	0.511	0.497	0.479	**0.496**	0.748	0.741	0.735	**0.741**
	F_2	0.539	0.531	0.500	**0.523**	0.798	0.788	0.766	**0.784**
	F_3	0.560	0.510	0.512	**0.527**	0.796	0.788	0.722	**0.769**
	F_4	0.580	0.530	0.510	**0.540**	0.829	0.785	0.760	**0.791**
	F_5	0.541	0.513	0.491	**0.515**	0.773	0.744	0.735	**0.751**
Mean		**0.546**	**0.516**	**0.498**	**0.520**	**0.789**	**0.769**	**0.744**	**0.767**
Picual	F_1	0.521	0.488	0.480	**0.496**	0.722	0.720	0.608	**0.684**
	F_2	0.519	0.508	0.477	**0.501**	0.766	0.737	0.704	**0.736**
	F_3	0.571	0.500	0.492	**0.521**	0.785	0.713	0.700	**0.733**
	F_4	0.543	0.498	0.472	**0.504**	0.770	0.766	0.757	**0.764**
	F_5	0.533	0.495	0.472	**0.500**	0.798	0.756	0.745	**0.766**
Mean		**0.538**	**0.498**	**0.478**	**0.505**	**0.768**	**0.739**	**0.703**	**0.737**
	F_1	0.516	0.493	0.479	**0.496**	0.735	0.731	0.671	**0.712**
	F_2	0.529	0.519	0.488	**0.512**	0.782	0.763	0.735	**0.760**
	F_3	0.565	0.505	0.502	**0.524**	0.790	0.750	0.711	**0.751**
	F_4	0.562	0.514	0.491	**0.522**	0.800	0.776	0.758	**0.778**
	F_5	0.537	0.504	0.482	**0.508**	0.785	0.750	0.740	**0.758**
Grand mean		**0.542**	**0.507**	**0.488**		**0.778**	**0.754**	**0.723**	
L.S.D 0.05	**2012**	**I** =0.0018	**F**=0.004	**Cv**=0.0022	**I*F**=0.0056				
		I*Cv=0.004	**F*Cv**=0.0049		**I*F*Cv**=ns				
	2013	**I** =0.0029	**F**=0.0034	**Cv**=0.003	**I*F**=0.006				
		I*Cv=0.005	**F*Cv**=0.0021		**I*F*Cv**=0.014				

Concerning the interaction effect between irrigation, fertilization treatments and olive cultivars on fruit calcium concentration, data show that, the highest fruit calcium concentration for Kronaki cultivar record at F_4 I_1 (0.580and 0.829%) in the first and second season respectively, while the highest value(0.571%)record under the treatment of F_3 I_1 in the first season and (0.798%) at F_5 I_1treatment in the second season in case of Picual cultivar. Statistically, the combination between these factors significantly affected the calcium concentration of olive fruits in the second season.

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