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# ONION YIELD AS AFFECTED BY FOLIAR APPLICATION WITH AMINO AND HUMIC ACIDS UNDER NITROGEN FERTILIZER LEVELS

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**A B S T R A C T**

In order to investigate the effect of nutrient foliar spraying such as amino and humic acids under nitrogen fertilizer levels on growth, yield and keeping quality of onion bulbs cv. Giza 20. Two field experiments were conducted at Gemmeiza Agriculture Research Station Farm, Gharbeia Governorate, Agriculture Research Center, during 2010/2011 and 2011/2012 seasons. The obtained results showed that foliar spraying with humic acid resulted in highest growth characters, total and marketable yields, total culls and bulb weight as well as TSS %, dry matter and total weight loss percentages at storage period compared with the control treatment. Increasing nitrogen fertilizer levels up to 214.2 kg N/ha significantly increased growth characters, total and marketable yields, total culls and bulb weight as well as total weight loss percentages at storage period. In addition, fertilization with 71.4 kg N/ha significantly increased TSS and dry matter percentages. It could be recommended that spraying with humic acid and adding 214.2 kg N/ha maximize onion bulb yield under the environmental conditions of Gharbeia Governorate. The interaction between nutrients spraying and nitrogen fertilizer levels significantly affected foliage fresh weight, total weight loss % after 1, 2, 3 and 5 months.

**Keywords**: Onion, foliar fertilization, amino acids, humic acids, nitrogen fertilizer levels.

## INTRODUCTION

In Egypt onion (*Allium cepa* L.) is one of the most important crops on account of its valued for local consumption and exportation commodity. It ranks third in this aspect after rice and citrus. For more yield farmers used increases in nitrogen fertilizer to produce quick results in onion field, but the excessive and uncontrolled use of this synthetic fertilizer can lead to serious water pollution and harm to humans. Using foliar nutrients is being considered as one of various techniques to improve fertilizer efficiency in order to increase productivity and improve quality of crop production (Romheld and El-Fouly, 1999). It can improve nutrient utilization and lower environmental pollution through reducing the amount of fertilizer added to the soil (Abou El-Nour, 2002). Amino acids are a well-known bio-stimulant which has positive effects on plant growth, yield and significantly mitigates the injuries caused by abiotic stresses (Kowalczyk and Zielony, 2008). Tugnoli and Bettini (2003) concluded that use of amino acids as foliar spraying makes it overcome the nutritional and environmental deficiencies that arise during the crop growth. Humic acid have many beneficial effects on soil structure and soil microbial populations as well as increase modify mechanisms involved plant growth stimulation (Lee and Bartlett, 1976), cell permeability (Vaughan and Ord, 1985) and nutrient uptake (Akinremi *et al*., 2000). It produce various morphological, physiological and biochemical effects on higher plants (Chen and Aviad, 1990 and Nardi *et al.*, 2002). It provide plant and soil with essential nutrients, vitamins and trace elements to improve plant growth, yield and its quality in various crops (Ayuso *et al*., 1996). Recently, foliar application of humic acid stimulates growth, yield and its quality (Brownell *et al.*, 1987). Geries (2013) revealed that foliar spraying of onion plants with humic acid markedly increased vegetative growth, bulb yield and its attributes, onion quality and chemical composition.

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Woldetsadik (2003) found that nitrogen fertilization promoted vegetative growth and exposed plants to soil moisture stresses ahead of maturity and, thus reduced yield of rainfed shallots. Katung *et al.* (2005) found that higher dose of nitrogen increased marketable yield (10 t/ha) and significantly reduced loss after 5 months of storage by 19.96% in 2002 and 37.12% during 2003. El-Desuki *et al.* (2006) showed that total bulbs yield, marketable yield, unmarketable yield and bulb quality were gradually increased with increasing level of NPK-fertilizers from 40, 70 up to 100% of the recommended dose of fertilization. Total marketable fresh onion yield increased with increasing N rate Halvorson *et al.,* (2006) . Total marketable fresh onion yield increased with increasing nitrogen rate from 0 to 224 kg N/ha *Halvorson et al.,* (2007). Sangeetha and Singaram (2007) showed that combined application of recommended dose of inorganic fertilizers (60:60:30 kg NPK $ha^{-1}$) and humic acid at 20 kg $ha^{-1}$ significantly increased plant height, number of leaves/plant and root length of onion. Combined application of lignite humic acid at 20 kg $ha^{-1}$ and recommended dose of inorganic fertilizers had conspicuously increased (11.31 %) of bulb yield over inorganic fertilizers alone. Geries (2013) showed that increasing nitrogen rate from 50% to 100% of recommended dose (60 up to 120 kg N/fed) significantly increased plant height, plant fresh and dry weight, number of leaves/plant and bulb diameter at 120 days after transplanting.

This study was conducted to elucidate the effect of foliar spraying with amino and humic acids under different of nitrogen fertilizer levels and their iteration effect on growth, yield and attribute, quality as well as storage ability under Gharbeia Governorate condition, Egypt.

**MATERIAL AND METHODS**

Two field experiments were conducted at Gemmeiza Agriculture Research Station Farm, Gharbeia Governorate, Agriculture Research Center, during two seasons of 2010/2011 and 2011/2012. The objectives of this investigation were aimed to study the effect of foliar spraying with amino or humic acids under nitrogen fertilizer levels on growth, yield and keeping quality of onion bulbs. Seeds of Giza 20 variety were obtained from Onion Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt.

The experiments were carried out in split plot design with four replications. The main plots were occupied with the following three foliar spraying treatments; without spraying (control treatment), spraying with amino acids in the form of Amino Power fertilizer at the rate of 4.76 liter/ha twice after 60 and 80 days from transplanting and spraying with humic acid in form of Humic fertilizer at the rate of 4.76 liter/ha twice after 60 and 80 days from transplanting.

Amino-Power® fertilizer was obtained from Union For Agriculture Development Co. Amino-Power is consider as natural growth promoter, which contains free amino acids in a form of Levogire "L-Amino Acids" (Glycin, Seriocin, Glutamic, Valin, Broline, Hydroxy broline, Methionine iso lucin, lucin, Phenyl, Alanine, Serine, Asparatic, Arginine, Hydroxy Lysine and Hestedine) in addition, microelements (Fe 1500 ppm, Zn 500 ppm and Mn 500 ppm) and citric acid (3.5 % potassium citrate). Uni Humic® fertilizer was obtained also from Union For Agriculture Development Co. Humic is extracted from natural resources by organic method and contains high quality humic acid in liquid form (18.5 %), fulvic acids (1.5 %), Fe (1 %), Zn (0.5 %) and Mn (0.5 %).

The sub-plots were assigned to nitrogen fertilizer levels i.e. (71.4, 142.8 and 214.2 kg N/ha).

The soil of the experimental sites was clayey, pH was 7.87 and 8.00, available nitrogen was 40.12 and 51.33 ppm, available phosphate was 3.36 and 4.44 ppm and exchangeable potassium was 299.1 and 315.2 ppm in both seasons, respectively as determined by Page (1982). The preceding crop was maize (*Zea mays* L.) in both seasons. Land preparation, transplanting and crop management, all agronomic practices and treatments, except both studied factors, were uniformly applied to plants in the nursery and permanent land, as normally done by farmers in their fields of the experimental location. Each plot area was 10.5 $m^2$, which consisted of 5 ridges, each of 3.5 m in length and 60 cm in width.

Nitrogen fertilizer levels were applied as previously mentioned rates. All dose of phosphorus as calcium superphosphate (15.5 % $P_2O_5$) was applied after dividing and before transplanting. Only half dose of nitrogen in the form of Ammonium sulphate (20.5 % N) and potassium sulphate (48 % $K_2O$) were applied after transplanting immediately and before irrigation. The other rest half of nitrogen and potassium was applied before the first irrigation. Transplanting took place during the first week of January, which seedlings were handy transplanted on both sides of ridges. The top portion of the transplants was pruned to a considerable extent, immediately before transplanting, for reducing

transpiration. Seedlings were irrigated immediately after transplanting and afterwards, irrigation treatments were given as the aforementioned irrigation schemes.

After 90 and 120 days from transplanting ten plants were selected at random from every sub-plot to record plant height, number of leaves/plant, foliage fresh weight per plant and bulbing ratio.At harvest time ten guarded plants were chosen at random from the outer ridges of each plot to determine the following characters: bulb weight (g), total soluble solids (TSS) in bulbs (%) and bulb dry matter (%). Total bulbs yield (t/ha), marketable bulbs yield (t/ha) and culls bulbs yield (t/ha) were determined by harvesting the two middles rows per plot in kg and then converted to t/ha.

Marketable yield of each plot were placed in common burlap bags and kept under normal storage conditions. Storability was measured as percentage of total loss in weight of bulbs during storage period (five months). Total soluble solids (TSS) and bulb dry matter percentages in bulbs were determined during storage period. Total loss percentage was determined by examining the yield every month, then rotting and sprouting bulbs were discarded and the remaining yield was weighted. All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split – plot design as published by Gomez and Gomez (1984) by using "MSTAT-C" computer software package. Least Significant of Difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by Snedecor and Cochran (1980).

**RESULTS AND DISCUSSION**

**Effect of nutrients foliar spraying:** Foliar spraying of nutrients on onion growth characters significantly affected plant height, number of leaves/plant, foliage fresh weight per plant and bulbing ratio at 90 and 120 days from transplanting, except number of leaves/plant at 90 days from transplanting in the first seasons only as shown from in Table 1. It could be observed that foliar spraying of humic acid in the form of Uni Humic fertilizer at the rate of 4.76 liter/ha twice after 60 and 80 days from transplanting produced enhanced growth characters. Followed by spraying of amino acids in the form of Amino Power fertilizer at the rate of 4.76 liter/ha twice after 60 and 80 days from transplanting. Lowest growth characters were resulted from of the control treatment at both samples in both seasons. Increases in onion growth characters by spraying 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 (Hartwigsen and Evans, 2000 and Canellas *et al*., 2002). The positive effect of humic on plant growth and productivity, which seem to be mainly due to hormone-like activities of the humic acids through their involvement in cell respiration, photosynthesis, oxidative phosphorylation, protein synthesis and various enzymatic reactions (Muscolo *et al.*, 1999). The positive 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. These results were parallel with those reported by El-Nemr *et al*. (2012) and Geries (2013). There was significant effect on total and marketable yields, total culls, bulb weight at harvesting, TSS % (at harvesting, after 2, 3, 4 and 5 months), dry matter % and total weight loss % on onion bulbs due to foliar spraying treatments as presented in Tables 2, 3, 4 and 5. From obtained results it could be observed that, foliar spraying of humic acid in the form of Uni Humic fertilizer at the rate of 4.76 liter/ha twice after 60 and 80 days from transplanting led to enhance onion growth, subsequently produced highest means of previously mentioned characters in both seasons. It was followed by spraying with amino acids in the form of Amino Power fertilizer at the rate of 4.76 liter/ha twice after 60 and 80 days from transplanting in both seasons. On the other side, the lowest of these characters were resulted from plants growing without foliar spraying in both seasons. The favorable effect of humic acid might have been due to the effective role in improvement early onion growth, more dry matter accumulation and stimulated the building of metabolic products that translocated to bulbs (Muscolo *et al*, 1999 and Hartwigsen and Evans 2000). These findings are coincidence with those recorded by Ayuso *et al.* (1996), Tugnoli and Bettini (2003) and Geries (2013).

**Effect of nitrogen fertilizer levels:** Results revealed that nitrogen fertilizer levels significantly affected growth characters *i.e.* plant height, number of leaves/plant, foliage fresh weight per plant and bulbing ratio at 90 and 120 days from transplanting as shown in Table 1.

Table 1: Averages of plant height, number of leaves/plant, foliage fresh weight per plant and bulbing ratio at 90 and 120 days from transplanting (DFT) as affected by foliar fertilization treatments and nitrogen fertilizer during 2010/2011 and 2011/2012 seasons.

| **Treatments Characters** | **Plant height (cm)** | | | | **Number of leaves/plant** | | | | **Foliage fresh weight (g/plant)** | | | | **Bulbing ratio** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seasons | **2010/2011** | | **2011/2012** | | **2010/2011** | | **2011/2012** | | **2010/2011** | | **2011/2012** | | **2010/2011** | | **2011/2012** | |
| **Sampling times** | 90 | 120 | 90 | 120 | 90 | 120 | 90 | 120 | 90 | 120 | 90 | 120 | 90 | 120 | 90 | 120 |
| ***A:* Foliar fertilization *treatments*** | | | | | | | | | | | | | | | | |
| Without | 79.03 | 59.45 | 75.46 | 41.75 | 10.55 | 8.98 | 8.09 | 7.55 | 189.6 | 211.3 | 121.7 | 157.4 | 2.20 | 3.70 | 1.94 | 3.40 |
| Amino acids | 80.98 | 59.98 | 76.14 | 44.53 | 10.61 | 9.25 | 8.39 | 7.97 | 194.3 | 217.7 | 129.1 | 161.7 | 2.26 | 3.86 | 2.01 | 3.51 |
| Humic acid | 81.75 | 60.41 | 77.40 | 46.97 | 10.70 | 9.31 | 8.61 | 8.20 | 197.3 | 223.3 | 135.8 | 167.9 | 2.36 | 4.00 | 2.08 | 3.60 |
| F. test | * | * | * | * | NS | * | * | * | * | * | * | * | * | * | * | * |
| LSD at 5% | 1.07 | 0.80 | 1.37 | 1.72 | - | 0.24 | 0.20 | 0.25 | 4.6 | 5.6 | 2.9 | 3.0 | 0.13 | 0.20 | 0.11 | 0.15 |
| ***B: Nitrogen fertilizer levels*** | | | | | | | | | | | | | | | | |
| 71.4 kg N/ha | 78.43 | 58.25 | 74.39 | 40.55 | 10.11 | 8.71 | 8.01 | 7.39 | 183.3 | 203.4 | 118.8 | 151.4 | 2.06 | 3.46 | 1.92 | 3.35 |
| 142.8 kg N/ha | 81.28 | 60.23 | 76.45 | 43.30 | 10.70 | 9.12 | 8.42 | 7.94 | 193.6 | 220.3 | 129.3 | 164.3 | 2.26 | 3.76 | 1.99 | 3.49 |
| 214.2 kg N/ha | 82.05 | 61.36 | 78.16 | 49.40 | 11.05 | 9.70 | 8.65 | 8.39 | 204.3 | 228.6 | 138.4 | 171.3 | 2.50 | 4.33 | 2.12 | 3.67 |
| F. test | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * |
| LSD at 5% | 1.58 | 1.56 | 1.92 | 2.25 | 0.42 | 0.23 | 0.21 | 0.28 | 4.8 | 5.4 | 2.3 | 3.8 | 0.16 | 0.15 | 0.10 | 0.16 |
| ***C: Interaction*** | | | | | | | | | | | | | | | | |
| A×B | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | * | NS | NS | NS | NS | NS |

N. S.= Not significant, *= significant at 5%, **= significant at 1%

It could be stated that all studied growth characters significantly increased as increasing nitrogen fertilizer levels from 71.4 to 142.8 and 214.2 kg N/ha and the differences between them were obvious over both seasons. Application highest level of nitrogen fertilizer (214.2 kg N/ha) produced highest growth parameters at 90 and 120 days from transplanting in both seasons. Fertilizing onion plants with 142.8 kg N/ha came in the second rank after fertilizing with 214.2 kg N/ha with respect to these characters. However, lowest all growth traits were produced from fertilizing with 71.4 kg N/ha at 90 and 120 days from transplanting in both seasons. The increase in growth characters associated with increasing nitrogen fertilization may be attributed to the role of nitrogen in improving the color, vigor of the leaf canopy, meristematic activity which contributes to the increase in number of cells and cell elongation, consequently increasing the vegetative growth of onion (Woldetsadik, 2003). These results are in harmony with those recorded by Sangeetha and Singaram (2007) and Geries (2013).

Results in Tables 2, 3, 4 and 5 showed that total and marketable yields, total culls, bulb weight, TSS %, dry matter % and total weight loss % were significantly affected by nitrogen fertilizer levels. There were substantial differences in bulb yields and its attributes and bulb quality as well as storability among various studied nitrogen fertilizer levels in both seasons. Application of 214.2 kg N/ha produced highest total and marketable yields, total culls, bulb weight and total weight loss %, while resulted in the lowest TSS % and dry matter percentages in both seasons. However, using 71.4 kg N/ha was accompanied with least in total and marketable yields, total culls, bulb weight and total weight loss % and highest TSS % and dry matter percentages in both seasons.

Table 2: Averages of total yield, marketable yield, total culls and bulb weight at harvesting as affected by foliar fertilization treatments and nitrogen fertilizer levels during 2010/2011 and 2011/2012 seasons.

| Treatments Characters | Total yield (t/ha) | | Marketable yield (t/ha) | | Total culls (t/ha) | | Bulb weight (g) | |
|---|---|---|---|---|---|---|---|---|
| Seasons | 2010/2011 | 2011/2012 | 2010/2011 | 2011/2012 | 2010/2011 | 2011/2012 | 2010/2011 | 2011/2012 |
| **A: Foliar fertilization treatments** | | | | | | | | |
| Without | 38.46 | 34.91 | 28.46 | 26.08 | 9.97 | 8.78 | 125.2 | 114.9 |
| Amino acids | 40.13 | 35.72 | 29.82 | 26.58 | 10.19 | 9.12 | 126.1 | 118.4 |
| Humic acid | 40.22 | 36.68 | 29.92 | 27.23 | 10.40 | 9.45 | 132.0 | 119.1 |
| F. test | * | * | * | * | * | * | * | * |
| LSD at 5% | 0.98 | 0.88 | 0.86 | 0.83 | 0.31 | 0.19 | 4.0 | 3.9 |
| **B: Nitrogen fertilizer levels** | | | | | | | | |
| 71.4 kg N/ha | 37.13 | 34.25 | 27.82 | 25.70 | 9.31 | 8.54 | 115.5 | 107.09 |
| 142.8 kg N/ha | 39.41 | 35.89 | 29.08 | 26.75 | 10.33 | 9.12 | 122.7 | 117.94 |
| 214.2 kg N/ha | 42.25 | 37.18 | 31.30 | 27.47 | 10.92 | 9.71 | 145.1 | 127.59 |
| F. test | * | * | * | * | * | * | * | * |
| LSD at 5% | 1.00 | 0.81 | 1.24 | 0.90 | 0.26 | 0.17 | 6.1 | 4.2 |
| **C: Interaction** | | | | | | | | |
| A×B | NS | NS | NS | NS | NS | NS | NS | NS |

N. S.= Not significant, *= significant at 5%, **= significant at 1%.

Table 3: Averages of total soluble solids (TSS) in bulbs at harvesting and every month after harvesting till end of storability as affected by foliar fertilization treatments and nitrogen fertilizer levels during 2010/2011 and 2011/2012 seasons.

| Treatments Characters | Total soluble solids (TSS %) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | At harvesting | | After 1 month | | After 2 months | | After 3 months | | After 4 months | | After 5 months | |
| Seasons | 2010/2011 | 2011/2012 | 2010/2011 | 2011/2012 | 2010/2011 | 2011/2012 | 2010/2011 | 2011/2012 | 2010/2011 | 2011/2012 | 2010/2011 | 2011/2012 |
| ***A: Foliar fertilization treatments*** | | | | | | | | | | | | |
| Without | 11.95 | 11.40 | 12.45 | 11.70 | 12.70 | 12.00 | 13.02 | 12.36 | 13.30 | 12.47 | 13.63 | 12.80 |
| Amino acids | 12.07 | 11.56 | 12.53 | 11.81 | 12.75 | 12.20 | 13.15 | 12.47 | 13.46 | 12.70 | 13.76 | 13.03 |
| Humic acid | 12.18 | 11.89 | 12.60 | 11.93 | 12.81 | 12.35 | 13.24 | 12.55 | 13.66 | 12.84 | 13.93 | 13.13 |
| F. test | * | * | NS | NS | NS | * | * | * | * | * | * | * |
| LSD at 5% | 0.15 | 0.18 | - | - | - | 0.24 | 0.10 | 0.13 | 0.19 | 0.20 | 0.19 | 0.23 |

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| Treatments Characters | Total soluble solids (TSS %) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | At harvesting | | After 1 month | | After 2 months | | After 3 months | | After 4 months | | After 5 months | |
| Seasons | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** |
| ***B: Nitrogen fertilizer levels*** | | | | | | | | | | | | |
| 71.4 kg N/ha | 12.25 | 11.93 | 12.65 | 12.00 | 12.94 | 12.37 | 13.41 | 12.65 | 13.60 | 12.90 | 13.96 | 13.20 |
| 142.8 kg N/ha | 12.03 | 11.63 | 12.61 | 11.78 | 12.75 | 12.23 | 13.10 | 12.59 | 13.50 | 12.65 | 13.76 | 12.96 |
| 214.2 kg N/ha | 11.92 | 11.29 | 12.32 | 11.66 | 12.57 | 11.95 | 12.89 | 12.15 | 13.33 | 12.46 | 13.60 | 12.80 |
| F. test | * | * | * | * | * | * | * | * | NS | NS | * | * |
| LSD at 5% | 0.14 | 0.16 | 0.18 | 0.22 | 0.15 | 0.18 | 0.14 | 0.24 | - | - | 0.20 | 0.25 |
| ***C: Interaction*** | | | | | | | | | | | | |
| A×B | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

N. S.= Not significant, *= significant at 5%, **= significant at 1%.

Table 4: Averages of dry matter percentage in bulbs at harvesting and every month after harvesting till end of storability as affected by foliar fertilization treatments and nitrogen fertilizer levels during 2010/2011 and 2011/2012 seasons.

| Treatments Characters | Dry matter (%) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | At harvesting | | After 1 month | | After 2 months | | After 3 months | | After 4 months | | After 5 months | |
| Seasons | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** | **2010/ 2011** | **2011/ 2012** |
| **A: Foliar fertilization treatments** | | | | | | | | | | | | |
| Without | 14.75 | 14.20 | 15.54 | 14.50 | 16.66 | 15.29 | 17.62 | 15.54 | 18.33 | 16.12 | 18.95 | 16.79 |
| Amino acids | 15.29 | 14.37 | 16.00 | 14.70 | 16.95 | 15.62 | 17.95 | 16.00 | 18.54 | 16.54 | 19.16 | 17.16 |
| Humic acid | 15.87 | 14.75 | 16.58 | 14.87 | 17.41 | 15.95 | 18.20 | 16.12 | 18.83 | 16.70 | 19.50 | 17.54 |
| F. test | * | * | * | NS | * | NS | NS | NS | NS | NS | NS | NS |
| LSD at 5% | 0.38 | 0.27 | 0.63 | - | 0.56 | - | - | - | - | - | - | - |
| **B: Nitrogen fertilizer levels** | | | | | | | | | | | | |
| 71.4 kg N/ha | 16.37 | 14.83 | 16.75 | 15.04 | 17.75 | 15.91 | 18.62 | 16.20 | 19.20 | 16.95 | 19.75 | 17.58 |
| 142.8 kg N/ha | 15.50 | 14.41 | 16.00 | 14.54 | 16.95 | 15.79 | 17.87 | 16.00 | 18.58 | 16.41 | 19.33 | 17.20 |
| 214.2 kg N/ha | 14.04 | 14.08 | 15.37 | 14.50 | 16.33 | 15.16 | 17.29 | 15.45 | 17.91 | 16.00 | 18.54 | 16.70 |
| F. test | * | * | * | NS | * | NS | * | * | * | * | * | * |
| LSD at 5% | 0.39 | 0.32 | 0.71 | - | 0.47 | - | 0.60 | 0.45 | 0.43 | 0.52 | 0.69 | 0.43 |
| **C: Interaction** | | | | | | | | | | | | |
| A×B | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

N. S.= Not significant, *= significant at 5%, **= significant at 1%.

Table 5: Averages of total weight loss percentage on onion bulbs as affected by foliar fertilization treatments and nitrogen fertilizer levels during 2010/2011 and 2011/2012 seasons.

| Treatments Characters | **Total weight loss (%)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | After 1 month | | After 2 months | | After 3 months | | After 4 months | | After 5 months | |
| Seasons | **2010/2011** | **2011/2012** | **2010/2011** | **2011/2012** | **2010/2011** | **2011/2012** | **2010/2011** | **2011/2012** | **2010/2011** | **2011/2012** |
| **A: Foliar fertilization treatments:** | | | | | | | | | | |
| Without | 3.46 | 5.56 | 8.49 | 11.79 | 15.00 | 14.10 | 21.69 | 18.96 | 28.25 | 23.60 |
| Amino acids | 4.03 | 6.32 | 9.39 | 11.94 | 15.84 | 14.92 | 22.90 | 19.14 | 28.83 | 24.30 |
| Humic acid | 6.15 | 6.78 | 11.09 | 12.50 | 17.99 | 15.23 | 25.10 | 21.66 | 31.46 | 26.43 |
| F. test | * | * | * | * | * | * | * | * | * | * |
| LSD at 5% | 0.32 | 0.48 | 0.58 | 0.47 | 0.48 | 0.54 | 0.85 | 1.05 | 0.45 | 0.58 |
| **B: Nitrogen fertilizer levels:** | | | | | | | | | | |
| 71.4 kg N/ha | 2.48 | 4.72 | 7.08 | 11.12 | 12.97 | 13.36 | 19.82 | 17.66 | 26.06 | 22.06 |
| 142.8 kg N/ha | 4.19 | 5.83 | 9.45 | 12.04 | 16.67 | 14.45 | 22.92 | 19.50 | 29.80 | 24.03 |
| 214.2 kg N/ha | 6.98 | 8.11 | 12.43 | 13.06 | 19.19 | 16.44 | 26.94 | 22.60 | 32.68 | 28.23 |
| F. test | * | * | * | * | * | * | * | * | * | * |
| LSD at 5% | 0.28 | 0.38 | 0.73 | 0.63 | 0.28 | 0.45 | 1.09 | 0.97 | 0.51 | 0.70 |
| **C: Interaction:** | | | | | | | | | | |
| A×B | * | * | * | NS | * | NS | NS | NS | * | * |

N. S.= Not significant, *= significant at 5%, **= significant at 1%.

It was worthy to mention that using 142.8 kg N/ha rate arranged between aforementioned nitrogen fertilizer rates with respect their effect on bulb yields and its attributes and bulb quality as well as storability in both seasons. The increase in bulb yields and its attributes because of increasing nitrogen fertilizer rates up to 214.2 kg N/ha can be easily ascribed to the role of nitrogen in activating growth of plants, consequently enhancement yield components and consequently increasing bulb yield per unit area( Jayathilake *et al*., 2002). Moreover, nitrogen encourages plant to uptake other elements activating, thereby improvement yields and its components. These results are in compatible with those found by El-Desuki *et al*. (2006), Halvorson et al. (2006), Halvorson *et al.* (2007) and Geries (2013).

**Interaction effects:** The interaction between nutrients foliar spraying and nitrogen fertilizer levels insignificant affected plant height, number of leaves/plant, bulbing ratio at 90 and 120 days from transplanting in both seasons and foliage fresh weight/plant at 90 and 120 days from transplanting in the first season and at 120 days from transplanting in the second season as well as total and marketable yields, total culls, bulb weight at harvesting, TSS and dry matter percentages in bulbs at harvesting and every month after harvesting till end of storability in both seasons, total weight loss percentage after 2 and 3 months in the second seasons and after 4 months in both seasons.

The interaction between nutrients foliar spraying and nitrogen fertilizer levels had a significant effect foliage fresh weight (at 90 days from transplanting in the second season) and total weight loss % (after 1 and 5 months in both season as well as after 2 and 3 months

in the first season. The interaction among nutrients foliar application and nitrogen fertilizer levels significantly affected foliage fresh weight at 90 days from transplanting only in the second seasons. Results showed that humic acid foliar application and increasing nitrogen fertilizer at rate of 214.2 kg/ha increased foliage fresh weight at 90 days from transplanting as shown in Fig. 1.

However, lowes foliage fresh weight at 90 days from transplanting was produced from without humic acid foliar application and nitrogen fertilizer at rate of 71.4 kg/ha with respect to the effect of the interaction between humic acid foliar application and nitrogen fertilizer levels on total weight loss percentage after one month, the results in Fig. 2 showed that highest loss percentage was produced from humic acid foliar application and increasing nitrogen fertilizer levels to 214.2 kg/ha. However, the lowest loss percentage was recorded from without humic acid foliar application and fertilizing with 71.4 kg/ha. Regarding the interaction effect between nutrient foliar application and nitrogen fertilizer levels on total weight loss percentage after five month, the results in Fig. 3 clearly showed that foliar spraying of humic acid and increasing nitrogen fertilizer to 214.2 kg/ha increased total weight loss percentage after five month.

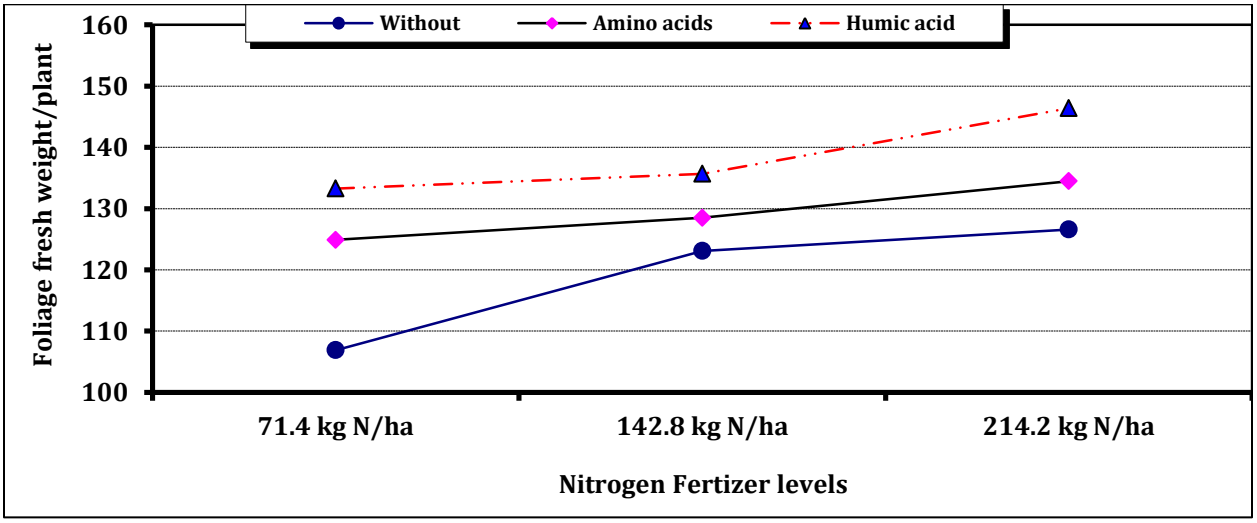


Fig. 1: Averages of foliage fresh weight/plant at 90 days from transplanting (DFT) as affected by the interaction between foliar fertilization treatments and nitrogen fertilizer levels during 2011/2012 season.

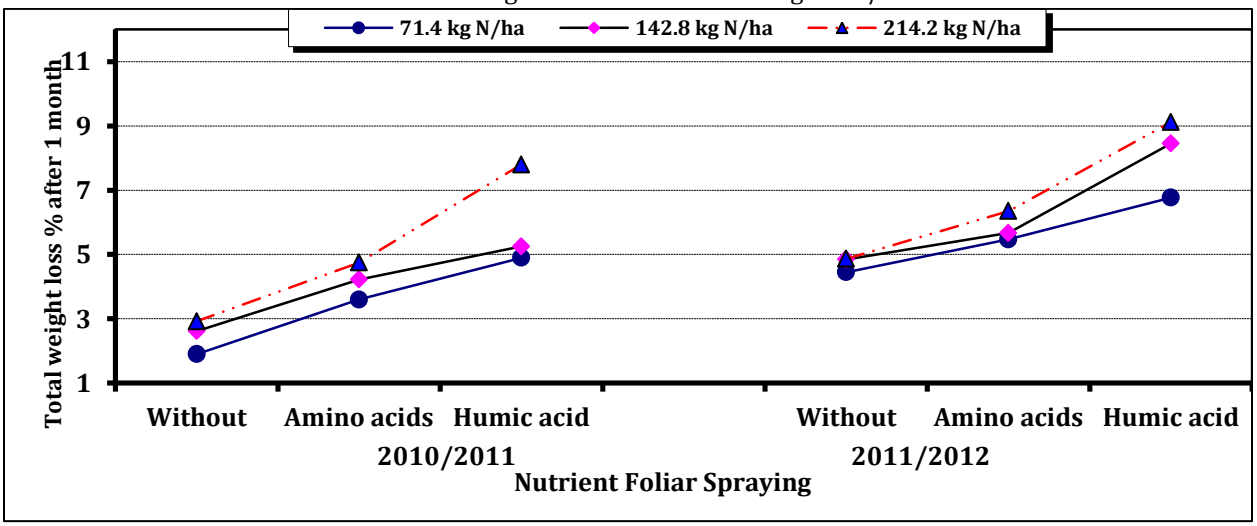


Fig. 2: Averages of total weight loss percentage on onion bulbs after 1 month as affected by the interaction between foliar fertilization treatments and nitrogen fertilizer levels during 2010/2011 and 2011/2012 seasons.

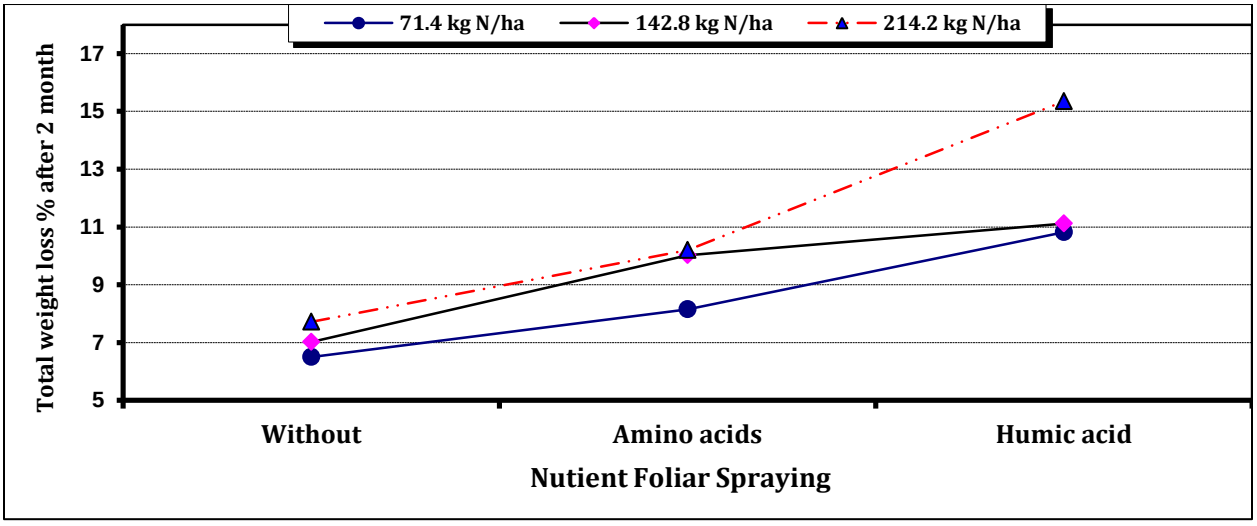


Fig. 3: Averages of total weight loss percentage on onion bulbs after 2 month as affected by the interaction between foliar fertilization treatments and nitrogen fertilizer levels during 2010/2011 season.

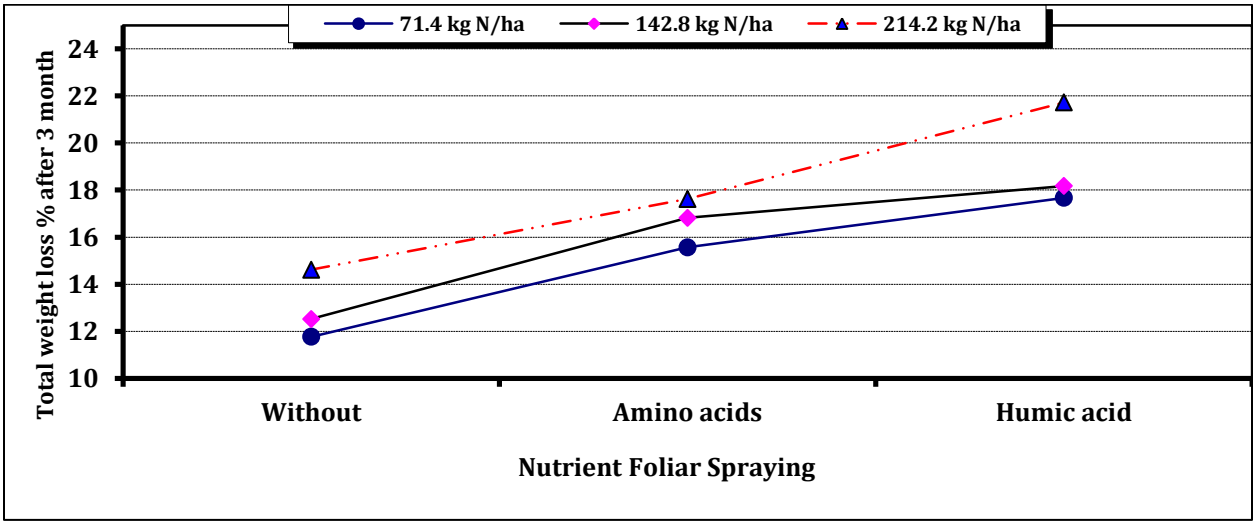


Fig. 4: Averages of total weight loss percentage on onion bulbs after 3 month as affected by the interaction between foliar fertilization treatments and nitrogen fertilizer levels during 2010/2011 season.

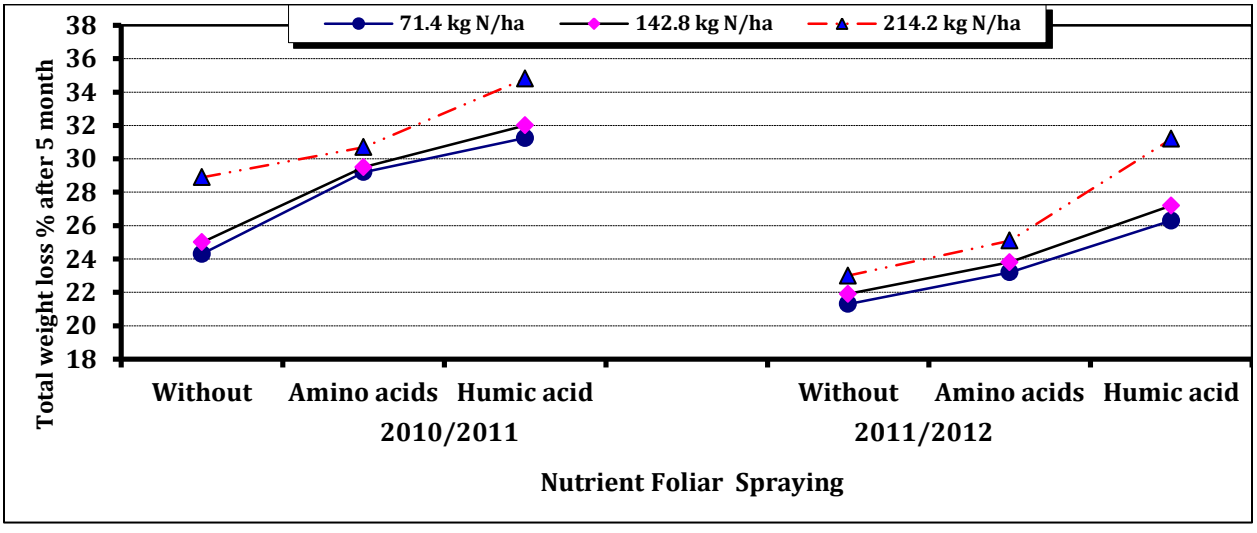


Fig. 5: Averages of total weight loss percentage on onion bulbs after 5 month as affected by the interaction between foliar fertilization treatments and nitrogen fertilizer levels during 2010/2011 and 2011/2012 seasons.

Concerning the interaction between nutrient foliar spraying and nitrogen fertilizer levels on total weight loss after 2 months in the first season only. The results showed that highest total weight loss after 2 months in the first season produced from nutrient foliar spraying of humic acid and increasing nitrogen fertilizer at 214.2 kg/ha as shown in Fig. 4. However, the lowest weight loss percentage after 2 months in the first season produced from without foliar application and fertilization with 71.4 kg/ha.

With respect to the effect of the interaction between nutrient foliar spraying and nitrogen fertilizer, the results in Fig. 5 clearly showed that hight total loss percentage after 3 months in the first season was produced from foliar spraying of humic acid and fertilizer with 214.2 kg/ha. However, the lowes total loss percentage after 3 months in the first season was recorded from without nutrient foliar spraying and fertilizing with 71.4 kg/ha.

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