OPTIMUM WATER REQUIREMENTS OF SOYBEAN IN THE CLAY SOIL UNDER RHIZOBIAL INOCULATION AND UREA FERTILIZATION

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ABSTRACT

Two field trials were conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate during the two successive growing seasons 2007 and 2008 to study the impact of irrigation water quantity, Rhizobial inoculation and urea fertilization on some water relationships, yield and its components of soybean plants. The experimental design used in this study is split-split plot with four replicates where the main treatments were randomly assigned by irrigation depths which were A. irrigation by 2.0 cm depth above soil surface, B- irrigation by 4.0 cm depth above soil surface and C- irrigation by 6.0 cm depth above soil surface. Sub-main treatments which were randomly assigned by application and non-application of rhizobial inoculation and sub-sub treatments were assigned by application two doses of urea fertilization.

The main results in this study can be summarized as follows:

Data obtained showed that the mean values of soybean seed yield were affected by the studied treatments (irrigation quantity, rhizobial inoculation and mineral fertilization. The highest mean values for soybean seed yield in the two growing seasons were recorded under irrigation by 4.0 cm depth above soil surface comparing with the other two irrigation depths 2.0 and 6.0 cm. The mean values for seed yield in the two growing season were 1099.41, 1226.19 and 1120.17 kg/fed. at 2.0, 4.0 and 6.0 cm irrigation depths, respectively. That means the quantity of irrigation water as a 4.0 cm head above soil surface leads to saving a large amount of irrigation water, improving soil properties and decreasing pressure on the drainage network in the clay soil. Data also showed that rhizobial inoculation

increased mean values of seed yield comparing with non-inoculation treatments.

Also, data illustrated that the mean values of soybean seed yield in the two growing seasons were affected by adding nitrogen fertilizer especially under the high level of application (20 N unit/fed.).

The mean values of applied irrigation water in the two growing seasons were 1287.55, 2524.65 and 3776.85 m^3/fed. obtained from watering till depth 2.0, 4.0 and 6.0 cm as irrigation depth above soil surface, respectively. Data also showed that the mean values of water utilization efficiency in the two growing seasons were increased under the lowest irrigation depth (2.0 cm) above soil surface comparing with the other two irrigation depths (2.0 and 6.0 cm). The mean values in the two growing seasons were 0.86, 0.48 and 0.30 kg/m^3 resulted from 2.0, 4.0 and 6.0 cm irrigation depth, respectively.

The concentration of NPK in seeds increased under 4.0 cm irrigation depth comparing with 2.0 and 6.0 cm above soil surface. Also, data showed that application of rhizobial inoculation and increasing nitrogen dose increased concentration of NPK. Data also illustrated that the mean values of yield components (number of tillers, weight of 1000 seed weight, plant height, number of pods/plant and weight of pods/plant) increased under 4.0 cm irrigation depth, application of rhizobial inoculation and increasing nitrogen dose to 43.4 kg urea/fed.

INTRODUCTION

In Egypt, the present capita share of water is about 1000 m^3/year, which is equivalent to the international standard of "water poverty limit". In addition there is a continuous and rapid degradation of the surface and groundwater quality, where the groundwater is important source of fresh water within the Nile system and in the desert. Unfortunately, while water supply is diminishing rapidly, water demand is continuously increasing due to population growth, increased economic activities and the escalating standards of living. Improving the irrigation system constitutes the key element in achieving the national goal of increasing irrigation efficiency, and fulfilling the equality of water distribution among the farmers in order to achieve the maximum crop yield. **(El-Mowelhi *et al.*, 1999 and Abo Soliman *et al.*, 2005)**.

Agriculture is the main sector in water demand at the national level. Water allocated the irrigation is about 85% from the total national water. So, effective management at the irrigation sector is the principal way towards the rationalization policy of the country. In this aspect, effective on-farm irrigation management becomes a must. One of the main procedure to achieve this target is through how much water should be applied.

Soybean (*Glycine max* L.) is considered as one of the most important protein and edible oil crops, introduced all over the world. The work of **Karte *et al.* (1983), Eck *et al.* (1987) and Speck *et al.* (1989)** and many of other investigators have shown that soybean is amenable to limited irrigation. **Stegman *et al.* (1990)** indicated that although short term water stress in soybean during early flowering, may result in flower and pod drop in the lower canopy; increased pod set in the upper nodes compensates for this, where there is a resumption of normal irrigation There is a great problem in oil production, where as lacking of edible oil with about 90% from the national consumption, so, we should give a wide attention for edible crops such as soybean by giving more due care for increasing its production quantitatively and qualitatively both by increasing its cultivated area which decreased obviously in the latest years and selection good varieties.

Under Egyptian conditions beside limitation of water resources there is a big problem faces Egyptian Agriculture that is increasing prices of mineral fertilizers in addition to their bad effects on soil and water properties by making pollution for them and will be hard to reuse drainage water again. This problem can 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 of the 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 main goals for this present work are to:

1. Make rationalization for irrigation water by controlling the irrigation depth without any drastic effect on yield and quality as well as crop water efficiencies.
2. Investigate the effect of mineral fertilizers on yield and quality and also make a great concentration for the effect of biofertilizers application on rationalization of mineral fertilizers and on yield and its quality.
3. Study the interaction effects for the three studied parameters (irrigation depth, mineral and biofertilizers application).

MATERIALS AND METHODS

Two field experiments were carried out at the experimental farm of Sakha Agricultural Research Station during the two summer seasons 2007 and 2008 to study the effect of irrigation water depth (amount of water applied), mineral and biofertilizers application on soybean yield, its components and some water relations. The station is situated at 31° N latitude, 30° 75 E longitude. It has elevation of about 6 metres above mean sea level (MSL). It represents the conditions and circumstances of the Northern part of the Nile Delta.

Soil samples for different depths at the experimental site were collected each (15 cm. soil depth) up to 60 cm and analyzed for some chemical and physical characteristics.

A. Chemical characteristics:

Total soluble salts (soil EC), soil reaction (pH) and both soluble cations and anions were determined according to the methods described by **Jackson (1962)**.

B. Soil physical characteristics:

1. Soil texture:

The particle size distribution was determined according to the international method **Klute (1962),** to the soil texture. The obtained results indicate that the soil is clayey in texture and the soil profile is uniform without distinct change in texture.

2. Soil bulk density (apparent density):

Soil bulk density or which so-called apparent density was determined by using cylindrical sharp edge samples **Vomocil (1957)**. Each cylinder was pressed gently into the soil to the desired depth to obtain a known volume of the undisturbed soil samples were oven dried at 105°C and the bulk density was calculated as g/cm^3. all values are presented in Table (1).

3. Field capacity (F.C.):

Field capacity was determined in the site.

4. Permanent wilting point (P.W.P):

Wilting point was calculated by divide field capacity by 1.84 for clay soil textured according to **Garcia (1978)**.

$$P.W.P. = \frac{F.C.}{1.84}$$

5. Available water (A.W):

The following formula is used to compute available water by **James (1988)**.

$$AW = Dr_3\ (FC - P.W.P)/100$$

Where:

AW = Available water cm.
Dr_3 = Depth of a soil layer that restricts water movement.
F.C. = Field capacity in percent by volume.
P.W.P = permanent wilting point in percent by volume.

Experimental layout:

Soybean as a summer crop was planted at the same date in the two growing season and it was on 13th June 2007 and 2008. Harvesting took place on 15th October during the two growing seasons. All cultured practices were the same as recommended for the area except the studied parameters (irrigation depths), rhizobial inoculation application and nitrogen application. The plot area was 24 m^2 (4 x 6).

Statistical analysis:

The experimental design for this present work is to split split plot with four replicates. The main plots were assigned to three irrigation treatments, sub plots were randomly assigned to biofertilizers treatments (rhizobial inoculation) and sub-sub plots were also randomly assigned to two mineral fertilizers (nitrogen application from urea).

Main treatments (irrigation depths):

a. Irrigation by 2.0 cm depth above soil surface.
b. Irrigation by 4.0 cm depth above soil surface.
c. Irrigation by 6.0 cm depth above soil surface.

The above mentioned irrigation depths were carried out under fixed irrigation period 15 days between irrigations during the whole growing seasons as recommended.

Sub-main treatments (application of rhizobial inoculation):

Seeds of soybean (*Glycine max* L.) variety Giza 21 was kindly supplied from field crops. Res. Institute. Agric. Res. Center. Department of Legumes, Sakha Agric. Res. Station.

Strain of B-*Rhizobium japonicum* namely 110 and 1577 Okadin inoculant were obtained from soil microbiology Dept. at Sakha Agric. Res. Station. The strain was grown separately in a liquid media 79. The resulting culture was used either individually or as a mixture by adding to a peat carrier under non-siteriec condition beat base inoculate was used as seed inoculants at a rate of 399 g/fed. biofertilizers treatments.

Sub-sub treatments (nitrogen application):

Also, the experiment was divided into two parts, the first part was taken half the amount of recommended dose (10 N unit/fed.) and the other one was taken the full dose as recommended for soybean fertilization (20 N unit/fed.

Data collection:

1. **Applied irrigation water:**

The irrigation flow rate per plot was calculated according to **Israelsen and Hansen equation (1962).**

$$q = 0.0226\ D^2\ h^{1/2}$$

Where:

q = Irrigation flow rate cm^3

h = Average effective head (the effective head of water above the center of irrigation.

D = Inside diameter of the pipe cm.

The water in the canal was controlled to maintain a constant head by means of fixed gate = 6.0 cm.

The amount of water applied for each plot was calculated by using the follow equation:

$$a = q \times T$$

Where:

a = Water volume/plot.

q = Irrigation flow rate which calculated from the above formula.

T = Total recorded time for each/plot.

2. Water utilization efficiency (W.Ut.E):

The water utilization efficiency as measure to clarify variation in yield, due to irrigation water, was calculated according to **Michael (1978)** as follows:

$$W.Ut.E = \frac{Y}{Wa}$$

Where:

W.Ut.E = Water utilization efficiency (kg/m^3)

Y = Total yield produced kg/fed. and

Wa = Total water applied m^3/fed.

3. Yield and its components:

1. Seed yield kg/fed.
2. Weight of 1000 seed (g).
3. Plant height (cm.).
4. Number of pods/plant.
5. Number of tillers/plant.

To make determination for NPK uptake, the dried plant samples were grind and then wet digested according to the method described by **Chapman and Pratt (1961)**. Total nitrogen percent in the digested was determined by using the modified kjeldahl method **(Cottenie *et al.*, 1982)**. Total phosphorus was determined using the colorimetric method **(Jackson, 1958)**. Potassium was determined by using flame photometer **(Jackson, 1958)**.

Statistical analysis:

Data collected were subjected to the statistical analysis according to **Snedecor and Cochran (1967)**.

Table (1): A- Physical and chemical characteristics and soil water constants for the studied soil at different depths.

Soil depth (cm.)	Particle size distribution			Texture	F.C %	P.W.P %	A.W %	Bd g/cm^3
	Sand %	Silt %	Clay %					
0-20	19.5	23.45	57.05	Clayey	43.00	22.00	21.00	1.14
20-40	18.22	22.74	59.04	Clayey	40.00	21.00	19.00	1.24
40-60	17.37	22.31	60.32	Clayey	39.00	21.00	18.00	1.32

Where:

F.C. = Soil field capacity
P.W.P = Permanent wilting point
B.D. = Soil bulk density
A.W. = Available water = F.C.-P.W.P.

B. Chemical characteristics:

Soil depth (cm.)	EC dS/m	pH	Soluble cations meq/L				Soluble anions meq/L			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
0-20	1.92	7.88	4.04	2.22	12.62	0.18	0.0	5.5	8.82	4.76
20-40	1.89	8.01	4.08	2.20	12.68	0.18	0.0	5.4	8.88	4.86
40-60	1.93	8.12	4.16	2.28	12.9	0.16	0.0	5.5	9.02	4.96

RESULTS AND DISCUSSION

1. Plant height cm:

Data in Table (2) showed that the mean values for soybean plant height were affected by irrigation water depth in the two growing seasons. The highest mean values were recorded under the medium irrigation water depth 4.0 cm, where the mean values are 43.26, 42.25 and 49.66, 49.71 and 46.37 and 45.67 cm in the first and second growing seasons at 2.0, 40 and 6.0 cm irrigation water depth, respectively.

Table (2): Effect of irrigation regime, application of rhizobial inoculation and nitrogen fertilization on soybean plant height and number of tillers during the two growing seasons.

Irrigation depth, cm	Bio-fertilizers	Mineral fertilizer	Plant height (cm)		Number of tillers/plant	
			1st season	2nd season	1st season	2nd season
2.0	Inoculation	10 kg N/fed.	42.63	42.50	5.52	5.62
		20 kg N/fed.	48.90	47.50	6.30	6.61
Mean			45.77	45.00	5.91	6.12
	Uninoculation	10 kg N/fed.	38.90	38.50	5.10	5.00
		20 kg N/fed.	42.60	40.50	5.30	5.50
Mean			40.75	39.50	5.20	5.25
Total mean			43.26	42.25	5.56	5.68
4.0	Inoculation	10 kg N/fed.	51.36	51.50	6.33	6.13
		20 kg N/fed.	60.70	61.50	8.16	8.14
Mean			56.03	56.50	7.25	7.14
	Uninoculation	10 kg N/fed.	42.86	41.27	5.90	5.60
		20 kg N/fed.	43.70	44.56	6.20	6.40
Mean			43.28	42.92	6.05	6.00
Total mean			49.66	49.71	6.65	6.57
6.0	Inoculation	10 kg N/fed.	48.56	46.47	5.92	5.87
		20 kg N/fed.	52.40	52.30	7.23	7.37
Mean			50.48	49.39	6.58	6.62
	Uninoculation	10 kg N/fed.	42.20	41.53	5.00	4.99
		20 kg N/fed.	42.30	42.36	6.40	6.80
Mean			42.25	41.95	5.70	5.90
Total mean			46.37	45.67	6.14	6.26
L.S.D. 5%			0.77	1.08	0.56	0.82
1%			0.76	1.12	0.54	0.75

Also, data in the same Table illustrated that the mean values of soybean plant height were affected by applying microbial inoculants where the highest mean values were recorded under treated plants comparing with untreated ones. The mean values under treated plant are 45.77, 45.00 and 56.03, 56.50 and 50.48 and 49.39 cm in the first and second growing seasons at 2.0, 4.0 and 6.0 cm irrigation depth above the soil surface, respectively. On the other hand, under all irrigation depths, the mean values were les than the above mentioned ones under untreated plants. The results are in a great harmony with those obtained by **Karam *et al.* (2005)**.

As shown in the same Table the mean values of plant height were increased by increasing nitrogen dose up to 100% from recommended dose where the height mean values were recorded in the two growing seasons. The highest mean values for soybean plant height are 60.70 and 61.50 cm in the first and second growing seasons under the highest dose of nitrogen, respectively.

Some yield components (number of tillers/plant, number of pods/plant, weight of 1000 seed and weight of pods/plant.

Data presented in Tables (2 and 3) showed that the above mentioned studied parameters were affected by the studied treatments (irrigation depths, microbial inoculants and nitrogen fertilization). Regarding to irrigation depth the highest mean values for the studied parameters were recorded under 4.0 cm irrigation depth above the soil surface comparing with the other two depths 2.0 and 6.0 cm. Increasing the mean values for the studied parameters under irrigation depth of 4.0 cm may be due to increasing availability of nutrients under this depth in comparison with the other two depths and consequently increasing uptake rate this leads to forming strong plants with good vegetative cover, this reflected on the studied parameters positively. The opposite trend will be happened under 2.0 and 6.0 cm irrigation depths.

Concerning with the effect of microbial inoculants and nitrogen fertilization application, the highest mean values for the studied parameters were recorded under application of microbial inoculants comparing with untreated plants. Also, data in the same Tables illustrated that the mean values for the studied parameters were increased under increasing nitrogen dose where the highest mean values were recorded.

Table (3): Effect of irrigation depth, application of rhizobial inoculation and nitrogen fertilization on soybean number of pods/plant, weight of 1000 seed and weight of pods/plant during the two growing seasons.

Irrigation depth (cm)	Bio- fertilizers	Mineral fertilizer	Number of pods/plant		Weight of 100 seed		Weight of pods/plant	
			1st season	2nd season	1st season	2nd season	1st season	2nd season
2.0	Inoculation	10 kg N/fed.	22.33	20.50	168.00	167.50	22.13	24.26
		20 kg N/fed.	25.00	25.50	176.02	178.40	26.01	26.51
Mean			23.67	23.00	172.01	172.95	24.07	25.39
	Uninoculation	10 kg N/fed.	18.55	18.50	151.04	155.30	20.46	21.03
		20 kg N/fed.	20.50	20.60	171.40	170.60	24.03	24.48
Mean			19.53	19.55	161.22	162.95	22.25	22.76
Total mean			21.60	21.28	166.62	167.95	23.16	24.08
4.0	Inoculation	10 kg N/fed.	22.50	23.50	180.00	164.40	24.70	24.27
		20 kg N/fed.	28.50	29.50	186.23	181.30	30.91	29.51
Mean			25.50	26.50	183.12	172.85	27.81	26.89
	Uninoculation	10 kg N/fed.	18.50	19.50	147.27	150.31	21.23	22.01
		20 kg N/fed.	25.50	26.50	171.47	172.30	24.80	25.30
Mean			22.00	23.00	159.37	161.31	23.02	23.66
Total mean			23.75	24.75	171.24	167.08	25.42	25.28
6.0	Inoculation	10 kg N/fed.	21.50	20.50	178.37	176.61	26.80	25.40
		20 kg N/fed.	27.50	28.50	185.57	184.67	28.14	28.20
Mean			24.50	24.50	181.97	180.64	24.47	26.80
	Uninoculation	10 kg N/fed.	18.56	18.50	145.20	143.76	22.19	21.96
		20 kg N/fed.	21.43	20.50	167.30	165.67	25.40	25.30
Mean			19.995	19.50	156.25	154.72	23.80	23.63
Total mean			22.25	22.00	169.11	167.68	25.64	25.22
L.S.D. 5%			1.089	0.961	42.85	38.87	0.141	0.159
1%			1.53	1.38			0.20	0.23

Seed yield (kg/fed.):

Data presented in Table (4) showed that the mean values of soybean seed yield were greatly affected by both irrigation regimes, microbial inoculants and nitrogen fertilization in both seasons. The highest mean values were recorded at 4.0 cm irrigation depth above the soil surface comparing with the other two depths 2.0 cm 6.0 cm. The mean values are 1098.80, 1099.96 kg/fed., 1238.52 and 1213.85 kg/fed. and 1125.14 and 1115.20 kg/fed. at 2.0, 4.0 and 6.0 cm of irrigation depth above the soil surface, respectively. Increasing soybean seed yield under 4.0 cm irrigation depth height 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 a great harmony with those obtained by **Balasubramanian and Chari (1983)**. Also, data in the same Table illustrated that the mean values for soybean seed yield increased under application of microbial inoculants and with increasing nitrogen dose.

Water applied (m^3/fed.):

Soybean as a summer crop, irrigation water applied is the only component for water applied because of no rainfall in Egypt during its growing season. Data presented in Table (5) showed that increasing irrigation depth up to 6.0 cm above soil surface increased amount of water applied in the two growing seasons and the values are 1284.3, 2518.6, 3752.9 and 1290.8, 2530.7, 3800.8 m^3/fed. in the first and second growing seasons at 2.0, 4.0 and 6.0 cm irrigation depth above the soil surface, respectively . These results are in a great harmony with those obtained by **Abd El-Rahman (1985), El-Mowelhi *et al.* 91999), Zhen Li *et al.* (2004) and Jiamin *et al.* (2005).**

Table (4): Effect of irrigation regime, application of rhizobial inoculation and nitrogen fertilization on soybean seed yield (kg/fed) during the two growing seasons.

Irrigation depth (cm.)	Biofertilizer	Mineral fertilizer	Seed yield (kg/fed.)	
			1st season	2nd season
2.0	Inoculation	10 kg N/fed.	1163.20	1164.33
		20 kg N/fed.	1301.50	1300.17
Mean			1232.40	1232.25
	Uninoculation	10 kg N/fed.	901.20	904.33
		20 kg N/fed.	1029.40	1031.00
Mean			965.30	967.67
Total mean			1098.80	1099.96
4.0	Inoculation	10 kg N/fed.	1297.33	1295.37
		20 kg N/fed.	1504.30	1435.50
Mean			1400.82	1365.44
	Uninoculation	10 kg N/fed.	1021.04	993.03
		20 kg N/fed.	1131.40	1131.50
Mean			1076.22	1062.27
Total mean			1238.52	1213.85
6.0	Inoculation	10 kg N/fed.	1112.57	1103.50
		20 kg N/fed.	1267.30	1278.27
Mean			1189.94	1190.89
	Uninoculation	10 kg N/fed.	1001.23	966.53
		20 kg N/fed.	1119.47	1112.50
Mean			1060.35	1039.52
Total mean			1125.14	1115.20
L.S.D. 5%			0.38	0.36
1%			0.53	0.52

Table (5): Irrigation water applied (m^3/fed.) for soybean during the whole growing seasons in the two growing seasons.

Irrigation depth (cm)	Irrigation water applied m^3/fed.	
	1st season	2nd season
2.0	1284.3	1290.8
4.0	2518.6	2530.7
6.0	3752.9	3800.8

Water utilization efficiency (W.Ut.E):

As regards to, water utilization efficiency it is worthy to mention that values of (W.Ut.E) were affected by irrigation treatments (irrigation depths) as shown in Table (6), where by increasing irrigation depth increased the mean values of (W.Ut.E). The mean values are 0.86, 0.48, 0.30 and 0.852, 0.48 and 0.293 kg/m^3 in the first and second seasons at 2.0, 4.0 and 6.0 cm irrigation depth above the soil surface.

Table (6): Values of water utilization efficiency for soybean crop (kg/m^3) under different irrigation depths.

Irrigation depth (cm)	Water utilization efficiency (W.Ut.E) (kg/m^3)	
	1st season	2nd season
2.0	0.86	0.852
4.0	0.48	0.48
6.0	0.30	0.293

Effect of irrigation depth, rhizobial inoculation and nitrogen fertilization on NPK concentration in seeds of soybean grown in the studied soil:

Data presented in Table (7) showed that concentration of NPK was affected by all treatments where the highest mean values for NPK were recorded under irrigation depth of 4.0 cm above soil surface comparing with the other two irrigation depths 2.0 and 6.0 cm Also, data in the same table illustrated that application of rhizobial inculcation increased content of NPK in the two growing seasons comparing with non-treated plants. Also, data in the same tables declared that increasing nitrogen application increased uptake of NPK where the highest mean values were recorded under the high dose comparing with the low one. Generally, the mean values of the three nutrients in the two growing seasons can be descended in order as follows: N > K > P.

Table (7): Effect of irrigation depth, rhizobial inoculation and nitrogen fertilization on NPK concentration in seeds of soybean plants during the two growing seasons.

Irrigation depth (cm)	Bio-fertilizers	Mineral fertilizer	Nitrogen (N %)		Phosphorus (P%)		Potassium (K%)	
			1st season	2nd season	1st season	2nd season	1st season	2nd season
2.0	Inoculation	10 kg N/fed.	5.84	5.88	0.42	0.45	1.36	1.37
		20 kg N/fed.	6.33	6.31	0.44	0.48	1.38	1.37
Mean			6.09	6.09	0.43	0.47	1.37	1.37
	Uninoculation	10 kg N/fed.	5.60	5.58	0.38	0.39	1.22	1.24
		20 kg N/fed.	6.00	6.02	0.40	0.41	1.28	1.29
Mean			5.80	5.81	0.39	0.40	1.25	1.26
Total mean			5.90	5.90	0.41	0.44	1.31	1.32
4.0	Inoculation	10 kg N/fed.	6.34	6.32	0.49	048	1.39	1.38
		20 kg N/fed.	6.65	6.68	0.51	0.47	1.40	1.39
Mean			6.44	6.50	0.50	0.475	1.39	1.39
	Uninoculation	10 kg N/fed,	5.92	5.88	0.40	0.38	1.31	1.30
		20 kg N/fed.	6.94	6.42	0.39	0.40	1.33	1.32
Mean			6.18	6.15	0.39	0.39	1.32	1.31
Total mean			6.34	6.32	0.45	0.43	1.36	1.35
6.0	Inoculation	10 kg N/fed.	5.30	5.28	0.35	0.33	1.26	1.27
		20 kg N/fed.	5.66	5.62	0.38	0.39	1.28	1.29
Mean			5.43	5.45	0.36	0.36	1.27	1.28
	Uninoculation	10 kg N/fed.	5.20	5.22	0.30	0.33	1.25	1.26
		20 kg N/fed.	5.46	5.48	0.34	0.36	1.27	1.28
Mean			5.53	5.35	0.32	0.35	1.26	1.27
Total mean			3.38	5.40	0.34	0.35	1.27	1.28

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الملخص العربي

الاحتياجات المائية المثلى لفول الصويا فى الأرض الطينية تحت التلقيح بالريزوبيا والتسميد باليوريا

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تجربتان حقليتان نفذتا فى محطة البحوث الزراعية بسخا خلال موسمى الدراسة ٢٠٠٧/٢٠٠٨م بمنطقة شمال وسط الدلتا بهدف دراسة تأثير عمق مياه الرى ، وإضافة اللقاح بالريزوبيا والتسميد النيتروجينى على بعض العلاقات المائية والمحصول ومكوناته. التصميم الإحصائى المستخدم فى الدراسة هو القطع المنشقة مرتين لأربع مكررات حيث المعاملات الرئيسية كانت عبارة عن أعماق الرى وهى: أ- الرى بعمق ٢سم فوق سطح التربة ، ب- الرى لعمق ٤سم فوق سطح التربة ، جـ- الرى بعمق ٦سم فوق سطح التربة. المعاملات تحت الرئيسية كانت عبارة عن إضافة اللقاح بالريزوبيا ومعاملات أخرى بدون إضافة. المعاملات تحت الرئيسية كانت عبارة عن إضافة جرعتين من التسميد باليوريا.

النتائج الأساسية لهذه الدراسة يمكن تلخيصها كالتالى:

- أوضحت النتائج أن متوسط القيم لمحصول فول الصويا تأثرت بصورة واضحة بمعاملات الدراسة (عمق مياه الرى ، إضافة اللقاح بالريزوبيا والتسميد باليوريا) وكانت أعلى المتوسطات بالنسبه للقيم فى كلا موسمى الدراسة سجلت تحت كمية مياه فى صورة عمق ٤سم فوق سطح التربة مقارنة بالعمق ٢,٠ ، ٦,٠سم وكانت متوسطات القيم ١٠٩٩,٤١ ، ١٢٢٦,١٩ ، ١١٢٠,١٧كجم/فدان تحت الأعماق ٢,٠ ، ٤,٠ ، ٦,٠سم على الترتيب لذا أوصى تحت هذه الدراسة بالرى حتى عمق ٤سم بدلا من ٦سم وهذا بدورة يؤدى إلى توفير كميات كبيرة من المياه على المستوى القومى. كذلك أوضحت البيانات أن إضافة لقاح الريزوبيا أدى إلى زيادة محصول البذور مقارنة بعدم الإضافة. حيث الإضافة بدورها عملت على زيادة عدد العقد الجذرية على الجذور مقارنة بعدم الإضافة حيث الأرضى فى حالتها العادية تكون تقريبا خالية من تلك اللقاحات بالإضافة إلى تأثيراها الكبير على المحصول وكذلك الكلى من النيتروجين ، الفوسفور ، البوتاسيوم.

- إضافة السماد النيتروجينى (سماد اليوريا) عمل على زيادة المحصول حيث سجلت أعلى المتوسطات تحت أعلى الإضافات ٤٣,٤كجم يوريا/فدان مقارنة بالإضافات القليلة ٢١,٧كجم يوريا/فدان.
- قيم المياه المضافة فى كلا موسمى الدراسة كانت ١٢٨٧,٥٥ ، ٢٥٢٤,٦٥ ، ٣٧٧٦,٨٥م^{٣}/فدان تحت الرى بالأعماق ٢,٠ ، ٤,٠ ، ٦,٠سم فوق سطح التربة على الترتيب. كذلك أوضحت القيم بالنسبه لكفاءة استخدام المياه فى كلا موسمى الدراسة قد زادت تحت العمق الأقل ٢سم مقارنة بالعمقين ٤ ، ٦سم وكانت متوسطات القيم ٠,٨٥٦ ، ٠,٤٨ ، ٠,٢٩٦٥كجم/م^{٣} على الترتيب.
- متوسطات القيم لتركيزات النيتروجين والفوسفور والبوتاسيوم فى البذور زادت تحت كمية المياه المضافة فى صورة عمق ٤سم بالمقارنة ٢ ، ٦سم فوق سطح التربة كذلك إضافة لقاح الريزوبيا زيادة إضافة النيتروجين المعدنى عمل على زيادة تركيزات العناصر السابقة الذكر.
- أوضحت النتائج كذلك أن متوسطات القيم لعدد الفروع ، وزن الألف بذرة ، طول النبات ، عدد القرون على النبات ، ووزن القرون على النبات زادت تحت كمية المياه المضافة فى صورة عمق ٤سم مقارنة ٢ ، ٦سم كذلك إضافة لقاح الريزوبيا والتسميد باليوريا أدى إلى زيادة القياسات السابقة الذكر مقارنة بعدم الإضافة.