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# EFFECT OF IRRIGATION REGIMES AND BIOFERTILIZERS ON YIELD AND SOME WATER RELATIONS OF SOYBEAN PLANT

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## ABSTRACT

Two field experiments were carried out at El-Karada station of irrigation requirements, Kafr El-sheikh Governorate, during the two summer seasons 2008 &2009, to study the effect of irrigation regimes (irrigating soybean plants at 25, 50 and 75% of available soil moisture depletion (ASMD) and biofertilizers (inoculation soybean seeds with phosphoriene, Rizobial and their mixture, comparing with recommended NPK) on yield and its components, as well as, some water relations of soybean plants. The experimental design is split plot with three replicates, where the main plots were assigned to irrigation regimes, while the sub plots were devoted to biofertilizers.

Results showed that both of irrigation treatments and biofertilizers had highly significant effect on yield and its attributes of soybean plants. Irrigated treatments after the depletion of 50% in available soil moisture, gave the highest values of plant height, No. of branches per plant, No. of pods/plant, pods weight /plant, seed weight /plant,1000 seed weight and seed yield (kg/fed) in both growing seasons. Meanwhile, the lowest values of the abovementioned parameters were recorded under irrigation at 75 % ASMD in both seasons. Data also showed that phosphorien + rhizobial inoculation produced the tallest plants; however, the remains aforementioned characters were the highest under application of recommended NPK, followed by rhizobial inoculation in both growing seasons comparing with phosphorien.

Seasonal applied water (as an average of the two seasons) was 3451.4, 3006.9 and 2515.5m$^3$/fed for irrigation at 25, 50 and 75%ASMD treatments, respectively. Irrigating soybean plants at 25% ASMD recorded the highest seasonal water consumption as an average of the two seasons (2272.9m$^3$/fed), followed by irrigation treatments at 50% ASMD (2074.2m$^3$/fed) , while the lowest seasonal water consumption was recorded under irrigation at 75% ASMD, and found to be (1859.2m$^3$/fed). The highest values of crop water use efficiency (0.96&0.84 Kg/m$^3$) and water productivity (0.66&0.58 kg seed yield /m3WA) were achieved under irrigation at 50% ASMD in both seasons, respectively. Meanwhile, irrigating soybean plants at 75% ASMD recorded the lowest values of CWUE (0.56&0.39 kg/m$^3$) and water productivity (0.38 &0.29 kg/m$^3$) in the 1$^{st}$ and 2$^{nd}$ seasons, respectively.
**Keywords:** soybean, irrigation regime, rhizobial and phosphorien inoculation.

## INTRODUCTION

Because of the water limitation facing Egypt, our best should be done towards effective rationalization of irrigation at farm level. One of the main procedures to achieve this target is, through how much water should be applied. Irrigation can significantly increases soybean seed yield, (Heatheruly, 1983) and can increase profits (Salassi *et al.,* 1984) where soil moisture deficits occur. However, Cox and Jolliff (1986) pointed out that soybean plants are unable to withstand prolonged droughts. They also found that evapotranspiration of soybean plants was 17 and 68% less in deficit-irrigated and non-irrigated plants, respectively than for the well-irrigated plants.

Soybean (*Glycirre max L.)* is considered as one of the most important protein and edible oil crops, introduced all over the world. The work of Foroud *et al*. (1993), Eck *et al.,* (1987) and Speck *et al*., (1989) and many other investigators had shown that soybean is amenable to limited irrigation. Stegman *et al.,* (1990) indicated that although short term water stress in soybean in the lower canopy, increased pods in the upper nods compensates for this, where there is a resumption of normal irrigation. There is a great problem in oil production, concerning lack of edible oil with about 90% from the national consumption, FAO (2007), so great attention must be made on edible crops such as soybean.

Under Egyptian conditions, besides limitation of water resources, there is a big problem facing Egyptian agriculture, which is the increasing prices of mineral fertilizers, in addition to their negative effects on soil and water properties by creating mineral pollution problems and limiting the reuse of drainage water again. Such problem could be solved by using biofertilizers instead of mineral ones. Douka *et al.,* (1986) reported that inoculation of soybean can save more than 84 kg N/fed. Many published reports showed that the relationship between soybean cultivars and rhizobium strain is one of the most important factors influencing biological –$N_2$-fixation, (Ghobrial, 1995). The present study aims to provide the outline of soybean, water use and production, with emphasis to irrigation regimes and biofertilizers, in comparison with recommended NPK, under the conditions of North Delta region.

## MATERIALS AND METHODS

Two field experiments were conducted at El-Karada station of irrigation requirements, Kafr El-Sheikh Governorate, Kafr El-Sheikh is located at 31$^{o}$ 07$^{-}$ latitude and 30 $^{o}$ 52$^{-}$ longitude and has elevation about 6m above sea level, during the two summer seasons 2008 and 2009, to study the effect of irrigation regimes (irrigating soybean plants, at 25, 50 and 75 % of available soil moisture depletion) and Biofertilizers (inoculation soybean seeds with phosphorien, Rhizobial, their mixture compared with recommended NPK) on yield and its components as well as some water relations of soybean.

Some chemical and physical characteristics of the soil at the experimental sites for the two seasons, according to the standard methods outlined by Klute (1986) and Page *et al.*, (1982) are shown in Table (1).

The experimental design was a split –plot with three replicates. The main plots were occupied by irrigation regimes: irrigating soybean plants at 25, 50 and 75% of available soil moisture depletion. The subplots were devoted to biological fertilizers inoculation with phosphorien, Rhizobial, mixture of them and comparison with recommended NPK.

Regarding to the biological fertilizers, phosphorien as aphosphate dissolving bacteria, PDB (Bacillus-magaterium var. phosphaticum) at rate of 500g/fed,was used as an inoculants which converts the insoluble tricalcium to the soluble monocalcium phosphate. phosphorien as a commercial compound produced by general organization for Agricultural Equalization found, Ministry of Agriculture. Inoculation with Rhizobia, strain of rhizobial Japonicum namely 110 and 1577 okadin inoculation were obtained from soil microbiology department of Sakha Agricultural Research Station. The strain was grown separately in a liquid media 79. The resulting culture was used as seed inoculants at rate of 399 g/fed.

**Table (1): Some physical and chemical properties of soil studied.**

| a-physical properties | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Soil depth, cm | Particle size distribution,% | | | Texture | Bulk density, $Mg/m^3$ | Soil water constants, % | | |
| | Clay | Silt | Sand | | | FC | PWP | AW |
| 0-15 | 53.4 | 25.40 | 21.20 | clay | 1.12 | 45.28 | 24.60 | 20.68 |
| 15-30 | 49.95 | 26.80 | 23.25 | clay | 1.18 | 44.12 | 23.73 | 20.39 |
| 30-45 | 40.40 | 34.30 | 25.30 | clay | 1.26 | 39.77 | 21.52 | 18.25 |
| 45-60 | 37.80 | 34.80 | 27.40 | clay | 1.33 | 39.42 | 21.43 | 17.99 |
| Mean | 45.40 | 30.33 | 24.29 | clay | 1.22 | 42.15 | 22.82 | 19.33 |

| b- Chemical properties | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Soil depth, cm | pH | EC, dS/m | Soluble cations, meq/L | | | | Soluble anions, meq/L | | | |
| | | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $CO_3^{--}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{-}$ |
| 0-15 | 7.56 | 1.34 | 3.28 | 2.10 | 12.10 | 0.10 | - | 2.50 | 8.52 | 6.56 |
| 15-30 | 7.62 | 1.47 | 3.36 | 2.60 | 12.63 | 0.10 | - | 2.80 | 8.84 | 7.05 |
| 30-45 | 7.61 | 1.42 | 2.72 | 1.20 | 12.81 | 0.04 | - | 2.70 | 9.12 | 4.95 |
| 45-60 | 7.58 | 1.21 | 1.45 | 1.92 | 11.43 | 0.04 | - | 2.75 | 9.02 | 3.07 |
| Mean | | 1.36 | 2.70 | 1.96 | 12.24 | 0.07 | - | 2.69 | 8.88 | 5.41 |

Seeds of soybean *(Glycine maxl.)* var. Giza 21 were obtained from Field Crops Research Institute, Agric. Res. Center, Department of legumes, Sakha Agric. Res. Station. Planting of soybean seeds was took place on June $15^{th}$ (2008) and June $17^{th}$ (2009), as well as harvesting date was October $15^{th}$ of each sub-plots consisted of both seasons, respectively. Each subplot consisted of 6 rows, 60cm apart and 5meters long, with an area of $18m^2$. All practices were applied as recommended for soybean production.

Soil moisture content gravimetrically determined in soil samples which were taken from consecutive depths of 15cm down to 60cm. for irrigating timing, soil samples were taken periodically until it reach the desired level of allowable moisture. The amount of water applied for each irrigation regime was determined on the basis of raising the soil moisture content to its field capacity plus 10% as leaching requirement. Irrigation water was pumped from the main canal near the experimental field into a settling basin with a baffle wall, to maintain a constant head over the crest of affixed rectangular weir. Irrigation water was calculated as the following:

$$Q = 1.84\ LH^{1.5}$$

Where: Q = Rate of discharge, m3/min.
L = length edge of weir, cm
H = Height column of water above edge of weir, cm

Irrigation water was controlled by a steel gate for each experiment plot, as well as, those fixed at the side of each feeder canal.

To compute the actual water consumed by the growing soybean plants, soil moisture percentage was determined gravimetrically before and 48 hours after each irrigation watering, as well as, harvesting. Soil samples were taken from the effective root zone of 60 cm, with 15 cm for each successive soil layers. Water consumptive use for each soil depth was calculated using the following equation as stated by Hansen *et al*., (1979).

$$CU = \sum \frac{\theta_2 - \theta_1}{100} \times Dbi \times Di$$

Where:

CU = actual water consumptive use of the growing plants (cm) in the effective root zone (60cm).

$\theta_2$ = Soil moisture content for each layer in percent, 48 hrs after irrigation

$\theta_1$ = Soil moisture content in percent before the next irrigation

Dbi = Bulk density of the specific soil layer ($Mgm^{-3}$)

Di = Depth of each soil layer = 15 cm

Water consumed per feddan was calculated, and crop water use efficiency (CWUE) was calculated according to Jensen (1983)

At harvest, ten soybean plants were collected from each replicate to determine yield components: plant height (cm), pods weight/plant (g), seeds weight/plant (g), 1000-seeds weight (g), No. of branches/plant, No. of pods /plant and stem weight /plant (g). Seed yield was obtained from central area of each plot (two rows) and calculated as kg/fed). Data collected were subjected to statistical analysis according to Snedecor and Cochram (1967). The differences between the means were compared by Duncan's multiple range test.

## RESULTS AND DISCUSSION

### A. Growth attributes

Results recorded in Table (1) indicated that most of vegetative characteristics of soybean plant were significantly affected by irrigation regimes in both growing seasons , except plant height and No. of branches /plant (1st season) did not significantly affected by irrigation regimes. Highest means values of plant height, No. of branches /plant , No. of pods/plant and stem weight /plant (g) were recorded under irrigation at 50% of available soil moisture depletion, in both growing seasons, comparing with the other two irrigation treatments 25 and 75%ASMD. Also, data in the same table illustrated that mean values of the aforementioned vegetative characters of soybean plant were highly significant, affected by biofertilizers in both growing seasons ,except stem weight/plant (2nd season). The highest mean values of plant height (63.4 and 61.9 cm) were recorded under treated plants with phosphoriene + rhizobial in both seasons, respectively, while ,the highest ones of No. of branches /plant (6.5 and 5.20), No. of pods /plant(99.7 and 86.6), and stem weight/plant (31.9 and 19.4 g) were recorded under applying recommended dose of NPK in both seasons ,respectively. Also, data showed that no significant differences were recorded due to inoculation with phosphorien, rhizobian and their mixture on No. of branches /plant (1st and 2nd seasons), No. of pods/plant (2nd season) and stem weight /plant(2nd season).

On the other hand, the interaction effect between irrigation regimes and biofertilizers was highly significant, except No. of branches /plants and No. of pods /plants (1st season) and stem weight/plant(1st and 2nd seasons) no significant differences were recorded. The results are in harmony with those obtained by Karam *et al.,* (2005) and Moursi *et al*., (2009)

**Table (1): Effect of irrigation regime and bio, mineral fertilization on some growth attributes of soybean during the two growing seasons.**

| Factor | Plant height, cm | | No. of branches/plant | | No. of pods/plant | | Stem weight/plant (g) | |
|---|---|---|---|---|---|---|---|---|
| | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 |
| Irrigation (I) | | | | | | | | |
| 25%ASMD | 54.5b | 51.3b | 5.1a | 3.9b | 48.0b | 56.6b | 17.9b | 14.8b |
| 50%ASMD | 61.7a | 63.4a | 5.0a | 4.6a | 83.6a | 77.9a | 24.4a | 25.2a |
| 75%ASMD | 59.1ab | 55.7b | 4.8a | 4.3ab | 57.4b | 49.9b | 21.6ab | 15.8b |
| F-test | Ns | ** | Ns | * | * | * | * | ** |
| Fertilizers (F) | | | | | | | | |
| Phos. | 51.0b | 52.2c | 4.2b | 4.2b | 40.4c | 56.8b | 13.4c | 17.0a |
| Rhiz. | 59.0a | 54.5bc | 4.9b | 4.1b | 60.6b | 52.7b | 17.8bc | 17.1a |
| Pho.+Rhiz. | 63.4a | 61.9a | 4.4b | 3.7b | 51.3bc | 49.8b | 22.1b | 18.3a |
| NPK | 60.3a | 58.6ab | 6.5a | 5.2a | 99.7a | 86.6a | 31.9a | 19.4a |
| F-test | ** | ** | ** | ** | ** | ** | ** | Ns |
| Interaction (IxF) | | | | | | | | |
| F-test | ** | * | Ns | ** | Ns | Ns | Ns | Ns |

***, **, ns indicate p‹0.05, p‹ 0.01 and not significant, respectively. Means of each column designated by the same letter are not significantly different at 5%level using Duncan's multiple range tests.**

## B. Seed yield and its components:

Data in Table (2) showed that soybean yield and its components were significantly affected by both irrigation regimes and Bio-fertilizers in both growing seasons. Regarding the effect of irrigation regimes, data indicated that pods weight/plant, seed weight/plant, 1000 seed weight and seed yield weight kg/fed were significantly affected by irrigation regimes in both seasons. Irrigation at 50%ASMD produced the highest values of pods weight/plant (40.3 and 38.6), seed weight/plant (19.8 and 17.4 g), 1000 seed weight (15.4&16.6 g) and seed yield (1986.3 &1734.7 kg/fed) in both growing seasons, respectively. On the other hand, the lowest values of the aforementioned parameters were recorded under irrigation at 75%ASMD in both seasons. Increasing soybean seed yield under irrigation at 50% ASMD may be due to improving the rate of aeration which will increase analysis of soil organic matter and hence increasing availability of nutrients, therefore, forming strong plants with good vegetative growth. These results are in agreement with those obtained by Balasubramanian and chari (1983) and Moursi *et al.,* (2009).

With respect to Bio, mineral fertilization, the results presented in the same table indicated that weight of pods /plant, seed weight/plant,1000 seed weight and seed yield (kg/fed) were highly significant affected by Bio, mineral fertilizers in both growing seasons . the highest mean values for soybean pods weight /plant (43.5&38.5 g), seed weight /plant (20.8 and 19.7 g),1000 seed weight (16.1&14.1) and seed yield kg/fed (2075.9 &1917.2) were recorded under application of recommended NPK in both seasons, respectively followed by rhizobial inoculation.

It was evident that, inoculation of soybean plant with rhizobial strain gave the highest values of the aforementioned parameters comparing with phosphoriene or their mixture in both seasons. These results are in a great harmony with those obtained by Moursi *et al.,* (2009). They reported that application of microbial inoculants (rhizobian) produced the highest seed yield and its components. Also , data showed that the interaction between irrigation regimes and fertilization was significant differences in both growing seasons, except for pods weight /plants, seed weight/plant and seed yield (2nd season) were not significantly affected.

**Table (2): yield and its component of soybean as affected by irrigation regimes and bio, mineral fertilization during the two growing seasons.**

| Factor | Pods weight/plant,(g) | | Seed weight/plant,(g) | | 1000-seeds weight,(g) | | Seed yield, (kg/fed) | |
|---|---|---|---|---|---|---|---|---|
| | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 |
| Irrigation (I) | | | | | | | | |
| 25%ASMD | 26.3b | 24.9b | 13.3b | 12.5b | 12.6b | 12.3b | 1324.8b | 1250.6b |
| 50%ASMD | 40.3a | 38.6a | 19.8a | 17.4a | 15.4a | 16.6a | 1986.3a | 1734.7a |
| 75%ASMD | 25.4b | 18.7c | 9.6c | 7.2c | 11.4c | 9.4b | 958.1c | 720.8c |
| F-test | * | ** | ** | ** | ** | ** | ** | ** |
| Fertilizers (F) | | | | | | | | |
| Phos. | 20.1c | 21.8b | 8.7c | 9.1b | 11.5c | 12.4b | 869.9c | 906.2b |
| Rhiz. | 34.3b | 26.0b | 15.7b | 11.4b | 11.9bc | 11.8b | 1572.6b | 1140.0b |
| Pho.+Rhiz. | 24.8c | 23.5b | 11.7c | 9.8b | 131b | 12.2b | 1173.9b | 978.0b |
| NPK | 43.5a | 38.5a | 20.8a | 19.7a | 16.1a | 14.6a | 2075.9a | 1917.2a |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** |
| Interaction (IxF) | | | | | | | | |
| F-test | * | Ns | * | Ns | ** | ** | * | Ns |

***, **, ns indicate p‹0.05, p‹ 0.01 and not significant, respectively. Means of each column designated by the same letter are not significantly different at 5%level using Duncan's multiple range tests.**

### C. Some water relations of soybean crop:

Under conditions of the present study, irrigation water applied for soybean as a summer crop is the only component for water applied since no rain fall in Egypt during such summer growing season. Data presented in Table (3) showed that the average values of water applied to soybean plants were 3450.5,3005.4 and 2516.30 $m^3$/fed(1st season) and 3452.3,3008.3 and 2514.7 $m^3$/fed(2nd season) for irrigating soybean plants at 25,50 and 75% ASMD , respectively. It is obvious that treatment which irrigated at 25%ASMD had the highest value of water applied in both seasons, while, such treatment irrigated at 75 % ASMD was accompanied with least value of water applied. On the other hand treatment which irrigated at 50%ASM lie in between.

These results are in harmony with those obtained by Zhen *et al., (*2004), Jiamin *et al., (*2005) and Moursi *et al.,* (2009).

**Table (3) :Irrigation water applied (WA), water consumptive use (WCU), crop water use efficiency(CWUE) and water productivity (WP) for soybean under different irrigation regimes during the two growing seasons.**

| Irrigation regimes | WA ($m^3$/fed) | | WCU($m^3$/fed) | | CWUE(kg/$m^3$) | | WP(kg/$m^3$) | |
|---|---|---|---|---|---|---|---|---|
| | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 |
| 25%ASMD | 3450.50 | 3452.2 | 2271.6 | 2274.2 | 0.61 | 0.55 | 0.40 | 0.36 |
| 50%ASMD | 3005.40 | 3008.3 | 2073.1 | 2075.2 | 0.96 | 0.84 | 0.66 | 0.58 |
| 75%ASMD | 2516.30 | 2514.7 | 1858.2 | 1860.1 | 0.50 | 0.39 | 0.38 | 0.29 |

Seasonal rates of water consumption by soybean plants under irrigation regimes and Bio, mineral fertilization during the two growing seasons are presented in Table (3). Data showed that irrigating soybean plants whenever 25%ASMD gave the highest values of seasonal water consumptive use and found to be (2271.6&2274.2 $m^3$/fed), followed by irrigation at 50%ASMD (2073.1 &2075.2 $m^3$/fed) and minimum of seasonal water consumption was (1858.2 &1860.1 $m^3$/fed), when irrigated at 75% ASMD in both seasons, respectively .These results demonstrate that water consumptive use increased as soil moisture was maintained high by frequent irrigations. The probable explanation of these results is that higher frequent irrigations (25%&50&ASMD) provided a chance for more consumption of water, which ultimately resulted in an increasing transpiration and evaporation from the soil surface. These results are confirmed with that reported by Karam *et al*., (2005).

Data illustrated that in Table (3) show that irrigating soybean plants at 50%ASMD achieved the highest values of crop water use efficiency (0.96 &0.84 Kg/$m^3$ of water consumed), followed by irrigation at 25% ASMD (0.61 &0.55 Kg /$m^3$ ) and 75% ASMD (0.57 & 0.39 Kg/$m^3$) in both seasons ,respectively. These findings are in harmony with the scientific approaches that supposed the plant roots could be extract more soil water from greater depth under moderate stress (50%ASMD) as compared to those irrigated at relatively wet level (25%ASMD). It means that the stored water in soil at a moderate irrigation can be more available for roots, as well as, can be used with more efficiency. Also, these findings may be attributed to the differences among seed soybean yield, as well as, differences between water consumptive uses.

Water applied use efficiency is an indicator to find out the yield per unit water applied (WA). From data obtained in Table (3), it was clear that highest values of WAUE (0.66 &0.58 kg seed yield /$m^3$ WA) were recorded under irrigating soybean plants at 50% ASMD, in both seasons, respectively. Meanwhile, the least values of WP (0.38 & 0.29 Kg /$m^3$) in both seasons, respectively. These findings may be attributed to the differences among seed soybean yield, as well as, differences between applied water values.

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## أثر نظام الري والتسميد الحيوي علي الأنتاج وبعض العلاقات المائية لنبات فول الصويا

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أجريت تجربتان حقليتان في محطة القرضا للأحتياجات المياه بمحافظة كفر الشيخ خلال موسمين متتاليبين 2008&2009 بهدف دراسة تأثير نظام الري ( ري نبات فول الصويا بعد استنزاف 75,50,25, %من الماء الميسر في التربة والتسميد الحيوي ( اضافة اللقاح بالفوسفورين الريزوبيا والخليط منهما) ، مقارنة بالجرعة الموصي بها من NPK علي الانتاج ومكوناته وكذلك بعض العلاقات المائية لنبات فول الصويا . وكان التصميم الأحصائي للتجربة هو القطع المنشقة مره واحده في ثلاث مكررات ، حيث كانت المعاملات الرئيسية عبارة عن نظم الري، المعاملات تحت الرئيسية عبارة عن التسميد الحيوي.

وكانت النتائج المتحصل عليها كالتالي :

- أوضحت النتائج أن كلا من نظم الري والتسميد الحيوي ذات تأثير عالي المعنوية علي الانتاج ومكوناته لنبات فول الصويا
- معاملة الري بعد استنفاذ 50% من الماء الميسر أعطت أعلي قيم لطول النبات ،عدد الأفرع/نبات ،عدد القرون /نبات ، وزن القرون/نبات ، وزن البذور/نبات ، وزن الألف بذره وانتاج البذور (كجم/فدان) في كلا الموسمين . بينما أقل القيم للصفات السابقة قد سجلت عند الري بعد استنفاذ 75%من الماء الميسر.
- ايضا أوضحت النتائج أن الخليط من الفوسفورين +الرايزوبيا أنتجت أطول النباتات ، الا ان قيم باقي الصفات السابقة كانت الأعلي عند اضافة الجرعات الموصي بها من NPK متبوعا باضافة لقاح الريزوبيا في كلا الموسمين.
- كذلك أوضحت النتائج أن الكميات الموسمية المضافة من مياه الري كمتوسط للموسمين كانت 3451.4 م$^3$ /فدان (82.18سم) ، 3006.9 م$^3$ /فدان (71.59سم) ، 2515.5 م$^3$ /فدان (59.89سم) لمعاملات الري عند 25 ،50 ، 75% من الماء الميسر.
- أيضا أوضحت النتائج أن ري محصول فول الصويا عند 25% من الماء الميسر سجلت أعلي قيم للاستهلاك المائي الموسمي (2272.9 م$^3$ /فدان) ، متبوعا بالري عند 50% من الماء الميسر (2074.2 م$^3$ /فدان) ، بينما أقل استهلاك مائي موسمي قد سجل عند معامله الري عند 75% من الماء الميسر (1859.2 م$^3$ /فدان)
- تحصل علي أعلي قيم للكفاءة الأستعماليه للماء بواسطه نبات فول الصويا ( 0.96 &0.84 كجم بذور/ م$^3$ ماء مستهلك) و أعلي قيم للكفائة الأستعمالية لمياه الري (0.66 &0.58 كجم بذور / م$^3$ ماء مضاف) قد تحصل عليها عند الري ب 50% من الماء الميسر .بينما عند الري ب 75% من الماء الميسر سجلت أقل قيم للكفاءة الأستعمالية بواسطه نبات فول الصويا (0.56 &0.39 كجم بذور / م$^3$ ماء مستهلك ) & أقل كفاءة استعمالية لمياه الري(0.38 & 0.29 كجم بذور / م$^3$ ماء مضاف ) في كلا الموسمين علي الترتيب.

**قام بتحكيم البحث**

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