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Quality and shelf-life of onion bulbs influenced by some bio-stimulates

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Abstract

Two experiments were conducted at Agricultural Research Station, Faculty of Agriculture, Cairo University, Giza, Egypt during two winter seasons 2013-2015 to investigate the effects of some bio-stimulates commercial products (Humic acid, Amino acids, Siammino, CaBoron and Elga600) on yield, bulb quality and storage ability of onion cv Giza20. The experiments were laid out in randomized complete block design arrangement having three replications. Results indicated that all bio-stimulates treatments increased total yield and bulb weight significantly. The superior treatments were humic acid and amino acids. Bulbs obtained from plants treated with humic acid, caboron and elga600 had the highest bulb diameter than other treatments. The control plants had the lowest bulb TSS and firmness compared to other treatments but the differences were not significant. The lowest decay rates were obtained from plots that received amino acids and siammino, while humic acid (in first season) or siammino (in second season) had lowest weight loss of bulbs than other treatments.

Keywords: Onion, storage, quality, salinity, sand

Introduction

Onion (*Allium cepa* L.) belongs to the family Amaryllidaceae which is one of the most important mono-cotyledonous crops. It is a cool season vegetable crop. It is widely used and most important vegetable crop which is grown in temperate and tropical regions of the world (Sajid et al. 2012). In Egypt, the total production of onion is 1903000 tons and is cultivated on an area 5292000 ha, in 2013. In Egypt, average yield is 40.4 t/ha (FAOSTAT). Egypt is located in arid and semi-arid region and can be classified into five main parts, the Western Desert, Eastern Desert, Nile Valley, Nile Delta, and the Sinai Peninsula. The majority of sandy soils are located in the eastern and western desert.Sandy soil is classified as poor soil in mineral nutrients and low water holding capacity as well as shortage of organic matter. Thus, the using of organic and mineral fertilizers should be assumed to this type of soil to obtained economic production.

Using foliar nutrients fertilizer is considered as one of several techniques to increase productivity and improve quality of crop production especially under sandy soil conditions.

Normally in sandy soil, micronutrients including boron and calcium become less available to plants with increasing soil pH (Tisdale and Nelson, 1995). Alam et al. (2010) applied six micronutrients to onion plants. They found that most of the yield contributing parameters of onion (number of leaves per plant, plant height, diameter of bulb, fresh weight of leaves, fresh weight of bulb, diameter of bulb and bulb yield) were increased with micronutrients fertilizers compared to control.Amino acids are a well-known bio-stimulant which has positive effects on plant growth, yield (Kowalczyk and Zielony 2008).

By the application of humic substance to plants, the water holding capacity of soil will increase. It helps plants to be more resistant against drought stress, and also stimulates growth (Sajid et al. 2012). Humic acid (HA) provide plant and soil with essential nutrients, vitamins and micro elements to improve plant growth, yield and its quality in various crops (Ayuso et al., 1996). Geries (2013) reported that foliar spraying of onion plants with humic acid increased vegetative growth, bulb yield, quality and chemical composition. There were little studies about the effects of humic acid, amino acids, Alge or micro elements on quality and storage ability of onion bulb under sandy soil condition. Thus this study was evaluated the effects of humic acid, amino acids, Alge and micro elements on yield, quality and storage ability of onion bulbs under sandy soil condition.

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Materials and Methods

The present study was carried out during two successive winter seasons; 2013/2014 and 2014/2015 at Agricultural Experimental Station in Nobaria farm, El-Monophyah Governorate, Egypt to study the effect of some micronutrients and bio-stimulants i.e. Humic acid, Caboron, Amino acids, Elga and Siamino on growth, yield and storability of onion Giza 20 cultivar. The experimental trails were conducted in sandy soil using drip irrigation system. Onion bulbs were selected for uniformity in size and were sown on 5 rows each with a distance of 15 cm between bulbs and 75 cm between rows. It contained two rows of 3.8 m length and 0.75 cm width. Planting was carried out on 20th and 22nd January in the first and second seasons, respectively. All agricultural practices were applied as commonly recommended for commercial onion production. The physical and chemical properties of the soil are presented in Table 1. The chemical analyses of irrigation water are presented in Table 2.

Foliar application of onion plants was including six different treatments as follow: 1) Humic acid at rate of 1g /l ; 2) Caboronat rate of 1g /l; 3) Amino X at rate of 1g /l; 4) Elga at rate of 1g /l; 5) Siamino at rate of 1g / l; 6) and 6) Tap water (control). Spraying treatments were started at 20/3/2014 and 22/3/2015 in the first and second seasons, respectively and repeated 3 times 15 days intervals throughout the growing season. The design of the experiments was a complete randomized blocks with three replicates. The commercial product of humic acid, Caboron, Amino acids, Elga and Siamino were used. The commercial product "Humic acid" contains 6% potassium oxide + 86% potassium hummate. The commercial product "Caboron" was used as a source of calcium and Boron and its components were 6% chelate calcium + 1.5% chelate boron + 20% calcium oxide. The commercial product "Amino X" was used as source of amino acids and its components were 80% total amino acid + 16% free amino acid + 10% organic nitrogen + 2.5% potassium oxide. The commercial product "Elga" contains 1% nitrogen + 18% potassium oxide + 2% sulfur. The commercial product "Siamino" contains free amino acid 19% + microelements.

At harvest stage, after 180 days from transplanting the following yield data were recorded: Total yield; Marketable yield (healthy bulbs free from defects, injuries and normal size) and unmarketable yield (misshapen bulbs). Samples of 20 bulbs from each experimental plot were taken and average weight of bulb (g) and diameter of bulb were recorded. At harvest and after curing, a sample of onions was taken from each plot then ten kilogram of healthy and marketable onions were stored in cartoon box at room temperature for 8 months. Weight loss, decay, firmness and TSS were determined after 2, 4, 6 and 8months of harvest. Weight loss was calculated as: WL = 100 × (Wi " Wf) / Wi, Wi being the initial sample weight and Wf the final sample weight. Results were expressed as percentage weight loss. Decay percentage was determined by evaluating the decay onions. Firmness was determined by a digital penetrometer. A total soluble solid (TSS) was determined by digital refractometer. Finally, SPSS program was used for data statistical processing. Tuky test at $P < 0.05$ was used to determine significant differences between the treatments.

Results and Discussion

Yield and its components: The effect of humic acids, amino acid, microelements and alge fertilizers on total, marketable and unmarketable yield in 2013/2014 and 2014/2015 seasons is presented in Table 3 and Table 4, respectively. In first growing season, plots treated with humic acid or amino acid had significantly higher total yield compared to other treatments. Control plots had the lowest total yield compared to all other treatments. In second growing season, caboron had superior total yield then humic acid and amino acid (Table 3). In first growing season, plots sprayed with amino acid or elga had significantly higher marketable yield compared to other treatments. In second season, the lowest marketable yield was obtained from plots sprayed with

Table 1: Physical and chemical analysis of the experimental soil in 2013/2014 and 2014/2015 seasons

Season	Soil texture	Soluble cations (meq l^{-1})				Soluble anions (meq l^{-1})		
		K^+	Na^+	Ca^{++}	Mg^{++}	$HCO3^-$	$SO4^{+2}$	Cl^-
2013/2014	Sandy	10.21	18.01	15.16	6.38	1.52	20.56	18.5
2014/2015	Sandy	10.74	38.52	60.21	48.65	5.62	21.87	30.26

Continue Table 1

Season	Soil EC (dS m^{-1})	Soil pH	Available nutrients (mg kg-1)					
			N	P	Zn	Mn	Cu	Fe
2013/2014	4.20	7.50	17.50	30.20	2.30	5.30	1.50	16.50
2014/2015	3.95	8.01	18.00	33.01	2.25	6.15	1.36	15.24

Table 2: Chemical analysis of irrigation water used in study

Water EC (dS m^{-1})	Water pH	Soluble cations (meq l^{-1})				Soluble anions (meq l^{-1})		
		K^+	Na^+	Ca^{++}	Mg^{++}	$CO3^-$	$SO4^{+2}$	Cl^-
3.5	7.5	.39	28.54	2.22	7.10	4.01	12.70	22.85

Table 3: Effect of some bio-stimulants on total, marketable and unmarketable yield and bulb weight and diameter in 2013/2014 season.

	Total Yield (ton/Fed)	Marketable Yield (%)	Unmarketable Yield (%)	Bulb weight (g)	Bulb Diameter (mm)
Humic Acid	15,33 a	94,16 b	5,83 a	123,33 a	76,20 a
Caboron	14,96 a	94,53 b	5,46 a	124.00 a	72,50 bc
Amino	15,63 a	97,53 a	2,46 b	124.00 a	67,36 de
Elga	14,44 a	96,33 ab	3,66 ab	115,33 b	73,50 ab
Siammino	14,50 a	94,83 ab	5,16 ab	99,33 c	65,66 e
Control	11,79 b	94,36 b	5,63 a	104,46 c	69,80 cd

Table 4: Effect of some bio-stimulants on total, marketable and unmarketable yield and bulb weight and diameter in 2014/2015 season.

	Total Yield (ton/Fed)	Marketable yield (%)	Unmarketable yield (%)	Bulb weight (g)	Bulb Diameter (mm)
Humic Acid	15,83 a	97,00 ab	3,00 bc	110,00 ns	69,76 ab
Caboron	16,02 a	98,36 a	1,63 c	117,07	73,13 a
Amino	14,89 ab	96,13 b	3,86 b	121,33	67,03 b
Elga	13,86 abc	97,63 ab	2,36 bc	72,50	68,76 ab
Siammino	13,10 bc	91,56 c	8,43 a	76,80	67,10 b
Control	11,49 c	92,66 c	7,33 a	110,50	70,03 ab

siammino or control. The lowest unmarketable yield was observed in plots sprayed with amino acid and caboron in the first and second seasons, respectively.

The improvement observed by humic acid may be due to the role of humic acid in stimulates root growth, increase proliferation of root hairs, production of smaller but more ramified secondary roots and enhancement of root initiation (Canellas et al. 2002). The enhancement effect of amino acids on onion growth may be due to improving the original ultra-structure in the cell especially the plastids in mesophyll tissue which improving photosynthetic efficiency leading to production of more assimilates needed for formation of new cell reflected to increase growth characters (Kandil et al. 2013). The improvement observed by amino acid may be due to enhance the metabolism processes in plant tissues (Shalaby and El-Ramadym 2014).

Bulb quality: The effect of humic acids, amino acid, microelements and alge fertilizers on bulb weight and diameter in 2013/2014 and 2014/2015 seasons is presented in Table 3 and Table 4, respectively. Plots that received humic acid, caboron and amino acids had significantly the highest bulb weight in first season, but second season was not significant.A Pearson correlation test was run to determine the relationship between total yield and bulb weight. There was a medium, positive correlation between total yield and mean of bulb weight, which was statistically significant (r = 0.543, n = 18, p = .005) in the first season. In 2013/2014, the highest bulb diameter was observed in plots sprayed with humic acid, caboron and elga while there were no differences among control, siammino and amino acids. In 2014/2015 the highest bulb diameter was observed in caboron treatment followed by control. The positive effect of humic acid may be due to improve dry matter accumulation and stimulated the building of metabolic products that translocated to bulbs (Kandil et al. 2013).

Total soluble solids: The effect of humic acids, amino acid, microelements and alge fertilizers on total soluble solids (TSS) during storage for 8 months in 2013/2014 and 2014/2015 seasons is presented in Fig 1. In both seasons, TSS was decreased during the first two months of storage then increased until 6 months. During the last two months of storage, TSS was decreased. At the end of storage (8 months), bulbs revised from control plots had the lowest TSS compared to all other treatments while bulbs revised from humic acid had the higher TSS value. The differences among treatments were not significant in both seasons. Our results are in agreement with Yildirim (2007). They reported that foliar fertilizer with humic acid increased tomatoes fruits TSS.

Firmness: The effect of humic acids, amino acid, microelements and alge fertilizers on firmness during storage for 8 months in 2013/2014 and 2014/2015 seasons is presented in Fig 2. After 8 months of storage in both growing seasons, the lowest firmness percentage was observed in control onion bulbs while the highest firmness was observed in siammino plots.

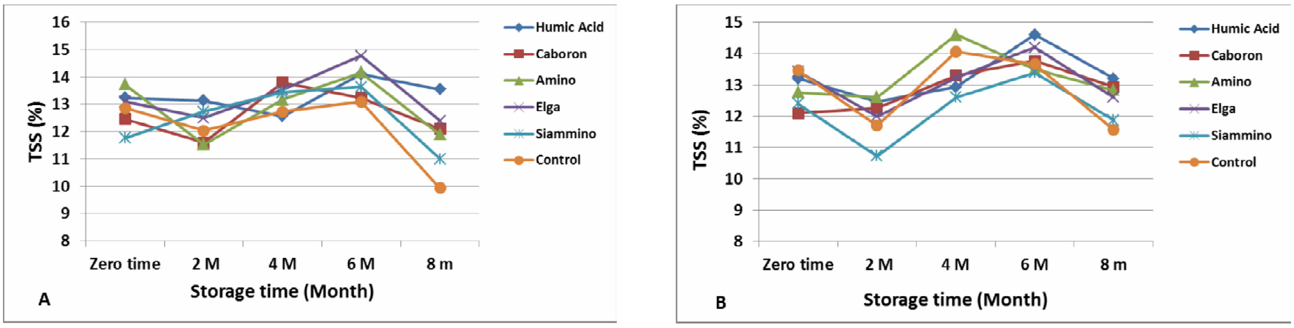

Fig 1: Effect of some bio-stimulantson TSS during storage for 8 months in (A) 2013/2014 and (B) 2014/2015.

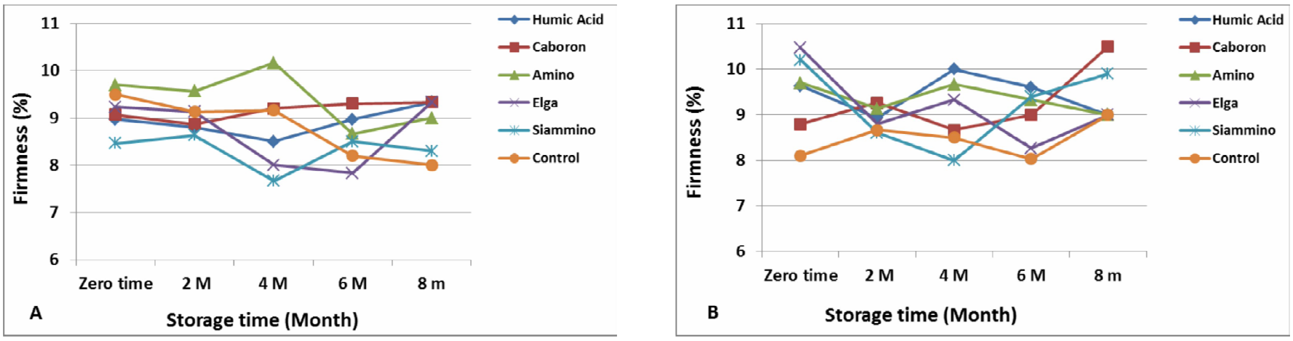

Fig 2: Effect of some bio-stimulants on firmness during storage for 8 months in (A) 2013/2014 and (B) 2014/2015

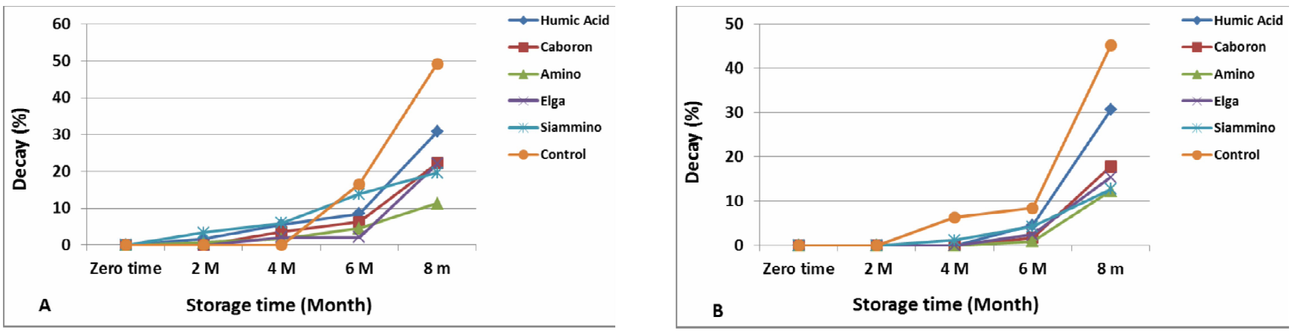

Fig 3: Effect of some bio-stimulantson decay during storage for 8 months in (A) 2013/2014 and (B) 2014/2015

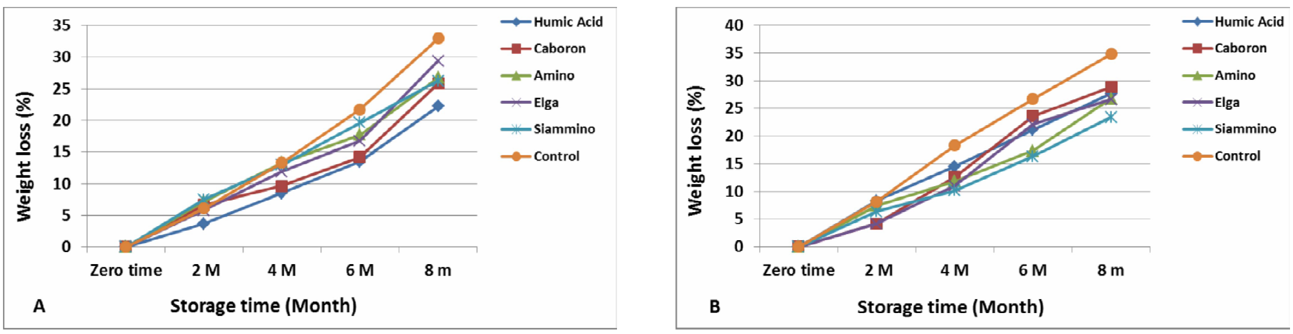

Fig 4: Effect of some bio-stimulantson weight loss during storage for 8 months in (A) 2013/2014 and (B) 2014/2015

Decay: The effect of humic acids, amino acid, microelements and alge fertilizers on decay percentage during storage for 8 months in 2013/2014 and 2014/2015 seasons is presented in Fig 3. Decay percentage was increased significantly with increasing storage time. After 8 months from harvest, the lowest decay rates were obtained from plots that received amino acids and siammino while the highest decay rates were obtained from control plots and that received humic acid. The same trend was observed in both growing seasons.

Weight loss: The effect of humic acids, amino acid, microelements and alge fertilizers on weight loss percentage during storage for 8 months in 2013/2014 and 2014/2015 seasons is presented in Fig 4. The percentage of weight loss was increased steadily until the end of storage. In both growing seasons, control treatment had the highest onion bulb weight loss during storage, compared to the other treatments. It was noticed that plants sprayed with either humic acid (in first season) or siammino (in second season) had lowest weight loss of bulbs than other treatments and the control. Our results are in accordance with Saif El-Deen et al. (2011). They reported that humic acid enhanced elements in available form for plants, enlarged root system and increased stimulation of plant-growth due to contribute some hormones and supply plants with P-element as well as certain micronutrients which led to decrease the weight loss of sweet potatoes roots.

सारांश

प्याज की प्रजाति गीजा–20 पर जैव उद्दीपक उत्पाद (ह्यूमिक एसिड, एमीनो एसीड, सियामिनों, कैबोरान तथा इल्गा 600) का उपज, कन्द गुणवत्ता तथा भण्डारण क्षमता प्रभाव को ज्ञात करने के लिए दो शीतकाल मौसमों वर्ष 2013–2015 में एग्रीकल्चर रिसर्च स्टेशन फैकल्टी आफ एग्रीकल्चर, कीरो युनिवर्सिटी, गीजा (इजिपट) में दो प्रयोग किये गये। प्रयोग तीन प्रकृतियों में रैण्डोमाइम्ड बालक डिजाइन के तहत किया गया। परिणाम से स्पष्ट हुआ कि सभी जैव–उद्दीपक शोधन से कुल उपज तथा शक्ल कंद भार में सार्थक वृद्धि हुई। सबसे उत्तम शोधन ह्यूमिक एसीड् तथा एमीनो एसीड्स थे। ह्यूमिक एसीड्, कैबोरान तथा इल्गा 600 से शोधित पौध से प्राप्त शक्ल कन्दों में अन्य की तुलना में कंद व्यास ज्यादा था। नियंत्रित पौध के शक्ल कंदों में सबसे कम कुल विलेय ठोस एवं कसावट था लेकिन अन्तर बहुत सार्थक नहीं था। सबसे कम सड़ावट उस उपखण्ड से प्राप्त हुआ जिनमें एमीनो एसीड्स तथा सियामिनो दिया गया था जबकि ह्यूमिक एसीड (प्रथम मौसम में) अथवा सियामिनो (द्वितीय मौसम में) अन्य शोधनों की तुलना में सबसे कम कंद भार में कमी पायी गया।

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