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Effect of GA_3 and BRs spray on growth and leaf mineral content of olive transplants

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Abstract: *This study was conducted in the olive orchard, Civil engineering department, College of Engineering– University of Baghdad- Jadiriyah during 2015 and 2016 growing seasons to investigate the influence of gibberellins spray (GA_3) and brassinolide spray on 3 year's old trees of "Nebali" olive cultivar.This study included two factors;Threeof GA_3 spray were used, 0, (GA_0), 100 (GA_{100}), 200 (GA_{200})mg.L^{-1} and the second factor includedthree levels of brassinolide, 0 (BR_0), 1mg.L^{-1} (BR_1) and 2mg.L^{-1} (BR_2) and their interaction.Each treatment replicated three times with a factorial experiment using RCBD. The numbers of transplants used were 27transplants. The experimental results showed that GA_3spray at 200 mg.L^{-1} and BRs spray at 2mg.L^{-1} significantly gave the highest leaves area of 1170 and 1311 cm^2, the highest increased in stem diameter of3.25 and 3.48 mm, andleaf chlorophyll content of 36.86and34.40mg.g^{-1},the highest nitrogen leaf content of 1.62 and 1.80 % and potassium leaf content of 1.66 and 1.70 for both seasons, respectively. The lowest value of these parameters was found in the control treatment. It could be concluded of this experiment that the GA_3spray at level 200 mg.$L^{-1}$and BRs spray at level2mg.L^{-1}improved vegetative characteristics in olive transplants cv.Nebali.*

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I. Introduction

Olive (*Olea europaea* L.) has been known as ''the fragrance of thesoft gold'' due to its high economic, social and cultural values. Nowadays ,olive is the most extensively cultivated oleiferous tree species in the world, covering an area of 10 million of hectares (Yang et al., 2007). There aremore than 1200 olive cultivars. Among them, more than 800 cultivars are foroil production, over 100 are table olives and the rest are used for dualpurpose(Bartolini et al., 1998). Olive is an evergreen tree grown primarily between 30 and 45° latitude in bothhemispheres. Current olive groves are estimated at approximately 960 million olive trees, of which some 945million (98% of the total), are found in the Mediterranean Basin countries where they cover approximately 9.3million hectares. Approximately 50 million olive trees are under irrigation, but most groves are rained. Oliveplantations have shown a continuous increase since 1987 with a spectacular increase of the irrigated area inmany countries. The average annual production is 14 million tones of olives, of which 90% are used for oilproduction and 10%, are used for the table olives. In 2008 total harvested area was over 10 500 000 ha, 95.5percent of which was concentrated in ten countries surrounding the Mediterranean Sea (FAO, 2011). Spain , Italy and Greece are the main producers of virgin oil followed by Tunisia, Syria, Turkey and Morocco (years2002-2008).

Gibberellins it is the second group of plant hormones that were discovered after auxins, are tetracyclic diterpenoid acids, biologically effective in stimulating cell division or elongation or both ,they also have a role in the phenomenon of genetic dwarfism of plants and their influence in the process of formation of flowers and parthenocarpic fruits and the removal of seed dormancy and buds(Al-Khafaji, 2014).(Shayal Alalam, 2009) Mentioned that the foliar spray with 50 mg GA_3.L^{-1} caused significant increase in leaves P concentration, leaves number, trees leaf area, leaves carbohydrates concentration and main stem diameter, mean while the foliar spray with 100 mg.GA_3.L^{-1}causedsignificant increase in leaves N concentration and trees height compared with the control treatment in his study on peach trees. (Al.mousawi, 2013) Fount that foliar spray with Gibberellic acid at 500mg.L^{-1} caused significant increase in height and diameter of the main stem, number of branches, leaves area, total chlorophyll in leaves and nitrogen , phosphorus, potassium and carbohydrates percentage in olive leaves. (Hassan, 2010) Recorded that, highest content of leaves N, K, Fe and Zn it was in the plum trees treated with gibberellic acid (GA_3) as foliar spray. (Al-Rawi et al., 2016) Found that the spray peach trees with gibberellic acid atmg.L^{-1}gave the highest leaf N, K, Zn and chlorophyll content,total leaves area and leaf carbohydrates content.

Brassinosteroids (BRs) are a class of poly hydroxylsteroids which have been recognized as a class ofplant hormones. These were first explored whenMitchell et al.(1970) reported that cell division andelongation

were promoted by the treatment of organicextracts of rape (*Brassica napus*L.) pollen .Brassinolide (BL) was the first isolatedbrassinosteroid when Michael et al.(1979) isolatedthe biologically active molecule .Montoya et al. (2005) showed that brassinosteroids are essential for many physiologicalfunctions in plants, however little is knownconcerning where and when they are synthesized. Inyoung tomato seedlings BR synthesis activity wasobserved mainly in apical and root tissues undergoingexpansion.Various studies have shown that plant growth regulatorssprays, especially brassinolide had beneficial effects with respect to yield and growth. Kaironget.al (2006) reported that Brassinolide spraying increased theleaf dry weight,shoot length of 'Red Fuji' apple trees.Abubakaret.al (2013) showed that foliar sprays of Homobrassinolidesignificantlyincreased shoot length, trunk diameter and leaf area in 'Kandhari Kabuli' pomegranate trees. Al-Hadethi (2015) reported that there was a positive correlation between the vegetative characteristics, leaf mineral content and brassinolide concentrations of apricot trees.The target of this study was to evaluate "Nebali" olive cultivar parameters under using GA_3 and BRs spray.

II. Materials And Methods

This study was conducted in the olive orchard, Civil engineering department, College of Engineering– University of Baghdad- Jadiriyah during 2015 and 2016growing seasons to investigate the influence of gibberellins spray (GA_3) and brassinolide spray on 3 year's old trees of "Nebali" olive cultivar. Trees were cultivated at 3 X 3 m apart under basin irrigation system. Trees were healthy, similar in vigor and subjected to the same horticultural practices adapted in the region. This study included the following treatment: three levels of spraying of GA_3, 0 (GA_0), 100mg.L^{-1}(GA_{100}) and 200mg.L^{-1}(GA_{200}) and three levels of brassinolide, 0 (BR_0), 1mg.L^{-1} (BR_1) and 2mg.L^{-1} (BR_2) and their interaction. Treatments were replicated three times at factorial experiment in a completely randomized block design. The number of transplant used was 27 transplants. The following parameters were determined in the two successive seasons:

1. Leaves area (cm^2): By taken ten leaves from the middle position of the shoot randomly and measuring leaf area (cm^2). By Digimizer program Windows 7 operating system, then mean of leaf area × number of leavesto calculate the total leaves area.
2. Increase in stem diameter (mm): Stem diameter were measured by (Vernier) at the beginning and end of the experiment, according to the difference between them and that such an increase in stem diameter and both seasons.
3. Leaf chlorophyll contents (mg.g^{-1} fresh weight): Representative fresh leaf sample at middle part of shoots were taken in the first week of June and used for analysis of chlorophyll were calorimetrically according to (Mackinny, 1941).
4. Leaf mineral content: Leaf samples were collected for chemical analysis at the 1st week of June of both seasons. Each sample consisted of 20 leaves / tree. Leaves were washed several times with tap water, rinsed with distilled water, and then dried at 70 c^0 until a constant weight, ground and digested according (Chapmanand Pratt, 1978). Nitrogen was estimated by semi-micro kieldahl method of (Plummer, 1974). Phosphorus was determined by the method outlined by (Jackson, 1973). Potassium was determined using atomic absorption spectrophotometer "Perkin Elmer 1100B" after samples digested according to (Chapman and Pratt, 1978).Iron, Manganese and Zinc weredetermined as ppm using atomic absorptionaccording to (Carter, 1993).

The obtained results were subjected to analysis of variance according to (Elsahookie andWuhaib, 1990) using L.S.D 0.05 for comparing differences between various treatment means.

III. Results And Discussions

Effects of $GA_3$and BRs spray on leaves area,Increase in stem diameterand Leaf chlorophyll contents: Data concerning the effect of treatments onleaves area, increase in stem diameter andleaf chlorophyll contentsduring the two experimental seasons are listed in Table (1). The data cleared that, GA_3 spray at 200mg.L^{-1} significantly increased leaves area of 1166 and 1288 cm^2, increase in stem diameter of 3.06 and 3.32 mm and leaf chlorophyll contents of 35.92 and34.19mg.g^{-1} fresh weightfor both seasons, respectively. Table (1) also shows that the sprayed BRs at levels2mg.L^{-1}significantly superiority of the control treatment and gave the highest leaves area of 1155 and 1279 cm^2, increase in stem diameter of 3.12 and 3.33 mm and the highest leaves chlorophyll content of 34.46 and 34.00 mg.g^{-1} fresh weightfor both seasons, respectively. The interaction between BRs and GA_3 significantly affected in all studied parameters.

This is probably due to the increased outputs of the process of photosynthesis and which carbohydrates when spraying this level of gibberellic acid , which are used in various processes of growth, and this is in line with the sentiments (Mostafa and Saleh, 2006) that the foliar spraying of gibberellic acid has the ability to stimulate plant growth and development, working to increase the speed of the process of photosynthesis. The gibberellic acid may lead to increased side buds open in many plant species, which produce branches and leaves, as well as that Gibberellic acid retards aging and fallen leaves, leading to increase the number of remaining leaves on the trees until the end of the season (Al-Khafaji, 2014). Generally, these results are in harmony with

those reported by (Al-Zebari, 2008 and Shayal Alalam, 2009) when they worked on peach trees. Also, (Al-Rubaie, 2011) decided the same results on olive trees.These results are probably due to the role of BRs, BRs have been shown to be involved innumerous plant processes such as promotion of cell expansion and cell elongation(Al-Khafaji, 2014),These results are conveyable withMohamed and Sherif (2015) on peach trees and Al-Hadethi (2015) on apricot trees.

Table 1. Effects of GA_3 and BRs spray on leaves area, Increase in stem diameterandleaf chlorophyll contentsofNebaliolive transplants during 2015 and 2016 seasons.

season	2015				2016			
GA_3	BRs (BR)				BRs (BR)			
	0	**1**	**2**	**mean**	**0**	**1**	**2**	**mean**
	Leaves area (cm^2)							
0	1132	1141	1143	**1139**	1243	1256	1259	**1253**
100	1144	1148	1151	**1148**	1255	1264	1268	**1262**
200	1163	1165	1170	**1166**	1270	1284	1311	**1288**
mean	**1146**	**1151**	**1155**		**1256**	**1268**	**1279**	
L.S.D5%	**GA_3**	**BR**	**Inter**		**GA_3**	**BR**	**Inter**	
	8.33	8.33	16.66		11.67	11.67	23.34	
	Increase in stem diameter (mm)							
0	2.77	2.84	2.92	**2.84**	2.91	2.98	3.11	**3.00**
100	2.86	2.93	3.19	**2.99**	3.15	3.25	3.39	**3.26**
200	2.90	3.02	3.25	**3.06**	3.16	3.32	3.48	**3.32**
mean	**2.84**	**2.93**	**3.12**		**3.07**	**3.18**	**3.33**	
L.S.D5%	**GA_3**	**BR**	**Inter**		**GA_3**	**BR**	**Inter**	
	0.13	0.13	0.25		0.16	0.16	0.32	
	Leaf chlorophyll contents ($mg.g^{-1}$ fresh weight)							
0	32.12	32.30	32.70	**32.37**	32.88	33.59	33.45	**33.31**
100	33.17	33.72	33.81	**33.57**	33.12	33.76	34.16	**33.68**
200	35.76	35.15	36.86	**35.92**	33.82	34.36	34.40	**34.19**
mean	**33.68**	**33.72**	**34.46**		**33.27**	**33.90**	**34.00**	
L.S.D5%	**GA_3**	**BR**	**Inter**		**GA_3**	**BR**	**Inter**	
	0.48	0.48	0.92		0.39	0.39	0.78	

Effects of $GA_3$and BRs spray on leaf N, P, K content: Data concerning the effect of treatments onnitrogen, phosphor and potassium during the two experimental seasons are listed in Table (2). The data cleared that, GA_3 spray at 200$mg.L^{-1}$ significantly increased and gave the highest leaf nitrogen content of 1.51 and 1.56 % and the highest leaf potassium content of 1.50 and 1.54 % for both seasons, respectively. Table (2) also shows that sprayed BRs at levels 2$mg.L^{-1}$significantly superiority of the control treatment and gave the highest leaf nitrogen content of 1.40 and 1.54 %, and the highest leaf potassium content of 1.47 and 1.51 % for both seasons, respectively. The interaction between BRs and GA_3 significantly affected all studied parameters.

Table 2. Effects of GA_3 and BRs spray on N, Pand Kleaves contentsofNebaliolive transplants during 2015 and 2016 seasons.

season	2015				2016			
GA_3	BRs (BR)				BRs (BR)			
	0	**1**	**2**	**mean**	**0**	**1**	**2**	**mean**
	N (%)							
0	1.04	1.08	1.14	**1.09**	1.09	1.11	1.31	**1.17**
100	1.18	1.24	1.44	**1.29**	1.17	1.26	1.52	**1.32**
200	1.39	1.51	1.62	**1.51**	1.30	1.59	1.80	**1.56**
mean	**1.20**	**1.28**	**1.40**		**1.19**	**1.32**	**1.54**	
L.S.D5%	**GA_3**	**BR**	**Inter**		**GA_3**	**BR**	**Inter**	
	0.10	0.10	0.20		0.13	0.13	0.26	
	P (%)							
0	0.18	0.20	0.20	**0.19**	0.19	0.22	0.23	**0.21**
100	0.20	0.23	0.24	**0.22**	0.21	0.23	0.25	**0.23**
200	0.22	0.26	0.29	**0.26**	0.23	0.25	0.27	**0.25**
mean	**0.20**	**0.23**	**0.24**		**0.21**	**0.23**	**0.25**	
L.S.D5%	**GA_3**	**BR**	**Inter**		**GA_3**	**BR**	**Inter**	
	N.S	N.S	N.S		N.S	N.S	N.S	
	K (%)							
0	1.19	1.23	1.29	**1.24**	1.22	1.33	1.35	**1.30**
100	1.22	1.31	1.45	**1.33**	1.27	1.33	1.49	**1.36**
200	1.34	1.51	1.66	**1.50**	1.39	1.54	1.70	**1.54**
mean	**1.25**	**1.35**	**1.47**		**1.29**	**1.40**	**1.51**	
L.S.D5%	**GA_3**	**BR**	**Inter**		**GA_3**	**BR**	**Inter**	
	0.08	0.08	0.16		0.10	0.10	0.20	

Effects of $GA_3$and BRs spray on leaf Fe, Mn, Zn content: Seen from the results shown in the table (3) the interaction between gibberellic acid and brassinolide are affected significantly. In the case of spray gibberellic acid it had no significant affect on the leaf Zn content. Either when sprayed BRs findings in table (3) that spray at levels 2 $mg.L^{-1}$significantly superiority of the control treatment and gave leaf Fe content of 166.5 and 175.3 ppm, leaf Mn content of 1.914 and 2.065 ppm and leaf Zn content of 19.99 and 21.05 ppm for both seasons, respectively.

Table 3. Effects of GA_3 and BRs spray on Fe, Mn and Znleaves contentsofNebaliolive transplants during 2015 and 2016 seasons.

season	2015				2016			
GA_3	BRs (BR)				BRs (BR)			
	0	**1**	**2**	**mean**	**0**	**1**	**2**	**mean**
				Fe (ppm)				
0	130.2	135.9	156.0	**140.7**	133.2	144.5	162.2	**146.6**
100	135.7	147.2	165.6	**149.5**	138.1	157.1	175.3	**156.3**
200	143.6	159.6	177.9	**160.4**	147.9	163.6	188.4	**166.6**
mean	**136.5**	**147.6**	**166.5**		**139.7**	**155.1**	**175.3**	
L.S.D5%	**GA_3**	**BR**	**Inter**		**GA_3**	**BR**	**Inter**	
	6.36	6.36	12.72		8.16	8.16	16.32	
				Mn (ppm)				
0	1.645	1.766	1.856	**1.756**	1.739	1.891	1.926	**1.852**
100	1.717	1.769	1.917	**1.801**	1.758	1.901	2.107	**1.922**
200	1.723	1.867	1.969	**1.853**	1.780	1.937	2.161	**1.959**
mean	**1.695**	**1.801**	**1.914**		**1.759**	**1.910**	**2.065**	
L.S.D5%	**GA_3**	**BR**	**Inter**		**GA_3**	**BR**	**Inter**	
	0.064	0.064	0.128		0.078	0.078	0.156	
				Zn (ppm)				
0	15.46	17.16	19.57	**17.40**	16.16	18.36	20.61	**18.38**
100	15.77	17.32	20.03	**17.71**	16.57	18.42	21.14	**18.71**
200	15.81	17.45	20.37	**17.88**	16.53	18.55	21.39	**18.82**
mean	**15.68**	**17.31**	**19.99**		**16.42**	**18.44**	**21.05**	
L.S.D5%	**GA_3**	**BR**	**Inter**		**GA_3**	**BR**	**Inter**	
	N.S	1.19	2.38		N.S	1.32	2.64	

The reason for this may be due to increase the growth and spread of root in the soil, as a result of the role of gibberellic acid in the division and cell elongation (Gindia, 2003), which may lead to increased absorption of some nutrients from the soil, including nitrogen potassium concentrations in leaves. Generally, these results are in harmony with those reported by (Desouky, 2016) on olive trees,(Al-Abbassy, 2009 and Al-Hamadany, 2009) when they worked on apricot trees.However, Homo brassinolide, increased nitrogenfixation and enhance soluble protein content andphotosynthesis (Clouse and Sasse, 1996).

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