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# RESPONSE OF (HAMED) OLIVE CULTIVAR TO IRRIGATION REGIME AND NITROGEN FERTIGATION UNDER SIWA OASIS CONDITIONS

**Hussein, A.H.A.**
**Faculty of Agriculture (Saba Bacha)- Alexandria University Alexandria – EGYPT**

## ABSTRACT

The present study was carried out during 1999 growing season on one- year old (Hamed) olive plants grown in a sandy soil located at Gabal El-Dakrour area in Siwa Oasis. The aim of the present study is to clarify the effect of irrigation regime and nitrogen fertigation rates on vegetative growth and leaf water contents, total chlorophyll and nutrients content of Hamed olive plants grown under Siwa Oasis conditions. The plants were irrigated through a drip irrigation network at rates of 10.2 and 13.6 $m^3$/plant/year according to the climatological conditions. Nitrogen fertigation was applied during the growing season at rates of zero (irrigation water), 70,140 and 210 mg N/L of irrigation water. The obtained results revealed that increasing both of irrigation rate and N fertigation rate significantly increased all vegetative growth parameters i.e., growth rate, average shoot length, plant height, canopy diameter, volume index and leaf area. Also, leaf chlorophyll content and leaf water contents were increased markedly due to increasing both irrigation and N fertigation rates. Increasing both irrigation level and N fertigation rate, significantly increased leaf contents of nutrients (N, P, K, Ca, Mg, Fe, Mn, Cu, Zn and B). Generally, it can be concluded that applying water at rate of 13.6 $m^3$/plant/year and N at the rate of 210 mg/L under drip irrigation system in Siwa Oasis enhanced vegetative growth and improved nutrients uptake for Hamed olive plants.

## INTRODUCTION

Olive (*Olea europea* L.) has an important role in agricultural production, especially where the soil is unsuitable for other crops due to its capability to grow under several conditions. In Egypt, olive crop is distributed in many areas such as Matrouh, Fayoum, North and South Sinai, North coast region and Noubaria. Matrouh region occupied the most area in olive production (17.5% of total area cultivated with olive). Olive acreage in Matrouh is concentrated in Siwa Oasis (6000 feddans) according to Agricultural Census of 1999, Ministry of Agriculture and Land Reclamation. Olive crop is the economic resource of the Siwa's farmers with date palm. In Siwa, the rainfall is about 5 mm/year at maximum value. Therefore, the only source of water for cultivation is groundwater, which follows from many springs and wells spreading all over the area.

From the view of water saving and good fertilization management of olive trees, the drip irrigation system can be used to insure good distribution of soil moisture in the root zone depth without raising the soil moisture which cause a low production of olives trees. Also, fertigation lead to good distribution of plant nutrients and increases the utilization efficiency of applied fertilizers (Abdel-Nasser and Harhash, 2001), besides saving the fertilizers and labor costs (Karmeli and Keller, 1975).

The N is the most important nutrient element for plant life. The N fertilizer application has the most important effects in terms of increasing crop production. All plants have a high response effect to N nutrition. In the same time, plants are more sensitive to N deficiency in the root medium. Many investigators at many locations studied the crop response to N fertilization ( Wehrmann and Scharpf, 1979, Agble, 1973, Hulpoi *et al.*, 1971,Hamissa, 1974, Scherer and Danzeisen, 1980, Mengel and Kirkby, 1987, Sud and Bhutani, 1988 and Sarmiento *et al.,* 1994). Nitrogen has an important role in plant growth and cell elongation. In the same time, N is very important for obtaining high fruit yield and quality due to its role in many metabolic processes (Mengel and Kirkby, 1987). The positive effect of N on olive had been previously reported by AL-Saket (1987). Also, nitrogen is a constituent of proteins of which chlorophyll protein complex of chloroplast is only one example.

Thus, the aim of the present investigation is to study the effect of irrigation regime and nitrogen fertigation on vegetative growth and leaf water contents, total chlorophyll and nutrients content of Hamed olive plants grown under Siwa Oasis conditions.

## MATERIALS AND METHODS

The present study was carried out during 1999 growing season on one-year-old (Hamed) olive plants grown in a sandy soil located at Gabal EL-Dakrour area in Siwa Oasis. The sandy soil profile is classified as Typic Torri-Psamment. Some of its physical and chemical properties are tabulated in Table (1).

The olive plants (*Olea europea* L.), Hamed cv. were selected as the same old, size, uniform and healthy. The olive plants were cultivated (Feb. 13,1999) at 6 by 7 m apart (100 plants/fed.) irrigated from a deep well (Table, 2) and received the same horticultural management.

**Irrigation regime:**

The plants were irrigated through a drip irrigation network. The irrigation water was supplied 4 hrs per day in early morning four times weekly during March, April, May, September and October, three times weekly during January, February, November and December and daily in the period of maximum consumption (June, July and August). Table (3) shows the monthly rate of irrigation during the months of the year ($m^3$/fed/month). The irrigation requirements was calculated according to the following equation:

**Table (1). Some physical and chemical characteristics of sandy soil used for the present study.**

| Parameters | Soil depth, cm | | |
|---|---|---|---|
| | **0-30** | **30-60** | **60-90** |
| **Particle-size distribution,** | | | |
| Sand (%) | 88.7 | 90.7 | 91.6 |
| Silt (%) | 6.5 | 5.8 | 4.1 |
| Clay (%) | 4.8 | 3.5 | 4.3 |
| Textural class | Sand | Sand | Sand |
| **Bulk density($Mg/m^3$)** | 1.61 | 1.68 | 1.70 |
| Saturation water content($cm^3/cm^3$) | 0.379 | 0.360 | 0.358 |
| Field capacity( $cm^3/cm^3$ ) | 0.154 | 0.141 | 0.143 |
| Permanent wilting point( $cm^3/cm^3$ ) | 0.068 | 0.060 | 0.064 |
| Available water( $cm^3/cm^3$ ) | 0.086 | 0.081 | 0.079 |
| Organic matter( %) | 1.51 | 1.10 | 0.91 |
| Calcium carbonates( % ) | 8.2 | 9.2 | 9.5 |
| pH (1 : 1 soil : water suspension) | 7.6 | 7.9 | 7.8 |
| Electrical conductivity (dS/m ,1:1 water extract ) | 1.35 | 1.42 | 1.45 |
| **Soluble cations, meq/L** | | | |
| $Ca^{2+}$ | 3.35 | 3.95 | 4.12 |
| $Mg^{2+}$ | 2.17 | 2.51 | 2.45 |
| $Na^{+}$ | 7.09 | 7.21 | 7.32 |
| $K^{+}$ | 0.85 | 0.43 | 0.50 |
| **Soluble Anions, meq/L** | | | |
| $CO^{2-}_3$ | - | - | - |
| $HCO^{?}_3$ | 2.11 | 2.35 | 2.40 |
| Cl? | 6.39 | 6.95 | 6.91 |
| $SO_4^{2-}$ | 4.92 | 4.85 | 5.07 |
| **Aailable nutrients(mg/kg soil)** | | | |
| N | 119 | 110 | 107 |
| P | 18.6 | 16.3 | 14.0 |
| K | 162.1 | 166 | 156 |
| Fe | 4.3 | 3.4 | 3.2 |
| Mn | 5.6 | 4.5 | 4.3 |
| Cu | 0.8 | 0.7 | 0.8 |
| Zn | 1.5 | 1.1 | 1.2 |
| B | 0.3 | 0.33 | 0.35 |

**Table (2). Analysis of well irrigation water used in the present study.**

| Parameters | Value |
|---|---|
| pH | 7.4 |
| EC, dS/m | 0.35 |
| **Soluble Cations, meq/L** | |
| $Ca^{2+}$ | 0.73 |
| $Mg^{2+}$ | 0.83 |
| $Na^{+}$ | 1.82 |
| $K^{+}$ | 0.07 |
| **Soluble Anions, meq/L** | |
| $CO_3^{=}$ | - |
| $HCO_3^{-}$ | 0.96 |
| $Cl^{-}$ | 1.34 |
| $SO_4^{=}$ | 1.13 |
| **Macronutrients, mg/L** | |
| $NO_3^{-}$ | 18 |
| $HPO_4^{=}$ | 2.47 |
| **Micronutrients, mg/L** | |
| Fe | 3.6 |
| Mn | 0.5 |
| Cu | 0.1 |
| Zn | 0.05 |
| B | 0.32 |

**Table (3). Mean monthly air temperature, mean daily potential evapotranspiration and monthly water applied to olive plants during 1999 growing season.**

| Month | Crop factor kc | Mean monthly air temperature, (°C ) | Potential Evapotranspir- tion, ETp, (mm/day) | Applied water ($m^3$/fed./month) | |
|---|---|---|---|---|---|
| | | | | Low | High |
| January | 0.40 | 12.8 | 2.09 | 24.79 | 33.06 |
| February | 0.45 | 14.6 | 2.57 | 29.69 | 39.59 |
| March | 0.50 | 18.0 | 3.52 | 52.44 | 69.92 |
| April | 0.55 | 22.2 | 4.98 | 78.36 | 104.48 |
| May | 0.60 | 27.3 | 6.85 | 122.17 | 162.90 |
| June | 0.65 | 29.3 | 7.83 | 145.59 | 194.13 |
| July | 0.65 | 30.9 | 8.33 | 159.85 | 213.14 |
| August | 0.65 | 31.8 | 8.32 | 159.39 | 212.52 |
| September | 0.55 | 29.9 | 7.10 | 112.26 | 149.69 |
| October | 0.45 | 25.2 | 5.23 | 69.42 | 92.57 |
| November | 0.40 | 19.3 | 3.44 | 39.36 | 52.48 |
| December | 0.40 | 14.1 | 2.29 | 26.94 | 35.93 |

$$ET_{crop} = \frac{ET_{drip}}{E_a} + LR$$

Where:

$ET_{crop}$ is the crop evapotranspiration, mm/day
$ET_{drip}$ is the water consumptive use under drip irrigation system, mm/day
Ea is the efficiency of irrigation system (assumed as 90 % for drip irrigation system).
LR is the Leaching Requirements required for salt leaching (assumed as 10 %).

$$ET_{drip} = K_r * K_c * ET_p$$

Kr is the reduction factor that reflects the percent of soil covering.
Kr can be calculated by the equation of Freeman & Garzoli (Karmeli and Keller, 1975):

$$K_r = GC + 0.5 * (1 - GC)$$

Where GC is the ground cover (plant canopy area divided by soil area occupied by one plant). We can assumed that GC= 0.2 for young plants.
$K_c$ is the crop coefficient ranging from 0.4 to 0.65 for olive plants (Allen *et al.*, 1998).
$ET_p$ is the potential evapotranspiration calculated with FAO Penman-Monteith equation (Allen *et al.*, 1998) expressed as :

$$ET_p = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} U_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34U_2)}$$

Where:

| | |
|---|---|
| ETp | Potential evapotranspiration, mm $day^{-1}$ . |
| $R_n$ | Net radiation at the crop surface, MJ $m^{-2}$ $day^{-1}$, |
| G | Soil heat flux density, MJ $m^{-2}$ $day^{-1}$, Generally very small and assumed to be zero). |
| T | Mean daily air temperature at 2.0 m height, °C, |
| $U_2$ | Wind speed at 2 m height, m $s^{-1}$ , |
| $e_s$ | Saturation vapor pressure at 1.5 to 2.5-m height, kPa, |
| $e_a$ | Actual vapor pressure at 1.5 to 2.5-m height, kPa, |
| $e_s - e_a$ | Saturation vapor pressure deficit, Kpa, |
| $\Delta$ | Slope vapor pressure curve, kPa$°C^{-1}$, |

**Fertigation:**

The fertigation with nutrients solution (Table, 4) containing all the essential plant nutrients including N (at different levels) was done three times weekly during the period from February to June and two times weekly during the rest period of the year, except that the fertigation was added one time only at October to January. All plants were received the recommended doses, but distributed over all the year.

Nitrogen fertigation was applied during the growing season at rates of zero addition (irrigation water), 70,140 and 210 mg N/L of irrigation water.

The treatments were arranged in split plot technique in randomized complete block design, where irrigation levels represent the main plots and the N rates were devoted to the subplots.

**Table (4). Concentration and sources of nutrients used for preparing the nutrient solution used for olive fertigation.**

| Element | Concentra-tion mg/L | Source |
|---|---|---|
| N | variable | Ammonium Nitrate |
| P | 60 | Ortho-phosphoric acid |
| K | 350 | Potassium Sulphate |
| Ca | 200 | Calcium Nitrate |
| Mg | 50 | Magnesium Sulphate |
| Fe | 4.5 | Fe- EDTA |
| Mn | 1.0 | Mn-EDTA |
| Cu | 0.1 | Cu-EDTA |
| Zn | 0.1 | Zn-EDTA |
| B | 0.5 | Borax |
| Mo | 0.05 | Ammonium Molybdate |
| $Na_2$-EDTA | 35 | Ethylin diamine tetra acetic acid - disodium salt |

Regarding to the vegetative growth, stem for each plant was tagged 5 cm above soil surface and the stem diameter was measured at the beginning (February) and at the end of the experiment. Growth rate (GR) expressed as the percent of net increase in stem diameter was calculated as follows:

$$GR = \left(\frac{Final.diameter - Initial.diameter}{Initial.diameter}\right) * 100$$

Ten shoots per plant were tagged at random at all plant directions at the beginning of growing season (February) and the average shoot length was determined at first of October. In addition, twenty mature leaves per plant, one year old, from tagged shoots were collected randomly and their areas were measured using a planimeter. Plant height and canopy diameter were measured at the end of growing season (December). Volume index was calculated using the equation for one-half of a prolate spheroid (Turrel, 1946):

$$V=0.5236*H*D^2$$

Where; V = volume index, $m^3$
H = canopy height, m, and
D = canopy diameter, m

At the first of October, sample of 10 leaves (one-year old) were collected randomly from all directions of the plant for elemental analysis. Each leaf sample was divided into two portions. In the first portion, leaves were washed with tap water, distilled water, air-dried then oven dried at 65°C to a constant weight. The dried samples were ground and digested with concentrated sulfuric acid+ 30% hydrogen peroxide according to the method of Wolf (1982). Total N was determined by micro-Keldahl method (Jackson, 1973). Phosphorus was determined colorimetrically according to the method of Murphy and Riley (1962). Potassium determined by Flame Photometer (Jackson, 1973). Leaf contents of calcium, magnesium and micro-nutrients (Fe, Mn, Cu and Zn) were determined by atomic absorption spectrophotometer (Carter, 1993). Leaf boron content was colorimetrically determined according to Jackson (1973). In the other portion of each leaf sample (fresh leaf material), total chlorophyll content was determined according to Moran and Porath (1980). Total water content (TWC) and relative water content (RWC) were determined by the method of Weatherly (1950). Free water content (FWC) and bound water content (BWC) were determined according to Abdel-Rasoul *et al.* (1987).

The collected data were subjected to analysis of variance according to Steel and Torrie (1982). Correlation coefficient and linear regression were done using the method described in Draper and Smith (1981) .

## RESULTS AND DISCUSSION

**Vegetative growth:**

All vegetative growth parameters (Table, 5), i.e., growth rate, average shoot length, plant height, canopy diameter, volume index and leaf area markedly increased with increasing the amount of irrigation water. Such increments may be due to increasing water supply, which improved the root function, consequently enhanced nutrients uptake and metabolic processes that led to increase plant growth (Mengel and Kirkby, 1987).

Increasing water supply from 10.2 to 13.6 $m^3$/plant /year increased the growth rate by 15.58%, average shoot length by 9.14%, plant height by 8.54%, canopy diameter by 9.46, volume index by 26.01% and leaf area by 1.66%.

Regarding to the N effect, it can be noticed a gradual increase in vegetative growth parameters with increasing N application rate. Increasing N concentration from 0 to 210 mg/L in irrigation water significantly increased the growth rate by 372.06%, average shoot length by 34.73%, plant height by 73.18%, volume index by 353.25 % and leaf area by 18.09%.

The increase in the vegetative growth as a result of N treatment could be interpreted on the basis of the role of N in improving plant

**Table (5). Vegetative growth of olive seedlings as affected by irrigation and N fertigation rates.**

| Irrigation $m^3$/plant/year | Nitrogen mg/L | Growth Rate % | Average shoot length cm | Plant height cm | Canopy diameter cm | Volume index $m^3$ | Leaf area $cm^2$ |
|---|---|---|---|---|---|---|---|
| 10.2 | 0 | 21.47 | 8.0 | 52.0 | 48.0 | 0.063 | 3.82 |
| | 70 | 34.87 | 8.7 | 61.2 | 59.3 | 0.113 | 4.12 |
| | 140 | 65.30 | 9.8 | 72.8 | 71.2 | 0.193 | 4.32 |
| | 210 | 97.60 | 10.7 | 81.9 | 86.9 | 0.324 | 4.57 |
| 13.6 | 0 | 22.77 | 8.7 | 58.6 | 54.9 | 0.092 | 3.91 |
| | 70 | 44.03 | 9.4 | 69.5 | 64.8 | 0.153 | 4.21 |
| | 140 | 75.37 | 10.7 | 76.9 | 79.5 | 0.254 | 4.43 |
| | 210 | 111.23 | 11.8 | 85.8 | 91.3 | 0.374 | 4.22 |
| Mean effect of irrigation regime, $m^3$/lant/year | | | | | | | |
| | 10.2 | 54.81 | 9.3 | 66.98 | 66.35 | 0.173 | 4.21 |
| | 13.6 | 63.35 | 10.15 | 72.70 | 72.63 | 0.218 | 4.28 |
| LSD | | 6.18 | 0.87 | 1.12 | 2.17 | 0.001 | 0.08 |
| Mean effect of nitrogen fertigation rate, mg/L | | | | | | | |
| | 0 | 22.12 | 8.35 | 55.3 | 51.45 | 0.077 | 3.87 |
| | 70 | 39.45 | 9.05 | 65.35 | 62.05 | 0.133 | 4.17 |
| | 140 | 70.34 | 10.25 | 74.85 | 75.35 | 0.224 | 4.38 |
| | 210 | 104.42 | 11.25 | 83.85 | 89.1 | 0.349 | 4.57 |
| LSD | | 2.50 | 0.34 | 1.27 | 2.61 | 0.015 | 0.14 |
| Interaction effect | | | | | | | |
| LSD | | 3.54 | 0.48 | 1.79 | 3.69 | 0.021 | 0.20 |

metabolism, enhancing plant merestimatic activity and increasing the photosynthesis rate (Gupta, 1979, Dugger, 1983 and Mengel and Kirkby, 1987).

There is a synergistic interaction between irrigation and N. When both irrigation and N are increased, the increase in growth or yield is higher than can be accounted for by adding the increase in growth or yield due to N and the increase in growth or yield due to irrigation.

Generally, the best vegetative growth was attained with high rate of N (210 mg/L) and the high level of irrigation water (13.6 $m^3$/plant/year)

**Leaf total chlorophyll:**

Total chlorophyll content of olive leaves as affected by irrigation levels and N rates are presented in Table (6). The data obtained clearly indicate that both irrigation levels and N rates significantly increased leaf content of total chlorophyll. Increasing irrigation water from 10.2 to 13.6 $m^3$/plant/year increased the chlorophyll content by 5.15% and increasing N fertigation rate from 0 to 210 mg/L increased chlorophyll content by 22.03%. Such increase may be due to improve the plant growth as a result of more

**Table (6). Leaf total chlorophyll , leaf water contents, and leaf proline content of olive seedlings as affected by irrigation and N fertigation rates.**

| Irrigation $m^3$/plant/year | Nitrogen mg/L | Leaf total chloro-phyll | Leaf water contents, % | | | | Leaf proline content |
|---|---|---|---|---|---|---|---|
| | | | FWC | BWC | TWC | RWC | |
| 10.2 | 0 | 117 | 14.8 | 39.0 | 53.8 | 71.6 | 2.8 |
| | 70 | 121 | 15.3 | 40.4 | 55.7 | 72.8 | 3.1 |
| | 140 | 128 | 16.2 | 41.6 | 57.8 | 74.5 | 3.8 |
| | 210 | 139 | 17.8 | 40.4 | 58.2 | 75.0 | 4.1 |
| 13.6 | 0 | 119 | 15.7 | 39.5 | 55.2 | 72.8 | 1.9 |
| | 70 | 128 | 16.9 | 40.5 | 57.3 | 73.9 | 2.0 |
| | 140 | 135 | 17.8 | 42.1 | 59.9 | 74.8 | 2.2 |
| | 210 | 149 | 18.5 | 43.6 | 62.1 | 76.1 | 2.5 |
| Mean effect of irrigation regime,$m^3$/plant/year | | | | | | | |
| | 10.2 | 126.25 | 16.03 | 40.35 | 56.38 | 73.48 | 3.45 |
| | 13.6 | 132.75 | 17.23 | 41.43 | 58.63 | 74.40 | 2.15 |
| LSD | | 8.69 | 0.12 | 0.062 | 0.43 | 0.68 | 0.0003 |
| Mean effect of fertigation rate, mg/L | | | | | | | |
| | 0 | 118.00 | 15.25 | 39.25 | 54.50 | 72.20 | 2.35 |
| | 70 | 124.50 | 16.10 | 40.45 | 56.50 | 73.35 | 2.55 |
| | 140 | 131.50 | 17.00 | 41.85 | 58.85 | 74.65 | 3.00 |
| | 210 | 144.00 | 18.15 | 42.00 | 60.15 | 75.55 | 3.30 |
| LSD | | 6.49 | 0.30 | 0.32 | 0.30 | 0.35 | 0.073 |
| Interaction effect | | | | | | | |
| LSD | | 9.18 | 0.42 | 0.45 | 0.43 | 0.49 | 0.103 |

Water absorption and more uptakes of N, Mg and Fe. Such elements have close association in chlorophyll biosynthesis (Mengel and Kirkby, 1987 and Hall and Rao, 1996). Also, it may be attributed for increasing of photosynthesis rate as a result of more absorption of available nutrients, which cause an increase in growth and photosynthesis efficiency. The present results are in harmony with the data of Shim *et al.* (1972) and Keleg *et al.* (1977).

**Leaf water contents:**

Data presented in Table (6) indicate a significant effects of both irrigation level and N fertigation rate i.e., free water content (FWC), bound water content (BWC), total water content (TWC) and relative water content (RWC), especially at the high level of irrigation. Also, increasing N fertigation rate in irrigation water significantly increased the leaf water contents. The leaf water contents were increased by about 7.47, 2.68, 3.99 and 1.25% for FWC, BWC, TWC and RWC, respectively as a result of increasing irrigation rate. The corresponding values were 19.02, 7.01, 10.37 and 4.64%%, respectively as N rate increased from 0 to 210 mg/L in irrigation water. The improvement effect of both irrigation level and N rate application may be due to improve the vegetative growth resulted in increasing water and nutrients absorption (Mengel and Kirkby, 1987).

**Leaf proline content:**

It is clear from the data presented in Table (6) that leaf proline content significantly decreased with increasing irrigation level. Such results may be due to the role of proline in regulating water transport in plant tissue (Aloni and Rosenshtein, 1984 and Srinivasa Rao, 1986).

The results of many studies suggested that the relative accumulation of proline in response to water stress is likely to vary between plant species (Good and Zaplachinski, 1994, Turner and Stewart, 1988 and Abdel-Nasser and El-Shazly, 2000 and Abdel-Nasser and Hussein, 2001). They found that a marked increase in proline content for drought-stressed leaves.

**Leaf nutrients content:**

Leaf nutrients content of olive plants as affected by irrigation level and N fertigation rate is presented in Table (7). Increasing irrigation level, significantly increased leaf contents of nutrients (N, P, K, Ca, Mg, Fe, Mn, Cu, Zn and B).

**Table (7). Leaf nutrients content of olive seedlings as affected by irrigation and N fertigation rates.**

| Irrigation $m^3$/plant/ year | Nitrogen mg/L | Macronutrients, % | | | | | Micronutrients, mg/kg | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | P | K | Ca | Mg | Fe | Mn | Cu | Zn | B |
| 10.2 | 0 | 1.58 | 0.12 | 0.70 | 0.82 | 0.17 | 176.7 | 31.8 | 14.2 | 21.3 | 54.0 |
| | 70 | 1.64 | 0.14 | 0.78 | 0.88 | 0.19 | 199.2 | 36.2 | 16.3 | 26.2 | 68.0 |
| | 140 | 1.73 | 0.17 | 0.85 | 0.97 | 0.23 | 235.3 | 40.5 | 18.1 | 30.4 | 84.0 |
| | 210 | 1.78 | 0.20 | 0.99 | 1.08 | 0.26 | 265.4 | 43.8 | 20.1 | 34.2 | 95.0 |
| 13.6 | 0 | 1.62 | 0.14 | 0.78 | 0.88 | 0.19 | 202.4 | 45.0 | 17.4 | 28.0 | 59.0 |
| | 70 | 1.72 | 0.18 | 0.84 | 0.98 | 0.23 | 259.2 | 48.4 | 19.6 | 32.6 | 74.0 |
| | 140 | 1.84 | 0.22 | 0.95 | 1.18 | 0.28 | 289.8 | 49.8 | 20.2 | 35.8 | 98.0 |
| | 210 | 1.95 | 0.24 | 1.12 | 1.27 | 0.32 | 300.8 | 45.2 | 23.4 | 39.8 | 102.0 |
| Mean effect of irrigation regime, $m^3$/plant/year | | | | | | | | | | | |
| | 10.2 | 1.68 | 0.158 | 0.83 | 0.94 | 0.21 | 219.2 | 38.1 | 17.2 | 28.0 | 75.6 |
| | 13.6 | 1.78 | 0.195 | 0.92 | 1.08 | 0.26 | 263.1 | 47.1 | 20.2 | 34.0 | 83.8 |
| LSD | | 0.093 | 0.043 | 0.087 | 0.043 | 0.043 | 10.7 | 1.9 | 0.9 | 2.9 | 8.1 |
| Mean effect of fertigation rate, mg/L | | | | | | | | | | | |
| | 0 | 1.60 | 0.130 | 0.74 | 0.85 | 0.18 | 189.6 | 38.4 | 15.8 | 24.7 | 56.9 |
| | 70 | 1.68 | 0.160 | 0.81 | 0.93 | 0.21 | 229.2 | 42.3 | 17.9 | 29.4 | 71.4 |
| | 140 | 1.79 | 0.195 | 0.90 | 1.08 | 0.26 | 262.6 | 45.2 | 19.2 | 33.1 | 91.7 |
| | 210 | 1.89 | 0.220 | 1.06 | 1.18 | 0.29 | 283.1 | 44.5 | 21.8 | 37.0 | 98.8 |
| LSD | | 0.022 | 0.011 | 0.034 | 0.055 | 0.21 | 7.8 | 1.5 | 1.0 | 1.1 | 1.9 |
| Interaction effect | | | | | | | | | | | |
| LSD | | 0.031 | 0.016 | 0.048 | 0.077 | 0.030 | 11.11 | 2.2 | 1.4 | 1.5 | 2.7 |

The same trend was noticed with increasing N fertigation rate. Such increase may be attributed to the increase of vegetative growth and improvement of water and nutrients absorption (Awada and Long, 1980, Smith *et al.*, 1985, Raese, 1986). The beneficial effect was noticed at the highest levels of water (13.6 $m^3$/plant/year) and N (210 mg/L), in which it improved the nutrients status of olive leaves.

Generally, it can be concluded that applying water at rate of 13.6 $m^3$/plant/year and N at rate of 210 mg/L under drip irrigation system in Siwa Oasis enhanced vegetative growth and nutrients uptake for Hamed olive plants.

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## استجابة صنف الزيتون (حامض) للرى والتسميد بالنيتروجين تحت ظروف واحة سيوة

**عادل حسين احمد حسين**
**قسم الأراضي والكيمياء الزراعية – كلية الزراعة ( سابا باشا)- جامعة الإسكندرية**

أجريت الدراسة الحالية خلال موسم النمو ١٩٩٩ على شتلات زيتون صنف حامض بعمر سنة واحدة تم زراعتها في ارض رملية بمنطقة جبل النكرور – واحة سيوة.وكان الهدف من الدراسة هو توضيح تأثير الرجيم المائي والتسميد النيتروجيني من خلال مياه الري على صفات النمو الخضري ومحتوى الأوراق من الماء والعناصر الغذائية والكلوروفيل الكلي .وقد تم ري النباتات من خلال شبكة للري بالتنقيط بمعدلات ٢و١٠ و ٦و١٣ م٣ / نبات/ سنة طبقا للظروف المناخية السائدة – التسميد النيتروجيني أضيف مع مياه الري بمعدلات صفر و ٧٠ و ١٤٠ و ٢١٠ مجم ن/لتر . توضح النتائج المتحصل عليها ان زيادة كلا من معدلات الري والتسميد النيتروجيني أدت إلى زيادة معنوية في صفات النمو الخضري مثل معدل النمو للساق ومتوسط طول الفرع وارتفاع النبات والمحيط الخضري ودليل الحجم ومساحة الورقة. أيضا فأن محتوى الأوراق من الكلوروفيل الكلي والمحتوى المائي زادت معنويا نتيجة زيادة معدلات الري والتسميد النيتروجيني – زيادة كلا من معدل الري ومعدل التسميد النيتروجيني أدت ألي زيادة معنوية في محتوى الأوراق من العناصر الغذائية. وبصفة عامة يمكن التوصية بإضافة مياه الري بمعدل ٦و١٣ م٣/نبات/سنة ومعدل تسميد نيتروجيني ٢١٠ مجم ن / لتر تحت نظام الري بالتنقيط في واحة سيوة لزيادة النمو الخضري وتحسين امتصاص العناصر الغذائية لشتلات الزيتون صنف (حامض).