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ESTIMATION OF SOME GENETIC PARAMETERS OF SEVERAL RICE CULTIVARS UNDER THE INFLUENCE OF SALT STRESS

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Abstract:

A field experiment was carried out during the season 2020 at the second research station of the College of Agriculture, Al-Muthanna University to study Response of three rice cultivars (Anber-33, Jasmine and Pokkali) to salt stress (three concentrations of irrigation water salinity: 3, 6, 9 ds m^{-1}). The treatment with saline level 3 ds m^{-1} was superior in all the studied traits except for the trait of the sterility percentage which recorded the lowest value of 17.57 %, while the treatment with saline level 9 ds m^{-1} was gave lowest value in all the studied traits except for the trait of the sterility percentage which recorded the largest value of 43.64 %. With regard to the interaction between cultivars and salinity had a significant effect on the traits, the combination of (Anber-33 × 3 ds m^{-1}) gave the highest number of filled grains with 91.30 grains per Cluster and the lowest percentage of sterility 14.40%. The traits of grain yield/plant (g) (71.07 and 75.07), Weight of 1000 grain (g) (63.67 and 63.21), Biological yield (60.03 and 58.34), Productive tillers/plant (62.09 and 53.75), Flag leave area (cm^2) (34.83 and 26.53), Sterility percentage (%) (30.54 and 30.31) and Cluster length (cm) (22.73 and 20.57) have recorded high PCV and GCV whereas plant height (20.78 and 19.87) recorded moderate PCV and GCV. However, the traits viz., days to 50 per cent flowering (9.87 and 9.73) and Chlorophyll content (9.40 and 6.92) were recorded low PCV and GCV. Plant height (cm) (98.55), days to 50 per cent flowering (97.06), Sterility percentage (%) (69.07), number of grain per Cluster (92.90), Cluster length (88.10), Biological yield (76.51) and weight of 1000 grain (g) (73.12) were recorded higher heritability.

Keywords: Rice, Sterility, Salt stress, Jasmine.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important strategic crops in the world and a main food for more than half of the world's population, with a global production of 61,853 million tons, which is the highest among cereal crops, although it ranks second after wheat in terms of the cultivated area of 214 million ha^{-1}. More than 90% of rice is produced and consumed in Asia, (Kumar *et al.*, 2007). In Iraq, the crop comes after wheat and barley in terms of cultivated area and productivity. The average area of rice planted in Iraq in 2019 was about 464.37 ha and produced approximately 574,710 tons ha^{-1} of raw rice, with a productivity rate of 4.495 tons ha^{-1} (Iraqi Central Statistical Organization, 2019).

The problem of salinity is one of the environmental determinants of rice production and it is expanding, and the area of saline or salinity-affected lands will reach about 25% by 2050, especially in the coastal delta areas (Dasgupta *et al.*, 2014), which are the rice-growing areas that constitute more than 65 % of the global production area, making salinity one of the factors threatening global food security, with the classification of rice as a sensitive crop to salt stress (Maas and Hoffman, 1977), for its direct and indirect impact on vegetative growth and yield, and this effect depends on the stage of growth and the duration of exposure stress, and a salinity of 6.9 dS m^{-1} is enough to reduce rice yield by 50 % (Grattan *et al.*, 2002).

Several studies have indicated that different cultivars of the same crop differ in their tolerance to salinity, which confirms the importance of taking diversity into consideration when evaluating the tolerance of crops to salinity. In saline soil or soil irrigated with saline water. For the purpose of preparing a breeding program to improve the traits, it is necessary to estimate the genetic parameters, especially those related to phenotypic, genetic and environmental variations, as genetic variation is the effective tool that affects the efficiency of selection (Chenu. 2015), so this experiment was carried out with the aim of evaluating the performance of cultivars of rice and selecting the best cultivars from Through some growth traits, yield and its components.

MATERIALS AND METHODS

A field experiment was carried out during the summer season 2020 at the second research station at the College of Agriculture, University of Al-Muthanna to study the response of three cultivars of rice to salt stress, and the experiment was applied in designing the split plots with three cultivars. Three cultivars of (Jasmine, Anber-33 and Pokkali) in the main plot, included three concentrations of salinity of irrigation water (3, 6, 9 dS m^{-1}) in the secondary plots. The experimental unit had an area of 2 m^2 and included eight lines with a length of 2 meters for each line, and the distance between the lines was 20 cm. In the seedling method, 46% urea nitrogen fertilizer was added at a rate of 280 kg ha^{-1} and in two phases, the first after 10 days of planting and the second after 30 days and fertilizers Phosphate (Tri-phosphate 21%) 400 kg ha^{-1}, irrigation and weeding were also carried out when needed.

Recording of notes

Ten plants were selected at random from each entry for recording the observation of all traits. The averages of observations recorded on these ten plants were considered for statistical analysis. The traits on which observations were recorded are Plant height at maturity (cm), Days to 50 % flowering, number of productive tillers per plant, chlorophyll content (mg m^2) calculated by the following equation (Monje and Bugbee,1992):

$$Ch= -80.05 + (10.40\times \text{Spad-502})$$

Cluster length (cm), Sterility percentage (%), Weight of 1000 grains (gm), Grain yield (g) per plant and biological yield (ton ha^{-1})

Phenotypic and Genotypic coefficient of variation (PCV and GCV)

Genotypic, phenotypic, and environmental traits were calculated using analysis of variance. The broad-sense heritability was estimated following the method proposed by (Johnson *et al.*, 1955), and the expected genetic advance was calculated following the method described by (Robinson *et al.*,1949). The data were statistically analyzed using the Genstat 12 program. Comparisons were also made by testing the least significant difference at a significant level of 0.05.

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

texture soil (g/kg soil)			Ca mg/kg soil	Mg mg/kg soil	K (mg/kg soil)	P (mg/kg soil)	N (mg/kg soil)	EC ($ds.m^2$)	PH	OM %
sand	clay	silt								
101	332	567	259	182	270	14	9.6	4.5	7	0.8

RESULTS AND DISCUSSION

Effect of cultivars on some growth traits, yield and its components

The results of table (2) showed that there were significant differences between the cultivars in some growth traits, as the jasmine cultivar took the longest period of days from planting to 50% of flowering, giving 116.22 days, the cultivar Anber-33 excelled in the two classes of plant height and deltoid length, as it gave averages of (109.74 and 20.37).The reason for this may be due to the genetic ability of the specific cultivar to the plant height traits according to the number of internodes and its length, which determines the height of the plant, which shows that high heights and large leaf area are more qualified for the consumption of light and then light and thus increase the efficiency of the photosynthesis process and dry matter production Which contributes to the product's abundance of representative materials, which reduces competition between plant parts and competition within a single plant, which prompted the direction of increasing the length of the deltoid, and this result agreed with what was reached (Zhao et al., 2020).

The results of the same table also indicated the superiority of the Pokkali cultivar in the number of fertile clusters, as it gave an average of 10.29 clusters $plant^{-1}$. Its growth and development with favorable conditions to produce fertile ears. This result agreed with what was found (AL-Enawey et al., 2015). The results indicated that there were no significant differences between the cultivars in the traits of the flag leaf area and the chlorophyll content of the leaves.

Table (2) the effect of genotypes on some traits of growth

Genotypes	No. of days to 50% flowering (days)	Plant height (cm)	Flag leaf area (cm^2)	Chlorophyll index (mg/m^2)	No. of tillers/m^2	Cluster length
Jasmine	116.22	68.89	19.67	0149.5	9.15	17.18
Anber-33	111.22	109.74	18.94	150.40	8.96	20.37
Pokkali	89.56	77.59	18.84	138.50	10.29	16.42
L.S.D	11.542	6.348	ns	ns	1.07	1.13

The results of Table (3) indicate that there is a significant effect between the cultivars on some traits of the yield and its components. The Anber-33 cultivar surpassed in the traits the number of filled grains as it reached 71.00 grains. cluster, and the biological yield was 44.5 kg ha^{-1}, and the grain yield of the plant was 15.32 g. $Plant^{-1}$, and the sterility rate, which amounted to 20.14%. The reason for the superiority of the Anber-33 cultivar in the number of filled grains may be attributed to the increase in the length of the cluster (Table 2) of the cultivar, which means an increase in the number of grains in a cluster and then the possibility of an increase in the fertilization state in it, in addition to the role of the area of the flag leaf and its role in the production of dry matter and its conversion to grain. While its superiority in terms of grain yield is attributed to its superiority in the two traits of cluster length (Table 2) and the number of filled grains in the cluster, achieving an increase in grain yield that may outweigh the decrease in traits (number of fertile clusters and weight of 1000 grains), which caused an increase in grain yield, whose increase was reflected in an increase the biological yield of the cultivar Anbar33, and this result agreed with the findings of (AL-Enawey et al., 2015), which showed that the difference between the cultivars is in the infertility.

While Pokkali cultivar was superior in weight of 1000 grains as it reached 20.59 gm, which did not differ significantly from Amber33 cultivar which gave an average of 19.42 gm. The superiority of the Pokkali cultivar may be attributed to the small number of grains in the cluster, which reduced the state of competition between grains per cluster, which increased the weight of its grains. This is consistent with what was found (Haque and Pervin, 2015).

Table (3) the effect of genotypes on some traits of yield and its components

Genotypes	No. of filled grains	Sterility percentage (%)	The weight of 1000 grains (g).	biological yield (kg/ha^{-1})	Grain yield (g) per plant
jasmine	54.40	34.67	17.79	30.90	11.62
Anber-33	71.00	20.14	19.42	44.50	15.32
Pokkali	49.80	38.62	20.59	32.90	13.48
L.S.D	3.02	1.25	1.27	7.94	1.82

Effect of salinity levels on some growth trait, yield and its components

The results of table (4) showed that there are significant differences between salinity levels in some growth traits, as the level of salinity exceeded 3 dS m^{-1} of 22.91 cm^2, 179.10 $mg.m^2$, 10.56 cluster/plant and 20.47 cm) respectively, followed by a decrease in the salinity level with a percentage of (7.46, 17.02, 16.47, 9.86 and 13.34%) respectively, while the decrease in the salinity level was 9 dS m^{-1}, for plant height 15.39%, flag leaf area was 32.21% and chlorophyll content was 38.75%, the decrease for number of fertile dahlias was 22.63% and spike length 23.01%. The reason for the reduction in plant height can be attributed to the very slow growth as a result of the decrease in the increase in the cell size, the decrease in the vital activities and the damage to the chloroplasts with the lack and shortness of the internodes, which leads to a decrease in the height of the plant. And these results are in agreement with the findings of (Soltabayeva et al., 2021) that the salinity has a significant effect on the decrease in plant height. While the reason for the decrease in the area of the flag leaf may be attributed to the fact that exposure to high concentrations of sodium chloride results in a decrease in plant growth and productivity, inhibition of leaf growth and a decrease in the rate of its elongation due to the ionic stress caused by the excessive accumulation of toxic ions, including Na^+, which causes This in turn leads to premature aging and defoliation of adult leaves, thus reducing the leaf area available for light absorption (Munns and Tester 2008). With regard to the low content of chlorophyll in leaves, it may be due to the inhibitory effect of ions accumulated from different salts on biosynthesis by breaking down chlorophyll and negatively affecting the structure of chloroplasts because the chloroplasts in the membrane are related to its stability and this depends on the stability of the membrane, which rarely remains intact in Under high salinity conditions, causing a decrease in chlorophyll content in leaves (Ali et al., 2004). These results are in agreement with (Ranim and Sharma 2017), who recorded a decrease in chlorophyll content by an amount ranging between (4.60-35.74%) under salt stress conditions. These results are in agreement with (Rashid et al., 2017), who observed a decrease in the number of effective branches of rice cultivars when salinity levels increased from 6-12 dS m^{-1}.

Table (4) the effect of salinity levels on some traits of growth

salinity levels ds m^{-1}	Days to 50% flowering (days)	plant height(cm)	area of flag leaf (cm^2)	index of chlorophyll (mg/m^2)	number of tillers per plant	length of the Cluster (cm)
3	106.89	92.45	22.91	179.10	10.65	20.47
6	102.78	85.55	19.01	149.60	9.51	17.74
9	107.33	78.22	15.53	109.70	8.24	15.76
L.S.D	ns	4.63	1.75	11.31	1.06	1.33

The results of Table (5) indicated that there was a significant effect between salinity levels in some traits of the crop and its components, as the salinity level exceeded 3 dS m^{-1} in the number of filled grains, which amounted to 72.30 grains. $cluster^{-1}$, the weight of 1000 grains is 21.25 g, the biological yield is 45.80 kg / ha, and the seed yield is

18.75 g Plant^{-1}, the lowest rate of sterility 17.57%. While the percentage of decrease at the salinity level was 6 dS m^{-1} by 24.62% for the number of filled grains, 8.28% for the weight of 1000 grains, 27.51% for the biological yield and 34.00% for the grain yield in the plant, while it increased the sterility rate of the plant by increasing the salinity levels and the increase was by 28.34% compared to the saline level 3 dS m^{-1}.
The results also indicated in the same table that the salinity level 9 dS m^{-1} gave the lowest average number of filled grains, which was 48.30 grains. Dalia, the weight of 1000 grains is 17.05 g, the biological yield is 29.30 kg ha^{-1}, and the grain yield is 9.21 g Plant-1 and the sterility rate increased to 43.64%

Table (5) the effect of salinity levels on some traits of yield and its components

Salinity levels ds m^{-1}	**Number of filled grains**	**Sterility percentage (%)**	**Weight of 1000 grains (g)**	**Biological yield (ton/ha^{-1})**	**Grain yield (g) per plant^{-1}**
3	72.30	17.57	21.25	45.80	18.75
6	54.50	32.22	19.49	33.20	12.47
9	48.30	43.64	17.05	29.30	9.21
L.S.D	5.40	3.48	1.431	6.89	1.877

The effect of interaction between cultivars and salinity levels on some growth traits, yield and its components

The results of table (6) showed that the interaction effect between cultivars and salinity levels did not significantly affect growth traits.

Genotypes	**Salinity levels ds m^{-1}**	**Period of flowering (days)**	**Plant height (cm)**	**Flag leaf area (cm^2)**	**Chlorophyll index (mg/m^2)**	**Number of tillers/m^2**	**Cluster length**
Jasmin	3	117.33	75.67	23.29	183.90	10.60	18.60
	6	113.67	67.44	19.66	159.70	9.53	16.93
	9	117.67	63.56	16.07	105.00	7.33	16.00
Anber-33	3	114.67	116.00	23.42	183.40	10.02	23.90
	6	106.00	110.89	18.44	149.70	8.82	20.33
	9	113.00	102.33	14.96	118.10	8.05	16.87
Pokkali	3	88.67	85.67	22.02	170.00	11.34	18.90
	6	88.67	78.33	18.94	139.50	10.18	15.97
	9	91.33	68.78	15.58	106.10	9.35	14.40
L.S.D		ns	ns	ns	ns	ns	ns

While the results of table (7) showed that, the effect of the interaction between cultivars and salinity levels had a significant effect on the traits of the number of filled grains and the percentage of sterility. The Anber-33 cultivar gave the highest average number of full grains, which was 91.30 grains. cluster, and the lowest sterility rate was 14.40% at the saline level of 3 dS m-1 compared to the salt level of 6 and 9 dS m-1, in which the number of filled grains decreased by (64.70 and 56.90 grains. Dalia) respectively, and the sterility percentage increased In the Anber-33 cultivar by (18.71 and 27.31%) respectively, this is due to the susceptibility of genetic varieties and their impact on salinity levels and their effect on the fertility of their flowers. The increase in salinity levels led to a decrease in the number of grains filled with cluster and an increase in sterility, which indicates the negative impact of salinity on the number of filled grains because the increase in salinity leads to a decrease in the number of spikelets formed and pollination of flowers due to a decrease in the percentage of pollen germination, which leads to an increase in the sterility of flowers (Solis et al., 2020). These results are in agreement with (Al-jana *et al.*, 2021)

Table 7: Interaction of the cultivars and salinity levels on some traits of yield and its components

Genotypes	**Salinity levels ds m^{-1}**	**No. of filled grains**	**Sterility percentage (%)**	**Weight of 1000 grains (g).**	**Biological yield (kg/h)**	**Grain yield (g) per plant**
Jasmin	**3**	61.70	17.98	19.45	35.30	15.22
	6	52.70	36.66	18.25	34.50	11.57
	9	48.70	49.38	15.67	22.90	8.08
Anber-33	**3**	91.30	14.40	21.34	57.90	21.95
	6	64.70	18.71	19.79	37.80	13.71
	9	56.90	27.31	17.13	37.70	**10.32**
Pokkali	**3**	64.00	20.34	22.97	44.10	19.08
	6	46.20	41.29	20.44	27.30	**12.13**
	9	39.40	54.24	18.36	27.30	**9.23**
L.S.D		7.87	4.98	ns	ns	**ns**

Genetic variability parameters

With respect to phenotypic and genotypic coefficient of variation (Table 8), the traits viz., number of grain per Cluster (76.49 and 76.44), Grain yield/plant (g) (71.07 and 75.07), Weight of 1000 grain (g) (63.67 and 63.21), Biological yield (60.03 and 58.34), Productive tillers/plant (62.09 and53.75), Flag leaf area (cm2) (34.83 and 26.53), Sterility percentage (%) (30.54 and 30.31) and Cluster length (cm) (22.73 and 20.57) have recorded high PCV and GCV whereas plant height (20.78 and 19.87) recorded moderate PCV and GCV. However, the traits viz., days to 50 per cent flowering (9.87 and 9.73) and Chlorophyll content (9.40 and 6.92) were recorded low PCV and GCV. Further, it is observed that, for almost all the traits narrow difference between PCV and GCV was observed depicting that the influence of environment on all these traits is less. The estimates of heritability revealed that all the 11 yield attributing traits viz., Plant height (cm) (98.55), days to 50 per cent flowering (97.06), Sterility percentage (%) (69.07), number of grain per Cluster (92.90), Cluster length (88.10), Biological yield (76.51) and weight of 1000 grain (g) (73.12) were recorded higher heritability (Table 8). It indicates that though the trait is least influenced by environmental effects the selection for improvement of such trait may not be useful, because broad sense heritability is based on total genetic variance which includes both fixable (Additive) and non-additive (dominance and epistatic) variances. These results are in accordance with (Karthikeyan et al., 2010; Basavaraj and Dushyanthakumar, 2014).

Table 8 : Estimates of genetic parameters for yield and related traits in 3 rice landraces evaluated under saline field condition during the season 2020

Sl. No.	Traits	PCV (%)	GCV (%)	h^2 (%)
1	Days to 50% flowering	9.87	9.73	97.06
2	Plant height (cm)	20.78	19.87	98.55
3	Flag leave area	34.83	26.53	-13.73
4	Chlorophyll content	9.40	6.92	42.79
5	Productive tillers/plant	62.09	53.75	52.58
6	Cluster length (cm)	22.73	20.57	88.10
7	Number of grain per Cluster	76.49	76.44	92.90
8	Sterility percentage (%)	30.54	30.31	96.07
9	Weight of 1000 grain (g)	63.67	63.21	73.12
10	Grain yield/plant (g)	71.07	75.07	4.22
11	Biological yield	60.03	58.34	76.51

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