EFFECT OF BIO ORGANIC FERTILIZERS AND DEFICIT IRRIGATION ON GROWTH, YIELD AND WATER USE EFFICIENCY IN PEANUT

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ABSTRACT

Field experiment was conducted during 2012 season in one of agricultural field in the right of Euphrates River in Heat town at Al-Anbar-Iraq to evaluate the effect of bio organic fertilizers and deficit irrigation on growth, yield and water use efficiency in peanut on Sandy Loam soil. A factorial arrangement in RCBD with three replications was used irrigation management (deficit irrigation) were full irrigation (control); irrigation was imposed at 60% depletion of available water. The non complete irrigation omitting one irrigation at branching $\mathbf{T_1}$, flowering $\mathbf{T_2}$, pod formation $\mathbf{T_3}$ and seed formation stage $\mathbf{T_4}$ and the second factor was spraying bio organic fertilizers in flowering and pod stage (Sea Bloom composed from 29% Sea Bloom, 21% OM, 0.41% N, 0.7% P_2O_5, 7% K, and 70, 10, 50 ppm of Fe, Zn, B, respectively and neutral growth activity such as oxinat, Ghebrelinat and cytokaninat) with rates 0, 1.5 and 3 m/L, were applied in different applications namely A_0 A_1 and A_2. Results of this study indicated that organic fertilizers in the growth components i.e. plant height, numbers of branches per plant, leaves number and leaf area increased with increasing amount of bio organic fertilizers applied. The values of all the plant growth parameters were not significant among the various deficit irrigation treatments (branching stage T_1, and seed formation stage T_4) compared with the irrigation treatment (control) T_0, but for the flowering stage T_2 and pod formation T_3 decreasing in this parameters. Deficit irrigation management and organic fertilizers have a significant effect on biological yield and pod yield, and the T_0 and T_4 irrigation treatment have the highest biological yield 6480 and 6470 kg/ha, respectively and pod yield 4900 and 4570 kg/ha, respectively compared with other treatment. While the biological yield and pod yield increased from 5410 to 5640 and 5770; 4010 to 4290 and 4900 kg/ha for 0.0, 1.5 and 3.0 ml/L, respectively. The organic fertilizers, an increase in IWUE record an increase from 2.34 to 2.61, 3.10 with 0.0, 1.5 and 3.0 ml/L foliar application bio organic fertilizers. The deficit-irrigated treatments produced higher IWUE in comparison to full-irrigated in all treatments accepted T_3 but not reached to significant in growth season.

Keywords: Water Use Efficiency, Deficit Irrigation, Bio Organic Fertilizers, peanut

1 INTRODUCTION

Drought is one of the most common environmental stresses that may limit agriculture production worldwide. Many crops have high water requirement and in most countries supplemental irrigation is necessary for successful crop production. However, in many countries as a consequence of global climate change and environmental pollution, water use for agriculture is reduced. Drought in general is severely detrimental to the growth and yield of agricultural crops. Drought stress is not seriously detrimental to yield and can, in some instances, result in increased yield (Nautiyal et al., 1999).

Maximized use of store soil water, increased biomass productivity per unit water use and highest of biomass productivity into economic yield under limited –water conditions are the ultimate goals of any drought research (Krishnamurthy et al., 2007). Root traits associated with drought tolerance are important for drought resistant mechanisms of plant. Root characteristics such as root length density, rooting depth and root distribution have been established as constituting factor of drought resistance (Matsui & Singh, 2003). Rucker et al. (1995) reported that a large root system may improve a plants ability to continue growth during drought stress.

Application of organic fertilizers is one of important practical measures to improve soil fertility. Adequate nutrition is the ecosystem response to the addition of artificial or natural substances, in addition to providing necessary nutrient for crops and improving soil physico-chemical properties, organic fertilizer is able

enhance soil microbial activity of soil, such as improving activity of soil enzymes and increasing soil microbial biomass (Sun, 2003). Peanut (*Arachis hypogaea* L.) is considered to be one of the most important crops which thrive in the newly reclaimed sandy soils as a leguminous crop of high nutritive value and a source of edible oil. These soil types are poor in organic matter and nutrient elements. Organic matter is a key component of soils affecting their physical, chemical and biological properties and is important as a source of energy and nutrient elements for soil ecosystem. Maintenance of sufficient levels of organic matter in soils is prerequisite for sustainable and high production of crop; therefore this study was conducted to investigate the role of bio organic fertilizers application and deficit irrigation on Peanut (*Arachis hypogaea* L.) productivity and water use efficiency.

2 MATERIAL AND METHODS

A Field experiment was carried in one of the agricultural field located in the right of Euphrates River in Heat town at Al-Anbar-Iraq on Sandy Loam soil. Soil samples from a horizon (0-30cm) were air dried ground and then sieved through 2 mm sieve. Soil samples then analyzed according to methods described in Black et al. (1965) and Page et al. (1985) for some physical and chemical soil properties respectively. Results of analyses show in Table 1. Season length and seasonal weather parameters in Al-Anbar are included in Table 2.

The treatments included three rates of bio organic fertilizers spraying in flowering and pod stage (Sea Bloom composed from 29% Sea Bloom, 21% OM, 0.41% N, 0.7% P_2O_5, 7% K, and 70, 10, 50 ppm of Fe, Zn, B, respectively and neutral growth activity such as oxinat, Ghebrelinat and cytokaninat) with rates 0, 1.5 and 3 ml/L, were applied in different applications namely A_0 A_1 and A_2. The growth cycle of the Peanut was divided into five stages: Emergence stage, Branching stage, flowering stage, pod formation and seed formation. Water stress treatment combinations comprised five treatments; full irrigation (control), irrigation was imposed at 60% depletion of available water. The non complete irrigation omitting one irrigation at branching $\mathbf{T_1}$, flowering $\mathbf{T_2}$, pod formation $\mathbf{T_3}$ and seed formation stage $\mathbf{T_4}$. The treatments were plants watered (W) and not watered (D) during the growth stages, which will be referred to as treatment **(Table 3).**

Table 1. Some physical & chemical properties of soil used

Soil Properties		Units	Values
pH		-	7.78
EC_e		dS m^{-1}	4.03
$CaCO_3$		g Kg^{-1}	255
OM			10.3
Sand		g Kg^{-1}	580
Silt			320
Clay			100
Texture		Sandy Loam	
Bulk Density		$Mg.m^{-3}$	1.38
Soil content moisture	33 Kpas	cm^3 cm^{-3}	0.198
	1500 Kpas		0.095
Available water			0.103

Irrigation system was surface flow irrigation through line pipe provided with meter gages for measuring water applied. The total soil water, calculated between field capacity and wilting point for an assumed Peanut root extracting depth from 0.15 to o.40 m.

Seeds of Peanut (*Arachis hypogaea* L.) were sown at a rate of 20 kg/ha, with recommended dose of 80 P_2O_5 kg/ha phosphorus fertilizer were applied as a form of calcium super phosphate. Recommended rate of nitrogen (50 kg N/ha) was applied as a form of urea in two split equal doses (at sowing, and at beginning of flowering stage). Planting took place on 15/5/2012 in RCBD as split plot arrangement with three replications, harvesting date 10 of November 2012. Each experimental unit consisted of 4 rows 2 meters in length within 25 cm; total plot area was 7

m^2. All plots were irrigated with river water an ECi = 1.73 $dS.m^{-1}$. Irrigation were scheduled when soil water content in the root zone was depleted by the crop to specific fraction of available water (irrigation was imposed at 60% depletion of available water).

Table 2. Monthly temperature (maximum, minimum), relative humidity and total amount of rainfall (mm) in the period from May to November 2012 season

Month	Month length (days)	Mean Temperature (^{0}C)		Mean R.H (%)		Total amount of rainfall (mm)
		Maximum	Minimum	Maximum	Minimum	
May	10	39.23	19.14	46.12	11.79	0.00
June	30	41.34	23.91	45.00	10.50	0.00
July	31	44.19	26.20	43.10	9.30	0.00
August	31	46.17	24.71	44.25	9.70	0.00
September	30	39.34	20.49	57.20	11.80	0.00
October	31	30.94	14.50	67.60	18.60	0.00
November	10	25.73	9.76	73.10	21.10	0.00

Table 3. Stage deficit irrigation of Peanut planted in the growing season of 2012

Treatment	Growth Stages			
Control T_0	W	W	W	W
T_1	D	W	W	W
T_2	W	D	W	W
T_3	W	W	D	W
T_4	W	W	W	D

The soil depth of the effective root zone is increased from 0.15 m at planting to 0.40 m in flowering, pod formation and seed formation stages. At harvest time, two central rows in each plot were harvested to determining pod yield and then; seed yield per hectare was calculated. Sub sample of 10 plants was taken from each plot to measuring plant height in cm, No. of branches/plant, No., leaf area, leaves No., biological and pod yield (kg/ha).

The sum of differences in soil water and applied irrigation water plus rainfall were calculated as ETa using water balance equation, assuming negligible deep percolation, groundwater contribution and runoff. Evapotranspiration (ETa) was calculated using the soil water balance method (Allen et al., 1998):

$$ET = P + I - D \pm \Delta W \ldots\ldots\ldots\ldots \textbf{(1)}$$

Where P is the rainfall (mm); I is the irrigation applied to individual plots (mm); D is the deep percolation; and ΔW is the change in water storage of the soil profile (mm). Since the amount of irrigation water was only sufficient to bring the water deficit to field capacity, deep percolation was ignored. Water productivity was calculated according to the following equation:

$$\textbf{Water productivity (WUE)} = \frac{Yield\ (Kg\ ha^{-1})}{Total\ water\ applied\ \ (m^3)} \quad \ldots\ldots\ldots\ldots\ldots \textbf{(2)}$$

Analysis of variance (ANOVA) was conducted to evaluate the effects of the treatments on the yield and water use efficiency. Least significant differences method (L.S.D) was used to differentiate means at the 0.05 level (**SAS**, 2002).

RESULT AND DISCUSSION

Results presented in Table (4) reveal all tested bio fertilizers in the growth components i.e. plant height, numbers of branches per plant, leaves number and leaf area. Theses results may be due the parameters of growth components increased with increasing amount of organic fertilizers applied. This can be due to the role of bio organic fertilization in plant physiology and improving the quantity and quality growth characterization and can provide plants with essential elements required (Sun et al., 2003 & Lin et al., 2010).

The values of all the plant growth parameters were not significant among the various deficit irrigation treatments (branching stage T_1, and seed formation stage T_4) compared with the irrigation treatment (control) T_0, but for the flowering stage T_2 and pod formation T_3 decreasing in this parameters.

Table 4. Effect of different levels of bio organic fertilizers and deficit irrigation on plant height, branches number, leaves number and leaf area

Treatment		Plant Height (cm)	Branches No.	Leaves No.	Leaf Area (cm^2)
Irrigation Treatment					
T_0		85.2	14.3	1023.3	76.8
T_1		83.3	13.1	876.6	71.6
T_2		75.7	12.6	870.3	57.9
T_3		74.9	11.6	834.2	67.3
T_4		83.6	14.2	956.3	66.9
LSD		2.328	0.824	NS	2.650
Bio Organic fertilizer levels					
A_0		64.2	11.0	736.8	56.7
A_1		88.7	14.0	960.7	66.0
A_2		89.7	14.4	1038.9	81.6
LSD		1.879	1.012	20.107	3.479
Irrigation Treatment × Bio Organic fertilizer levels					
T_0	(A_0)	70.1	11.0	797.0	61.3
	(A_1)	90.3	15.8	1108.3	79.3
	(A_2)	95.1	16.0	1164.7	89.9
T_1	(A_0)	62.3	11.0	753.7	61.6
	(A_1)	89.5	13.3	926.7	65.2
	(A_2)	95.1	15.0	949.3	88.1
T_2	(A_0)	59.2	10.5	709.3	51.5
	(A_1)	84.5	13.2	894.3	53.6
	(A_2)	83.3	14.0	1007.3	68.8
T_3	(A_0)	60.3	11.0	663.7	53.1
	(A_1)	82.1	11.8	878.0	66.7
	(A_2)	82.3	11.9	961.0	82.1
T_4	(A_0)	69.3	11.5	760.2	56.1
	(A_1)	85.5	15.3	996.5	65.3
	(A_2)	95.6	15.9	1112.1	79.4
LSD		2.657	1.731	NS	5.614

Results showed that deficit irrigation management and bio organic fertilizers have a significant effect (P<0.05) on biological yield and pod yield (Table 5) and the T_0 and T_4 irrigation treatment have the highest biological yield 6480 and 6470 kg/ha, respectively and pod yield 4900 and 4570 kg/ha, respectively compared with other treatment. While the biological yield and pod yield increased from 5410 to 5640 and 5770; 4010 to 4290 and 4900 kg/ha for 0.0, 1.5 and 3.0 ml/L, respectively. By studying the effect of drought stress on peanut, Vorasoot et al. (2003) and El- Boraie et al. (2009) concluded that under stress condition, the yield was decreased. And these effects might be due to that in organic fertilizers system a set of soil microorganisms, processing the ability of mobilizing the unavailable forms of nutrient element to available forms has been successfully.

Table 5. Effect of different levels of bio organic fertilizers and deficit irrigation on biological yield, pod yield, water use efficiency ($WUE_{Biological}$ and WUE_{Pod})

Treatment		Biological Yield (kg/ha)	Pod Yield (kg/ha)	$WUE_{Biological}$ (kg/m^3)	WUE_{Pod} (kg/m^3)
Irrigation Treatment					
T_0		6480	4900	1.64	1.24
T_1		5430	4270	1.64	1.29
T_2		5050	4250	1.47	1.24
T_3		4610	4000	1.40	1.22
T_4		6470	4570	1.85	1.31
LSD		163	333	0.211	0.014
Bio Organic fertilizer levels					
A_0		5410	4010	3.16	2.34
A_1		5640	4290	3.43	2.61
A_2		5770	4900	3.62	3.10
LSD		146	139	0.136	0.250
Irrigation Treatment × Bio Organic fertilizer levels					
T_0	(A_0)	5630	4230	1.42	1.07
	(A_1)	6730	4500	1.70	1.14
	(A_2)	7100	5980	1.79	1.51
T_1	(A_0)	5700	4050	1.72	1.22
	(A_1)	5460	4320	1.65	1.31
	(A_2)	5130	4440	1.55	1.34
T_2	(A_0)	5400	3960	1.58	1.16
	(A_1)	4730	4310	1.38	1.26
	(A_2)	5030	4490	1.47	1.31
T_3	(A_0)	4800	3800	1.46	1.16
	(A_1)	4430	3960	1.35	1.21
	(A_2)	4600	4240	1.40	1.29
T_4	(A_0)	5530	3990	1.59	1.14
	(A_1)	6860	4370	1.97	1.25
	(A_2)	7030	5370	2.02	1.54
LSD		320	326	0.404	0.301

Results of data on irrigation water use efficiency (IWUE) for all treatments are presented in Table 5 indicated the importance of bio fertilizers for good yield and better utilization of water, this can be attributed to the role of macro and micronutrients in improving crop resistance to water stress and other stresses (Rahimizadeh et al., 2007). The foliar application bio organic fertilizers used the lower amounts of water than non- bio fertilizers. IWUE of bio fertilizers treatments were higher and differed from non- bio fertilizers treatment in the growth season (P<0.05). However, the IWUE did differ (P<0.05) for deficit irrigation and bio organic fertilizers interactions. The deficit-irrigated treatments produced higher WUE in comparison to full-irrigated in all treatments accepted T_3 but not reached to significant in growth season (P<0.05). The irrigation water use efficiency (WUE_{pod}) of all the treatment ranges from 1.07 to 1.54 kg m^{-3} while the irrigation water uses efficiency ($WUE_{biolog.}$) range from 1.32 to 2.02 kg m^{-3}. It can also be deduced from the results of the

percentage difference in water use efficiency compared between irrigation treatments. Also the bio fertilizers, an increase in IWUE record an increase from 2.34 to 2.61, 3.10 with 0.0, 1.5 and 3.0 ml/L foliar application bio fertilizers. Songsri et al. (2009) showed that drought stress in a reduction in efficiency of seeds water consumptive from 1.69 kg/ha under unstressed condition to 0.98 kg/ha under stressful conditions in different peanut cultivars, and Gohari (2011) showed the highest water use efficiency based on biomass and pod in 6 days irrigation treatment were 2.88 and 1.24 kg/ha compared to 12 days irrigation were 2.39 and 1.00 kg/ha. Therefore, it can be concluded that bio organic fertilizers application with good crop management can achieved good productivity and high WUE under west of Iraqi conditions.

CONCLUSION

Bio organic fertilizers treatment increased both peanut pod yield and biological compared with control (without fertilization). Deficit irrigation in pod formation as the most sensitive to water stress, therefore we must not cut irrigation in this stage, but the interaction between deficit irrigation and bio organic fertilizers improved highest pod yield in any treatment.

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