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Effect of Planting Dates on Stability of New Rice Genotypes Traits Grown in Iraqi Conditions

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Abstract: Selecting the appropriate date for planting rice can be one of the viable solutions for proper growth and development of rice to avoid unsuitable conditions that can lead to lower productivity. Two experiments were conducted in the field of Al-Mishkhab Rice Research Station in Najaf City / Iraq during 2020 and 2021. In each season, eight genotypes used and two germination dates (15 and 30 Jun). After 20 days, seedlings were transferred to the field and planted on 5th and 20th of July respectively. The experiment was based on a three-blocks in RCBD design to study the performance of eight genotypes at two planting dates in two seasons. Results showed significant differences for genotypes and planting dates for all traits, while seasons showed significant differences only for the number of days to 50% flowering and panicle length. The values of heritability in the broad sense (h^2_{BS} %) were medium for all studied traits, which in turn led to an increase in the values of expected genetic advance as a percentage of the general mean (GA %), which was slightly high for grain yield (13.66 %). The genotypes showed a significant response to the late sowing date of 20th July compared to the early date of 5th July in the two growing seasons for most of the studied traits, including grain yield. The stability of the genotypes in four environments was highly variable. Genotype T93 had the most stable grain yield and the highest 1000-grain weight, while Forat1 showed a response to late sowing. Furthermore, the Forat1 responded to suitable environmental conditions of the number of days to 50% flowering, 1000-grain weight, and grain yield. Therefore, the genotypes which have superiority and stability over various environments could be successfully used as crucial material in the future breeding programs.

Keywords: Genetic stability, Heritability, Planting dates, Rice genotypes.

Introduction

Rice is one of the most important cereal crops for food to the most of the world's population. At least 90% of the world's rice is produced and consumed in Asia and the Pacific (Muthayya *et al*., 2014). Globally, it is grown in about 114 countries on 150 million hectares with estimated productivity of over 505 million tons per season, which is nearly 11% of the world's cultivated area. China ranks the first in rice production with an estimated production of 146.73 million tons, followed by India with a production of 118.87 million tons. Rice yields are greatly challenged by productivity variances compared to other crops in regions where climate changes are greatly varied from year to year. In addition, population growth requires an increase in total rice production, along with a decrease in the annual rice yield in the total cultivated area due to increased land use for industrial facilities, housing and highways reduce agricultural use (FAOSTAT, 2021). Additionally, One-third of global corn, wheat, rice and soybean yield variability has been explained by climate change (Ray *et al.*, 2015).

Locally, Iraqi rice production for the 2020 summer season was estimated at 464 thousand tons with a cultivated area of 102 thousand hectares and an average value of 4563 $kg.ha^{-1}$ (Central Statistical Organization, 2021). This is low productivity according to the lack of support of the government for rice growers and less use of modern techniques in rice crops (Hade, *et al.*, 2021). Most rice varieties grown in southern Iraq are photoperiod sensitive and are affected by daily light and high temperatures, which are increasing the challenges of rice cultivation. Under Iraqi growing conditions, the early planted rice varieties go through a long growing season that requires additional irrigation water due to the increase in their biomass.

However, genotypes that is respond to late planting date are a crucial as safe solution to reducing watering amounts in Iraqi conditions, which is suffering from a water shortage. In many international studies, different planting dates are used to achieve high productivity of rice and to solve the problems that exist during cultivation. The study of Sultana *et al.* (2020) indicated the superiority of the grain yield for rice that planted in 1st August. However, optimal rice planting dates are regional and vary by location and genotype (Duvallet *et al.,* 2021).

Phenotypes of the growth and yield traits are structured by a genetic factor, but it is affected by the environment. Also, the stability of grain yield and other interesting traits of genotype across a wide range of environmental changes are great interest to plant breeders (Lakew *et al.*, 2021). Thus, Genotype-environment interaction studies provide the basis for selecting genotypes suitable for general agriculture across a wide range of environmental changes, and other genotype for specific regions and environmental conditions. Kumar *et al.* (2020) pointed out that the instability of the grain yield among genotypes from one environment to another may arise due to different genes expression and responses in different environments. The stability of grain yield between genotypes can be expressed as a linear response to environmental effects and the deviation from this response (Singh *et al.,* 2020). The elite genotype generally exhibits low variance in genetic and environmental responses, exceeding the environmental response rate, with deviations less than the expected response within the target environment (Bhargava & Srivastava, 2019).

The time of planting can significantly affect the growth and productivity of cultivated rice genotypes.

The present study was conducted to determine the optimum planting dates for eight selected high-yielding inbred rice genotypes and their hybrids. Evaluation of the performance of new rice genotypes in different environments (planting dates) provides efficient information to help plant breeders develop rice genotypes characterized by high yield and great stability in different environments.

Materials & Methods

The experiments were conducted in Al-Mishkhab Rice Research Station in Najaf city, Iraq for two seasons 2020 and 2021. Each season included eight genotypes in two germination dates 15th and 30th of June, then after 20-days, seedlings were grown in the field to plant dates: 5 and 20 July. The experiment was based on a randomized complete blocks design (RCBD) with three replicates to study the traits performance of eight genotypes at two planting dates in two seasons.

Seedlings of eight genotypes: five hybrids derived from three cultivars (K1: Forat1 ♀ X Anber33 ♂, K2: Anber33 ♂ X Forat1 ♂, T65: Ghader ♀ X Forat1 ♂, T93: Ghader ♀ X Forat1♂ and T94: Ghader ♀ X Forat1♂) were prepared with plastic plates (size 3×28×58 cm^3) filled with sieved soil. Then young seedlings were transported to the field which was formerly prepared in rows 25 cm and with 20 cm distance between plants within the rows, the experimental unit was 1.5×3.0 m^2 with six lines for each genotype. Irrigation was applied to grow the genotypes during the vegetative stage and the reproductive stage continuous flooding with a thin layer of water (1-2 cm).

Chemical fertilizers applied: 400 kg ha^{-1} of compound NP [18×18] and 280 kg.ha^{-1} of urea (46% nitrogen) (Al-Hasanie & Al-Maadhedi, 2017). Field management for weed control and manual weeding was applied 3-4 times.

At the maturity stage, plants were sampled at one m^2 harvested areas per plot to estimate grain yield from middle lines. In addition, agronomic traits were determined using 10 rice panicles randomly selected for each plot to determine the components of rice yield. Data collected, such as plant height and days to flowering was recorded when 50% of plants in a plot formed flowers, panicles length (cm), 1000-seed weight (gm), days to physiological maturity, and grain yield (ton.ha^{-1}) (Zulkifli *et al.*, 2021). Some climatic factors for the seasonal agricultural experiment field (2020-2021) showed in table (1). The soil was prepared in terms of tillage, smoothing and leveling, and random samples were taken to analyze the soil and determine some of its physical and chemical properties at the experiment site (Table 2).

Table (1): Agro-meteorological data in the experiment area during the growing seasons (2020 and 2021).

Month	Season	Air temperature ºC			Evaporation (mm/month)
		Max	Min	Average	
Jul.	2020	42.0	26.6	34.3	255.1
	2021	41.2	28.3	34.8	257.4
Aug.	2020	42.3	27.8	35.1	255.2
	2021	43.4	28.1	35.8	258.8
Sept.	2020	39.1	23.4	31.2	167.5
	2021	38.7	23.0	30.9	165.7
Oct.	2020	33.5	20.3	26.9	108.4
	2021	32.8	20.1	26.5	105.7
Nov.	2020	26.5	11.3	18.7	96.5
	2021	26.8	12.3	19.6	97.2

Source: Center Agricultural Meteorology, Ministry of Agriculture - Republic of Iraq

Table (2): Some physical and chemical properties of the study soil before transplanting

Properties	Unit	Value 2020	Value 2021
pH 1:1	-	7.5	7.6
E.C. 1:1	Ms/cm	3.63	3.65
Nitrogen	Ppm	76.2	78.6
Potassium	Ppm	559.0	546.0
Phosphorous	Ppm	36.6	35.3
Organic matter	%	1.75	1.59
$CaSO_4$	%	0.89	0.86

To determine the stability of eight genotypes under the environmental conditions suggested in study (four environments representing two planting seasons and two dates in each growing season). The following linear regression model used according to the method Eberhart & Russell (1966):

$Yij = \mu + biIj + \delta ij + eij$, where, Yij is the average of genotype ***i*** in Environment ***j*** and bi is the regression coefficient of genotype i at the given environmental index, which means the variety's response to environmental changes, and ***Ij*** is the environmental index, defined as the deviation of the mean of all cultivars in a given environment from the general mean and

δj is the deviation from the regression for genotype ***i*** in environment *j* and ***eij*** is the experimental error.

A combined analysis of variance of data for the traits across seasons was performed according to the experimental design used (eight genotypes and four environments, with matches between planting dates and agricultural seasons considered as different environments). Then, the differences between the mean values of each genotype were compared by Duncan's multiple range method and the four environments were compared by the least significant difference (LSD) test at the probability level of 5 % (Ireland, 2010).

Variances of components and heritability in the broad sense (h^2_{BS}) were estimated according to method by Fehr (1991) using the following equation:

$$h^2_{BS} = \sigma^2_G / \sigma^2_P = \sigma^2 G / (\sigma^2_G + \sigma^2_{GE}/e + \sigma^2_E/re)$$

Where $\boldsymbol{\sigma^2_G}$ is the total genotypic variance, $\boldsymbol{\sigma^2_P}$ is the phenotypic variance, $\boldsymbol{\sigma^2_{GE}}$ is the variance of genotypes that overlap with environments, $\boldsymbol{\sigma^2_E}$ is the environmental variance, e is the number of environments, and ***r*** is the number of replicates. In addition, the expected genetic advance in the next generation was estimated as a percentage of the trait mean, and the ratio of the coefficient of variation was estimated to determine the percentage of environmental influence on the trait compared to the season mean of the trait.

Two stability parameters measured were based on Singh & Chaudhary (2010) as follows: (1) the regression coefficient representing the regressive impact of each variety in different environments, estimated from the equation: $bi = \Sigma\ Yij\ Ij / \Sigma\ Ij^2$, where: $\Sigma\ Yij\ Ij$ is the sum of the products and $\Sigma\ Ij^2$ is the sum of squares and (2) the mean deviation (S^2di) from the linear regression: $[\Sigma\ \delta ij^2 /s-2)] - S^2e/r$, Note: $\Sigma\ \delta ij^2 = [\Sigma\ Yij^2 - Yi2/t] - (\Sigma\ Yij\ Ij)^2/ \Sigma Ij^2$, and S^2e is the mean square estimate for the pooled error. The significance of the regression coefficients for the items and each trait was tested by t-test. The linear regression coefficient ***bi*** of the relationship between each trait of the genotype in each environment and the outcome and response of each trait for the environmental mean is a measure of the linear response to environmental change. The mean of deviation from regression (S^2di) is a measure of the stability of this response or it is a measure of heterogeneity. Depending on these two parameters, the stability of the genotypes is evaluated. In this case, if (1) $S^2di = zero$ and $bi > 1$, the genotype responds effectively to good environmental conditions, and (2) $S^2di = zero$ and $bi = 1$, the genotype had less respond to environmental changes and it is highly stable, and (3) $S^2di = 0$ and $bi < 1$ the genotype grew in unfavorable environmental conditions, and (4) $S^2di > 0$ impairs linear prediction. All statistical analyzes were performed using the prepackaged programs, GenStat program 12th edition, Microsoft Office Excel 2016 and OPSTAT Website.

Results & Discussion

Table (3) shows the results of the combined data analysis of variance for rice genotypes at different environments. The mean squares of the environments for all the studied traits was significant at 1%, except for panicle length, which was significant at a probability level of 5%, while the weight of 1000 grains did not statically significant. The mean of the squares of the genotypes were significant at a probability level of 1% for the traits studied. Hasan *et al.* (2022) mentioned in their studies that there is a high variation of genotypes. The presence of significant differences between genotypes indicates that they are genetically different, due to genetic factors that control the inheritance of these genotypes traits. However, the interaction between genotype and environment was significant at a probability level at 1% for all traits except for 1000 grain weight, which was not significant. The significance of all traits indicates a difference in the performance of some genotypes depending on the different environmental conditions (Maji *et al.*, 2015). It is also noted that the environment, the genotypes and their interaction differ in their relative importance for the studied traits. It is clear that the differences attributable to the genotypes were much larger than the differences ascribable to the individual environments for all the traits, which is one of the encouraging results to be used in completing the stability variance analysis procedure.

Table (3): Combined analysis of variance for traits of eight rice genotypes grain yield and some of its components grown in different environments.

S.O.V	d.f	M.S for traits					
		50% flowering (day)	Plant height (cm)	Pencil length (cm)	1000 seed weight (gm)	Physiological mature (day)	Grain yield (ton.ha^{-1})
Environments	3	34.847**	121.010**	5.657*	0.443n.s	166.566**	1.306**
Rep, (Env.)	8	1.889	0.302	1.162	0.128	3.139	0.024
Genotypes	7	132.446**	3119.725**	55.149**	54.318**	33.879**	5.611**
G × D	21	12.252**	101.534**	2.046**	0.163n.s	11.137**	0.147**
Error	56	1.113	3.060	0.714	0.117	1.796	0.032

(**) and (*) are significant probability level at the 1% and 5%, respectively.

The results of variance components and some genetic parameters (Table 4) showed that the coefficient of variation was high for panicle length and grain yield traits (3.241% and 2.878%, respectively), implying that random environmental variation caused greater changes in these two traits. The values of coefficient of variation are not consistent in different studies, the reason is due to the differences in genotypes or environmental conditions (Awad-Allah *et al.*, 2022). The values of heritability in the broad sense (h^2_{BS} %) were medium for all studied traits, which in turn led to an increase in the values of expected genetic advance as a percentage of the general mean (GA %) and was slightly high for grain yield at 13.66 % compared to other traits except for the trait plant height. In contrast trait "number of days to physiological maturity" showed a low genetic advance (1.465 %), which had a low heritability rate of 74.232 %, indicating that this trait is more sensitive to unsuitable environmental conditions compared to the other traits, suggesting that tensions during the reproductive and maturation stages lead to a reduction in heritability and that the influence of the environment is greater. In a study by Chakrabarty *et al*. (2020) and Prajapati *et al.* (2022) who found a high percent heritability for all traits.

Table (5) illustrates the combined variance analysis of genotypes of rice planted on two planting dates and replicated in two seasons. The results of seasons showed highly significant differences at probability level 1% for the characteristics of plant height and grain yield, whereas at 5% for the two traits of 1000-grain weight and the number of days until physiological maturity, but it was not significant for the rest of the traits.

Table (4): Variances, heritability and expected genetic improvement of rice grain yield and some components.

Parameters	Traits means					
	50% flowering (day)	Plant height (cm)	Pencil length (cm)	1000 seed weight (gm)	Physiological mature (day)	Grain yield (ton.ha^{-1})
σ^2_G	10.944	259.722	4.536	4.5167	2.674	0.465
σ^2_{GE}	43.778	1038.888	18.145	18.067	10.694	1.859
σ^2_E	1.113	3.060	0.714	0.1169	1.796	0.032
σ^2_p	21.982	519.699	9.132	9.043	5.497	0.932
h^2_{BS}	91.468	96.845	96.377	99.699	74.232	97.438
GA	4.085	19.938	2.627	2.628	1.996	0.843
GA%	4.093	19.939	10.075	11.424	1.465	13.660
C.V%	1.057	1.749	3.241	1.486	0.984	2.878
Mean	99.798	99.988	26.074	23.007	136.238	6.168

Where: σ^2_G is genetic variance, σ^2_{GE} is genetic and environmental interaction, σ^2_E is environmental and σ^2_p is phenotypic variances, h^2_{BS} is Heritability broad sense, GA is genetic advance, GA% is genetic advance of mean and C.V% is coefficient variance.

While planting dates showed highly significant differences for most of the traits except for the two traits (the weight of 1000 grains and grain yield), both showed significance at the probability level of 5%, which means that the environments have the greatest impact on the performance of the traits. The results of the two sources above were reflected in their interaction (D × S) in the emergence of differences that reached the statistical significance of all traits except for the number of days to 50 % flowering was non-significant. The significance of the interaction between years and planting dates (D × S) indicates that the characteristics of some rice genotypes may overtake their performance relatively on some dates and in some years than on other years. The genotypes showed a significant effect at a probability level of 1% for all studied traits. Musa *et al.* (2021) referred to a significant difference in the performance of local cultivars in field conditions similar to the current study when their experiments were carried out in different environments.

Regarding to the interactions between genotypes and seasons (G × S) or with planting dates (G × D) where differences were significant at the probability level of 1% for all traits except the 1000 grain weight trait, which was not significant for (G × S) and significant at 5% for (G × D). Zaid *et al.* (2022) established high differences in genotypes during the studied seasons. The triple interaction (G×S×D) showed significant differences for all traits except the panicle length and 1000-grain weight. The variance of this source indicates that some genotypes may enhance the production in some seasons with some planting dates than others. Therefore, prior to the genotype selection, further general adaptability and stability analysis for genotypes should be conducted. Consequently, these results will be encouraging to continue searching for superior and stable genotypes to test in multi-environments.

Table (5): Combined analysis of variance for eight rice genotypes grown in two planting dates replicated over two seasons (2020 and 2021).

S.O.V	d.f	M.S for traits					
		50% flowering (day)	Plant height (cm)	Pencil length (cm)	1000 seed weight (gm)	Physiological mature (day)	Grain yield (ton.ha^{-1})
Seasons (S)	1	0.002	10.03**	1.426	0.388*	3416.4*	3.808**
Dates (D)	1	104.17**	197.51**	9.188**	0.401*	50793.2**	0.109*
D × S	1	0.288	55.51**	6.355**	0.442*	5491.3*	0.089*
Rep. (Env.)	8	1.322	0.115	0.595	0.061	575.4	0.015
Genotypes	7	132.45**	3119.73**	55.15**	54.32**	25682.7**	5.610**
G × S	7	4.896**	192.34**	2.332**	0.199	4521.0*	0.204**
G × D	7	21.667**	43.03**	2.601**	0.289 *	6801.3**	0.135**
G × S × D	7	11.076**	48.71**	1.019	0.089	4168.6*	0.084 *
Error	56	1.113	3.061	0.714	0.117	1835.1	0.032

(**) and (*) are significant probability level at the 1% and 5%, respectively

To determine the performance of the genotypes at the two planting dates during seasons 2020 and 2021 as shown in table (6). Significant differences were observed among genotypes in the studied traits during the two cultivation seasons, where there was a clear superiority for the trait of grain yield at the late planting date (20th July) compared to the early date (5th July) in the 2021 agricultural season compared to the 2020 season. The Forat1 genotype was distinguished by the highest grain yield (6.885 ton.ha^{-1}) when planted late (20 July) compared with the early date (6.802 ton.ha^{-1}) in the season 2020. While in the season 2021, Forat1 showed a grain yield (6.389 and 6.352 ton.ha^{-1}) for both planting dates 20th and 5th of July, respectively. The two genotypes, T93 and K2 also recorded superiority in the trait of grain yield during the 2020 and 2021 planting seasons, with higher values for grain yield at the late date compared to the early planting dates. This is consistent with the findings of some researchers on significant variation in their studies on the genotypes of rice in seasons (Zaid *et al.*, 2022) and locations (Musa *et al.,* 2021) and different dates (Ali *et al*., 2019).

To clarify the differences above, the averages of the genotypes were set at the two planting dates as an average for the two seasons, as shown in table (7). There was a superiority in the trait of grain yield for the genotypes at the late planting date (20 July) compared to the early date (5 July). The K2 genotype had the highest grain yield (6.735 and 6.396 ton.ha^{-1}) and the T65 genotype (6.317 and 6.087 ton.ha^{-1}) respectively. While, Forat1 showed little difference between the two planting dates (6,637 and 6.582 ton.ha^{-1}) at late (20 July) and early (5 July) dates, respectively. Furthermore, the three genotypes above were characterized by the lowest number of days for flowering 50%, physiological maturity and the lowest plant height. The two genotypes, T94 and Al Ghader did not differ significantly between them in the trait of grain yield, as they were recorded in the early and late dates (6.377 and 6.283 ton.ha^{-1}) and (6.237 and 6.321 ton.ha^{-1}), respectively.

Table (6): Rice genotypes mean two planting dates replicated over two seasons (2020 and 2021).

Seasons		Traits means											
		50% Flowering (day)		Plant height (cm)		Panicle length (cm)		1000 seed weight (gm)		Physiological Mature (day)		Grain yield (ton.ha^{-1})	
	Geno.	5/07	20/07	5/07	20/07	5/07	20/07	5/07	20/07	5/07	20/07	5/07	20/07
Season 2020	K1	111.0 a	103.3 a	115.7 b	119.0 b	24.4 c	24.2 bc	27.9 a	27.9 a	141.7 a	136.0 a	5.445 b	5.623 e
	K2	97.3 d	98.3 d	89.0 e	96.0 d	25.8 bc	25.9 ab	23.3 c	23.4 c	139.3 b	134.7 ab	6.279 a	6.856 a
	T65	99.7 d	97.0c d	93.3 d	88.3 e	27.1 b	26.7 a	24.7 b	24.5 b	139.7 b	134.3 ac	6.115 a	6.163 cd
	T93	99.3 d	96.0 e	87.3 e	87.7 e	25.6 c	26.6 a	22.2 d	22.1 d	136.3 c	134.0b c	6.199 a	6.559 ab
	T94	102.3 c	101.7 ab	105.7 c	11200 c	25.3 c	24.1 bc	23.9 c	24.6 b	133.7 e	136.0 a	6.032 a	5.912 de
	Anber33	107.00 b	99.7 cd	138.7 a	133.3 a	25.4 c	26.3 a	21.3 e	21.7 d	139.3 b	131.7 d	4.509 c	3.995 f
	Ghader	98.7 d	99.3 cd	93.7 d	97.0 d	30.3 a	28.1 a	21.8 de	21.8 d	138.7 b	132.7 cd	6.205 a	6.225 cd
	Forat1	103.7 c	101.0 bc	80.7 f	86.7 e	22.3 d	23.3 c	23.9 c	24.5 b	135.0 d	133.0 bd	6.352 a	6.389 bc
	Date	100.4	99.3	98.3	100.1	25.9	25.9	23.0	23.2	137.4	133.8	5.956	6.014
Season 2021	K1	111.0 a	105.0 a	102.0 b	101.3 c	24.0 d	23.8 d	27.8 a	28.1 a	143.3 a	139.3 a	6.183 cd	6.139 e
	K2	98.7 de	100.3 bc	89.0 e	99.3 c	27.8 c	25.4 c	22.9 c	22.8 e	141.0 ac	136.7 ab	6.513 bc	6.613 cd
	T65	98.0 e	94.3 e	92.7 d	104.0 b	27.7 c	26.4 bc	24.3 b	23.8 d	135.7 d	132.0 c	6.059 d	6.472 cd
	T93	99.3 de	99.0 c	93.3 d	100.0 c	29.1 b	27.4 ab	22.3 d	21.9 f	139.0 bc	133.0 bc	6.692 ab	6.855 ab
	T94	101.7 bc	100.3 bc	92.0 d	104.0 b	24.9 d	23.8 d	24.3 b	24.5 b	139.3 bc	135.7 ac	6.722 ab	6.653 bc
	Anber33	103.3 b	101.0 b	136.0 a	136.7 a	26.6 c	26.4 bc	21.3 e	21.2 g	141.3 ab	138.0 a	4.920 e	4.827 f
	Ghader	100.3 cd	97.3 d	97.7 c	99.3 c	30.4 a	28.0 a	21.3 e	21.4 g	138.3 c	132.3 c	6.268 cd	6.417 d
	Forat1	102.7 b	100.0 bc	84.0 f	82.3 d	21.6 e	21.9 e	24.2 b	24.2 c	140.3 bc	133.7 bc	6.812 a	6.885 a
	Date	100.6	98.9	97.8	103.7	26.9	25.60	22.9	22.8	139.3	134.5	6.209	6.389
	Seasons	101.8	99.7	99.4	102.9	26.1	25.52	23.6	23.7	138.9	134.6	6.082	6.161
	$LSD_{0.05}$	3.75		1.11		2.52		0.81		18.23		0.399	

The values followed by the same letter for each trait are not significantly different from each other (Duncan test, 0.05).

The K1 genotype differed significantly from the rest of the genotypes with a decrease in grain yield (5.814 and 5.881 ton.ha^{-1}) in the early and late planting dates, respectively. In contrast, Amber 33, recorded the lowest values of grain yield, which did not exceed 5 tons per hectare, which differed significantly from the other of the studied genotypes. Additionally, it exhibited the highest number of days for flowering 50%, physiological maturity with the highest plant height. The outcome of the characteristics of the genotypes showed a clear response to the late planting date and during the seasons of study. The genotypes were characterized by giving the least number of days from planting to flowering by 50%, the least plant height and the least number of days until physiological maturity when planted late on 20th July compared to early 5th July. While the characteristics of panicle length and 1000-grain weight were less affected by the different planting dates. Sultana *et al.* (2020) found a superior date on 1st August in grain yield compared to other late planting dates, which was the closest to the late planting date (20th July) in the current study.

Table (7): Rice genotypes means two planting dates an average of two seasons (2020 and 2021).

Genotype	Traits means											
	50% Flowering (day)		Plant height (cm)		Panicle length (cm)		1000 seed weight (gm)		Physiological Mature (day)		Grain yield (ton.ha^{-1})	
	5/07	20/07	5/07	20/07	5/07	20/07	5/07	20/07	5/07	20/07	5/07	20/07
K1	111.0 a	104.2 a	108.8 b	110.2 b	24.27 d	24.00 c	27.87 a	27.98 a	142.5 a	137.7 a	5.814 c	5.881 d
K2	98.0 e	99.3 cd	89.0 f	97.7 c	26.78 b	25.68 c	23.12 cd	23.10 c	140.2 a	135.7 b	6.396 a	6.735 a
T65	98.8 e	95.7 d	93.0 e	96.2 c	27.40 b	26.53 bc	24.50 b	24.18 b	137.7 bc	133.2 e	6.087 b	6.317 b
T93	99.3 e	97.5 cd	90.3 f	93.8 d	27.33 b	27.02 ab	22.25 d	22.05 cd	137.7 bc	133.5 de	6.445 a	6.707 a
T94	101.9 d	101.0 b	98.8 c	108.0 b	25.08 cd	23.92 cd	24.08 bc	24.57 b	136.5 c	135.8 bc	6.377 ab	6.283 b
Anber33	105.2 b	100.3 bc	137.3 a	135.0 a	26.00 c	26.35 bc	21.28 d	21.43 d	140.3 a	134.8 cd	4.715 d	4.411 e
Ghader	99.5 e	98.3 cd	95.7 d	98.2 c	30.33 a	28.07 a	21.53 d	21.58 d	138.5 b	132.5 e	6.237 bc	6.321 b
Forat1	103.2 c	100.5 bc	82.3 f	84.5 e	21.95 e	22.58 d	24.08 bc	24.33 b	137.7 b	133.3 de	6.582 a	6.637 a
Date	101.8	99.73	99.42	102.9	26.14	25.52	23.59	23.65	138.9	134.6	6.094	6.161
LSD $_{0.05}$	3.75		1.11		2.52		0.81		18.23		0.40	

The values followed by the same letter for each trait are not significantly different from each other (Duncan test, 5%).

Table (8) shows the results of the pooled variance analysis using the Eberhart & Russell (1966) method for the traits of the grain yield and some of its components. It is noted that the mean squares of the linear environments were highly significant for all traits except for the trait of plant height, which did not reach statistical significance. The significance of this source indicates the response to different environments under genetic control (Priyanka & Jaiswal, 2017; Jaruchai *et al.,* 2018; Lakew, *et al*., 2021).

Whereas it seems that the mean squares of the linear component of the interference of genotypes x environments when tested against pooled deviation were significant only at the probability level of 5% for a number of days until flowering. The mean squares of the pooled deviation for 1000 grains weight were not significant, this indicates that the main component of the differences in the stability of the genotypes for this trait is due to the linear regression and predicting is possible. Pandey *et al.* (2020) reported in their study the presence of variation among the five environments tested for all the studied traits.

The means of plant height, panicle length, number of days until physiological maturity and grain yield were not significant, while the pooled deviation was significant. This means that the deviation from the linear function is the deviation in the stability of the genotypes of the above traits. Therefore, deviation is one of the most important parameters of stability (Singh & Chaudhary, 2010). Whereas, the number of days until flowering at 50%, both components were significant, which means that the differences in the stability of the genotypes are due to both the linear regression and the deviation from the linear function. Both components (linearity of genotypes × environments) and (pooled deviation) were not significant for the 1000-grain weight trait, which means that it is difficult to predict the relationship between differences in the linear regression and the deviation from the linear function. These results are in agreement with those reported by Meena *et al*. (2016) and Singh *et al*. (2020).

Eberhart & Russell (1966) indicated that the two components, linear (the regression coefficient *bi*) and non-linear (the deviation from the regression S^2di), are both important in refereeing the stability of genotypes. When the regression coefficient is close to one and is associated with a value of deviation from the regression equal to zero, this means the genotypes have a low response to environmental changes and high stability (Bernardo, 2020). When the regression coefficient is greater than one, the genotypes are described as being highly sensitive to environmental changes and adapting to highly favorable environments. Nonetheless, the regression coefficient is less than one, it is evidence that the genotypes have a tolerance to environmental changes and that it increases the limitation of adaptation to poorly yield environments.

The linear regression of the average of any of the six traits of a single genotype over the average of all genotypes in each environment resulted in regression coefficient values that ranged between 0.647-3.244 for the number of days to 50% flowering; 0.256-2.881 (day) for plant height, 0.619-2.126 (cm) for the panicle length; 0.504-1.771 (gm) for the weight of 1000 grains, 0.379 and 1.158 (day) for the number of days until physiological maturity and between 1.138 and 1.561 ($ton.ha^{-1}$) for the grain yield.

Table (8): Pooled variance of stability analysis for eight rice genotypes in four environments.

S.O.V	d.f	M.S for traits					
		50% flowering (day)	Plant height (cm)	Pencil length (cm)	1000 seed weight (gm)	Physiological mature (day)	Grain yield ($ton.ha^{-1}$)
Verities (Var.)	7	44.149 **	1,039.9**	18.383**	18.11**	11.29*	1.870**
Environments(Env.)	3	11.616 *	40.34	1.885 *	0.148 *	55.52**	0.435**
Var.× Env.	21	4.084**	33.85**	0.682	0.054	3.712 *	0.049
Env.+Var. ×Env.	24	5.025	34.66	0.833	0.066	10.189	0.097
Env. (Linear)	1	34.847**	121.01	5.656**	0.443*	166.57 **	1.306**
Env.×Var.(Linear)	7	6.900*	16.58	0.746	0.039	2.160	0.062n.s
Pooled deviation	16	2.342**	37.17**	0.569**	0.054	3.928 **	0.037**
Pooled Error	64	1.113	3.060	0.714	0.117	1.796	0.032

(**) and (*) are significant probability level at the 1% and 5%, respectively.

These large changes in the regression coefficients, especially for the characteristics of the number of days to flowering 50%, plant height and the number of days until physiological maturity indicate the different responses of the genotypes to environmental changes (Table 9).

The present study showed that the lowest averages for the number of days until flowering 50% were for T93 genotype by 98.417 days earlier in maturity, but it did not differ significantly from genotype K2 (98.667 days). However, the genotypes T93, K2, T65, Anber33 and Ghader showed regression coefficients not significant from one (***bi*** = 1) and significant for the deviation from the regression from zero (S^2di = 0), which means that they have an unstable response to the environments. While the Forat1 genotype exhibited non significance for both regression coefficients and deviation from the regression, which indicates that it responds to suitable environments.

The plant height trait showed averages that ranged from the lowest plant height was Forat1 (83.42 cm), which differed significantly from all the genotypes, whereas, the highest plant height was Anber33 genotype (136.17 cm). The T94, K2 and T65 genotypes were the lowest in the height of the plant (92.08, 93.33 and 94.58 cm) respectively.

Table (9): Stability parameters of rice genotypes traits in four environments.

Genotypes	50% Flowering (day)			Plant height (cm)			Panicle length (cm)		
	Mean	*Bi*	S^2di	Mean	*Bi*	S^2di	Mean	*bi*	S^2di
K1	107.58 a	3.24 *	0.75*	109.50 b	0.78	120.01 *	24.11 d	0.06*	-0.15
K2	98.67 e	-0.65	1.05 *	93.33 of	2.14	5.53 *	26.23 c	2.13 *	-0.18
T65	97.25 f	0.63	4.92 *	94.59 e	1.24	53.88 *	26.97 b	1.17 *	-0.22
T93	98.42 e	0.83	2.05 *	92.08 f	0.74	47.97 *	27.18 b	1.99 *	1.57
T94	101.48 c	-0.19*	1.48 *	103.42 c	2.88 *	40.91 *	24.50 d	0.88	0.22
Anber33	102.75 b	2.24 *	4.19 *	136.17 a	-0.26	5.76 *	26.18 c	0.33	0.15
Ghader	98.92 e	0.61	1.19 *	96.92 d	0.36	6.47 *	29.20 a	2.07 *	0.83
Forat1	101.83 c	1.28	0.14	83.42 g	0.14	8.65 *	22.27 e	-0.62	0.44
SE(*bi*)	0.733			1.568			0.897		

Genotypes	1000 seed weight (gm)			Physiological mature (day)			Grain yield (ton.ha^{-1})		
	Mean	*Bi*	S^2di	Mean	*Bi*	S^2di	Mean	*bi*	S^2di
K1	27.93 a	-0.50	-0.02	140.08 a	1.16	0.59 *	5.85 c	1.56*	-0.01
K2	23.11 c	1.66	-0.01	137.92 b	1.06	-0.38	6.56 a	0.14	0.07
T65	24.34 b	1.77	0.08	135.42 c	0.69	9.82 *	6.20 b	0.39	0.03
T93	22.15 d	0.17	-0.01	135.58 c	0.96	0.61 *	6.58 a	1.07	0.01
T94	24.33 b	0.58	0.12	136.17 c	0.38	6.18 *	6.33 b	1.71*	0.01
Anber33	21.36 e	1.71	-0.04	137.58 b	1.39	5.57 *	4.56 d	1.38	0.09
Ghader	21.56 e	1.49	0.01	135.50 c	1.22	1.97 *	6.28 b	0.34	-0.01
Forat1	24.21 b	1.12	0.01	135.50 c	1.15	2.27 *	6.61 a	1.39	0.01
SE(*bi*)	0.991			0.434			0.476		

(*) is a significant probability level at 5%. The values followed by the same letter for each trait are not significantly different from each other (Duncan test at 5).

The genotypes (T65 and T94) had significant regression coefficients for one and non-significant for the rest of the genotypes, with a significant deviation from the regression coefficients for all genotypes. These results indicate that they were non-stable and responsive to different environments.

For the panicle length trait, the genotype Ghader had the longest panicle length (29.2 cm), which differed significantly from all other genotypes. Whereas, Forat1 had the lowest panicle length (22.27 cm). The genotypes (K2 and T65) showed significant regression coefficients from one (***bi*** = 1) and non-significant deviation from zero ($\boldsymbol{S^2di}$ = 0), which means that they are responsive to adequate environments. While the genotypes (T94, Anber33 and Forat1) had non-significant regression coefficients with less than one and deviation from the regression was not significant, this results in evidence that they are responsive to inappropriate environments. While the genotypes (K2, T65, T93 and Ghader) had regression coefficients more than one (***bi*** > 1) indicating that they have response to suitable environments.

It is also noted from table (9) that the largest weight of 1000 grains was for the K1 genotype (29.93 gm) and differed significantly from all other genotypes. The lowest weight of 1000 grains was for genotypes (Anber33 and Ghader) with values of 21.36 and 21.56 gm, respectively. The all genotypes showed not significant for both regression coefficients and deviation from regression, (K2, T65, Anber33, Ghader and Forat1) have regression coefficients more than one which means that they are responsive to appropriate environments. Whereas, the genotypes (K1, T93 and T94) had regression coefficients less than one that they have response to good environments. However, Forat1 is the most stable genotype for 1000 grain weight trait due to it has regression coefficients close to one and deviation from regression was not significant on zero.

The rice genotypes showed different averages for the number of days until physiological maturity trait, which ranged between the lowest average (135.42 day) for the T65 genotype and the highest average (140.08 day) for the K1 genotype. The genotypes (K1, Anber33, Ghader and Forat1) showed not significant regression coefficients from one with values more than one, whereas their deviation from the regression were significant from zero, it indicates that they have response to suitable environments. The K2 genotype had a non-significant regression coefficient of close to one and also the deviation from the regression was not significant, which indicates that the genotype is stable for this trait. Whereas, other trait has regression coefficients values less than one, this means those genotypes have response to poor environments.

For the grain yield trait, the Forat1 genotype had 6.610 tons per hectare and did not differ significantly from the K2 and T93 genotypes. While, the Anber33 genotype had the lowest grain yield (4.563 $ton.ha^{-1}$). K2, T65 and Ghader displayed non-significant regression coefficients of less than one (***bi***=1) and a non-significant deviation from zero ($\boldsymbol{S^2di}$=0), which means that they are responsive to unsuitable environments. Whereas the T93, Anber33 and Forat1genotypes showed not significant for one for the regression coefficients and the deviation from the regression was also not significant, this indicates that it has less response to environmental changes and is highly stable for this trait. The genotypes (K1 and T94) had significant regression coefficients (***bi*** >1) and deviation from the regression ($\boldsymbol{S^2di}$ = 0) was not significant, indicating that they are characterized by a response to suitable environments.

To summarize above, the genotypes under study varied in the stability of their different traits. The genotypes T93, K2 and Forat1 distinguished by a high grain yield of 6.576, 6.565 and 6.610 $ton.ha^{-1}$, respectively. The T93 was the highest stability for two important traits, the weight of 1000 grains and the grain yield, while its performance for the rest of the traits was unstable in response to different environments. The K2 genotype comes in second place in response to the suitable environments for the traits of the panicle length, the weight of 1000 grain and the number of days until physiological maturity, while, grain yield in K2 genotype represents a response to the appropriate environments. Incomparable to Forat1 variety which showed a response to favorable environments for the traits of the number of days to flowering 50%, the weight of 1000 grains and grain yield, while being responsive to poor environments for the panicle length trait, and an unstable response to environmental conditions for the rest of the traits. Besides, the Anber33 variety showed the lowest grain yield (4.563 $ton.ha^{-1}$) by responding to suitable environments for the two traits (weight of 1000 grains and grain yield) and it has responded to unfavorable environments for the panicle length, also it is difficult to predict linearly for the rest of the traits (Meena *et al.*, 2016; Kumar *et al.*, 2020; Debsharma *et al.,* 2021).

Conclusion

The results of the current study showed a clear response to some genotypes for delaying planting, especially for the traits of grain yield and its components. The genotype K2 showed superiority in grain yield and its components. The genotype T65 comes in second place in terms of superiority in yield and components. However, these results were very important when we compared them with the results of the productivity on the early date (5^{th} July). Furthermore, the reduction in the quantities of water supplied to the plants on the first date, estimated at four irrigations suggested reducing the field requirements provided to the plants. The appropriateness of the environmental conditions that affected the increase in the components of the yield helped the genotypes show their maximum adaptive capabilities for the late date during July. During the last decades, global climatic changes have contributed significantly to changing the growth patterns of the rice crop and the search for the best suitable planting dates with local varieties and the possibility of their adaptation to unexpected of environmental conditions.

The encouraging results of this study, it may be recommended the late date (20^{th} July) is adopted as an appropriate date for new genotypes. In addition to exposing these genotypes to other treatments to reach optimum productivity. The stability analysis results showed that the genotypes that have genetic stability do not necessarily have a high yield. The T93 genotype (a hybrid of Ghader × Forat1) exhibited high stability for two important traits from the yield components (weight of 1000 grains and the grain yield. Whereas, K2 (Anber33 × Forat1 hybrid) and Forat1 genotypes showed response to suitable environments. In contrast, the Anber33 cultivar, which is desired by the Iraqi population due to the presence of aromatic in its seeds, which showed the lowest grain yield and its high response to the suitable environments. Therefore, it is making it difficult to create linear predictions for the other traits.

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Conflicts of interest

The author declare that they have no conflict of interests.

References

Al-Hasanie, L. N. H., & Al-Maadhedi, A. D. (2017). Influence of irrigation periods and organic fertilizer on soil physical characterization under the system of rice intensification (SRI*). Iraqi Journal of Agricultural Sciences*, *48*(3). https://doi.org/10.36103/ijas.v48i3.397

Ali, M. I., Islam, M. A., Islam, M. M., Islam, M. S., Rouf, M. A., & Mehedi, N. H. (2019). Effect of transplanting dates on yield and yield components of nerica rice mutants at drought prone areas of Bangladesh. *Asian Journal of Agricultural and Horticultural Research*, *3*(4), 1-6. https://doi.org/10.9734/ajahr/2019/v3i430006

Awad-Allah, M. M. A., Mohamed, A. H., El-Bana, M. A., El-Okkiah, S. A. F., Abdelkader, M. F. M., Mahmoud, M. H., El-Diasty, M. Z., Said, M. M., Shamseldin, S. A. M., & Abdein, M. A. (2022). Assessment of genetic variability and bran oil characters of new developed restorer lines of Rice (*Oryza sativa* L.). *Genes (Basel), 13*(3), 509. https://doi.org/10.3390/genes13030509

Bernardo, R. (2020). Reinventing quantitative genetics for plant breeding: something old, something new, something borrowed, something blue. *Heredity, 125*(6), 375-385. https://doi.org/10.1038/s41437-020-0312-1

Bhargava, A., & Srivastava S. (2019). *Participatory Plant Breeding: Concept and Applications.* Springer; Singapore, 247pp. https://link.springer.com/book/10.1007/978-981-13-7119-6

Central Statistical Organization (2021). Rice and sunflower production. *Directorate of Agricultural Statistics, Ministry of Planning, Iraq – Baghdad*. (In Arabic). https://cosit.gov.iq/ar/agri-stat/veg-prod

Chakrabarty, T., Islam, M., Akter, N., & Khalequzzaman, M. (2020). Variability, traits association and path coefficient of yield and yield contributing traits of selected boro rice (*Oryza sativa* L.) germplasm. *SAARC Journal of Agriculture, 17*(2), 103-115. https://doi.org/10.3329/sja.v17i2.45298

Debsharma, S., Roy, P., Begum, R., & Iftekharuddaula, K. (2021). Elucidation of genotype × environment interaction for identification of stable genotypes to grain yield of rice (*Oryza sativa* L.) varieties in Bangladesh rainfed condition. *Bangladesh Rice Journal*, *24*(1), 59-71. https://doi.org/10.3329/brj.v24i1.53240

Duvallet, M., Dumas, P., Makowski, D., Boé, J., del Villar, P., & Ben-Ari, T. (2021). Rice yield stability compared to major food crops in West Africa. *Environmental Research Letters*, *16*(12), 124005. https://iopscience.iop.org/article/10.1088/1748-9326/ac343a

Eberhart, S. A., & Russell, W. A. (1966). Stability parameters for comparing varieties 1," *Crop Science*, *6*(1), 36–40. https://doi.org/10.2135/cropsci1966.0011183x000600010011x

FAOSTAT (2021). *Grain Production Worldwide By Type.* Food and Agricultural Organization of the United Nations. (Accessed: 23/12/2022). https://www.statista.com/statistics/263977/World - grain- production-by-type /

Hade, H. F., H., Midhas, A. A., & Abd Alfarach, D. M. (2021). Problems which were facing the local rice crop farmers in Agra region and its relationship with some variables. *Tikrit Journal for Agricultural Sciences*, *21*(1), 113-122. https://doi.org/10.25130/tjas.21.1.11

Hasan, N., Rafii, M. Y., Harun, A. R., Alı, N. S., Mazlan, N., & Abdullah, S. (2022). Genetic analysis of yield and yield contributing traits in rice (*Oryza sativa* L.) BC2F3 population derived from MR264 × PS2. *Biotechnology & Biotechnological Equipment, 36*(1), 184-192. https://doi.org/10.1080/13102818.2022.2060760

Ireland, C. R. (2010). *Experimental Statistics for Agriculture and Horticulture. Modular texts*, CAB International, British Library, London, 380pp. https://www.sandbarbookstore.com/book/9781845935375

Jaruchai, W., Monkham, T., Chankaew, S., Suriharn, B. & Sanitchon, J. (2018). Evaluation of stability and yield potential of upland rice genotypes in North and Northeast Thailand. *Journal of Integrative Agriculture*, *17*(1), 28-36. https://doi.org/10.1016/S2095-3119(16)61609-X

Fehr, W. R. (1991) "*Principles of Cultivar Development, vol. 1, theory and technique*. Iowa State University, Digital Repository, 536pp.

Kumar, B., Purushottam, A., Raghavendra, P., Vittal, T., Shubha, K., & Madhuri, R. (2020). Genotype environment interaction and stability for yield and its components in advanced breeding lines of red rice (*Oryza sativa* L.). *Bangladesh Journal of Botany*, *49*(3), 425-435. https://doi.org/10.3329/bjb.v49i3.49328

Lakew, T., Dessie, A., Asrat, B., Berie, A., Tewachew, A., Abebe, D., & Solomon, H. (2021). Stability and performance assessment in 18 short-duration rice genotypes under rain fed lowland production conditions of Ethiopia. *Journal of Environment and Earth Science*, *11*(7), 10-20. https://doi.org/10.7176/jees/11-7-02

Maji, A. T., Bashir, M., Odoba, A., Gbanguba, A. U. and Audu, S. D. (2015). Genotype × environment interaction and stability estimate for grain yield of upland rice genotypes in Nigeria. *Rice Research: Open Access, 03*(02). https://doi.org/10.4172/2375-4338.1000136

Meena, H., Kumar, D., Srivastava, T., & Prasad, S. R. (2016). Stability of Popular Rice Hybrids for Important Grain Yield Parameters. *Indian Journal of Plant Genetic Resources, 29*(2), 144. https://doi.org/10.5958/0976-1926.2016.00020.6

Musa A. J., Abbas, S. H., & Hameed, K. A. (2021). Performance of two rice (*Oryza sativa* L.) genotypes under sri and conventional farming methods in three locations in Iraq. *Fourth International Conference for Agricultural and Sustainability Sciences, 910*(1), 1315-1755. https://doi.org/10.1088/1755-1315/910/1/012138

Muthayya, S., Sugimoto, J., Montgomery, S., & Maberly, G. (2014). An overview of global rice production, supply, trade, and consumption. *Annals of the New York Academy of Sciences*, *1324*(1), 7-14. https://doi.org/10.1111/nyas.12540

Pandey, V., Singh, S. K., Korada, M., Singh, D. K., Khaire, A. R., Habde, S., & Majhi, P. K. (2020). Stability analysis in rice (*Oryza sativa* L.) genotypes with high grain zinc. *Indian Journal of Agricultural Research, A-5353*, 1-10. https://doi.org/10.18805/ijare.a-5353

Prajapati, M. R., Madhu Bala, V. P., Patel, R. K. Patel, U. S. Sushmitha, A. D., Kyada, D. P., Patel, J. P., & Sriramkumar, B. (2022). Analysis of genetic variability and correlation for yield and it's attributing traits in f2 population of rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding*, 13(3). https://doi.org/10.37992/2022.1303.127

Priyanka, K., & Jaiswal, H. K. (2017). Genetic Analysis of yield and yield contributing traits in boro rice (*Oryza sativa* L.) over environments. *Bangladesh Journal of Agricultural Research*, *42*(3), 457–466. https://doi.org/10.3329/bjar.v42i3.34504

Ray, D., Gerber, J., MacDonald, G., & West, P. (2015). Climate variation explains a third of global crop yield variability. *Nature Communications*, *6*, 5989. https://doi.org/10.1038/ncomms6989

Singh, R. K., & Chaudhary, B. D. (2010). *Biometrical methods in quantitative genetic Analysis*. Kalyani Publishers, New Delhi, 304pp. https://www.cabdirect.org/cabdirect/abstract/19801689021

Singh, S. K., Behera, P. P., Singh, D. K., Korada, M., Habde, S. V., & Khaire, A. (2020). Stability analysis of rice (*Oryza sativa* L.) genotypes with high grain zinc in five different locations of Eastern Uttar Pradesh. *Current Journal of Applied Science and Technology*, *39*(34), 123-135. https://doi.org/10.9734/cjast/2020/v39i3431042

Sultana, A., Shaikh, N., Zahan, M., Badshah, M., Akter, R., & Issak, M. (2020). Effect of transplanting date on growth and yield of advanced lines of transplanted aman rice. *Research in Agriculture Livestock and Fisheries*, *7*(1), 1-7. https://doi.org/10.3329/ralf.v7i1.46825

Zaid, I. U., Zahra, N., Habib, M., Naeem, M. K., Asghar, U., Uzair, M., Latif, A., Rehman, A., Ali, G. M., & Khan, M. R. (2022). Estimation of genetic variances and stability components of yieldrelated traits of green super rice at multi-environmental conditions in Pakistan. *Agronomy*, *12*, 1157. https://doi.org/10.3390/agronomy12051157

Zulkifli, Z., Bejo, S. K., Muharam, F. M., Yule, I., Pullanagari, R., Dan, L., & Abdulllah, W. N. Z. Z. (2021). Biomass and yield estimation of MR219 and MR220 of paddy varieties using terrestrial laser scanning data. *Basrah Journal of Agricultural Sciences*, *34*(Special Issue 1), 54–62. https://doi.org/10.37077/25200860.2021.34.sp1.6

تأثير مواعيد الزراعة في إستقرارية صفات تراكيب وراثية جديدة من الرز مزروعة في الظروف العراقية

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المستخلص: تعد اختيار الموعد المناسب لزراعة الرز من أحد الحلول القابلة للتطبيق للنمو السليم للرز وتطويره لتجنب الظروف البيئية الغير المناسبة التي يمكن أن تؤدي إلى خفض الإنتاجية. تم اجراء تجربتين في حقل محطة ابحاث ارز المشخاب في مدينة النجف الاشرف / العراق خلال موسمي الزراعة 2020 و 2021. وفي كل موسم ، تم استخدام ثمانية تراكيب وراثية في موعدين انبات (6/15 و 6/30). بعد 20 يومًا ، تم نقل الشتلات إلى الحقل وزرعتها بتاريخ 7/5 و 7/20 على التوالي. اعتمدت التجربة على تصميم RCBD وبثلاثة قطاعات لدراسة أداء ثمانية تراكيب وراثية في موعدين زراعيين وفي موسمين. أظهرت النتائج وجود فروق معنوية للتراكيب الوراثية ومواعيد الزراعة وللصفات جميعها ، بينما أظهر المواسم فروق معنوية فقط لعدد الأيام حتى 50٪ من التزهير وطول الدالية. قيم التوريث بالمعنى الواسع (h^2_{BS}) كانت متوسطة لجميع الصفات المدروسة، مما أدى بدوره إلى زيادة قيم التحسين الوراثي المتوقع كنسبة مئوية من المتوسط العام (GA٪)، والتي كانت مرتفعة قليلاً بالنسبة لحاصل الحبوب (13.66٪). أظهرت التراكيب الوراثية استجابة معنوية لموعد البذار المتأخر في 20 تموز مقارنة بتاريخ 5 تموز في موسمي الزراعة لمعظم الصفات المدروسة بما في ذلك حاصل الحبوب. اظهر التراكيب الوراثية في البيئات الأربع استقرار متغيرًا بدرجة كبيرة، حيث كان التركيب الوراثي T93 هو الأكثر ثباتًا في حاصل الحبوب وأعلى وزن 1000 حبة . بينما لوحظ استجابة للموعد البذار المتأخر للصنف فرات1. بالإضافة الى، ان التركيب الوراثي فرات 1 اظهر استجابة للظروف البيئية المناسبة في صفات عدد الأيام إلى للتزهير 50٪ ووزن 1000 حبة وحاصل الحبوب. لذلك يمكن استخدام التراكيب الوراثية المتفوقة والمستقرة عبر البيئات المختلفة بنجاح كمواد أساسية في برامج التربية التالية.

الكلمات المفتاحية: الاستقرارية الوراثية، التوريث، مواعيد زراعة، تراكيب وراثية، رز .