*J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., Vol. 13 (1):15 - 24, 2022*

# Journal of Soil Sciences and Agricultural Engineering

**Journal homepage & Available online at: www.jssae.journals.ekb.eg**

# Effect of Different Irrigation Rates and Organic Amendments on Sandy Loam Soil Productivity for Peanut Crop

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## ABSTRACT

Two experiments wereperformed in 2019 and 2020 to study the effect of the irrigation levels and organic amendmentson nutrientavailability and peanut productivityAmendmentsas ton/fed were 5 tons of compost, 5 tons of farmyard manure and 50 kg/fed of humic acid. Irrigation as $m^3$/fed were 1652, 2203 and 2754 in the first season but were 1555, 2074 and 2592 in the second one as 60, 80 and 100 % of ETc. respectively. Higher availabilityof N, P, K, Fe, Mn and Zn occurred in farmyard manuredsoils under irrigation rates comparing with other organic amendments. Increasingirrigation water increased available N and Mn in the soil, but was not significant for P, K, Fe and Zn. All used organic amendments caused a significant increase in growth parameters and productivity. The highest growth parameters and productivity were associatedwith composttreatment with all rates of irrigation compared with other treatments of organic amendments. Growth parameters were notaffectedbyirrigation ratesexcept for branched plants. The interaction between irrigation rates and organic amendments were significant for growth parameters. Adding organic amendments with and without irrigation water rates increased N, P, K, Fe, Mn and Zn concentrations in the seeds, while the high increases were found with compost combined with different rates comparing with other treatments of organic amendments. The effect of irrigation rates on nutrients concentration in the seeds was not significant except when organic amendments was applied.

***Keywords***: Irrigation water rates, Organic amendments, Available nutrients, Growth parameters, and peanut Giza6

## INTRODUCTION

River Nile provides Egypt 55.5 billion cubic metersof water per year, which is mostly consumed as 79% for the agricultural sector (FAO, 2019). Egypt in 2009, developed a sustainable agricultural development strategy towards 2030 considering the sustainability of agricultural land use and water resources. This plane will be realized by protecting and agricultural land as well as , increasing the efficiency of water-use via the irrigation system from 50% in the year 2007 to 80% by the year 2030. These practices were to conserve water requirement for reclaiming about 1.25 million feddans in 2017and about 3.1 million feddans by the year 2030 (Abul-Naga, 2009). Water deficit occurs when the plant water requirement cannot be available when the rate of transpired water are more than the water taken up by the roots. The case is based on insufficient precipitation, decreased ground water level or the retention of water by soil matrix (Salehi-Lisar and Bakhshayeshan, 2016). The severity of drought on the crop production is generally depending on the soil moisture status and nutrients availability (Gandah *et al.*, 2003). Enzymatic activities in the plants is diminished by drought stress, which decrease the yield and the quality of oilseed of the plants (Fahad *et al.*, 2017).

The oxidation of some certain of the polyunsaturated fatty acids cause reduction in oil content under drought stress (Singh and Sinha, 2005). The application of different irrigation levels resulting in different effects on the protein content of the seeds of groundnut; while the plants with sufficient irrigation water gave more kernels and produced higher contents of total proteins and oil (Reddy *et al*., 2003). Availability of soil water is directly involved in mineral uptake by plants. On other hand, the drought can decreases carpeted translocation of nutrients in relation to lowered transpiration rates and impair active transport and membrane permeability (Misle *et al*., 2014).

Sandy soils as having loose texture and gaps between particles, include low contents of organic matters and nutrition. Accordingly, the capacity of saving water and nutrients is poor. (Yongx*et al.*, 2013).Adding organic matter to sandy soil activate the production of a good physical structure due to the greater cohesion and aggregation between particles. The case causes an increase in porosity, retention of water, root development. Accordingly, root growth increases in the soils resulting in availability of water to plants.(Pen *et al*., 2018).

Groundnut is one of the most important oil plant in the world as its seeds inclue 45 % oil with 26-28 % protein, 20% carbohydrates and 5 % fiber (Fageria *et al.*, 1997). In Egypt , during the farming seasons in the years 2013-2014, the area of groundnut cultivation was about 56,866 hectare (FAO, 2014). The cultivated area of peanut during 2014 season was about 165000 feddans (FAO, 2015). Peanut yield reduced to 24% when peanut was subjected to drought during the end of growing season (Boontang *et al.*,2010). Water stress often encourages the growth of roots in deeper soil layers. The capacity to modify the root attributes, especially root length, by extracting the available of water in deeper soil layers represents an important mechanism to avoid drought and ensure plant survivals (Kambiranda *et al.*, 2011). Adding soil amendments improve peanut yield production, soil moisture retention capacity and soil microbial activity (Chalwe *et al.*, 2019).Water deficit stress at vegetative phase had significant effect on leaf solution and proteins. At the end of cetain phase

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**DOI: 10.21608/jssae.2022.221140**

of stress, water deficiency encourage significant proline production in leaves, while led to significant decrease of chlorophyll. Also water deficiency had significant effect on free amino acid levels of leaf at the end of reproductive stress (Soltani*et al.*,2013). Humic acid facilitates fertilizer nutrients for improving plant growth (Khungar and Manoharan, 2000). Nithila*et al.*,(2016) reported that adding adequate contents of humic acid improves soil status , increases yield production and enhances the nutrient up take by acting as a chelate in mobilizing nutrients. Also reduces the process of leaching nutrients, which in turn reduces the use of inorganic fertilizers as well as increasing the efficiency added fertilizers (Kalaichelvi *et al.,* 2006). El-Metwally and Ahmed (2012) concluded that humic acid increases water holding capacity in sandy soils and reduces the evaporation of irrigation water

According to Nabil *et al*. (2018), organic manure function as an important role on lowering soil bulk density, increasing water holding capacity. Also develops the beneficial soil microbes, improving good soil structure , enhancing soil aggregates; increasing yield and its attributes and nutrient uptake. Organic farm manure application improves soil structure and soil moisture content, provides plant with essential elements, increases number of plants and seed yield (Mohamed *et al*., 2015). Organic farming application enhances the chemical, biological, and physical soil properties as well as increases crop production. On other hand, this soil treatment increases nutrients content in crops, and activity of symbiotic N fixation(UKROFS, 2001). Vengadaramana and Jashothan (2012), founded that adding organic matter to the soil increases water holding capacity

.Organic fertilizers increase the efficiency of the irrigation water in wheat cultivation (Deng *et al.,* 2004).Yassen *et al.* (2006) recorded pronounced effect of cattle manureon enhancing the water use efficiency of grain crops.

This work was carried out to study the individual and combined treatments of irrigation rates (irrigation deficient) and soil organic amendments on peanut plant growth, yield and its content of some essential nutrients, soil availability of some nutrients and water use efficiency.

# MATERIALS AND METHODS

## Soil location and soil sampling

tow field experiments were conducted at Ismalia agriculture station of Agric. Res. Center, Egypt, during two summer seasons of 2019 and 2020 to study the effect of three organic amendments (farmyard manure, compost and humic acid) on the soil content of available nutrients and growth parameter and yield of peanut plant at different irrigation levels .i.e. 60, 80 and 100% of ETc.

Before planting, disturbed and undisturbed surface soil samples (0 – 30 cm) were taken from the studied area to determine its chemical and physical soil properties as well as its content of certain available essential nutrients. Disturbed soil samples were air-dried and ground to pass through a 2 mm sieve. The soil analyses were carried out according to Cottenie *et al.* (1982), Page *et al.* (1982) and Klute (1986).

## Applied irrigation water (AIW)

The amounts ofAIWwere calculated according to the proposed equation by Vermeiren and Jopling (1984) as follows:

$$AIW=\frac{ETc \times I}{Ea(1-LR)}$$

**Where,**

**AIW= Depth of applied irrigation water (mm), ETc= Crop evapotranspiration (mm day$^{-1}$), I= Irrigation interval (days), Ea= Irrigation application efficiency and LR= Leaching requirements: which was calculated according to the equation of FAO (1985) as follows:**

$$LR = \frac{ECiw}{ECe}$$

**Where,**

**ECiw = Salinity of irrigation water (dS m$^{-1}$) and ECe = average soil salinity tolerated by the crop as measured by soil saturated extract (dS m$^{-1}$).**

Soil physical and chemical analyses were performed for grain size distribution; organic matter; calcium carbonate; Ph; EC; soluble cations and anions; available macr- and micro-elements (Table 1). These analyses were also carried out for field capacity, wilting point, available water, and bulk density (Table 2).

**Table 1. Soil physical and chemical properties before peanut planting**

| Grain size distribution % | | | | Texture | | OM | | CaCO3 |
|---|---|---|---|---|---|---|---|---|
| **Coarse sand** | **Fine sand** | **Silt** | **Clay** | **class** | | **%** | | **%** |
| 10.55 | 62.78 | 12.30 | 14.37 | Sandy loam | | 0.72 | | 1.44 |
| pH (1:2.5) soil:watersusp | EC(dS/m) (1:5) | Soluble cations (meq/l) | | | | Soluble anions (meq/l) | | |
| | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $HCO_3$ | Cl | $SO_4^{--}$ |
| 7.92 | 1.80 | 5.93 | 3.78 | 7.44 | 0.85 | 1.12 | 6.12 | 10.76 |
| Available macronutrients (mg/kg) | | | | Available micronutrients (mg/kg) | | | | |
| N | P | K | | Fe | | Mn | | Zn |
| 38.21 | 4.90 | 188.00 | | 2.56 | | 1.08 | | 0.59 |

**Table 2. Field capacity wilting point, available water, and bulk density of studied soil**

| Field capacity (F.C.) % | | Wilting point (WP) % | | Available water (AW) % | | Bulk density (BD) g/cm$^3$ |
|---|---|---|---|---|---|---|
| w/w % | Mm | w/w % | Mm | w/w % | Mm | |
| 15.1 | 36.24 | 3.4 | 8.06 | 11.7 | 28.18 | 1.60 |

Under the current experimental conditions, no additional water was added for leaching to avoid any effect on stress treatments. In this study, the magnitude of Ea (1-LR) equals 0.8.

The ETc values were calculated according to the following equation given by FAO (1977):

$$ETc = ETo \times Kc$$

**Where,**

**ETc = Crop evapotranspiration (mm day$^{-1}$)**

**$ET_o$ = Potential evapotranspiration (mm/day) values obtained by Doorenbos-Pruitt equation.**

**Kc = Crop coefficient (Current Kc values published for peanut are given based on five growth stages Table (3) according to Allen *et al*., 1998.**

The water requirements were calculated by meteorological parameters (Table, 4) using the "WATER"computer model (Zazueta and Smajstrla, 1984) where, Reference evapotranspiration (ETo or ETp) was calculated by the equation of Doorenbos and Pruitt (1977) as follows:

$$ET_p = b\ w\ Rs/L - 0.3$$

**Where:**

**$ET_p$= Daily potential evapotranspiration (mm/day).**

**b = Adjustment factor based on wind and mean relative humidity.**

**w = Weighting factor based on temperature and elevation above sea level.**

**Rs = Daily total incoming solar radiation for the period of consideration (cal/cm$^2$/day).**

**L = Latent heat of vaporization of water (cal/ cm$^2$/ day).**

Factors (b) and (w) could be obtained from the tables cited by (Doorenbos and Pruitt 1977).

**Table 3. ETc values (mm/day and mm/month) of months for two summer seasons (2019 /2020).**

| Month | Kc FAO, 56 | Doorenbos-Pruitt (ETc) | | | |
|---|---|---|---|---|---|
| | | mm/day | mm/month | mm/day | mm/month |
| | | 2019 | | 2020 | |
| May ( 10 – 5 days) | 0.45 | 1.9 | 18.9 | 1.6 | 8.1 |
| June | 0.75 | 3.9 | 118.4 | 3.3 | 100.1 |
| July | 0.98 | 5.4 | 167.4 | 5.2 | 161.0 |
| August | 0.8 | 4.5 | 138.9 | 4.4 | 134.9 |
| September | 0.55 | 2.7 | 81.0 | 3.0 | 89.6 |
| Seasonal (mm) | | | 524.5 | | 493.7 |

**Table 4. Meteorological data in 2019 and 2020 seasons.**

| Month | *Meteorological data | | | | | | |
|---|---|---|---|---|---|---|---|
| | T.max | T.min | WS | RH | SS | SR | RF |
| | | | 2019 | | | | |
| May | 34.9 | 17.4 | 3.2 | 33.8 | 10.3 | 415 | 0.1 |
| June | 36.6 | 21.2 | 3.2 | 41.6 | 12.9 | 506 | 0.0 |
| July | 37.7 | 22.2 | 2.8 | 40.9 | 12.7 | 530 | 0.0 |
| August | 37.6 | 22.7 | 2.6 | 42.2 | 11.5 | 542 | 0.0 |
| September | 34.2 | 20.6 | 2.8 | 52.0 | 10.6 | 493 | 0.0 |
| | | | 2020 | | | | |
| May | 31.3 | 16.0 | 2.8 | 49.3 | 10.3 | 381 | 0.25 |
| June | 34.7 | 18.6 | 2.9 | 43.7 | 12.9 | 443 | 0.02 |
| July | 37.5 | 21.4 | 2.8 | 42.9 | 12.7 | 510 | 0 |
| August | 37.6 | 22.0 | 2.6 | 44.8 | 11.5 | 526 | 0 |
| September | 36.6 | 22.0 | 3.0 | 52.0 | 10.6 | 526 | 0 |

***[T.max and T.min= Maximum and minimum temperatures °C; WS = Wind speed (m/ sec); RH= Relative humidity (%); S.S= Actual sun shine (hour), SR= Solar radiation (cal/ $cm^2$/ day) and RF = Rainfall (mm / month)].**

**Soil organic amendments**

The organic amendments (compost, farm yardmanure and humic acid) were analyzed according tousing the standard methods as introduced by Brunner and Wasmer (1978). The obtained data were recorded in Table 5.

**Field experiment**

Spilt plot design with three replicates was used and the main plots were assigned to the organic amendments (compost, farmyard manure and humic acid) and control treatments, while the sub plots were assigned to three rates of applied irrigation water "AIW" which were defined as previously mentioned based on 60, pH was determined in suspension of 1:10 (organic amendment: water),while EC was determined in water extraction of 1: 20 (organic amendment: water), OM= organic matter, TC= Total Carbon, TN= Total Nitrogen.80 and 100 % of crop evapotranspiration "ETc".

**Table 5. Chemical analysis of the used organic amendments**

| Organic amendments | EC $dSm^{-1}$ | pH | C/N | TC | O.M | TN | P | K | Fe | Mn | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (%) | | | | | ($mgkg^{-1}$) | | |
| Compost | 3.35 | 7.4 | 17.03 | 24.70 | 33 | 1.45 | 0.83 | 1.37 | 225 | 97 | 130 |
| Farmyard manure | 4.73 | 7.39 | 20.22 | 46.51 | 37 | 2.30 | 0.88 | 2.75 | 195 | 94 | 134 |
| Humic acid | 2.77 | 7.77 | 21.55 | 47.19 | 70 | 2.19 | 1.66 | 3.88 | 213 | 157 | 116 |

The tested cultivar for beanut of Giza 6 (*Arachishypogaea L.*)was obtained from Crop Research Institute, Agriculture Research Center.

The experimental plots were divided into four groups. The first group was a control without amendments, the second and third groups were treated with 5 ton/fed of compost and farmyard manure respectively and the fourth group was treated with 50 kg /fed humic acid mixed with the soil. All soil organic amendments were applied mixed with soil before 15 days from planting. The area of each experimental plot was $4.8 \times 10$ $m^2$ which divided into rows with 60 cm. Three seeds were put in a hill with 3 cm depth where the distance between the hill and another was 10 cm. The plants were thinned to two plants per hill and then were singled to one plant per hill after 30 days of sowing where No's of plants became around 66500 plants/fed.

Single super-phosphate (15.5% $P_2O_5$) was added at a rate of 31 kg $P_2O_5fed^{-1}$ during soil preparation. Mineral N (ammonium nitrate 33.5 %) fertilizer was added in three equal dosed after 21, 45 and 65 days of sowing plant. Potassium sulphate (48 % $K_2O$) at rate of 75 kg $K_2O$ $fed^{-1}$ was added in two equal doses; after 30 and 50 days from planting. These mineral fertilizer rates were recommended by Egyptian Ministry of Agriculture bulletin (2018).

At harvest, a sample of ten plants of each plot was randomly taken and the average of following measurements were recorded: plant height (cm), No. of branches/plant, No. of pods/plant, weight of seeds (g/plant), weight of 100 seeds (g) , weight of seeds yield (ton/fed). Sample of 0.5 gm of oven dried seeds (at 70℃ for 48 hours) of each plot was digested to determine some macronutrients (N, P and K) in the diluted digest according to the methods described by Cottenie *et al.* (1982). The atomic absorption spectrophotometer was used to determine Fe, Mn, Zn, and Cu concentrations in the prior part according to the methods recommended by A.O.A.C. (2002). After harvesting, surface (0-30 cm) soil sample was taken separately from experimental plot to extract and determine the contents of available N, P, K, Fe, Mn, and Zn according to the methods described by Cottenie et al. (1982) and Page *et al.* (1982).

**Irrigation system**

Sprinkler irrigation system was used in this experiment, which consisted of control head unit that was located at the source of water supply, centrifugal pump with flow rate of 45.5 $m^3.fed^{-1}/hr$ (sprinkler discharge 1.3 $m^3$/ hr at 2.5 bar ), sand media filter of 100 mesh followed by screen filter of 120 mesh, pressure gauges, pressure regulator, control valves fertilizer tank and flow meter. The control head unit was connected to the main\ line with110 mm in diameter PVC, sub-main line of 90 mm PVC and sprinkler line of 75/63 mm PVC. The laterals were spaced 12 m apart. The sprinklers were spaced 10 meters lateral. Each two laterals and sprinklers have a control valve to adjust the quantity of applied water.

The quantity of applied water was exactly controlled with excellent uniform distribution of water. The number of sprinkler per fed was 35. The application rate (A) is calculated as follows:

$$A = K\frac{Qs}{LS}$$

**Where:**

**A= Application rate [mm/hr], Qs = Discharge of sprinkler [L/min], L= the distance between lateral [m], S= The distance between sprinklers on lateral [m], and K= Fraction equal 60.**

### Water utilization efficiency (WUE)

Applied irrigation water is used to describe the relationship between production and the amount of water applied. Water utilization efficiency (WUE) values were calculated according to Jensen (1983) as follow:

$$WUE = \frac{Seeds\ yield\ (kg/fed)}{Seasonal\ AIW\ (m^3 fed^{-1})}$$

## RESULTS AND DISCUSSIONS

### 1. Applied irrigation water AIW (m3 fed.$^{-1}$)

The quantities of applied irrigation water expressed as $m^3$/fed/day, $m^3$/fed/month, and $m^3$/fed/year for growing seasons of 2019 and 2020(Table 6). Average amounts of applied irrigation water were 1652, 2203 and 2754 $m^3$/fed/yr in the first season and 1555, 2074 and 2592 $m^3$/fed/year in the second season at the irrigation levels of 60, 80, and 100 % ET crop treatments, respectively. These results could be concluded that, the amount of applied irrigation water for a good yield of peanut crop was ≤ 2754 and 2592 $m^3$/fed/year (655 and 617 mm/fed/year in both seasons). The data showed that, the amounts of applied irrigation water (AIW) for peanut crop are higher in the first season than that found in the second. Such results are mainly due to differences in climatic factors such as the increasing in air temperatures. Attia and Hammad (1999) stated that maximum peanut pod yield was 1378.7 kg/fed with newly reclaimed sandy soils under drip irrigation system. While, seasonal amount of applied irrigation water and seasonal water consumptive use were 2835 and 2261.7 m3/fed./year, respectively.

The data in Table 6) show that, the lowest amounts of water requirements were found during May of both seasons and the highest amounts occurred during July. Average amounts of applied irrigation water during July were 527.3, 703.1 and 878.8 m3/fed./month in the first season and were 507.2, 676.3and 845.3 m3/fed./ month in the second season with irrigation levels of 60, 80, and 100 % ETc treatments, respectively. Monthly water consumption started low at the earlier growth periods and increased gradually with the increase of plant growth and the maximum of water consumption was in July, as a result of increased demand for water by plants (fig. 1). Therefore, soil moisture are mainly lose by evaporation.

**Table 6. Average monthly and seasonal irrigation water supplied to peanut crop in the seasonsof 2019 and 2020**

| Month | *AIW | 60 % | 80 % | 100 % | 60 % | 80 % | 100 % |
|---|---|---|---|---|---|---|---|
| | | | 2019 | | | 2020 | |
| May | $m^3$/fed./day | 6.0 | 7.9 | 9.9 | 5.1 | 6.8 | 8.5 |
| | $m^3$/fed/month | 59.5 | 79.4 | 99.2 | 25.4 | 33.8 | 42.3 |
| June | $m^3$/fed./day | 12.4 | 16.6 | 20.7 | 10.5 | 14.0 | 17.5 |
| | $m^3$/fed/month | 372.8 | 497.1 | 621.3 | 315.4 | 420.5 | 525.7 |
| July | $m^3$/fed./day | 17.0 | 22.7 | 28.3 | 16.4 | 21.8 | 27.3 |
| | $m^3$/fed/month | 527.3 | 703.1 | 878.8 | 507.2 | 676.3 | 845.3 |
| August | $m^3$/fed./day | 14.1 | 18.8 | 23.5 | 13.7 | 18.3 | 22.8 |
| | $m^3$/fed/month | 437.5 | 583.3 | 729.1 | 425.0 | 566.6 | 708.3 |
| September | $m^3$/fed./day | 8.5 | 11.3 | 14.2 | 9.4 | 12.5 | 15.7 |
| | $m^3$/fed/month | 255.2 | 340.3 | 425.3 | 282.2 | 376.3 | 470.4 |
| Total | $m^3$/fed/year | 1652 | 2203 | 2754 | 1555 | 2074 | 2592 |

***AIW = Applied irrigation water**

From soil surface at the earlier growth period butwith the advance of plant age, transpiration was increasing and consequently monthly water consumptive increased as a result of plant foliage developing. The water content in plants changes depending on soil moisture and air humidity, the season of the year and time of the day as well as plant age (Tarantino 1984).

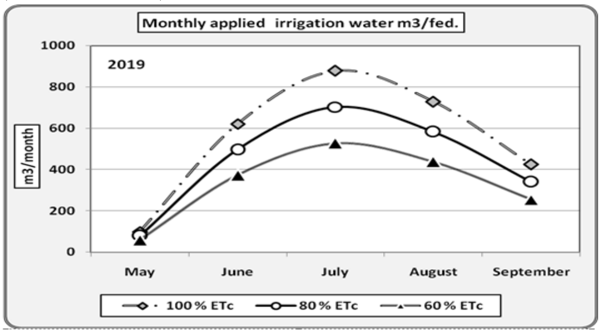


**Fig. 1.a Monthly applied irrigation water under irrigation tratments in 2019 seasons.**

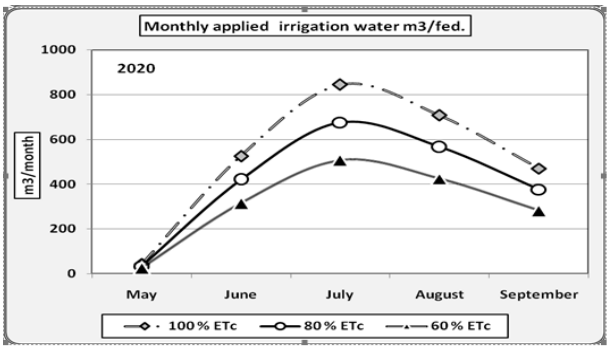


**Fig. 1.b Monthly applied irrigation water under irrigation tratments in 2020 seasons.**

Also, Denmead and Shaw (1962) found that water stress at certain phases of plant growth causes more injury than those at other stages. The critical period usually act at the time of reproductive organs formation and pollination and fertilization .

Accurate estimates of crop water requirements (crop evapotranspiration) are needed for improving irrigation management. To avoid crop water stress, water should be applied when needed throughout the growing season, especially during the flowering and pod development stages (Bandyopadhyay *et al.,* 2005).Wright *et al.*(1991) reported that crop water deficit that occurs during flowering to the start of pod growth phase reduced pod yield by17–25% for various varieties.

**2. Effects of different irrigation rates and organic amendments on soil and plant**

**Available macronutrients contents in soil**

Available macronutrients (N, P and K mg/kg soil) in the studied soil were presented in Table 7. The results showed a positive effect of different irrigation water rates individually and in combined with organic amendments on available N, P and K in soil after peanut harvest. The higher increase of available N, P and K in soil was found in the soil manured by farmyard manure in combined with different irrigation rates compared with other organic amendments. Increasing rates of irrigation water resulted in a significant increase of available N content in the soil, while the increase in the content of available P and K contents were not significant.

Also, the soil contents of available N and K as a result of organic amendments were significant, while the increase in the content of available P was not significant. The interaction effect between different rates of irrigation water and organic amendments on available contents of N and K were significant, while the found increase in the content of available was not significant. Mousa and Shaban (2017) indicated that the increase of N, P and K contents in soil were more pronounced at the highest rate of irrigation (3000 $m^3$ $fad^{-1}$) alone or combined with the prepared compost.

**Table7. Contents of available macro-micronutrients in soil after peanut plants harvest (Mean values of two seasons).**

| Organic amendments | Applied irrigation water | Available nutrients (mg/kg) | | | | | |
|---|---|---|---|---|---|---|---|
| | | N | P | K | Fe | Mn | Zn |
| Control | 60%Etc | 39.85 | 5.03 | 189.00 | 2.85 | 1.22 | 0.61 |
| | 80%Etc | 40.23 | 5.08 | 192.85 | 2.94 | 1.30 | 0.64 |
| | 100%Etc | 41.85 | 5.17 | 194.55 | 3.09 | 1.35 | 0.66 |
| | Mean | 40.64 | 5.09 | 192.13 | 2.96 | 1.29 | 0.64 |
| Compost | 60%Etc | 42.96 | 5.09 | 193.00 | 2.89 | 1.28 | 0.65 |
| | 80%Etc | 44.36 | 5.22 | 195.63 | 3.05 | 1.40 | 0.70 |
| | 100%Etc | 44.95 | 5.29 | 198.32 | 3.18 | 1.49 | 0.73 |
| | Mean | 44.09 | 5.20 | 195.65 | 3.04 | 1.39 | 0.69 |
| Humic | 60%Etc | 41.33 | 5.07 | 190.32 | 2.86 | 1.24 | 0.63 |
| | 80%Etc | 43.12 | 5.14 | 193.64 | 2.96 | 1.36 | 0.69 |
| | 100%Etc | 44.26 | 5.24 | 195.75 | 3.15 | 1.44 | 0.71 |
| | Mean | 42.90 | 5.15 | 193.24 | 2.99 | 1.35 | 0.68 |
| Farmyard manure | 60%Etc | 44.50 | 5.14 | 195.00 | 2.96 | 1.36 | 0.66 |
| | 80%Etc | 48.52 | 5.35 | 197.62 | 3.12 | 1.53 | 0.72 |
| | 100%Etc | 51.32 | 5.44 | 202.00 | 3.26 | 1.59 | 0.78 |
| | Mean | 48.11 | 5.31 | 198.21 | 3.11 | 1.49 | 0.72 |
| Mean | 60%Etc | 42.16 | 5.08 | 191.83 | 2.89 | 1.28 | 0.64 |
| | 80%Etc | 44.06 | 5.20 | 194.94 | 3.02 | 1.40 | 0.69 |
| | 100%Etc | 45.60 | 5.29 | 197.66 | 3.17 | 1.47 | 0.72 |
| $LSD_{0.05}$ | Organic amendments (O) | 1.9 | ns | 1.62 | ns | 0.022 | 0.06 |
| | Applied irrigation water(A) | 1.14 | ns | ns | ns | 0.021 | ns |
| Interaction (O×A) | | *** | ns | *** | ns | *** | ** |

The relative increase of available N, P and K contents were 7.72, 1.39 and 1.94 %, respectively with the treatment of irrigation water at rate 60% ETc in combined with different organic amendments compared with control treatment (without organic amendments).Also, the corresponding relative increases of available N, P and K contents in soil were 12.68, 3.07 and 1.44 % respectively, as affected with irrigation water at rate 80 % ETc combined with different organic amendments compared with control treatment. On the other hand, the relative increases in the contents of available N, P, and K were 11.93, 2.97 and 2.13 % respectively, at rate 100 % ETc combined with different organic amendments compared with control treatment.

The found increases in the soil contents of available N, P and K may be due to the application of organic fertilizers might be a result of its decomposition and producing organic acids, which increases the nutrients availability in the soil. It might also, be due to the increases of these nutrients after the decomposition of the organic fertilizers and preventing fixation of P and probably other nutrients (AbouHussien and Shaban, 2008).

**Available micronutrients contents in soil**

Data in Table 7 show that, treatment of applied irrigation water rates alone orin combination were associated by an increase in soil content (mg/kg) of available Fe, Mn and Zn. With the same treatment of irrigation water, the amended soils by farmyard manure have a high content of available Fe, Mn and Zn compared with those found in the soils treated by compost or humic acid. This trend was found with all treatments of the used organic amendment. The effect of irrigation water rates on the soil content of available Mn was significant while, this effect with content of available Fe and Zn were not significant. Differences between Mean values of available Mn and Zn contents as affected with organic amendments were significant while, this effect was not significant on the available Fe contents. Concerning, the interaction between irrigation water rates and organic amendments appeareda significant increase in the soil content of available Mn and Zn while, this effect on the available Fe content was not significant. The relative increases of mean values were 1.86, 6.01 and 6.01 for the soil content of available Fe, Mn and Zn respectively as affected with irrigation water at rate 60 % ETc combined with organic sources compared with control treatment (without organic amendments). Also, the relative increases of mean values were 3.50, 10.0 and 9.89 % for the soil content of available Fe, Mn and Zn respectively as affected with irrigation water at rate 80 % ETc combined with organic amendments compared with control treatment (without organic amendments). Also these values were 3.43, 11.85 and 12.12 for available Fe, Mn and Zn contents in soil as affected with irrigation water at rate 100 % ETc combined with organic amendments compared with control treatment. El-Galad *et al.* (2013) indicated that the application of humic acid and compost led to increases of micronutrients Fe, Mn and Zn in both seasons. Abou Hussien and Shaban(2008) found that the increase of irrigation water period from El-Salam Canal gave an increment of micronutrients content in saline soil. Getinet (2016) suggested that the increase of added compost to soil led to increasing macro-micronutrients content in soil.Mousa and Shaban (2017) reported that, the increases of Fe, Mn and Zn contents in soil were more pronounced at the highest rates of irrigation. Kuan and Daniel (2020) indicated that, the application of organic amendments as compost, humic substances and organic manure led to increases in soil Zn, Mn and Fe, Cu, and organic matter. Hamad and Tantawy(2018) found that, the organic amendment utilization increased the soil content of available nutrients and their contents in plant, i.e Fe, Mn and Zn.The effect was related to the residual of organic compounds that are directly decomposed after different biochemical and chemical changes resulting in releasingof more available microelements. It is worthy to mention that the contents of all the studied available microelements, in general, lay within the sufficient limits of Fe and Mn or in the critical limits identical division for the others (FAO, 1992).

**Growth parameters of peanut plants**

Data presented in Table 8 show that,growth parameters and seeds productivity of peanut plants i.e. plant height (cm), No. of branches /plant, No. of pods/plant, weight of seeds /plant, weight of 100 seeds (g) and weight of seeds yield (ton/fed) as affected by resources of organic amendments and irrigation water rates. These data show that, the highest values of the deteremined growth parameters and seeds productivity were found in the plants treated by compost with all rates of irrigation water compared with other treatments of organic amendments. The effect of irrigation water rates on all growth parameters was not significant except the effect on the No. of branches/plant which was significant. Also, the used organic amendments caused significant increase for plant height plant (cm), No. of branches /plant, No. of pods/plant, weight of seeds /plant, weight 100 seeds (g) and weight of seeds yield (ton/fed).The interaction between irrigation water rates and organic amendments were significant for all growth parameters of plant under study.

**Table 8.Growth characters and seeds yield of peanut.**

| Organic amendments | Applied Irrigation water | Plant height (cm) | No of branches per plant | No of pods per plant | Weight of Seeds (g/plant) | Weight of 100 seeds (g) | Weight of seeds yield (Ton/fed) |
|---|---|---|---|---|---|---|---|
| Control | 60%Etc | 52.34 | 5.32 | 22.63 | 15.89 | 66.40 | 1.057 |
| | 80%Etc | 54.63 | 6.21 | 24.87 | 17.32 | 68.39 | 1.152 |
| | 100%Etc | 55.19 | 6.66 | 28.74 | 18.63 | 73.29 | 1.239 |
| | Mean | 54.05 | 6.06 | 25.41 | 17.28 | 69.36 | 1.149 |
| Compost | 60%Etc | 60.25 | 7.63 | 26.58 | 19.34 | 73.20 | 1.286 |
| | 80%Etc | 67.52 | 8.88 | 28.94 | 25.66 | 77.50 | 1.706 |
| | 100%Etc | 72.32 | 9.95 | 38.68 | 29.87 | 82.19 | 1.986 |
| | Mean | 66.70 | 8.82 | 31.40 | 24.96 | 77.63 | 1.660 |
| Humic | 60%Etc | 55.34 | 6.88 | 24.85 | 17.32 | 69.40 | 1.152 |
| | 80%Etc | 62.10 | 7.12 | 27.66 | 19.42 | 73.28 | 1.291 |
| | 100%Etc | 65.88 | 8.52 | 33.54 | 26.31 | 77.46 | 1.750 |
| | Mean | 61.11 | 7.51 | 28.68 | 21.02 | 73.38 | 1.398 |
| Farmyard manure | 60%Etc | 58.75 | 7.12 | 25.99 | 18.59 | 71.55 | 1.236 |
| | 80%Etc | 65.89 | 7.89 | 28.10 | 22.47 | 75.49 | 1.494 |
| | 100%Etc | 69.52 | 9.47 | 35.41 | 28.75 | 78.43 | 1.912 |
| | Mean | 64.72 | 8.16 | 29.83 | 23.27 | 75.16 | 1.547 |
| Mean | 60%Etc | 56.67 | 6.74 | 25.01 | 17.79 | 70.14 | 1.183 |
| | 80%Etc | 62.54 | 7.53 | 27.39 | 21.22 | 73.67 | 1.411 |
| | 100%Etc | 65.73 | 8.65 | 34.09 | 25.89 | 77.84 | 1.722 |
| LSD 0.05 | Organic amendments (O) | 10.42 | 0.53 | 1.8 | 1.85 | 1.67 | 0.04 |
| | Applied irrigation water(A) | ns | 0.34 | ns | ns | ns | ns |
| Interaction (O×A) | | * | ** | *** | *** | *** | ** |

The relative increases of mean values were 11.03,35.53,14.05,15.92,7.50 and 44. 63 % for plant height (cm), No. of branches /plant, No. of pods/plant, weight of seeds /plant, weight of 100 seeds (g) and weight of seeds yield (ton/fed) respectively, as affected with irrigation water at rates 60 % ETc combined with organic amendments compared control. Concerning, the relative increases of mean values were 19.29 % for plant height plant (cm); 27.05 % for No. of branches /plant; 13.51 % for No. of pods/plant; 30.02 % for weight of seeds /plant; 10.28 % for weight 100 seeds (g) and 49.16 % for weight of seeds yield (ton/fed) as affected with irrigation water at rates 80 % ETc combined with organic amendments compared control. Also, the relative increases of mean values were 25.46, 39.79, 24.81, 51.96, 8.28 and 55.31 % for plant height plant (cm), No. of branches /plant, No. of pods/plant, weight of seeds /plant, weight 100 seeds (g) and weight of seeds yield (ton/fed)respectively as affected withirrigation water at rates 100 % ETc combined with organic amendments compared control. Therefore, it could be categorized the beneficial effects of the used irrigation water rates combined with organic amendments according the relative increase in all plant parameters as follows : 100 % ETc> 80 % ETc> 60 % ETc for plant height (cm) , weight of seeds/plant and seeds yield, 100 % ETc> 60 % ETc $m^3$> 80 % ETc for No. branches /plant and No. of pods/plant and was 80 % ETc> 100 % ETc> 60 % ETc $m^3$ for weight of 100 seeds (g) compared control (without organic amendments).

These results indicate that soil organic amendments inputs and deficit irrigation are valuable strategies to establish sustainable systems for peanut production, which will not only increase yield but also significantly improve soil quality and save irrigation water.

**Macronutrients concentrations in seeds of peanut plants**

Data in Table 9 showed that, the application of organic amendments with and without irrigation water rates resulted in an increase of macronutrients concentrations in seeds of peanut plants. The concentration of N, P and K in the seeds of peanut gave a high increase with compost application combined with different rates of compared with other treatments of organic amendments. Adding compost to sandy soil causes consequent increases in the concentration of macronutrients in seeds of peanut (Abd El-Hamid *et al*., 2013).

Data in Table 9raveled that, the increase effect of irrigation water rates on macronutrients (N, P and K concentrations in seeds peanut) wasnot significant, while the effect of applied organic amendments on N, P and K concentrations in the seeds was significant. The interaction between irrigation water rates and organic amendments gave a significant increase of P concentration in seeds while these effects on N and K concentrations in seeds were not significant. The relative increases of mean values were 7.31, 7.62 and 3.55 % of N, P and K concentrations in the seeds respectively as affected by organic amendments under irrigation water at rate 60 % ETccompared with the control and these values for N, P and K concentrationsin seeds were 9.54, 16.22 and 9.08 % respectively, as affected with organic amendmentswith irrigation waterat rate 80 % ETc compared with control (without organic amendments). Also these values were 18.43, 23.33 and 13.33 for available N, P and Kconcentrations in seeds respectively as affected with irrigation water at rate 100 % ETc combined with organic amendments compared with the control treatment.

**Table 9. Macro-micronutrient concentrations in seeds peanut**

| Organic amendments | Applied irrigation water | Nutrients concentration (Mg/Kg) | | | | | |
|---|---|---|---|---|---|---|---|
| | | N | P | K | Fe | Mn | Zn |
| Control | 60%Etc | 3.10 | 0.35 | 1.88 | 55.34 | 39.45 | 23.45 |
| | 80%Etc | 3.18 | 0.37 | 1.91 | 56.10 | 40.32 | 24.10 |
| | 100%Etc | 3.22 | 0.40 | 1.95 | 57.00 | 42.31 | 24.85 |
| | Mean | 3.17 | 0.37 | 1.91 | 56.15 | 40.69 | 24.13 |
| Compost | 60%Etc | 3.38 | 0.39 | 1.97 | 57.21 | 45.20 | 29.63 |
| | 80%Etc | 3.52 | 0.45 | 2.15 | 62.41 | 48.63 | 33.45 |
| | 100%Etc | 3.89 | 0.53 | 2.23 | 66.52 | 53.14 | 36.41 |
| | Mean | 3.60 | 0.46 | 2.12 | 62.05 | 48.99 | 33.16 |
| Humic | 60%Etc | 3.27 | 0.36 | 1.93 | 58.10 | 41.35 | 24.63 |
| | 80%Etc | 3.44 | 0.41 | 2.02 | 59.47 | 44.23 | 27.96 |
| | 100%Etc | 3.74 | 0.46 | 2.19 | 62.34 | 47.63 | 31.20 |
| | Mean | 3.48 | 0.41 | 2.05 | 59.97 | 44.40 | 27.93 |
| Farmyard manure | 60%Etc | 3.33 | 0.38 | 1.94 | 58.69 | 43.65 | 26.71 |
| | 80%Etc | 3.49 | 0.43 | 2.08 | 60.43 | 47.63 | 30.10 |
| | 100%Etc | 3.81 | 0.49 | 2.21 | 64.87 | 50.88 | 34.10 |
| | Mean | 3.54 | 0.43 | 2.08 | 61.33 | 47.39 | 30.30 |
| Mean | 60%Etc | 3.27 | 0.37 | 1.93 | 57.34 | 42.41 | 26.11 |
| | 80%Etc | 3.41 | 0.42 | 2.04 | 59.60 | 45.20 | 28.90 |
| | 100%Etc | 3.67 | 0.47 | 2.15 | 62.68 | 48.49 | 31.64 |
| | G.Mean | 3.45 | 0.42 | 2.04 | 59.87 | 45.37 | 28.88 |
| LSD 0.05 | Organic amendments (O) | 0.4 | 0.001 | ns | 1.75 | 0.83 | 0.25 |
| | Applied Irrigation Water(A) | ns | ns | ns | Ns | ns | ns |
| Interaction (O×A) | | ns | *** | ns | *** | *** | *** |

Application of tested organic amendments led to an increases in macronutrients (N, P and K %) concentrations in seeds of peanut which may be due to increase of the nutrients availability in the soil. These beneficial effects are most probably related to the improvements status of soil water regime of sandy soil, which in turn increases nutrients availability for plants. During the decomposition of organic matter, macro and micronutrients are merged into the soil matrix, allowing the soil to act as a storage of these nutrients (Abou Hussien *et al*., 2020 ).

**Micronutrients concentrations in seeds of peanut plants**

Data in Table 9show that, the application of compost, humic acid and farmyard manure to soil irrigated with different rates of irrigation water led to an increase in Fe, Mn and Zn concentrations in seeds. The high increases in mean values of Fe, Mn and Zn concentrations in the seeds were found in the plants grown on soil treated with different irrigation water rate combined with organic amendments. The effect of different irrigation water rateson the micronutrients concentration in seeds was not significant, while the effect of organic amendments on these concentrations were significant. Also, the interaction between different rates of irrigation water and organic amendments on the seeds content of micronutrients was significant**.** Generally, applications of organic amendments under the three rates of irrigation water caused markedly increases in the concentrations of Fe, Mn and Zn in seeds, with a more pronounced increase with increment of irrigation water rate from 60 to 80 and 100 % ETc. These results are the same as concluded by Gonzalez and Cooperband, (2003) who reported that adding organic manures to the soils increased nutrients uptake. The increase of micronutrients concentrations in seeds were referred to compost, humic substances and farmyard manure role in improving soil physical and chemical properties and providing the energy for microorganism activity .

**3. Water utilization efficiency (WUE)**

As shown in fig. 3, the values of WUEreveal that, the highest WUE was detected in treatment of compost with 60% ETc while the lowest WUE was found in treatment of control (without organic amendment) fewer than 100% ETc. The mean values of WUE for peanut as affected by different organic amendments with 60, 80 and 100%ETc were arranged as follows:compost> farmyard manure >humic> control.

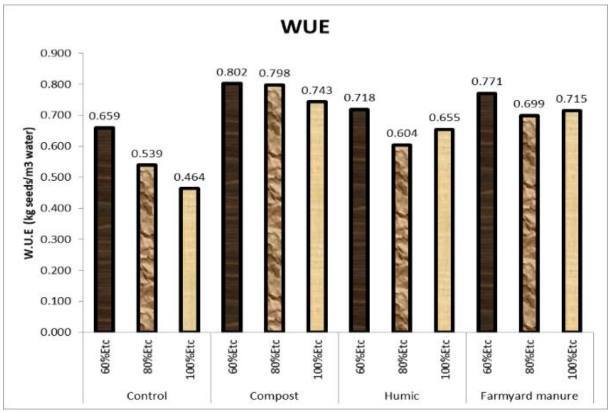


**Fig. 3. Mean values of WUE for peanut crop as affected by organic amendments and irrigation water quantity**

The data presented in fig. 4 pointed that, mean values of water utilization efficiency (WUE) for peanut crop as affected by different applied organic amendments under different rates of irrigation water were as follows: 0.781, 0.728, 0.659 and 0.554 kg seeds / m$^3$ water with the application of compost, farmyard manure, humic acid and control, respectively. Organic fertilizers increases the efficiency of the irrigation water over the control in wheat (Deng *et al*., 2004).Yassen *et al*. (2006) recorded pronounced effect of cattle manure (CM) on enhancing the water use efficiency WUE of grain crops.

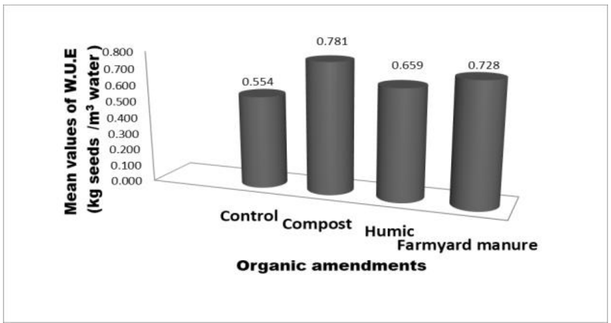


**Fig. 4. The individual effect of organic amendments on WUE for peanut crop.**

The mean values of WUE as a result of individual effect of irrigation water rates were showed in Fig. (5). These mean values gradually decreased with increasing irrigation water quantity in the order of 60% ETc> 80% ETc> 100% ETc .Zeng *et al.* (2009) and Tiwari et al. (2003) found that the yield per unit quantity of water used increased by increasing water deficit.

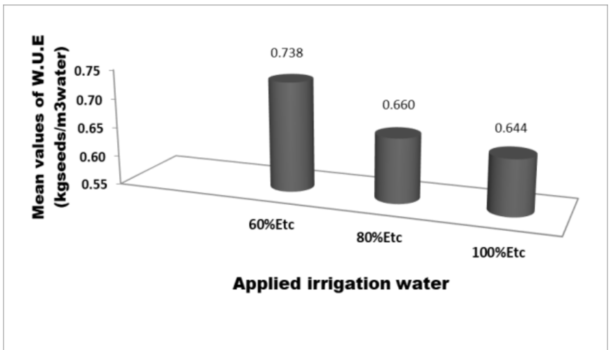


**Fig. 5. The individual effect of applied irrigation water on WUE for peanut crop.**

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# تأثيرمعدلات الري المختلفة والمحسنات العضوية علي انتاجية تربة الطمى الرملى للفولالسوداني

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تم إجراء تجربة حقلية في المناخ شبه الجاف بمحطة البحوث الزراعية بالإسماعيلية - بمحافظة الإسماعيلية خلال الموسمين المتتاليين (2019 و 2020) لدراسة تأثير ثلاث كميات من مياه الري المختلفة و هي 60 و 80 و 100٪ من (ETc) معثلاثة مصادر من الاسمدة العضوية (كمبوست بمعدل 5 طن / فدان ، سماد بلدي بمعدل 5 طن / فدان وحمض الهيوميك بمعدل 50 كجم / فدان) على خصوبة التربة وإنتاجية الفول السوداني. ويمكن تلخيص أهم النتائج فيما يلي: سجلت مياه الري المضافة (2754 و 2203 و 1652 م 3 / فدان) في الموسم الأول و (2592 و 2074 و 1555 م 3 / فدان) في الموسم الثاني والتي تساوي 60 و 80 و 100٪ من الاستهلاك المائي للمحصول ، على التوالي. أدت زيادة كمية مياه الري إلى زيادة خصائص النمو للفول السوداني في الموسمين. أدى الكمبوست والسماد البلدي إلى زيادة ملحوظة في معظم صفات النمو بالمقارنة بالكنترول. المستوى الاعلي من الري (100٪ من ETc) مع إضافة الكومبوست كان له التأثير الأكبر على معظم صفات النمو في موسمي الدراسة. الحد الأقصى لقيمة المحصول الكلي طن / فدان. تم الحصول عليها عند معاملة نباتات الفول السوداني بالكمبوست تحت مستوى الري المرتفع (100٪ ETc) بالمقارنة مع المعاملات الأخرى. كما زاد متوسط كفاءة استخدام المياه (WUT) باستخدام 60٪ من ETc تليها 80٪ من ETc ثم 100٪ من ETcوسجلت (0.714 و 0.590 و 0.512 كجم بذور / م 3 ماء) على التوالي. وكذلك أعطى الكومبوست والسماد البلدي وحمض الهيوميك اعلي كفاءة لاستخدام المياه بنسبة 54.6 و 50.6 و 42.0٪ أعلي من الكنترول على التوالي. كما كانت قيم كفاءة استخدام المياه القصوى 0.812 كجم بذور / م 3 من المياه عن طريق الري 60٪ ETc مع الكمبوست.