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(Original Article)

Foliar Fertilization of Moringa Leaf Extract, Humic Acid, Seaweed Extract and Mineral Fertilizers as Affect Productivity and Storability of Onion Crop

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Abstract

The study was conducted to investigate the influence of moringa leaf extract, humic acid, seaweed and NPK (mineral fertilizers) as foliar fertilization on the yield and storability of onion (Giza 6 cultivar) during 2019/2020 and 2020/2021 seasons. Our results indicated that there were significant differences among the twelve fertilization treatments for yield and storability parameters in both seasons. Results revealed that yield and its components increased by foliar application of NPK 2000 ppm + Moringa leaf extract 5% (T9) treatment. The highest means of bulb fresh weight i.e., (102.87 and 99.97 g) were obtained from treatment of NPK 2000 ppm + Moringa leaf extract 5% (T9) ,while the lowest average bulb fresh weight (69.60 and 70.50) was recorded under control (without fertilizers) treatment, in the first and second seasons, respectively. Total yield increased by 40.66% and 47.66% in the two seasons respectively by applying NPK 2000 ppm + Moringa leaf extract 5% (T9) treatment as a foliar application. On the other hand, Moringa leaf extract 5% (T3), seaweed 3% (T5), and NPK 500 ppm+ Moringa leaf extract 5% (T6) treatments have a positive effect on marketable yield percentage. Cull yields % due to foliar application with seaweed 3% (T5) or NPK 500 ppm+ Moringa leaf extract 5% (T6) treatment recorded the lowest value while, foliar application with NPK 2000 ppm (T2) gave the highest cull yield %. Weight loss % was affected by storage period and treatments. For all treatments, the weight loss increased during the storage period .

Keywords: *Dry matter, Marketable yield, Productivity, Bio-stimulants*

Introduction

Onion (*Allium cepa* L) is the most widely grown and very popular spices throughout the world. It is a vegetable crop belonging to the family of *Allaceae*. It is considered one of the most important vegetable crops in Egypt for both exportation and local consumption, also, it has many pharmacological activities (Hefzy *et al*., 2020). It is used in the daily diet of people in the whole world and

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has medicinal value. It is considered as a rich source of carbohydrates, protein, vitamin C, phosphorus, and calcium (Ramesh *et al*., 2017). Onion production in Egypt was approximately 3.08 million tons produced from the harvested area of 87 948 ha, in 2019 (FAOSTAT, 2020).

Mineral fertilizers play an important role in onion production. Many investigators indicated that mineral uptake was enhanced by increasing the level of NPK- fertilizers. On the other hand, we can say that continuous use of fertilizers causes environmental pollution and affect in an adverse way the sustainability of agricultural production (Bagali *et al.,* 2012). Unfortunately, Egyptian farmers used to use excessive amounts of fertilization to increase productivity. The usage of chemical fertilizers in excessive amounts causes great damage either to our ecosystem, atmosphere or to human health (Mostafa *et al*., 2021) in addition to the increasing costs of chemical fertilizers and the deterioration of soil fertility.

Concerning onion, the residual of mineral fertilizers is the main factor that reduce the exportable quantities of Egyptian onion (Mousa and Mohamed, 2009). Thus, searching for alternative safe natural sources of plant nutrients and suitable approaches to increase crop productivity to maintain food security is necessary.

Moringa leaf extract is also considered as one of the alternatives, due to its effect on the growth and yield of crops and thus can be promoted as a supplementary substitute to inorganic fertilizers. Moringa leaf extract is rich with growth hormones and sufficient quantities of micronutrients that increase the growth, yield and yield components of a variety of crops. Moringa leaves have high zeatin content which is considered one of the active plant hormone substances in the cytokinin group (Mohammed *et al*., 2013). Moreover, many studies have indicated that Moringa leaf extract is considered a natural bio-stimulant that play an important role in improving drought tolerance in plants (Abd El-Mageed *et al*.,2017) as well as in saline condition (Howladar, 2014).

Foliar application with humic acid causes an increase in growth and yields of various vegetables (Zandonadi *et al.,* 2007) and is beneficial to plant growth and development (Atiyeh *et al*., 2002). Humic acid has several benefits to plant such as enhancing nutrient uptake of vegetable crops (Cimrin and Yilmaz, 2005; Zandonadi *et al.,* 2007), controlling hormone levels as it acts as growth regulators, improves soil physical properties (Serenella *et al.,* 2002) and it also enhances photosynthesis and cell elongation.

Foliar application with bio-stimulants like seaweed extract is one of such alternatives that has a very important role in improving crop productivity and enhancing the quality of vegetables as a growth- promoting substance (Datta *et al.,* 2003) and (Saravanan *et al.,* 2003). Foliar application of bio-stimulants is being applied to enhance vegetative growth, yield, and quality in some vegetables. Seaweed extract is a new generation of natural organic fertilizers highly nutritious that affect plant growth and development (Battacharyya *et al*., 2015) and enhance yield (Dhargalkar *et al.,* 2005). Seaweed is considered as a

rich source of both micro and macro nutrients (Shehata *et al*.,2011). Seaweed liquid extract is a fertilizer supplement that contains macronutrients (small amounts of nitrogen, potassium, and phosphorus), organic substances like amino acids, plant growth regulators such as auxin, cytokinin, and gibberellins and trace elements (Begum *et al.,*2018).

Storage bulbs of onion after harvest is crucial to ensuring their availability in the off-season. Many cultivars of onion don't keep long in ambient storage because they tend to weight loss, decay shortly, and sprout after harvest (Obiadalla-Ali *et al*., 2016).

Therefore, this research work aimed to assess the response of the onion plant's yield and storability to some different types of foliar fertilization i.e., mineral fertilizers (NPK), moringa leaf extract, humic acid and seaweed extract.

Table 1. Analysis of chemical and physical characteristics of the soil of the experimental site for the two growing seasons

Characteristic	Seasons	
	2019 / 2020	**20/ 2021**
Chemical Properties		
pH (1:1)	7.5	7.6
EC ds/ m	1.3	1.1
Total Nitrogen (ppm)	15	13
Available Phosphorous (ppm)	10.2	9.8
Available Potassium(ppm)	312	310
Soluble Cations (meq/kg soil)		
Ca2+	10.00	9.2
Mg2+	4.00	3.3
Na+	4.70	5.2
K+	1.30	1.1
Soluble Anions, (meq/kg soil)		
Cl^-	5.70	4.4
HCO_3+ CO_3^{2-}	4.30	5.5
SO_4^{2-}	10.00	9.2
Physical Properties		
Clay %	47	46.6
Silt %	32.1	31.2
Sand %	20.9	22.2
Total $CaCO_3$	3.3	3.2

Materials and Methods

Experimental site soil characteristics and plant materials

This study was carried out at the Experimental Farm, Faculty of Agriculture, Assiut University, Assiut, Egypt, (Latitude 270°,18′ and Longitude 310°18′ ,and the Altitude 70m above sea level) during two winter seasons (2019-2020 and 2020-2021). The experiment was conducted to assess the influence of different types of foliar fertilization i.e., mineral fertilization (NPK), moringa leaf extract, humic acid and seaweed extract on yield components characteristics and

storability of onion plants (Giza 6) grown in clay soil. The soil analysis of the experimental site is illustrated in Table (1). The analysis was carried out in the soil and water Department, Faculty of Agriculture, Assiut university according to the recommendation.According to soil anaylsis results, soil texture of the experimental site was clay with an average pH of 7.6. Seeds of onion cultivar (Giza 6) were obtained from the Yosef Bebawy establishment for import and export (seed company).

Treatments and Experimental design

The treatments were foliar application with mineral fertilizers (NPK), bio-stimulants, and their combination. Untreated onion seeds were sown on the 24th and 21st of September in the two growing seasons (2019/2020 and 2020/2021), respectively. All the normal practices of onion nurseries were applied as recommended. No fertilizer was applied prior to transplanting. Transplants were selected for uniformity in size for planting. Onion seedlings were lifted and transplanted 60 days after the sowing date on the 21st and 26th of November in both growing seasons respectively. The plants were sprayed 4 times during the growing season starting 30 days after transplanting and subsequently at 15-day intervals by different treatments.

The experiment was conducted in a randomized complete-block design (RCBD) with three replications. Each experimental plot consisted of three rows. Each row was 3.5 meters long and 60 cm wide. Onion seedlings were transplanted 7 cm apart on both

Sides of the ridge.

Elven treatments were used as a foliar application.

The foliar application with mineral fertilizers (NPK) and bio-stimulants were as follows:

1- NPK 500 ppm (T1)

2- NPK 2000 ppm (T2)

3- Moringa leaf extract 5% (T3)

4- Humic acid 200 ppm (T4)

5- Seaweed extract 3% (T5),

6- NPK 500 ppm+ Moringa leaf extract 5% (T6)

7- NPK 500 ppm + Humic acid 200 ppm (T7)

8- NPK 500 ppm + Seaweed extract 3% (T8)

9- NPK 2000 ppm + Moringa leaf extract 5% (T9)

10- NPK 2000 ppm + Humic acid200 ppm (T10)

11- NPK 2000 ppm + Seaweed extract 3% (T11)

12- The control (without foliar application) treatment.

The commercial product Humic acid as Ultra Humi Max 80% compound (Potassium Humated 80% and Potassium 10%)

Table 2. The mineral contents of moringa leaf extract

Mineral contents (mg/100g.d.wt)							
Essential macro-elements					Essential micro-elements		
N (g/100g)	P	K	Mg	Ca	Fe	Cu	Zn
1.78	9.7	2.8	3.5	1.28	1.18	0.87	2.4

Table 3. Chemical composition analysis of moringa leaf extract according to Abdalla (2014)

Chemical composition	(mg/100g. d.wt)
Water	5.90
Protein	27.20
Fiber	19.20
Total sugar	38.60
Lipids	17.10
Ascorbic acid	3.26
Total carotenoids	2.24
Soluble phenols	2.24
Gibberellins	0.802
Zeatin	0.936

Preparation of Moringa Leaf Extract

Moringa leaf extract was prepared by collecting young and disease-free leaves from the Moringa tree.1 kg of Moringa leaves was air-dried under shade for two weeks and subsequently ground to reach a powder case then mixed with 1 liter ethyl alcohol (80% aq.) using a blender. The extract was purified by filtering twice through (Whatman No. 1) filter paper. After purification, the extract was subjected to a rotary evaporator to fully evaporate the alcohol and get the crude extract. The concentrations were prepared using 50 ml of the crude extract and diluted with 950 ml of distilled water for reaching the concentration of 5% (Bashir *et al.,* 2014).

The mineral content and chemical composition analysis in moringa leaf extract were summarized in Table (2) and Table (3).

Foliar spraying was carried out early in the morning. During soil preparation, 200 kg/fed superphosphate (15.5% P_2O_5) were added. Foliar application treatments were practiced 4 times at 15-day intervals. All other cultural practices including irrigation and pest control were carried out uniformly in all plots as recommended by the Egyptian Ministry of Agriculture for onion production. Irrigation was stopped 7 days before harvesting to avoid excess water accumulation in bulbs.

Data recorded

At harvesting time (the last week of April in both seasons), all onion plants in each plot were harvested and left for curing (for 15 days after harvest). to determine yield and storability traits.

Yield and its components

At harvest, shoots were removed and then random samples of 10 bulbs, each of the single-center bulbs, were taken from each plot to measure average bulb fresh weight (g) and bulb diameter (cm). All bulbs harvested from each plot were weighted to measure the total bulb yield and data were converted into bulb yield in ton/fed. Also, marketable yield (%) (healthy bulbs free from defects, injury, and normal size), cull yield (%) (misshapen bulbs). Furthermore, relative total yield (%) was calculated as follows:

$$\text{Relative total yield (\%)} = \frac{\text{Total yield of treatment}}{\text{Total yield of control}} \times 100$$

Storability

At harvest and after the curing process was done by laying the harvested bulbs on the soil surface for two weeks under shade to avoid direct exposure to the sun to dry, the sample of single and marketable bulbs yield of each plot was placed in a common burlap bag and kept under normal storage conditions for four months starting at 15th May till 15th September in the two seasons. Stored onions were inspected and stored to discard the rotted and sprouted bulbs and remained bulbs were weighted for 4 months to calculate the total weight loss% of bulbs. Total weight loss% of bulb was estimated after 30, 60, 90 and 120 days of storage according to the formula of Wills *et al*. (1982) as follows:

$$\text{Total weight loss\%} = \frac{\text{Original bulb weight} - \text{Remained bulb weight}}{\text{Original bulb weight}} \times 100$$

Statistical analysis

According to Snedecor and Cochran (1980), data were exposed to the analysis of variance (ANOVA). Based on the homogeneity of error variance. The treatment means were compared using Duncan's multiple range test at the probability of 5% level according to Duncan (1958).

Results and Discussion

Yield and its components

Effect of foliar application with different types of foliar fertilization on marketable yield (%) and cull yield (%)

Data in Table (4) cleared that, foliar application treatments affected all yield and its components attributes. Marketable yield percentage was affected by different foliar application treatments (Table 4). Moringa leaf extract 5% (T_3) treatment, seaweed extract 3% (T_5), and NPK 500 ppm+ Moringa leaf extract 5% (T_6) have a positive effect on marketable yield percentage. Marketable

yields resulted from plants treated with moringa leaf extract 5% (T_3) treatment, seaweed extract 3% (T_5), and NPK 500 ppm+ Moringa leaf extract 5% (T_6) recorded the superiority percentage of marketable yield percentage. Marketable yield percentage obtained from the previous treatments (T_3 , T_5 and T_6) were similar and greater than for other foliar application treatments and the control (without fertilizers) (Table 4).

Table.4. Effect of applying different types of foliar fertilization on marketable yield (%) and cull yield (%) of 'Giza6' onion cultivar in the growing seasons of 2019/2020 and 2020/2021

Foliar applications	Marketable yield (%)		Cull yield (%)	
	Season 1	Season 2	Season 1	Season 2
NPK 500ppm (T_1)	86.67 f	88.33 d	13.33 b	11.67 b
NPK 2000 ppm (T_2)	82.67 g	84.33 e	17.33 a	15.67 a
Moringa leaf extract 5% (T_3)	97 a	97 a	3 g	3 e
Humic acid 200 ppm (T_4)	93.67 d	94 c	6.33 d	6 c
Seaweed extracts 3% (T_5),	96.67 ab	96 ab	3.33 fg	4 de
NPK 500 ppm+ Moringa leaf extract 5% (T_6)	96 abc	97 a	4 efg	3 e
NPK 500ppm+ Humic acid 200 ppm (T_7)	95 bcd	95 bc	5 def	5 cd
NPK 500 ppm+ Seaweed extract 3% (T_8)	94.67 cd	94.67 bc	5.33 de	5.33 cd
NPK 2000ppm+ Moringa leaf extract 5% (T_9)	95 bcd	95.67 abc	5 def	4.33 cde
NPK 2000ppm+ Humic acid 200 ppm (T_{10})	94.33 cd	94 c	5.67 de	6 c
NPK 2000 ppm+ Seaweed extract 3% (T_{11})	94.33 cd	94 c	5.67 de	6 c
Control	88.67 e	89 d	11.33 c	11 b

Values having the same alphabetical letter (s) did not show a significant difference at 0.05 level of significance according to Duncan's multiple range test.

The highest marketable yield percentage resulting from T_3 and T_6 treatments may be attributed to Moringa leaf extract which contains cytokinin, phenolics, ascorbates, vitamins, and essential amino acids (Rady and Mohamed, 2015) causing enhancing in onion marketable yield. Moringa leaf extract is a useful natural extract to be used as a foliar spray to increase onion yield (Arshad Yaseenn and Maria Takacs-Hajos,2020). Many researchers indicated that, the moringa leaf extract has been used as a natural plant growth regulator in different vegetables such as tomatoes (Culver *et al.,* 2012), pepper (Matthew, 2016), and lettuce (El-saady and Omar, 2017). Natural zeatin is considered one of the active plant hormone substances in the cytokinin group found in fresh moringa leaf juice (Mohammed *et al*., 2013). On the other side, the higher marketable yield percentage resulted from T_5 treatment due to seaweed extract. Much research revealed that the usage of seaweed as foliar fertilization affects yield quality and quantity. Seaweed extract is considered organic fertilizer that affects plant growth and development (Battacharyya *et al*.,2015) and enhances yield (Dhargalkar *et al*.,2005). The enhancement of yield may be due to the content of Seaweed liquid extract from organic substances like amino acids, plant growth regulators such as auxin, cytokinin, gibberellins and trace elements (Begum *et al.,*2018) beside it considered a rich source of both micro and macro- nutrients (Shehata *et al*.,2011).

The percentage of marketable yield due to foliar application with Humic 200 ppm (T_4), NPK 500ppm+ Humic 200 ppm (T_7), NPK 2000 ppm+ Humic 200 ppm (T_{10}), NPK 500 ppm+ Seaweed extract 3% (T_8) and NPK 2000 ppm+

Seaweed extract 3% (T_{11}) treatments were intermediate**.** On the other side, the lowest percentage of marketable yields were obtained from onion fertilized by NPK 2000 ppm (T_2) as foliar application. However, there was no significant difference between marketable yield resulting from onion fertilized by NPK 500 ppm (T_1) as a foliar application and control treatments in the first season.

According to the Cull yields percentage parameter, data illustrated in Table 4 showed that cull yield is affected by foliar application treatments. Foliar application with NPK 2000 ppm (T_2) gave the highest cull yield . Cull yield due to foliar application with seaweed extract 3% (T_5) or NPK 500 ppm+ Moringa leaf extract 5% (T_6) treatment recorded the lowest value.

Effect of applying different types of foliar fertilization on average bulb fresh weight (g) and bulb diameter (cm).

Data in Table (5) indicated that there was a significant difference among the twelve fertilization treatments for average bulb weight in both seasons. The highest means of bulb weight i.e., (102.87 and 99.97 g) were obtained from treatment of NPK 2000 ppm + Moringa leaf extract 5% (T_9) treatment in both seasons respectively. While the lowest average bulb fresh weight (69.60 and 70.50) was recorded under no fertilization (control) treatment, in the first and second seasons, respectively. NPK 500 ppm (T_1) and NPK 2000ppm (T_2) gave higher bulb weight than the control treatment but lower than the bio- fertilizer treatments (Table 5). This result reflects the role of moringa leaf extract in encouraging crop growth and increasing the weight of bulbs, this result was in line with that found by Battacharyya *et al*., 2015 who reported that moringa leaf extract contains nutrients that affect plant growth and development. Also, Fuglie, 2000 deduces that moringa leaf extract promotes the growth of young plants and increases leaf area, and that help in an increase in yield.

Table 5. Effect of applying different types of foliar fertilization on average bulb fresh weight (g) and bulb diameter (cm) of 'Giza6' onion cultivar in the growing seasons of 2019/2020 and 2020/2021

Foliar applications	Average bulb fresh weight (g)		bulb diameter (cm)	
	Season 1	Season 2	Season 1	Season 2
NPK 500ppm (T_1)	75.87 e	75.8 d	4.83 ef	4.87 c
NPK 2000 ppm (T_2)	82.53 d	80.47 d	5.33 de	5.1 c
Moringa leaf extract 5% (T_3)	95.87 be	95.87 ab	6.43 be	6.37 a
Humic acid 200 ppm (T_4)	91.67 c	93.53 b	6.13 c	6.27 a
Seaweed extract 3% (T_5),	83.93 d	86.47 c	5.6 d	5.77 b
NPK 500 ppm+ Moringa leaf extract 5% (T_6)	97.87 ab	96.07 ab	6.53 abc	6.43 a
NPK 500ppm+ Humic acid 200 ppm (T_7)	94.6 bc	96.53 ab	6.47 abc	6.5 a
NPK 500 ppm+ Seaweed extract 3% (T_8)	95.53 bc	93.53 b	6.37 bc	6.27 a
NPK 2000ppm+ Moringa leaf extract 5% (T_9)	102.87 a	99.97 a	6.9 a	6.67 a
NPK 2000ppm+ Humic acid 200 ppm (T_{10})	99.23 ab	98.7 ab	6.67 ab	6.56 a
NPK 2000 ppm+ Seaweed extract3% (T_{11})	97.6 ab	96.2 ab	6.57 abc	6.5 a
Control	69.6 f	70.5 e	4.67 f	4.8 c

Values having the same alphabetical letter(s) did not show a significant difference at 0.05 level of significance according to Duncan's multiple range test.

Regarding the bulb diameter parameter, data presented in (Table 5) showed that the bulb diameter was affected by different types of foliar fertilization treatments. The foliar application of different bio-stimulants as used alone or in combination with mineral fertilizer treatments led to higher bulb diameter than control (T_{12}) or than mineral fertilizers (T_1 and T_2) treatments. Also, onion plants fertilized with moringa leaf extract 5% (T_3) or humic 200 ppm (T4) treatments as foliar application gave significantly higher bulb diameter than seaweed 3% (T5) treatment in both seasons (Table 5). However, in the second season, NPK 2000ppm (T_2) gave a higher bulb diameter than T_1 or the control treatment (Table 5).

Effect of applying different types of foliar fertilization on total yield (ton/fed.) and relative total yield (%)

Data in Table (6) revealed that Fertilization treatments significantly affected total yield in both seasons. Foliar application with NPK 2000 ppm + Moringa leaf extract 5% (T_9) treatment surpassed the other treatment and recorded the highest value (7.583 and 7.383 ton/fed) in total yield parameter in both seasons respectively. These results are in agreement with those results obtained by Jason, 2013, who reported that foliar application with moringa leaf extract solution increases yields by 25 to 30% for nearly any crop as moringa leaf extract contains plant growth hormone, called zeatin as a cytokinin that causes the increment of yield. Also, the moringa leaf extract is used as a plant bio-stimulant as it rich in phyto-hormones such as indole-3-acetic acid (IAA) and gibberellins (GAs) Yasmeen *et al*., 2013 and Rehman *et al.,* 2014). In our study, the relative total yield (%) when applied NPK 2000 ppm + Moringa leaf extract 5% (T_9) treatment as foliar application increased yields by 40.66% and 47.66% in the two seasons respectively (Table 6). The presence of cytokinin in moringa leaf extract induces cytokinin biosynthesis led to healthy plant growth and also maintains a higher leaf area for photosynthetic activity (Rady *et al*., 2015). Many investigators on different crops revealed that foliar application of moringa leaf extract has a positive effect on yields such as soya beans, sorghum and tomato (Palada, 1996). Also, Caceres (1999) deduced that moringa leaf extract enhances growth and yield as it contains a high level of elements and hormone

Foliar application with humic 200 ppm also affects the total yield (Table 6). Foliar application with humic acid led to an increase in the growth and yields of various vegetables (Zandonadi *et al*., 2007), Humic acid has several benefits to plants such as enhancing nutrient uptake of vegetable crops (Cimrin and Yilmaz, 2005; Zandonadi *et al*., 2007), control hormone levels as it acts as growth regulators and it also enhance photosynthesis and cell elongation (Serenella *et al.,* 2002).

Table 6. Effect of applying different types of foliar fertilization on total yield (ton/fed.) and relative total yield (%) of 'Giza6' onion cultivar in the growing seasons of 2019/2020 and 2020/202

Foliar applications	Total yield (ton/fed.)		Relative total yield (%)	
	Season 1	Season 2	Season 1	Season 2
NPK 500ppm (T_1)	5.588 e	5.564 ef	105.67 de	109 e
NPK 2000 ppm (T_2)	6.06 a	5.897 e	112.67 d	118.33 d
Moringa leaf extract 5% (T_3)	7.057 bc	7.063 abc	134.67 ab	137.67 bc
Humic acid 200 ppm (T_4)	6.64 bc	6.85 c	130.67 b	131.33 bc
Seaweed extract 3% (T_5),	6.17 d	6.377 d	121.33 c	120.67 d
NPK 500 ppm+ Moringa leaf extract 5% (T_6)	7.207 ab	7.077 abc	135 ab	140.67 ab
NPK 500ppm+ Humic acid 200 ppm (T_7)	6.93 bc	7.162 abc	136.33 ab	135.33 bc
NPK 500 ppm+ Seaweed extract 3% (T_8)	7.043 bc	6.903 bc	131.33 b	137.33 bc
NPK 2000ppm+ Moringa leaf extract 5% (T_9)	7.583 a	7.383 a	140.67 a	147.67 a
NPK 2000ppm+ Humic acid 200 ppm (T_{10})	7.327 ab	7.233 ab	137.67 ab	143 ab
NPK 2000 ppm+ Seaweed extract 3% (T_{11})	7.4 ab	7.103 abc	135 ab	140.33 ab
Control	5.14 f	5.267 f	100 e	100 f

Values having the same alphabetical letter (s) did not show a significant difference at 0.05 level of significance according to Duncan's multiple range test.

In general, foliar application with bio-stimulants alone or in combination with mineral fertilizers gave a higher total yield than foliar application by mineral fertilizers in the two seasons (Table 6). The increment in total yield which is attributed to applying bio-stimulants plus minerals may be due to both more balanced C/N ratio, hence, encouraging metabolic activities in the plant. Also, this may be due to an increase in plant photosynthesis accumulation and plant photosynthesis rates, which led to an increase in total yield. Asimilar result was obtained by Geries, *et al.,* (2012); Mouna *et al*., (2013) and Rizk *et al*., (2014). They recorded the highest onion bulb yield which was obtained by the combination of organic with inorganic fertilizers compared with mineral fertilizers alone. Foliar application with NPK 2000 ppm (T1) treatment gave a higher total yield than a foliar application with NPK 500 ppm (T2) treatment however, the difference between them was not significant in the second season (Table 6). On the other hand, the control (T_{12}) treatment recorded the lowest total yield (5.14 and 5.267 ton/fed.) in the two seasons respectively.

Storability

Weight loss is the most important factor in the shelf life of vegetable crops (Shehata *et al*., 2019). As shown in Fig.1 and 2, weight loss was affected by storage period and treatments. For all treatments, as expected, the weight loss increased during the storage period. Data presented in Fig.1 indicated significant differences among the twelve fertilization treatments for total weight loss % in both seasons. The highest means of total weight loss % after four months were obtained when fertilized with NPK 2000 ppm (T_2) as a foliar application (33.12 % and 30.26 %) in the two seasons respectively during storage periods compared with the other treatments . The same trend was found by Marey, (2009); Geries *et al*., (2012) and Morsy *et al*., (2012), who reported that extensive application especially of nitrogen fertilizers causes maximum total weight loss percentages of onion bulbs. Also, Mozumder *et al*. (2007) indicated that excessive nitrogen caused rapid deterioration and weight loss of bulbs during storage at ambient

temperature. While the lowest means of total loss % were from onion bulb resulted from foliar application of NPK 2000ppm+ Moringa leaf extract 5% (T_9) that recorded (27 % and 23.6 %) of weight loss percentage after four months in the two seasons respectively without significant difference between them. these results were in both seasons. Similar results were obtained by Kandil *et al.* (2013)

From the results of this investigation, it was found that a combination of bio- stimulants and mineral fertilizers (NPK 2000ppm+ Moringa leaf extract 5% (T_9)) achieve proper growth and production of onion and could give profitable yield in onion cultivation.

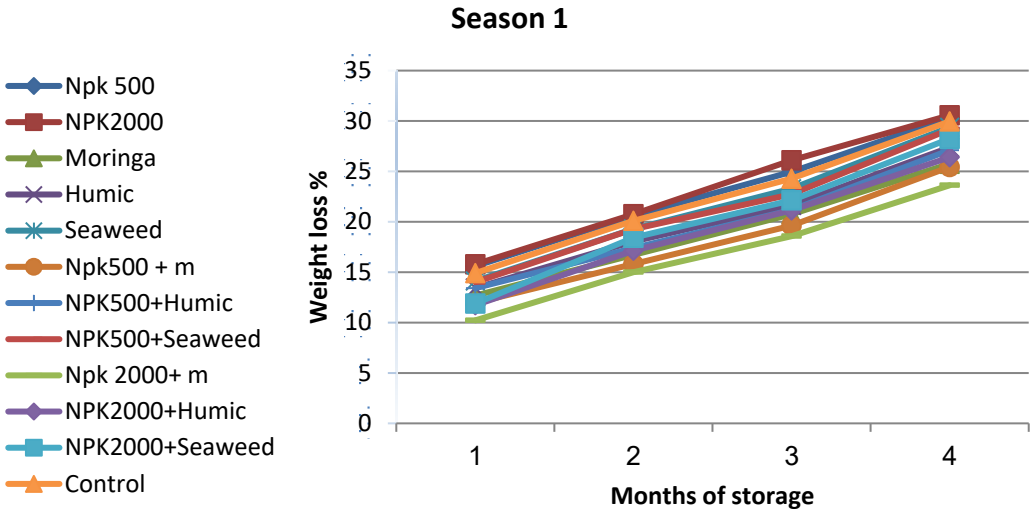

Fig. 1. Weight loss (%)after 0, 1, 2,3 and 4 months of storage affected by treatment and months of storage in season 2019/2020

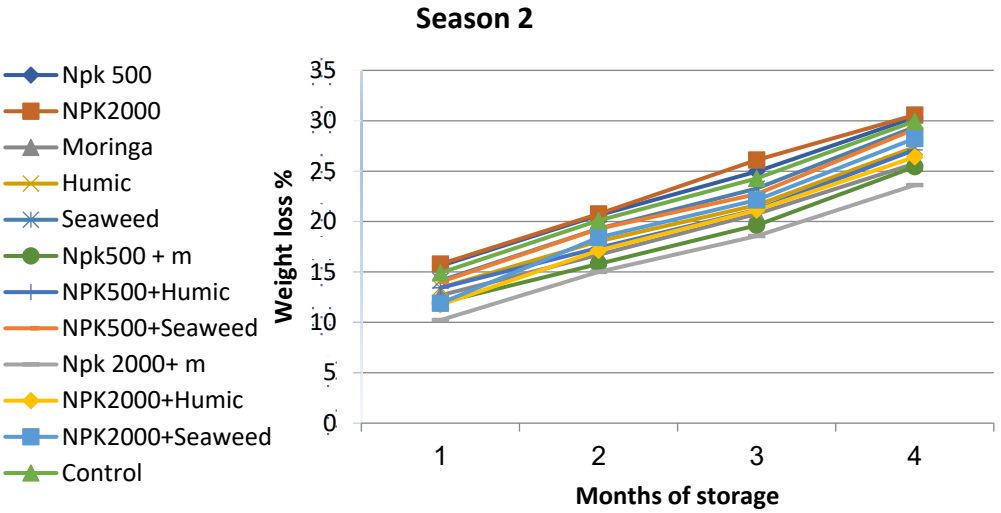

Fig. 2. Weight loss (%)after 0, 1, 2,3 and 4 months of storage affected by treatment and months of storage in season 2020/2021

Conclusion

These results suggest that fertilization of onion plants cv. Giza 6 with (NPK 2000ppm+ Moringa leaf extract 5%. increased yield and improved bulb storability. For that, it can recommend that foliar application with bio-stimulants alone or in combination with mineral fertilizers enhance yield and improve storability than the foliar application by mineral fertilizers alone.

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التسميد الورقي بمستخلص اوراق المورينجا والهيوميك والطحالب البحرية والاسمدة المعدنية يؤثر على الانتاجية والقدرة التخزينية في محصول البصل

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الملخص

أجريت التجربة في المزرعة البحثية بكلية الزراعة جامعة اسيوط خلال موسمي 2020/2019 و2021/2020م لتقييم استجابة البصل صنف جيزة 6 لبعض الأسمدة الورقية مثل مستخلص اوراق المورينجا والهيوميك والطحالب البحرية والاسمدة المعدنية بالإضافة إلى معاملة المقارنة (بدون تسميد) وتأثيرها على المحصول ومكوناته وكذلك القدرة التخزينية للبصل، وتم الرش 4 مرات خلال موسم النمو. بعد الحصاد تم تخزين البصل لمدة 4 أشهر.

أظهرت النتائج التي تم الحصول عليها الى وجود اختلافات معنوية في صفات المحصول ومكوناته والقدرة التخزينية لمحصول البصل نتيجة لتطبيق معاملات التسميد المختلفة. ادى التسميد الورقي لنباتات البصل باستخدام NPK بتركيز 2000 جزء في المليون مع مستخلص اوراق المورينجا 5% الى زيادة متوسط وزن البصلة، فسجلت 102.87 و99.97 جرام في الموسمين على التوالي، بينما كان اقل متوسط وزن طازج للبصلة في معاملة الكنترول (بدون تسميد). ايضا كان لكل من معاملة التسميد الورقي باستخدام مستخلص اوراق المورينجا 5%، معاملة التسميد بمستخلص الطحالب البحرية3%، NPK بتركيز2000 جزء في المليون مع مستخلص اوراق المورينجا 5% تأثير إيجابي على النسبة المئوية للمحصول القابل للتسويق.

اما بالنسبة للنسبة المئوية للفقد في الوزن للبصل نتيجة التخزين فأظهرت النتائج ان اقل نسبة مئوية للفقد في الوزن تم الحصول عليها بعد 4 أشهر تخزين هي عند التسميد باستخدامNPK بتركيز 2000 جزء في المليون مع مستخلص اوراق المورينجا 5% فكانت نسبة الفقد 27%، 23.6% في الموسمين على التوالي، بينما اعلى نسبة فقد كانت باستخدام التسميد المعدني بمفرده NPKبتركيز 2000 جزء في المليون.

ونستنتج من هذه الدراسة، ان الرش الورقي استخدام NPK بتركيز2000 جزء في المليون مع مستخلص اوراق المورينجا 5% كان أكثر فاعلية في تحسين المحصول وقدرته التخزينية في صنف البصل جيزة 6.