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Study of the morpho-physiological indicators of several rice genotypes with the levels of water irrigation

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Abstract

A field experiment was carried out at the rice research station in Al-Mishkhab\ Al-Najaf Governorate affiliated to the Agricultural Research station during the summer agricultural season 2022, in order to study some morpho-physiological indicators of several rice genotypes, which were (Anber-33, Jasmine, Baraka , Al-Furat, K1, K35.K45) under the effect of three levels of irrigation (daily irrigation, irrigation every five days and irrigation every ten days), according to the RCBD (Randomized Complete Block Design) with three replications and split-plot arrangement, where irrigation levels occupied the main plots and the seven genotypes were placed in the sub-plots. The results showed that there were significant differences for the varieties, the genotype (K1) was superior in the leaf area and the traits of water use efficiency, while Al- Furat variety was superior in the number of days from planting until emergence and from planting to maturity, while the variety Anber- 33 Superiority in of plant height and panicle length, and genotype K45 was significantly superior in the chlorophyll content of the flag leaf. As for the binary interactions between genotypes and irrigation periods, the results showed that the treatment (Al-Furat × irrigation every 10 days) Superiority in the number of days from sowing until emergence and the treatment (Baraka with irrigation every 10 days) superiority in the number of infertility tillers and the treatment (K1 with irrigation every 10 days) superiority in the water use efficiency trait.

Keywords: Varieties, chlorophyll content, Water use efficiency, water stress.

Introduction

Rice (*Oryza sativa* L.) is considered one of the strategic and important grain crops in the world, as it is a food for more than half of the world's population, as it is produced and consumed in Asia at a rate of more than 90%, and in Iraq it comes after Crops of wheat and barley in terms of cultivated area and production.

Drought stress is a serious limiting factor for rice production, which leads to great economic losses due to global climate change. In view of the current and expected growing global demand for food, it has become necessary to enhance crop productivity in drought lands. The field is sensitive to drought compared to most other grain crops, because it is a plant that grows under conditions of submersion and waterlogging, since its genetic origin is semi-aquatic. Therefore, drought stress and due to lack of water is a major problem in rice cultivation and enlargement (Bernier et al., 2008). As the rice plant's tolerance to water deficiency varies according to the growth stage, so it is moderately tolerant during the germination stage, the plant becomes very sensitive during the early seedling stage, then regains its tolerance to water deficiency during the vegetative growth stage, and then increases its tolerance during the maturity stage (Panda *et al.*, 2021).

Iraqi rice varieties suffer from the problem of their sensitivity to water shortage, which greatly contributed to reducing their growth and production rates, and to the importance and role of genotypes as a basis in any production program in the field crops from the programs that deal with the problem of drought and water Insufficient. This experiment was carried out with the aim of: Knowing the effect of water stress on some growth traits, and determining the best tension through which to obtain the highest yield. And trying to understand the response mechanisms of rice under water stress conditions by measuring the content of the physiological indicator chlorophyll by exposing the plants to different levels of water stress.

MATERIALS AND METHODS

The field experiment was carried out at the rice research station in Al-Mishkhab in Al-Najaf Governorate, which is affiliated to the Agricultural Research Department - Rice Research Department, during the summer agricultural season 2022, with the aim of studying some morpho-physiological indicators of several genotypes of Iraqi rice in terms of water stress (lack of irrigation).

The soil of the field was chemically and physically analyzed in the Soil Physics Laboratory at the College of Agriculture / Al-Muthanna University, as its properties are shown in Table No. (1). Seedlings were prepared and experimental units were grown for the treatments using the seedling method. 6/22/2022, the seeds were soaked and placed in cloth bags inside containers filled with pure water for two days, and the water was changed every 12 hours. In order to encourage the germination process, a process of composting the seeds was carried out for a full day. After that, plastic dishes were prepared filled with fine soil, then it was moistened until saturation, and the seeds of the genotypes were scattered in the dishes on 6/25/2022, then the dishes were transferred to the nursery, and the nursery was watered twice a day. With puncture and

the nursery remaining moist, the dishes were left in the nursery for fifteen days, and then transferred to the permanent field on July 17, 2022. The solu for the experiment was prepared while the agricultural operations of plowing, leveling and fertilizing were carried out according to the recommendations approved for the rice crop (Hassan, 2011). Seedlings were planted in the field in a hole, in each hole one seedling was placed with a distance of (15 cm) between one hole and another, and the distance between one line and another was (25 cm) in plots of (2 x 3 m^2), with four lines inside each plot, leaving a distance 2 meters between one experimental unit and another and with three replications using the split plot arrangement using the complete randomized block design (R.C.B.D), Regarding the irrigation management of the experiment, the method of alternate immersion with drying was followed, which lasted in this way for two weeks, and then stress treatments were applied until the plant reached the stage of physiological maturity. The experiment included two factors: genotypes (Anber-33, Yasmin, Baraka , Al-Furat, K1, K35, K45) The second factor: water stress (continuous daily irrigation by flooding (comparison treatment), flood irrigation every five days, flood irrigation every ten days) The treatment began with drought stress after two weeks from the date of transferring the seedlings to the land of the permanent field, and on the first of August 2022.

Table (1): Some chemical and physical properties of the field soil before planting

Traits	**the value**	**measruing unit**	**Adjective**	**Value**	**measruing unit**
Sand	23.1	gm Kg^{-1} Soil	organic matter	1.5	Mg Kg^{-1} Soil
Silt	41.07	gm Kg^{-1} Soil	N	23.27	Mg Kg^{-1} Soil
Clay	45.2	gm Kg^{-1} Soil	P	15.30	Mg Kg^{-1} Soil
PH	7.42	–	K	172.1	Mg Kg^{-1} Soil
EC 1:1	4.00	dS m^{-1}	Soil tissue	**Clay admixture**	Clay loam
CEC	5.98	Cmol +Kg^{-1} Soil			

The studied traits: number of days from emergence to 50% flowering, number of days from emergence to physiological maturity, plant height (cm), flag leaf area (cm^2), number of infertilitytillers (m^2), panicle length (cm), determination of chlorophyll content Total (mg m^2) by the CCM200-Plus Leaf Chlorophyll Content Meter, water use

efficiency according to the following equation approved by (Mchugh, 2002)

Then the data of phenotypic traits were analyzed statistically using the statistical program Genstat Discovery 4.

Results

1) Number of days from emergence until 50% flowering (day)

The results showed in Table (2) that the genotype of Baraka superior by giving lowest number of days from emergence to 50% flowering, with an average of 110.78 days, while the variety Furatgave the highest number of days, amounting to 119,044 days. This difference may be due to the nature of the genotype, which differs in the length of its flowering period and the extent to which it is affected by environmental conditions.

There was no significant effect of irrigation intervals on the number of days from emergence until 50% flowering

As for the interaction between genotypes and irrigation periods, only the results of the table showed the superiority of the interaction between (Baraka and irrigation every ten days) which gave the lowest average of 108.67 days, while the highest average was recorded between (Furat and the irrigation period every ten days). It reached 120.33 days.

Table (2): Effect of genotypes and irrigation periods and their interactions on the number of days from emergence to 50% flowering

genotypes	**Every day**	**5 days**	**10 days**	**Average genotypes**
K1	119.00	118.00	117.33	118.11
K35	116.67	114.00	115.33	115.33
K45	115.67	120.00	115.67	117.11
Anber-33	111.67	112.67	112.67	112.33
Jasmine	117.33	119.00	117.00	117.78
Furat	120.00	118.00	120.33	119.44
Baraka	113.33	110.33	108.67	110.78
Average irrigation periods	116.24	116.00	115.29	Interaction =2.240
L.S.D	irrigation periods = N.S	for genetic combinations = 1.292		

It was clear from the results of Table No. (3) that k45 was superior by giving it the lowest number of days for this trait, which amounted

2-Number of days from emergence to physiological maturity (day)

The results of the irrigation periods of table No. (3) showed that the irrigation period was every ten days and gave the lowest average of 149.52 days, while the daily irrigation period gave the highest number of days with an average of 152.14 days.

With regard to the interaction between the two factors, the results showed that the interaction between the Variety (Jasmine and the irrigation period every ten days) gave the lowest average of 144.67 days, while the interaction between (Baraka × daily irrigation period) gave the highest average of 157.67 days.

to 146.11 days, while the variety Furat gave the highest number of days, which amounted to 153.33 days. The reason for the difference in genotypes in the period required for flowering and physiological maturity is they differ in the length of the stages of vegetative and reproductive growth, starting from germination until physiological maturity, which is consistent with what was mentioned by (Hilal et al., 2019), as plant breeders prefer genotypes whose growth period is short or medium to avoid the negative impact of rainwater on grain deterioration and reducing its quality, as well as reducing irrigation water and production and storage costs.

Table (9): Effect of genotypes and irrigation periods and their interactions on the number of days to physiological maturity

genotypes	Every day	5 days	10 days	Average genotypes
K1	151.33	149.67	149.00	150.00
K35	151.67	151.33	150.67	151.22
K45	148.67	145.33	144.33	146.11
Anber-33	152.33	146.33	146.00	148.22
Jasmine	146.67	151.67	144.67	147.67
Furat	156.67	153.00	150.33	153.33
Baraka	157.67	149.33	148.33	151.78
Average irrigation periods	152.14	149.52	147.62	interaction=2.999
L.S.D	irrigation periods 2.065 =	for genotypes= 1.606		

plant height trait, the Anber-33 Variety excelled and gave an average of 102.78 cm, while the Furat variety recorded the lowest

3- Plant height (cm)

The results of table No. (4) showed that the genotypes had a significant effect on the

55.67 cm. The reason for the decrease in plant height with the period of intermittent irrigation leads to an increase in the osmotic potential in the medium in which the plant lives and a decrease in the amount of absorbed water and nutrients, which prevents cell division or expansion, photosynthesis and subsequent transport, and then reduces cell length and breadth, which leads to shortening.Plant height under drought, which is consistent with his findings. (Al-bourky et al.,2021 Monisha et al., 2021)

height of 58.89 cm, and perhaps the reason for this is due to the ability of the genotype and its specific nature of the plant height trait according to the number of internodes and their length which determine the plant height.

The results of Table No. (4) also indicated that the interaction between (variety Anber-33 and daily irrigation) gave the highest average of 107.00 cm, while the interaction between (variety Furat and irrigation every five days) showed the lowest average of

Table 4: Effect of genotypes and irrigation periods and their interactions on plant height

genotypes	Every day	5 days	10 days	Average genotypes
K1	84.00	73.67	77.67	78.44
K35	81.67	77.67	77.67	79.00
K45	78.33	74.67	76.67	76.56
Anber-33	107.00	102.67	98.67	102.78
Jasmine	70.67	61.33	65.00	65.67
Furat	62.33	55.67	58.67	58.89
Baraka	78.00	75.00	72.33	75.11
Average irrigation periods	80.29	74.38	75.24	Interaction 7.601=
L.S.D	irrigation periods= N.S	for genotypes 3.613=		

4- Flag leaf area (cm^2)

The data of Table No. (5) showed that the genotypes significantly affected the flag leaf area trait, as genotype k1 gave the highest mean for the flag leaf area trait of 25,037 cm^2, while the Variety Baraka gave the lowest flag leaf area of 12.22 cm^2, and may be attributed to The reason for this superiority is the variation in the genetic structure of the studied genotypes, as the difference between the Varieties or genotypes in the trait of the flag leaf area cm^2 is due to the genetic differences among them (Almshhdani, 2010), in addition to that the structures that showed superiority in the flag leaf area trait are Almost itself excelled in plant height, and this confirms the presence of a significant positive correlation, which means that the growth of these structures was better than the rest that

worked to increase the area of the flag leaf, and these results agreed with what he found (Al-Burki *et al*., 2021).Which indicated the difference between the genotypes of rice and the size of the flag leaf.

The results of the data of the same table indicated that the daily irrigation period gave the highest leaf area of 22.53 cm^2, while the irrigation period every ten days gave the lowest average of 19,010 cm^2 .

The results of the table also showed that the interaction between (Anber-33 × daily irrigation) gave the highest mean leaf area of 30.26 cm^2, while the interaction between (Baraka × irrigation every five days) recorded the lowest average of 11.42 cm^2.

Table (5): Effect of genotypes and irrigation periods and their interactions on the flag leaf area

genotypes	Every day	5 days	10 days	Average genotypes
K1	26.96	24.26	24.90	25.37
K35	21.26	22.74	21.66	21.89
K45	26.47	25.27	21.80	24.51
Anber-33	30.26	23.94	20.64	24.95
Jasmine	22.10	18.73	17.69	19.51
Furat	16.93	15.74	15.50	16.06
Baraka	13.74	11.42	11.50	12.22
Average irrigation periods	22.53	20.30	19.10	Interaction =2.850
L.S.D	irrigation periods = 0.967	for genotypes 1.727 =		

five days) gave the lowest value of 0.00 strand m^2 for each of them, while the interaction between (Baraka and irrigation every ten days) recorded the highest mean of 23.00 strand m^2, these results are consistent with what was found by (Al-bourky et al, 2021, Abdul Hussein, 2017).

5- Number of infertility tillers (m^2)

The results of Table No. (6) showed that the k1 genotype gave the lowest average number of infertility tillers per square meter, which amounted to 0.11. The two factors showed that (genotype k1 × daily irrigation period) and (genotype k1 and irrigation every

Table (6): Effect of genotypes and irrigation periods and their interactions on the number of infertility tillers

Genotypes	Every day	5 days	10 days	Average genotypes
K1	0.00	0.00	0.33	0.11

K35	8.33	3.33	2.33	4.67
K45	0.33	0.33	1.00	0.56
Anber-33	0.67	12.00	6.67	6.44
Jasmine	1.00	9.00	2.00	4.00
Furat	1.33	1.67	2.00	1.67
Baraka	3.00	21.00	23.00	15.67
Average irrigation periods	2.10	6.76	5.33	interaction = 6.662
L.S.D	irrigation periods = N.S	for genotypes = 3.556		

6- The length of the panicle (cm)

The results, Table (7), indicated that there were significant differences between the compositions, as the Anber-33 Variety excelled, recording the highest average of 27.56 cm, while the Furat Variety recorded the lowest average of 19.72 cm.

With regard to the irrigation periods, the results of the table showed that the daily irrigation period gave the highest average of 23.90 cm, while the irrigation period every ten days recorded the lowest average of 22.69 cm. The effect of little irrigation on the stage of emergence, the formation of the fruiting cluster, and the flowering stage, and its effect on the vital processes carried out by the plant. From an increase in the number of grains and the number of filled grains in particular, and the positive significant correlation between the length of the panicle, the height of the plant, and the flag leaf area, which indicates that plants with high height and large leafy area are more qualified to consume light, and then increase the efficiency of the photosynthesis process and dry matter production, thus increasing the length of the panicle.

The results of the interaction between the two workers showed that the interaction between (variety of Amber 33 and the daily irrigation period) had the highest average of 30.84 cm, while the lowest average of the interaction between (Furat × irrigation every ten days) was 18.99 cm. The result is with what was found by (Sarhid and Ahmed, 2019), who attributed the reason for the decrease in the length of the panicle in the treatment of intermittent irrigation to the effect of little irrigation in the stage of emergence and formation of the fruiting cluster and in the flowering stage and its effect on the overall vital processes that occur in the plant.

Table (7): The effect of genotypes and irrigation periods and their interactions on the trait of the panicle length

Genotypes	Every day	5 days	10 days	Average genotypes
K1	24.53	22.45	21.28	22.75
K35	21.90	23.58	23.07	22.85
K45	25.26	23.60	25.08	24.65
Anber-33	30.84	26.16	25.69	27.56
Jasmine	21.61	20.28	20.34	20.74
Furat	20.63	19.55	18.99	19.72
Baraka	22.53	23.85	24.36	23.58
Average irrigation periods	23.90	22.78	22.69	interaction=2.056
L.S.D	irrigation periods = 0.735	genotypes = 1.242		

7- Chlorophyll content in the flag leaf

The results of table (8) indicated that there was a significant effect of the combinations, as the k45 genotype achieved the highest average chlorophyll content of 44.45 micrograms cm^3, while the Furat Variety gave the lowest average of 37.71 micrograms cm^3.

The decrease in chlorophyll content may be due to the ionic imbalance caused by the lack of water and the inhibition of the photosynthesis process, in addition to the fact that water stress has a role in stimulating the chlorophyll-degrading enzyme (Willows, 2003), and these results are consistent with what was observed by (Al-Jana *et al.*, 2021).

Table (8): Effect of genotypes and irrigation periods and their interactions on chlorophyll content

Genotypes	Every day	5 days	10 days	Average genotypes
K1	42.40	42.77	40.05	41.74
K35	40.55	40.08	38.23	39.62
K45	42.95	45.78	44.62	44.45
Anber-33	40.68	38.51	41.12	40.10
Jasmine	42.14	39.04	38.55	39.91
Furat	36.27	37.63	39.25	37.71
Baraka	44.44	41.05	40.31	41.93
Average irrigation periods	41.35	40.69	40.30	interaction = N.S
L.S.D	irrigation periods = N.S	genotypes = 1.975		

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8-Water use efficiency (kg m^3)

The results of Table (9) showed that there were highly significant differences in the effect of genotypes on the efficiency of water use, as the genotype K1 recorded the highest average for this trait amounting to 0.1986 kg m^{-3}, while the Al Baraka Variety gave the lowest average for this trait amounting to 0.0390 kg m^{-3}.

The results also showed that the irrigation period every ten days gave the highest water use efficiency amounting to 0.1443 kg m^{-3}, while the daily irrigation recorded the lowest average amounting to 0.0689 kg m^{-3}.

As for the interaction, the interaction between (K1 and irrigation every ten days) gave the highest average water use efficiency of 0.2791 kg m^{-3}, and the lowest average (Baraka × irrigating every 10 days) 0.0231 kg m^{-3}.

Table (9): The effect of genotypes and irrigation periods and their interactions on the water use efficiency trait

Genotypes	Every day	5 days	10 Days	Average genotypes
K1	0.0997	0.2172	0.2791	0.1986
K35	0.0565	0.1243	0.1167	0.0992
K45	0.0625	0.1090	0.1265	0.0993
Anber-33	0.0514	0.1206	0.1453	0.1058
Jasmine	0.0796	0.0872	0.1215	0.0961
Furat	0.0838	0.1661	0.1978	0.1493
Baraka	0.0485	0.0453	0.0231	0.0390
Average irrigation periods	0.0689	0.1242	0.1443	interaction = **0,0317**
L.S.D	irrigation periods = 0,0219	genotypes = 0,0169		

Conclusions

1-The K1 genotype was significantly superior to the rest of the genotypes under study by giving the highest values for most of the studied traits, especially the use of water under the influence of water stress, which indicates that it tolerates high levels of drought compared to the rest of the studied

genotypes, such as Baraka , which showed a weak indicator of water shortage tolerance.

2- Water stress negatively affected most of the vegetative growth traits, including (plant height, flag leaf area, and panicle length).

3- The effect of water stress on the chlorophyll content of the leaves for the two genotypes (K1 and K45) was clear, which showed high values, which indicates their ability to withstand water stress.

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