EVALUATION OF MORPHOLOGICAL AND PHYSIOLOGICAL PERFORMANCE OF TWO IRAQI RICE VARIETIES UNDER DIFFERENT LEVELS OF SALT STRESS

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Abstract

With the aim of evaluating the morphological and physiological performance of two Iraqi rice cultivars (Anber 6 and Anber 33) under several levels of salinity, an experiment was carried out on a farmer's farm in the Al-Hasaniya area in Najaf Governorate, Iraq. The results showed that the two rice varieties were negatively affected by salt stress, and the treatment (S0) achived the highest averages in most of the vegetative growth traits (plant height, leaf area, panicle length and dry weight) which reached 93.72 cm, 79.00, 21.40 cm, and 121.00 g plant, respectively. Regarding the yield and its components, the control treatment (S0) also recorded the highest averages in most of the traits namely No. of effective tillers, yield of grains; Weight of 1000 grains; and index of harvest of 41.00, 23.79 g 67.04 g plant-1, 29.15 respectively, with exclude of biological yield trait at level (S01) with an average of (161.00). The Anber 33 variety also recorded superiority in most of the yield traits. As well as content of chlorophyll and carbohydrate reaching 0.078 and 17.38 respectively. As for the interaction, the combination (Anber 33 × S0) also achieved the highest average for chlorophyll and carbohydrate content, reaching 0.080 and 21.85 respectively. In general, the performance of the Anber 33 variety outperformed that of the Anber 6 variety in most of its traits. These findings could help clarify the physiological mechanisms behind rice plants' responses to salt stress and aid in the development of more salt-tolerant rice varieties.

Keywords: Rice, growth traits, yield, carbohydrates, chlorophyll, salt stress.

Introduction

Rice (Oryza sativa L.) is a key food crop cultivated in numerous countries. Approximately 90% of the world's rice is produced and consumed in Asia, making it the most vital food source for impoverished and developing nations. [1]. By 2050, the demand for rice is projected to rise to 607 million tons due to population growth, based on current consumption patterns. [2]. However, over the past 20 years, due to climate change and increased salinization of soils and irrigation water, rice production has declined and will continue to decline in the future [3]. Salinity is a major challenge that restricts rice growth and production globally. It was found [4, 5] that high levels of salinity directly or indirectly affect the physiological state of the organism by changing metabolism and growth and lead to a reduction in the average yield of the most important crops by more than 50%. It also leads to a series of morphological, physiological, biochemical and molecular changes at the level of gene expression [6]. The presence of the plant under excessive salinity stress leads to a decrease in its height, root growth, bud formation, dry weight, leaf area, panicle length, number of effective tillers, yield and its components [7], disruption of the ionic balance of cells, increased oxidative stress and slowing down of protein synthesis [8]. [9] found that salt stress had a significant impact on growth traits, such as plant height, number of tiller and dry weight, which showed a greater decrease of 15.7%, 11.2%, 25.2%, and 24.6% in salt-sensitive rice compared to rice that is sensitive to salt. Rice cultivars sensitive to salt also showed a 5.1% decrease in number of spikelet , a 6.1% reduction in weight of grains, and a 15.3% greater decrease in grain yield, in comparison to salt-tolerant genotypes when exposed to salinity stress. This study the effect of irrigation with saline water on two Iraqi rice varieties (Anber 6 and Anber 33)..

Materials and methods

Morphological analysis

A field experiment was implemented on a private farm in Najaf Governorate (Iraq) during the summer season of 2024. 3 tiers of salinity in irrigation water were used (10, 5, 0) dS m^{-1}. Treatment with saline water was started by irrigating the plants after 45 days of germination. The seeds of the two varieties were planted on June 20 in a quantity of 116 kg ha^{-1} according to the randomized complete block design with 3 replicates. The size of the experimental unit was 2 m by 2 m, totaling 4 m^2 and the distance between the experimental units was 2 m. The soil's chemical and physical characteristics were analyzed as shown in (table 1). Soil and crop service operations were carried out, including fertilization, according to the recommendations [10]. At the maturity stage, the plants were harvested on 19/12/2024. Growth and yield traits and their components were calculated (plant height cm, leaf area cm^2, spike length cm, No. of inactive tillers $plant^{-1}$, dry weight, No. of grains per spike, weight of 1000 grains g^{-1}, grain yield kg^{-1}, No. of active tillers $plant^{-1}$, harvest index and biological yield). The chlorophyll content in leaves and carbohydrates were analyzed according to the protocol followed by [11, 12]. The apparent data were statistically analyzed using the statistical program Genstat Discovery 4, and the means were compared utilizing the test of least significant difference (LSD) with a significance level set at 5%. [20].

Table 1: Chemical and Physical Properties of Soil of Field (Prior to Planting)		
Properties	**Unit**	**Results**
Ece	ds m^{-2}	3.11
pH	-	7.8
O.M	mg kg^{-1}	1.12
N	=	50.02
P	=	21.65
K	=	184.42
Sand	=	49.32
Silt	=	41.22
Clay	=	9.46
Soil composition	Silty clay	

Results and discussion

1- Impact of salt stress on vegetative growth traits

The results of Table (3) showed the significant effect of treating rice varieties with salt water, which resulted in a reduction of all examined vegetative growth traits. The third level (S2) achived the highest decrease for all traits except for the number of inactive tillers and dry weight, which reached 80.24 cm, 70.04 cm^2, and 20.10 cm for plant height, flag leaf area, length of panicle, respectively. The control treatment gave the highest average for the three mentioned traits, in addition to the dry weight, which reached 93.72 cm, 79.00, 21.40 cm, and 121.00 g plant. Anber 33 variety also outperformed and recorded the highest average for plant height and panicle length, which reached 109.18 cm and 21.66 cm, respectively. As for the interaction, the combination (Anber 33×S0) gave the highest average for plant height, leaf area, and dry weight, which reached 115.20 and 79.90 cm2 and 134.00 g $plant^{-1}$ respectively. As for the lowest average, they appeared to be different. The combination (Anber 6 × S2) recorded the lowest average for the plant height trait, which amounted to 61.13 cm. The presence of the plant exposure to high salinity stress results in a reduction of certain traits. of vegetative growth, including its height, leaf area , dry weight, disruption of the ionic balance of the cells, and an increase in oxidative stress, along with a reduction in cell division and their small size, which causes a reduction in the leaf area of the plant, and then a decrease in the rate of photosynthesis of the plant growing under stress, and this is consistent with what was found by [13, 14].

Table 3: Impact of Salt Stress on Vegetative Growth Characteristics					
Plant height (cm)					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	72.23	68.39	61.13	67.25	N=ns
Anber 33	115.20	113.00	99.35	109.18	V=10.09*
Average	93.72	90.70	80.24		N×V=18.25*

Leaf area (cm^2)					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	78.10	76.33	75.00	76.48	N=1.45*
Anber 33	79.90	67.63	65.07	70.87	V=1.1*
Average	79.00	71.98	70.04		N×V=ns
Panicle length (cm)					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	21.12	18.30	19.10	19.51	N=1.15*
Anber 33	21.68	22.20	21.10	21.66	V=ns
Average	21.40	20.25	20.10		N×V=ns
Number of inactive tillers (Tiller plant^{-1})					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	19.00	3.00	4.00	8.67	N=ns
Anber 33	12.00	0.00	0.00	4.00	V=4.1*
Average	15.50	1.50	2.00		N×V=5.15*
Dry weight (gm plant^{-1})					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	108.00	96.43	105.00	103.14	N=16.2*
Anber 33	134.00	95.60	92.00	107.20	V=4.1*
Average	121.00	96.02	98.50		N×V=8.71*

2- Effect of salt stress on yield and its components

The data in Table (4) show the significant effect of salinity on rice plants. The control treatment (S0) achieved the highest average in most of the yield traits, namely the number of effective tillers (41.00), 1000-grain weight (23.79 g), grain yield (67.04 g plant^{-1}) and harvest index (29.15), with the exception of the biological yield trait at level (S01) with an average of (161.00). The Anber 33 variety also recorded superiority in most of the yield traits, namely the number of effective tillers (45.75), grain yield (64.67 g plant-1) and biological yield (136.67), with the exception of the 1000-grain weight trait (22.47 g plant^{-1}) and harvest index (29.15) in the Anber 6 variety (64.67 g).As for the interaction, the combination (Anber 33×S0) recorded the highest average number of effective tillers, grain yield and grain weight, reaching 47.90, 67.04 g plant^{-1} and 24.76 g, respectively. This clear variation in the average characteristics of the crop and its components reflects the variation that occurred in the characteristics of vegetative growth and their relationship to it (Table 3). The variety of Anber 33 outperformed Anber 6, which showed good tolerance to high salinity concentration. This is consistent with the results obtained by [15, 16] through the effect of the traits of leaf area, panicle length, and dry weight on most of the traits of the crop.

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Table 4: Impact of Salt Stress on Yield and Its Components

Variety	S0	S1	S2	Average	L.S.D
Number of active tillers (Tiller plant^{-1})					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	43.60	39.90	32.00	38.00	N=3.56*
Anber 33	47.90	37.97	37.00	41.00	V=1.1*
Average	45.75	38.94	34.50		N×V=3.91*
Weight of 1000 grain (g)					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	22.82	22.11	22.47	22.47	N=2.2*
Anber 33	24.76	19.66	19.37	21.26	V=ns*
Average	23.79	20.89	20.92		N×V=ns
Grain yield (g plant^{-1})					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	57.08	40.00	56.10	51.06	N=6.2*
Anber 33	77.00	55.00	62.00	64.67	V=6.11*
Average	67.04	47.50	59.05		N×V=11.33*
Biological yield (g plant^{-1})					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	145.00	113.00	141.00	133.00	N=21.5*
Anber 33	105.00	209.00	96.00	136.67	V=3.1
Average	125.00	161.00	118.50		N×V=24.1*
Harvest index (%)					
Variety	S0	S1	S2	Average	L.S.D
Anber 6	36.58	22.58	33.22	30.79	N=2.2*
Anber 33	21.72	27.42	32.42	27.19	V=3.3*
Average	29.15	25.00	32.82		N×V=4.72*

3. Impact of salt stress on chlorophyll and carbohydrates

The results of figure (1) indicated the superiority of the control treatment (S0) and gave the highest average for both content of chlorophyll in the leaf and carbohydrates, reaching 0.0785 and 18.115 respectively, while the Anber 33 variety recorded the highest average for chlorophyll content in its leaves and carbohydrates, reaching 0.078 and 17.38 respectively. As for the interaction, the combination (Anber 33 × S0) also achieved the highest average for chlorophyll and carbohydrate content, reaching 0.080 and 21.85 respectively. This indicates that the chlorophyll content in rice leaves and carbohydrates is negatively affected by irrigation treatment with saline solution, especially for varieties with medium tolerance to salinity or sensitive to it, and this is consistent with what was found by [17, 18].

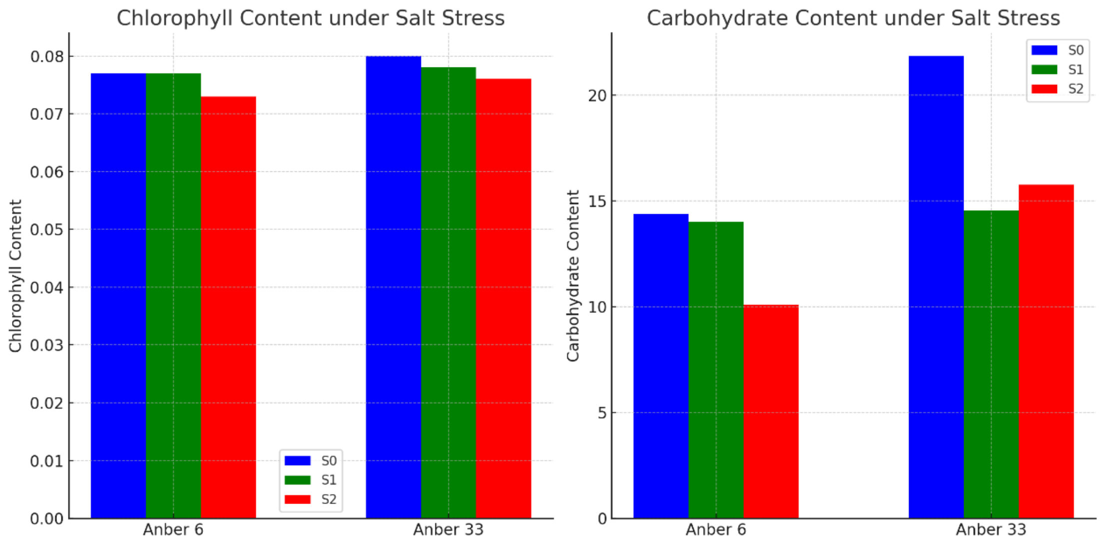

Fig. 1. Impact of Salt Stress on Chlorophyll Content and Carbohydrate Levels

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