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# Effect of Irrigation Period and Bio-fertilizers in 1. Water Productivity and Yield of Wheat (IPA 99 Varieties) in Middle Region of Iraq/ Al- Diwanyh province

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***Abstract:*** *The experimental treatments were arranged in Randomize Complete Block Design with three replicates was carried out at Al- Diwanyh province during winter season 2017-2018 in silt loam soil. The main plots were assigned to irrigation period, whereas biofertilizers application was assigned to the sub plots. NPK mineral fertilizer were applied, as they are commonly used for growing wheat plants and recommended by Ministry of Agriculture were applied to all treatment excepted treatments biofertilizers application added half amount of chemical fertilizers recommended. Sowing was done on November 20th/2017 and harvest was done on 7/ May /2018. The irrigation period (every 10, 15 and 20 days) were arranged in main plots whereas, treatments of biofertilizers application in the sub plots (Bacteria solvent phosphate – Bacillus sabtilus + Azotobacter chroococcum for nitrogen fixation + Bacillus muceliganus solvent potassium and Tricoderma harzianum) were added rate 4 kg $h^{-1}$ at band near seeds at planting and not added biofertilizers application.*
*The obtained results could be due to irrigation every 10 and/or 15 days supplied sufficient soil moisture in the root zone which increased the capacity of wheat plant in photosynthesis and consequently increased flag leaf area, plant height, number of tillers $m^{-2}$ and rate of chlorophyll in flag leaf. For interaction, the tallest flag leaf area 64.4 $cm^2$, 105 cm 310 $m^{-2}$ and 54.32 for flag leaf area, plant height, number of tillers $m^{-2}$ and rate of chlorophyll in flag leaf, respectively were recorded for wheat plants treated with addition of biofertilizers and irrigated every 15 days for IPA 99 cultivars.*
*Water productivity varied from 0.61 mm to 0.76 mm and 0.53 mm depending on the irrigation period at irrigation every 10, 15 and 20 day. The total amount of water productivity was 0.48 and 0.78 mm without and with addition biofertilizers application, respectively.*

***Key words:*** *irrigation period, biofertilizers application, wheat, water productivity*

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## I. Introduction

Wheat is not only the most important cereal crop in the world but also the major staple food for the people of Iraq. Wheat (*Triticum aestivum* L.) is considered the most strategic crop for Iraq and some other developing countries. Increasing wheat productivity is a national target in Iraq to fill the gap between wheat consumption and production. Water stress affects physiological processes, growth and yield of wheat plant. ***Amer (2004)*** studied the effect of irrigation levels: control treatment (depletion of 50% of available water) and four treatments which represented (75%, 50% and 25% of the mount of the control) on the productivity of some bread and durum wheat cultivars. The results revealed that, the highest number of spikes/$m^2$, 1000 grain weight and grain yield were obtained from irrigation 75% watering amount treatment, and saved 696 and 490 $m^3$ of water $ha^{-1}$ for two seasons. Water stress affects physiological processes, growth and yield of wheat plants. Whenever, soil moisture stress increased, the wheat yield decreased (***Abbas et al., 2001***). ***Bushra and Khdhayer (2015)*** studies the drought treatment (50 ،49 ،and 90%) depletion of available water of occupied the main plots. While seed priming treatments (gibberellins, Kinetin, cycocel, salicylic acid، KCl, Ascorbic acid, distilled water and Dry seeds). The results of experiment revealed that there were significant differences between seed priming treatments with emergence. The result showed that Moisture depletion treatment 90% with seed priming by Salicylic acid increase in water use efficiency of grain reached quotient 1.850 kg. $m^3$ increase exceeded 100% compared to the treatment comparison Dry seed at the same level of attrition 90% causing moisture depletion at 90% with no motivation Dry seeds in the reduction of water use efficiency of cereal quotient 0.8381 kg $m^3$.

Agrochemical fertilizers have been inflicting adverse effect on the environment causing pollution and damaging beneficial soil flora and fauna, causing erosion and no longer able to sustain the productivity.

Therefore, in order to make agriculture sustainable, biofertilizer and organic fertilizers have important role to play in improving nutrient supplies and thus yield. Biofertilizers are ecofriendly, cost effective and renewable source of plant nutrients. They can play a vital role in maintaining soil fertility and sustainability, the long term use of biofertilizer is economical, ecofriendly, more efficient, productive and accessible to marginal and small farmers over chemical fertilizers. The role and importance of Biofertilizers in sustainable crop production has been reviewed by several authors (***Wani and Lee, 1995***). Thus, the aim of this study were to investigate the effect of irrigation period and biofertilizers on the yield and water productivity of wheat under semi arid conditions in middle of Iraq.

## II. Material and Methods

Field experiments on Wheat was carried out at Al- Diwanyh province during winter season 2017-2018 in silt loam soil classified as *Typic Torriflovent* (as subgroup classification). Some soil characteristics (Table 1) were determined according **to Black (1965 a,b).**

The experimental treatments were arranged in Randomize Complete Block Design with three replicates. The main plots were assigned to irrigation period, whereas biofertilizers inoculation was assigned to the sub plots**.** NPK mineral fertilizer as urea, calcium super phosphate and potassium sulphate were applied, as they are commonly used for growing wheat plants and recommended by Ministry of Agriculture were applied to all treatment excepted treatments inoculation added half amount of chemical fertilizers recommended. Sowing was done on November 20$^{th}$/2017 and harvest was done on 7/ May /2018. The treatments were:

**Table 1: Physic-chemical properties of the soil**

| Soil depth (cm) | BD | F.C | W.P | AW | Particle size distribution (gm/kg) | | | | EC | pH | OM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | mg m$^{-3}$ | % | | | clay | Silt | sand | Texture | dS m$^{-1}$ | | % |
| 0-30 | 1.40 | 34.0 | 16.2 | 17.8 | 209 | 500 | 291 | Silt Loam | 3.45 | 7.78 | 9.14 |
| 30-60 | 1.42 | 34.5 | 14.1 | 18.4 | 420 | 470 | 110 | Silt clay | 4.11 | 7.6 | 4.42 |

**1. Irrigation treatment as follows (main plot):**

a. Irrigation every 10 days.
b. Irrigation every 15 days.
c. Irrigation every 20 days.

**2. Biofertilizers application treatment (sub plot):** (Bacteria solvent phosphate – *Bacillus sabtilu*s + *Azotobacter chroococcum for nitrogen fixation* + *Bacillus muceliganu*s solvent potassium and *Tricoderma harzianum*) were added rate 4 kg h$^{-1}$ at band near seeds at planting.

a. Added biofertilizers application ($C_1$)
b. Non added biofertilizers application ($C_0$)

The area of each plot was 9 m$^2$ (3×3). Grains of wheat were sown at a rate of 140 kg ha$^{-1}$, All agriculture practices for growing wheat were applied as recommended. During the cultivation seasons; the mean relative humidity was 45.6 % and mean rainfall was less than 100 mm during wheat growing season.

The amounts of applied irrigation water (m$^3$/ha) correspond to each interval. Irrigation was applied according to the irrigation period. Irrigation system was surface flow irrigation through line pipe provided with meter gages for measuring water applied. 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 50% depletion of available water). The amount of water consumed from the root zone between two successive irrigations as a water depth in cm, was calculated from the following equation (***Israelson and Hansen, 1962***):

$$d = D \times P_b \times \frac{(Q_2 - Q_1)}{100} \dots\dots (1)$$

Where: d = Depth of water added D = The irrigation root zone depth (cm)

$P_b$ = Bulk density of soil (g. cm$^{-3}$) $Q_2$ = The percentage of soil moisture at field capacity

$Q_1$ = The percentage of soil moisture before irrigation

Water productivity was calculated according to **Allen et al. (1998)** as following equation:

$$water\ productivity = \frac{Yield\ \ (Kg\ ha{-}1)}{Water\ \ applied\ \ (mm)} \dots\dots\dots (2)$$

Plant samples of one square meter from each plot were harvested and ten plants were taken randomly to determine yield attributes (flag leaf area, plant height, tillers m$^{-2}$, rate of chlorophyll in flag leaf, weight of 1000 grains and total grain yields). 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, 2012*).**

## III. Result and Discussion

**Yield Attributes**

**Flag leaf area ($cm^2$), Plant height (cm) and Number of tillers $m^{-2}$**

Results presented in Table 2, 3 and 4 show that irrigation of wheat plants at short period every 10 days (15 irrigations till harvest) and period every 15 days (12 irrigations till harvest) led to significant increase and gave the highest values of flag leaf area ($cm^2$), plant height (cm) and number of tillers $m^{-2}$ in IPA 99 wheat cultivar led to not significant between the treatments 10 and 15 irrigation period but increase when compare with period every 20 days (8 irrigations till harvest). The results also showed that the application of biofertilizers significantly improved the wheat flag leaf area plant height and number of tillers $m^{-2}$ raising biofertilizers inoculation from 50.20 to 59.53 $cm^2$, from 88 to 96 cm and from 203 to 268 $m^{-2}$ for flag leaf area, plant height and number of tillers $m^{-2}$ respectively. As shown in the combined analysis**,** the interaction effects between irrigation period biofertilizers on flag leaf area, plant height and number of tillers $m^{-2}$ in Tables 2, 3 and 4 were significant. As for interaction, the tallest flag leaf area 64.4 $cm^2$, 105 cm 310 $m^{-2}$ for flag leaf area, plant height and number of tillers $m^{-2}$ respectively were recorded for wheat plants treated with addition of biofertilizers and irrigated every 15 days for IPA 99 cultivars.

**Table 2: Flag leaf area ($cm^2$) of wheat as affected by the irrigation period and biofertilizers**

| **Irrigation** Treatment | $C_0$ | $C_1$ | **Mean** |
|---|---|---|---|
| **10** | **52.50** | **63.80** | **58.15** |
| **15** | **53.30** | **64.40** | **58.85** |
| **20** | **44.80** | **50.40** | **47.60** |
| **Mean** | **50.20** | **59.53** | |
| **LSD** | **I** | **C** | **IC** |
| **0.05** | **1.35** | **0.96** | **1.63** |

**Table 3: Wheat plant height (cm) as affected by the irrigation period and biofertilizers**

| **Irrigation** Treatment | $C_0$ | $C_1$ | **Mean** |
|---|---|---|---|
| **10** | **93** | **101** | **97** |
| **15** | **94** | **105** | **100** |
| **20** | **77** | **81** | **79** |
| **Mean** | **88** | **96** | |
| **LSD** | **I** | **C** | **IC** |
| **0.05** | **1.80** | **1.97** | **2.13** |

**Table 4: Number of tillers $m^{-2}$ of wheat as affected by the irrigation period and biofertilizers**

| **Irrigation** Treatment | $C_0$ | $C_1$ | **Mean** |
|---|---|---|---|
| **10** | **216** | **304** | **260** |
| **15** | **223** | **310** | **267** |
| **20** | **171** | **190** | **181** |
| **Mean** | **203** | **268** | |
| **LSD** | **I** | **C** | **IC** |
| **0.05** | **7.80** | **5.43** | **9.61** |

**Rate of chlorophyll in flag leaf**

Data presented in Table 5 showed the effect of the irrigation interval, different biofertilizers on the rate of chlorophyll in flag leaf of wheat. Irrigation interval every 10 days (15 irrigations till harvest) and period every 15 days (12 irrigations till harvest) led to significant increase and gave the highest values of chlorophyll in flag leaf of IPA 99 wheat cultivar led to not significant between the treatments 10 and 15 irrigation period but increase when compare with period every 20 days (8 irrigations till harvest).

The obtained results could be due to irrigation every 10 and/or 15 days supplied sufficient soil moisture in the root zone which increased the capacity of wheat plant in photosynthesis and consequently increased flag leaf area ($cm^2$), plant height (cm), number of tillers $m^{-2}$ and chlorophyll in flag and number of tillers $m^{-2}$ in IPA 99 wheat cultivar. Plant growth parameter promoting bacteria improved photosynthesis may be by increasing water and nutrients absorption leading to produce more assimilation and improve plant growth (***Naderifar and daneshian, 2012***). Rainfall in this season was not enough to bear plants to irrigation every 20 days.

**Table 5: Rate of chlorophyll in flag leaf of wheat as affected by the irrigation period and biofertilizers**

| **Irrigation** Treatment | **$C_0$** | **$C_1$** | **Mean** |
|---|---|---|---|
| **10** | **48.20** | **51.70** | **49.95** |
| **15** | **49.93** | **54.32** | **52.13** |
| **20** | **41.10** | **44.22** | **42.66** |
| **Mean** | **46.41** | **50.08** | |
| **LSD** | **I** | **C** | **IC** |
| **0.05** | **2.76** | **1.23** | **3.12** |

**Grains weight (gm) and Grain yield (kg ha$^{-1}$)**

Data illustrated in Table 6 and 7 showed the effect of irrigation period and biofertilizer on the wheat grain weight (gm) and grain yield (kg ha$^{-1}$). The treatment irrigation every 15 days produced highest average grain yield 4042 kg ha$^{-1}$ and differ significantly from treatment irrigation every 10 days 3620 kg ha$^{-1}$,and irrigation every 20 days 2192 kg ha$^{-1}$. while the percentage reduced grain yield for the treatment irrigation every 20 days by 39.45% and 45.77%, as compared to irrigation every 10 and 15 days respectively. This significant decrease if we calculated the actual amount of water added during the growing season, rainfall an average of less than 100 mm was not enough to give the protection of yield and this good production. The results also showed that the application of biofertilizers significantly improved the wheat flag leaf area plant height, number of tillers m$^{-2}$ and the rate of chlorophyll in flag leaf because biofertilizers application is important in terms of production of plant growth regulators, particularly auxin and increase plant growth by elongation of plant cells, stimulate of cell division and differentiation of plant cells), iron chelating compounds, organic acids (succinic acid and lactic) and solving phosphorus by secretion of organic acids and phosphates

**Table 6: Weight of 1000 grains (gm) of wheat as affected by the irrigation period and biofertilizers**

| **Irrigation** Treatment | **$C_0$** | **$C_1$** | **Mean** |
|---|---|---|---|
| **10** | **31.04** | **35.50** | **33.27** |
| **15** | **30.27** | **37.47** | **33.87** |
| **20** | **25.73** | **27.12** | **26.43** |
| **Mean** | **29.01** | **33.36** | |
| **LSD** | **I** | **C** | **IC** |
| **0.05** | **0.81** | **0.92** | **1.11** |

**Table 7: Grain yield (kg ha$^{-1}$) of wheat as affected by the irrigation period and biofertilizers**

| **Irrigation** Treatment | **$C_0$** | **$C_1$** | **Mean** |
|---|---|---|---|
| **10** | **2800** | 4440 | **3620** |
| **15** | **3134** | 4950 | **4042** |
| **20** | **1820** | **2564** | **2192** |
| **Mean** | **2585** | **3985** | |
| **LSD** | **I** | **C** | **IC** |
| **0.05** | **47** | **38** | **131** |

**Water productivity**

Table 8 presents the informative data about water productivity varied from 0.61 mm to 0.76 mm and 0.53 mm depending on the irrigation period at irrigation every 10, 15 and 20 day. The total amount of water productivity was 0.48 and 0.78 mm without and with addition biofertilizers application, respectively.

**Table 8: Water productivity (kg m$^{-3}$) as affected by the irrigation period and biofertilizers**

| **Irrigation** Treatment | **$C_0$** | **$C_1$** | **Mean** |
|---|---|---|---|
| **10** | **0.46** | **0.76** | **0.61** |
| **15** | **0.56** | **0.95** | **0.76** |
| **20** | **0.42** | **0.64** | **0.53** |
| **Mean** | **0.48** | **0.78** | |
| **LSD** | **I** | **C** | **IC** |
| **0.05** | **0.10** | **0.18** | **0.23** |

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