IMPACT OF IRRIGATION WATER REGIMES AND ANTI-TRANSPIRATIONS WITH HYDRO-GEL ON NUTRITIONAL STATUS OF PEANUT GROWN IN SANDY SOIL

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ABSTRACT: Two field experiments were carried out on a newly reclaimed sand soil under drip irrigation system at Ismailia Agricultural Research Station, Ismailia Governorate, Egypt located between Latitude 30° 35' 30" N, Longitude 32° 14' 50" E and Elevation 3 meters, and cultivate with peanut plants as summer season (Arachis hypogaea, Giza 5 c.v) during the agricultural growing season of 2016 and 2017 at rate of 50 kg fad°1. To evaluate foliar application of some anti-respiration (chitosan at rate of 0.0, 5.0, 10.0) and (abscisic acid at rate of 0.0, 15.0, 20.0 mg l−1), as foliar spray afternoon at three times after three weeks from sowing (30, 60 and 90 days) and applied hydrogel at rate of zero, 2 and 3% as soil application under two irrigation water requirements 100 and 75% (1125 and 884 m3 fad). Results obtained showed that: It was clear that applied irrigation water requirements at rate 100% with foliar spray of 5 mg l−1 chitosan and soil application of hydrogel at rate of 2% on both seed yield of peanut and contents of macro-nutrients (N, P and K) and micro-nutrias (Fe, Mn and Zn) for seeds and high water use efficiency at irrigation water requirements 100% accompanied with foliar application of abscisic acid and hydrogel at rate of 3%.

Key word: Irrigation water, anti-raspirations, drip irrigation system, nutritional status, peanut plants, sandy soils.

INTRODUCTION

Peanut (Arachis hypogaea L.) is one of the most important cash crops grown in Egypt (Shaban et al., 2009). Increasing planted area of peanut is considered a good way to improve its production (El-Hameed, 2005). Nutritional quality of oil is determined by its fatty acid composition. Oleic, a monounsaturated acid, and linoleic, a polyunsaturated fatty acid, account for 75-80% of the total fatty acids in peanut oil. Oleic/linoleic acid ratio and iodine value are both indicators of oil stability and shelf life of peanut products. Peanuts with high oil ratio and low iodine value have long product stability (Dwivedi et al., 1993).

Plants under water stress can avoid the harmful of drought throw several ways among them stomatal closure, leaf rolling, osmotic adjustments, reductions and consequently decreases in cellular expansion, and alterations of various essential physiological and biochemical processes that can affect growth, productivity and yield quality (Hefny, 2011; Farouk and Ramadan, 2012). In this respect, Bittelli et al. (2001) reported that occasional or episodic drought events can be counteracted through the use of anti-transpirants, compounds applied to foliage to limit the water loss. These compounds are able to increase leaf resistance to water vapor loss, thus improving plant water use and increasing biomass or yield (Tambussi and Bort, 2007).

The hydrogel has the ability to function in absorption-desorption cycles of water and nutrients, releasing them to the plants.
accompanying low physiological constituents in plant shoot under the frequency of irrigation (Sivapalan, 2006). In addition, they enhance the efficiency of fertilizer use (El-Hady and Wanas, 2006).

Water stress impaired the growth of plants and decreased the content of nutrient elements and photosynthetic pigments as well as carbohydrate concentration in shoots. Also water stress affects the yield and its quality represented by nutrient elements, protein and carbohydrate concentrations. Foliar-applied chitosan, in particular 200 mg l$^{-1}$, increased plant growth, yield and its quality as well as physiological constituents in plant shoot under stressed or non-stressed conditions as compared to chitosan untreated plants. It is suggested that chitosan could be a promising material used to reduce the harmful effect of water stress on the growth and yield of common plant (Abu-Muriefah, 2013).

Peanut has the potential to have very high photosynthetic capacity accompanied by low stomatal conductance levels, translating into high WUE without sacrificing carbon assimilation and possibly yield (Wright et al., 1993).

The objectives of this study are to evaluate the impact of some anti-respiration and hydrogel with irrigation water regimes on productivity and nutritional status of both peanut plant grown under sandy soil conditions and to increase water use efficiency.

**MATERIALS AND METHODS**

A field experiment was conducted on a newly reclaimed sandy texture class under drip irrigation system at Ismailia Agricultural Research Station, Ismailia Governorate, Egypt, and cultivated with peanut plants as summer season (Arachis hypogaea, Giza 5) during the agricultural growing season of 2016 and 2017. The current study aims to evaluate foliar application of anti-Transpiration chitosan and abscisic acid at rate of 0.0, 5.0, 10.0 and 0.0, 15.0, 20.0 mg l$^{-1}$, respectively at different water requirements 100 and 75% (1125 and 884 m$^{3}$ fad$^{-1}$) on nutrient contents in soil, seeds productivity, nutritional status of peanut plants, and water use efficiency. Some physical and chemical properties of studied sandy soil are illustrated in Table 1.

Irrigation water requirement for peanut plant is 1125 m$^{3}$ fad$^{-1}$. The design was split-split plot, two irrigation water regimes are 100 and 75% from water requirement (1125 and 884 m$^{3}$ fad$^{-1}$) as main plots. Two type of anti-transpiration were used as sub plots with three concentration rates as sub-sub plots of chitosan at rate of 0.0, 5.0 and 10.0 g l$^{-1}$ and abscisic acid at rate of 0.0, 15.0 and 20.0 g l$^{-1}$. Two application rates applied of hydro-gel at 0.0, 2.0 and 3.0% as soil application.

All peanut plots received 40 kg fad$^{-1}$ nitrogen as ammonium sulphate (20.6% N), added as basal doses in two equal ones (one and two months after planting). Phosphorus was (12.0% P$_{2}$O$_{5}$), while K was added with a rate of 50 kg fad$^{-1}$ K$_{2}$O as potassium sulphate (48% K$_{2}$O) during the preparation of soil cultivation.

Physical, chemical and fertility properties of the investigated soil (bulk density, total porosity, hydraulic conductivity, moisture constants and nutrients retained) at elongation stage of vegetative growth were determined according to the standard methods as described by Piper (1950), Richards (1954) and Page et al. (1982). Available N, P and K were extracted by 1.0% K$_{2}$SO$_{4}$ 0.5 M solution sodium bicarbonate and 1.0 N ammonium acetate, respectively and were determined according to Jackson (1981). Available micronutrients of Fe, Mn and Zn were extracted by DTPA (Lindsay and Norvell, 1978) and determined using Atomic Absorption Spectrophotometer.

Yield of peanut and seed nutrient contents of N, P, K, Fe, Mn and Zn were determined.

For each plot, the selected samples for both seeds and foliage were dried; ground and wet digested using mixture of H$_{2}$SO$_{4}$+HClO$_{4}$ acid. In the digested products, N was determined with 2$^\text{nd}$ Jackson (1981) and abscisic acid. Phosphorus was determined colourometrically according to Watanab and Olsen (1965). Water use efficiency (WUE, kg ha$^{-1}$ cm$^{-1}$) was calculated using the equation of Vites (1965) for grain yield, as followed formula:

$$\text{WUE} = \frac{\text{Seed yield in kg ha}^{-1}}{\text{actual consumptive use in m}^{3} \text{ ha}^{-1}}.$$
Table 1. Some physical and chemical properties of the experimental soil

| Soil characteristic                  | Value  | Soil characteristic                  | Value  |
|--------------------------------------|--------|--------------------------------------|--------|
| Particle size distribution (%)       |        | Soluble cations (soil paste mmole \(L^{-1}\)) |        |
| Sand                                 | 87.25  | Ca\(^{2+}\)                           | 0.82   |
| Silt                                 | 8.90   | Mg\(^{2+}\)                           | 0.58   |
| Clay                                 | 3.85   | Na\(^{+}\)                            | 0.95   |
| Textural class                       | Sand   | K\(^{+}\)                             | 0.14   |
| Soil chemical properties             |        | Soluble anions (soil paste mmole \(L^{-1}\)) |        |
| pH (1:2.5 soil water suspension)     | 7.69   | CO\(_3^{2-}\)                         | 0.00   |
| CaCO\(_3\) (%)                      | 1.33   | HCO\(_3^{-}\)                         | 1.45   |
| Organic carbon (%)                  | 0.21   | Cl\(^{-}\)                            | 0.71   |
| ECE (dS m\(^{-1}\), soil paste extract) | 0.25   | SO\(_4^{2-}\)                         | 0.34   |
| Soil physical properties            |        |                                      |        |
| Bulk density g cm\(^{-3}\)          | 1.68   | Total aggregate (%)                  | 14.79  |
| Hydraulic conductivity (cm hr\(^{-1}\)) | 5.84   | Avail. Water (%)                     | 7.11   |
| Soil moisture at wilting point (%)   | 4.98   | Soil moisture at field capacity (%)   | 12.09  |
| Available nutrients mg kg\(^{-1}\)  |        |                                      |        |
| N                                   | 11.79  | P                                    | 5.58   |
| P                                   |        | K                                    | 70.01  |
| K                                   |        | S                                    | 0.99   |
| S                                   |        | Fe                                   | 6.42   |
| Fe                                  |        | Mn                                   | 0.88   |
| Mn                                  |        | Zn                                   | 0.51   |

Potassium was determined using a Flamephotometer, according to Jackson (1981). Iron, manganese and zinc were determined using an Atomic Absorption Spectrophotometer. All collected data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The current work may be helpful for identifying the best soil agro-management practices of some newly reclaimed soils for maximizing their productivity, especially for soils have no partially capable to retain neither water nor nutrients for growing plants. In addition, these soils are poor not only in the nutrient-bearing minerals, but also in organic matter, which are a storehouse for the essential plant nutrients; in turn the productivity of different crops tends to decrease markedly (Moustafa et al. 2005).

Soil Properties

The experimental soil is mainly developed on the sand deposits as a parent material, and occupying the desert zone adjacent to Ismailia Governorate, Egypt. The prevailing climatic conditions of the studied area are long hot rainless summer and short mild winter with scare amounts of rainfall. The obtained results in Table 2 reveal that, the studied soil is characterized by coarse texture grade of sand and low CEC value as well as poorer in each of organic matter and nutrient bearing minerals, consequently its capacity to retain either plant nutrients or soil moisture is low. Such severe conditions get more attention for soil supplying essential nutrients to plants as well as soil amendments. That is true, since the available macro and micronutrient contents in the experimental sandy soil (Table 2) are lying at the low levels according to the critical levels of
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Table 2. Soil limitations and rating indices for the evaluation of the studied soil

| Source               | Rating (Ci) | Class | Sub class |
|----------------------|-------------|-------|-----------|
| Topography           | 100         | S3    | S3S1S4    |
| Wetness              | 100         | S3    | S3S1S4    |
| Soil texture (S1)    | 30          |       |           |
| Soil depth (S2)      | 100         |       |           |
| CaCO$_3$ (S3)        | 100         |       |           |
| Gypsum (S4)          | 90          |       |           |
| Soil Salinity/Alkalinity (o) | 100     | S3    | S3S1S4    |

available plant nutrients outlined by Lindsay and Norvell (1978) and Page et al. (1982). Such unfavorable conditions are more attributed to the siliceous in nature of soil, which is dominated by sand fraction that is not only poorer in the nutrient bearing minerals but also it is not partially capable to retain nutrients or moisture for grown plants.

According to USDA (2006), data presented in Table 2 indicate that, by applying the parametric system undertaken by Sys and Verheye (1978), the suitability class of studied sandy soil could be evaluated as marginally suitable class of (S3) either in current or potential conditions, besides soil texture (S1) and gypsum (S4) represent the most effective limitations for soil productivity, with intensity degrees of very severe (rating < 40) and slight (rating > 90), respectively.

Effect of Water Regime with Hydro-Gel with Different Anti-transpiration

Peanut seeds yield

Results recorded in Table 3 show that the application of two anti-transpiration (chitosan and abscisic acid) combined with 100 and 75% irrigation water at 2% application rate of hydrogel resulted in a significant increases in yield of peanut seeds. Further, hydrogel addition improved water storage properties of porous soils and resulted in the delay and onset of permanent wilting percentages under intense evaporation. An increase in water holding capacity due to hydrogel significantly reduced the irrigation requirement of many plants (Taylor and Halfacre, 1986).

Results presented in Table 3 reveal that reducing irrigation requirements for 75% and the application of chitosan or abscisic acid at both rate under study gave less seed yield compared to 100% irrigation water applied under same condition. Drought resistance may be enhanced by improving the ability of the crop to extract water from the soil. Deep rooting, root length density and root distribution have been identified as drought adaptive traits (Songsri et al., 2008). It is worth to note that 3.0% applied hydrogel combined with abscisic acid at rate of 20 mg l$^{-1}$ gave the lowest yield compared with the other treatments used.

The available results in Table 3 revealed that the effect of 100% irrigation water on peanut seeds yield was significantly increased with increasing the rate of hydro-gel from 0 to 2% under both foliar spray of anti-transpiration. The application of hydrogels may be be an important practice to assist plant growth by increasing water retention in sandy soils and its availability to grow in dry regions. The soil applied with hydrogel is known to improve seed and increases the quantity of available water and reduces plant stress with influence seed germination, growth, and the yields of plants (Wallace and Wallace, 1986).

Results in Table 3 show the effect of the interaction between 100% water requirement and chitosan at rate of 5.0 mg l$^{-1}$ accompanied with 2.0 % soil application of hydro-gel. The interaction was significant and more pronounced on peanut yield. This result may be explained by that hydrogels increased the efficiency of water use and reduce the frequency of irrigation (Sivapalan, 2006). In addition, they enhance the efficiency of fertilizer use (El-Hady and Wanas, 2006).
Table 3. Effect of water regime with hydro-gel soil application and different anti-transpiration types on yield (kg fad.⁻¹) of peanut plants grown in sandy soil

| Hydro-gel (%) (H) | Anti-transpiration types (A) | Control | Chitozan | Abscisic acid | 5 | 10 | Mean | 15 | 20 | Mean | Seed yield (Kg fad.⁻¹) |
|------------------|-----------------------------|---------|----------|---------------|---|----|------|----|----|------|----------------------|
|                  |                             | mg l⁻¹   |          |               |   |    |      |    |    |      |                      |
|                  | 100% from water requirements (R) |         |          |               |   |    |      |    |    |      |                      |
| 0                |                             |          |          |               | 976.8 | 1698.4 | 1612.3 | 1429.1 | 1533.8 | 1435.9 | 1331.9 |
| 2                |                             |          |          |               | 979.2 | 1765.0 | 1665.1 | 1469.7 | 1561.6 | 1472.6 | 1484.8 |
| 3                |                             |          |          |               | 910.0 | 1675.7 | 1567.9 | 1384.5 | 1439.0 | 1306.8 | 1223.1 |
| Mean             |                             |          |          |               | 955.3 | 1713.0 | 1615.1 | 1427.8 | 1511.4 | 1405.1 | 1346.6 |
| 75% from water requirements |                 |          |          |               |   |    |      |    |    |      |                      |
| 0                |                             |          |          |               | 943.9 | 1333.8 | 1275.1 | 1304.4 | 1258.3 | 1234.7 | 1146.5 |
| 2                |                             |          |          |               | 961.5 | 1406.1 | 1309.0 | 1225.5 | 1300.9 | 1243.2 | 12168.5 |
| 3                |                             |          |          |               | 923.6 | 1299.0 | 1275.3 | 1165.9 | 1234.7 | 1221.0 | 1126.4 |
| Mean             |                             |          |          |               | 942.5 | 1346.3 | 1286.4 | 1231.9 | 1264.6 | 1232.9 | 1180.4 |
| LSD at 0.05      |                             |          |          |               | 12.3 | 10.7 | 6.2  | 7.8  | 2.3  | 4.4  | 25.3  |

Nutritional Status of Peanut Plants

Mineral nutrients such as nitrogen, phosphorus, and potassium and calcium ion play multiple essential roles in plant mechanisms (Junjittakarn et al., 2013).

Macronutrients content

The results obtained of macro-nutrients (N, P and K) content of peanut plants in Tables 4, 5 and 6 show that irrigation water applied at 100% (1125 m³ fad.⁻¹) was more efficient than that applied at 75%. These results may be due to nutrient transportation to the root and root growth. Drought generally reduces nutrient uptake in crop plants and concentrations of mineral nutrients in plant tissues (Fageria et al., 2002). Generally, nutrient uptake by crop plants grown in soil is greatly influenced by several factors including climate and water stress (Alam, 1999). Drought stress reduced the uptake of N, P and K in peanut (Kulkarni et al., 1988). The reduction in nutrient uptake by plant under drought stress is due to reduced transpiration and impaired active transport and membrane permeability resulting in reduced root absorbing power (Junjittakarn et al., 2013). Moreover, water stress at flowering, beginning, pod formation and pod development stages reduced pod yields of peanut and it also reduced the uptake of N, P, K, Ca, magnesium and sulfur (Kolay, 2008). Under drought stress conditions, the available soil N (NO₃⁻ and NH₄⁺) and N₂ fixation is greatly reduced and such reduction leads to low N accumulation and consequently low dry matter production and low crop yield (Pimratch et al., 2013).

Concerning the anti-transpiration type and rates, results obtained showed that the same effect on macronutrients content as previously was found at all studies parameters. Chitosan was more effective at rate of 5 mg kg⁻¹ at both 100% and 75% irrigation water than data obtained under abscisic acid condition.
Table 4. Effect of water regime with hydro-gel soil application and different anti-transpiration types on nitrogen content (g kg\(^{-1}\)) of peanut plants grown in sandy soil

| Hydro-gel (%) (H) | Control | Chitozan | Abcissic acid | mg l\(^{-1}\) | 100% from water requirements requirements (R) | Mean | 15 | 20 | Mean |
|------------------|---------|----------|---------------|---------------|-----------------------------------------------|------|-----|----|------|
| 0                | 0.169   | 0.472    | 0.444         | 0.361         | 0.387                                          | 0.411| 0.322|
| 2                | 0.191   | 0.587    | 0.465         | 0.414         | 0.291                                          | 0.365| 0.282|
| 3                | 0.150   | 0.589    | 0.409         | 0.382         | 0.271                                          | 0.211| 0.210|
| Mean             | 0.17    | 0.549    | 0.439         | 0.386         | 0.316                                          | 0.329| 0.271|
| 75% from water requirements requirements |
| 0                | 0.155   | 0.311    | 0.323         | 0.277         | 0.261                                          | 0.253| 0.227|
| 2                | 0.143   | 0.354    | 0.392         | 0.282         | 0.274                                          | 0.283| 0.229|
| 3                | 0.131   | 0.233    | 0.220         | 0.194         | 0.183                                          | 0.152| 0.155|
| Mean             | 0.143   | 0.998    | 0.971         | 0.277         | 0.239                                          | 0.229| 0.203|
| Grand mean       | 0.156   | 0.773    | 0.705         | 0.331         | 0.277                                          | 0.279| 0.237|
| LSD at 0.05      | H       | R        | A             | H×R           | H×A                                           | R×A | H×R×A|
|                  | 0.23    | 0.12     | 0.33          | 0.11          | 0.21                                           | 0.09 | 0.16 |

Table 5. Effect of water regime with hydro-gel soil application and different anti-transpiration types on phosphorus content (g kg\(^{-1}\)) of peanut plants grown in sandy soil

| Hydro-gel (%) (H) | Control | Chitozan | Abcissic acid | mg l\(^{-1}\) | 100% from water requirements requirements (R) | Mean | 15 | 20 | Mean |
|------------------|---------|----------|---------------|---------------|-----------------------------------------------|------|-----|----|------|
| 0                | 0.332   | 0.808    | 0.734         | 0.624         | 0.446                                          | 0.563| 0.447|
| 2                | 0.316   | 0.711    | 0.645         | 0.557         | 0.365                                          | 0.479| 0.386|
| 3                | 0.211   | 0.623    | 0.563         | 0.465         | 0.240                                          | 0.274| 0.241|
| Mean             | 0.286   | 0.714    | 0.647         | 0.549         | 0.350                                          | 0.438| 0.358|
| 75% from water requirements requirements |
| 0                | 0.244   | 0.418    | 0.301         | 0.321         | 0.318                                          | 0.2671| 0.276|
| 2                | 0.287   | 0.444    | 0.350         | 0.360         | 0.344                                          | 0.301| 0.310|
| 3                | 0.210   | 0.390    | 0.285         | 0.295         | 0.290                                          | 0.266| 0.255|
| Mean             | 0.247   | 0.417    | 0.312         | 0.325         | 0.317                                          | 0.278| 0.280|
| Grand mean       | 0.266   | 0.565    | 0.479         | 0.437         | 0.333                                          | 0.358| 0.319|
| LSD at 0.05      | H       | R        | A             | H×R           | H×A                                           | R×A | H×R×A|
|                  | 0.321   | 0.221    | 0.111         | 0.089         | 0.088                                          | 0.108| 0.096|
Table 6. Effect of water regime with hydro-gel soil application and different anti-transpiration types on potassium content (g kg\(^{-1}\)) of peanut plants grown in sandy soil

| Hydro-gel (%) (H) | Anti-transpiration types (A) | Control | Chitozan | Abcissic acid | mg l\(^{-1}\) |
|------------------|-----------------------------|---------|---------|--------------|-----------|
|                  | 5   | 10 | Mean | 15 | 20 | Mean |
| **100% from water requirements (R)** |     |     |      |    |    |     |
| 0                | 0.176 | 0.314 | 0.267 | 0.252 | 0.209 | 0.201 | 0.195 |
| 2                | 0.197 | 0.319 | 0.299 | 0.271 | 0.285 | 0.229 | 0.237 |
| 3                | 0.153 | 0.301 | 0.263 | 0.239 | 0.198 | 0.174 | 0.175 |
| **Mean**         | 0.175 | 0.311 | 0.276 | 0.254 | 0.230 | 0.201 | 0.202 |
| **75% from water requirements** |     |     |      |    |    |     |
| 0                | 0.166 | 0.182 | 0.175 | 0.176 | 0.162 | 0.150 | 0.159 |
| 2                | 0.158 | 0.197 | 0.190 | 0.179 | 0.177 | 0.168 | 0.167 |
| 3                | 0.140 | 0.166 | 0.186 | 0.164 | 0.155 | 0.146 | 0.147 |
| **Mean**         | 0.154 | 0.181 | 0.183 | 0.173 | 0.164 | 0.154 | 0.158 |
| **Grand mean**   | 0.164 | 0.246 | 0.229 | 0.213 | 0.197 | 0.177 | 0.180 |
| **LSD at 0.05**  | H×R | A×H | H×A×R | H×A | R×A | H×R×A |

On the other hand, results also indicated that the hydro-gel at 2% in sandy soil application was more effective on nutrients (N, P, and K) content of peanut plants than 3.0% pronounced.

From the aforementioned results, it could be concluded that peanut plant under different water irrigation application accompanied with 2% soil application of hydro-gel with foliar spray of anti-transpiration chitosan at rates of 5.0 and 15 mg l\(^{-1}\) abscisic acid, has higher macronutrients contents under study.

**Micronutrients content**

The values of the interaction between amount of irrigation water, hydro-gel and anti-transpiration are given in Tables 7, 8 and 9. The results showed that irrigating peanut plants by 1125 m\(^3\) fad.\(^{-1}\) and application of hydro-gel at rate of 2.0% with foliar spray of 5.0 mg l\(^{-1}\) chitosan and 15 mg l\(^{-1}\) abscisic acid resulted in remarkable increases micronutrients (Fe, Mn and Zn) content of peanut. Nerveless, decreasing the amount of irrigation water from 1125 to 884 m\(^3\) fad.\(^{-1}\) decreased the micronutrients content.

This behavior may be due to soil moisture that plays an important role in the movement of nutrient to root and consequent absorption and final concentration in the plants. Similar findings were noticed by Gunes et al. (2006) who stated that decreasing water availability under drought generally results in reduced total nutrient uptake and frequently causes reduced concentrations of mineral nutrients in crop plants. Water deficit had important effect on the nutrient transport. Ghanbari et al. (2011) noted that yield, plant growth and nutrient uptake were reduced under conditions of drought. Since the reduction in soil water availability affects the rate of diffusion of many plant nutrients, the compositions and concentrations of soil solutions are also affected by drought.

**Water Use Efficiency (WUE)**

Results in Table 10 show the water use efficiency for peanut plants grown under drip irrigation system and irrigation water regime with different foliar application of anti-transpiration types and rates accompanied with soil application rate of hydro-gel.
Table 7. Effect of water regime with hydro-gel soil application and different anti-transpiration types on iron content (mg kg\(^{-1}\)) of peanut plants grown in sandy soil

| Hydro-gel (%) (H) | Control | Chitozan | Abcissic acid | 5 | 10 | Mean | 15 | 20 | Mean |
|------------------|---------|----------|---------------|---|----|------|---|----|------|
| 0                | 97.6    | 287.0    | 237.3         | 207.3 | 151.7 | 209.9 | 150.1 |
| 2                | 108.6   | 333.5    | 248.0         | 230.0 | 171.3 | 226.4 | 168.7 |
| 3                | 94.7    | 273.4    | 205.2         | 191.1 | 144.7 | 195.5 | 144.9 |
| Mean             | 100.3   | 298.0    | 230.3         | 209.4 | 155.9 | 207.6 | 154.6 |

100% from water requirements (R)

| 0                | 90.3    | 166.7    | 161.0         | 139.3 | 157.3 | 156.1 | 134.6 |
| 2                | 100.9   | 170.3    | 165.8         | 145.7 | 164.9 | 162.7 | 142.8 |
| 3                | 88.9    | 162.8    | 159.8         | 137.2 | 152.8 | 145.7 | 129.1 |
| Mean             | 93.4    | 166.6    | 162.2         | 140.7 | 158.3 | 154.8 | 135.5 |
| Grand mean       | 96.9    | 232.3    | 196.3         | 175.1 | 157.1 | 181.2 | 145.1 |

75% from water requirements

| 0                | 127.5   | 374.5    | 261.2         | 254.4 | 350.2 | 259.78 | 245.8 |
| 2                | 128.3   | 379.0    | 267.7         | 258.3 | 351.6 | 260.4 | 246.7 |
| 3                | 125.8   | 372.9    | 265.7         | 254.8 | 348.6 | 253.86 | 242.7 |
| Mean             | 127.2   | 375.4    | 264.8         | 255.8 | 350.2 | 258.0 | 245.1 |

Grand mean

H R A H\(\times\)R H\(\times\)A R\(\times\)A H\(\times\)R\(\times\)A

LSD at 0.05

Table 8. Effect of water regime with hydro-gel soil application and different anti-transpiration types on manganese content (mg kg\(^{-1}\)) of peanut plants grown in sandy soil

| Hydro-gel (%) (H) | Control | Chitozan | Abcissic acid | 5 | 10 | Mean | 15 | 20 | Mean |
|------------------|---------|----------|---------------|---|----|------|---|----|------|
| 0                | 127.5   | 374.5    | 261.2         | 254.4 | 350.2 | 259.78 | 245.8 |
| 2                | 128.3   | 379.0    | 267.7         | 258.3 | 351.6 | 260.4 | 246.7 |
| 3                | 125.8   | 372.9    | 265.7         | 254.8 | 348.6 | 253.86 | 242.7 |
| Mean             | 127.2   | 375.4    | 264.8         | 255.8 | 350.2 | 258.0 | 245.1 |

100% from water requirements (R)

| 0                | 129.5   | 248.1    | 237.8         | 205.1 | 218.9 | 207.6 | 185.3 |
| 2                | 121.1   | 255.0    | 239.5         | 205.2 | 225.7 | 219.1 | 188.6 |
| 3                | 118.6   | 243.3    | 232.5         | 198.1 | 203.5 | 191.2 | 171.1 |
| Mean             | 123.1   | 248.8    | 236.6         | 202.8 | 216.0 | 205.9 | 181.8 |
| Grand mean       | 125.2   | 312.1    | 250.7         | 229.3 | 283.1 | 232.0 | 213.5 |

75% from water requirements

| 0                | 129.5   | 248.1    | 237.8         | 205.1 | 218.9 | 207.6 | 185.3 |
| 2                | 121.1   | 255.0    | 239.5         | 205.2 | 225.7 | 219.1 | 188.6 |
| 3                | 118.6   | 243.3    | 232.5         | 198.1 | 203.5 | 191.2 | 171.1 |
| Mean             | 123.1   | 248.8    | 236.6         | 202.8 | 216.0 | 205.9 | 181.8 |

Grand mean

H R A H\(\times\)R H\(\times\)A R\(\times\)A H\(\times\)R\(\times\)A

LSD at 0.05
Table 9. Effect of water regime, hydro gel soil application and different anti-transpiration types on zinc content (mg kg\(^{-1}\)) of peanut plants grown in sandy soil

| Hydro-gel (%) (H) | Anti-transpiration types (A) | Control | Chitozan | Abscisic acid |
|------------------|-----------------------------|---------|---------|--------------|
|                  | mg l\(^{-1}\)               | 5       | 10      | Mean 15 20  
|                  | 100% water application (R)  |         |         |             |
| 0                | 31.06                       | 51.45   | 49.21   | 43.90 37.00 | 38.61 35.55 |
| 2                | 42.14                       | 62.36   | 51.86   | 52.12 41.75 | 40.99 41.62 |
| 3                | 30.45                       | 40.00   | 45.18   | 38.54 36.52 | 32.85 33.27 |
| Mean             | 34.55                       | 51.27   | 48.75   | 44.85 38.42 | 37.48 36.81 |
| 75% from water application |             |         |         |             |
| 0                | 20.42                       | 31.45   | 30.21   | 27.35 26.45 | 24.43 23.76 |
| 2                | 30.91                       | 35.36   | 32.86   | 33.04 32.66 | 31.57 31.71 |
| 3                | 19.80                       | 25.00   | 23.18   | 22.66 23.07 | 22.49 21.78 |
| Mean             | 23.70                       | 30.60   | 28.75   | 27.68 27.39 | 26.16 25.75 |
| Grand mean       | 29.125                      | 40.935  | 38.75   | 36.265 32.905 | 31.82 31.28 |
| LSD at 0.05      |                             | 2.90    | 1.60    | 1.40 2.00 | 1.90 2.30 | 2.70 |

Table 10. Effect of water regime, hydro gel soil application and different anti-transpiration types on water use efficiency (kg fad.\(^{-1}\)) of peanut plants grown in sandy soil

| Hydro-gel (%) (H) | Anti-transpiration types (A) | Control | Chitozan | Abscisic acid |
|------------------|-----------------------------|---------|---------|--------------|
|                  | mg l\(^{-1}\)               | 5       | 10      | Mean 15 20  
|                  | 100% water application (R)  |         |         |             |
| 0                | 0.868                       | 1.509   | 1.443   | 1.273 1.363 | 1.276 1.169 |
| 2                | 0.870                       | 1.569   | 1.480   | 1.306 1.388 | 1.309 1.189 |
| 3                | 0.809                       | 1.490   | 1.394   | 1.231 1.279 | 1.620 1.236 |
| Mean             | 0.849                       | 1.523   | 1.439   | 1.270 1.343 | 1.402 1.198 |
| 75% from water application |             |         |         |             |
| 0                | 1.067                       | 1.509   | 1.442   | 1.339 1.423 | 1.397 1.295 |
| 2                | 1.087                       | 1.590   | 1.488   | 1.388 1.472 | 1.406 1.321 |
| 3                | 1.045                       | 1.469   | 1.455   | 1.323 1.431 | 1.381 1.285 |
| Mean             | 1.066                       | 1.522   | 1.461   | 1.350 1.442 | 1.394 1.301 |
| Grand mean       | 0.957                       | 1.522   | 1.450   | 1.310 1.392 | 1.398 1.249 |
| LSD at 0.05      |                             | 0.957   | 1.522   | 1.450 1.310 | 1.310 1.392 | 1.249 |
Results obtained in Table 10 indicate that hydrogel at 2.0% was more efficient on WUE compared with 3.0% and without application. This may due to the addition of hydrogel at the rate of 2.0% increasing the water holding capacity of coarse sand from 171 to 402% (Johansen et al., 1984). Further, hydrogel addition improved water storage properties of porous soils and resulted in the delay and onset of permanent wilting percentages under intense evaporation. An increase in water holding capacity due to hydrogel significantly reduced the irrigation requirement of many plants (Taylor and Halfacre, 1986).

Conclusions

From the abovementioned results it could be concluded that application of irrigation water regime at 100% (1125 m$^3$/fd.) accompanied with anti-transpiration chitosan or abscisic acid at low rates and companied with 2.0% hydro-gel were more efficient on yield, nutrients content in soil, and nutritional status in term of water use efficiency of peanut plants grown under sandy soil condition.

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تأثير مياه الري ومضادات النتجم مع الهيدرو جل على حالة المغذيات في نباتات القول السوداني النامية في أرض رملية

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أجريت تجربة حقلية على أرض رملية مستصلاحة حديثاً تروي بنظام الري بالتقطية بمحطة الإسماعيلية للبحوث الزراعية، محافظة الإسماعيلية، مصر، وهي تقع بين خط الطول 30°32'14"، خط العرض 30°5'0"، N
وارتفاع 3 متر عن سطح البحر وزرعت بنباتات القول السوداني (Arachis hypogaea، cv Giza 5) خلال موسم الزراعة الصيفي لعام 2012 و 2013 مع عاملات 5 كجم فدان. وكان الهدف من أجراء التجربة تقييم الإضافة عن طريق الري الورقي لبعض مضافات النتجم (حمض الشنتزان بمعادلات صفر و 5 و 10 مليجرام لتر ) و (حمض الأسبنيك بمعادلات صفر و 15 و 20 مليجرام لتر ) رشًا على الأوراق بدءًا في فترة ظهورها على ثلاثة مرات تبدأ بعد ثلاثة أسابيع من الزراعة (0، 10 و 20 يوم) وقد تم إضافة الهيدرو جل بمعادلة صفر و 2 و 3% كإضافة أرضية وذلك تحت معدلين من الري هما 100% من الاحتياجات المائية للفول السوداني و75% منها (125 و 112.5 و 88.4 مللي في 3 فدانات). وقد اظهرت النتائج المستفادة: كان هناك تأثير واضح معنوي لاستخدام 100% من الاحتياجات المائية للفول السوداني ورش بالشنتزان بمعدل 5 مليجرام لكل لتر مع إضافة 2% هيدرو جل كإضافة أرضية على محصول الريور للفول السوداني ومحتوى العناصر الكبرى (الفيتامينات والفلوسفور والبوتاسيوم) وكذلك محتوى العناصر الصغرى (الحديد والمنجنيز والزئبق) في البذور أعلى كفاءة استخدام للمياه كانت مع استخدام 100% من الاحتياجات المائية عند الري بحمض الأسبنيك مع إضافة ارضية للهيدرو جل بمعدل 3%.

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