Effect of Foliar Application of Potassium and IAA on Growth and Yield of Two Cultivars of Squash (*Cucurbita pepo* L.)

Abduljabbar I. Marie
Agr. College/ Mosul Univ.
IRAQ

***Ghurbat H. Mohammed**
Agr. College/ Dohuk Univ.
IRAQ

ABSTRACT

This experiment was carried out at the Vegetable field, College of Agriculture, Dohuk University during the spring growing season of 2006, to study the response of two summer squash cultivars namely local variety (Mullah Ahmed) and Opal type- HED 103, to four concentrations of potassium (0.0, 0.5, 1.0, 1.5) gl^{-1} and Indole Acetic Acid (IAA) at concentrations of (0.0, 100, 200, 300) mg l^{-1} in terms of vegetative growth and flowering characteristics, yield and its components. Treatments of Potassium were applied at tow stages; the first was at the beginning of the female flowering and the second was after tow weeks from the first one. Whereas, IAA was sprayed at (3-4) true leaf stage (after 21 days) from planting until run- off point for one time. Treatments were arranged in an experiment within split plots in a factorial Randomized Complete Block Design RCBD. The cultivars were considered as the main plots and the interactions between Potassium and IAA concentrations were arranged in the subplots with three replicates for each treatment. The results revealed that the local cultivar was superior over the hybrid cultivar in plant height and no. of branches per plant. Application of potassium caused a significant increase in traits of plant height, number of branches at concentration of 1.0 g l-1. IAA also significantly increased plant height, no. of branches. The interaction among treatments exhibited significant effect on vegetative growth characteristics. On the other hand, the two cultivars did not exhibit any effect on sex ratio and yield characteristics. Whereas, Potassium at 1.0 gl^{-1} highly increased the no. of fruits per plant, average fruit weight, and total yield. Hence, spraying with IAA at conc. of 300 mg l^{-1} gave a significant increase in the no. no. of fruits $plant^{-1}$, fruit weight and total yield. Spraying Plants of local cultivar with potassium at conc. 1.0 g K l^{-1} with 200 mg IAA l^{-1} resulted in the greatest significant increase in fruit weight and total yield of fruits.

Introduction

Summer squash (*Cucurbita pepo* L.) is one of the most important Cucurbitaceae crops. This importance comes from utilizing it as a food for human, in addition to several medical purposes (Majeed and Mahmoud, 1988).

Nutrient elements play an important role in fruit setting. Iraqi soils are characterized with high content of calcium carbonate and approximately alkaline PH (Abuthahi and Younis, 1988) which is lead to more difficulty in

* Part of MSc. Thesis for the second investigator.

realization of some nutrient elements from the soil as potassium, thereby available potassium becomes insufficient for plant growth .Summer squash plant is a big herbaceous, and considered to be sensitive potassium deficiency (AL-Sahaf, 1989). So application of adequate amount of this element results in a greater crop production with better quality.

Growth regulators are regarded as one of the most important treatments, used nowadays in agriculture, which in most cases modify the plant growth and the subsequent fruiting. They are applied to stimulate seed germination, vegetative growth, flowering and fruiting in some vegetable crops such as Gibberellin and Auxin. Available reports emphasize that better yield can be achieved by using various levels of growth regulators (Abdul & Saleh, 1983).

Juan *et al.* (1999) observed that treating cucumber plants with three rates of K in the form K_2SO_4 0.075, 0.15 and 0.30 K mg ml^{-1} in which the rate 0.15 mg ml^{-1} gave the highest commercial yield in plants. AL-Jebory (2001) in his study involving spraying different concentrations of K_2O (0.0, 2.5 and 5.0) $g.l^{-1}$ in some genotypes of summer squash, he noticed that high level $5g.l^{-1}$ resulted in lower leaf P content, and highest N and K rates in the leaves of the different genotypes, while vegetative growth traits were not affected significantly by potassium treatment. Grazia *et al.* (2003) carried out a study to investigate the effect of different (N-P-K) concentrations (50:50:0, 50:50:50 & 50:50:100) kg N-P-K ha^{-1} on summer squash plants. They found a high number of female flowers for the relations containing potassium (50:50:50 & 50:50:100) in comparison with the interactions free from K element (50:50:0).

Manacini (1999) reported that spraying summer squash cultivated in the greenhouse with Ethephon at concentrations 100 and 400 $mg.l^{-1}$ when plant produced by 3-4 true leaf and 1000 $mg.l^{-1}$ of IAA at the commencement of flowers appearance. He found that both Ethephon and IAA substantially improved fruit quality and yield.

Jalall (2000) carried out a study to know the effect of (GA_3, IAA and IBA) at concentration of 50, 100 and 200 mgl^{-1} on summer squash and cucumber plants, growth regulators generally increased vegetative growth traits and the amount of total yield was increased significantly by application of IAA and IBA at 50, 100 mg l^{-1} for both crops . Shawket (2005) noticed that spraying summer squash plants with IAA at concentrations of 100 and 200 mgl^{-1} at 3-4 true leaf stage increased fruit number, plant yield and total yield per unit area as compared with control plants.

The objectives of this study were to improve the yield of summer squash by increasing sex ratio, in addition to modify plant growth toward better production and quality.

Materials and Methods

The experiment was conducted at the Vegetable Research Farm, College of Agriculture, University of Dohuk, Iraq, during spring season of 2006. Four concentrations of K were used in the experiment 0.0, 0.5, 1.0 and 1.5 $g.l^{-1}$ as K_2SO_4, whereas, IAA sprayed at concentrations 0.0, 100, 200 and 300 $mg.l^{-1}$. They were sprayed on the 3rd May at stage of 3-4 true leaves for one time after 21 days from seed sowing until run-off point (Saleh, 1978). Potassium concentrations were sprayed two times in the form of K_2SO_4. The first dose was done at female flowering on 21st May and the second dose was after two weeks from the first spraying. The experiment involved the effect of two cultivars namely Mullah Ahmed (No. 1) and Opal type-HED103 (No. 2), four concentrations of each K & IAA as previously mentioned. Therefore, 32 treatments were involved in this study (2x4x4=32) were implicated in a Split Plots system within a Factorial Randomized Complete Block Design (F-RCBD). Each treatment was replicated three times and each replicate was represented by two ridges, each ridge (4 x 2.25 m) of 12 plants, with 35cm intra plant spaces. Comparison among averages was done by using Duncan's Multiple Range Test at 5% to verify the differences between means of treatments (Al-Rawi and Khalaf- Allah , 2000) . Other agricultural practices were similarly carried out to each experimental unit as followed by farmers in the area. Random sample of the studied soil were taken before starting the research from every site at a depth of approximately (30cm) to study the necessary analysis of physical and chemical characteristics of the soil (Page *et al*., 1982), the results of the analysis are shown in Table (1).

Table 1. Some physical and chemical properties of the studied soil in the field

Characteristics	Measuring units	2004
Volumetric distribution of soil separate		
Sand	Percentage (%)	3.40
Silt	Percentage (%)	55.000
Clay	Percentage (%)	41.600
Texture		Silty clay
Available nutrient content		
Total-N	Percentage (%)	0.200
Available phosphorus	ppm	8.900
Available potassium	$Mmol.l^{-1}$	0.195
Organic matter	Percentage (%)	1.180
pH	1:1 in peste	7.660
Electrical Conductivity	dsm^{-1}	0.322

Experimental Measurements :

Five plants were selected randomly from each experimental unit to measure:

a. Vegetative Growth Characteristics :

Plant Height (cm) : Plant heights were measured from the contact point between the stem and soil surface to the growing point of the main stem in each plant of the experimental unit at the end of the season.

Number of Branches/plant .

b. Flowering characteristics :

Sex Ratio : It was calculated according to the following equation :

$$\text{Sex ratio} = \frac{\text{No. of female flowers}}{\text{No. of male flowers}}$$

c. Yield Measurements : Fruits were harvested three times a week, then the following parameters were measured :

Number of Fruits Plant^{-1} : Number of fruits per plant was counted from each experimental unit, starting from the commence of harvesting and lasted to the end of the growing season (20 harvests) and calculated according to the following equation :

$$\text{number of Fruits plant}^{-1} = \frac{\text{Total fruit number experimental unit}^{-1}}{\text{Plant number in each experimental unit}}$$

Fruit weight (g) :

Total Yield (tha^{-1}) : The rate of the total yield was measured by estimating the yield of the plants for each experimental unit and then converted into the yield per hectar.

Results and Discussion

Effect of Cultivars, Potassium and IAA on the Vegetative Growth:

Plant Height (cm) :

The obtained results (table, 2) revealed that Mullah-Ahmed cv. (1) was significantly dominated over Hybrid Opal cv. (2) in plant height. Potassium-treated squashes highly exceeded untreated plants, especially 1mg.l^{-1} which showed the highest plant height (64.17 cm), in relation to untreated (55.16 cm). Spraying squash plants with 100, 200 mg.l^{-1} IAA significantly increased the plant height particularly 200 mg.l^{-1} rate (61.25 cm), as compared to check treatment (55.77 cm).

As for the interaction between cultivars, potassium and IAA, the interaction between cultivar 1 with 1.0 g.l^{-1} K and 100 mg.l^{-1} IAA showed a significant effect on the plant height of summer squash measured (71.17 cm).

Number of Branches Plant^{-1} :

Data in table (3) shows that there was no significant differences between its two cultivars as in the number of branches. The effect of potassium in all concentrations of 0.5, 1.0 and 1.5 g.l-[1] caused a significant increase in the number of branches, especially at 1.0 $g.l^{-1}$ as compared with the control treatment. Spraying with (100, 200) $mg.l^{-1}$ of IAA had a significant increase in the number of branches, especially at 100 $mg.l^{-1}$ which produced the highest number (3.14) with an increase of (23.14%) as compared with the control treatment.

Table 2. Effect of cultivars, potassium, IAA and their interactions on plant height (cm) .

Cultivar	Potassium ($g.l^{-1}$)	IAA ($mg.l^{-1}$) 0	100	200	300	Effect of K	Effect of cultivar
1	0.0	53.60 f-k	59.00 c-k	56.17 e-k	60.50 b-j	55.16 c	61.31a
1	0.5	67.50 a-d	63.83 a-f	62.17 a-i	53.17 g-k	55.16 c	61.31a
1	1.0	62.30 a-i	71.17 a	70.00 ab	68.33 a-c	59.10 b	61.31a
1	1.5	57.33 d-k	59.17 c-k	62.72 a-h	54.00 f-k	59.10 b	61.31a
2	0.0	50.17 k	54.10 f-k	55.27 f-k	52.50 h-k	64.17 a	56.15 b
2	0.5	52.67 h-k	57.67 d-k	63.17 a-g	52.67 h-k	64.17 a	56.15 b
2	1.0	52.23 i-k	59.83 b-k	66.17 a-e	63.33 a-g	56.48 bc	56.15 b
2	1.5	50.33 jk	59.00 c-k	54.30 f-k	55.00 f-k	56.48 bc	56.15 b
Effect of IAA		55.77 c	60.47 ab	61.25 a	57.44 bc		

* Means followed by the same letter within a column do not differ significantly ($\alpha=0.05$).

Table 3. Effect of cultivars, potassium, IAA and their interactions on number of branches/plant .

Cultivar	Potassium ($g.l^{-1}$)	IAA ($mg.l^{-1}$) 0	100	200	300	Effect of K	Effect of cultivar
1	0.0	2.17 f-h	2.83 c-g	2.23 f-h	2.83 c-g	2.37 b	2.91 a
1	0.5	2.67 d-h	3.50 a-d	3.17 a-f	2.50 d-h	2.37 b	2.91 a
1	1.0	2.70 d-h	3.15 a-f	2.33 e-h	4.17 a	2.89 a	2.91 a
1	1.5	2.67 d-h	3.33 a-e	3.83 a-c	2.50 d-h	2.89 a	2.91 a
2	0.0	1.70 h	2.67 d-h	2.73 d-g	1.83 gh	3.18 a	2.82 a
2	0.5	2.60 d-h	2.83 c-g	2.64 d-h	3.17 a-f	3.18 a	2.82 a
2	1.0	2.57 d-h	3.83 a-c	4.00 ab	2.70 d-h	3.02 a	2.82 a
2	1.5	3.30 a-e	3.00 b-f	2.67 d-h	2.83 c-g	3.02 a	2.82 a
Effect of IAA		2.55 b	3.14 a	2.95 a	2.82 ab		

Means followed by the same letter within a column do not differ significantly ($\alpha=0.05$).

With regard to the effect of interaction between cultivars, potassium and IAA on the number of branches, the data reveal a significant effect resulted from the interaction between Mullah-Ahmed cv. 1, 1.0 $g.l^{-1}$ K and 300 $mg.l^{-1}$ of IAA which gave a higher number of branches (4.17).

It was observed from the above mentioned results in tables (2 and 3) that the local variety (Mullah-Ahmed cv.) was better than the hybrid variety (Opal type-HED103) in plant height and no. of branches traits, especially plant height. The reason behind that may be due to the genetic factors of Mullah-Ahmed cv. Which cultivated in the Northern Iraq for a long time acquiring adaptation to the environmental conditions of this region more than the hybrid variety. Thus potassium has revealed as observed from the mentioned tables a significant increase on the vegetative growth expressed by plant height, number of branches, especially at concentration of (1.0 g $K.l^{-1}$). These results support the findings of AL-Mukhtar *et al*. (1988) who confirmed that application of potassium increased different components of squash vegetative growth. The reason behind this may be interpreted to the physiological role of potassium in stimulating enzymes responsible for carbohydrate synthesis and energy production. In addition to protein synthesis, it is considered as the main carrier of NO_3^- from the root through xylem to the leaves (source of food manufacturing) after replacing NO_3^- in HCO_3^- resulted from analysis of Malete (Lips *et al.*, 1971). In addition to potassium role in activation of Nitrate reduction inside the plant to produce Ammonia then to Amino Acids (AL-Sahaf, 1989) associate with each other to form proteins, the physiological and nutritional state of plant will improve. Hence, potassium was found to be a regulator in closing and opening stomata (Humble & Raschke, 1971).

Concerning the effect of IAA, it is clear from tables (1 and 2) that significant increases occurred in plant height, number of branches. These results are in agreement with findings of (Jalal, 2000) in which application of IAA significantly increased plant height, number of branches/plant, number of leaves in squash and cucumber plants. The reason might be attributed to increasing photo-oxidation of endogenous auxins (i.e. IAA) which finally led to increase plant elongation, (Devlin, 1975), or might be due to the decomposition of adding exogenous IAA at final stages of plant age by enzymatic or irradiation way causing deficiency of endogenous auxin.

Many studies mentioned that IAA plays an important physiological role in increasing the division and elongation of cells. Moreover it increased the permeability of the cell wall which would allow greater amount of water and dissolved materials to enter the cell (Heyn, 1931) which increased cell size. There is a general role that low concentrations of auxin promote the plant growth, whereas high concentrations inhibit plant growth and the optimum concentration depends on the types of plant and tissue (Weaver, 1972). There is another opinion that auxin may control the type of enzyme present in the cell. Thimman (1969) supposed that auxin affect on the activation of the nucleic acid (RNA) messenger type which caused or promoted formation of specialized enzymes resulting in cell enlargement. It was found in many crops that auxin stimulated and accelerated formation of RNA & protein (Sacher and

Salmine, 1969; Soleimane *et al*., 1970). There is a relationship between synthesis of nitrogen and carbohydrates and the factors affect on increasing nitrogen content and deficiency of carbohydrate content that lead to promote stem elongation in treated plants with auxin (Ito and Saito, 1960).

On the other hand, it is possibly applicable that IAA (auxin) in general comprises increasing vegetative growths which reflect in increasing plant size, number of branches, number of flowers/plant and finally lead to high number of fruits and yield.

Effect of Cultivars, K and IAA on Flowering Characteristics :
Sex Ratio :

It is obvious from table (4) that cultivars and spraying with potassium revealed nonsignificant effects on sex ratio. Whereas, treatment with IAA at concentrations of 200, 300 $mg.l^{-1}$ caused significant increases in the sex ratio as compared with the control treatment.

Concerning the effect of the interaction between three factors, cultivar 1 with 1.0 $g.l^{-1}$ K and 200 $mg.l^{-1}$ IAA exhibited the highest sex ratio (0.861).

Table 4. Effect of cultivars, potassium, IAA and their interactions on sex ratio

Cultivar	Potassium ($g.l^{-1}$)	IAA ($mg.l^{-1}$) 0	100	200	300	Effect of K	Effect of cultivar
1	0.0	0.535 cd	0.631 a-d	0.720 a-d	0.760 a-d	0.669 a	0.725 a
	0.5	0.708 a-d	0.759 a-d	0.764 a-d	0.838 ab		
	1.0	0.583 a-d	0.805 a-c	0.861 a	0.807 a-c	0.759 a	
	1.5	0.783 a-c	0.681 a-d	0.662 a-d	0.699 a-d		
2	0.0	0.569 b-d	0.702 a-d	0.722 a-d	0.720 a-d	0.737 a	0.695 a
	0.5	0.765 a-d	0.660 a-d	0.819 a-c	0.755 a-d		
	1.0	0.667 a-d	0.698 a-d	0.747 a-d	0.726 a-d	0.676 a	
	1.5	0.490 d	0.717 a-d	0.720 a-d	0.654 a-d		
Effect of IAA		0.637 b	0.707 ab	0.752 a	0.744 a		

* Means followed by the same letter within a column do not differ significantly (α=0.05).

The nonsignificant increase in the sex ratio by application of potassium agree with the results of (AL-Jebory, 2001; Grazia *et a*l., 2003) that potassium minimized male flowers and increased female flowers in squash plant . Hence, it is obvious from the same table , that IAA increased the number of female flowers and reduced male flowers. In other words it increased the value of sex ratio. In this respect, (Manacini, 1999; Jalal, 2000) in squash, cucumber and watermelon plants found similar observations. The possible interpretation of these results could be attributed to formation of compounds acting as anti-gibberellin (Abdul and Mohammed, 1986). Also it could be concluded that lack of GA_3 level increased the number of female flowers on the account of male flowers. In addition to the influence of IAA on the ratio of sex expression, there is a relation between the flowers arrangement change and the changes of auxin, nitrogen and carbohydrate in the plant which will eventually increase the number of female flowers and that will lead to a positive effect of the number of fruit setting (Manacini, 1999). Or the reason behind that may be interpreted that squash monoecious plants contain endogenous gibberellins-like substances more than gynecious plant. Whereas, the plants that have male and complete flowers (andromonoecious) contain auxins extract more than the hermaphrodite plants (Iwahori *et al*., 1969). Therefore, the values of sex expression in squash plant can be regulated through the balance between endogenous gibberellins and auxins, since in the case of high GA content, the plant will produce male flowers and this idea can be supported by the fact that the growth retardant (Allyitrmethyl ammonium bromide) which reduces the endogenous GA content can modify the sex expression toward femaleness. It was found that auxins can affect through releasing ethylene, and therefore, ethylene causes reversal effects to those occurred by GA in different plant systems (Iwahori, *et al*., 1970).

Generally and practically, IAA can be used to alter the sex ratio of cucurbitaceae plants, so it can be directly effective on the yield quantity.

Effect of Cultivars, Potassium and IAA on the Yield and Yield Components

Number of Fruits Plant^{-1} :

Table (5) shows the effect of cultivars, potassium, IAA and their interactions on the number of fruits per plants. It could be noticed that there was no significant differences between the two cultivars. On the other hand, treatment with potassium at concentration 1.0 g.l^{-1} caused a significant increase in the number of fruits per plant as compared with untreated plants accounted 19.15 fruits with an increase of 12.25%. As for the effect of IAA, an increase was observed in the number of fruits, especially at high concentration 300 mg.l^{-1} where the number was 18.89 with an increase of 11.18% as compared with the control treatment.

Concerning the effect of the interaction between three factors, it was significant on the number of fruits per plant. The best interaction was found between cultivar (2) with 0.5 g.l^{-1} K and 300 mg.l^{-1} IAA resulting in 20.44 fruits per plant.

Fruit weight (g) :

It can be observed from table (6) that cultivars does not have any significant differences on the fruit weight. Regarding the effect of potassium treatment, there was a significant effect in increasing the weight of fruit at concentration 1.0 g K L^{-1} as compared with the control `treatment. But the differences between concentrations of potassium (0.5, 1.0) g L^{-1} were not significant which produced fruit weights 181.54, 186.56 g respectively with an increase (6.23%, 9.17%) as compared with the control. The effect of spraying with IAA at concentration of 300 mg L^{-1} caused a significant increase in fruit weight in comparison with the control treatment.

As for the triple interaction, the best interaction occurred among cultivar 1 with 1.0 g L^{-1} K and 200 mg L^{-1} IAA giving (200.35 g) of fruit weight.

Table 5. Effect of cultivars, potassium, IAA and their interactions on number of fruits per plant.

Cultivar	Potassium ($g.l^{-1}$)	IAA ($mg.l^{-1}$) 0	100	200	300	Effect of K	Effect of cultivar
1	0.0	16.33 b-d	17.60 a-d	17.67 a-d	17.67 a-d	17.06 b	18.30 a
	0.5	18.45 a-d	20.33 a	18.00 a-d	16.55 b-d		
	1.0	16.78 a-d	20.42 a	19.53 a-c	20.00 ab	18.12 ab	
	1.5	19.89 ab	17.67 a-d	16.00 cd	19.89 ab		
2	0.0	15.22 d	17.00 a-d	17.00 a-d	18.00 a-d	19.15 a	17.93 a
	0.5	15.00 d	17.67 a-d	18.56 a-d	20.45 a		
	1.0	17.00 a-d	19.00 a-c	20.44 a	20.00 ab	18.12 ab	
	1.5	17.22 a-d	16.33 b-d	19.44 a-c	18.56 a-d		
Effect of IAA		16.99b	18.25 ab	18.33 a	18.89 a		

Means followed by the same letter within a column do not differ significantly (α=0.05).

Total Yield *(tha^{-1}) :

Table (7) reveals that cultivars had no significant differences on the total yield of summer squash plants. Regarding the effect of spraying with potassium, it increased the total yield at concentration 1.0 $g.l^{-1}$ resulting in 41.6 tha^{-1} with an increase of 19.95%. For the effect of IAA, table (7) shows that there was an increase in the total yield of summer squash by increasing concentrations of IAA. The greatest total yield per hectar occurred at 200, 300 $mg.l^{-1}$ measured 38.12 and 40.82 tha^{-1} respectively.

As for the interaction between each two factors, the superior interaction was between cultivar 2 with 1.0 $g.l^{-1}$ K (41.67 tha^{-1}). Whereas, the maximum interaction between cultivar and IAA occurred between cultivar 2 with 300 $mg.l^{-1}$ (41.74 tha^{-1}). The best interaction between K and IAA was existed (44.80 tha^{-1}) between 1.0 $g.l^{-1}$ K and 200 $mg.l^{-1}$ IAA.

Table 6. Effect of cultivars , potassium, IAA and their interactions on average weight of fruit (g).

Cultivar	Potassium ($g.1^{-1}$)	IAA($m .1^{-1}$) 0	100	200	300	Effect of K	Effect of cultivar
1	0.0	160.80c	183.41 a-	156.86 d	181.64a-d	170.88 b	176.91 a
	0.5	163.77b-	191.66a-c	180.70a-	197.20 a		
	1.0	183.74a-	179.91a-d	200.35 a	186.OOa-d	181.54ab	
	1.5	170.31	154.98 d	168.06a-d	171.16a-d		
2	0.0	168.SSa	159.48cd	176.20a-d	180:13a-d	186.56 a	178.75 a
	0.5	177.OO	185.82a-d	170.44a-d	185.74a-d		
	1.0	183.95a-	187.57a-d	183.56a-d	187.44a-d	172.32 b	
	1.5	161.21	195.70 ab	172.89a-d	184.27a-d		
Effect of IAA		171.17 b	r179.82 ab	176.13 ab	184.20 a		

- Means followed by the same letter within a column do not differ significantly(a=0.05).

Table 7. Effect of cultivars, potassium, IAA and their interactions on the total yield (ton/hectar).

Cultivar	Potassium ($g.l^{-1}$)	IAA ($mg.l^{-1}$) 0	100	200	300	Effect of K	Effect of cultivar
1	0.0	31.00gh	37.28 a-h	32.52 f-h	37.48 a-h	34.66 b	37.36 a
	0.5	34.64 d-h	36.40 b-h	37.56 a-h	39.40 a-g		
	1.0	36.16 b-h	41.60 a-e	45.60 a	42.80 a-d	37.54 b	
	1.5	39.96 a-f	31.68 f-h	33.68 e-h	39.92 a-f		
2	0.0	30.08 h	35.60 c-h	35.16 d-h	38.16 a-h	41.60 a	37.90 a
	0.5	31.16 gh	38.56 a-h	37.08 b-h	44.80 ab		
	1.0	36.68 b-h	42.00 a-e	44.00 a-c	44.00 a-c	36.79 b	
	1.5	32.56 f-h	37.12 a-h	39.44 a-g	40.00 a-f		
Effect of IAA		34.03 c	37.56 b	38.12 ab	40.82 a		

Cultivar	potassium 0.0	0.5	1.0	1.5
1	34.57 b	37.00 b	41.54 a	36.31 b
2	34.75 b	37.90 ab	41.67 a	37.28 ab

Cultivar	IAA 0	100	200	300
1	35.44 cd	36.74 b-d	37.34 a-c	39.90 ab
2	32.62 d	38.32 a-c	38.92 a-c	41.74 a

potassium	IAA 0	100	200	300
0.0	30.54 f	36.44 c-f	33.84 ef	37.82 b-e
0.5	32.90 ef	37.48 b-e	37.32 b-e	42.10 a-c
1.0	36.42 c-f	41.80 a-c	44.80 a	43.40 ab
1.5	36.26 c-f	34.40 d-f	36.56 c-f	39.96 a-d

* Means followed by the same letter within a column do not differ significantly (α=0.05).

It was noticed from table (5, 6 and 7) that the differences between the two cultivars were not significant in the properties stated in the above mentioned tables, but the local cultivar (Mullah- Ahmed cv.) was superior over the hybrid cultivar in no. of female flowers/plant, sex ratio and no. of fruits/plant. While the hybrid cultivar was the best in fruit weight and total yield. The reason of this interpreted to the genetic factors and different responses to the environmental conditions.

As for effect of potassium, It was noticed from tables (5, 6 & 7) that treating squash plants with 1.0 $g.l^{-1}$ K was significantly superior over the remnant levels of potassium in number of fruit, average weight of fruit, and the total yield in comparison with the untreated plants. The reason of this might be interpreted that plants during flowering and fruit setting stages are in critical demand of their physiological activation which require high amount of potassium to perform the biological operations and to do this plants require to absorb high quantities of potassium from the soil, as the available potassium is not enough. Hence the average changing of non - exchangeable potassium to available form in the soil solution is not restricted with its average absorption by the plant, so it leads to exhibit the symptoms of the element deficiency on the plant, so spraying with K resulting in replacing this deficiency of K in the soil which accompanied with achieving the biological operations favourably which help in increasing number of fruits, average fruit weight (Table 5,6) and total yield. In addition, potassium had an active effect in producing more female flowers which positively reflected on the previously mentioned characteristics. These results confirm with those of (AL-Mukhtar *et al*., 1988; AL-Jebory, 2001; Grazia *et al*., 2003) in summer squash plants and (Watcharasak and Thammasak, 2005) in cucumber plants. They mentioned that potassium concentrations increased number of fruits, average fruit weight, and the total yield.

It was also revealed that spraying squash plants with IAA had significantly increased number of fruits, average fruit weight, in addition to the total yield. These results correspond with those of (Manacini, 1999; Jalal, 2000; Shawket, 2005) in squash and cucumber plant. This may be attributed that IAA had a positive effect on the number of female flowers, fruit setting, number of $fruits/plant^{-1}$ and average weight of fruit which reflected eventually on increasing the total yield $plant^{-1}$ of fruits .

References

Abdul, K. S. and A. A. K. Mohammed (1986). Vegetable Physiology. Directorate ofBook house of printing and publishing. Mosul. Iraq

Abuthahi, U. M. and M. A. Younis (1988). Indication to Plant Nutrition. Ministry of Higher Education and Scientific Research. Directorate of Book house of printing and publishing. Mosul Univ. Iraq. (In Arabic).

AL-Sahaf, F. H.(1989). Practical Plant Nutrition. Ministry of Higher Education and Scientific Research. Baghdad Univ. Iraq.

AL-Jebory, K. D. H. (2001). Studying of the combining ability of developed summer squash genotypes to potassium. Ph. D. Thesis. Baghdad.Univ. Iraq.

AL-Mukhtar, F.A.; F.M. Hummadi and F.H. Al-Sahaf. (1988). Effect of different levels of NPK fertilizer on growth and yield of two summer squash cultivars. Acta Hort. 220:253-258.

AL-Rawi , K. M. Khalaf-Allah (2000). Design and analysis of agricultural experiments. Directorate of Book House for publishing and pressing . Mosul Univ. Iraq (In Arabic) .

AL-Sahaf, F. H.(1989). Practical Plant Nutrition. Ministry of Higher Education and Scientific Research. Baghdad Univ. Iraq.

Devlin, R. M. (1975). Plant Physiology 3rd. Edition D. Van Nostrand Comp. New York, P. 600.

Grazia; Javier; Tittonell; Pablo; P. Salvapor and Omer (2003). Summer squash (*Cucurbita maxima* var. zapallito (carr.) Millán), earliness and yield as affected by the nitrogen:potassium ratio. Agric. Téc. Abst. Vol. 63, No (4): 428-435.

Heyn, A. N. J. (1931). Der Mecanismuc der Zellstreckung . Rec. Trav. Bolt. Neeland , 28, 113-244 (C.F. Plant Growth Substances in Horticulture . W.H. Freeman Company , San Francisco .

Humble G.D. and K. Raschke (1971). Stomata opening quantitatively related to potassium transport . Plant Physiology , 48 : 447 – 453 .

Ito., H., and T. Saito. (1960). Factors responsible for the sex expression of the cucumber plant. XIV. Physiological factors associated with the sex expression of flowers. Tohoku Journal of Agricultural Research, 11(4):287-308.

Iwahori, S.; J. M. Lyons and W. L. Sims (1969). Induced femaleness in cucumber by 2-chloroethane phosphonic acid. Nature 222: 271-272.

Iwahori, S.; J. M. Lyons and C. E. Smith (1970). Sex expression in cucumber plants as affected by 2-chloroethane phosphonic acid, ethylene and growth regulators. Plant physiology 46: 412-415.

Jalal, M. M. (2000).Effect of some plant growth regulators on growth, sex expression and yield of (*Cucurbita pepo* L. and *Cucumis sativus*) M.Sc. Thesis. College. Agr. Sulaimania Univ. Iraq.

Juan, M. R. ; D. A. Moreno and L. Romero (1999). Pyruvate Kinase Activity as an Indicator of the level of K^+ , Mg^+ and Ca^+ in leaves and fruits of the cucumber . The role of potassium fertilization . E-18071 , Granada Spain . Vol. 47 No. 3 : 845-849 .

Lips, S. H.; A. Pen-Z zioni and Y. Vadia (1971). K^+ recirculation in plant and its important for adequate nitrate nutrition. In. Recent Advantage in plant nutrition. 1: 207-215.

Majeed, S. H. and M. J. Mahmoud (1988). Iraqi Herbs and plants in Popular Medical and Scientific Research. First publication. Drug and Drug Education Department. Biological Research Centre. Scientific Research Council. Iraq.

Manacini, L. (1999). Effect of growth regulators on flower differentiation and yield in Zucckini *cucurbita pepo* grows in protected cultivation. Acta Hort. (492) p. 265-272.

Page, A.l. ; R.H. Miller and D.R. Keeney (1982). Methods of Analysis. Part 2, chemical and microbiological properties (2^{nd} edition). Amer. Soc. of Agronomy, Inc. Madison, U.S.A.

Sacher, J. A. and S. O. Salmine (1969). Comparative studies of effect of auxin and Ethylene on permeability and synthesis of RNA and protein. Plant physiology. 44: 1371-1377.

Saleh, M. M. S. (1978) Effect of Gibberellic Acid and cycocel on growth, flowering and fruiting of Tomato (*Lycopersicon esculentum* M.) Plant M.Sc. Thesis. Dep. Hort. College Agri. Univ. of Sulaimania.

Shawkat, M. M. (2005). Effect of Indol Acitic acid and nitrogen fertilizer on growth and yield of summer squash (*Cucurbita pepo*). Dep. Hort. Colle.. Agric. Dohuk Univ. Iraq. Vol. 8 (2): 30-35.

Soleimane, A.; W. M. K. Knerwer and R. J. Weaver (1970). Influence of growth regulators on concentration of protein and nucleic acid in Book grapes. J. Amer. Soc. Hort. Sci. 95: 143-146.

Thimman, K. V. (1969). The Auxin. In Wilkins, 1969 (C.F plant growth substances Horticulture. W.H. Freeman and Company, Sanfrancisco).

Watcharasak S. and T. Thammasak (2005). Effect of nitrogen and potassium concentrations in fertigation on growth and yield of cucumber (Cucumis *sativus* L.) Thailand. Abst. Vol. 3. (1):18-29.

Weaver, R. J. (1972). Plant growth substances in agriculture. W. H. Freeman and company, San Francisco.

تأثير الرش بالبوتاسيوم وأندول حامض الخليك في نمو وحاصل صنفي من القرع (*Cucurbita pepo* L.)

عبد الجبار إسماعيل مرعي
كلية الزراعة والغابات/ جامعة الموصل
العراق

*غربت حسن محمد
كلية الزراعة / جامعة دهوك
العراق

الخلاصة

أجري البحث في حقل الخضروات التابع إلى كلية الزراعة/ جامعة دهوك خلال الموسم الربيعي لعام 2006، بهدف دراسة تأثير أربعة تراكيز مختلفة لكل من البوتاسيوم (0.0، 0.5، 1.0، 1.5) غم/ لتر وأندول حامض الخليك IAA (0.0 ، 100، 200، 300) ملغم/ لتر في بعض صفات النمو الخضري، الزهري، الحاصل والصفات النوعية لصنفين من قرع الكوسة المحلي (ملا أحمد) والصنف الهجين المستورد (Opal type- HED 103) . تم رش النباتات بالبوتاسيوم على مرحلتين الأولى في بداية التزهير الأنثوي والثانية بعد أسبوعين من الرشة الأولى، أما أندول حامض الخليك فقد تم رشه في مرحلة 3-4 أوراق حقيقية(بعد 21) يوما من زراعة البذور لدرجة البلل التام ولمرة واحدة. نظمت المعاملات في تجربة عاملية داخل نظام القطع المنشق في تصميم القطاعات العشوائية الكاملة RCBD حيث وضعت الأصناف في القطع الرئيسية Main plots والتوافق بين تراكيز البوتاسيوم وأندول حامض الخليك في القطع الثانوية Sub plots وبثلاث مكررات. أظهرت النتائج بأن الصنف المحلي كان متفوقا في صفتي طول النبات وعدد الأفرع/النبات، وادى الرش بالبوتاسيوم الى زيادة معنوية في صفات طول النبات وعدد الأفرع عند التركيز 1.0 غم K / لتر. وكذلك اندول حامض الخليك سبب زيادة معنوية في طول النبات وعدد الأفرع. كما اظهرت معاملات التداخل زيادة معنوية في صفات النمو الخضري. وبينت النتائج ان كلا الصنفين لم يكن لها

تأثيرا معنويا في صفات النسبة الجنسية والحاصل. في حين ان البوتاسيوم بتركيز 1.0 غم/ لتر سبب زيادة عالية في صفات عدد الثمار/ نبات، معدل وزن الثمرة والحاصل الكلي. كذلك فأن الرش باندول حامض الخليك بتركيز 300 ملغم/ لتر اعطى زيادة معنوية في عدد الثمار /نبات ووزن الثمرة والحاصل الكلي. ان نباتات الصنف المحلي المعاملة بالبوتاسيوم بتركيز 1.0غم/لتر مع 200 مغلم IAA/ لتر نتج عنها اكبر زيادة معنوية في معدل وزن الثمرة والحاصل الكلي للثمار.

*جزء من رسالة ماجستير للباحث الثاني .