

# Effects of Melatonin Applications on Yield and Some Fruit Quality Characteristics Pomegranate ( *Punica granatum* L.).

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Melatonin which has found in the roots, leaves, fruits and seed, have important effects in plant growth and development. Melatonin concentrations in plants increase under various stress conditions. Increasing melatonin concentrations provides stress resistance. In this study, the effects of melatonin (100 ppm, 75 ppm, 50 ppm) spray on yield and fruit quality were studied in irrigated and non-irrigated pomegranate orchards in Muğla province which is the main pomegranate producing region after Antalya province. Application of melatonin was applied in full blossoming. Yields (Average fruit weight, average fruit size, fruit juice yield, fruit grain yield) and some fruit quality characteristics (antioxidant activity, total phenolic content, anthocyanin, vitamin C) were determined. The maximum average fruit weight were determined in (374,18g) 75 ppm - irrigated and (304,341g) 100ppm- non irrigated treatments. The maximum antioxidant activity were measured in (26.791µl/ml) 100ppm- irrigated and (148,7µl/ml) 100ppm- non irrigated samples. And anthocyanin contents and vitamin C concentrations were increased in highest melatonin treatments. Key words: Melatonin, pomegranate, abiotic stress, tolerance, fruit quality

## INTRODUCTION

Pomegranates (*Punica granatum* L.) are one of the most important commercial fruits in Turkey especially for Subtropical region. In these area, climate is very hot, with dry summer season and mild and rainy winters (Mediterranean Climate). A large proportion of pomegranate orchards were located in this regions with seasonal drought where soil and atmospheric water deficits, together with high temperatures, cause significant yield and quality losses. There is not so much information about that the mechanisms of pomegranate trees have developed to cope with drought and water stresses (Rodriguez vd., 2012).

Melatonin, which has proven to be ubiquitously synthesized in plant organs, plays vital role in many events such as plant propagation, growth and development, stress tolerance ( Park et al., 2012; Nawaz et al,2016). It has been shown that the application of melatonin on apple (Wang vd.,2012) cucumber ( Zhang et al.,2013) rice (Park et al., 2013) and grape (Vitalini vd.,2013) soybean ( Wei et al.,2014), tomato (Liu et al.,2015) , reduce the negative effects of water stress.

The objective of this study was to determine if the melatonin application at Hicaznar pomegranate will tolerance to drought stress at irrigated and non-irrigated treatments.

## MATERIALS AND METHODS

The experiment was carried out 2016 season on 10 years old pomegranate trees ( *Punica granatum* L.) Hicaznar Cultivar located within the Ortaca Region of Mugla Province. Tree spacing were 3m X 5 m. Irrigation treatments applied were full irrigated (FI) and non irrigated (NI). Full irrigated water was applied with six drip emitters (4 Lh-1) and placed in double lines parallel to the tree stem. Irrigation application was performed according to criteria used by the pomegranate growers. Non irrigated was applied as % 25 of full irrigation from May to September. 50,75,100 ppm melatonin were applied in the full blossoming period.

Table 1. Month and meteorological event years of 2015 and 2016

Month and meteorological event	May	June	July	August	September	October
<b>2015</b>						
Average temperature (°C)	19.8	23.3	26.6	27.0	25.2	20.8
Maximum temperature (°C)	25.4	28.4	32	33.2	30.9	26.6
Minimum temperature (°C)	13.9	17.3	20	22.1	19.8	15.4
Relative humidity (%)	71.3	65.2	60.8	59.9	64.9	64.8
Rain (mm)	15.2	0.4	0.8	0.0	72.6	77.8
<b>2016</b>						
Average temperature (°C)	19.4	23.4	27.5	27.2	24.3	20.5
Maximum temperature (°C)	25.1	28.4	32.8	31.7	28.7	25.8
Minimum temperature (°C)	13.2	18.3	21.5	21.5	18.7	14.1
Relative humidity (%)	63.4	63.2	60.8	66.1	55.3	60.0
Rain (mm)	60.6	20	0.0	0.0	6.2	33.8

The experiment was laid out in randomized design in split plots, with three replications. Pomegranate fruits were harvested at the end of the October 2016.

DPPH method was used to test the antioxidant activity of pomegranate juices. Folin-Ciocalteu reagent method ( Singleton and Rossi,1965) was used to test the total phenols. Results were expressed as mg GAE 100g-1 FW. Total anthocyanin was determined according to the ph differential spectroscopic method ( Cheng and

Breen, 1991). Ascorbic acid was determined according to the method of spectrophotometrically at 525nm according to the procedure of (Hodges et al.,2001)

## RESULTS AND DISCUSSION

Some physical characteristics of Hicaznar Pomegranate cultivar which was melatonin applied in irrigated and non irrigated treatments were presented on Table 2.

Table 2. Some physical characteristics of Hicaznar Pomegranate cultivar

W.situation	Application	Yield(kg/tree)	F. Weight(g)	F.Diameter(mm)	Aril yield(%)	F.Juice Yield (%)
I	100ppm	23.33	278.53	79.08	41.98	30.75
I	75 ppm	17.33	<b>374.18</b>	<b>90.96</b>	50.77	36.13
I	50ppm	<b>21.48</b>	326.19	85.35	<b>57.55</b>	<b>39.21</b>
I	Control	9.34	304.66	86.78	50.38	34.99
NI	100 ppm	5.74	304.34	81.17	49.24	33.32
NI	75 ppm	0.56	190.57	74.03	58.43	43.26
NI	50 ppm	4.05	289.18	79.29	60.06	35.22
NI	Control	1.59	173.58	70.32	54.42	21.58

I: Irrigated NI: Non Irrigated

The maximum average fruit weight were determined in (374,18g) 75 ppm - irrigated and ( 304,341g) 100ppm- non irrigated treatments. In this study, the fruits which treated melatonin 75 ppm- irrigated and 100 ppm- non irrigated were significantly heavier than the other applications. In grape berries, melatonin applications to pre-veraison fruits increased fruit weight. For 100 berries, the weight was 151g for fruits treated twice with melatonin, whereas control fruits were only 142 gr (Meng et al., 2015). Some chemical characteristics of Hicaznar Pomegranate cultivar which was melatonin applied in irrigated and non irrigated treatments were presented on Table 3.

Table 3. Antioxidant activity, total phenolic, anthocyanin and Vitamin C composition of pomegranate

W.situation	Application	Antioxidant activity		Total Phenolic		Total Anthocyanin		Vitamin C	
		µl/ml		mg GAE/L		(mg/L)		mg/100ml	
		mean	SE mean	mean	SE mean	mean	SE mean	mean	SE mean
I	100ppm	<b>26.81</b>	0.06 c*	508.33	0.31 b*	228.17	0.03bc*	<b>64.26</b>	0.01 a*
I	75 ppm	16.10	2.01 cd	527.40	49.8 b*	<b>286.2</b>	5.65 a	53.06	3.49ab
I	50ppm	16.29	0.70 cd	<b>528.50</b>	38.3 b	172.5	15.8cd	57	0.6ab
I	Control	2.27	0.01 d	708.78	0.20 ab	167.71	0.02 d	47.07	0.87 b
NI	100 ppm	<b>148.70</b>	10 a	<b>1277</b>	372 a	229.9	13.2 ab	27.59	8.51 d
NI	75 ppm	13.12	0.10 cd	1079.1	0.25ab	230.49	0.14 ab	28.10	0.15 cd
NI	50 ppm	12.80	3.71 cd	810.4	58.9 ab	<b>267.6</b>	28.1 ab	<b>42.99</b>	2.47 bc
NI	Control	44.55	0.02 b	952.76	0.18ab	168.67	0.00 d	24.00	0.01 d

\*The differences between the numbers shown in the same column with different letters are statistically significant ( $P \leq 0,01$ )

I: Irrigated NI: Non Irrigated

Melatonin 100 ppm application ( non-irrigated) caused high increased in antioxidant activity ( 148µl/ml). Antioxidant activity was showed increased except control ( irrigated) in all melatonin applications either irrigation or non irrigated. The total phenolic of applications were varied of 508,33 to 1277 mg GAE/L. The highest total phenolic value were determined in 100 ppm non irrigated treatment ( 1277 mg GAE/L ) . Total antocyanins values were determined between 167,71- 286,2 mg/L. Highest value was observed in 75 ppm melatonin application ( 286,2 mg/L ) with irrigated. Highest vitamin C value were observed in 100ppm melatonin application ( 64,26 mg/100ml) with irrigated. (Zhang et al., 2016) reported that melatonin application had resulted in a significant increase in anthocyanin accumulation and up-regulated antioxidant activities in cabbage sprouts.

Table 4. Comparison of water situation for some chemical characteristics of Hicaznar Pomegranate cultivar

Water situation	Antioxidant activity µl/ml	Total phenolic	Total Anthocyanin	Vitamin C
		mg GAE/L	(mg/L)	mg/100ml

Irrigated	15,37	b*	568,26	b*	213,64	a*	<b>55,35</b>	a*
Non irrigated	<b>54,79</b>	a	<b>1029,84</b>	a	<b>224,16</b>	a	30,67	b

\* The differences between the numbers shown in the same column with different letters are statistically significant ( $P \leq 0,01$ )

The values we obtained in our study shows that antioxidant activity, total phenolic, total anthocyanins were increased in non irrigated pomegranate trees (Table 3). Pomegranate plants confort water stress by developing stress avoidance and stress tolerance mechanisms (Rodriguez et al., 2012). (Stefanelli et al., 2009) reported that despite a marginal fruit size decrease, a 50% or more reduction of irrigation volumes increased fruit phenolic content without diminishing total yield in Royal gala apple. In our study, similar results with literature were founded. Total phenolic was 568,26 mg GAE/L in irrigated treatments while 1029,84 mg GAE/L in non irrigated treatments. There are few published studies investigating the effects of low water availability on ascorbic acid content (Stefanelli et al., 2010).

Table 4. Comparison of melatonin application doses for some chemical characteristics of Hicaznar Pomegranate cultivar

Application	Antioksidant aktivty		Total phenolic		Total Anthocyanin		Vitamin C	
	$\mu\text{l/ml}$		mg GAE/L		(mg/L)		mg/100ml	
100 ppm	<b>87,75</b>	a*	<b>892,75</b>	a	229,03	ab*	45,93	ab*
75 ppm	14,61	b	803,25	a	<b>258,35</b>	a	40,58	bc
50 ppm	14,54	b	669,43	a	220,02	b	<b>49,99</b>	a
Control	23,41	b	830,77	a	168,19	c	35,54	c

\* The differences between the numbers shown in the same column with different letters are statistically significant ( $P \leq 0,01$ )

100 ppm melatonin application caused maximum increase not only antioxidant activity but also total phenolic.

## CONCLUSION

Pomegranates have very important for health because of anhocyanin and phenolics substances. Generally, pomegranate orchards located in Mediterranean climate. In this research which was conducted to increase of these components with melatonin treatments in irrigated and non irrigated situation. we determined that melatonin treatments have positive effect according to control plot not only irrigated but also non irrigated. 100ppm melatonin applications have the most effective results for antioxidant capacity and total phenolic content and fruit weight. All non irrigated melatonin applications have the most effective for all chemical characteristics except Vitamin C. These melatonin treatments and less watering can be recommended.

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