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# IMPROVING SQUASH (*Cucurbita pepo* L.*)* PLANT GROWTH, SEX EXPRESSION AND YIELD BY FOLIAR APPLICATION OF POTASSIUM AND ETHEPHON UNDER HIGH SUMMER TEMPERATURE CONDITIONS

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## ABSTRACT

*This field experiment was carried out during the summer seasons of 2013 and 2014 to the Experimental Farm, Faculty of Technology and Development (Ghazala-Zagazig), Zagazig University, Sharkia Governorate, to study the response of squash plants cv.Revera to the foliar spray of potassium fertilization at the concentration of 1,2and 3ml $l^{-1}$ as 37.5% $K_2O$ (four times) and ethephon (ethrel) at 150,250 and 350ppm( once at 2-4 true leaves stage) each alone or in combinations.*

*The obtained results revealed that treated squash plants with foliar application of potassium and ethephon separately or in combination significantly influenced the studied characters compared to untreated plants in both seasons. However, spraying plants with 2 ml $K_2Ol^{-1}$+ 250 ppm ethephon gave the maximum values of most growth characteristics, i.e. number of leaves, fresh and dry weight per plant. Moreover, the treatment with 2 ml $K_2O$ $l^{-1}$ +250 or 350 ppm ethephon recorded the best results of floral traits by decreasing the number of male flowers and sex ratio whereas increased number of female flowers, femaleness as well as yield and its components ,i.e. number of fruits /plant, fresh weight of fruit ,early and total yield per plot.*

***Conclusively,** from these results it could be concluded that foliar application of potassium at 2ml $K_2O$ $l^{-1}$ +ethephon at 250 or 350ppm proved to be the best choice for growing and improving sex-expression by increasing number of female flowers and consequently the yield of plants when squash grown under high summer temperature condition (June , July and August).*

**Key words:** Squash, Potassium, Ethephon, Foliar application, Sex ratio, Summer temperature .

## INTRODUCTION

Since quite a few years ago Global climate change is resulting in increase of the concentration of atmospheric $CO_2$ as well as changes in the daily seasonal and annual mean temperatures experienced by plants. Most plant processes are sensitive to temperature , hence changes in it can have markedly different effects on physiological and biomass characters that contribute to plant growth (loveys *et al.*, 2002). Summer squash (*Cucurbita pepo* L.) is one of the most popular vegetable crops belonging to the family Cucrbitaceae. Squash is very sensitive to agroclimatic features such as temperature and day length. Bannayan *et al*. (2011) realized that climate impose a wide range of direct and indirect impacts on squash production and any change in local weather conditions especially during critical development stages may adversely influence plant growth and result to yield reduction.

In the cucurbits crops, sex determination of individual flower buds is regulated by a combination of genetic, environmental, nutritional and hormonal factors (Manzano *et al*., 2011). Squash very affected by temperature, low temperature inhibits the development of male flowers and increase the number of female flowers (Wien *et al*., 2004), while high temperature induces a partial transformation of female flowers into hermaphrodites or male flowers( Penaranda *et al*., 2007).

The concern of climate and its effects on agricultural crops have stimulated researchers to work on the analysis of climate and agricultural plants productivity (Bannayan *et al.*, 2010).

In this respect, the use of some novel means instead of traditional practices is desirable to overcome the effects of these changes and regulating the environmental factors such as breeding new varieties, modification sowing date, agricultural transactions (irrigation , fertilization , etc.) and used effective chemicals (antioxidants , growth regulators, etc.).

The application of foliar spray is an important horticultural crop management strategy, which may help maximizing plants yield and its quality. Foliar spray is used as a mean of supplying supplemental doses of macro and micro-nutrients, plant hormones, stimulants and other beneficial substances.

Potassium is a major essential nutrient and it is being taken up by the plants in quite large quantities similar to or more than nitrogen. In the recent works there is a trend to reduce the soil mineral fertilizers used, especially nitrogen, phosphorus and potassium. This fact creat the importance of potassium foliar fertilization as an alternative to meet plant nutrient demand during growing season. Foliar fertilization had several advantages such as,

use of nutrients in adequate amounts, much faster to uptake by foliage, quickly correct physiological disorders, help overcome various stress conditions, lower crop production cost, easy of application and good quality of fertilizers were used which readily soluble in water (Haytova, 2013). Although potassium is not a constituent of any organic molecule or plant structure, it is involved in numerous biochemical and physiological processes vital to plant growth, yield, quality and stress (Marschner, 1995 and Cakmak, 2005). It is involved in stomatal regulation of transpiration , photosynthesis, photophosphorylationg transportation of photoassimilates from source tissues via the phloem to sink tissues, enzyme activation, turgor maintenance and stress tolerance (Usherwood, 1985, Marschner, 1995 and Pettigrew, 2008). Foliar potassium fertilizers were tested at different doses on squash and other cucurbits crops, its use increased vegetative growth, flowering as well as yield and its components (Al-Hamzawi, 2010; Abdulgabbar and Mohammed, 2010; Abd- El- Hamed *et al*., 2011; Ezzo *et al*., 2012; Glala *et al*., 2012; Baruah and Sarma, 2013; Kazemi, 2013; Pal *et al*., 2016 and Shafeek *et al*., 2013 and 2016).

Recently, researchers are concentrating their works on enhancement productivity of horticultural crops by using growth retardants, like the conventional retardants ethephon (ethrel). Ethephon (2-chloroethyl phosphonic acid) is an ethylene-releasing compound and it is widely used as plant growth regulator. The effect of the application of exogenous gaseous ethylene or ethephon solution can be affected by genotype, the amount of applied hormone and the stage of development at the time of application (Sure *et al*. 2012 , 2013 and Shakar *et al*., 2015). Ethephon include many aspects of plant growth and development, Thappa *et al*. (2011), Sure *et al*. (2013) and Shakar *et al*. (2015) found that application of ethephon reduce the stem length of different cucurbits plants. On the other hand, many investigators showed that ethephon had promotion effect on plant growth paramenters, *i.e*. number of leaves as well as fresh and dry weight of plant (Phillips, 1971; Ezzo *et al*., 2012 and Glala *et al*., 2012).

Flower development is a critical factor influencing plant reproduction and crop yield. Exogenous application with ethylene-releasing compounds such as ethrel or ethephon is among growth regulators have tremendous effects on sex expression and flowering in various cucurbits leading to either suppression of male flowers or an increase in the number of female flowers (Al-Masoum and Al-Masri, 1999 and Thappa *et al*., 2011) without imposing any deleterious effect on the environment and human health. Manzano *et al*. (2011) reported that ethylene is the principal hormone regulating sex expression in the cucurbitaceae family, promote the

production of female flowers as well as regulate the individual development of floral primordia in squash. The application of ethephon proved significant in the ratio of female to male flowers and femaleness percentage in cucurbit plants which are valuble and very important trait, whereas total fruit yield depend of it (Gad *et al*., 1993; Yongan *et al*., 2002, Manzano *et al*., 2011 and Shafeek *et al*., 2016 on squash and Sur *et al*., 2012, 2013; and Baruah and Sarma, 2013 and 2015 on different cucurbit plants). Spray ethelen releasing compounds, *i.e.* ethephone or ethrel have been shown to increase yield and its components in cucurbit crops (Gad *et al*., 1993; Ezzo *et al*.;Glala *et al* 2012 and Shafeek *et al*., 2016 on squash as well as Baruah and Sarma, 2013 and Shakar *et al*.,2015 on other cucurbit crops.

The scope of currant investigation is to evaluate the effectiveness either foliar potassium fertilization as 37.5 $K_2O$ and/ or ethephon (ethrel) applications on improve summer squash yield by decreased sex ratio, enhanced femaleness and plant growth under high summer temperature months (June-July and August).

## MATERIALS AND METHODS

Two field experiments were carried out during two successive summer seasons of 2013 and 2014 at the Experimental Farm , Faculty of Technology and Development (Ghazala–Zagazig), Zagazig University, Sharkia Governorate to improve squash (*Cucurpita pepo* L.) cv. Revera growth, sexual expression and productivity by foliar application of 37.5% potassium oxide and ethephon (ethrel) at high summer temperature. Soil texture of the experimental field was clay. Soil chemical analysis was applied using the method described by Black(1982). Results of pH 8.1-8.2,organic matter(%)1.5 -1.7and available inorganic N 22-20, P 22-19 and K 332-323 ppm in the first and second seasons,respectively. Average temperature during the two growing seasons was shown in Table 1.

**Table 1:** Maximum and minimum temperature during the two growing seasons in Zagazig region

| **Months** | **First season (2013)** | | **Second season (2014)** | |
|---|---|---|---|---|
| | **Temperature (˚C)** | | | |
| | **Maximum** | **Minimum** | **Maximum** | **Minimum** |
| **June** | 35.3 | 21.7 | 35.9 | 20.8 |
| **July** | 36.10 | 21.5 | 36.9 | 22.8 |
| **August** | 36.8 | 22.1 | 37.2 | 23.5 |

**The source:** The National Authority for Meteorology

Squash seeds Revera *cv.* were sown in 19th and 17th of June in two growing seasons, respectively. These experiments were set out in a completely randomized block design with three replicates. Treatments included four foliar applications of potassium 37.5% which contained 37.5% $K_2O$ (0, 1, 2 and 3 $ml^{-1}$ ) and four concentrations of ethephon (0 , 150 , 250 and 350 ppm ) each alone or in combination between them. Each plot included four ridges 70cm wide and 4m long with area about 11.2$m^2$. Two seeds were planted per hill on one side of the ridge at a distance of 40cm apart.

Plants were sprayed with solution of ethephon treatments for one time in the early morning at 2-4 true leaves stage. Potassium solutions were sprayed four times, the first one was after 20, 30, 40 and 50 days from seed sowing, respectively. All agricultural practices were carried out according to the recommendations of Egyptian Ministry of Agriculture for summer squash production. The source of 37.5% potassium was Kafr El Zayat pesticides and chemicals Co. (S.A.E).

***Data recorded:***

Vegetative growth characteristics: After 10 days from the last spraying of potassium (60 days from seed sowing ) , five plants were selected randomly from each plot to measure: vine length and diameter , number of leaves / plant as well as fresh and dry weight / plant.

Floral traits: At flowering stage, a randome sample of three plants from each treatment was labeled. Number of male and female flowers were counted all over the flowering period. Sex ratio and femaleness percentage were calculated according to the following equations:

$$\text{Sex ratio} = \frac{\text{Number of male flowers}}{\text{Number of female flowers}}$$

$$\text{Femaleness (\%)} = \frac{\text{Number of female flowers}}{\text{Number of female flowers} + \text{Number of male flowers}} \text{ x } 100$$

Yield and its components: Fruits were harvested from two to three times a week., total number of fruits / plant and average fruit weight were determined as well as total fruit yield / plot was calculated . Early yield was calculated from the first three harvests.

Obtained data of experiments were subjected to statistical analysis of variance (ANOVA) to test treatment effects for significance according to Gomez and Gomez(1984) and the differences among treatments were compared for significance at 5% level. All statistical analysis were performed using the SPSS software according to Pallant (2001).

## RESULTS AND DISCUSSION

### *Vegetative growth characteristics*

All vegetative growth parameters, *i.e.* vine length and diameter, number of leaves / plant as well as fresh and dry weight / plant, were affected by the different foliar spray treatments of potassium (37.5 %$K_2O$) and ethephon either alone or in combination (Table 2). The results indicated that all the applications had significant effect for all studied traits compared with the control. The highest value of squash plants vine length was obtained by spraying potassium at the concentration 2 ml $K_2O$ $l^{-1}$, while the reduction of length was observed by used 350 ppm ethephon compared to the control and other treatments. On the other hand, there was inverse relationship between vine length and the increase of ethephon concentration when sprayed lonely or with potassium treatments. Such trend was true during both seasons of study.

As for vien diameter, results in Table 2 revealed that there were positive corrolection between increase the concentration of either potassium or ethepnon as alone and/ or in combination of increased vien diameter. The highest value was recorded by the application 3ml $K_2O$ $l^{-1}$ + 350 ppm ethephon compared with the control. In this respect, application of potassium as foliar spray at the concentration 2 or 3 ml $K_2O$ $l^{-1}$ each, lonely or combined with 350 ppm of ethephon had no different significance between them.

Obtained data in Table 2 indicated that the maximum values of number of leaves / plant as well as fresh and dry weight/ plant were observed by using 2ml $K_2O$ $l^{-1}$+250 ppm ethephon compared with the control and other treatments during the two growing seasons except number of leaves/plant which had no different significant with the treatment 2ml $K_2O$ $l^{-1}$.

The positive effect of supplemented potassium on vegetative growth characters indicating the role of it in plant metabolism and its involvement in many related processes needed to sustain and promote growth and development. Marschner (1995), Cherel (2004) and Cakmak (2005) reported that ,although potassium is not a constituent of any functional molecules or plant structure, it is involved in numerous biochemical and physiological processes and pivotal role to plant growth and environmental stress. In this respect, Usherwood (1985) ,Bhandal and Malik (1988) and Pettigrew ( 2008) mentioned that potassium play roles in regulating the opening and closing of stomata and water retention. It promotes the growth of meristematic tissue, activates some enzymatic reactions, aids in nitrogen metabolism and the synthesis of proteins, and catalyzes activities of some

mineral elements and aids in carbohydrate metabolism and translocation. Abduljabbar and Mohammed (2010) observed the significant increase of the components of squash vegetative growth. They referred this enhancing effect to the physiological role of potassium in stimulating enzymes responsible for carbohydrate synthesis and production of energy as well as protein synthesis through its role in activation of nitrate reduction inside the plant to produce ammonia then amino acids. Similar induced in morphological characters of squash and other cucurbits plants of potassium foliar application has been reported by Abd El-Hamed and Elwan (2011), Kazem (2013), Shafeek *et al.* (2013) and Pal *et al.*(2016).

Ethylene performs various physiological functions in plant. It has stimulatory as well as inhibitory effect depending upon its concentration and sensitivity to plants. The results in Table 2 indicated that the lowest value of vine length was produced by the higher concentration of ethephon (350 ppm). The reducing effect of ethephon in this respect might be due to different probabilities. The inhibition of apical growth may have been due to ethylene released from ethephon which inhibits elongation because of its more impact on cell enlargement instead of division of cells (Kieber *et al*.,1993) and plant polar auxin transport (Arora *et al*.,1982). Moreover, the reduction of stem length might be due to antigibberellin activity of ethylene hormone that causes cessation of mitotic cell division in the apical meristematic zone of root and shoot (Hayashi *et al.*,2001).The obtained results of the decrease in vein length are similar to those observed in various cucurbits plants by Thappa *et al*.(2011) Sure *et al*.(2013) and Shakar *et al*. (2015).

On the other hand, the stimulative effect of 250 ppm ethephon on plant growth attributes such as vine diameter, number of leaves as well as fresh and dry weight of plant explored by Phillips (1971) who reported that ethrel can regulate plant metabolism and produce desired physiological effect at different growth sites such as buds, leaves and roots.

The positive effect of 2 ml $K_2O$ $l^{-1}$ + 250 ppm ethephon on promote most growth parameters may be attributed to the interaction effect of each potassium and ethephon whereas potassium is involved in the activation of more than 60 enzymes which are necessary for essential plant processes such as energy utilization ,starch synthesis ,N metabolism ,respiration and regulating plant water status which reflect on plant growth (Walling Ford, 1980) . In addition ,Ezzo *et al*.(2012) and Glala *et al*.(2012) stated that positive effect of spray seedling in early stage with ethephon enhance root growth and this reflect on plant growth characters.

***Floral traits***

It is clear from such data in Table 3 that foliar application of potassium (37.5% $K_2O$) and ethephon either alone or in combination had a significant role on all floral traits, *i.e.* number of male flowers , female flowers , sex ratio and femaleness percentage compared with the control. Different concentrations of $K_2O$ (1, 2 and 3 ml $K_2O$ $l^{-1}$) had positive effect on all floral characters. Potassium at 2 or 3 ml $K_2O$ $l^{-1}$ showed increase in the number of female flowers and femaleness as well as decrease in the number of male flowers and sex ratio compared with 1 ml $K_2O$ $l^{-1}$ and the control. Spray ethephon at 350,250 and 150 ppm , respectively achieved best results in this respect than potassium treatments and control which increase female flowers number and femaleness percentage ,on the same time reduce male flowers number and sex ratio. In this respect, application of potassium at 2ml $K_2O$ $l^{-1}$ + 350ppm ethephon maximized the number of female flowers and femaleness percentage, where the number of male flowers and sex ratio were decreased. Moreover, there was no significant difference by spraying plants with 2 or 3 ml $K_2O$ $l^{-1}$ + 350 ppm ethephon or 2ml $K_2O$ $l^{-1}$ + 250 ppm ethephon on squash floral traits.These findings were similar in the two experimental seasons.

In this concern ,Noggl and Fritz (1983) stated that potassium has no direct role in promoting flowering in most plants, indirectly, if a plant is suffering from a potassium deficiency then growth will be stunted because photosynthesis (sugar production) and respiration (burning of sugars for energy) is limited, as well as the role of potassium is an act as catalyst of activator of enzyme, promotes overall growth. Foliar application of potassium improving flowering of plants, such effects may be attributed to the positive influence of potassium concentrations used on nutrient availability which reflected on enhancing plant growth and this resulting to higher flowering and improve floral characteristics (Al-Hamzawi (2010) and Shafeek *et al*. (2013). Abduljabbar and Mohammed (2010) endorsed the present results ,which that the application of foliar potassium increased female flowers and minimized male flowers and therefore sex ratio in squash plants.

Ethylene is a critical plant hormone for vegetative as well as reproductive growth and development processes. Spraying ethephon at 350 ppm as a source of ethylene increased female flowers and shifted sex expression towards femaleness. Such effects might be due to ethephon slightly inhibited vegetative growth, enhanced carbohydrate percentage and reduced respiration causing to enhanced the development of pistillate flowers (Abdel-Rahman and Thompson,1969 and Sams,1976). Furthermore,

Rudich *et al*.(1972) ,(Arora *et al.*)1982 and Shakar *et al*.(2015) indicated that hybrid cultivar produced more ethylene and this may be due to increase female flowers where female buds of cucurbits plants produced high amount of ethylene than those produced by male buds. Moreover, Glala *et al*.(2012) and Shafeek *et al*. (2016) suggested that spraying squash seedling with ethephon in early stage might be due to promote root growth which reflect on intensity shoot growth , thus consequently increased number of female flowers and reduced sex ratio.

In this concern,Al-Masoum and Al-Masri (1999) and Baruah and Sarwa (2013) indicated that sexual expression of cucurbit plants is in control by ethephon application or similar unsaturated hydrocarbon which release ethylene and this may be responsible for the flower induction. On the other hand, Little *et al*.(2007) and Manzano *et al*.(2011) reported that, besides controlling the duration of the two sexual phases of development and the number of postillate and staminate flowers per plant ,ethylene released by ethephon regulates the growth and development of carple in squash female flower.

Results of this studies showed also that, foliar application of the integrated between 2ml $K_2O$ $l^{-1}$ + 350 ppm ethephon gained the maximum number of female flowers (12.02 and 11.87) and femaleness percentage (65.02 and 65.27), simultaneously reducing the number of male flowers (6.46 and 6.31) and sex ratio (0.530 and 0.526) , respectively for the two growing seasons. These results might be attributed to the major roles of potassium and ethephon on metabolism and physiological processes of plants which reflect on plant growth and floral characteristics. Such effects could be referred to that potassium at the concentration 2 ml $K_2O$ $l^{-1}$ promoted vegetative growth, therefore improved floral characters. Application of ethephon was correlated with the amount of ethylene production from the leaves, so plants treated with 350 ppm ethephon produced the highest number of female flowers, percentage of femaleness as a result of the physiological changes of there (Ries, 1985).

***Yield and its components***

Data presented in Table 4 reveals that, all potassium and ethephon treatments either applied alone or in combination had significant influence of all studied yield characters such as number of fruits / plant, fresh weight of fruit, early yield and total yield / plot. Maximum number of fruits/ plant(10.98 and 9.91in the $1^{st}$ and $2^{nd}$ seasons ,respectively)were recorded during the two growing seasons by the treatment 2ml $K_2O$ $l^{-1}$ +350ppm ethephon as compared with the control(6.76 and 5.35 in the $1^{st}$ and $2^{nd}$ seasons, respectively).

On the same time there were positive correlation between the increase of ethephon concentration from 150,250 and 350 ppm and the enhance of fruit number / plant. Regarding to the fresh weight of fruit and early yield / plot foliar spray of potassium at the concentration 2 or 3 ml $K_2O$ $l^{-1}$ due to increase of both during the two growing seasons compared with the control and some other treatments. Moreover, such data show also that there were inverse relationship between the increase of ethephon concentration and the decrease of fruit fresh weight. In addition, application ethephon at 250 ppm in combination with any of potassium treatments used (1,2 and 3 ml $K_2O$ $l^{-1}$ ) gained higher values compared with the other combinations in each concentration. Also, such data illustrated that the maximum increments of fruit fresh weight and early yield/plot was obtained by the treatment 2 ml $K_2O$ $l^{-1}$+ 250 ppm ethephon. In this respect, there were no differences when spraying potassium at the concentration 2 ml $K_2O$ $l^{-1}$ separately or with 250 ppm ethephon on fresh weight of fruit . Obtained results in Table 4 show that application the different concentrations of potassium and ethephon lonely or in combination significantly enhanced fruit yield /plot compared to the control .Application of 2ml $K_2O$ $l^{-1}$ +350ppm ethephon recorded the highest fruit yield / plot(27.64 and26.08 kg/ plot, respectively) during the two growing seasons compared to control (17.10and14.07kg/ plot , respectively).

In this concern, increased total fruit yield with foliar application of potassium and ethephon proved the positive correlation between total yield and the number of female flowers , sex ratio and the number of fruits/ plant as shown in Tables 3 and 4. In this respect, squash plants treated with ethephon showed a cyclic pattern of producing fruit by increased fruit production followed by a period of decreased fruit production as observed for individual treatments as shown in Figure 1.

The favorable effect of potassium on yield and its components might be interpreted by plants during flowering and fruit setting stages require high amount of potassium as an important nutritional element, play a part in regulation and to perform the physiological processes. Foliar spraying of potassium resulting in increased the available needed potassium to accomplish the two operations which in turn effect on all studied parameters of yield. Moreover, potassium had a positive effect in producing more female flowers ,increased femaleness and decreased sex ratio which reflected on the previously mentioned characters of yield. These results correspond with those of Abduljabbar and Mohammed (2010) on squash and Al-Hamzawi (2010) as well as Shafeek *et al*. (2013) on cucumber. Furthermore, Kazemi (2013) observed an increase of fruits number / plant,

fruit weight and total yield of cucumber and tomato to the application of potassium. This increment may be due to that plants need a high amount of potassium and other nutrients during flowering and fruit setting stages to perform the biological operations as increase in photosynthesis which couple with chlorophyll synthesis. (Pal *et al*.,2016). An adequate quantity of potassium plays a principal role in plant growth and development by activating abundant enzymes which control cell osmoregulation and the stomatal movement during photosynthesis (Broadley *et al*.,2009).

Results of this study showed also that spraying squash plants with ethephon significantly increased the number of fruits / plant and total fruit yield / plot. These findings were consistent with each of Gad *et al*.(1993),Ezzo *et al*.(2012),Glala *et al*.(2012) and Shafeek *et al*.(2016) on squash , Baruah and Sarma (2013) and Shakar *et al.(*2015) on other cucurbit crops. The potential yield of cucurbits plants depends largely on the number of nodes produced and the sex of the flower born at each node ( Hopping and Hawthorne,1979),this suggest was observed by spraying the different concentrations of ethephon on number of leaves ( Table 2) and number of female flowers (Table 3) of squash plants whereas the concentrations 250 and 350 ppm gained the maximum results of these features. Such results of increased the fruit yield by spraying ethephon at the concentrations 150,250 and 350 ppm may be due to the higher ethylene produced which due to increase the number of female flowers, tendency the plants to femaleness and decreased sex ratio (Yongan *et al*. ,2002; Manzano *et al*.,2011 ; Sur *et al*.,2012 and 2013;Shafeek *et al*.(2016) on squash and Shakar *et al*., 2015 on cucumber. In addition ,the improve of squash fruit yield by the use of ethephon could be attributed to its effect on increasing number of fruits per plant (Gad *et al*.,1993, Ezzo *et al*., 2012 , Glala *et al*., 2012 and Shafeek *et al*., 2016). In this concern, obtained results of the increase of total fruit yield by ethephon treatments explored the positive correlation between the number of pistillate flowers per plant, sex ratio with total yield as shown in Table 5 (Hidayatullah *et al*.,2012 and Sure *et al*.,2013).

The present experiment can be explored the suggestions of Ries (1985),in which that the application of growth retardants increased the endogenous ethylene production which triggered metabolic and physiological processes as well as affected C:N ratio in plants , in turn stimulating flowering , increased the number of female flowers ,femaleness expression ,reduced sex ratio and thereby fruit yield.

Moreover, the experiment shows also the cyclic pattern of producing fruits throughout the season when spraying plants with ethephon. This observation is consistent with the theory that flowering and fruit set in summer

**Table 5.** Correlation coefficient for the effect of foliar spray of ethephon on sex expression and squash yield

| Correlation coefficient | No. of female flowers per plant | Sex ratio | No. of fruits per plant | Total yield kg/plot |
|---|---|---|---|---|
| **No. of female flowers per plant** | 1 | 0.345 | 9826** | 9586** |
| **Sex ratio** | 0.345 | 1 | 0.3156 | 0.3315 |
| **No. of fruits per plant** | 9826** | 0.3156 | 1 | 9883** |
| **Total yield kg/plot** | 9586** | 0.3315 | 9883** | 1 |

squash follow a cyclic pattern, with periods of increased flower production being followed by periods of decreased flower production (Sams, 1976). In addition, Hopping and Hawthorne (1979) reported that ethrel applications just after the onset of enhanced staminate flower production did not result in a second wave of pistillate flowering similar to that obtained by the initial ethrel treatment.

The superiority of total yield of squash plants as a result of using the different concentrations of potassium and ethephon is mainly due to its improving effect on the most vegetative growth characteristics (Table 2) and floral traits (Table 3). Obtained results are in agreement with those found by Abduljabbar and Mohammed (2010),Ezzo *et al.* (2012), Glala *et al*. (2012) and Shafeek *et al*.(2016) on squash Al-Hamzawi (2010), Baruah and Sarma (2013) and Shafeek *et al*. (2013) on different cucurbit plants.

***Conclusively,*** *from these results it could be concluded that* influence of foliar spray of potassium 37.5% $K_2O$ and ethephon ( as plant growth regulator) on the habit of growth ,flowering and yield of summer squash when cultivated under unsuitable temperature. The findings could be used to improve squash fresh market production if plants sprayed with 2 or 3 ml $l^{-1}$ of potassium as 37.5% $K_2O$ ( three times) and 250 or 350 ppm of ethephon (one time at 2-4 true leaves).

These treatments promote vegetative growth ,increases the number of female flowers, enhancing femaleness on plants, reduced sex ratio and all of these results followed by improved fruit yield under unfavorable temperature summer conditions during (June ,July and August).

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# تحسين النمو ، السلوك الجنسي والمحصول فى نبات الكوسة بالرش بالبوتاسيوم والاثيفون تحت ظروف درجات حرارة الصيف المرتفعة

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أجريت هذه التجربة خلال موسمى الصيف لعام ٢٠١٣ و ٢٠١٤بمزرعة التجارب بكلية التكنولوجيا والتنمية (غزالة-الزقازيق) جامعة الزقازيق ، محافظة الشرقية لدراسة استجابة نباتات الكوسة صنف ريفيرا للتسميد البوتاسي رشا وذلك بالتركيز صفر ، ١، ٢ ، ٣ ملليلتر/لتر فى صورة اكسيد البوتاسيوم ٣٧,٥ % (أربع رشات) وكذلك معاملة النباتات بالاثيفون (الاثيريل) بالتركيز صفر،١٥٠،٢٥٠،٣٥٠ جزءفي المليون (رشه واحدة عند ٢-٤ اوراق الحقيقة) كلا بمفرده اوفي توليفات منهما معا .
وقد اوضحت النتائج المتحصل عليها ان رش نباتات الكوسة بالبوتاسيوم والاثيفون كلا بمفرده أو فى توليفات بينهما قد أدت الى زيادة معنوية لكل الصفات المدروسة مقارنة بالنباتات الغير معاملة خلال موسمى الزراعة. وكذلك أدى رش النباتات بالمعاملة ٢ ملليليتر/ لتر من اكسيد البوتاسيوم+ ٢٥٠ جزء فى المليون اثيفون الى الحصول على أعلى القيم لمعظم صفات النمو الخضرى متمثلا فى عدد الاوراق و الوزن الغض و الجاف للنبات. وبالاضافة الى ذلك فقد ادت المعاملة ٢ ملليليتر/ لتر اوكسيد البوتاسيوم + ٢٥٠ او ٣٥٠ جزء فى المليون اثيفون للحصول على افضل النتائج للصفات الزهرية حيث قل عدد الازهار المذكرة والنسبة الجنسية بينما ازداد عدد الازهار المؤنثة و اتجاه النباتات للتأنيث وكذلك المحصول ومكوناته متمثلا فى عدد الثمارلكل نبات، الوزن الغض للثمرة والمحصول المبكر والكلى للقطع التجريبية.
التوصية: بناء علي ذلك فقد اثبتت المعاملة ٢ ملليلتر /لترمن اكسيد البوتاسيوم٣٧,٥% +٢٥٠او٣٥٠ جزء في المليون اثيفون انها هي الافضل للنمو وتحسين السلوك الجنسي للنباتات بزيادة عدد الازهار المؤنثة وبالتالي محصول النباتات وذلك عند زراعة الكوسة تحت ظروف شهور الصيف ذات الحرارة المرتفعة ( يونيو – يوليو- اغسطس) .