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EFFECT OF PLANTING DATE AND FOLIAR SPRAY WITH POTASSIUM SILICATE ON GROWTH AND YIELD OF SOME GARLIC CULTIVARS

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ABSTRACT: A field experiment was carried out during the two successive winter seasons of 2016/2017 and 2017/2018 in a private Farm at Hehia Distrect, Sharkia Governorate, Egypt, to study the effect of planting date, and foliar spray with potassium silicate on dry weight, bulb yield and its components of Balady and Sids 40 garlic cultivars under clay soil conditions and using flood irrigation system. The obtained results indicated that planting Balady cultivar on 1st Oct. and spraying with potassium silicate (K silicate) at 2 ml/l increased dry weight of leaves/plant, bulb and total dry weight/plant, yield of grades 1, 2, 3 and 4, exportable, marketable and total yield/fad., as well as average bulb weight.

Key words: Garlic, planting dates, cultivars, potassium silicate, dry weight, yield and its components.

INTRODUCTION

Garlic (*Allium sativum* L.), a member of the Alliaceae family, is one of the most aromatic herbaceous annual spices (**Kurian, 1995**). It is the second most widely spice crop of the cultivated Allium crops, next to onion in the world (**Purseglove, 1975**) with a characteristic pungent smell. In Egypt, the total cultivated area of garlic, was about 29688 fad., during 2016 season which produced 280216 tons with average of 9.438 tons/faddan (**FAO, 2016**).

Planting dates plays an important role on the growth and yield of garlic. Garlic is known to be thermo and photo-sensitive crop (**Jones and Mann, 1963**) and its vegetative growth and bulb formation are greatly influenced by growing environment, such as cool weather and grows well in a well-drained soils (**Rahim and Fordham, 1988**).

There were significant differences among planting dates of garlic (15th Sept., 1st Oct. and 15th Oct.) concerning dry weight (**Abdalla *et al*., 2011; Gunda, 2013; Vidya *et al.,* 2013; Hassan *et al*., 2016)** on garlic, and yield and its components (**Muhammad *et al.,* 2001; Ahmed, 2002; Bhuiya *et al.,* 2003; Rahim *et al.,* 2003; El-Zohiri and Farag, 2014; Youssef and Tony, 2014; Choudhary, 2015; Mohammad, 2018**).

Silicon (Si) is the second most abundant element in the earth crust, yet its role in plant physiology has been poorly understood and attempts to associate Si with metabolic or physiological activities have been inconclusive. Although Si has not been classified as an essential element for higher plants, it has been shown to be beneficial for plant growth (**Epstein, 1994 and 1999**). Silicon has been shown to ameliorate the adverse effects of heavy metals on plants.

Foliar spray with potassium silicate increased plant growth, and yield and its components on strawberries **(Wand and Galletta 1998)**, bean **(Abou-Baker *et al.,* 2011)**, sweet pepper (**Kamal, 2013)**, potato **(Salim *et al*., 2014)**, Jerusalem artichoke (**Abou El-Khair and Mohsen, 2016)** and pea **(Elrys and Merwad, 2017)**.

Therefore, the aim of this work was to determin suitable planting date and potassium silicate rate to obtain high growth and best productivity of two garlic cultivars under clay soil and using flood irrigation system.

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MATERIALS AND METHODS

A field experiment was carried out during the two successive winter seasons of 2016/2017 and 2017/2018 in a private Farm at Hehia Distrect, Sharkia Governorate, Egypt, to study the effect of planting date and foliar spray with potassium silicate on growth, yield and its components of some garlic cultivars (Balady and Sids 40) under clay soil conditions and using flood irrigation system.

The physical and chemical analyses of the soil are presented in Table 1.

This experiment was included 18 treatments, which were the combinations among three planting dates (15th Sep., 1st Oct. and 15th Oct.), two cultivars (Balady and Sids 40) and three levels of potassium silicate (0, 1 and 2 ml/l). These treatments were arranged in a split - split plot design with three replications. Planting dates were randomly arranged in the main plots, cultivars were randomly distributed in the sub plots and potassium silicate rates were randomly arranged in the sub sub plot.

Garlic plants were sprayed with K silicate rate three times at 60, 80 and 100 days after planting. The experimental unit area was 10.8 m^2. It contained three ridges with 6m length and 60 cm in width. One ridge was used for the samples to measure vegetative growth and the other two ridges were used for yield determination.

All plots received equal amounts of farmyard manure (FYM) at 30 m^3/fad., and 54, 54 and 76.5 kg/fad., of N, P and K_2O, respectively in the form of ammonium sulphate (20.6% N), calcium superphosphate (15.5 % P_2O_5) and potassium suphate (50% K_2O). One third of mineral fertilizers were added during soil preparation with the same rate of FYM and the rest amounts were added at three portions as soil application monthly beginning one month after planting. The normal agricultural practices were carried out as commonly followed in district.

Data Recorded

Growth parameters

Ten plants from each experimental unit were randomly taken at 105 and 135 days after planting (DAP) in both seasons and the following data were recorded:

Dry weight

The different parts of garlic plant; *i.e.,* bulb and leaves were oven dried at 70°C till constant weight, and then the following data were recorded: Bulb dry weight/plant (g), leaf dry weight/plant (g), and total dry weight (bulb + leaves)/ plant (g).

Yield and its components

Bulbs of every plot were harvested at proper maturity stage of bulbs (200 DAP approximately), then translocated to a shady place in the same day for curing. Plants were placed for about two weeks in a shady place at 25 ± 5°C and 60-75% RH, and then graded into four categories according to the **Ministry of Economic for Garlic Exportation (1963)** as follows: Grade 1: Bulbs with diameter above 5.5 cm, Grade 2: bulbs with diameter between 4.5-5.5 cm. Grade 3: Bulbs with diameter between 3.5-4.4 cm, and Grade 4: Bulbs with diameter less than 3.5 cm.

Then after, each grade was weighed separately in the same day and the following data were recorded: Exportable yield (grade 1 + grade 2) ton/fad., marketable yield (grade 1 + grade 2 + grade 3) ton/fad., total yield (grade 1 + grade 2 + grade 3 + grade 4) ton/fad., and average bulb fresh weight was measured.

Statistical Analysis

The data was subjected to proper statistical analysis of variance according to **Snedecor and Cochran (1980)** and means separation were done according to least significant differences (LSD) at 5% level.

RESULTS AND DISCUSSION

Dry Weight

Effect of planting date

Results in Table 2 show that there were significant differences among planting dates with respect to dry weight of leaves, bulb and total dry weight/plant at 105 and 135 days after planting (DAP) in both seasons. At 135 DAP, planting on 1st Oct. increased dry weight of leaves, bulb and total dry weight/plant in both seasons compared to other planting dates (15th Sep. and 15th Oct.).

Table 1. The physical and chemical properties of soil during 2016/2017 and 2017/2018 (average of two seasons)

Character	Value
Soil particles distribution	
Sand (%)	22.07
Silt (%)	35.03
Clay (%)	42.90
Texture	Clay loam
Field capacity (FC) (%)	25.4
$CaCO_3$ (%)	1.17
Organic matter (%)	1.23
pH*	8.21
EC (dSm^{-1})**	1.18
Soluble cations and anions ($meq/100\ g^{-1}$)	
Ca^{++}	2.56
Mg^{++}	1.64
Na^{+}	2.09
K^{+}	0.18
$CO_3^{=}$	0.00
HCO_3^{-}	0.76
Cl^{-}	1.69
$SO_4^{=}$	4.02
Available nutrients (mg/kg^{-1} soil)	
Available N	78.4
Available P	13.9
Available K	172

* Soil water suspension 1:2.5 ** soil water extract 1:5

Table 2. Effect of planting date, cultivar and potassium silicate rate on dry weight of garlic plant at 105 and 135 days after planting during 2016/2017 and 2017/2018 seasons

Treatment	Dry weight of leaves/plant (g)				Dry weight of bulb (g)				Total dry weight/plant (g)			
	Days after planting											
	105		135		105		135		105		135	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Planting date	**Effect of planting date**											
15th Sep.	2.82	2.81	4.21	3.40	1.38	1.19	2.42	2.35	4.20	4.00	6.63	5.75
1st Oct.	3.44	3.54	4.95	5.03	1.62	1.71	2.94	3.00	5.06	5.25	7.89	8.03
15th Oct.	3.05	3.14	4.15	3.79	1.44	1.32	2.58	2.50	4.49	4.46	6.73	6.29
LSD at 0.05 level	**0.20**	**0.07**	**0.05**	**0.16**	**0.04**	**0.09**	**0.09**	**0.10**	**0.19**	**0.09**	**0.08**	**0.22**
	Effect of cultivar											
Balady	3.24	3.26	4.54	4.24	1.59	1.51	2.74	2.73	4.83	4.77	7.28	6.97
Sids 40	2.97	3.06	4.33	3.91	1.37	1.30	2.55	2.50	4.34	4.36	6.88	6.41
LSD at 0.05 level	**0.10**	**0.12**	**0.05**	**0.11**	**0.03**	**0.03**	**0.02**	**0.11**	**0.11**	**0.12**	**0.06**	**0.15**
	Effect of potassium silicate rate											
0	2.92	2.90	4.19	3.71	1.40	1.31	2.52	2.44	4.32	4.21	6.71	6.15
1ml/l	3.15	3.13	4.44	4.05	1.48	1.37	2.63	2.66	4.63	4.50	7.07	6.71
2 ml/l	3.25	3.46	4.68	4.46	1.56	1.54	2.79	2.75	4.81	5.00	7.47	7.21
LSD at 0.05 level	**0.10**	**0.10**	**0.08**	**0.11**	**0.04**	**0.04**	**0.03**	**0.12**	**0.10**	**0.10**	**0.09**	**0.19**

S1: 1st season and S2: 2nd season

Planting dates plays an important role on garlic growth. Garlic is known to be thermo and photo-sensitive crop (**Jones and Mann, 1963**) and its vegetative growth and bulb formation are greatly influenced by growing environment (**Rahim and Fordham, 1988**). These results agree with those reported by **Abdalla *et al.* (2011), Gunda (2013), Vidya *et al.* (2013), Hassan *et al.* (2016) and Mohammad *et al.* (2018)** on garlic.

Effect of cultivars

Balady cultivar gave higher values of dry weight of leaves, bulb and total dry weight/plant than Sids 40 at 105 and 135 DAP in both seasons (Table 2). The differences between garlic cultivars could be attributed to the genetic differences between cultivars. Differences between garlic cultivars were also observed by **Youssef and Tony (2014), Hassan (2015), Hassan *et al.* (2016) and Merwad (2018)**.

Effect of K silicate

Dry weight of leaves, bulb and total dry weight/plant significantly increased with increasing K silicate up to 2 ml/l at 105 and 135 DAP in both seasons (Table 2). This means that K silicate at 2 ml /l increased dry weight of leaves, bulb and total dry weight/plant compared to 1 ml/l and control.

The previous positive action of potassium silicate on growth characters because it contains higher amounts of silicon (25%) might be attributed to its important roles in protecting plants against drought, cold, diseases and fungal attack, alleviating abiotic stress of heavy metals

toxicity and salinity and improving root development, uptake of water and nutrients and plant pigments (**Qin and Tian 2009**). The obtained results are in a good accordance with those recorded by **Salim *et al.* (2014)** on potato and **Abou El-Khair and Mohsen (2016)** on Jerusalem artichoke.

Effect of the interaction between planting date and cultivars

The interaction between planting date and cultivars reflect significant effect on dry weight of leaves/plant, bulb and total dry weight/plant at 105 and 135 DAP in both seasons (Table 3). At 135 DAP, planting Balady cultivar on 1st Oct. gave the highest value for each of dry weight of leaves/plant, bulb and total dry weight/plant in both seasons, followed by planting Sids 40 on 1st October.

Effect of the interaction between planting date and K silicate

The interaction between planting date and K silicate had significant effect on dry weight of leaves/ plant, bulb and total dry weight / plant at 105 and 135 DAP in both seasons (Table 4). At 135 DAP, planting on 1st Oct. and spraying with K silicate at 2 ml/l increased dry weight of leaves/plant, bulb and total dry weight/plant, followed by planting on 1st Oct. and spraying with K silicate at 1 ml/l in both seasons.

Effect of the interaction between cultivars and K silicate

Results in Table 5 indicate that, the interaction between cultivars and K silicate reflect significant effect on dry weight of leaves/plant, bulb and total dry weight/plant at 105 and 135 DAP. At 135 DAP, spraying Balady cultivar with K silicate at 2 ml/l increased dry weight of leaves/ plant, bulb and total dry weight/plant, followed by spraying Balady cultivar with K silicate at 1 ml/l .

Effect of the triple interaction among planting date, cultivars and K silicate

The interaction among planting date, cultivars and K silicate had significant effect on dry weight of leaves/plant, bulb and total dry weight/plant at 105 and 135 DAP in both seasons (Table 6). At 135 DAP, planting Balady cultivar on 1st Oct. and spraying with K silicate at 2 ml/l and planting Sids 40 cultivar on 1st Oct. and spraying with K silicate at 2 ml/l increased dry weight of leaves/ plant, bulb and total dry weight/plant in both seasons.

Yield and its Components

Effect of planting date

Planting garlic on 1st Oct., increased yield of grades 1, 2, 3 and 4, exportable, marketable and total yield as well as average bulb weight, followed by planting on 15th Oct. in both seasons (Table 7). The differences between planting dates in total yield/fad., as a result of their variation in the total dry weight (Table 1).

The enhancement of bulb yield and its components as a results of early planting might be due to that the plants received enough earlier cool weather period and a shorter day length which enhanced the vegetative growth of plant before the formation of their bulbs, consequently, resulting in assimilation of more carbohydrates and their translocation to the bulbs, leading to increase head bulb yield and its components (**Hassan *et al.*, 2016**). Results are in harmony with those reported by **Muhammad *et al.* (2001), Bhuiya *et al.* (2003), Rahim *et al.* (2003), Vidya *et al.* (2013) , Youssef and Tony (2014), Choudhary (2015), Hassan *et al.* (2016) and Mohammad** (**2018**) on garlic.

Effect of cultivars

Balady cultivar gave higher yield of grades 1, 2, 3 and 4, exportable, marketable and total yield as well as average bulb weight than Sids 40 cultivar in both seasons (Table 8). These results might be referred to the genetic variation among garlic cultivars and their abilities to benefit from the environmental sources, particularly, light, CO_2, water and nutrients.

These results are in agreement with those reported by **Abdalla *et al.* (2011), Mohsen (2012), Abdel-Razzak and El-Sharkawy (2013), Abo El-Fadel and Mohamed (2013) and Merwad (2018)**. They found that the Balady garlic cultivar gave higher total yield and its components of bulbs, than Sids 40 cultivar.

Effect of K silicate

Yields of grades 1, 2, 3 and 4, exportable, marketable and total yield as well as average bulb weight significantly increased with increasing K silicate level at 2 ml/l in both seasons (Table 9). Spraying garlic plants with K silicate at 2 ml/l

Table 3. Effect of the interaction between planting date and cultivar on dry weight of garlic plant at 105 and 135 days after planting during 2016/2017 and 2017/2018 seasons

Treatment		Dry weight of leaves/plant (g)		Dry weight of bulb (g)		Total dry weight/plant (g)	
		Days after planting					
		105	135	105	135	105	135
Planting date	Cultivar	2016/2017 season					
15th Sep.	Balady	2.89	4.33	1.49	2.51	4.38	6.84
	Sids 40	2.76	4.09	1.27	2.33	4.03	6.42
1st Oct.	Balady	3.63	5.05	1.74	3.03	5.37	8.08
	Sids 40	3.25	4.85	1.50	2.85	4.75	7.70
15th Oct.	Balady	3.19	4.25	1.54	2.68	4.73	6.93
	Sids 40	2.92	4.05	1.34	2.48	4.26	6.53
LSD at 0.05 level		0.17	0.10	0.05	0.03	0.19	0.11
		2017/2018 season					
15th Sep.	Balady	2.86	3.56	1.27	2.50	4.13	6.06
	Sids 40	2.77	3.24	1.10	2.20	3.87	5.44
1st Oct.	Balady	3.70	5.13	1.84	3.10	5.54	8.23
	Sids 40	3.39	4.93	1.58	2.90	4.97	7.83
15th Oct.	Balady	3.24	4.02	1.40	2.60	4.64	6.62
	Sids 40	3.04	3.56	1.24	2.40	4.28	5.96
LSD at 0.05 level		0.21	0.19	0.05	0.19	0.21	0.26

Table 4. Effect of the interaction between planting date and potassium silicate rate on dry weight of garlic plant at 105 and 135 days after planting during 2016/2017 and 2017/ 2018 seasons

Treatment		Dry weight of leaves/plant (g)		Dry weight of bulb (g)		Total dry weight/plant (g)	
		Days after planting					
		105	135	105	135	105	135
Planting date	K silicate rate	2016/2017 season					
15th Sep.	0	2.66	4.12	1.33	2.25	3.99	6.37
	1ml/l	2.83	4.17	1.37	2.38	4.2	6.55
	2 ml/l	2.98	4.34	1.45	2.64	4.43	6.98
1st Oct.	0	3.30	4.75	1.52	2.85	4.82	7.6
	1ml/l	3.48	4.94	1.63	2.91	5.11	7.85
	2 ml/l	3.54	5.17	1.72	3.06	5.26	8.23
15th Oct.	0	2.79	3.70	1.36	2.48	4.15	6.18
	1ml/l	3.14	4.22	1.44	2.60	4.58	6.82
	2 ml/l	3.23	4.54	1.52	2.25	4.75	6.79
LSD at 0.05 level		0.18	0.14	0.07	0.05	0.10	0.15
		2017/2018 season					
15th Sep.	0	2.38	2.98	1.10	2.14	3.48	5.12
	1ml/l	2.77	3.17	1.16	2.47	3.93	5.64
	2 ml/l	3.30	4.06	1.30	2.44	4.6	6.5
1st Oct.	0	3.36	4.71	1.57	2.84	4.93	7.55
	1ml/l	3.52	5.06	1.66	3.01	5.18	8.07
	2 ml/l	3.75	5.33	1.90	3.14	5.65	8.47
15th Oct.	0	2.97	3.45	1.26	2.34	4.23	5.79
	1ml/l	3.10	3.93	1.29	2.50	4.39	6.43
	2 ml/l	3.34	3.99	1.42	2.67	4.76	6.66
LSD at 0.05 level		0.18	0.20	0.07	0.21	0.17	0.34

Table 5. Effect of the interaction between cultivar and potassium silicate rate on dry weight of garlic plant at 105 and 135 days after planting during 2016/2017 and 2017/2018 seasons

Treatment		Dry weight of leaves/plant (g)		Dry weight of bulb (g)		Total dry weight/plant (g)	
		Days after planting					
		105	135	105	135	105	135
Cultivar	K silicate rate	2016/2017 season					
Balady	0	3.05	4.33	1.52	2.62	4.57	6.95
	1ml/l	3.26	4.52	1.59	2.72	4.85	7.24
	2 ml/l	3.41	4.78	1.66	2.88	5.07	7.66
Sids 40	0	2.78	4.05	1.28	2.43	4.06	6.48
	1ml/l	3.04	4.36	1.37	2.53	4.41	6.89
	2 ml/l	3.10	4.58	1.46	2.69	4.56	7.27
LSD at 0.05 level		0.15	0.12	0.05	0.04	0.15	0.12
		2017/2018 season					
Balady	0	3.06	3.88	1.41	2.54	4.47	6.42
	1ml/l	3.23	4.17	1.46	2.85	4.69	7.02
	2 ml/l	3.51	4.66	1.65	2.81	5.16	7.47
Sids 40	0	2.74	3.54	1.21	2.34	3.95	5.88
	1ml/l	3.03	3.93	1.28	2.47	4.31	6.4
	2 ml/l	3.42	4.25	1.43	2.69	4.85	6.94
LSD at 0.05 level		0.15	0.16	0.06	0.17	0.14	0.27

Table 6. Effect of the triple interaction among planting date, cultivar and K silicate rate on dry weight of garlic plant at 105 and 135 days after planting during 2016/2017 and 2017/ 2018 seasons

Treatment			Dry weight of leaves/plant (g)				Dry weight of bulb (g)				Total dry weight/plant (g)			
Planting date	Cultivar	K silicate rate	Days after planting											
			105		135		105		135		105		135	
			S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
15th Sep.	Balady	0	2.74	2.48	4.34	3.30	1.43	1.20	2.35	2.25	4.17	3.68	6.69	5.55
		1ml/l	2.92	2.88	4.21	3.27	1.50	1.26	2.48	2.84	4.42	4.14	6.69	6.11
		2 ml/l	3.03	3.23	4.44	4.12	1.55	1.36	2.71	2.43	4.58	4.59	7.15	6.55
	Sids 40	0	2.58	2.28	3.90	2.66	1.22	1.00	2.15	2.04	3.80	3.28	6.05	4.70
		1ml/l	2.75	2.66	4.13	3.07	1.24	1.06	2.28	2.10	3.99	3.72	6.41	5.17
		2 ml/l	2.94	3.36	4.24	3.99	1.35	1.25	2.56	2.45	4.29	4.61	6.80	6.44
1st Oct.	Balady	0	3.50	3.62	4.85	4.81	1.67	1.67	2.93	2.94	5.17	5.29	7.78	7.75
		1ml/l	3.64	3.62	5.04	5.16	1.74	1.76	3.00	3.11	5.38	5.38	8.04	8.27
		2 ml/l	3.75	3.85	5.27	5.43	1.82	2.10	3.17	3.24	5.57	5.95	8.44	8.67
	Sids 40	0	3.09	3.09	4.65	4.61	1.36	1.47	2.76	2.74	4.45	4.56	7.41	7.35
		1ml/l	3.32	3.42	4.84	4.96	1.53	1.56	2.83	2.91	4.85	4.98	7.67	7.87
		2 ml/l	3.34	3.65	5.07	5.23	1.62	1.70	2.96	3.04	4.96	5.35	8.03	8.27
15th Oct.	Balady	0	2.90	3.07	3.80	3.53	1.46	1.36	2.58	2.44	4.36	4.43	6.38	5.97
		1ml/l	3.24	3.20	4.32	4.10	1.54	1.35	2.70	2.60	4.78	4.55	7.02	6.70
		2 ml/l	3.44	3.44	4.64	4.44	1.62	1.51	2.77	2.77	5.06	4.95	7.41	7.21
	Sids 40	0	2.68	2.87	3.60	3.36	1.26	1.16	2.38	2.24	3.94	4.03	5.98	5.60
		1ml/l	3.05	3.00	4.12	3.76	1.34	1.22	2.50	2.40	4.39	4.22	6.62	6.16
		2 ml/l	3.02	3.24	4.44	3.54	1.42	1.33	2.56	2.57	4.44	4.57	7.00	6.11
LSD at 0.05 level			0.26	0.26	0.20	0.28	0.09	0.10	0.07	0.31	0.26	0.25	0.22	0.48

S1: 1st season and S2: 2nd season

Table 7. Effect of planting date on yield and its components of garlic during 2016/2017 and 2017/ 2018 seasons

Treatment	Yield and its components (ton/fad.)							Average bulb weight (g)
	Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	
Planting date	**2016/2017 season**							
15th Sep.	1.998	1.668	1.343	0.820	3.666	5.009	5.829	43.08
1st Oct.	2.311	2.183	1.694	1.140	4.494	6.188	7.328	52.07
15th Oct.	2.160	1.775	1.520	0.899	3.935	5.455	6.354	46.40
LSD at 0.05 level	**0.050**	**0.071**	**0.049**	**0.037**	**0.054**	**0.042**	**0.056**	**0.68**
	2017/2018 season							
15th Sep.	1.980	1.147	1.301	0.815	3.127	4.428	5.243	40.62
1st Oct.	2.323	1.494	1.687	1.144	3.817	5.504	6.648	50.60
15th Oct.	2.158	1.283	1.527	0.945	3.441	4.968	5.913	40.87
LSD at 0.05 level	**0.047**	**0.283**	**0.040**	**0.070**	**0.303**	**0.323**	**0.310**	**3.77**

Table 8. Effect of cultivar on yield and its components of garlic during 2016/2017 and 2017/2018 seasons

Treatment	Yield and its components (ton/fad.)							Average bulb weight (g)
	Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	
Cultivar	**2016/2017 season**							
Balady	2.295	2.011	1.659	1.090	4.306	5.965	7.055	47.43
Sids 40	2.018	1.739	1.379	0.817	3.757	5.136	5.953	46.94
LSD at 0.05 level	**0.097**	**0.030**	**0.012**	**0.030**	**0.098**	**0.022**	**0.020**	**0.20**
	2017/2018 season							
Balady	2.291	1.49	1.643	1.106	3.781	5.424	6.530	44.20
Sids 40	2.016	1.126	1.368	0.829	3.142	4.51	5.339	43.19
LSD at 0.05 level	**0.032**	**0.160**	**0.077**	**0.034**	**0.160**	**0.156**	**0.155**	**0.56**

Table 9. Effect of potassium silicate rate on yield and its components of garlic during 2016/2017 and 2017/2018 seasons

Treatment	Yield and its components (ton/fad.)							Average bulb weight (g)
	Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	
K silicate rate	**2016/2017 season**							
0	2.035	1.752	1.393	0.854	3.787	5.180	6.034	44.46
1ml/l	2.153	1.897	1.532	0.956	4.050	5.582	6.538	47.57
2 ml/l	2.282	1.977	1.631	1.050	4.259	5.890	6.940	49.51
LSD at 0.05 level	**0.016**	**0.020**	**0.031**	**0.020**	**0.021**	**0.034**	**0.037**	**0.37**
	2017/2018 season							
0	2.024	1.239	1.391	0.852	3.263	4.654	5.506	40.44
1ml/l	2.153	1.31	1.516	0.955	3.463	4.979	5.934	42.91
2 ml/l	2.284	1.375	1.609	1.096	3.659	5.268	6.364	47.74
LSD at 0.05 level	**0.030**	**0.129**	**0.026**	**0.048**	**0.127**	**0.131**	**0.141**	**2.85**

increased yield of grades 1, 2, 3 and 4, exportable, marketable and total yield as well as average bulb weight in both seasons. Results are in harmony with those reported by **Wand and Galletta (1998)** on strawberries, **Abou-Baker *et al.* (2011)** on bean, **Kamal (2013)** on sweet pepper, **(Salim *et al*., 2014)** on potato, **Abou El-Khair** and **Mohsen (2016)** on Jerusalem artichoke and **Elrys and Merwad (2017)** on pea.

Effect of the interaction between planting date and cultivars

The interaction between planting date and cultivars had significant effect on yield and its components in both seasons (Table 10). Planting Balady cultivar on 1st Oct. increased yield of grades 1,2,3 and 4, exportable, marketable and total yields as well as average bulb weight in both seasons, followed by planting Balady cultivar on 15th Oct. and planting Sids 40 cultivar on 1st Oct. in both seasons.

Effect of the interaction between planting date and K silicate

The interaction between planting date and K silicate reflect significant effect on yields and its components in both seasons (Table 11). Planting on 1st Oct. and spraying with K silicate at 2 ml/l increased yield of grades 1, 2, 3 and 4, exportable, marketable and total yields as well as average bulb weight, followed by planting on 1st Oct. and spraying with K silicate at 1 ml/l in both seasons.

Effect of the interaction between cultivars and K silicate

Results in Table 12 show that, the interaction between cultivars and K silicate reflect significant effect on yield and its components in both seasons. Spraying Balady cultivar with K silicate at 2 ml/l increased yield of grades 1, 2, 3 and 4, exportable, marketable and total yields, followed by spraying Balady cultivar with K silicate at 1 ml/l in both seasons. As for average bulb weight, spraying Balady and Sids 40 cultivars with K silicate at 2ml /l increased average bulb weight in both seasons.

Effect of the triple interaction among planting date, cultivar and K silicate

The interaction among planting date, cultivar and K silicate had significant effect on yield and its components in both seasons (Tables 13 and 14). Planting Balady cultivar on 1st Oct. and spraying with K silicate at 2 ml /l increased yield of grades 1, 2, 3 and 4, exportable, marketable and total yields as well as average bulb weight with no significant differences with

Table 10. Effect of the interaction between planting dates and cultivars on yield and its components of garlic during 2016/2017 and 2017/2018 seasons

Treatment		Yield and its components (ton/fad.)							Average bulb weight (g)
		Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	
Planting date	**Cultivar**					**2016/2017 season**			
15th Sep.	**Balady**	2.134	1.805	1.482	0.957	3.939	5.421	6.378	43.39
	Seds 40	1.863	1.531	1.205	0.682	3.394	4.599	5.281	42.78
1st Oct.	**Balady**	2.449	2.317	1.831	1.275	4.766	6.597	7.872	52.26
	Seds 40	2.172	2.049	1.557	1.006	4.221	5.778	6.784	51.87
15th Oct.	**Balady**	2.302	1.911	1.664	1.037	4.213	5.877	6.914	46.63
	Seds 40	2.019	1.639	1.375	0.762	3.658	5.033	5.795	46.16
LSD at 0.05 level		**0.016**	**0.052**	**0.022**	**0.053**	**0.017**	**0.038**	**0.035**	**0.36**
						2017/2018 season			
15th Sep.	**Balady**	2.117	1.272	1.439	0.955	3.389	4.828	5.783	38.55
	Seds 40	1.843	1.022	1.164	0.674	2.865	4.029	4.703	38.69
1st Oct.	**Balady**	2.462	1.777	1.822	1.280	4.239	6.061	7.341	48.58
	Seds 40	2.184	1.21	1.552	1.008	3.394	4.946	5.954	48.62
15th Oct.	**Balady**	2.295	1.421	1.667	1.084	3.716	5.383	6.467	45.48
	Seds 40	2.021	1.144	1.387	0.806	3.165	4.552	5.358	42.27
LSD at 0.05 level		**0.056**	**0.277**	**0.013**	**0.059**	**0.277**	**0.270**	**0.269**	**4.67**

Table 11. Effect of the interaction between planting dates and potassium silicate rates on yield and its components of garlic during 2016/2017 and 2017/2018 seasons

Treatment		Yield and its components (ton/fad.)							Average bulb weight (g)
		Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	
Planting date	**K silicate rate**					**2016/2017 season**			
15th Sep.	**0**	1.838	1.469	1.191	0.694	3.307	4.498	5.192	41.20
	1ml/l	2.013	1.718	1.369	0.814	3.731	5.100	5.914	43.13
	2 ml/l	2.144	1.816	1.470	0.951	3.96	5.43	6.381	44.93
1st Oct.	**0**	2.210	2.140	1.593	1.070	4.35	5.943	7.013	48.65
	1ml/l	2.271	2.178	1.690	1.143	4.449	6.139	7.282	52.78
	2 ml/l	2.451	2.231	1.799	1.208	4.682	6.481	7.689	54.77
15th Oct.	**0**	2.057	1.647	1.396	0.797	3.704	5.100	5.897	43.54
	1ml/l	2.175	1.795	1.539	0.911	3.97	5.509	6.420	46.81
	2 ml/l	2.250	1.883	1.624	0.989	4.133	5.757	6.746	48.84
LSD at 0.05 level		**0.027**	**0.034**	**0.054**	**0.035**	**0.037**	**0.059**	**0.065**	**0.64**
						2017/2018 season			
15th Sep.	**0**	1.804	1.001	1.175	0.690	2.805	3.980	4.670	36.47
	1ml/l	2.010	1.213	1.296	0.793	3.223	4.519	5.312	39.08
	2 ml/l	2.125	1.228	1.433	0.961	3.353	4.786	5.747	40.31
1st Oct.	**0**	2.202	1.562	1.585	1.069	3.764	5.349	6.418	45.56
	1ml/l	2.277	1.427	1.687	1.145	3.704	5.391	6.536	47.01
	2 ml/l	2.490	1.492	1.789	1.217	3.982	5.771	6.988	53.22
15th Oct.	**0**	2.064	1.155	1.412	0.797	3.219	4.631	5.428	39.30
	1ml/l	2.172	1.29	1.564	0.928	3.462	5.026	5.954	42.64
	2 ml/l	2.238	1.404	1.605	1.110	3.642	5.247	6.357	49.68
LSD at 0.05 level		**0.052**	**0.225**	**0.045**	**0.083**	**0.220**	**0.227**	**0.245**	**4.94**

Table 12. Effect of the interaction between cultivars and potassium silicate rates on yield and its components of garlic during 2016/2017 and 2017/2018 seasons

Treatment		Yield and its components (ton/fad.)							Average bulb weight (g)
		Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	
Cultivar	K silicate rate	2016/2017 season							
Balady	0	2.173	1.883	1.531	0.992	4.056	5.587	6.579	44.74
	1ml/l	2.289	2.036	1.680	1.089	4.325	6.005	7.094	47.85
	2 ml/l	2.423	2.114	1.767	1.187	4.537	6.304	7.491	49.70
Sids 40	0	1.897	1.621	1.256	0.715	3.518	4.774	5.489	44.19
	1ml/l	2.017	1.758	1.385	0.823	3.775	5.16	5.983	47.30
	2 ml/l	2.141	1.839	1.495	0.912	3.98	5.475	6.387	49.33
LSD at 0.05 level		0.022	0.028	0.044	0.029	0.030	0.048	0.053	0.52
		2017/2018 season							
Balady	0	2.162	1.376	1.528	0.991	3.538	5.066	6.057	40.37
	1ml/l	2.290	1.53	1.654	1.093	3.82	5.474	6.567	42.89
	2 ml/l	2.422	1.564	1.746	1.235	3.986	5.732	6.967	49.35
Sids 40	0	1.885	1.102	1.254	0.713	2.987	4.241	4.954	40.52
	1ml/l	2.015	1.089	1.377	0.818	3.104	4.481	5.299	42.93
	2 ml/l	2.147	1.185	1.472	0.957	3.332	4.804	5.761	46.13
LSD at 0.05 level		0.042	0.183	0.036	0.067	0.179	0.185	0.200	4.03

Table 13. Effect of the triple interaction among planting date, cultivar and potassium silicate rate on yield and its components of garlic during 2016/2017 season

Treatment			Yield and its components (ton/fad.)							Average bulb weight (g)
			Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	
Planting date	Cultivar	K silicate rate								
15th Sep.	Balady	0	1.975	1.603	1.330	0.830	3.578	4.908	5.738	41.51
		1ml/l	2.151	1.857	1.507	0.950	4.008	5.515	6.465	43.40
		2 ml/l	2.275	1.956	1.609	1.080	4.231	5.840	6.920	45.26
	Sids 40	0	1.700	1.336	1.053	0.550	3.036	4.089	4.639	40.89
		1ml/l	1.875	1.579	1.230	0.670	3.454	4.684	5.354	42.86
		2 ml/l	2.014	1.677	1.332	0.810	3.691	5.023	5.833	44.60
1st Oct.	Balady	0	2.349	2.265	1.728	1.200	4.614	6.342	7.542	48.83
		1ml/l	2.409	2.317	1.829	1.270	4.726	6.555	7.825	53.06
		2 ml/l	2.590	2.369	1.937	1.340	4.959	6.896	8.236	54.89
	Sids 40	0	2.071	2.015	1.458	0.930	4.086	5.544	6.474	48.46
		1ml/l	2.133	2.040	1.551	1.010	4.173	5.724	6.734	52.50
		2 ml/l	2.313	2.092	1.661	1.070	4.405	6.066	7.136	54.66
15th Oct.	Balady	0	2.195	1.782	1.535	0.930	3.977	5.512	6.442	43.87
		1ml/l	2.309	1.933	1.703	1.040	4.242	5.945	6.985	47.09
		2 ml/l	2.404	2.019	1.754	1.120	4.423	6.177	7.297	48.95
	Sids 40	0	1.919	1.513	1.258	0.650	3.432	4.690	5.340	43.21
		1ml/l	2.042	1.656	1.375	0.770	3.698	5.073	5.843	46.54
		2 ml/l	2.095	1.748	1.494	0.850	3.843	5.337	6.187	48.74
LSD at 0.05 level			0.039	0.049	0.077	0.050	0.053	0.083	0.092	0.91

Table 14. Effect of the triple interaction among planting date, cultivar and potassium silicate rate on yield and its components of garlic during 2017/2018 season

Treatment			Yield and its components (ton/fad.)							Average bulb weight (g)
			Grade (1)	Grade (2)	Grade (3)	Grade (4)	Exportable yield	Marketable yield	Total yield	
Planting date	**Cultivar**	**K silicate rate**								
15th Sep.	**Balady**	**0**	1.943	1.139	1.314	0.829	3.082	4.396	5.225	36.39
		1ml/l	2.149	1.351	1.434	0.936	3.500	4.934	5.870	39.00
		2 ml/l	2.260	1.325	1.568	1.099	3.585	5.153	6.252	40.26
	Sids 40	**0**	1.666	0.862	1.037	0.551	2.528	3.565	4.116	36.55
		1ml/l	1.872	1.074	1.157	0.650	2.946	4.103	4.753	39.16
		2 ml/l	1.991	1.131	1.298	0.822	3.122	4.420	5.242	40.36
1st Oct.	**Balady**	**0**	2.340	1.696	1.719	1.208	4.036	5.755	6.963	45.46
		1ml/l	2.416	1.811	1.826	1.276	4.227	6.053	7.329	47.10
		2 ml/l	2.629	1.825	1.922	1.356	4.454	6.376	7.732	53.17
	Sids 40	**0**	2.064	1.428	1.451	0.930	3.492	4.943	5.873	45.66
		1ml/l	2.138	1.043	1.549	1.015	3.181	4.730	5.745	46.91
		2 ml/l	2.351	1.16	1.657	1.078	3.511	5.168	6.246	53.27
15th Oct.	**Balady**	**0**	2.203	1.293	1.550	0.936	3.496	5.046	5.982	39.26
		1ml/l	2.307	1.429	1.703	1.067	3.736	5.439	6.506	42.56
		2 ml/l	2.377	1.543	1.749	1.249	3.920	5.669	6.918	54.61
	Sids 40	**0**	1.926	1.017	1.274	0.658	2.943	4.217	4.875	39.35
		1ml/l	2.037	1.151	1.426	0.789	3.188	4.614	5.403	42.71
		2 ml/l	2.100	1.265	1.462	0.971	3.365	4.827	5.798	44.75
LSD at 0.05 level			**0.073**	**0.318**	**0.063**	**0.117**	**0.311**	**0.321**	**0.346**	**6.99**

planting Balady cultivar on 1st Oct. and spraying with K silicate at 1 ml /l in the 2nd season only.

Conclusion

From foregoing results it could be concluded that, planting Balady cultivar on 1st Oct. and spraying with K silicate at 2 ml /l increased total dry weight and yield and its components as well as average bulb weight.

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تأثيـــر ميعـــاد الـــزراعـــة والـرش الورقي بسليكات البوتاسيوم على نمو ومحصول بعض أصناف الثوم

ياسر عبدالعزيز السيد محمد - المتولى عبدالسميع الغمرينى - عبدالله برديسى - داليا أحمد سامى نوار

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أجريت هذه التجربة خلال موسمى شتاء ٢٠١٦/٢٠١٧، ٢٠١٧/٢٠١٨ بمزرعة خاصة بمنطقة ههيا، محافظة الشرقية، مصر وذلك لدراسة تأثير ميعاد الزراعة، والرش الورقى بسليكات البوتاسيوم على الوزن الجاف ومحصول الأبصال ومكوناته لصنفي الثوم البلدى وسدس ٤٠ تحت ظروف الأرض الطينية واستخدام نظام الرى بالغمر، وقد أظهرت النتائج أن زراعة صنف الثوم البلدى فى ١ أكتوبر ورش النباتات بسليكات البوتاسيوم بتركيز ٢ ملليلتر/لتر قد أدى إلى زيادة الوزن الجاف لكل من الأوراق والبصلة والوزن الجاف الكلى للنبات، ومحصول الدرجة الأولى والثانية والثالثة والرابعة والمحصول القابل للتصدير والقابل للتسويق والمحصول الكلى، وكذلك متوسط وزن البصلة.

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