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# INFLUENCE OF WATER REGIMES AND SOIL CONDITIONERS ON YIELD, YIELD COMPONENTS AND WATER UTILIZATION EFFICIENCY OF EG YPTIAN CLOVER (VARIETY FAHL)

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## ABSTRACT

Two field experiments were carried out at Giza Agriculture Research Station during the two growing seasons of 2010/2011 and 2011/2012. This investigation was aired to study the effect of different levels of irrigation i.e. irrigation at 100, 80 and 60% $ET_O$ with the soil conditioner such as compost and humic acid on Egyptian clover variety (Fahl) yield, yield components and crop - water relations. The experimental treatments were arranged in a split plot design with three replicates. The main plots represented three irrigation regimes, whereas the sub-main plots represented the test soil conditioners i.e. compost at a rate of 6 ton/fad and humic acid sprayed as 2% v/v solution three times in 15- day interval starting at sowing. The main results could be summarized as follows:-

Irrigation regimes had a significant effect on growth traits, yield and yield components of clover crop and maximum values were obtained with irrigation at 100% $ET_0$ (wet regime). On the contrary, minimum values for the corresponding respective characters were recorded with irrigation at 60% $ET_0$ (dry regime). It could be stated that all growth, yield and yield components traits were significantly increased due to applying the assessed soil conditioners, compared with the control.

- Seasonal applied water increased as irrigation rate increased, where the values were 1010, 808 and 606 $m^3$ $fad^{-1}$ in 1$^{st}$ season and 1069, 855 and 641 $m^3$ $fad^{-1}$ in 2$^{nd}$ season, respectively, with 100, 80 and 60% $ET_0$ irrigation regimes. In addition, applied water was slightly increased due to the tested soil conditioners.
- Water Utilization Efficiency was enhanced under irrigation at 60% $ET_0$ (dry regime) and both compost and similar trend was exhibited with humic acid application . Results showed that application of the tested soil conditioners increased total NPK content of mono -cut Egyptian clover plants and the soil after harvest as well, comparing with the control.

**Keywords**: mono - cut clover, irrigation regimes, soil conditioners, water utilization efficiency, plant and soil NPK contents.

## INTRODUCTION

Crop yield is affected by both excessive and deficient soil water condition. With limited water supply and with increasing of population, water has become the most precious natural resource in arid and semi-arid regions. So, there is an argent need for sound information on the amount of water required to achieve maximum economic returns. Irrigation is the detrimental factor in agricultural production under the Egyptian conditions. On accomplishing sustainable agriculture concept, the limited available water resources must be efficiently used in order to conserve such resources and to improve its productivity as well. Egyptian clover (*Trifolium alexanrinum L.*) is the main forage crop grown in Egypt during the winter season. Early, Mahrous *et al* (1984) concluded that to obtain optimum yields of Egyptian clover, depletion of the available soil moisture should be maintained between 40 - 60 %. Moreover, El-Babbly (2002), found that three irrigation events between cuttings significantly increased total cuttings of Egyptian clover fresh and dry yields to be 104.14 and 19.48 t $ha^{-1}$, respectively. Furthermore, water use efficiency (WUE) were 135.29, 145.66 and 179.16 kg dry matter $fed^{-1}$ $cm^{-1}$ consumed water, over both seasons, for three, two, and one irrigation events between cuttings, respectively. In this sense, Lazaridou, Martha and Koutroubas (2004), stated that water stress resulted in a reduction of the above ground dry biomass to one third of irrigated berseem clover plants ( 2.3 vs 6.8 g $plant^{-1}$ ) and simultaneously increased water use efficiency. In addition, Magy and Meleha (2007) reported that forage crops like Egyptian clover requires a continuous supply of readily available soil moisture, in order to maintain vigorous growth.

The uses of organic manure as compost in agriculture are widely extended in Egypt. Therefore, the technology for recycling farm wastes, under intensive cropping system should be developed to maintain soil fertility level and to increase the crop yield (Tolessa and Friesen 2001). Moreover, Singh *et al*. (2006) reported that the use of organic materials as compost is an effective and eco-friendly approach for reducing the large volume of organic waste and nutrients stored in them are returned to soil. It not only reduces the dependence on chemical fertilizer, but also improves soil structure, promotes the growth and activity of mycrorrhizae and other beneficial organisms in the soil, alleviates the deficiency of secondary and micronutrients, sustains higher productivity due to improved soil health.

In addation, Rashad et al. (2011) assessed five types of composts and reported a positive effect as it improved the soil properties, ameliorated the plant growth, enhanced nutrient’s uptake. The author added that compost application at the rate of 5% was good nutrient supplier equal to or surpasses the mineral fertilizer at the recommended dose as indicated by the improvement of different plant growth criteria and nutrients uptake. Increasing compost application rate resulted in parallel significant enhancement.

Humic acid is a commercial product contains many elements which improve the soil fertility and increase availability of nutrients and consequently increase plant growth and yield. It is particularly used to ameliorate or reduce the negative effect of salt stress. Sangeetha *et al*. (2006) stated that humic acids in the soil have multiple effects that can greatly benefit plant growth. Moreover, Kadam and Wadje (2011) found that potassium humate significantly increased growth and yield characters of soybean and black gram plants more than the control plants.

The present study aiming to investigate the effect of compost and humic acid (as soil conditioners) along with different irrigation regimes on fresh and dry yield, yield components of Egyptian clover besides N, P and K in the plants and in the soil after harvest.

## MATERIALS AND METHODS

Two field experiments conducted at Giza Agricultural Research Station, Agricultural Research Center, Egypt in 2010/2011 and 2011/2012 seasons. Particle size distribution % and chemical soil characteristics of the experimental site are shown in Table 1. according to Piper (1950), Cottenie *et al*. (1982) and Page *et al* (1982).

The objectives of these experiments were aimed to study the effect of some soil conditioners such e.g. compost and humic acid along with three irrigation rates e.g. 100, 80 and 60% of reference evapotranspiration ($ET_0$). Yield, yield components and some water-crop relations for mono cut Egyptian clover (*Trifolium alexandrinum*, variety Fahl) were investigated. The adopted treatments were arranged in a split plot design with three replicates. The main plots represented the irrigation regimes and the sub ones represented compost and humic acid besides the control.

**Table 1: Particle size distribution % and some soil chemical soil characteristics of the experimental site during 2010/2011 and 2011/2012 seasons.**

| Soil characteristics | Means of both seasons |
|---|---|
| Particle size distribution % | |
| Coarse sand | 5.40 |
| Fine sand | 4.20 |
| Silt | 30.40 |
| Clay | 60.00 |
| Textural class | Clayey |
| Chemical properties | |
| pH (suspension 1:2.5) | 8.09 |
| EC dS $m^{-1}$ (saturated paste extract) | 3.20 |
| Organic matter (%) | 0.62 |
| Saturation Percentage (%) | 86.2 |
| Available macronutrients (mg $L^{-1}$) | |
| N | 116.0 |
| P | 7.00 |
| K | 98.0 |

Some chemical properties of applied both compost and humic acid are presented in Table (2). The sub plot area equals 24 $m^2$ (4x6 m). During seed bed preparation, calcium superphosphate (15.5% $P_2O_5$) was incorporated into topsoil a rate of 15.5 Kg $P_2O_5$fad$^{-1}$. Furthermore, 24 kg $KO_2$ fad$^{-1}$ as potassium sulfate, 48% $KO_2$ and added just before sowing. Nitrogen fertilizer was added in the form of ammonium sulfate, 20.5 % N at the rate of 75Kg fad$^{-1}$ before the second irrigation.

**The adopted experimental treatments can be assgined as followed:**

**1.** Main plot (Irrigation regimes)

1.1. Irrigation at 100% $ET_o$ (wet regime $I_1$).
1.2. Irrigation at 80% $ET_o$ (Medium regime $I_2$).
1.3. Irrigation at 60% $ET_o$ (Dry regime $I_3$).

**2.** Sub main plot (Soil conditioners )

1. Control, without neither compost nor humic acid application ($T_1$).
2. Compost was assessed at 6 tonfad$^{-1}$ rate and incorporated into the soil during seed bed preparation ($T_2$).
3. Humic acid, was sprayed 3 times as (2%, v/v solution) in 15 - day interval starting at sowing ($T_3$).

**Table 2: Some chemical characteristics of applied compost and humic acid in the experiment.**

| Analysis | Value |
|---|---|
| **Compost** | |
| Moisture % | 12.0 |
| pH (1:10) | 8.02 |
| EC dS m$^{-1}$ | 3.14 |
| OM % | 24.5 |
| C :N | 29.6 :1 |
| Total N % | 0.48 |
| $NH_4$ – N mg Kg$^{-1}$ | 55.0 |
| $NO_3$ – N mg Kg$^{-1}$ | 155.0 |
| Total P % | 0.38 |
| Total K % | 0.60 |
| **Humic acid** | |
| EC dSm$^{-1}$ | 6.10 |
| pH | 5.00 |
| **Available nutrients (mg L$^{-1}$)** | |
| Fe | 0.440 |
| Mn | 0.058 |
| Zn | 0.940 |
| Cu | 0.030 |

The experimental plots were divided into two equal parts the first was for estimating yield and its component, while the second was left to the stage of flowering and seed formation to estimate seed yield fad$^{-1}$. The plant samples were collected from each sub plot, weighed and oven dried at 70°C for 48 h up to the constant weight, ground and prepared for digestion as described by Page *et al.* (1982). The digests were subjected to N, P and K evaluation according to Cottenie *et al.* (1982).

**Data recorded**

**- Growth traits:**

1. Plant height (cm).
2. Number of leaves plant$^{-1}$.
3. Number of branches plant$^{-1}$.
4. Leaves : stem ratio.

**- Fresh and dry yields (ton fad$^{-1}$).**

**- Yield components:**

1. Number of heads plant$^{-1}$.
2. Number of seeds head$^{-1}$.
3. 1000 -seed weight (g).

**Crop water requirements calculation:**

Water requirements were calculated by CROPWAT model (version 4.3) which is a computer program uses Penman-Monteith combination method for calculating reference evapotranspiration ($ET_0$) values (Smith 1992).These estimates are used in crop water requirements and irrigation scheduling calculations**.** Reference evapotranspiration (mm $d^{-1}$) values were determined via the metrological data of Giza region and illustrated Table 3.

**Table 3: Meteorological data* for Giza region in 2010/2011 and 2011/2012 winter seasons.**

| Month | 2010/2011 | | | | | |
|---|---|---|---|---|---|---|
| | **T.max (ºC)** | **T.min (ºC)** | **W.S. (m $s^{-1}$)** | **R.H. (%)** | **S.S. (h)** | **S.R. (cal $cm^{-2}$ $day^{-1}$)** |
| November | 24.5 | 13.3 | 1.3 | 65 | 10.5 | 647 |
| December | 21.7 | 10.1 | 1.5 | 68 | 10.1 | 679 |
| January | 19.2 | 8.3 | 1.4 | 61 | 12.1 | 670 |
| February | 20.7 | 9.0 | 1.4 | 59 | 11.8 | 646 |
| March | 23.6 | 11.3 | 1.8 | 61 | 10.8 | 572 |
| April | 30.7 | 15.9 | 1.8 | 51 | 10.1 | 488 |
| | 2011/2012 | | | | | |
| November | 28.6 | 17.1 | 1.3 | 68 | 10.5 | 647 |
| December | 23.6 | 12.1 | 1.3 | 63 | 10.1 | 679 |
| January | 21.2 | 9.7 | 0.9 | 68 | 12.1 | 670 |
| February | 22.9 | 11.3 | 1.3 | 57 | 11.8 | 646 |
| March | 24.8 | 11.9 | 1.8 | 57 | 10.8 | 572 |
| April | 28.4 | 18.5 | 1.4 | 51 | 10.1 | 488 |

**** T.max= Maximum temperature; T.Min = Minimum temperature; W.S.=Wind speed; R.H.=Relative humidity; S.S. =Actual sunshine duration; S.R.= Solar radiation.***

**1- $ET_0$ Calculation procedure:**

**The FAO Penman-Monteith method is expressed as:**

$$ETo = \frac{0.408\,\Delta\,(Rn - G) + \gamma\,\dfrac{900}{T + 273}\,u2\,(es - ea)}{\Delta + \gamma\,(1 + 0.34\,u2)}$$

Where:

ETo: Reference evapotranspiration (mm $day^{-1}$)
Rn: Net radiation at the crop surface (MJ $m^{-2}$ $day^{-1}$)
G: Soil heat flux density (MJ $m^{-2}$ $day^{-1}$)
T: Mean daily air temperature at 2m height (oC)
u2: Wind speed at 2m height (m $s^{-1}$)
es: Saturation vapor pressure (kPa)
ea: Actual vapor pressure (kPa)
es-ea: Vapor pressure deficit (kPa)
Δ: Slope vapor pressure-temperature curve (kPa $^oC^{-1}$)
γ: Psychrometric constant (kPa $^oC^{-1}$)

**2. Crop water use:**

Crop water use (ETcrop) over the growing season was determined from both ETo and the appropriate crop coefficient (Kc) values according to the following equation:-

$$\textit{Crop water use (ETcrop, mm } d^{-1}) = ET_o, \ mmd^{-1} \times K_c$$

**3. Irrigation water requirement estimation**

Irrigation water requirements are the irrigation water quantities must be applied to the experimental plot and estimated as follows:-

$$\text{Irrigation water requirement} = [(ET_o \times K_c) / \textit{irrigation efficiency}] + \textit{leaching requirements}$$

Irrigation water quantities which conveyed to the experimental plots were measured using Cutthroat flume.

**4. Water Utilization Efficiency (W.Ut.E)**

Water utilization efficiency values were calculated as (fresh yield, $kgm^{-3}$ applied water) according to **BOS 1980** as follows:

$$W.Ut.E, \ kg \ m^{-3} = \textit{Final yield } (kg \ fad^{-1}) \ / \ \textit{Applied water } (m^3 \ fad^{-1})$$

**Statistical Analysis:**

Data were statistically analyzed according to **Snedecor and Cochran (1980)** and treatment means were compared by least significant difference test (LSD) at 0.05 level of significance. Bartlett's test was done to test the homogeneity of error variance. The test was not significant for all assessed traits, so, the two season's data were combined.

## RESULTS AND DISCUSSION

**A. Growth, Yield and yield components**

**A.1. Effect of irrigation regimes**

**A.1.1. Growth traits:**

Results in Table 4 indicated that irrigation regimes had a significant effect on plant height, No. of leaves $plant^{-1}$, No. of branches $plant^{-1}$ and leaves : stem ratio. The maximum traits were obtained from wet regime (irrigation at 100% $ET_O$) and comprised 97.5cm; 35.94; 5.33 and 0.37, respectively. The abovementioned traits exhibited lower figures due to irrigation at 80 and 60% $ET_O$ reached (5.88 and 11.79%); (7.74 and 19.64%);(17.82 and 24.02%) and (21.62 and 45.95%), respectively, comparable with those under 100% $ET_O$ regime. These findings could be attributed to less available soil moisture, under 80 and 60% $ET_O$ regimes, which restricted plant growth by controlling the elongation of the above ground part of plants. These findings are in parallel with those reported by El-Babbly (2002) and Lazaridou, Martha and Koutroubas (2004). Improving leaves/plant trait with wet irrigation regime could be attributed to the role of sufficient soil water in enhancing potosyntheic activity and the net assimilation rates which increased the meristimatic activity and leaf growth.

### A.1.2. Yield and yield components

The adopted irrigation regimes resulted insignificant effect on fresh yield, dry yield, No. of heads plant$^{-1}$, No. of seeds head$^{-1}$ and weight of 1000 seeds (Table 5). The highest values of such traits were scored from wet irrigation regime (irrigating at 100% $ET_O$) and amounted to 15.15 ton fad$^{-1}$; 2.64 ton fad$^{-1}$; 7.88; 89.38 and 3.63 g, respectively.

**Table 4: Effect of irrigation regimes and soil conditioners on plant height, number of leaves plant$^{-1}$, number of branches plant$^{-1}$ and leaves : stem ratio of Egyptian clover.**

| Treatments | Plant height (cm) | | | Nº leaves plant$^{-1}$ | | | Nº branches plant$^{-1}$ | | | Leaves / stem ratio | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010/ 2011 | 2011/ 2012 | Comb. | 2010/ 2011 | 2011/ 2012 | Comb | 2010/ 2011 | 2011/ 2012 | Comb. | 2010/ 2011 | 2011/ 2012 | Comb. |
| **Irrigation regimes*** | | | | | | | | | | | | |
| $I_1$ | 84.55 | 110.4 | 97.50 | 33.33 | 38.55 | 35.94 | 5.33 | 5.33 | 5.33 | 0.38 | 0.36 | 0.37 |
| $I_2$ | 79.11 | 104.4 | 91.77 | 32.11 | 34.22 | 33.16 | 4.33 | 4.44 | 4.38 | 0.29 | 0.28 | 0.29 |
| $I_3$ | 73.77 | 98.2 | 86.00 | 26.66 | 31.11 | 28.88 | 3.77 | 4.33 | 4.05 | 0.20 | 0.19 | 0.20 |
| L.S.D 0.05 | 1.81 | 2.90 | 1.42 | 1.46 | 2.85 | 1.33 | 0.73 | 0.39 | 0.34 | 0.04 | 0.04 | 0.02 |
| **Soil conditioners**** | | | | | | | | | | | | |
| $T_1$ | 76.55 | 101.22 | 88.88 | 30.0 | 33.44 | 31.72 | 4.11 | 4.55 | 4.33 | 0.29 | 0.26 | 0.27 |
| $T_2$ | 79.22 | 104.4 | 91.83 | 30.55 | 34.33 | 32.44 | 4.44 | 4.66 | 4.55 | 0.30 | 0.30 | 0.30 |
| $T_3$ | 81.66 | 107.4 | 94.55 | 31.55 | 36.11 | 33.83 | 4.88 | 4.88 | 4.88 | 0.27 | 0.27 | 0.28 |
| L.S.D 0.05 | 2.38 | 1.66 | 1.37 | 2.20 | 1.37 | 1.22 | 0.57 | 0.62 | 0.40 | 0.04 | 0.03 | 0.02 |
| **Interaction** | | | | | | | | | | | | |
| $I_1$ X $T_1$ | 82.66 | 106.0 | 94.3 | 33.0 | 37.66 | 35.33 | 5.33 | 5.0 | 5.16 | 0.39 | 0.33 | 0.36 |
| $I_1$ X $T_2$ | 85.0 | 111.0 | 98.0 | 33.33 | 38.66 | 36.0 | 5.33 | 5.33 | 5.33 | 0.38 | 0.38 | 0.38 |
| $I_1$ X $T_3$ | 86.0 | 114.3 | 100.16 | 33.66 | 39.33 | 36.50 | 5.33 | 5.66 | 5.5 | 0.36 | 0.36 | 0.37 |
| $I_2$ X$T_1$ | 78.0 | 101.33 | 89.66 | 31.33 | 33.0 | 32.16 | 3.66 | 4.33 | 4.0 | 0.28 | 0.27 | 0.28 |
| $I_2$ X$T_2$ | 79.3 | 104.0 | 91.66 | 32.0 | 33.66 | 32.83 | 4.33 | 4.33 | 4.33 | 0.33 | 0.30 | 0.31 |
| $I_2$ X $T_3$ | 80.0 | 108.0 | 94.0 | 33.0 | 36.60 | 34.50 | 5.0 | 4.667 | 4.83 | 0.27 | 0.27 | 0.27 |
| $I_3$ X $T_1$ | 69.0 | 96.3 | 82.6 | 25.66 | 29.66 | 27.66 | 3.33 | 4.33 | 3.83 | 0.20 | 0.19 | 0.19 |
| $I_3$ X $T_2$ | 73.33 | 98.33 | 85.83 | 26.33 | 30.66 | 28.50 | 3.66 | 4.33 | 4.0 | 0.21 | 0.21 | 0.21 |
| $I_3$ X $T_3$ | 79.0 | 100.0 | 89.5 | 28.0 | 33.0 | 30.50 | 4.33 | 4.33 | 4.33 | 0.19 | 0.18 | 0.18 |
| L.S.D 0.05 | 4.13 | 2.87 | 2.38 | 3.81 | 2.37 | 2.12 | 0.99 | 1.08 | 0.69 | 0.06 | 0.06 | 0.03 |

***** $I_1$ = 100% ETo; $I_2$ = 80% ETo; $I_3$ = 60% ETo; **$T_1$= Control; $T_2$ = Compost; T3 = Humic acid*

On the contrary, with 80 and 60% $ET_O$ irrigation regimes the abovementioned parameters were reduced by (2.37 and 28.51%), (10.23 and 25.0%), (19.6 and 35.38%), (11.12 and 22.75%) and (2.48 and 9.09%), respectively, comparable with 100% $ET_O$ irrigation regime. These results are expected since soil water availability plays an important role in plants growth where deficit soil moisture has deleterious effects on most physiological processes, which reflected on lower fresh and dry yields and yield components as well. In this sense, Iannucci (2001) reported a yield reduction of berseem clover subjected to drought. In addition Lazaridou, Martha and Koutroubas (2004) stated that drought conditions resulted in a reduction of the above ground dry biomass, growth rate, leaf area and transpiration rate in berseem clover plants more than that under irrigation.

**T5**

**A.2. Effect of soil conditioners**

**A.2.1. Growth traits:**

Results in Table 4 showed that all studied growth traits of Egyptian clover i.e. plant height, No of branches plan$^{-1}$t and leaves : stem ratio were significantly influenced by the different applied treatments, compared to the control. Highest values of growth traits were recorded with humic acid as compared to either compost or control treatments. Relative percentage in growth traits, as compared to control, were 6.38, 6.65, 12.7 and 3.70% for plant height, No. of leaves plant$^{-1}$, No. of branches plant$^{-1}$ and leaves : stem ratio, respectively. This result may be due to the role of humic as being a source of nutrients in increasing soil fertility, which consequently increased the growth of Egyptian clover. The obtained results are in agreement with those attained by Abd- El-Al *et al.,* (2005) and Kadam and Wadje (2011).

Addition of compost as soil conditioner affected all studied growth traits as compared to control. Results in Table 5 demonstrated that using compost alone had a positive effect on the aforementioned growth traits. This might be related to improvement in physical conditions of the soil provided energy for microorganism activity and increase the availability and uptake of N, P and K which were positively reflected on the growth (Romero *et al.,* 2000 and Vendrame *et al* .2005).

**A.2.2. Yield and its components:-**

Results in Table 5 revealed that fresh and dry yield as well as No. of head plant$^{-1}$, No. of seeds head$^{-1}$ and weight of 1000 seeds were significantly influenced by soil conditioners as compared to control. Application of humic acid as a soil conditioner recorded highest values of yield components as compared to either compost or control. Relative percentage in yield components, as compared to control treatment, which were 33.2, 30.2, 16.4,9.12 and 6.76% for fresh weight, dry weight, No. of heads plant$^{-1}$, No. of seeds head$^{-1}$ and weight of 1000 seeds, respectively. The obtained are in agreement with Piccolo *et al.* (1992) and Mazhar *et al.* (2012) who reported that the use of humic acids as nutrient increase soil fertility and the availability of nutrient elements which were reflected on yield and its components.

**A.3. Interaction effects:**

**A.3.1. Growth traits:-**

The interaction effect between irrigation regimes and soil conditioners significantly influenced growth traits as shown in Table 4. Results indicated that the highest values of all studied growth traits were obtained due to irrigation at 100% $ET_O$ as interacted with humic acid application followed by irrigation at 100% $ET_O$ and compost interaction.

**A.3.2. Yield and yield components**

The effect of irrigation regimes and soil conditioners interaction on yield components was significant, Table 5. The highest values were obtained with combination of irrigation at 100% $ET_O$ (wet regime) and humic acid application and such findings were true in the two seasons of study.

**B. Crop - Water Relations**

**B.1. Seasonal applied water**

**B.1.1. Irrigation regimes effect**

Seasonal applied irrigation water was differed due to irrigation regimes, soil conditioners and their interaction as shown in Table 6. In general, as irrigation rate increased water applied increased. The quantities of irrigation water were 1010, 808, 606 $m^3$ $fad^{-1}$ in 1st season and 1069, 855 and 641 $m^3$ $fad^{-1}$ in 2nd one, respectively, under 100, 80 and 60% $ET_0$ irrigation regimes. It is noticed that, in 2nd season, applied water quantities were higher than those in 1st season which may be due to higher air temperature prevailing in 2nd season which resulting in higher crop water use and consequently higher applied irrigation water.

**Table 6: Seasonal applied water ($m^3$ $fad^{-1}$) and water utilization efficiency (W.ut.E, Kg $m^{-3}$) as affected by irrigation regimes and soil conditioners in 2010/2011 and 2011/2012 seasons.**

| Irrigation regime* | Soil conditioner** | 2010/2011 | | | 2011/2012 | | |
|---|---|---|---|---|---|---|---|
| | | Applied water $m^3fed^{-1}$ | Fresh yield $tonfed^{-1}$ | W.ut.E,$Kgm^{-3}$ water applied | Applied water $m^3fed^{-1}$ | Fresh Yield $tonfed^{-1}$ | W.ut.E, $Kgm^{-3}$ water applied |
| $I_1$ | $T_1$ | 988 | 12.46 | 12.61 | 1048 | 13.25 | 12.64 |
| | $T_2$ | 1013 | 14.60 | 14.41 | 1072 | 15.11 | 14.10 |
| | $T_3$ | 1019 | 17.62 | 17.29 | 1087 | 17.86 | 16.43 |
| **Mean** | | 1010 | 14.89 | 14.77 | 1069 | 15.41 | 114.4 |
| $I_2$ | $T_1$ | 793 | 10.45 | 13.18 | 836 | 12.54 | 15 |
| | $T_2$ | 813 | 12.61 | 15.51 | 859 | 13.13 | 15.29 |
| | $T_3$ | 818 | 15.79 | 19.30 | 870 | 13.82 | 15.89 |
| **Mean** | | 808 | 12.95 | 16.00 | 855 | 13.16 | 15.39 |
| $I_3$ | $T_1$ | 599 | 7.54 | 12.59 | 644 | 11.09 | 16.94 |
| | $T_2$ | 608 | 10.23 | 16.83 | 650 | 11.52 | 17.89 |
| | $T_3$ | 611 | 12.69 | 20.77 | 649 | 11.91 | 18.35 |
| **Mean** | | 606 | 10.15 | 16.73 | 641 | 11.51 | 17.73 |
| **Soil conditioner mean** | | | | | | | |
| $T_1$ | | 793 | 10.15 | 12.79 | 845 | 12.29 | 14.86 |
| $T_2$ | | 811 | 12.48 | 15.58 | 858 | 13.25 | 15.76 |
| $T_3$ | | 816 | 15.37 | 19.12 | 869 | 14.53 | 16.89 |

***$I_1$ = 100% ETo; $I_2$ = 80% ETo; $I_3$ = 60% ETo; ** $T_1$= Control; $T_2$ = Compost; $T_3$ = Humic acid***

**B.1.2. Soil conditioners effect**

Data revealed that the quantities of applied water were increased due to the adopted compost and humic acid as soil conditioners which comprised, in 1st and 2nd seasons, 2.27 and 1.54% and 2.90 and 2.84%, respectively, comparable with the control. These findings may be attributed to the role of such soil conditioners in enhancing the plant growth and improving the soil physical properties where Romero *et al.* (2000) reported that compost application provided energy for microorganism activity and increase the availability and uptake of N, P and K. In addition, Mesut *et al.* (2010) stated that humic acid have been reported to enhance mineral nutrients uptake by plants, through improving its effect on the permeability of roots membranes.

**B.1.3. Interaction effect**

The interaction data cleared out that higher value of applied irrigation water were attained due to irrigation at 100% $ET_O$ as interacted with humic acid application, whereas the lowest figures were recorded as 60% $ET_O$ regime interacted with the control and such trend was true in 1st and 2nd seasons.

**B.2. Water utilization Efficiency (W.ut.E):**

**B.2.1. Irrigation regimes effect**

Water utilization efficiency (W.ut.E) is a quantitative term defines the relationship between crop produced and the amount of applied water. It is a useful indicator for quantifying the impact of irrigation scheduling decisions with regard to water management (BOS, 1980). Data in Table 6 indicated that irrigation at 60% $ET_o$ (dry irrigation regime) exhibited the maximum W.ut.E values e.g.16.73 and 17.75 kg $m^{-3}$ applied water in 1st and 2nd seasons, respectively. This may be due to the lower applied irrigation water under 60% $ET_o$ regime. Furthermore, 100 and 80% irrigation regimes resulted in lower W.ut.E values comprised 12.76 and 18.72% and 5.49 and13.20%, respectively, in 1st and 2nd seasons, comparable with 60% irrigation regime. The obtained results are in accordance with those reported by El-Babbly (2002) and Lazaridou, Martha and Koutroubas (2004) who stated that less applied irrigation water resulted in higher water use efficiency figures for berseem clover.

**B.2.2. Soil conditioners effect**

Data in Table 6 showed that the tested soil conditioners exerted a favorite effect on W.ut.E for mono cut clover, where compost and humic acid revealed higher W.ut.E values reached 21.81 and 6.06% and 49.49 and13.66%, respectively, in 1st and 2nd seasons, more than the control. Such findings could be attributed to favorite effect of both compost and humic acid on the soil physical and chemical properties as well as enhancing mineral nutrients uptake which undoubted positively reflected on plant growth and yield (Romero et al. 2000 and Mesut et al. 2010).

**B.2.3. Interaction effect**

The interaction of irrigation regimes and soil conditioners revealed that W.ut.E reached to its maximum value (20.77 kg $m^{-3}$ applied water) under irrigation at 80% $ET_o$ as interacted with humic acid in 1st season, whereas the value was 18.35 kg/$m^3$ applied water under irrigation at 60% $ET_o$ and humic acid in 2nd season.

**C.Total contents of macronutrients and protein % in the plants**

The adopted both irrigation regimes and soil conditioners and interaction as well significantly influenced N, P & K and protein% contents, Table 7.

### C.1. Irrigation regimes effect

Data in Table 7 revealed that the highest figures of N, P & K and protein% contents were recorded with 100% $ET_0$ irrigation regime and comprised 74.78, 6.85, 43.91 and 18.57, respectively. Further decreases in irrigation rate resulted in reduced values of the abovementioned contents amounted to (14.20 and 28.86%), (19.85 and 37.08%), (22.25 and 40.47%) and (4.36 and 5.28%), respectively, under 80 and 60% $ET_0$ irrigation regimes comparing with100% $ET_0$ irrigation one. These reductions may be attributed to less nutrients absorption under 80 and 60% $ET_0$ irrigation regimes due to less applied irrigation water.

**Table 7: Effect of irrigation regimes and soil conditioners on total content of macronutrients mg $L^{-1}$) and protein content (%) of Egyptian clover.**

| Treatment | N uptake | | | P uptake | | | K uptake | | | Protein % | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010/ 2011 | 2011/ 2012 | Comb. | 2010/ 2011 | 2011/ 2012 | Comb. | 2010/ 2011 | 2011/ 2012 | Comb. | 2010/ 2011 | 2011/ 2012 | Comb |
| **Irrigation regime*** | | | | | | | | | | | | |
| $I_1$ | 71.67 | 77.89 | 74.78 | 6.48 | 7.22 | 6.85 | 41.87 | 45.94 | 43.91 | 17.63 | 19.5 | 18.57 |
| $I_2$ | 63.56 | 64.76 | 64.16 | 5.39 | 5.58 | 5.49 | 33.55 | 34.72 | 34.14 | 16.82 | 18.69 | 17.76 |
| $I_3$ | 56.04 | 50.36 | 53.20 | 4.47 | 4.15 | 4.31 | 27.43 | 24.84 | 26.14 | 16.65 | 18.53 | 17.59 |
| L.S.D 0.05 | 6.98 | 7.12 | 7.05 | 0.48 | 0.87 | 0.68 | 5.28 | 3.92 | 4.60 | 0.67 | 0.67 | 0.68 |
| **Soil conditioner**** | | | | | | | | | | | | |
| $T_1$ | 56.47 | 48.56 | 52.52 | 3.21 | 2.76 | 2.99 | 25.69 | 22.09 | 23.89 | 16.15 | 18.03 | 17.09 |
| $T_2$ | 66.19 | 64.22 | 65.21 | 6.37 | 6.22 | 6.29 | 36.47 | 35.47 | 35.97 | 17.34 | 19.22 | 18.28 |
| $T_3$ | 68.62 | 80.25 | 74.44 | 6.76 | 7.96 | 7.36 | 40.69 | 47.92 | 44.31 | 17.61 | 19.48 | 18.55 |
| L.S.D 0.05 | 6.23 | 5.06 | 5.65 | 0.59 | 0.56 | 0.58 | 4.53 | 3.91 | 4.22 | 0.33 | 0.33 | 0.33 |
| **Interaction** | | | | | | | | | | | | |
| $I_1$ X $T_1$ | 61.02 | 60.04 | 60.5 | 3.49 | 3.44 | 3.47 | 28.65 | 28.21 | 28.43 | 16.42 | 18.29 | 17.36 |
| $I_1$ X $T_2$ | 77.99 | 77.64 | 77.82 | 7.54 | 7.57 | 7.56 | 27.83 | 47.45 | 37.64 | 18.0 | 19.88 | 18.94 |
| $I_1$ X $T_3$ | 75.99 | 96.02 | 86.00 | 8.40 | 10.65 | 9.52 | 49.31 | 62.15 | 55.72 | 18.46 | 20.33 | 19.40 |
| $I_2$ X$T_1$ | 57.48 | 49.92 | 53.70 | 3.34 | 2.89 | 3.12 | 25.19 | 21.84 | 23.52 | 16.1 | 17.98 | 17.04 |
| $I_2$ X$T_2$ | 64.59 | 63.77 | 64.18 | 6.62 | 6.54 | 6.58 | 34.49 | 34.17 | 34.33 | 17.08 | 18.96 | 18.02 |
| $I_2$ X $T_3$ | 68.62 | 80.59 | 74.61 | 6.21 | 7.29 | 6.75 | 40.98 | 48.15 | 44.56 | 17.27 | 19.15 | 18.21 |
| $I_3$ X $T_1$ | 50.89 | 35.71 | 43.30 | 2.79 | 1.94 | 2.37 | 23.22 | 16.25 | 19.74 | 15.94 | 17.82 | 16.88 |
| $I_3$ X $T_2$ | 55.99 | 51.24 | 53.62 | 4.96 | 4.55 | 4.75 | 27.09 | 24.79 | 25.94 | 16.94 | 18.81 | 17.88 |
| $I_3$ X $T_3$ | 61.24 | 64.14 | 62.69 | 5.67 | 5.95 | 5.81 | 31.98 | 33.47 | 32.73 | 17.09 | 18.96 | 18.03 |
| L.S.D 0.05 | 10.79 | 8.78 | 9.79 | 1.04 | 0.96 | 1.00 | 7.85 | 5.73 | 6.79 | 0.57 | 0.57 | 0.57 |

****$I_1$ = 100% ETo; $I_2$ = 80% ETo; $I_3$ = 60% ETo; **$T_1$= Control; $T_2$ = Compost; $T_3$ = Humic acid***

### C.2. Soil conditioner effect

Application of humic exhibited the highest values of total contents of N, P K and protein% which reached to 41.74, 213.04, 85.48 and 8.54%, respectively, more than the control. This may be attributed to favorite effect of humic acid in enhancing mineral nutrients uptake by plants, through its effect on the permeability of roots membranes (Mesut et al., 2010). In this sense, Richard (2004) reported that humic acid renowned for their ability to chelate soil nutrients, improve nutrient uptake especially nitrogen, phosphorus and sulfur, stimulate soil biological activity and act as a storehouse of N,P ,S and

Zn. In addition, compost application resulted in similar trend where N, P K and protein% contents were increased by 24.16, 110.36, 50.57 and 6.96% more than the control, respectively. Such findings are referred to compost role in improving soil physical and chemical properties and providing the energy for microorganism activity and increase the availability and uptake of N,P and K(Escalada and Ratilla, 1998 and Romero et al. (2000).

**C.3 Interaction effect**

Interaction results indicated that the highest values of N, P K and protein% were obtained due to irrigation at 100% $ET_0$ (wet regime) and humic acid interaction, Table 7.

**D.1 Irrigation regimes effect**

Data in Table 8 pointed out that irrigating with 100% $ET_0$ (wet regime) exhibited the highest available soil N, P & K values after harvest which amounted to 112.98, 14.96 and 85.12 mg $Kg^{-1}$, respectively. Reducing irrigation rate to be 80 and 60% $ET_0$ resulted in lower values of available soil N, P & K which comprised (4.23 and 9.81%), (7.09 and 16.38%) and (3.54 and 5.53%), respectively, comparable with 100% $ET_0$ regime.

**Table 8: Effect of irrigation regime and some organic conditioners on available macronutrients in soil after Egyptian clover harvest (two seasons'^s mean).**

| Treatment | Available soil macronutrients, mg $Kg^{-1}$ | | |
|---|---|---|---|
| | N | P | K |
| **Irrigation regime*** | | | |
| $I_1$ | 112.78 | 14.96 | 85.12 |
| $I_2$ | 108.2 | 13.90 | 82.11 |
| $I_3$ | 101.9 | 12.21 | 81.26 |
| L.S.D 0.05 | 10.7 | 1.92 | 10.22 |
| **Soil conditioners**** | | | |
| $T_1$ | 108 | 11.43 | 77.23 |
| $T_2$ | 112 | 13.26 | 82.87 |
| $I_3$ | 115 | 16.39 | 88.39 |
| **L.S.D 0.05** | 7.94 | 1.41 | 9.31 |
| **Interaction** | | | |
| $I_1$ X $T_1$ | 110.3 | 13.13 | 77.67 |
| $I_1$ X $T_2$ | 112.0 | 14.23 | 88.67 |
| $I_1$ X $T_3$ | 115.0 | 18.50 | 95.5 |
| $I_2$ X$T_1$ | 109.6 | 10.90 | 75.4 |
| $I_2$ X$T_2$ | 110.3 | 13.20 | 79.93 |
| $I_2$ X $T_3$ | 113.0 | 13.17 | 91.00 |
| $I_3$ X $T_1$ | 109.0 | 10.27 | 78.63 |
| $I_3$ X $T_2$ | 109.0 | 12.33 | 79.63 |
| $I_3$ X $T_3$ | 111.0 | 13.50 | 89.03 |
| L.S.D 0.05 | 13.77 | 5.94 | 16.1 |

****$I_1$ = 100% ETo; $I_2$ = 80% ETo and $I_3$ = 60% ETo; **$T_1$= Control; $T_2$ = Compost and $T_3$ = Humic acid***

**D.2. Soil conditioners effect**

Data in Table 8 revealed that humic acid application resulted in the highest available soil N, P & K figures after harvest which reached to 6.48, 43.39 and 14.45%, respectively, more than the control. These findings may be due to that humic acid help in increased the biologically fixed atmospheric nitrogen and increased the availability of native and applied P and other crop nutrients (Dhanushkodi and Subrahmanlyan 2012). Data also cleared out that compost application exerted similar trend where available soil N, P & K values were increased by 3.90, 16.01 and 7.30% higher than the control, respectively. In this respect, Dhanushkodi and Subrahmaniyan (2012) found that the application of compost as soil conditioner increased available N in soil compared to control, and the authors added that available N increased due to mineralization of native N by soil organism.

**D.3. Interaction effect**

Statistical analysis showed that the interaction of the adopted both irrigation regimes and soil conditioners significantly affected soil availability of N, P and K after crop harvesting. The highest figures of N, P and K were recorded with 100% ETo irrigation regime as interacted with humic acid application. It is worthy to mention that, either under irrigation regimes or soil conditioners treatments, available N was slightly decreased after crop harvesting, as compared to before cultivation, which may be due to absorption by grown plants along with loss of N by leaching and volatilization during N mineralization in soil.

## CONCLUSION

Achieving higher water utilization efficiency became the most important challenge for scientists in the agriculture, particularly in arid and semi arid areas. Mitigation such problem could be achieved via techniques and practices those deliver more accurate supply of water to the crops. Furthermore, using improved agricultural management practices, such as application of compost and humic acid could improve growth and yield of Egyptian clover. Our results showed that either compost or humic acid and irrigating with 100% ETo regime improved growth characteristics and final yield.

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## تأثير نظم الرى مع بعض محسنات التربة على محصول البرسيم المصرى (الفحل)

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بالجيزة موسمى ٢٠١١/٢٠١٠ ، ٢٠١٢/٢٠١١ لدراسة أثر معاملات الرى عند ١٠٠ ، ٨٠ ، ٦٠% من جهد البخر نتح النظرى بالإضافة الى إستخدام الكمبوست و حمض الهيومك كمحسنات التربة على محصول البرسيم الفحل ومكوناتة وبعض العلاقات المائية.

**يمكن تلخيص أهم النتائج فى التالى:**

- أشارت النتائج إلى تأثير كلا من معاملات الرى وإضافة المحسنات تأثيرات معنوياً على صفات النمو، المحصول والمحصول ومكوناته.
- أشارت النتائج إلى أن الرى عند ١٠٠% من جهد البخر نتح القياسي الي أعلى القيم لطول النبات وعدد الاوراق للنبات وعدد الفروع للنبات ونسبة الاوراق للساق وانخفضت هذة الصفات بالرى عند ٨٠ أو ٦٠% من جهد البخر نتح القياسي.
- أدى الرى عند ١٠٠% من جهد البخر نتح الي أعلي القيم للوزن الطازج والوزن الجاف للفدان وعدد الكبسولات للنبات وعدد البذور للكبسولة ووزن ال١٠٠٠ بذرة وانخفضت هذة الصفات بالرى عند ٨٠ أو ٦٠% من جهد البخر نتح القياسي .
- لقد تأثرت جميع صفات النمو المدروسة والمحصول ومكوناتة معنوياً بتطبيق معاملات محسنات التربة بالمقارنة بالكنترول وسجلت معاملة حمض الهيومك أعلى القيم بالمقارنة بمعاملة الكمبوست والكنترول.
- اوضحت النتائج ان التفاعل بين معاملات الرى ومحسنات التربة معنوياً لصفات النمو والمحصول ومكوناتة وسجلت أعلى القيم تحت نظام الرى ١٠٠% من جهد البخر نتح القياسي ومعاملة حمض الهيومك .
- زادت كمية الماء المضاف بزيادة معدل الرى حيث كانت القيم ١٠١٠ ، ٨٠٨ و ٦٠٦ متر مكعب / فدان فى الموسم الأول بينما بلغت ١٠٦٩ ، ٨٥٥ و ٦٤١ متر مكعب /فدان فى الموسم الثانى على الترتيب عند الرى ١٠٠ ، ٨٠ ، ٦٠% من حهد البخر نتح القياسي بالاضافة الى زيادة الماء المضاف قليلاً نتيجة لمحسنات التربة المختبرة.
- لقد تحسنت الكفاءة الاستعمالية للمياة عند الرى ب ٦٠% من جهد البخر نتح عنها بالري ب ٨٠ و ١٠٠% من جهد البخر نتح القياسي . اضافة كلا من حمض الهيومك أو الكمبوست ادي الي تحسن الكفاءة الاستعمالية للمياة . أعلي قيم للكفاءة الاستعمالية للمياة نتجت من تفاعل حمض الهيومك و الري ب ٦٠% من جهد البخر نتح القياسي .

أوضحت النتائج ان إضافة محسنات التربة أدت إلى زيادة المحتوى الكلى لعناصر ال NPK فى أوراق نباتات البرسيم المصرى و كذا بالتربة بعد الحصاد مقارنة بالكنترول.

**قام بتحكيم البحث**

| | |
|---|---|
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**Table 5: Effect of irrigation regimes and soil conditioners on fresh yield, dry yield, No of heads/plant, No. of seeds and 1000 -seed weight of Egyptian clover.**

| Treatment | Fresh yield (ton fad$^{-1}$) | | | Dry yield (ton fad$^{-1}$) | | | No of heads plant$^{-1}$ | | | No. of seeds head$^{-1}$ | | | 1000- seed Weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010/ 2011 | 2011/ 2012 | Comb | 2010/ 2011 | 2011/ 2012 | Comb | 2010/ 2011 | 2011/ 2012 | Comb | 2010/ 2011 | 2011/ 2012 | Comb | 2010/ 2011 | 2011/ 2012 | Comb |
| **Irrigation regimes*** | | | | | | | | | | | | | | | |
| $I_1$ | 14.89 | 15.41 | 15.15 | 2.74 | 2.53 | 2.64 | 7.66 | 8.11 | 7.88 | 88.33 | 90.40 | 89.38 | 3.65 | 3.61 | 3.63 |
| $I_2$ | 12.95 | 13.16 | 13.06 | 2.39 | 2.35 | 2.37 | 6.22 | 6.44 | 6.33 | 78.44 | 80.40 | 79.44 | 3.54 | 3.54 | 3.54 |
| $I_3$ | 10.16 | 11.51 | 10.83 | 1.87 | 2.10 | 1.98 | 5.77 | 6.00 | 5.88 | 68.77 | 69.33 | 69.05 | 3.17 | 3.43 | 3.30 |
| **Mean** | 12.67 | 13.36 | 13.01 | 2.22 | 2.33 | 2.33 | 6.55 | 6.85 | 6.70 | 78.51 | 80.04 | 79.29 | 3.45 | 3.53 | 3.49 |
| **L.S.D 05** | 1.30 | 1.43 | 0.80 | 0.25 | 0.23 | 0.14 | 0.69 | 0.79 | 0.43 | 2.15 | 0.10 | 1.00 | 0.27 | 0.11 | 0.12 |
| **Soil conditioners**** | | | | | | | | | | | | | | | |
| $T_1$ | 10.15 | 12.29 | 11.22 | 1.87 | 2.18 | 2.02 | 5.88 | 6.33 | 6.11 | 74.44 | 76.66 | 75.55 | 3.42 | 3.38 | 3.40 |
| $T_2$ | 12.48 | 13.25 | 12.87 | 2.30 | 2.37 | 2.34 | 6.77 | 7.00 | 6.88 | 79.22 | 80.55 | 79.88 | 3.39 | 3.57 | 3.48 |
| $T_3$ | 15.37 | 14.53 | 14.95 | 2.83 | 2.43 | 2.63 | 7.00 | 7.22 | 7.11 | 81.88 | 83.0 | 82.44 | 3.63 | 3.63 | 3.56 |
| **mean** | 12.67 | 13.36 | 13.01 | | | | | | | | | | 3.48 | 3.53 | 3.48 |
| **L.S.D 05** | 0.94 | 0.39 | 0.48 | 0.17 | 0.21 | 0.13 | 0.44 | 0.50 | 0.31 | 4.16 | 0.09 | 2.22 | 0.28 | 0.10 | 0.14 |
| **Interaction** | | | | | | | | | | | | | | | |
| $I_1$ X $T_1$ | 12.46 | 13.25 | 12.85 | 2.28 | 2.32 | 2.30 | 6.66 | 7.33 | 7.0 | 83.0 | 85.66 | 84.33 | 3.42 | 3.45 | 3.43 |
| $I_1$ X $T_2$ | 14.60 | 15.11 | 14.85 | 2.69 | 2.70 | 2.70 | 8.0 | 8.33 | 8.16 | 89.66 | 90.33 | 90.0 | 3.72 | 3.65 | 3.68 |
| $I_1$ X $T_3$ | 17.62 | 17.86 | 17.74 | 3.25 | 2.57 | 2.91 | 8.33 | 8.66 | 8.50 | 92.33 | 95.33 | 93.83 | 3.81 | 3.75 | 3.78 |
| $I_2$ X$T_1$ | 10.45 | 12.54 | 11.50 | 1.93 | 2.23 | 2.08 | 5.66 | 6.0 | 5.83 | 75.3 | 76.33 | 75.83 | 3.29 | 3.35 | 3.32 |
| $I_2$ X$T_2$ | 12.61 | 13.13 | 12.87 | 2.33 | 2.36 | 2.34 | 6.33 | 6.667 | 6.50 | 79.0 | 81.66 | 80.33 | 3.66 | 3.62 | 3.64 |
| $I_2$ X $T_3$ | 15.79 | 13.82 | 14.80 | 2.91 | 2.48 | 2.70 | 6.66 | 6.667 | 6.66 | 81.0 | 83.33 | 82.16 | 3.68 | 3.65 | 3.66 |
| $I_3$ X $T_1$ | 7.54 | 11.09 | 9.32 | 1.39 | 1.99 | 1.69 | 5.33 | 5.667 | 5.50 | 65.0 | 68.0 | 66.50 | 2.80 | 3.34 | 3.07 |
| $I_3$ X $T_2$ | 10.23 | 11.52 | 10.87 | 1.89 | 2.06 | 1.97 | 6.00 | 6.00 | 6.0 | 69.0 | 69.6 | 69.33 | 3.14 | 3.46 | 3.30 |
| $I_3$ X $T_3$ | 12.69 | 11.91 | 12.30 | 2.347 | 2.24 | 2.29 | 6.00 | 6.33 | 6.16 | 72.33 | 70.3 | 71.33 | 3.56 | 3.51 | 3.53 |
| **L.S.D 05** | 1.63 | 0.68 | 0.83 | 0.30 | 0.36 | 0.22 | 0.76 | 0.87 | 0.54 | 7.21 | 0.16 | 3.84 | 0.49 | 0.18 | 0.24 |

- ***$I_1$ = 100% ETo; $I_2$ = 80% ETo; $I_3$ = 60% ETo; ** $T_1$= Control; $T_2$ = Compost; T3 = Humic acid***