

## RESEARCH PAPER

# Effect of Application Nitrophenolates and IAA on growth and yield of Squash (*Cucurbita pepo*)

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### ABSTRACT:

A field experiment was conducted out from March 11<sup>th</sup> to July 20<sup>th</sup> to study the effect of foliar application nitrophenolates (0, 2, 4 and 6 ml.l<sup>-1</sup>) biostimulators and IAA (0,150 and 300 mg. l<sup>-1</sup>) on the growth and yield of summer squash. Nitrophenolates had the best significant effect on plant length and shoot dry weight (63.12 cm and 98.72 g respectively) were obtained with 2 ml.l<sup>-1</sup>, leaf area (256.00 cm<sup>2</sup>) was measured in 4 ml.l<sup>-1</sup> resentment. However, the best results of stem diameter (17.47 mm) was obtained from 300 ml.l<sup>-1</sup> IAA. The interaction of 2 ml.l<sup>-1</sup> nitrophenolates and 300 mg. l<sup>-1</sup> IAA caused highest significant in Stem diameter (19.10 mm), plant length (69.20 cm) and fruit length (17.16cm), and the best results of fruit. weight Plot<sup>-1</sup>, fruit weight plant<sup>-1</sup> and fruit weight hectare<sup>-1</sup>(7.30, 1.82 kg and 29.11 ton) were obtained from 150 ml.l<sup>-1</sup> IAA without nitrophenolates treatments. 2 ml.l<sup>-1</sup> nitrophenolates is the best levels significantly effect on vegetative and reproductive parameter, however the interaction between IAA and nitrophenolate more significantly effects.

KEY WORDS: Summer squash, fruit quality, quantity, Nitrophenolates, IAA, Growth stimulators

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### 1. INTRODUCTION:

Squash (*Cucurbita pepo L.*) is an annual herbaceous plant, belonging to the family of Cucurbitaceae (Quintana *et al.*,2018). Summer squash its importance comes from utilizing it as a food for human, in addition to several medical purposes (Martinez *et al.*, 2015)

Nitrophenolates used as biostimulators contains the following active ingredients: sodium p-nitrophenolate, sodium o- nitrophenolate, sodium 5-nitroguaiacolate (Heikal, 2017). It is used to promote germination, enhance vegetative growth, actives plant cell metabolism and thereby enhance growth and yield (EL-Shabrawy,2009 and Wiraatmaja, 2017). Results obtained by EL-Shabrawy, (2009) showed that spraying squash plants with growth regulators nitrophenolates at (0, 0.25- and 0.50-ml. l<sup>-1</sup>)

were increased the number of leaves, plant height, plant fresh, dry weights, female flowers, number of fruit and average fruit weight, yield kg. plant<sup>-1</sup> however reduced male flowers and sex ratio, in addition induced significantly the yield components. Kocira *et al.* (2015) used the application nitrophenolates (0, 0.1, and 0.3%) on common bean advantageously effect on the number and the weight of seeds and the number of pods. Foliar spray of cucumber (*Cucumis sativus L.*) with nitrophenolate at (0, 0.5, 0.75, 1 ml.l<sup>-1</sup>) significantly increased yield and the number of primary branches plant<sup>-1</sup>, the number of fruits. plant<sup>-1</sup>, fruit length and fruit diameter (Hussein *et al.*,2019).

Indole acetic acid (IAA) is one of the plant growth regulators, it is regulated cell division, cell expansion, ion fluxes, root initiation, phototropism, geotropism, apical dominance, ethylene production, fruit development, parthenocarp, abscission and sex expression (Wang & Helen R. Irving, 2011).Significant

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increases in the plant height, number of fruits plant<sup>-1</sup> and fruit weight and total yield of squash were demonstrated by an application IAA at (0.0, 100, 200, 300 mg. l<sup>-1</sup>) compared with control (Abduljabbar and Mohammed 2010). Results obtained by Khandaker *et al.* (2018) showed that spraying of okra with IAA and GA<sub>3</sub> (0, 30, 60, 90, and 120 mg. l<sup>-1</sup>) were increased number of leaves, branches, flowers and pods. plant<sup>-1</sup> and TSS content. Nassef and El-aref (2018) investigated the effect of foliar spray IAA and gibberellic acid (GA<sub>3</sub>) with same concentration (0, 2.5, 5 and 10 mg. l<sup>-1</sup>) increased the production and protein content in fruits of two summer squash hybrids (Rosina and Eskandrani), 2.5 mg. l<sup>-1</sup> IAA recorded the highest values of in two seasons respectively of sex ratio which were (1.19 and 1.16), number of fruit. plant<sup>-1</sup> (12.24 and 11.41), fruit weight. plant<sup>-1</sup> were (1.49 and 1.42 kg) and total yield (16.57 and 16.08 tons. Fed<sup>-1</sup>).

The aim of this study is to evaluate the effect of foliar spraying of nitrophenolates as ecofriendly

biostimulator and Indole Acetic acid in several concentrations and their interactions on summer Squash (*Cucurbita pepo L.*) growth and yield.

## 2. Materials and Methods

This experiment was carried out from March 11<sup>th</sup> to July 20<sup>th</sup> 2021 at Grdarasha field, College of Agriculture, Salahaddin University to study the effect of foliar application Nitrophenolate (at the concentrations 2, 4 and 6 ml.l<sup>-1</sup>) and IAA (at the concentrations of 0,150, and 300mg. l<sup>-1</sup>). on morphological parameters of squash (*Cucurbita pepo L.*) LYDA F1 cultivar. The seeds were sown in plastic seedling trays under plastic house condition, on the date of April 17<sup>th</sup> 2021, the seedlings were transplanted to the open field after 5 weeks. Some chemical and physical properties of the soil taken from several sites in the field are present in table (1). The following experimental parameters were taken at the end of the experiment (July 20<sup>th</sup> 2021) for all plants:

**Table 1 Some physical and chemical properties of the soil used in the study\*.**

Properties	Field Soil (Grdarasha)
pH	7.65
Electro Conductivity (EC)	1.23 dS.m <sup>-1</sup>
Organic mater	1.14%
Total nitrogen	2.35 mg. g <sup>-1</sup> soil
Available Phosphorous	3.42 ug. g <sup>-1</sup> soil
Total potassium	0.09 mmol <sup>-1</sup>
Sand	12.935%
Silt	52.355%
Clay	33.710%
Soil texture	Silty Clay loam

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**Table 2 The metrological data during the study periods\*:**

Month	Average air temperature °C		Average air Humidity %	Rain (mm)
	Minimum	Maximum		
March	11.7	20.0	42.7	26.1
April	17.6	28.9	24.3	0.2
May	24.3	35.3	16.6	0.2
June	26.5	38.5	13.5	0.0
July	31.0	42.0	13.4	0.0
August	30.0	41.9	13.7	0.0

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## 2.1 Morphological parameters

Vegetative Parameters includes: plant height(cm), stem diameter (mm), number of leaves. plants<sup>-1</sup>, and leaf area (cm<sup>2</sup>) (Hussein *et al.*, 2019 and Regmi *et al.*,2021). However reproductive parameters include: Number of male and female flowers. plant<sup>-1</sup>, sex ratio. Production traits fruit set, number of fruits. plot<sup>-1</sup>, number of fruits. plant<sup>-1</sup>, fruit length(cm), hardness (newton·mm<sup>-1</sup>), yield. Plot<sup>-1</sup> (kg), yield. plant<sup>-1</sup> (kg) and Yield.ha<sup>-1</sup> (ton) (Shafeek *et al.*, 2016 and Aman and Rab, 2013).

## 2.2 Statistical analysis:

The statistical analysis of the experiment was based on Factorial Randomized Complete Block Design with three replicates (Block). The data were submitted to analysis of variance and the means were compared by Duncan's Multiple Range test at 0.05 probability level, by using SAS program (SAS institute,2005).

## 3.Results and Discussion

### 3.1 Vegetative Growth Parameters:

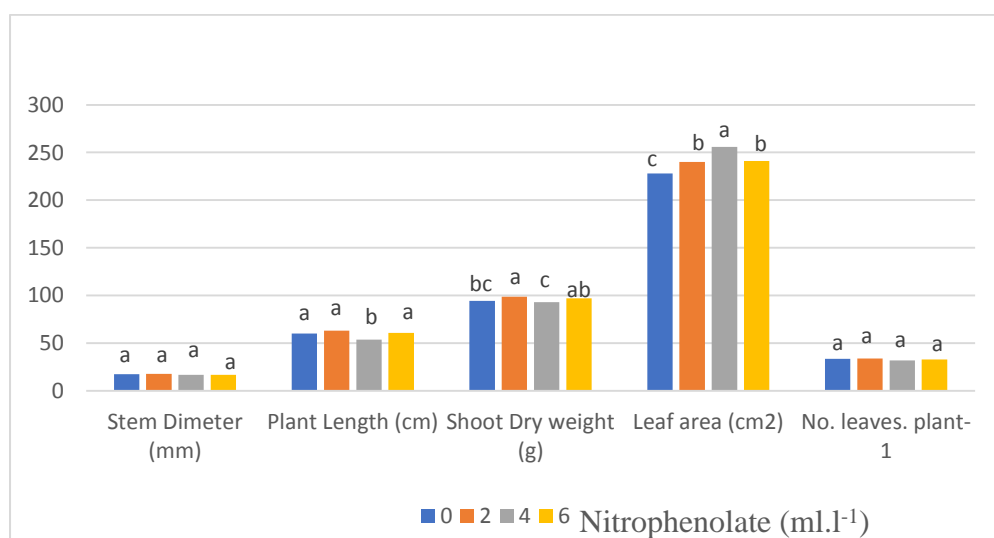
Figure (1) shows significant effect of nitrophenolates levels on vegetative growth parameters except stem diameter and number of leaves. Plant<sup>-1</sup>. The best plant length and shoot dry weight (63.12 cm and 98.72 g respectively) were obtained from 2 ml.l<sup>-1</sup>the highest leaf area (256.00 cm<sup>2</sup>) was recorded from 4 ml.l<sup>-1</sup>.

Figure (2) shows the best results of stem diameter and plant length (17.47 mm and 62.54 cm respectively) were obtained from 300 ml.l<sup>-1</sup> IAA, and the highest of leaf area (257.66 cm<sup>2</sup>) was

observed in the control treatment. While, shoot dry weight and number of leaves. plant<sup>-1</sup> were not affected significantly by IAA application.

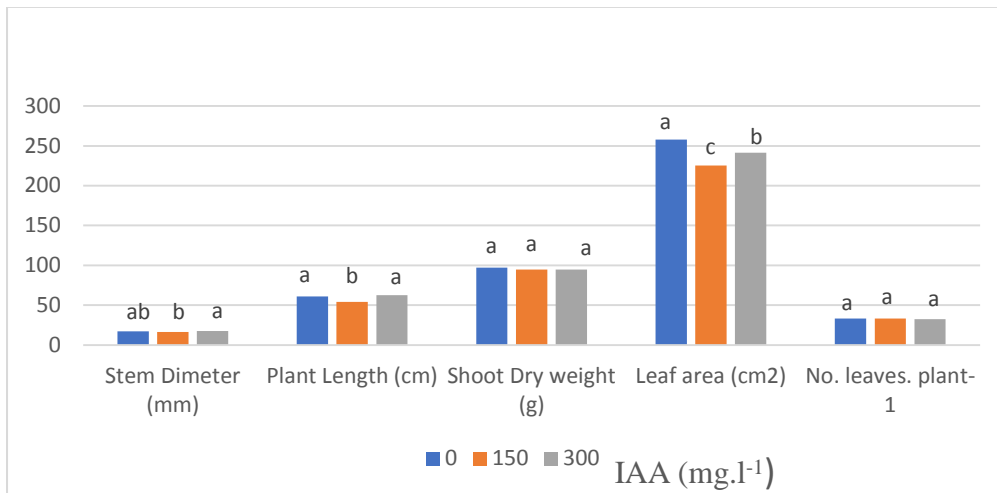
Table (3) shows that the interaction of nitrophenolate and IAA levels affected significantly on all studied parameters. The best results of stem diameter and plant length (19.10 mm and 69.20 cm respectively) were observed from 2 ml.l<sup>-1</sup> nitrophenolate and 300 mg. l<sup>-1</sup> IAA interaction treatment. The highest value of shoot dry weight and leaf area (99.50 g and 274.33 cm<sup>2</sup> respectively) were recorded from 2 ml.l<sup>-1</sup> nitrophenolate without IAA, however, maximum number of leaves. Plant<sup>-1</sup> (37.20) was recorded from 150 mg. l<sup>-1</sup> IAA without nitrophenolate treatment.

Our results partially agree with those of EL-Shabrawy, (2009) and Alam *et al.*, (2020). The effect nitrophenolates might be due to that it contains a significant amount of nitrogen compounds which in turn reflected on increasing the metabolic processes in plants (Amin 2003). IAA play a critical role in the physiological process through growth period; increasing the division and elongation of cells, and it increased the permeability of the cell wall which would allow a greater amount of water and dissolved materials to enter the cell which increased cell size and growth (Devlin, 1975). In addition, the levels of IAA oxidase are low in the areas of high auxin levels and therefore, plant growth (Devlin and Witham, 2001).



**Figure 1 Effects of Nitrophenolate on vegetative growth parameters of squash (*Cucurbita pepo L.*)**

\*(columns with the same letter are not significantly different from each other according to Duncan's Multiple Range test at 0.05 level).



**Figure 2** Effects of IAA on vegetative growth parameters of squash (*Cucurbita pepo L.*) \*(columns with the same letter are not significantly different from each other according to Duncan's Multiple Range test at 0.05 level).

**Table (3)** Interaction effects of nitrophenolate and IAA on vegetative growth parameters of squash (*Cucurbita pepo L.*)

Nitro. (ml.l <sup>-1</sup> )	IAA (mg.l <sup>-1</sup> )	Stem Dimeter (mm)	Plant Length (cm)	Shoot Dry weight (g)	Leaf area (cm <sup>2</sup> )	No. leaves. plant <sup>-1</sup>
0	0	18.00 ab	63.33 abc	95.75 a	233.33 e	31.40 cde
	150	17.56 ab	53.50 de	98.00 a	225.66 f	37.20 a
	300	16.50 b	61.10 bcd	88.66 b	225.00 f	31.77 bcd
2	0	16.30 b	63.40 abc	99.50 a	274.33 a	31.86 bcd
	150	15.70 b	56.76 cde	97.66 a	224.00 f	33.63 abcd
	300	19.10 a	69.20 a	99.00 a	223.33 f	36.06 ab
4	0	16.96 ab	57.53 cde	97.33 a	278.00 a	35.63 abc
	150	16.40 b	51.50 e	86.00 b	225.00 f	32.20 bcd
	300	16.53 b	51.86 e	95.66 a	265.00 b	27.30 e
6	0	16.86 ab	60.43 bcd	98.26 a	245.00 d	33.96 abc
	150	15.40 b	53.50 de	96.66 a	226.66 ef	29.53 de
	300	17.76 ab	68.00 ab	96.33 a	252.66 c	35.06 abc

\* Values within each column followed with the same latter are not significantly different from each other according to Duncan's Multiple Range test at the 0.05 level.

### 3.1 Reproductive Parameters:

Figure (3 a and b) show the significant effects of different levels of nitrophenolates on reproductive parameters. The best results of the number of female flowers and sex ratio (15.83 and 1.32) were recorded from 2 ml.l<sup>-1</sup>. While the negative

effect was recorded on number of male flowers. plant<sup>-1</sup> that the higher value (13.11) was in the control treatment. The best values of fruit length, number fruit. plot<sup>-1</sup>, number fruit. plant<sup>-1</sup>, fruit weight plot<sup>-1</sup>, fruit weight Plant<sup>-1</sup> and fruit weight hectare<sup>-1</sup> (16.50 cm, 27.77, 6.94, 1.42, 5.70 kg and 22.91ton respectively) were obtained from 2 ml.l<sup>-1</sup>

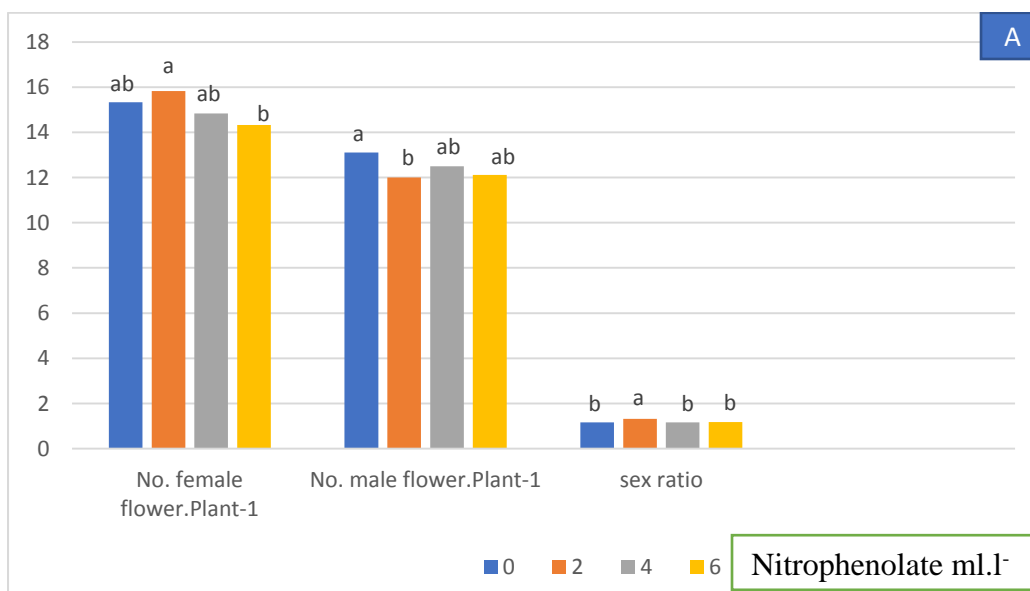
nitrophenolate treatment, and more fruit hardness ( $10.25 \text{ newton.mm}^{-1}$ ) was recorded from  $6 \text{ ml.l}^{-1}$  nitrophenolate.

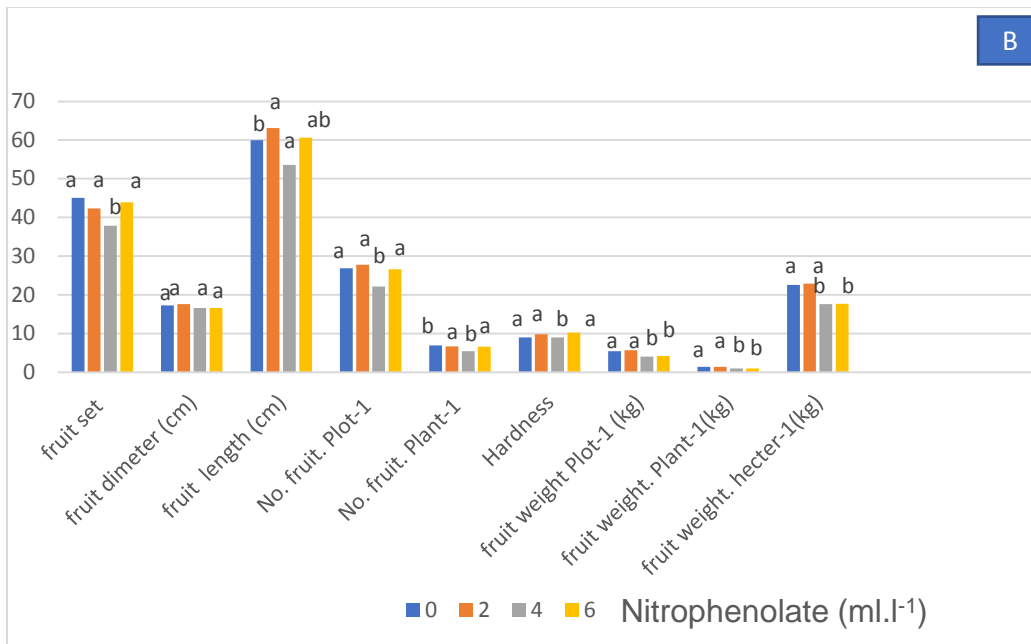
Figures (4 a and b) show a significant effect of different levels of IAA on reproductive parameters. The best value of fruit set, number of fruits.  $\text{plot}^{-1}$  and plant ( $46.25\%$ ,  $27.50$  and  $6.87$  respectively) were recorded from  $300 \text{ ml.l}^{-1}$  IAA. The highest fruit diameter ( $13.53\text{mm}$ ) was obtained from  $150 \text{ ml.l}^{-1}$  IAA. While, the other parameters were not affected significantly by IAA application.

The data in table (4) shows significant effects of nitrophenolate and IAA interaction treatments. The highest number of female flowers.  $\text{plant}^{-1}$  ( $18.00$ ) was recoded from  $4 \text{ ml.l}^{-1}$  nitrophenolate without IAA treatment. The maximum number of male flowers.  $\text{plant}^{-1}$  ( $14.00$ ), number of fruits.  $\text{plot}^{-1}$  and number of fruits.  $\text{plant}^{-1}$  ( $32.66$  and  $8.16$  respectively) and fruit. weight  $\text{Plot}^{-1}$ , fruit weight  $\text{Plant}^{-1}$  and fruit weight  $\text{hectare}^{-1}$  ( $7.30$ ,  $1.82$  and  $29.11 \text{ kg}$ ) were recorded from  $150 \text{ ml.l}^{-1}$  IAA without nitrophenolate treatments. The best results of sex ratio ( $1.48$ ) was recorded from  $2 \text{ ml.l}^{-1}$  nitrophenolate and  $150 \text{ ml.l}^{-1}$  IAA interaction treatments. The highest value of fruit set ( $51.99\%$ ) was observed from  $300 \text{ mg. l}^{-1}$  IAA without nitrophenolate treatment. The best results

of fruit diameter ( $14.00 \text{ mm}$ ) was obtained from  $6 \text{ ml.l}^{-1}$  nitrophenolate and  $150 \text{ mg. l}^{-1}$  IAA interaction treatments. However, the maximum value of fruit length ( $17.16 \text{ cm}$ ) was recorded from  $2 \text{ ml.l}^{-1}$  nitrophenolate and  $300 \text{ mg. l}^{-1}$  IAA interaction treatments. The highest value of fruit hardness ( $10.57 \text{ newton.mm}^{-1}$ ) was obtained from  $6 \text{ ml.l}^{-1}$  nitrophenolate and  $300 \text{ ml.l}^{-1}$  IAA interaction treatments.

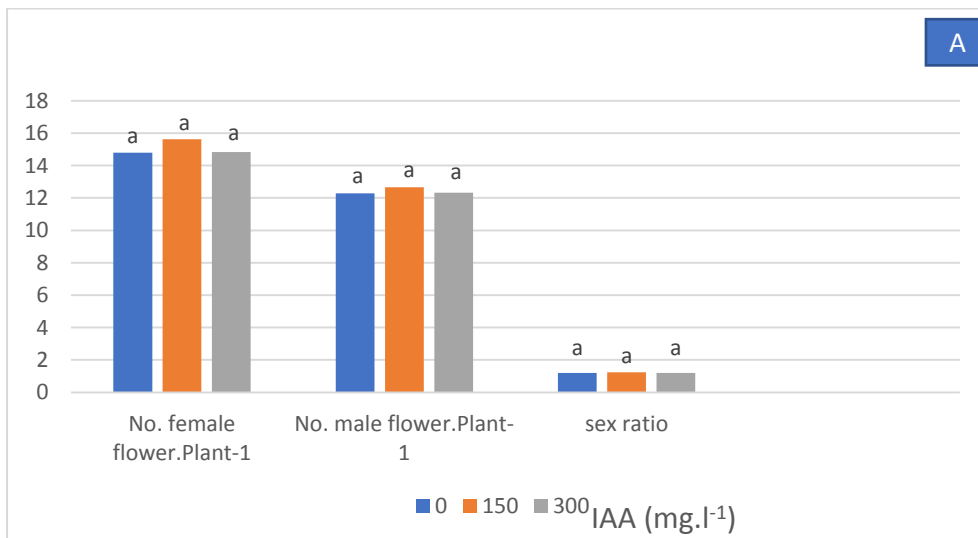
Generally, it may be stated that under such experimental condition, the improving effect of use nitrophenolates on flowering traits would be excepted, and such treatments promoted vegetative traits. Growth regulators have tremendous effects on sex expression and flowering in various cucurbits leading to either suppression of male flowers or increasing in the number of female flowers (Abd Alla et al., 2015). Auxins are those compounds that give a positive effect on the formation of bud, enlargement of cell and root initiation, root induction, control fruits drops, regulation of flowering, parthenocarpy, phototropism, geotropism, herbicides, inhibit abscission, sex determination, xylem differentiation, nucleic acid activity and they are also helpful for the formation of other growth hormones. (Acharya et al., 2020).

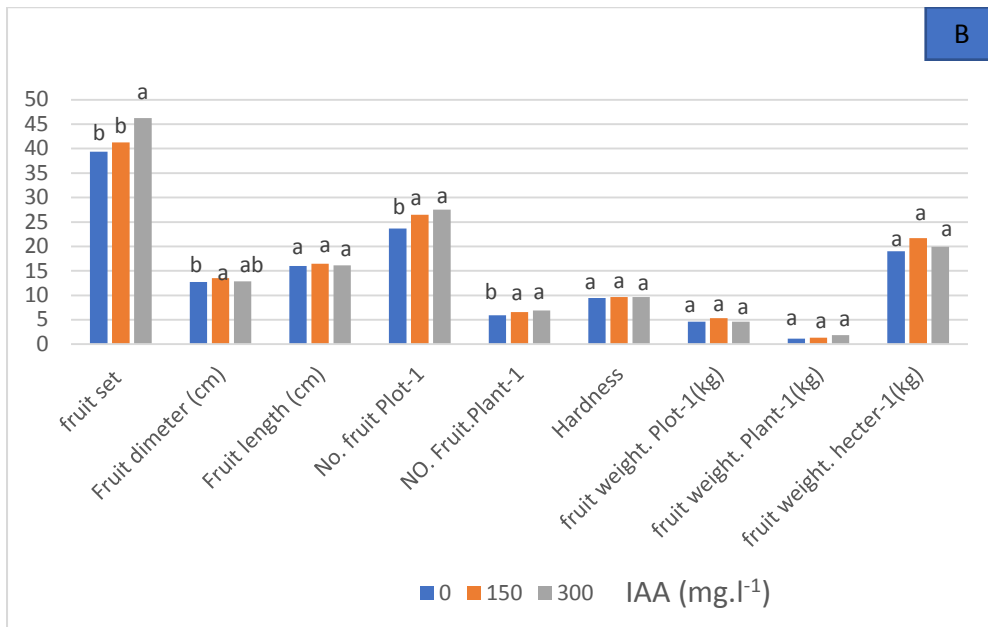




**Figure (3 a and b) Effects of Nitrophenolate on Reproductive growth parameters of squash (*Cucurbita pepo L.*)**

\*(columns with the same letter are not significantly different from each other according to Duncan's Multiple Range test at 0.05 level).





**Figure (4 a and b) Effects of IAA on Reproductive growth parameters of squash (*Cucurbita pepo L.*)**

\*(columns with the same letter are not significantly different from each other according to Duncan's Multiple Range test at 0.05 level).

**Table (4) Interaction effects of Nitrophenolate and IAA on Reproductive Growth parameters of squash (*Cucurbita pepo L.*)**

Nitro. (ml.l <sup>-1</sup> )	IAA (mg.l <sup>-1</sup> )	No. female flower. Plant <sup>-1</sup>	No. male flower. Plant <sup>-1</sup>	sex ratio	fruit set	fruit diameter (cm)	Fruit length (cm)	No. Fruit. Plot <sup>-1</sup>	No. Fruit. Plant <sup>-1</sup>	Hardness (newton .mm <sup>-1</sup> )	fruit weight . Plant <sup>-1</sup> (kg)	fruit weight . Plot <sup>-1</sup> (kg)	fruit Weight. Hecter <sup>-1</sup> (kg)
0	0	15.00 bc	13.33 ab	1.13 cd	37.45 d	12.00 b	14.66 c	22.66 cd	5.66 cd	9.08 bcd	1.14 bc	4.56 bc	19.00bb c
	150	17.83 a	14.00 a	1.28 abc	45.71 abc	13.66 ab	16.00 abc	32.66 a	8.16 a	8.87 cd	1.82 a	7.30 a	29.11 a
	300	13.16 cde	12.00 abc	1.09 cd	51.99 a	12.83 ab	16.00 abc	28.00 abc	7.00 abc	9.07 bcd	1.17 bc	4.70 bc	19.58 bc
2	0	14.16 c	12.00 abc	1.17 bcd	42.60 bcd	13.00 ab	16.00 abc	24.00 cd	6.00 cd	9.87 abc	1.14 bc	4.70 bc	19.58 bc
	150	16.33 ab	11.00 c	1.48 a	38.51 cd	13.33 ab	16.33 ab	25.33 bc	6.33 bc	10.26 ab	1.67 ab	6.68 ab	25.66 ab
	300	17.00 a	13.00 abc	1.30 abc	45.9 abc	13.16 ab	17.16 a	31.33 ab	7.83 ab	9.58 abcd	1.43 abc	5.71 abc	23.50 abc
4	0	18.00 a	12.50 abc	1.43 a	36.08 d	13.66 ab	16.50 ab	26.00 bc	6.50 bc	8.51 d	1.25 bc	5.01 bc	20.82 bc
	150	14.33 c	13.00 abc	1.10 cd	38.43 cd	13.13 ab	17.00 a	22.66 cd	5.50 cd	9.28 abcd	0.94 c	3.70 c	15.89 c
	300	12.16 de	12.00 abc	1.01 d	39.19 cd	13.33 Ab	16.00 abc	18.00 d	4.50 d	9.45 abcd	0.90 c	3.61 c	16.20 c
6	0	12.00 e	11.33 bc	1.06 d	41.30 bcd	12.33 B	16.83 ab	22.00 cd	5.50 cd	10.25 ab	1.06 c	4.25 c	16.63 c
	150	14.00 cd	12.66 abc	1.11 cd	42.49 bcd	14.00 A	16.50 ab	25.33 bc	6.33 bc	10.07 abc	0.89 c	3.56 c	16.10 c
	300	17.00 a	12.33 abc	1.37 ab	48.03 ab	12.16 B	15.33 bc	32.66 a	8.16 a	10.57 a	1.23 bc	4.91 bc	20.47 bc

\* Values within each column followed with the same letter are not significantly different from each



other according to Duncan's Multiple Range test at the 0.05 level.

#### 4- Conclusion

Most growth and yield parameters of summer squash were affected by foliar spray of nitrophenolate, IAA and their interactions. The best level of nitrophenolates significantly affected on vegetative growth parameters (leaf area, plant length and shoot dry weight) and reproductive parameters (number female flower, sex ratio, fruit length, number fruit per plot and plant, fruit weight per plot, plant and hector) which were (2 ml.l<sup>-1</sup>). IAA significantly affected on plant length, stem diameter, fruit diameter and number fruit per plot and plant. The interaction between nitrophenolates and IAA significantly affect on vegetative and reproductive parameters of squash.

We can recommend that using of nitrophenolate as biostimulator and one of the organic growth regulators substance without any phytotoxicity or any harm effects to human or environment, so are now among tools used in sustainable agriculture.

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