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THE EFFECT OF TWO LEVELS OF IRRIGATION ACCORDING TO THE STAGES OF GROWTH IN YELLOW MAIZE CROP (ZEA MAYS L.)

Mustafa. R. Al-Shaheen[1,2*], Awang Soh[2], Rabah S. Shareef[2,3]

Muhammad Shahzad Aslam[2]

[1]Department of Field Crop, College of Agriculture, University of Anbar, Anbar, Iraq;

[2]School of Bioprocess Engineering,Universiti Malaysia Perlis,Kompleks Pusat Pengajian Jejawi 3,02600 Arau,Perlis, Malaysia.

[3]College of Education-Al-Qiam, University of Anbar, Iraq;

Submitted on: 12.10.2015 Revised On: 02.11.2015 Accepted on: 05.11.2015

ABSTRACT

A field experiment was carried out in autumn season2009 in one of the farmers' fields on the banks of Euphrates river in the city of Ramadi on yellow maize crop class (Abaa5018 *Zea mays L*)**,** which is a newly derived synthetic variety in Iraqi agriculture, with the objective of studying the effect of two levels of irrigation of 75% and 50% of yellow maize crop plants with three stages of growth on the production of yellow maize in grain and dry matter.Seeds were sown on 15/07/2009 and harvested on 14/11/2009, the two levels of irrigation were distributed randomly over the stages of growth and eight coefficients were obtained.The stages of growth included the vegetative stage which begins from the date of isolation of irrigation coefficients on 1/8 till the onset of emergence of male inflorescence, the flowering stage which begins from the emergence of male inflorescence until the end of emergence of female inflorescence and then the last stage which begins from the end of second stage till the maturation of seedsThe coefficients of the experiment were randomly distributed and according to Randomized Complete Block Design (RCBD). While the irrigation coefficient (T8) which is irrigated by the second level of 50% throughout the season of growth gave the lowest rate for each of leaf area , dry matter, and grain harvest with water consumption of 276 mm. showed gradation in the production of grain, dry matter and leaf area, according to the distribution of irrigation water over the sensitive stages of growth for each character and are limited between the productions of irrigation coefficients (T1 & T8). They also varied in water consumption, total water requirement and water consumption efficiency. This variation occurred as a result of distribution of irrigation levels over the coefficients according to stages of growth.

KEYWORDS: Water Stress, Irrigation coefficients, Corn Growth, Irrigation Level

Corresponding author: **Mustafa. R. Al-Shaheen**;
E-mail : alani2005ms@yahoo.com

Indian Research Journal of Pharmacy and Science; 7(2015) 287-298;
Journal home page: https://www.irjps.in

INTRODUCTION

Water resources are among the natural resources that life is associated with its existence and the preservation of these resources has become a necessity. The agricultural sector is considered the main consumer of this resource in most of the Arab countries, consuming about 90% of the available water[1]. The management of water resources and its appropriate utilization is considered a priority in dry and semi-dry areas or in the areas of low rainfall such as Iraq. Among the good methods of management of agricultural production is to control the amount of water given in each irrigation and reduce the number of irrigations used as per the ability of absorption of the soil and the plant need in various stages of growth in order to reach the highest productivity[2]. There has been newly adopted agricultural applications that aim to overcome the physiological symptoms that arise in the plants growing in harsh environments such as thirst, desiccation and lack of ground water, which also contributes to the supply of some of the water need of the plants. It has been observed that the plants which were gradually exposed to drought in one of its growth stages become more resistant to it when exposed to another period of drought in comparison to other plants which were not exposed to at all[3].

The method of evaporation basin class (A) in the calculation of water consumption for any crop is considered as an indirect method that can be adopted by using the crop coefficient, which is considered as one of the good indicators in determining the amount of irrigation for any crop if the results were comparable to the reality[4]. Evaporation can be calculated by this method using the impact of sun rays on the water surface of evaporation basin, the temperature of air in contact with the surface of the basin and wind speed[5][6]had used evaporation data of evaporation pan class _A_ as a proof in their study about the amount of irrigation water added to yellow maize and obtained good results.Objectives of the study:

1. To identify the most appropriate amount of water to produce the best quantity of grain dry matter.
2. To identify the most sensitive stage of growth to the decrease in soil moisture and its impact on the production.
3. To determine the possibility of using crop coefficient plants and evaporation pan class _A_ in estimating the amount of water to be added to the crop.
4. To determine the feasibility of adopting ten days time interval between successive irrigation events in autumn season.

METHODOLOGY

A field experiment was carried out in autumn season2009 in one of the farmers' fields on the banks of Euphrates River in the city of Ramadi/Al-Anbar province. The field soil is classified as sedimentary soil of muddy slimy texture. The field is irrigated from Euphrates River. A sample of the field soil was taken prior to planting, it is then dried, milled and passed through a sieve of 2mm diameter pores in order to estimate some of the chemical and physical properties of the soil of the study (Table 1).

The methods used in estimation of these properties are:

1. **Soil Texture:** It was estimated by absorbent method as reported in[6].
2. **Bulk Density:** It was estimated by Core Sampler method[7].
3. **Electrical conductivity:** It was measured in the saturated paste extract using Conductivity Bridge apparatus according to the method reported by [8].
4. **Soil Moisture:** estimated at tensions of 1/3 Bar to estimate field capacity and 15 Bar to estimate wilting point using Pressure membrane apparatus and Pressure Plate according to the method reported by [9].
5. **PH**: It was measured in the saturated paste extract using pH-meter according to the method reported by[10].
6. **Organic matter:** Estimated by Black and Walkley`s method mentioned in [11].
7. **Available Nitrogen**: Estimated by Bremmer`s method (1960) mentioned in[12].
8. **Available phosphorus:** Estimated by Oslen`s method (1960) mentioned in[13].
9. **Available Potassium:** It was ex-

tracted using ammonium acetate solution (N1) and estimated using flame photometer as mentioned in [7]and the results were recorded in table (1).

Table 1. Some chemical and physical properties of the experimental field soil prior to planting.

The value	Analysis Type
The characteristic	2.35
Electrical conductivity ds.m^{-1}	7.35
Degree of reaction of soil **Nutrients for sale:**	
Nitrogen is ready PPm	64.2
WP-ready PPm	13.7
Potassium ready PPm	141
Organic matter g/kg	1.09
Bulk density miligram/m^3	1.22
Volumetric distribution of soil dismissed during pregnancy (G. kg-1 soil)	
Sand	144
Clay	320
Silt	536
Conception	Sand,salt,clay
Percentage soil moisture when you tighten 1/3 bar	31.4%
Percentage of soil moisture at 15 bar tighten	16.6%

Final Stage

The field land was plowed then divided into experimental units of dimensions 3 × 3 m. Each experimental unit includes 6 lines. The distance between every line is 0.50m and that between every jouret on the same line is 0.25m and a space of 2m between the replications and that of 1.5m between the experimental units in order to control the water movement. The coefficients of the experiment were distributed randomly with three replications according to randomized complete block design (R.C.B.D). Yellow maize seeds (Abaa 5018) were planted (This is one of the newly derived classes in Iraqi agriculture and no researches has been done previously on water consumption of this class) in autumn season on 16/7/2009 with 3-4 seeds in each jouret and plant density of 80000 plants/hectare. The germination irrigation was given on 16/07/2009 in depth of 25 mm, then a second irrigation was given on 21/7/2009 in depth of 25 mm in order to promote the growth process and completion of germination. Later a third irrigation was given on 31/7/2009 in depth of 25mm in order to maintain the proper ratio of moisture and promote the growth of new plants and prepare to receive the stage of isolation of coefficients that took place on 1/8/2009. The irrigation was done according to the water requirement for the two levels of irrigation 75% and 50% in 10/8/2009 and later on according to the coefficients in table 3. Following the appearance of 75% of failure signs, the failing jourets were grafted with seedlings that were planted in sand glass material at the same time of planting the field to ensure that no significant difference in the growth of plants occurs. The corn stem borer (Sesamia cretica) was controlled using the pesticide diazinon granular (10% active ingredient) with a quantity of 6 kg / ha for three times, the first time was 20 days after planting, the second time10 days after the first time and the third time 10 days after the second time. After three weeks of germination the plants decreased to one plant in the jouret.

Diammonium phosphate (DAP)fertilizer was added as a source of phosphorus and nitrogen in the range of 70 kg /ha of phosphorus and 62.64 kg/ha of nitrogen before planting. Later, nitrogen fertilizer was added from which the nitrogen quantity was removed. It was added in the range of 200

kg/ha of nitrogen in the form of urea fertilizer (N 46%) in four equal batches[14]. The first batch was added immediately after germination, the second after 21 days from the first batch, the third at the beginning of flowering and the fourth batch at the beginning of kernel formation in the corncob.
The bushes were continuously controlled by manual weeding during the growth season in order to ensure the flow and uniform distribution of water. The crops were harvested on 14/11/2009. Two levels of irrigation were determined depending on the crop coefficient values which are typically as were calculated in the scientific experiments conducted by Al- Saad and others in 1989. These values were calculated on the basis of maximum transevaporation of the coefficient irrigated by 75% and maximum transevaporation of the coefficient irrigated by 50% in the same experiment. The amount of irrigation to be added for each level in the experiment was calculated using the crop coefficient values in Table (2) multiplied by the evaporation values recorded from evaporation pan class (A) located in the meteorological station in Ramadi city and close to the experiment field. The period of irrigation was decided to be every ten days distributed over the physiological stages of growth i.e. vegetative stage, flowering stage and maturation stage (represents the period from pollination till physiological maturation)

Table 2. Shows the typical values of Kc (crop coefficient) for yellow maize crop calculated for every ten days

The time period	Kc Value 75%	Kc Value 50%
8/1To 8/10	0.19	0.12
11/8 To 20/8	0.20	0.13
21/8 To 30/8	0.22	0.15
31/8 To 9/9	0.33	0.22
9 /10 To 9/19	0.68	0.46
9/20To 9/29	1.00	0.67
9 /30 To 10/9	0.94	0.63
10/10 To 10/19	0.54	0.35
10/20To 10/29	0.48	0.31

The two levels of irrigation were distributed randomly over the stages of growth and eight coefficients were obtained as shown in table (3):

Table 3. Levels of irrigation used to distribute over the experiment coefficients according to the stages of growth of yellow maize

The plants	Stages of growth		
	Vegetative stage	Flowering stage	Maturity
T1	75%	75%	75%

T2	75%	75%	50%
T3	75%	50%	75%
T4	75%	50%	50%
T5	50%	75%	75%
T6	50%	75%	50%
T7	50%	50%	75%
T8	50%	50%	50%

The amount of irrigation to be added for each level was calculated using the following equation: **Kc × Epan=Eta**
Where,
Kc = Crop coefficient of yellow maize.
Epan = the value is obtained by multiplying pan coefficient Kp into the amount of evaporated water from evaporation pan class A.

The value of Kp varies depending on the type of the pan, the surrounding vegetation and the nature of soil surface (11).
The wetting events were distributed over the stages of growth with 4 wettings in the vegetative stage, two wettings in the flowering stage and three wettings at maturity stage (Table 8). Irrigation water depths for each wetting were calculated as shown in Table 4.

Table 4. Irrigation water depths (mm) for each irrigation.

50% Pan evaporation * crop coefficient		75% Pan evaporation * crop coefficient		Date of irrigation
16		25		2009/8/10
15		24		2009/8/20
16		23		2009/8/30
22		33		2009/9/9
44		65		2009/9/19
61		90		2009/9/29
54		81		2009/10/9
28		43		2009/10/19
20		31		2009/10/29
Total	**276**	**Total**	**415**	

The stages of growth were determined on the basis of some physiological phenomena of the plant as follows:
The vegetative growth stage: begins from the date of isolation of coefficients on 01/08/2009 till the onset of emergence of male inflorescence.
The flowering stage: begins with the emergence of male inflorescence till 100 % of emergence of female inflorescence.
Maturation stage: begins from the end of flowering until the physiological maturation.

CHARACTERS STUDIED

1. Leaf area of the plant (cm 2) was calculated according to the following equation:1. Leaf area (cm^2) = length of the leaf below the upper corncob leaf * 0.75 if the leaf number of the plant exceeds 14 leaves.

2.Dry weight ton/ha: 10 plants were taken randomly from the middle lines of each experimental unit, then cut and dried in an electric oven at 65 degree Celsius for 48 hours until the stability of weight and then the average yield per plant was extracted and multiplied by usinga plant density of 80,000 hectares in order to obtain the dry yield in tons/ hectare.

3.Grain yield tons / ha: was calculated from the average weight of kernels yielded from all the harvested corncobs oftenplanets, then dried in an electric oven at 65 degrees for 48 hours until they reach the standard humidity (15%) and then the average yield per plant was extracted and multiplied by used plant density of 80,000 hectares in order to obtain the grain yield in tons/ hectare.

4. Total water consumption:

5. Efficiency of water consumption (Kg/m^3): was calculated according to the following equation mentioned in:

$$WUE_f \quad \frac{Y}{WA}$$

Y = Grain yield (Kg)
WA = The volume of water added in the irrigation process (m3).
The data were statistically analyzed according to **randomized complete block design** (**R.C.B.D**) using software (GenStat Discovery Edition 3). Also Least Significant Difference Test (L.S.D) had been used to identify statistically different averages at 5% probability level (15). The experiment included eight irrigation coefficients T1, T2, T3, T4, T5, T6, T7, T8. The coefficients were randomly distributed in experiment with three repetitions.

RESULT AND DISCUSSION:

LEAF AREA (CM^2):

Figure 3 indicates that the levels of irrigation have a significant effect on leaf area. The irrigation coefficient (T1) in which the plants were not exposed to water stress throughout the growth season statistically exceeded with the highest average of leaf area of 5721.63 cm 2 / plant compared to the irrigation coefficient (T8) in which the plants were exposed to water stress throughout the growth season and produced the least average of leaf area of 3953 cm 2 / plant. This may be attributed to the adequacy of irrigation in both the stages of vegetative growth and flowering which led to the increase in plant height and this is reflected in the increase in number of leaves in the plant as well as the direct effect of water in the increase of cell division and size. All of this had been reflected in the increase in leaf area of the plant Table (5)[15]. And in this respect [16]pointed out that the exposure of yellow maize plants to water stress during both the stages of vegetative growth and flowering reduces the dilation and elongation of plant leaves. This adversely affects the processes of photosynthesis and other vital or biological activities and functions which results in reduction in general growth of the plant including the leaf area. [17]and [18]also obtained similar results.
As for the irrigation coefficient (T2) that was exposed to water stress only during maturity stage, it did not show significant difference from the coefficient (T1). This is attributed to the reason that the effect of water stress during maturity stage on the average of leaf area is very less because there is completion of major of the growth at this stage which is followed by deceleration in biological processes. This is consistent with the findings of[19], who pointed to the lack of effect of water stress in the maturity stage on leaf area of the plant due to the fact that the vegetative growth has stopped.
The irrigation coefficient (T3) that was exposed to water stress only during flowering stage did not show significant difference from the irrigation coefficient (T4) that was exposed to water stress during both the vegetative and flowering stage as the leaf area values for both the coefficients was 5116.67 and 5018.43 cm2/plant respectively.
Similarly, the two coefficients T5 and T6 did not show significant difference in this trait, but they significantly differed from the irrigation coefficients T1, T2, T3 and T4 and also from T7 and T8 which also did not differ significantly from each other with the least average of 4018.68 and 3953.07 cm2/plant respectively. These results demonstrate the importance of providing adequate irrigation during vegetative growth stage and flowering stage for their clear effect over the average leaf area of the plant. This is consistent with the results of [20]that indicated a decrease in the average of leaf area of maize plant as a result of lack of irrigation at the beginning of flowering stage.

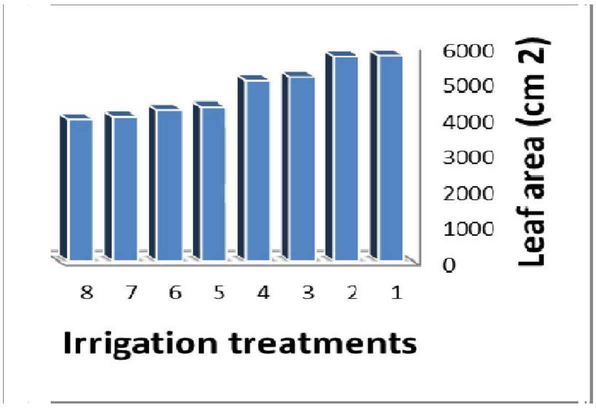

Figure 1. Effects of irrigation coefficients on leaf area

DRY MATTER YIELD TON/HA:

Information in Table 2 and Figure 2 show that water stress, especially in the two stages of vegetative growth and flowering play an important role in the formation of dry matter. It was observed that no significant differences exist between the irrigation coefficient (T1) that was not exposed to water stress throughout the growth season, and the irrigation coefficient (T2) which was exposed to water stress in the maturity stage, where the average dry matter for both the coefficients was 20.05 and 19.97 tons/ha respectively. Whereas the irrigation coefficient (T8) which was exposed to water stress throughout the growth season gave the lowest average of dry weight of 13.12 tons/ha. The superiority of irrigation coefficients T1 and T2 may be attributed to the availability of appropriate moisture throughout the sensitive stages of plant growth that could meet the water needs of the plants, which allowed the completion of growth processes through the increase in plant height, leaf area, and increase in grains yield. These results are consistent with the findings of[21], who pointed that a decrease in dry matter yields of the plant occur when exposed to water stress during both the stages of vegetative growth and flowering. This is supported by the results of [22] which showed high increase in the average of dry weight of the leaves of yellow maize on transformation from stress to non-stress conditions.

Whereas the irrigation coefficient (T3) that was exposed to water stress only during flowering stage showed a significant decrease on comparison with the irrigation coefficients (T1and T2) as it produced an average dry weight of 17.20 tons/ha, which is close to the average dry weight of irrigation coefficient (T4) that was exposed to water stress during both the vegetative and flowering stage and produced an average dry weight of 16.893 tons/ha. While the irrigation coefficient (T5) which was exposed to water stress during the vegetative growth stage, showed a significant difference in comparison with irrigation coefficient (T6) that was exposed to water stress during both vegetative growth stage and maturity stage and both the coefficients gave an average of 15.24 and 13.68 tons/ha respectively. This may be attributed to the importance of flowering stage in the growth of plants and consequently its effect on dry weight. These results are consistent with the findings [23], who pointed that, the processes of formation of reproductive parts are very sensitive to water stress as enlargement and division of cell form a basic constituent in the growth and dry matter of the plant which is later reflected upon the reproductive part.

The irrigation coefficient (T7) which was exposed to water stress during the vegetative growth and flowering stage, did not show a significant difference compared with the coefficient (T8) as it produced an average dry weight of 155.7 tons/ha. The previous results showed the significant effect of vegetative growth stage and flowering stage on the average dry weight of the plant. This is consistent with the findings of [24]who pointed out that the adequacy of irrigation during vegetative growth stage and flowering stage led to acceleration of growth and cell division and best utilization of water and the dissolved nutrients. This in

turn led to increase in the growth of stem and leaves which later reflects in the reproductive stage and increase of the dry matter.

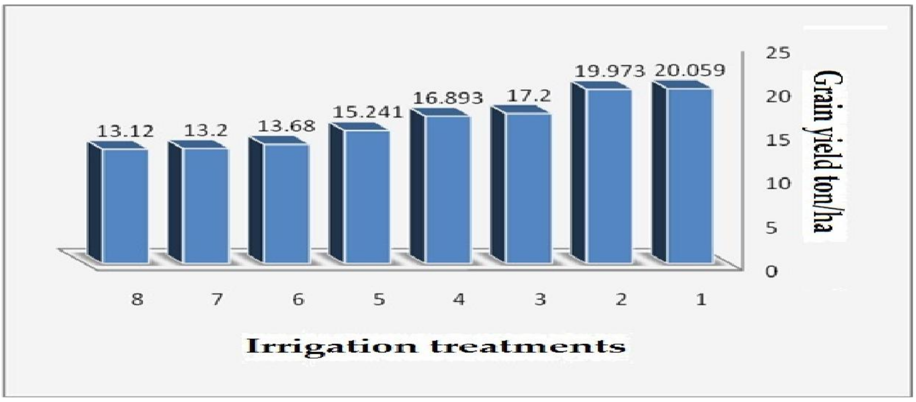

Figure 2. The effect of irrigation treatments on dry tons winning E.

Ton/ha

The results in figure (3) showed that the amount of irrigation plays a vital role in increasing or decreasing the production as it is observed that a significant difference of high value exists between the irrigation coefficient (T1) that was not exposed to water stress throughout the season and the coefficient (T8) that was exposed to water stress throughout the season where both the coefficients produced 10.92 ton/ha and 7.41 tons/ha of seeds respectively. The superiority of the irrigation coefficient (T1) in terms of vegetative growth, plant height and leaf area can be attributed to the availability of adequate moisture for dissolution of nutrient elements, easy transport to other parts and broad activity in blocking the incident sun rays which contribute to the process of photosynthesis. These results are consistent with (26) who pointed out a decrease in grain yield as a result of exposure of the plant to water stress during the vegetative growth stage and flowering stage.

No significant difference appeared between the irrigation coefficient (T2), in which the plants were exposed to water stress during maturity stage, and the irrigation coefficient (T1), as it produced a grain yield of 10.78 tons/ha. This may be contributed to the lack of effect of water stress in maturity stage on the grain yield. This is consistent with (27) who pointed that the exposure of yellow maize plant to water, strain during the stage of formation of the yield did not lead to significant reduction in grain yield but contributed in saving 25 and 34 % of irrigation requirements. The results indicate a significant difference between the irrigation coefficient (T3) which was exposed to water, strain during flowering stage compared with the irrigation coefficients (T1 and T2) as it produced an average grain yield of 9.30 tons/ha, whereas it did not show a significant difference when compared to irrigation coefficient (T5) in which the plants were exposed to water stress during the vegetative growth stage and produced an average grain yield of 9.64 tons/ha.

This can be attributed to the significance of flowering stage in grain yield tons/ha. This is consistent with the findings of who pointed out that water stress during the flowering stage affects the flowering process;

this in turn affects the compatibility process between the male and female flowering which reflects adversely upon the number and weight of grains especially when there is lack of pollen grains on time. The irrigation coefficient (T7) in which the plants were exposed to water stress during the stages of vegetative growth and flowering did not show any significant difference compared with the irrigation coefficient (T8) and produced 7.41 tons/ha.

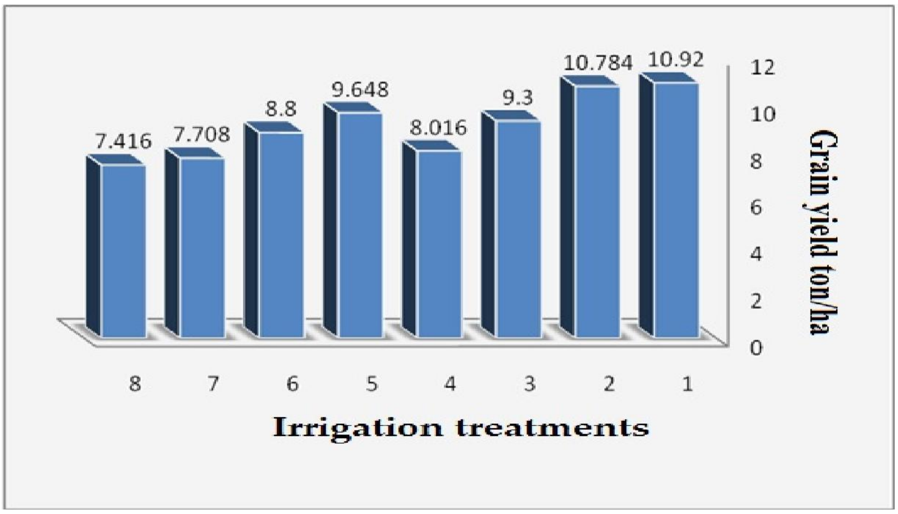

Figure 3. The effect of irrigation treatments on grain holds Tons/h

Total water consumption:

Table (5) shows the values of water consumption calculated from the date of isolation of coefficients till the date of harvest and the amount of irrigation water added including three wetting events that were added prior to the isolation of coefficients in order to promote germination and vegetative growth and according to the calculated amounts for each stage (table4) on the basis of experiment coefficients mentioned in table (3) where the irrigation coefficient (T1) which was not exposed to water stress throughout the growth season recorded highest water consumption value of 415mm/season and amount of added water of 490 mm/season which reflected positively on the growth of the plants and its production of dry matter and seeds (table5), while the irrigation coefficient (T8) which was exposed to water stress throughout the growth season recorded lowest water consumption value of 276mm/season and amount of added water of 351 mm/season which reflected negatively on the productivity of dry matter and seeds as a result of the impact on vegetative growth. Whereas the irrigation coefficient (T5) in which the plants were exposed to water stress during the vegetative growth stage, recorded average water consumption of 379mm/season and amount of added water of 454mm/season, which reflected positively on grain yield, dry matter yield and leaf area compared with irrigation coefficients (T6, T7 and T8).

The irrigation coefficient (T2) in which the plants were exposed to water stress during the maturity stage was distinguished as it recorded an average water consumption of 362mm/season and amount of added water of 437mm/season which reflected positively on traits studied in comparison with the other coefficients except the coefficient (T1).

The irrigation coefficient (T7) in which the plants were exposed to water stress during the stages of vegetative growth and flowering did not give a significant difference in the most important traits compared with

(T8) which is irrigated by the second level 50%

The values of water consumption in Table (5) which are distributed over the stages of growth demonstrated the significance of vegetative growth in the total dry matter yield of the plant and this is consistent with the results of [25] who obtained a higher average of dry matter on transformation from lack of irrigation to adequate irrigation conditions in that stage.

Water use efficiency Kg/m^3:

It is the plant's ability to use water to produce the economic yield and it varies depending on the variety of the crop, the amount of irrigation water and associated environmental conditions. Water use efficiency was calculated on the basis of seeds yield and the amount of water consumed by the plant.

Figure (15) and table (7) indicates the impact of levels of irrigation on the efficiency of water use, the irrigation coefficient (T2) in which the plants were exposed to water stress during the maturity stage was significantly distinguished as it recorded water use efficiency of 2.97 Kg (m3) without affecting the amount of production compared with the irrigation coefficients T3, T4, T5 and T7 which gave values of 2.54, 2.56, 2.55 and 2.35 respectively.

It is followed by the coefficient (T6) in which the plants were exposed to water stress during the vegetative growth and maturity stage as it gave a value of 2.69 kg(m3) but this difference is not as significant as other coefficients. This can be attributed to the reason that the adequacy of irrigation led to decrease in average of water use efficiency which is consistent with (30) who pointed out that reducing irrigation water by 25% of total irrigation may lead to increase in water use efficiency.

The irrigation coefficient (T8) in which the plants were exposed to water stress throughout the growth stages gave rise in the values when compared with the coefficient (T1), as it gave average water use efficiency of 2.68 and 2.63 kg(m3) respectively. Although this difference is not significant but it can be attributed to decrease in irrigation water throughout the growth season which further led to increase in water use efficiency of the plant. This is consistent with (31) who mentioned that water use efficiency increases from 6.7 kg (m3) to 11.2 kg (m3) on reduction of amount of water added from 575mm to 200 mm.

Whereas the irrigation coefficient (T7) in which the plants were exposed to water stress during the vegetative growth stage and flowering stage gave a significant difference when compared with the irrigation coefficient (T2) as it gave water use efficiency of 2.35 kg (m3) and this may be attributed to the significance of vegetative stage in affecting the efficiency of irrigation. This is consistent with the results of [26]who obtained lowest water use efficiency of 0.97 kg (m3) when blocking the irrigation during the vegetative growth stage.

The previous results are consistent with those of [27] which showed a reduction in water use efficiency of measurement coefficient due to increase in amount of water used relative to the produced grain yield compared to the rest of the coefficients of white maize crop

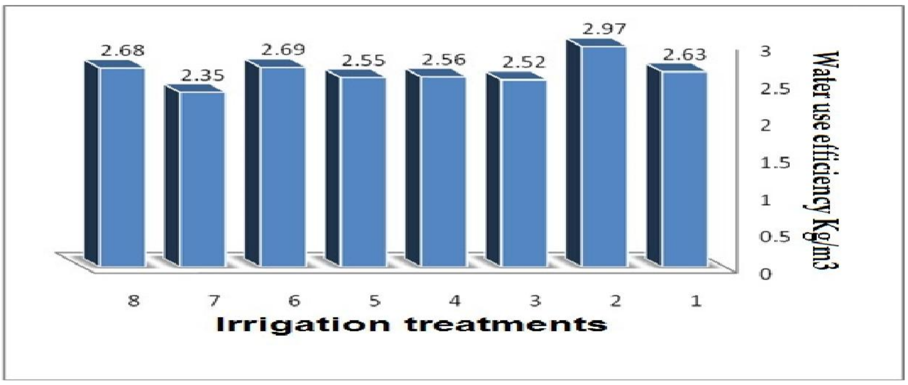

Figure 4 the effect of irrigation treatments on Water use efficiency Kg/m^3

CONCLUSION

Through the results of this study, the following conclusions were reached:
No difference between the treatment of irrigation T1 And irrigation treatment T2 to some extent in the production of grain and dry holds that if possible, provide 530 m3/h, which can be used in other crops or planting the same crop expansion. Prepare phase of vegetative growth and flowering of more growth sensitive to moisture for dry grain quotient quotient. Irrigation has led to a level of 75% vegetative growth stage to increase the rate of plant growth and reflected philosophically in the dry aggregate plant. Have an adequate irrigation in the flowering stage to flowering and pollen release with the flowering of the female which has increased the rate of vaccination, which reflected moral on a grain. The study showed that the use of the interval of time between the Republic and the other (10 days) and the length of the growing season to lug an autumn without harming the plants.

ACKNOWLEDGMENT

We would like to acknowledge Institute Of Sustainable Agrotechnology, Sg. Chuchuh, Universiti Malaysia Perlisand School of Bioprocess Engineering for providing facilities to conduct this research.

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Conflict of Interest Reported: Nil; Source of Funding: None Reported