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INFLUENCE OF SOME SQUASH CULTIVARS AND GROWTH STIMULANTS ON FLOWERING, YIELD AND FRUIT QUALITY AT AUTUMN – WINTER SEASON UNDER OPEN FIELD CONDITIONS

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ABSTRACT

This investigation was conducted at the Experimental Farm, Fac. Tech. and Develop. (Gazala region – Zagazig), Zagazig Univ., Sharkia Governorate under open field during the two fall – winter seasons of 2015/2016 and 2016/2017, to study the effect of three cultivars of squash (Eskandarany, Revera and Azyad) and foliar spray treatments with, yeast extract at the rate of 3 and 6gl^{-1} ,as well as potassium silicate at the rate of 2 and 4gl^{-1} plus control (tap water)and their interactions on flowering expression, i.e., number of male and female flowers plant^{-1}, sex ratio and femalness percentage, yield and its components (number of fruits plant^{-1} , fruit fresh weight, and dry matter percentage, total fruit yield plot^{-1} and relative yield), as well as fruit quality, i.e., fruit physical characters (both of fruit length and diameter) and fruit chemical composition (nitrogen, phosphorus and potassium content, protein and total carbohydrates percentage). Results showed the superiority of the two tested cultivars Azyad and Revera at all studied characteristics compared with Eskandarany cv. Spraying with yeast extract or potassium silicate significantly increased most parameters of flowering, fruit yield and quality attributes of squash than control treatment . Moreover, spraying plants with potassium silicate at rate of 4gl^{-1} or yeast extract at 6gl^{-1} significantly surpassed compared with the other foliar treatments and control in this respect. The best results of the interaction treatments for flowering, yield and fruit parameters were recorded by the two cultivars Azyad or Revera combined with the foliar

spray by 4gl^{-1} of potassium silicate or 6gl^{-1} of yeast extract which recorded increased in most of all the mentioned studied parameters.

Hence, each of these treatments could be recommended for enhancement flowering, yield and fruit quality of squash plants with low cost production when planted in open field at fall – winter season under the same conditions of this experiment.

Key words: Squash, cultivars, yeast extract, potassium silicate, flowering, yield, fruit quality

INTRODUCTION

Squash (*Cucurbita pepo L.*) is one of the most popular cucurbits vegetable crops grown in Egypt. The immature fruits are eaten as boiled, fried or stuffed. It has Various health and medicinal benefits of human (Bannayan *et al*., 2011). Squash fruits contain considerable amounts of carbohydrates, proteins, minerals and vitamins (Base *et. al.,* 2000).

Squash is cultivated all over the year in Egypt, in open field during spring and summer, where in tunnels or – greenhouse in fall and winter. Global climate changes, *i.e*., amount of CO_2, solar radiation and changes in temperature, the intensity of extreme weather have a different effects of plants at molecular function, morphological characteristics, physiology and developmental processes (Gray and Brady, 2016). In this concern, there is an urgent need to improve agricultural practices to ensure that crop production is balanced with environmental sustainability. Under climate changes the production of vegetable crops may be improved by using various novel agricultural practices, i.e., suitable new cultivars, modification of sowing date, as well as spraying growth stimulants such as, yeast extract and potassium silicate to overcome the effects of these undesirable conditions.

Squash plants is very sensitive to agroclimatic factors like photoperiod and temperature considerably during critical development stages which influenced on plant growth and yield (Bannayan *et al.,* 2011).In this respect, genotypes behave differed under different environmental conditions and most crop cultivars were adapted to temperature where it is the major factor affected on their distribution (Moursy *et al.,* 2014). Numerous studies on the cultivars of cucurbitaceae members family indicated that flowering characters, yield and its components, as well as fruit physical and chemical parameters have highly variation depending on

their genetic make -up and/or environmental factors (Marie *et al*., 2011, Yoldes, 2014, Esho and saeed, 2016 and 2017 Hassan *et al*., 2016 , Mousa and Al-Qurashi, 2017 as well as Kumar and Sharma,2018).

Lately, foliar spray of growth stimulants considered as one of the most important points among management strategy to improve growth, flowering, yield and quality of horticultural crops particularly under stress conditions.

Growth stimulants are micro-organisms or substances supplemented for plants to enhancement the tolerance of the abiotic stress, nutrient uptake and efficiency, as well ass crop quality. Both yeast as fungi and silicon as inorganic compound considered amoung these biostimulants (Laane , 2018).

Yeast extract has become a hot topic for used with various plants as it is more natural, safe and low cost. Moreover, it is rich in effective constituents, such as low-molecular-weight organic matter, amino acids, nucleotides, peptides, nitrogen, phosphorus and trace elements (Vieira *et al*., 2016).

Additionally, yeast extract contains vitamins especially B- Complex vitamins, enzymes and phytohormones such as, auxins and cytokinins (Barnett *et al*., 1990 and Glick, 1995). The improvement of some vegetable crops attributes by application of yeast extract were recorded by Hamail *et al*.(2014) and Shehata *et al*.(2016) on flowering characteristics, Nassef and El-Aref (2016), Shehata *et al*.(2016) Morsy *et al*. (2018) and Al-Madhagi (2019) on yield and fruit quality.Also, it had a beneficial role during stress conditions due to the exist of cytokinins in its content (Barnett *et al*., 1990).

Potassium silicat can be used in agricultural production systems where, it is a good source of highly soluble from each potassium and silicon. Foliar application of silicon has a biostimulative effect, and the best results are observed in stressful conditions for plants such as, salinity, high and low temperature and the strong pressure of diseases and pests (Mitani and Ma, 2005). Also, it is important to underline of the fact that foliar application of silicon is safe for the natural environment and can also be used in organic farming. In this respect Abd-Alkarim *et al*. (2017) on cucumber reported that foliar spray of silicon improving the flowering behavior of plants, yield and fruit quality. As for potassium, it is among the principal elements for plant growth and physiology. It is vital for plant survival under physiological and stress conditions. Potassium helps in energy transport, water and nutrients movement, as well as influencing on many physiological and biochemical processes, such as respiration, photosynthesis,

carbohydrates metabolism, protein synthesis and enzyme activation (Wang *et al*., 2013).

In addition, Abduljabbar and Mohammed (2010) and Fekry (2016) on summer squash, as well as , Kazemi (2013) and Shafeek *et al*. (2013) on cucumber reported that potassium foliar application increased the number of pistillate flowers, as well as yield and fruit quality. Furthermore, many recearchers studied the effect of spraying potassium silicate on different vegetable crops among them Dehghanipoodeh *et al*. (2016) who found that potassium silicate enhaced flowering in strawberry. El- Bassiony *et al*. (2010) and Atress and Rashid, (2016) on sweet pepper, Rakha, (2014) and Hussein and Muhammed, (2017) on eggplant and Merwad, (2018) on pea mentioned that foliar spray plants with potassium silicate increased yield and its components, as well as fruit quality.

Therefore, the objective of this study was to investigate the effect of some squash cultivars and spraying yeast extract and potassium silicate on flowering, yield and fruit quality at fall- winter season in open field conditions.

MATERIALS AND METHODS

This investigation was carried out during the two successive fall-winter seasons of 2015/2016 and 2016/2017 at the Experimental Farm, Faculty of Technology and Development (Ghazala region – Zagazig), Zagazig University, Sharkia Governorate, to study the influence of different squash cultivars (*Cucurbita pepo* L.) and foliar application with yeast extract and potassium silicate on flowering behavior, as well as yield and fruit quality under open field conditions.

Soil texture of the experimental field was clayey . Soil chemical analysis was applied using the method described by Black (1982). Results of $_{P}$H8.54-8.50, organic matter (g/kg)10.45-10.40 and available N 22-20, P22-19 and K323-290 (mg/kg soil)in the first and second seasons, respectively.

The local meterological data during the two growing seasons was performed by the National Authority for Meterology are shown in Table 1.

This experiment included fifteen treatments which were the combinations between three cultivars of squash, *i.e.*, Eskandarany, Revera and

Azyad and five foliar applications, *i.e*., control (tap water), yeast extract at rates of 3 and 6gl^{-1} , as well as potassium silicate at the rates of 2 and 4gl^{-1} .

Table 1. The meterological data during the two growing seasons in Zagazig City Sharkia Governorate, Egypt.

Months	Temperature (°C)					
	2015/2016 season			2016/2017 season		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
October	32.0	19.0	22.5	31.0	17.0	24.0
November	25.0	15.0	20.0	27.0	13.0	20.0
December	22.0	10.0	16.0	23.0	9.0	16.0
January	18.0	9.0	12.5	19.0	9.0	14.0

Treatments were arranged in a split plots system in a randomized complete blocks design with four replicates. Cultivars were randomly situated in the main plots and those of foliar applications with yeast extract and potassium silicate were randomly put in the sub-plots.

The source of squash seeds cultivars (Eskandarany, is a local cv., secured from the Agricultural Research Center (ARC) , Ministry of Agriculture; Revera, is a hyprid cv.,, produced and manufactured by Seminis Vegetable Seeds Company, USA and Azyad,is hyprid cv., produced by Sakata Vegetables Company, Jaban. As the sources of foliar spray treatments, potassium silicate (K_2SiO_3) which contain 11% Si and 60% K_2O, it imported by Technogene Company from China. Yeast extract, was prepared from active dry yeast (*Saccharomyces cerevisiae*). It was dissolved in water and sugar was added at the ratio 1:1, kept in warm place for 10 minutes to activation and reproduction.

Seeds of the tested cultivars were sown in nursery at October 5^{th} in both seasons of 2015/2016 and 2016/2017. Squash seedlings were transplanted to the open field in October 15^{th} and 17^{th} in the first and second seasons, respectively. Each experimental plot area was $11.2m^2$, it comprised of four ridges, 4m length and 0.7m width. Transplants were spaced 45cm apart, on one side of the ridge. Foliar spray treatments were applied four times 10, 20, 30 and 40 days after transplanting, respectively.

Ammonium sulphate (20.5%N), calcium superphosphate (15.5-16.0% P_2O_5) and potassium sulphate (48-50.0% K_2O) were used as the sources of N, P and K mineral fertilizers at the rate of 200 kg, 150 kg and 100 kg per feddan, respectively. All the amount of phosphorus fertilizer was applied once during soil preparation. The amounts of nitrogen and potassium fertilizers were added in two equal doses, 20 days after transplanting and during the flowering time.

All other normal culture practices were done according to the recommendation by the Ministry of Agriculture for squash crop.

Data recorded

***Floral characteristics*:** At flowering stage (about 30 days from seed sowing), a random sample of three plants from each experimental plot was labeled. Number of both male and female flowers were counted all over the period of flowering . Sex ratio and femaleness percentage were determined according to the following equations which reported by Gad *et al*.(1993).

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

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

***Yield and its components*:** Squash fruits were harvested twice weekly, number of fruits per plant ,fruit fresh weight and dry matter percentage of fruit were determined , as well as total fruit yield per plot and relative yield were calculated**.**

***Fruit quality*:** It was determined at the mid of harvesting season by using ten fruits from each plot, as follows,

1- **Fruit physical characters,** such as fruit length and diameter .
2- **Fruit chemical constituents,** were determined in dry basis by oven dried the samples at 70°C till constant weight and then ground. N, P and K content were assayed according to the methods advocated by Horneck and Miller (1998), Cottenie *et al*. (1982) and Chapman and Pratt (1982), respectively. Protein percentage according to A.O.A.C.(1990),by using the following equation:

Protein (%) = Total nitrogen × 6.25.

Total carbohydrates (%), was determined according to the method described by Dubois *et al*.(1956).

Statistical analysis

Analysis of variance (ANOVA) using SAS Institute program (2008), performed to detect the differences between treatments. Means were compared using L.S.D at 0.05 probability level, as the methods depicted by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Floral characteristics

a. Effect of cultivars

Data in Table 2 show that there were a significant differences among the three tested cultivars at all studied floral parameters.

Results indicated also that Azyad *cv.*, recorded the highest number of female flowers per plant, and femaleness percentage, whereas sex ratio was the lowest one compared with the two other tested cultivars. Moreover, the hypride Revera cv., appeared the same flowering habit in this concern.

On the contrary, Eskandarany cultivar recorded the lowest number of male and female flowers per plant, femaleness percentage, as well as the highest value of sex ratio. Obtained results hold true in the two growing seasons. In this connection, the increment in number of female flowers of the two hybrid cultivars Azyad and Revera may be attributed to the genetic variations and / or environmental conditions. In this connection, Hume and Lovell (1983), Van Der Vlugt (1983), as well as Mousa and Al- Qurashi (2017) in cucurbits plants indicated that the variation in floral characters depending on environmental factors, *i.e.*, temperature and photoperiod, as well as cultivar. Moreover , Ne Smith and Hoogenboom (1994) and Mady (2014) on squash, as well as Wien (2002) on some cucurbits vegetable crops demonstrated that the number of female flowers increased over male flowers when plants exposed to low temperature during winter season as a result to higher assimilate content of carbohydrates which enhance plants to the femaleness expression.

In addition, Aly (2002) observed the increasing of male and female flowers number, as well as decrease of six ratio in some hybrid squash cultivars compared with Eskandarani cv., during winter season. Moreover, Moursy *et al*. (2014) concluded that hybrid cultivars Rozina and Revera are suitable to sowing in season or areas had low temperature to start or finish any of phonological stages, particularly flowering stage compared with Eskandarani cv., which able to grow under the opposite conditions. On the other hand, many workers demonstrated that the differences between squash cultivars in floral habit produced by the genetic make –up (Marie *et al*., 2011, Esho and Saeed, 2016 and Hassan *et al*., 2016).

Table 2. Effect of squash cultivars and foliar spray with yeast extract and potassium silicate on plant floral characters during 2015/2016 and 2016/2017 seasons

Characters / Treatments / Cultivars foliar spray	Number of male flowers plant^{-1}		Number of female flowers plant^{-1}		Sex ratio		Femaleness (%)	
	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
Eskandarany	6.19	6.37	9.66	9.64	0.64	0.66	60.73	59.87
Revera	6.57	6.89	11.22	10.82	0.59	0.63	62.00	61.07
Azyad	6.59	6.45	11.42	10.96	0.57	0.59	63.13	62.13
LSD at 5%	0.23	0.15	0.14	0.12	0.04	0.03	0.42	0.45
Control	6.05	6.07	9.24	9.00	0.65	0.67	59.89	59.22
Yeast 1	6.70	6.56	10.48	10.05	0.63	0.65	60.78	59.89
Yeast 2	6.56	6.83	11.43	11.26	0.57	0.61	63.22	62.00
Potassium silicate 1	6.47	6.59	10.78	10.50	0.60	0.63	61.67	60.89
Potassium silicate 2	6.40	6.78	11.90	11.57	0.53	0.58	64.22	63.11
LSD at 5%	0.29	0.19	0.18	0.15	0.05	0.04	0.54	0.58

Control = Tap water, Yeast 1= Yeast extract at 3gl^{-1} , Yeast 2= Yeast extract at 6gl^{-1} , Potassium silicate 1= Potassium silicate at 2gl^{-1}, Potassium silicate 2= Potassium silicate at 4gl^{-1}

b. ***Effect of foliar spray with yeast extract and potassium silicate***

Obtained date in Table 2 show that there were a significant differences among the foliar spray treatments in most measured floral characters. It is clear that potassium silicate at the rate $4gl^{-1}$ or yeast extract at $6gl^{-1}$ exhibited the highest values in the number of female flowers, femaleness and the lowest one of sex ratio compared with the control and other applications. These results were similar in both growing seasons.

In this regard, the promoting effect of potassium silicate on sex expression under winter season conditions, i.e., increasing the number of female flowers and reduce sex ratio, may be attributed to both silicon and potassium involvement in numerous metabolic and physiological processes in plant through enhancing or suppressing the uptake and translocation of some elements depending on the biotic and abiotic conditions, as well as increased carbohydrates translocation and accumulation (Wang *et al.,* 2013 and Abd-Alkarim *et al*.,2017). In this respect Fekry (2016) on squash and Shafeek *et al*.(2013) on cucumber reported that foliar application of potassium increased the number of pistillate flowers and femaleness, whereas decreased both the number of staminate and sex ratio in these plants. Moreover, Dehghanipoodeh *et al*. (2016**)** indicated the enhancing effect of potassium silicate and nanosilica on strawberry flowering.

Furthermore, the advantages of spraying yeast preparation on flowering characters could be due to its contain of essential bioconstituents, i.e., carbohydrates, protein, hormones (GAs, IAA, Cytokinins), minerals content and vitamins particulary B-complex vitamins which affected on physiological and biochemical processes in plants such as ion uptake, cell division and elongation, hormonal and enzymatic activities and this reflected on induces the growth as well as flowering (Barnett *et al*.,1990 and Vieira *et al* ., 2016).In addition, Hamail *et al*. (2014) and Shehata *et al*. (2016) reported that yeast treatments play a beneficial role in improving the formation of flowers in cucumber plants due to its effect on carbohydrates accumulation.

c. Effect of the interaction between cultivars and foliar spray with yeast extract and potassium silicate

Data presented in Table 3 show clearly that, the highest values of female flowers number, femaleness and reduction in male / female flowers ratio was showed by the interaction among Azyad *cv.*, with $4gl^{-1}$ potassium

Table 3. Effect of the interaction between squash cultivars and foliar spray with yeast extract and potassium silicate on plant floral characters during 2015/2016 and 2016/2017 seasons

Characters / Treatments / Cultivars / foliar spray		Number of male flowers plant^{-1}		Number of female flowers plant^{-1}		Sex ratio		Femaleness (%)	
		2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
Eskandarany	Control	5.72	5.95	8.30	8.50	0.68	0.70	59.00	58.33
	Yeast 1	6.11	6.32	9.25	9.30	0.66	0.67	60.00	58.67
	Yeast 2	6.20	6.65	10.00	10.20	0.62	0.65	62.00	61.00
	Potassium silicate1	6.37	6.20	9.85	9.40	0.64	0.66	60.33	59.67
	Potassium silicate2	6.55	6.76	10.91	10.50	0.60	0.64	62.33	61.67
Revera	Control	6.31	6.23	9.70	9.10	0.65	0.68	59.67	59.33
	Yeast 1	7.06	7.16	11.20	10.85	0.63	0.65	61.00	60.00
	Yeast 2	6.71	7.00	12.00	11.75	0.55	0.59	63.33	62.00
	Potassium silicate1	6.43	6.93	11.10	11.00	0.57	0.63	61.67	61.00
	Potassium silicate2	6.31	7.11	12.10	11.90	0.52	0.59	64.33	63.00
Azyad	Control	6.12	6.03	9.73	9.50	0.62	0.63	61.00	60.00
	Yeast 1	6.80	6.20	11.00	10.00	0.61	0.62	61.33	61.00
	Yeast 2	6.77	6.85	12.70	11.90	0.53	0.57	64.33	63.00
	Potassium silicate1	6.61	6.66	11.40	11.00	0.57	0.60	63.00	62.00
	Potassium silicate2	6.54	6.48	13.00	12.50	0.50	0.51	66.00	64.00
	LSD at 5%	**0.50**	**0.34**	**0.31**	**0.27**	**0.08**	**0.07**	**0.94**	**0.99**

Control = Tap water , Yeast 1= Yeast extract at 3gl^{-1} , Yeast 2= Yeast extract at 6gl^{-1} , Potassium silicate 1= Potassium silicate at 2gl^{-1}
Potassium silicate 2= Potassium silicate at 4gl^{-1}

silicate followed by the treatment 6gl^{-1}yeast extract as foliar application during the two seasons of study.

Yield and its components

a. ***Effect of cultivars***

It is clear from such data in Table 4 that most measured yield parameters were significantly differed among the tested cultivars. In this respect, Azyad cultivar recorded the highest fresh weight, dry matter percentage, maximum number of fruits plant^{-1} and yield plot^{-1} ,followed by Revera cultivar, compared with Eskandarany cv., which achieved the lowest values in these parametars during the two seasons of study.

The increase in total yield per plot were about 28% and 32% by Azyad cv., followed by Revera cv., which the increased reach to 20% and 22% compared with Eskandarany cultivar in both growing seasons, respectively. The differences in yield and its components between tested varieties may be attributed to the variation in genetic structure, which capable to adapte with the environmental growing conditions, as well as the potential to transport and accumulate photosynthetic assimulate materials, beside the minerals concentration absorbed and uptake by plants. Moreover, the increase in squash hybrid cultivars (Azyad and Revera) might be attributed to the increase of the distillate flowers number as shown in Table 2, which in turn enhanced the number and yield of fruits either per plant or total yield. These results are in accordance with those obtained by Aly (2002), Yoldas (2014) and Hassan *et al*. (2016) on summer squash, who recorded a significant difference between the tested hybrid squash cultivars and Eskandarany cv., in yield and its components. In this connection, Marie *et al*.(2011), Esho and Saeed (2016 and 2017), as well as Kumar and Sharma (2018) all working on different varieties and hybrids of squash, and Ene *et al*. (2016) on cucumber , reported that the differences between either squash or cucumber varieties in number of fruits per plant and total yield attributed to the genetic variation. However, Bielinski *et al*. (2008) stated that members of cucurbits plants are adapted to particular dominant of temperature which considered a main factor influencing of flowering, the opening of flowers, as well as growth of fruits which reflected on yield. Meanwhile, Moursy *et al*. (2014) demonstrated that the variability between the evaluated squash varieties in yield and its components may be due to the genetic make – up and environmental factors.

Table 4. Effect of squash cultivars and foliar spray with yeast extract and potassium silicate on fruit yield and its components during 2015/2016 and 2016/2017 seasons

Characters Treatments Cultivars foliar spray	Number of fruits plant-1		Fruit fresh weight (g)		Fruit dry matter (%)		Fruit yield plot-1 (kg)		Relative yield (%)	
	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
Eskandararry	7.33	7.28	71.54	69.66	3.80	3.42	11.64	10.87	100	100
Revera	9.02	8.90	85.78	78.65	4.79	4.29	13.99	13.37	120	122
Azyad	9.42	9.06	99.19	89.76	5.10	4.61	14.98	14.35	128	132
LSD at 5%	**0.11**	**0.39**	**2.00**	**2.15**	**0.20**	**0.19**	**0.41**	**0.44**	-	-
Control	7.46	7.36	70.76	68.20	3.55	3.00	10.53	9.84	100	100
Yeast 1	8.05	7.86	80.80	79.80	4.55	3.54	12.99	12.44	123	126
Yeast 2	9.27	9.12	95.32	90.95	5.03	4.63	14.73	14.09	139	143
Potassium silicate1	8.56	8.20	89.50	81.7	4.38	4.07	13.98	13.16	132	133
Potassium silicate2	9.61	9.52	100.51	98.75	5.65	5.18	15.46	14.78	146	150
LSD at 5%	**0.14**	**0.50**	**2.60**	**2.82**	**0.26**	**0.26**	**0.53**	**0.56**	-	-

Control = Tap water., Yeast 1= Yeast extract at 3gl^{-1} , Yeast 2= Yeast extract at 6gl^{-1} , Potassium silicate 1= Potassium silicate at 2gl^{-1}
Potassium silicate 2= Potassium silicate at 4gl^{-1}

b. ***Effect of foliar spray with yeast extract and potassium silicate***

Results in Table 4 show clearly that different foliar supplied had significant effect on most characters of yield and its components in both seasons. Furthermore, it is worthy to mention that the treatments $4gl^{-1}$ potassium silicate followed by $6gl^{-1}$ yeast extract as foliar spray excerted a marked and significant effect of all studied parameters expressed as number of fruits per plant, fruit fresh weight and dry matter percentage, as well as total yield per plot and relative yield. The total fruit yield $plot^{-1}$ of squash recorded increase about 46 and 50% by $4gl^{-1}$ potassium silicate over the gained by control treatment(tap water) during the two seasons, respectively

From the above mentioned results, it could be suggested that, the superiority of potassium silicate in this respect may be attributed to the combination effect between the two sources, silicate and potassium which potassium silicate contains. Silicon had profitable effects on plant growth, yield quality, stimulate photosynthesis and improvement the resistance of plant to abiotic and biotic stresses (Mitani and Ma, 2005, Abd- AlKarim *et al*., 2017 and Laane, 2018). In the same time, the favorable effect of potassium on yield and its attributes might be interpreted to spraying potassium increased the available potassium which needed to accomplish the two processes flowering, as well as fruit setting and consequently reflected on all yield parameters. Potassium had main role in producing more pistillate flowers, enhancing femaleness and decreased sex ratio as shown in Table 2 which in turn on number of fruits, total yield and fruit quality (Abduljabbar and Mohammed 2010 and Fekry, 2016 on squash, and Kazemi, 2013 on cucumber). In this connection, several studies on different vegetable crops came to similar conclusion on the effect of potassium silicate, Atress and Rashid (2016) on sweet pepper, Hussein and Muhammed (2017**)** on eggplant and Merwad (2018) on pea. They found that foliar spray of potassium silicate increased number of fruits, yield and fruit quality of these plants.

The improvement of yield by spraying yeast extract may be suggested to its beneficial role through improving flower formation particullary female flowers as shown in Table 2. Moreover, this effect may be attributed to its own content of various nutrients, high percentage of proteins, vitamins especially B- complex and levels of endogenous hormones, i.e., IAA and cytokinins (Barnett *et al*., 1990 and Vieira *et al.,* 2016) . In addition, Hamail *et al.* (2014) on cucumber concluded that the advantages effect of yeast extract on increased yield could be attributed to

the increment of leaf area and its influence on photosynthesis, accumulate more carbohydrates hence enhancement femaleness, as well as formed fruits. These results were consistent with the previous findings of Shehata *et al.* (2012 and 2016), , Nassef and El-Aref (2016) and Al- Madhagi (2019) on cucumber, as well as Morsy *et al*. (2018) on melon, who found that foliar spray of yeast extract appear to have a positive effect of different cucurbit plants yield.

c. Effect of the interaction between cultivars and foliar spray with yeast extract and potassium silicate

Data in Table 5 show that, spraying the plants of cvs Azyad and Revera by potassium silicate at $4gl^{-1}$ or the application $6gl^{-1}$ of yeast extract reflected the highest produced yield and its components in most cases compared with the other interaction treatments during both seasons of study. Furthermore, the relative yield increment in Azyad cultivar reach to 55 and 51%, as well as 48 and 49% in Revere cultivar in the first and second seasons, respectively when treated with $4gl^{-1}$ potassium silicate over the interaction treatments.

Fruit quality

1. Fruit physical characters

a. Effect of cultivars

Data in Table 6 reveal that both of the studied characters, i.e., fruit length and diameter were significantly differed among the varieties during the two seasons of study. In this regard, fruits produced by the hybrid cultivars, Azyad and Revera ، respectively show the highest values of the two tested characteristics compared with Eskandarany cv., This increment in these characters of fruits may be refer to the genetic variation between the genotypes. In this regard, Esho and Saeed (2016) and Hassan *et al*. (2016) indicated that the variability among summer squash varieties attributed to its genetic make–up. The varietal differences in this connection were also reported by Aly (2002) and Yoldas (2014) who working on summer squash, and Ene *et al*. (2016) on cucumber. They demonstrated that fruit physical characters were significantly affected by the variety.

b. ***Effect of foliar spray with yeast extract and potassium silicate***

Data in Table 6 indicate that most the foliar spray applications, *i.e*., 3 and $6gl^{-1}$ of yeast extract or 2 and $4gl^{-1}$ of potassium silicate significantly increased the measured squash fruit physical characters compared to the control treatment

Table 5. Effect of the interaction between squash cultivars and foliar spray with yeast extract and potassium silicate on fruit yield and its components during 2015/2016 and 2016/2017 seasons

Characters / Treatments / Cultivar foliar spray		Number of fruits plant^{-1}		Fruit fresh weight (g)		Fruit dry matter (%)		Fruit yield plot^{-1} (kg)		Relative yield (%)	
		2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
Eskandarany	Control	6.15	6.20	65.83	62.73	3.02	2.66	6.62	8.95	100	100
	Yeast 1	7.00	7.03	70.50	65.51	3.44	2.87	10.74	10.77	111	120
	Yeast 2	8.00	8.10	81.65	70.95	4.21	3.86	12.97	11.57	134	129
	Potassium silicate 1	7.30	6.56	76.70	74.45	3.71	3.43	11.86	10.89	123	121
	Potassium silicate 2	8.22	8.50	80.9	79.41	4.61	4.27	13.02	12.17	135	135
Revera	Control	8.00	7.89	75.80	75.00	3.63	3.17	10.97	9.88	100	100
	Yeast 1	8.30	8.00	80.57	72.85	4.50	3.65	13.65	12.00	124	121
	Yeast 2	9.80	9.50	92.83	83.78	5.22	4.94	14.96	13.60	136	137
	Potassium silicate 1	9.00	9.03	85.21	75.60	4.67	4.22	14.14	12.59	128	127
	Potassium silicate 2	10.00	10.05	98.90	92.95	5.90	5.44	16.24	14.80	148	149
Azyad	Control	8.23	8.00	79.66	70.15	4.01	3.45	11.01	10.68	100	100
	Yeast 1	8.85	8.55	83.00	79.91	4.64	4.10	14.59	13.98	132	130
	Yeast 2	10.00	9.75	100.33	93.20	5.66	5.08	16.27	15.90	147	148
	Potassium silicate 1	9.40	9.00	90.50	82.95	4.90	4.55	15.92	15.00	144	140
	Potassium silicate 2	10.60	10.00	108.60	100.51	6.45	5.82	17.10	16.17	155	151
	LSD at 5%	**0.24**	**0.87**	**4.50**	**4.95**	**0.45**	**0.44**	**0.91**	**0.97**	-	-

Control = Tap water , Yeast 1= Yeast extract at 3gl^{-1} , Yeast 2= Yeast extract at 6gl^{-1} , Potassium silicate 1= Potassium silicate at 2gl^{-1}
Potassium silicate 2= Potassium silicate at 4gl^{-1}

Table 6. Effect of cultivars and foliar spray with yeast extract and potassium silicate on the physical characters and chemical constituents of squash fruit during 2015/2016 and 2016/2017 seasons

Characters / Treatments / Cultivars foliar spray	Fruit physical characters		Fruit chemical constituents				
	Length (cm)	Diameter (cm)	Minerals content (%)			Protein (%)	Total Carbohydrates (%)
			N	P	K		
	2015/2016 season						
Eskandarany	11.00	2.71	1.44	0.234	2.23	8.98	17.95
Revera	12.34	2.92	1.65	0.262	2.38	10.28	18.84
Azyad	13.00	3.10	1.72	0.269	2.43	10.72	19.10
LSD at 5%	0.30	0.20	0.12	0.01	0.03	0.76	0.06
Control	11.2	2.59	1.34	0.221	2.15	8.35	16.82
Yeast 1	12.60	2.80	1.48	0.269	2.23	9.23	18.38
Yeast 2	13.00	3.12	1.73	0.285	2.37	10.83	18.55
Potassium silicate 1	12.85	2.98	1.63	0.255	2.46	10.14	19.42
Potassium silicate 2	13.30	3.15	1.83	0.244	2.53	11.43	20.19
LSD at 5%	**0.42**	**0.15**	**0.16**	**0.01**	**0.04**	**0.98**	**0.03**
	2016/2017 season						
Eskandarany	11.10	2.68	1.40	0.227	2.19	8.75	17.50
Revera	12.00	2.83	1.58	0.248	2.89	9.72	18.59
Azyad	13.10	2.95	1.67	0.256	2.34	10.43	18.93
LSD at 5%	**0.29**	**0.10**	**0.08**	**0.01**	**0.03**	**0.42**	**0.04**
Control	11.32	2.61	1.28	0.2088	2.11	7.99	16.72
Yeast 1	12.67	2.72	1.47	0.258	2.20	8.98	18.00
Yeast 2	13.00	3.00	1.66	0.274	2.28	10.39	18.32
Potassium silicate 1	12.75	2.90	1.57	0.246	2.36	9.75	19.20
Potassium silicate 2	13.50	3.18	1.77	0.231	2.43	11.06	19.88
LSD at 5%	**0.30**	**0.17**	**0.10**	**0.01**	**0.03**	**0.54**	**0.04**

Control = Tap water, Yeast 1= Yeast extract at $3gl^{-1}$, Yeast 2= Yeast extract at $6gl^{-1}$, Potassium silicate 1= Potassium silicate at $2gl^{-1}$, Potassium silicate 2= Potassium silicate at $4gl^{-1}$

during both seasons of the experiment. Furthermore, using potassium silicate at $4gl^{-1}$ followed by yeast extract at $6gl^{-1}$ in the second rank exhibited the highest values in this respect. Obtained results are true during the two seasons of growth. Such increments by potassium silicate may be due to the role of both potassium and silicate for faced the biotic and abiotic conditions which adversely affect on the strength and improved growth parameters, as well as physiological process especially photosynthesis which reflected on the quantity of assimilate products and its translocation in fruits. In this respect Ashraf *et al*. (2010) and Patil *et al*. (2017) stated that silicon had positively effect on the activities of certain enzymes and reduce the injury caused by abiotic and biotic stress factors and this may reflected on the benefit of crop productivity and quality. Furthermore، Marschner (1995) reported that potassium is participate in several physiological and biochemical processes which in turn affect on vegetative growth، yield and its quality, as well as under stress conditions. Similarly، El-Bassiony *et al*. (2010) on sweet pepper mentioned that fruit quality, i.e., length and diameter were significantly increased by spraying $4cml^{-1}$ of potassium oxide.

As for the effect of yeast extract on fruit physical character, it may be due to its high contents of different nutrients, protein, vitamins as well as it considered a rich source of phytohormones particularly cytokinins which enhanced cell division and enlargement (Barnett *et al*., 1990 and Glick, 1995), which may be promoted plant growth characters and this reflected on quality of yield. Obtained results are in agreement with those of Shehata *et al*.(2012)and Shehata *et al*.(2016) on cucumber, as well as Morsy *et al*. (2018) on melon. They showed that fruit length and diameter were improved by foliar spray of yeast extract.

c. *Effect of the interaction between cultivars and foliar spray with yeast extract and potassium silicate treatments*

Data in Tables 7 and 8 revealed that spraying the two cultivars Azyad and Revera with potassium silicate at rate $4gl^{-1}$ in the first rank or yeast extract at $6gl^{-1}$ in the second rate reflected the highest values of all determined physical fruit traits, *i.e.*, fruit length and diameter compared with other interaction treatments without significant differences in most cases during the two growing seasons of study.

Table 7. Effect of the interaction between cultivars and foliar spray with yeast extract and potassium silicate on the physical characters and chemical constituents of squash fruits during 2015/2016

Characters / Treatments cultivars foliar spray		Fruit physical characters		Fruit chemical constituents				
		Length (cm)	Diameter (cm)	Minerals content (%) N	P	K	Protein (%)	Total Carbohydrates (%)
		2015/2016 season						
Eskandarany	Control	10.89	2.50	1.23	0.210	2.08	7.68	16.77
	Yeast 1	11.32	2.63	1.36	0.245	2.11	8.50	18.22
	Yeast 2	12.55	2.80	1.55	0.260	2.25	9.78	18.55
	Potassium silicate 1	12.00	2.70	1.42	0.229	2.33	8.72	18.97
	Potassium silicate 2	12.70	2.83	1.63	0.225	2.40	10.25	19.73
Reyera	Control	11.12	2.60	1.35	0.223	2.15	8.43	17.50
	Yeast 1	12.60	2.80	1.47	0.278	2.25	9.18	18.37
	Yeast 2	12.91	3.00	1.79	0.294	2.41	11.18	18.60
	Potassium silicate 1	12.75	2.89	1.72	0.265	2.50	10.75	19.55
	Potassium silicate 2	13.00	3.03	1.90	0.250	2.57	11.87	20.35
Azyad	Control	11.75	2.73	1.43	0.230	2.21	8.93	17.21
	Yeast 1	12.65	2.85	1.60	0.285	2.33	9.99	18.57
	Yeast 2	13.12	3.12	1.85	0.300	2.45	11.53	18.80
	Potassium silicate 1	12.93	3.00	1.75	0.270	2.55	10.97	19.76
	Potassium silicate 2	13.50	3.20	1.95	0.258	2.63	12.18	20.50
	LSD at 5%	**0.63**	**0.22**	**0.27**	**0.02**	**0.72**	**1.70**	**0.06**

Control = Tap water., Yeast 1= Yeast extract at $3gl^{-1}$, Yeast 2= Yeast extract at $6gl^{-1}$, Potassium silicate 1= Potassium silicate at $2gl^{-1}$, Potassium silicate 2= Potassium silicate at $4gl^{-1}$

Table 8. Effect of the interaction between cultivars and foliar spray with yeast extract and potassium silicate on the physical characters and chemical constituents of squash fruits during 2016/2017

Characters / Treatments: cultivars	foliar spray	Fruit physical characters: Length (cm)	Fruit physical characters: Diameter (cm)	Fruit chemical constituents: Minerals content (%): N	P	K	Protein (%)	Total Carbohydrates (%)
				2016/2017 season				
Eskandarany	Control	10.60	2.51	1.17	0.200	2.05	7.31	16.00
	Yeast 1	11.25	2.60	1.28	0.240	2.15	7.99	18.14
	Yeast 2	12.00	2.70	1.55	0.251	2.20	9.68	18.38
	Potassium silicate 1	11.70	2.65	1.40	0.228	2.28	8.75	18.79
	Potassium silicate 2	12.15	2.78	1.60	0.216	2.31	9.99	19.61
Reyera	Control	11.30	2.62	1.29	0.215	2.10	8.06	17.36
	Yeast 1	12.00	2.71	1.52	0.265	2.20	9.31	18.14
	Yeast 2	13.00	2.93	1.65	0.280	2.30	10.31	18.50
	Potassium silicate 1	12.54	2.75	1.62	0.250	2.38	9.60	19.26
	Potassium silicate 2	13.00	3.00	1.81	0.233	2.46	11.31	20.00
Azyad	Control	11.50	2.70	1.38	0.210	2.18	8.59	17.12
	Yeast 1	12.50	2.81	1.60	0.273	2.25	9.62	18.30
	Yeast 2	13.00	3.00	1.79	0.291	2.35	11.18	18.60
	Potassium silicate 1	12.83	2.95	1.69	0.260	2.42	10.89	19.65
	Potassium silicate 2	13.12	3.15	1.90	0.245	2.15	11.87	20.04
	LSD at 5%	**0.50**	**0.19**	**0.17**	**0.01**	**0.06**	**0.93**	**0.06**

Control = Tap water, Yeast 1= Yeast extract at 3 gl^{-1}, Yeast 2= Yeast extract at 6 gl^{-1} , Potassium silicate 1= Potassium silicate at 2 gl^{-1}, Potassium silicate 2= Potassium silicate at 4 gl^{-1}

2. *Fruit chemical constituents*

a. Effect of cultivars

Data presented in Table 6 indicate that, Azyad cv., followed by Revera cultivar exhibited the highest values of all assayed parameters compared with Eskandarany cv., Obtained results are similar during two seasons of study.

In this connection, Rouphael and Colla(2005) found that fruit yield of squash zucchini plants in season summer – fall had the higher fruit quality ، i.e. total carbohydrates ، phosphorus and potassium percentage. Also, Gajc–Wolska *et al.*, (2010) indicated the effect of sowing date on the chemical composition of cucumber fruits. They detected the higher content of nitrogen and phosphorus at autumn season, where potassium percentage were increased at summer cultivation. In addition, Gadomska (2010) found that fixed varieties contained lower total carbohydrates content than heterotic ones.

b. Effect of foliar spray with yeast extract and potassium silicate

Data in Table 6 indicate that most of the studied chemical composition , *i. e.*, nitrogen ،phosphorus ،potassium ، protein and total carbohydrates statistically affected by the different applied treatments compared with the control (tap water)

In this respect, such increment in nitrogen content, and protein percentage were recorded in case used foliar spray of potassium silicate at the higher rate 4 gl^{-1} in the first order and yeast extract at 6 gl^{-1} in the second rank. Moreover, the highest values of both potassium and total carbohydrates percentage were obtained by the two used rates of potassium silicate, *i.e.* 4 and 2gl^{-1} respectively. On the other hand, foliar spray of yeast extract at the levels 6 and 3gl^{-1} gave the highest phosphorus percentage in fruit.

The favorable effect of spraying potassium silicate may be attributed to the quickly absorption of its content (potassium and silicate) by plant surface particularly leaves. Both of the two minerals can translocation in plant parts causing improvement of growth, enhancing metabolism and many important regulatory process which due to increase the minerals uptake ، i.e., nitrogen ، phosphorus and

potassium. (Mohamed *et al*., 2010 and Marschner, 2012). With regard to the highest values of carbohydrates percentage by foliar spray of potassium ، Mengel (2007), as well as, Lester *et al*. (2010) reported that potassium considered as one of the essential elements for sugar production, transport, translocation and storage in fruit and decrease of it affected on fruit quality, especially during the critical fruit development period. Furthermore, Kazemi (2013) on cucumber stated that potassium promotes photosynthesis and transport assimilates of the carbohydrates to the storage organs. Moreover, Pal *et al*. (2016) found that applied plants with potassium increased protein synthesis and accelerating enzymes activity which responsible for biomass accumulation in cucumber fruits . Also ، Abd-Alkarim *et al.* (2017) on cucumber found that silicon increased fruit chemical composition، *i.e.,* nitrogen ، phosphorus ، potassium and protein percentage.

Furthermore, the positive effect of yeast extract on increasing the minerals content, total carbohydrates and dry matter percentage in squash fruits may be attributed to its own content as discussed in floral characteristics as well as fruit yield and its components.

Obtained results are in agreement with those reported by Abdel Nabi *et al*. (2014) on cantaloupe who found that spraying yeast extract positively affected fruit nitrogen, phosphorus, potassium and total carbohydrates.

c. ***Effect of the interaction between cultivars and foliar spray with yeast extract and potassium silicate***

Data presented in Tables 7 and 8 show clearly that, the maximum values of minerals concentration (nitrogen, phosphorus and potassium) ، protein and total carbohydrates were obtained as a result of the interaction among Azyad or Revera cultivars with potassium silicate at $4gl^{-1}$ followed by the second application $6gl^{-1}$ yeast extract as foliar spray compared with other interaction treatments during both seasons of study.

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تاثير بعض اصناف الكوسة ومنشطات النمو على الإزهار، والمحصول وجودة الثمار في موسم الزراعة الخريفى – الشتوى تحت ظروف الحقل المكشوف.

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أجريت هذه الدراسة بمزرعة التجارب بكلية التكنولوجيا والتنمية (غزالة – الزقازيق) جامعة الزقازيق ، محافظة الشرقية. بالحقل المكشوف خلال موسمى الزراعة الخريفى – الشتوى لعامى ٢٠١٥/٢٠١٦ و ٢٠١٦/٢٠١٧ لدراسة تأثير ثلاثة اصناف من الكوسة وهى اسكندرانى ، ريفيرا وازياد مع معاملات الرش بمستخلص الخميرة بمعدل ٦،٣ جرام / لتر وسليكات البوتاسيوم بمعدل ٤،٢ جرام / لتر بالإضافة إلي الكنترول (ماء الصنبور) والتداخل فيما بينهما على السلوك الزهرى متمثلا في عدد الازهار المذكرة والمؤنثة لكل نبات ، النسبة الجنسيه ونسبة اتجاه النبات للتأنيث وكذلك المحصول ومكوناته (عدد الثمار/ نبات، الوزن الغض والنسبة المئوية للمادة الجافه للثمرة، المحصول الكلى من الثمار/ قطعة تجريبية والزيادة النسبية للمحصول) وايضا جودة الثمار متمثلا فى الصفات الطبيعيه للثمار (طول وقطر الثمرة) والتركيب الكيماوى للثمار (المحتوى من النتروجين والفوسفور والبوتاسيوم والنسبة المئوية للبروتين ، والكربوهيدرات الكلية).

وقد اوضحت النتائج تفوق كلا الصنفين الذى تم اختبارهما ازياد وريفيرا لكل الصفات التى تم دراستها مقارنة بالصنف اسكندرانى. كما أدى إستخدام معاملات الرش بمستخلص الخميرة او سليكات البوتاسيوم إلى زيادة معنوية لمعظم صفات الازهار، المحصول وصفات الجودة لثمار الكوسة مقارنة بالكنترول . وبالإضافة إلي ذلك فقد ادى رش النباتات بسليكات البوتاسيوم بمعدل ٤ جم/ لتر او مستخلص الخميرة بمعدل ٦ جم/ لتر إلي تفوق معنوى مقارنة بمعاملات الرش الاخرى والكنترول. كما سجلت افضل النتائج لمعاملات التفاعل للصفات الزهرية والمحصول والثمار عند زراعة اى من الصنفين ازياد او ريفيرا مع الرش بمعدل ٤ جم/ لتر من سليكات البوتاسيوم او ٦ جم/ لتر من مستخلص الخميرة حيث أدت الى زيادة معنوية فى جميع الصفات التى تم دراستها مقارنة بمعاملات التفاعل الأخرى خلال موسمى النمو.

التوصية: يمكن ان نوصى بأي من هذه المعاملات لتحسين التزهير، المحصول وصفات الثمار الطبيعية والكيماوية لنباتات الكوسة مع أقل تكلفة للإنتاج عند الزراعة المكشوفة بالحقل خلال موسم الزراعة الخريفى – الشتوى وتحت نفس ظروف التجربة.