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ORIGINAL ARTICLES

Effect of potassium fertilizer and foliar spraying with Etherel on plant development, yield and bulb quality of onion plants (*Allium cepa* L).

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ABSTRACT

Two field experiments were carried out during two successive winter seasons of 2010 and 2011 in the experimental station of National Research Centre at Nubaria, Behira Governorate, Egypt to study the response of onion productivity to the application of potassium at different rates and foliar application with growth regulator (Etherel) at different levels. The obtained results showed that: The highest plant vegetative growth character (the tallest plant, the highest leaves number, the heaviest fresh, dry weight of whole plant, total bulbs yield per unit area and dimension of bulb as well as its average weight) were detected with using potassium sulphate at the highest rate (300 kg/fed.). The application of potassium fertilizer at the highest rate gained the highest nutritional values of TSS, protein, N, P, K, Fe, Mn, Zn and Cu. Etherel application at higher level (200 ppm) gave the highest plant growth, total yield and all nutritional values i.e. N, P and K % as well as Fe, Mn, Zn and Cu ppm contents in bulb tissue. 3- The highest values of plant growth criteria, total bulb yield and best nutritional values of bulb tissue were recorded when onion plants fertilized by potassium up to 300 kg/fed. with spraying by the highest level of Etherel as growth regulator (200ppm). 4- Adding the highest rate of potassium fertilizer (300 kg/fed.)and Etherel (200 ppm) gained the highest values of growth promoting phytohormones expressed as mg /g fresh weight of gibberellins and IAA and the lowest value of ABA as growth retardant.

Key words: Onion, Potassium, Etherel, plant growth, bulb yield, Quality and Endogenous hormones.

Introduction

For the importance of onion, trials were made to improve the efficiency of onion plant to grow and bulb formation. One of these trials is using potassium fertilizer with spraying plants by growth regulator (Etherel) at different levels.

Among the major nutrients, potassium plays a vital role in plant metabolism such as photosynthesis, translocation of photosynthetic substrates regulation of plant pores, activation of plant catalysts and resistance against pests and diseases. It is also considered as a quality element as it improves quality parameters of many crops including onion. Potassium improves color, glossiness and dry matter accumulation besides improving, it also keeping bulb quality of onion (Dorais *et al*., 2001). In the same respect, Yadav *et al*., (2003) noticed significantly higher onion yield of bulb and fresh weight of bulbs with application of 150 kg K_2O/ha over other potassium levels. Increased bulb yield of garlic was obtained with application of 150 kg K_2O/ha. However, considering economics of crops balanced use of K_2O fertilizers at 50 kg/ha gave the optimum returns (Tiwari *et al*., 2003). Increasing levels of potassium significantly increased the TSS content of onion bulb. Higher TSS (11.99%) content of onion bulb was obtained in the treatment receiving K at 125 kg/ha which was on parallel with K at 150 kg/ha. while the maximum ascorbic acid content (9.93 mg /100g) was recorded with 50 kg K_2O/ ha. Many investigators studied the response of onion plant to the potassium rates such as Singh and Verma (2001); Mohanty and Das (2002); Sharma *et al*. (2003); Yadav *et al*. (2003); Abd El-Aal *et al*. (2005); El-Bassiouny (2006); El-Desuki *et al*. (2006) and Aisha *et al.* (2007).

Bio-regulators like gibberellins and Ethrel have a particularly interesting role in modern agriculture (Ashraf *et al*., 2010). They have been found to improve the bulb yield and its quality. They can induce leaf senescence as well as generation of reactive oxygen species, which in turn leads to cell death (Chen *et al*., 2010). In the same respect**,** Habba (2003) reported that, foliar spraying of Etherel increased plant height, number of leaves and leaves weight of onion plants. On the same time, increase length, diameter as well as weight of onion bulb. In most cases, spraying Etherel at the highest level may resulted in a promising in the soluble sugar and the chemical constituents. On the other hand, spraying Etherel was not significantly affected fruit weight (Abd El-Fatah *et al*., 2008). However, Tiwari *et al*. (2003) found that, spraying of bio-regulators Etherel at 25 ppm gave the highest plant height and bulb yields. While, at 50 ppm resulted heavier average weight of bulb. Etherel

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application at a higher rate suppressed vegetative growth of onion and reduced both bulb diameter and total yield. While, caused bulb initiation in onion as observed by many investigators (Tendaj, 1993; Singh *et al*., 1995; Lopez *et al*., 2000; Starman and Williams, 2000 and Abd El-Fatah *et al*., 2008).

This work is attempted to evaluate the importance of potassium fertilizer application and foliar sparing of different concentrations of Etherel on vegetative growth, yield and bulb physical and chemical quality of onion.

Material and Methods

Two experiments were conducted at Experimental Station of National Research Centre at Nubaria region, North Egypt during two successive seasons 2010 and 2011 under newly reclaimed sandy soil to study the effect of three application rates of potassium sulphate, i.e. 0, 150 and 300 kg/fed. which were arranged within the main plots, and 3 levels of Etherel spraying (0, 100 and 200 ppm) which were distributed in the sub-plots, on the vegetative growth, total yield and the nutrition all values of bulb tissues of onion plants. Physical and chemical properties of the experimental soil are presented in Table (1). Uniform onion seedlings cv. Giza 20 at 4 to 5 green true leaf stage or 20 cm height, were transplanted in the experimental field on the third week of December in both seasons of 2010 and 2011. Seedlings were planted on drip irrigated ridges of 70 cm width, 10 m length and 10 cm apart on both sides of ridge. Each experimental plot included 5 ridges with a net area of 35 m^2. All agricultural practices for onion crop production in the growing area were carried out as recommended by Egyptian Ministry of Agriculture.

Table 1: Physical and chemical properties of the experimental soil.

Physical properties							
Sand		Clay	Silt	Texture		F.C. %	W.P. %
90.08		9.26	0.66	Sandy		16.57	5.25
Chemical analysis							
EC mmohs/m	pH	Meq/ L					
		Ca	Mg	Na	K	HCO_3	Cl
1.7	8.2	7.02	0.527	0.982	0.31	1.3	0.566

The treatments were arranged in a split plot design with three replicates. Spraying of Etherel was conducted three times; first one after 30 days of transplanting and then every 15 days for the second and third spraying. Spraying was applied in early morning. The full amounts of different sources of phosphorus were applied at the time of final land preparation. However, the nitrogen fertilizer at 120 units/ fed. as ammonium sulphat (20.6%) was side dressed in two equal portions 60 and 90 days after transplanting date. Also, potassium sulphate was added at two equal amounts, the first half was one month after transplanting and the second one 60 days late. The following data were recorded:

1-Plant growth: after 150 days from transplanting, samples of onion plants were taken and plant length (cm), number of leaves/plant, fresh and dry weight of leaves, neck, bulb and total (g/plant) were recorded.

2- Bulb yield and its physical properties: at harvesting time (180 days old) the total weights of bulbs resulting from each experimental plot were recorded and the yield of bulbs as ton/fed. was calculated. Samples of 10 bulbs from each plot were taken and average weight (g), length and diameter of bulb (cm) as well as TSS were recorded.

3- Nutritional elements: at harvesting time onion bulb samples from each plot were taken for elemental analysis, N, P, and K elements in the dry matter of bulb tissue were determined according to the methods described by Pregl (1945); Troug and Mayer (1939) and Brown and Lilleland (1946), respectively. While, Fe, Mn, Zn and Cu concentration were determined using flam ionization atomic absorption spectrophotometer model company name 1100 B according to the method of Chapman and Pratt (1978). Reading of TSS was taken using hand refract meter calibrated as percent sucrose. In addition, protein percentages in bulb were calculated by multiplying nitrogen content by 6.25.

4- Determination of endogenous hormones: Samples for determination of endogenous hormones Indole acetic acid (IAA), gibberellins (GA_3) and abscisic acid (ABA), in fresh leaves were taken after 15 days from the last spraying. Samples were extracted according to the method adopted by Badr *et al* .(1971). Identification and determination of acidic hormones (IAA, GA and ABA) were carried out by Gas Liquid Chromatography (GLC) model and company name.

All obtained data were subjected to the statistical analysis and means were compared according to LSD at 5% level test described by Gomez and Gomez (1984).

Results And Discussion

A-Vegetative growth characters:

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1- Effect of potassium fertilizer:

Table (2) clearly showed that, addition of potassium fertilizer as plant side dressing at different levels caused a significantly effect on plant vegetative growth characters of onion in both seasons of study. However, increasing the potassium addition levels up to 150 kg/fed. of potassium sulphate resulted in the highest plant length which had the highest number of leaves as well as the heaviest fresh and dry weight of whole plant and its different organs, these result are true in both seasons. Moreover, the highest onion plant growth values recorded with that plant which received the highest potassium sulphate level, i.e. 300 kg/fed. It addition K is necessary for carbohydrate manufacture and its deficiency seems to make plant develop, abnormal leaf color, stems and underdeveloped roots (Denizen, 1979). The obtained results are in good accordance with these which results by Abd El-Aal *et al*. (2005); El-Bassiouny (2006); El-Desuki *et al*. (2006) and Aisha *et al*. (2007).

2- Effect of growth regulator Etherel:

Results in Table (2) framed the effect of spraying growth regulators Etherel at different concentrations on vegetative growth characters of onion plant. Spraying onion plants with different levels of growth regulators Etherel increased plant growth in most cases compared with untreated plants (control). These were completely similar in the experiments of 2010/2011 and 2011/2012.The highest mean value of plant growth expressed as plant length, number of leaves, fresh and dry weight of whole plant and its different organs were obtained as a result of spraying Etherel at 200 ppm. The statistical analysis of the obtained data indicated that, the differences within different treatments were great enough to reach the significant at 5% level. Improvement of plant growth characters under spraying with Etherel may be due to the role of these materials on enhancing cell division activity, increasing of proline accumulation of plant and increasing of endogenous phytohormones i.e. increasing promotion hormones (IAA, GA_3 and Cytokinins) and reducing ABA content (Bijay, 1999). This result was harmony with those reported by Tiwari *et al*. (2003); Yu *et al.* (2009); Ashraf *et al*. (2010) and Ouzounidou *et al.* (2011).

3-Effect of potassium fertilizer with Etherel:

The interaction effect of potassium fertilizer as potassium sulphate at levels of 0, 150 and 300 kg/fed. with the treatments of Etherel as spraying at levels of 0, 100 and 200 ppm are presented in Table (2). The recording data showed that the effect of interaction between addition potassium fertilizer and spraying growth regulator Etherel on vegetative growth of onion plants was not significant in both seasons except for dry weight of whole plant in the first season only. Generally, in spite of the in-significant response but the obtained data showed that the highest values of plant growth criteria were recorded when fertilized onion plants by potassium up to 150 kg/fed. with spraying plants with high level of growth regulator Etherel (200ppm) as compared to the other interaction treatments, these results held good in both two experimental seasons.

Table 2: Effect of potassium sulphate and Etherel spraying on growth characters of onion plants during 2010/2011 and 2011/2012 seasons.

K kg/ fed.	Etherel ppm	Plant length (cm)		Number of leaves/plant		Fresh weight (g)								Dry weight (g)							
						Leaves		Neck		Bulb		Total		Leaves		Neck		Bulb		Total	
Seasons		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
0	0	47.00	46.00	9.00	9.67	21.57	23.47	9.27	11.40	77.47	97.23	108.30	132.10	3.79	3.33	2.90	2.28	8.66	11.83	15.35	17.91
	100	51.33	51.67	9.67	11.33	35.90	41.27	15.20	14.97	97.73	104.03	151.03	160.27	3.77	3.80	3.65	2.44	16.82	13.03	24.24	18.81
	200	52.00	53.67	11.33	11.67	38.10	31.23	17.87	15.80	100.80	107.37	154.57	154.40	4.68	4.47	3.84	2.43	17.90	14.53	26.43	21.43
Mean		50.11	50.44	10.00	10.89	31.86	31.99	14.11	14.06	92.00	102.88	137.97	148.92	4.08	3.87	3.46	2.39	14.46	13.13	22.01	19.38
150	0	49.67	53.00	9.33	11.00	39.23	28.87	12.87	17.50	107.67	101.30	159.77	147.67	4.07	4.27	2.62	2.37	12.95	13.08	21.99	20.95
	100	52.33	53.33	11.00	12.33	44.17	31.53	16.60	19.73	107.00	119.17	167.77	174.17	5.33	5.50	4.51	2.47	17.57	15.44	28.36	23.50
	200	52.67	54.67	11.67	12.67	43.30	46.37	21.60	20.83	122.20	121.80	187.10	185.27	5.67	5.60	5.25	2.50	17.92	17.08	28.98	23.85
Mean		51.56	53.67	10.67	12.00	42.23	35.59	17.02	19.36	112.29	114.09	171.54	169.03	5.03	4.46	4.13	2.44	16.15	15.20	26.44	22.77
300	0	51.67	49.33	11.00	12.00	41.67	32.73	15.00	18.43	111.73	117.17	168.40	168.33	5..53	4.15	3.42	2.57	17.44	15.12	24.94	21.84
	100	54.33	55.67	13.67	13.00	43.80	37.83	22.30	22.67	129.23	124.97	197.70	195.77	6.41	4.67	4.94	2.77	22.04	18.15	32.78	24.78
	200	56.67	54.67	14.33	13.33	46.17	48.13	26.10	26.90	180.60	158.23	250.50	222.97	6.55	4.57	5.07	2.63	29.64	17.58	39.91	25.58
Mean		54.22	53.22	13.00	12.78	43.88	39.57	21.13	22.67	140.52	133.46	205.53	195.69	6.17	5.12	4.48	2.66	23.04	16.95	32.54	24.07
Average Etherel	0	49.44	49.44	9.78	10.89	34.16	28.36	12.38	15.78	98.96	105.23	145.49	149.37	4.76	4.48	2.98	2.41	13.02	13.34	20.76	20.23
	100	52.67	53.67	11.44	12.22	41.00	33.53	18.03	19.12	111.32	116.06	172.17	180.43	5.22	4.43	4.37	2.52	21.46	15.54	31.04	22.63
	200	53.78	54.22	12.44	12.56	42.81	45.26	21.86	21.18	134.53	129.13	197.39	183.84	5.29	4.53	4.72	2.56	19.17	16.40	29.19	23.35
LSD at 5%	K	2.11	2.29	1.98	0.87	6.38	3.32	1.56	1.24	36.22	11.97	35.44	12.19	0.99	0.44	0.56	0.12	4.74	1.01	5.74	1.15
	Etherel	3.38	1.95	2.04	0.97	6.00	4.43	2.69	1.71	22.38	13.55	20.00	13.86	N.S.	N.S.	0.47	0.12	2.85	0.94	2.65	1.08
	Intra.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	NS	N.S.	N.S.	N.S.	N.S.	4.59	N.S.

B- Total bulb yield and its some physical properties:

1- Effect of potassium fertilizer:

Total onion bulb yield as ton/fed. recorded its heaviest values (14.23 and 17.28 ton/fed.) for 1st and 2nd seasons, respectively, with addition of potassium fertilizer at rate of 300 kg as potassium sulphate per Fadden (Table 3). The statistical analysis of the obtained data showed that the differences within different treatments of

potassium fertilizers were great enough to reach significance at 5% levels. It is clear that, the heaviest bulb weight and total yield (in both seasons) and bulb diameter (1st season only) recorded with fertilizer onion plants by both of potassium fertilizers levels (150 and 300 kg/fed.) compared with non treated plant (control). In the same respect, the average weight of bulb, TSS % and protein content did not reach the significant level when onion plants received 150 kg/fed. However, the highest significant increased of average weight of bulb and total yield (ton/fed.) was recorded with the highest level of potassium fertilizer (300 kg/fed.) compared to medium level (150 kg/fed.) and control (0 kg/fed.). These findings were true in both experimental seasons. It could be concluded that, the increments of bulb yield and its best values of bulbs may be attributed to the best vigor of plant growth as show in Table (2). Many investigators studied the response of onion plant to the potassium rates such as Singh and Verma (2001); Mohanty and Das (2002); Sharma *et al*. (2003); Yadav *et al*. (2003); Abd El-Aal *et al*. (2005); El-Bassiouny (2006); El-Desuki *et al*. (2006) and Aisha *et al*.(2007).

2- Effect of growth regulator Etherel:

Data presented in Table (3) showed that growth regulator, Etherel had a significant effect on total yield and it's some physical bulb quality of onion. The application of Etherel at 200 ppm induced a highly significant increased of bulb characters expressed as bulb length, diameter, average weight of bulb, total yield, TSS and protein content compared to untreated plants. However, the average weight of bulb, total yield, TSS and protein content significantly increased by foliar application of Etherel at low concentration (100 ppm) compared to control. Regarding to spraying growth regulators Etherel at high level 200 ppm significantly increased average weight of bulb and total yield compared to low level and control. Moreover, the heaviest total bulbs yield (12.78 ton/fed and 16.26 ton/fed.) for 1st and 2nd seasons respectively with foliar spraying of Etherel at rate of 200 ppm (Table 3). From the above data, it could be concluded that spraying onion plant with growth regulators Etherel had a favorable effect on total yield and its physical quality, this may be attributed to the best vigor of plant growth characters as shown in Table (2) and may be attributed in large part to the augmented effect on cell division in the sub apical meristems and cell enlargement (Audus, 1972). These results could be in agreement with those obtained by Habba (2003); Tiwari *et al*. (2003); Yu *et al.* (2009) and Ashraf *et al*. (2010). They mentioned that Etherel application at a higher level are important in cell division, growth, yield and its quality of onion bulb.

3-Effect of potassium fertilizer with Etherel:

The resulted data in Table (3) revealed that the addition of potassium sulphate as soil fertilizer at rate of 300 kg/fed. and foliar spraying of growth regulator Etherel at a higher level 200 ppm gave the heaviest total bulb yield (15.81 and 17.84 ton/fed., respectively, in 1st and 2nd season). The statistical analysis of the obtained data recorded a significantly increase in average weight of bulb and protein content in bulb tissue in the first season only by interaction treatments.

Table 3: Effect of potassium sulphate and Etherel spraying on total yield and physical quality of onion bulbs during 2010/2011 and 2011/2012 seasons.

K kg/fed.	Etherel ppm	Bulb (cm)				Average weight of bulb (g)		Total yield (ton/fed.)		%			
		Length		Diameter						Protein		TSS	
Seasons		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
0	0	5.57	5.20	7.50	7.47	110.30	112.44	8.52	11.33	10.73	11.40	11.40	12.50
	100	6.23	5.80	7.90	7.70	185.55	187.97	8.58	13.45	13.94	16.40	12.73	12.63
	200	6.60	6.07	8.37	8.03	197.63	211.17	9.53	14.43	14.10	15.98	12.77	13.00
Mean		6.13	5.69	7.92	7.73	164.49	170.53	8.88	13.07	12.92	14.59	12.30	12.71
150	0	6.87	6.40	8.40	8.10	120.50	131.37	10.87	14.57	10.10	12.77	12.20	12.53
	100	7.07	6.73	8.67	8.23	159.61	164.03	12.06	15.91	13.10	15.56	13.10	13.20
	200	7.20	6.80	8.90	8.60	201.47	195.09	13.00	16.50	16.23	16.71	13.23	13.90
Mean		7.04	6.64	8.66	8.31	160.52	163.50	11.98	15.66	13.15	15.01	12.84	13.21
300	0	7.43	6.77	8.87	8.47	139.77	146.41	12.48	16.54	12.04	13.79	12.37	12.87
	100	7.53	7.17	9.00	9.10	208.20	215.26	14.40	17.46	14.56	16.56	13.53	14.33
	200	7.70	7.57	9.70	9.30	215.67	219.87	15.81	17.84	15.10	18.00	13.77	14.40
Mean		7.56	7.17	9.19	8.96	187.88	193.85	14.23	17.28	13.90	16.11	13.22	13.87
Average Etherel	0	6.62	6.12	8.26	8.01	123.52	130.07	10.62	14.15	10.96	12.65	11.99	12.63
	100	6.94	6.57	8.52	8.34	186.94	190.62	11.68	15.61	14.10	16.41	13.12	13.41
	200	7.17	6.81	8.99	8.64	202.43	207.17	12.78	16.26	14.91	16.65	13.26	13.74
LSD at 5%	K	0.53	0.81	0.85	0.61	2.47	8.39	0.62	1.37	0.74	1.12	0.23	0.83
	Etherel	0.41	0.53	0.39	0.49	5.23	19.00	0.68	1.40	2.10	0.64	0.93	0.50
	Intra.	N.S.	N.S.	N.S.	N.S.	9.06	N.S.	N.S.	N.S.	N.S.	1.11	N.S.	N.S.

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C- Chemical nutrition values:

1- Effect of potassium fertilizer:

Data recorded in Table (4) clearly showed that values of N, P, K, Fe, Mn, Zn and Cu in bulb tissues were increased with increasing potassium fertilizer level frome 0 to 300 kg/fed. The mineral contents in onion bulb tissues raised to reach the highest values with addition the highest potassium sulphate rate (300 kg/fed.). These findings are in good accordance with the two seasons. However, the statistical analysis of the obtained data revealed that the differences within different potassium levels were great enough to be significant in both seasons. It is evident from data illustrated in Table (4) that the highest rate of potassium fertilizer (300 kg/fed.) significantly increased K % and Fe, Mn and Zn ppm contents in both seasons and Cu ppm in the season only compared to the low potassium fertilizer levels (150 kg/fed.) and control. It be concluded that, increasing the levels of potassium fertilizer in soil solution raised the availability of nutrient elements which favored to enhancement their absorption and hence increased its concentration in storage organs. The obtained results are in good accordance with previous investigators such as Sing and Mohanty (2000); Abd El-Aal *et al*. (2005) and El-Bassiouny (2006). There is no doubt that potassium fertilizer as an important nutritional element plays an important role in regulation many physical criteria in plant which in turn effect on the resulted total yield. The previous references of current knowledge about potassium may reflect the interest of many workers in studying its mode of action and its role in the production of onion.

2- Effect of growth regulator Etherel:

Data in Table (4) indicated that, all concentrations of growth regulator Etherel had a significant effect on N, P and K contents and Mn content in both seasons and Zn content in the first season only. However, bulb tissues contents of Fe in both seasons and Zn in the first season were un-significant increased between low level of Etherel (100 ppm) and control. In this respect, Etherel at higher level (200ppm) gave the highest value of all nutritional values i.e. N, P and K % as well as Fe, Mn, Zn and Cu ppm contents in bulb tissue. These results were true in the two seasons. In the same respect, onion plants treated with high level of growth regulators Etherel (200 ppm) gave the highest value of Fe, Mn, Zn and Cu ppm in the first season only than plants treated with low level (100ppm). These results are in good agreement with those obtained by Tiwari *et al*. (2003) who reported that, bio-regulators Etherel (25 ppm) gave the highest bulb yield and its nutritional value of bulb tissues.

3-Effect of potassium fertilizer with Etherel:

The interaction between three levels of potassium fertilizer and three levels of growth regulator Etherel had a slow great effect on the most of chemical nutritional composition of onion bulb tissues. Whereas, onion plants which received 300 kg of potassium sulphate and 200 ppm foliar spraying of Etherel resulted the highest N, Mn and Cu ppm contents (in the first season only).

Table 4: Effect of potassium sulphate and Etherel spraying on chemical quality of onion bulbs during 2010 /2011and 2011/2012 seasons.

K kg/fed.	Etherel ppm	%						ppm							
		N		P		K		Fe		Mn		Zn		Cu	
Seasons		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
0	0	1.62	1.82	0.25	0.24	0.55	0.61	250.00	253.00	26.33	27.67	32.33	33.67	11.00	10.00
	100	2.10	2.62	0.34	0.32	0.74	0.78	259.33	257.33	28.33	28.67	35.33	35.00	12.00	11.67
	200	2.60	2.56	0.36	0.37	0.82	0.85	267.33	265.33	29.00	30.67	35.67	36.67	12.00	13.67
Mean		2.07	2.33	0.32	0.31	0.70	0.75	258.89	258.56	27.89	29.00	34.44	35.11	11.67	11.78
150	0	1.62	2.04	0.30	0.28	0.71	0.74	276.00	270.00	30.67	34.00	37.00	38.67	13.67	13.00
	100	2.10	2.49	0.40	0.38	0.81	0.76	277.33	273.33	33.00	36.33	38.67	35.33	14.00	14.00
	200	2.60	2.67	0.40	0.37	0.75	0.86	284.33	282.33	33.33	35.00	38.67	39.33	13.67	14.67
Mean		2.10	2.40	0.37	0.34	0.76	0.79	279.22	275.22	32.33	35.11	38.11	37.78	13.78	13.89
300	0	1.93	2.21	0.33	0.33	0.84	0.81	303.67	302.00	35.33	36.00	42.33	42.67	14.33	15.67
	100	2.33	2.88	0.44	0.42	0.92	0.94	309.33	306.67	37.00	36.67	43.33	44.33	14.67	16.00
	200	2.42	2.65	0.46	0.46	0.94	0.95	317.00	317.67	38.00	40.33	45.00	46.00	16.00	17.67
Mean		2.22	2.58	0.41	0.40	0.90	0.90	310.00	308.78	36.78	37.67	43.56	44.33	15.00	16.44
Average Etherel	0	1.75	2.02	0.29	0.28	0.70	0.72	276.56	275.00	30.78	32.56	37.22	38.33	13.00	13.22
	100	2.26	2.66	0.39	0.37	0.83	0.85	282.00	279.11	32.78	33.89	39.11	38.22	13.56	13.56
	200	2.39	2.63	0.41	0.40	0.84	0.86	289.56	288.44	33.44	35.33	39.78	40.67	13.89	15.33
LSD at 5%	K	0.12	0.18	0.04	0.07	0.12	0.10	2.77	9.47	1.63	1.90	1.99	3.02	1.26	1.30
	Etherel	0.34	0.10	0.08	0.06	0.07	0.06	6.17	6.42	1.36	1.27	1.28	1.92	0.66	0.63
	Intra.	N.S.	0.18	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	2.20	N.S.	N.S.	N.S.	1.08

D- Endogenous phytohormones:

The effect of potassium fertilizer levels (0, 150 and 300 kg/fed.) and foliar spraying by bio regulators Etherel at three levels (0, 100 or 200 ppm) on the endogenous phytohormones of onion leaves tissues comparing with control are shown in Table (5). The obtained results showed that, all IAA and GA_3 contents significantly increased by foliar spraying with all treatments compared with control. However, the highest content of IAA on onion leaves tissues was increase by fertilized onion plants by potassium at the highest level (300 kg/fed.) and foliar application of Etherel at 200 ppm. On the contrary, control plants (untreated) produced the highest content of ABA. It could abstracted that, the adding of highest rate of potassium (300 kg/fed.) and Etherel at (200 ppm) gained the highest values of growth promoting expressed as GA_3 and IAA followed in descending order by the application of potassium 150 kg/fed. and Etherel at 100 ppm.

Table 5: Effect of spraying with potassium sulphate and Etherel spraying on endogenous hormones of onion leaves tissues (ng/g fw).

K (kg/fed.)	Etherel (ppm)	ng/g fw		
		GA_3	IAA	ABA
0	0	37.66	31.30	21.00
	100	38.33	32.15	20.12
	200	39.00	33.00	19.21
Mean		38.33	32.15	20.11
150	0	47.17	41.16	12.67
	100	46.27	39.16	15.66
	200	48.12	42.22	13.73
Mean		47.19	40.85	14.02
300	0	53.45	44.00	13.46
	100	47.67	48.10	12.20
	200	48.00	46.12	11.00
Mean		49.71	46.07	12.22
Averages	0	38.33	32.15	20.11
	100	41.16	35.19	16.11
	200	39.67	38.00	14.20

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