Effect of Different Cultivation Systems on the Growth and Yield of Three Varieties of Rice (*Oryza sativa L.)*

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Abstract. A field experiment was carried out at Al-Najaf Governorate at Rice Research Station - Mishkaab / Agricultural Research Office during the summer season of 2019 to study the effect of cultivation methods for three varieties of rice, using Randomized Complete Block Design (RCBD) in a split plot arrangement with three replicates. The study contains three varieties of Rice ($Anmbar_{33}$, Yasmine and $Furat_1$) as main treatments, whereas, sub plots contain four treatments of the cultivation methods (direct seeds drilling in plots (flat sowing) its symbol (S_1), transplanting seedlings in plots (flat sowing) its symbol (S_2), direct seed drilling by mastaba method (raised bed sowing) its symbol (S_3) and transplanting seedling by mastaba method (raised bed sowing) its symbol (S_4)). The results presented the superiority of the variety $Furat_1$ significantly gave the best results of (weight of 1000 grains (gm), number of panicles.m^2, and yield ton. ha^{-1}. The treatment of cultivation method S_4 was also superior by giving the best results of (Panicle Length cm, Number of Days from Planting to 100% Flowering, Number of Grains. panicle $^{-1}$, and Yield ton. ha^{-1}).

Keywords. Rice, Varieties, Transplanting, Cultivation systems, Direct seed.

1. Introduction

Rice is one of the main grain crops and it's a most substantial source of dietary energy and the second most substantial crop after wheat from where cultivated area and consumption in Iraq and some countries of the world. where the Local statistics in Iraq indicate that there are (96225) hectares planted with rice crop, which produced about (422.5) thousand tons of rice grains for the summer season in 2021 [1]. Farmers in Iraq used to grow rice by flood irrigation throughout the growing season, this method causes a lot of damage to the soil in addition it needs a large amount of water.

Diminishing of Irrigation Water available for agriculture in Iraq due to climate change as well as a decrease in the level of the Tigris and Euphrates rivers due to neighboring countries and rapid population growth and along with rising demand for food, are challenges that facing Iraqi food security. So, one of the main challenges to cultivation rice in Iraq is a lack of water. Declining water levels are a major worry in rice farming because they limit normal rice growth, which leads to significant production loss. As a result, it is necessary to transfer the production of rice to water-efficient agricultural technologies. It is necessary to create effective management plans in order to provide water so that the yield can be increased sustainably.

There is a contradiction among researchers which of different cultivation techniques is better. Where, it was noticed have a view that shifting rice from flat to beds increases the water use efficiency of rice resulting in yield improvement [2], While it was found that flat and ridge sowing techniques improved better than others [3,4].
In a field experiment conducted to evaluate the impact of several sowing techniques (conventional transplanting, transplanting on raised beds, drill sowing through bed planter and direct sowing on flat) on the rice yield and yield components, results revealed significant differences among planting techniques for plant height at maturity, number of panicles .m^{-2}, number of grains $panicle^{-1}$ and yield [5]. Whilst, that rice bed planting and furrow irrigation gave high water use efficiency, high values saved water amount with considerable grain yield [6,7]. In a field experiment carried out using four rice planting methods were tested, they found that the system of rice intensification (SRI) gave the highest values of yield and yield attributing traits compared with continuous flooding for transplanted rice. Also, the result showed that SRI saved 27% water versus continuous watering in transplanting rice [8]. While, in a field experiment carried out using various sowing systems (traditional methods (control treatment), system of rice intensification (SRI) with intermittent irrigation system, dry rice seed on dry levees and transplanted rice on levees) where, the Results showed that the different systems of rice planting and technology significantly variation in their impact on soil properties, yield and most of yield components of rice In addition, saved water and water productivity in rice crop [9]. As observed in a field study conducting two different field experiments that applied in Bangladesh which included two methods of cultivation (raised bed sowing system, compare with traditional method). the Results showed that the raised bed sowing method gave better plant growth with an increased yield up to 16.0 % and also increased the number of panicle m^{-2}, number of grains $panicle^{-1}$, and 1000 grain weight, and gave the Lowest Sterility percentage and weed infestation. Also, saved irrigation water by 35 - 42 %, Water use efficiency, crop productivity for grain and biomass production was higher compared to traditional cultivation method [10,11].

2. Materials and Methods

2.1. Experimental Site and Soil Preparation

During summer season of 2019 A field study was carried out at Al-Najaf Governorate at Rice Research Station- Mishkaab/ Agricultural Research Office, to determine the effect of different cultivation systems on the growth and production of three varieties of rice. using Randomized Complete Block Design (RCBD) in a split plot arrangement with three repetitions. The study includes three varieties of Rice (Anmbar33, Yasmine and Furat1) as main treatments, while, sub plots comprised four treatments of the cultivation methods (direct seeds drilling in plots (flat sowing) its symbol (S_1), transplanting seedling in plots (flat sowing) its symbol (S_2), direct seed drilling by mastaba method (raised bed sowing) its symbol (S_3) and transplanting seedling by mastaba method (raised bed sowing) its symbol (S_4))
Agricultural processes included deep ploughing with a disc plough for two opposite directions, as well as land smoothing and leveling, area of the experimental unit was 16 m^2.
The crop was sown on June,15th /2019. the plots were sown with seeding rate of 120 kg. ha^{-1} by direct seeding (dry sowing), and 20 kg ha^{-1} for seedling transplanting.
The field was divided into experimental units with an area of 4×4 m^2, After the soil was prepared from ploughing, smoothing and leveling. The treatments were randomly distributed to the experimental plots as follows:

- S_1: Direct seed sowing in flat-beds: Seeds were sown in lines within flat-beds. The experimental unit included sixteen lines, and the distance between the lines was 25 cm.
- S_2: seedlings in flat boards: seedlings on lines within flat slabs, the experimental unit included sixteen lines, and the distance between the lines was 25 cm.
- S_3: direct seeds in raised-beds: Dry seeds sowing on lines at the bottom of the bed. the experimental plots were divided into four raised-beds, with a length of 4 m for each terrace and a width of 0.75 m. The raised-beds included three lines, the distance between lines was 25 cm.

- S_4: seedlings in raised-beds: seedlings were sowing on lines at the bottom of the raised-beds. The experimental plots were divided into four raised-beds, the length of line was 4 m and its width is 0.75 m planted with three lines.

Transplanting of Seedlings for treatments of S_2 and S_4. Transplant seedlings at 30 days old by hand transplanted. transplanted Two - three seedlings to hill^{-1} and keeping the distance between plant-to-plant at 10 cm and the row distance at 25 cm. One day prior to transplanting, irrigation was applied to soften the soil.

2.2. Crop Management

The following fertilizers were added: urea fertilizer (N 46%) at 280 kg. ha^{-1} in three equal doses during planting, when the second node appears and at booting stage. All other agronomic practices such as irrigation, weed control, hoeing and others were carried out normally and uniformly for all the treatments as needed. weeds were controlled by using Nominee SC (Bispyribac Sodium 10%) herbicide at a use rate of 300 ml per h^{-1}.

The experiment was harvested manually when the plants reached full maturity at moisture content less than 14% on December, 1st / 2019, and the crop was threshed separately for each plot.

2.3. Characters Studied

All studied characters were measured and observed following standard procedures as follows

- Number of days from planting to 100% flowering.
- Plant height (cm): calculated as the average of ten randomly chosen plants, measured for each experimental unit from the level of the soil surface to the base of the panicles.
- Panicle length (cm): was calculated as the average for ten panicles selected randomly from each experimental unit.
- Sterility percentage: according to the equation

$$\text{Sterility percentage} = (\text{number of empty grains} / \text{numbers of total grains}) \times 100$$

- Number of panicles per m^2.
- Number of grains. panicle $^{-1}$: calculated as an average of full grains number per ten panicles for each experimental unit.
- Weight of 1000 grains (gm).
- Grains production ton. ha^{-1}.

2.4. Statistical Analysis

Following data collection and tabulation for all studied traits, statistically analyzed by RCBD using the statistical program Genstat. The least significant difference (LSD) at a probability of 0.05 was used to compare means [12].

3. Results and Discussion

3.1. Number of Days from Planting to 100% Flowering

The outcomes revealed that there were Significant variations in the number of days from planting to 100% flowering between different cultivation methods (Table 1). the S_4 has a higher average mean of 108.89 days, which did not differ significantly from the S_2 which gave 108.44 days, whereas the S_1 gave the lowest mean for This characteristic of 105.44 days. This confirms what was reported by [13,14] they showed that cultivation by seedling transplanting gives the highest period from planting to flowering.

Whereas the results revealed that there were significant differences in the average of number days from planting to 100% flowering between varieties. Where Anmber 33 gave the highest average was 112.83 days in comparison with Yasmine which achieved the lowest average was 103.58 days. This difference between varieties in the period required to reach the flowering stage can be explained by the

differences in genetic makeup for these varieties. This result is consistent with what was found by other researchers [15,16,17.18, and 19].

while the effect significant of the interaction between cultivation methods and varieties, Anmber 33 with S_2 achieved the highest average that reached 114.0 days, and its effect was similar to the treatment of the same variety with S_4, whilst Yasmine with S_1 achieved the lowest average was 100.0 days.

Table 1. Number of days from planting to 100% flowering by an effect of methods of cultivation, varieties, and their interactions.

	S_1	S_2	S_3	S_4	Mean
$Anmbar_{33}$	112.0	114.0	111.67	113.67	112.83
Yasmine	100.0	105.33	103.33	105.67	103.58
$Furat_1$	104.33	106.0	106.33	107.33	106.0
L.S.D ≤0.05		1.523			0.855
Mean	105.44	108.44	107.11	108.89	107.47
L.S.D ≤0.05			0.934		

3.2. Plant Length (cm)

The results revealed that there were significant variations between varieties (Table 2), $Anmber_{33}$ achieved the highest average was 141.0 cm compared to $Furat_1$ which achieved the lowest average amounting to 86.67. Furat1 is classified as a semi-short variety as a result of breeding programs, and the $Anmber_{33}$ is a long variety. This is consistent with what other researchers have stated [17-21].

Table 2. Plant Length cm by effect of methods of cultivation, varieties, and their interactions.

	S_1	S_2	S_3	S_4	Mean
$Anmbar_{33}$	140.33	142.0	142.67	139.00	141.0
Yasmine	91.33	91.67	94.0	92.0	92.25
$Furat_1$	87.67	85.67	85.0	88.33	86.67
L.S.D ≤0.05		N. S			3.144
Mean	106.44	106.44	107.22	106.44	106.64
L.S.D ≤0.05			N. S		

Results revealed that there were no significant variations in the effect of cultivation methods and the interaction between cultivation methods and varieties.

3.3. Panicle Length (cm)

The results revealed that there are significant variations in panicle length according to cultivation methods Table (3). S4 gave the highest mean of panicle length reached 24.122 cm, and its effect was similar S2 and S3, while S1 gave the lowest average was 23.022 cm. The reason for the decrease in panicle length in S1was due Inability of the soil to retain water and evaporation, which leads to decrease the efficiency of water consumption, which leads to a decrease in the outputs of photosynthesis and consequently weak vegetative growth and a decrease in the panicle length. This was confirmed by [22,23] that the seedling transplanting gave the highest mean of panicle length compared to the dry method.

Table 3. Effect of cultivation methods, varieties and the interaction between them on panicle length.

	S_1	S_2	S_3	S_4	Mean
$Anmbar_{33}$	26.267	27.333	27.000	28.100	27.175
Yasmine	21.600	22.400	23.200	22.067	22.317
$Furat_1$	21.200	21.667	21.200	22.200	21.567
L.S.D ≤0.05		N. S			0.5350
Mean	23.022	23.800	23.800	24.122	23.686
L.S.D ≤0.05			0.5909		

The varieties differed significantly in this characteristic. $Anmbar_{33}$ achieved the highest mean of 27,175 cm, compared with $Furat_1$ which achieved the lowest mean of 21.567 cm. This is due to genetic

differences between varieties. The results matched what had been discovered by [15,17,18,19] that varieties differ in the panicle length.
While no significant differences in the effect of the interaction between cultivation methods and varieties, and this is due to each factor was independent in its influence on this characteristic.

3.4. Sterility Percentage
Results revealed in that there was a significant effect between varieties in the Sterility percentage (Table 4), $Anmber_{33}$ achieved the lowest average Sterility percentage of 7.51% compared to $Furat_1$ which recorded the highest Sterility percentage of 14.21%. This difference between varieties can be explained by genetic variations and their impact on environmental conditions. This result is consistent with what was stated [17,18] that the varieties differ in the Sterility percentage.
Results revealed that there were no significant variations in the effect of cultivation methods and the interaction between cultivation methods and varieties.

Table 4. Effect of cultivation methods, varieties and the interaction between them on Sterility percentage.

	S_1	S_2	S_3	S_4	Mean
$Anmbar_{33}$	9.00	5.53	8.20	7.30	7.51
Yasmine	13.67	8.43	10.33	10.47	10.73
$Furat_1$	13.73	13.67	13.43	16.00	14.21
L.S.D ≤0.05		N. S			3.558
Mean	12.13	9.21	10.66	11.26	10.81
L.S.D ≤0.05			N. S		

3.5. Number of Panicles per m^2
The results of the experiments clearly revealed that there was significant effect in the average of the number of panicles per m^2 between Varieties table (5). $Furat_1$ achieved the highest mean which reached 453.2 panicles. M^{-2} compared to Anmber 33 which achieved the lowest average of 348.9 panicles. m^{-2}. The genetic variation in this characteristic has been confirmed by [15,17,18 and 24].
As for the effect of cultivation methods, treatment S_4 gave the highest mean 425.9 panicles per m^2, while treatment S_2 gave the lowest average which was 392.0 panicles per m^2. As for the interaction, a significant effect was found, where $Furat_1$ with S_4 treatment achieved the highest mean was 483 panicles per m^2, while $Anmbar_{33}$ with S_2 treatment achieved the lowest average which was 296.3 panicles per m^2.

Table 5. Number of panicles m^2 by effect of methods of cultivation, varieties, and their interactions.

	S_1	S_2	S_3	S_4	Mean
$Anmbar_{33}$	333.0	296.3	371.7	394.7	348.9
Yasmine	422.0	443.7	399.7	400.0	416.3
$Furat_1$	436.0	436.0	458.0	483.0	453.2
L.S.D ≤0.05		48.26			22.46
Mean	397.0	392.0	409.8	425.9	406.2
L.S.D ≤0.05			30.51		

3.6. Number of Grains.Panicle^{-1}
The results revealed (Table 6) that there was significant effect in the mean for the number of grains, panicle^{-1}, according to different sowing methods. Treatment S_4 gave the highest average of 140.4 grains. panicle^{-1}, while treatment S_1 gave the lowest average of 118.9 grains. panicle^{-1}. The cause of the panicle's increased grain production due to the increase in the panicle length (table 3).
As for the rice Varieties, they differed significantly in the number of grains per panicle, as the $Amber_{33}$ achieved the highest mean was 149.7 grains. panicle^{-1} in comparison with $Furat_1$ which achieved the lowest average of 108.9 grains. panicle^{-1}. The result is in agreement with what was discovered by [15,17,18,19 and 25] that the characteristics of the number of grains. panicle^{-1} differ between the genotypes.

Results showed that there were no significant variations in the interaction between cultivation methods and varieties, this is due that each factor was independent in its influence on this characteristic.

Table 6. Number of grains. panicle $^{-1}$ by effect of cultivation methods, varieties and the interaction between them.

	S_1	S_2	S_3	S_4	Mean
$Anmbar_{33}$	141.3	146.0	145.7	165.7	149.7
Yasmine	110.0	130.0	134.7	136.0	127.7
$Furat_1$	105.3	108.0	102.7	119.7	108.9
L.S.D ≤0.05			N. S		10.95
Mean	118.9	128.0	127.7	140.4	128.9
L.S.D ≤0.05			13.29		

3.7. Weight of 1000 Grains (gm)

The grain's weight is one of the important factors that directly affect the yield of the plant per unit area, and it is an indicator of the efficiency of the transfer of metabolic materials from the source to the grain. The results showed (Table 7) that there were no significant variations in the average weight of 1000 grains according to different cultivation methods, and also the interaction between cultivation methods and varieties, and this is due that each factor was independent in its influence on this characteristic.

Table 7. Weight of 1000 grains (gm) by the effect of methods of cultivation, varieties, and interactions between them.

	S_1	S_2	S_3	S_4	Mean
$Anmbar_{33}$	20.67	20.67	20.67	20.00	20.50
Yasmine	21.67	22.33	22.67	22.67	22.33
$Furat_1$	25.33	25.00	24.00	25.33	24.92
L.S.D ≤0.05			N. S		1.224
Mean	22.56	22.67	22.44	22.67	22.58
L.S.D ≤0.05			N. S		

As for the rice Varieties, they differed significantly in the weight of 1000 grains, $Furat_1$ achieved the highest average of 24.92 gm comparison with $Anmber_{33}$ that achieved the lowest average of 20.50 gm. This may be attributed that $Furat_1$ gave the lowest number of grains. panicle^{-1}(Table 6) and upon it, the weight increased according to the compensation mechanism, Also, the difference between the Varieties in the grain weight is due to the differ in the length of the grain filling period and the efficiency of the grain in receiving the photosynthesis products. This result agrees with what was found by [15, 17,18,19,25,26, and 27].

3.8. Grains Yield ton. ha^{-1}

The results of the study revealed that there were significant variations in the mean yield according to different cultivation methods (Table 8). Treatment S_4 gave the highest average 7.69 tons. ha^{-1}, while the treatment S_1 gave the lowest average of 5.86 tons. ha^{-1}. The reason for the increase in the yield is attributed to the increase in the number of grains. panicle^{-1} (table6) and panicle length (cm) (table 3). This is consistent with what was found by [10, and 28], who confirmed that raised board gave the highest grain yield. and also consistent with what was confirmed by [29, and 30], who confirmed that the seedling gave the highest grain yield compared with dry sowing.

As for the Varieties, they differed significantly in the yield, $Furat_1$ achieved the highest average of 8.25 tons. h^{-1} compared to $Anmber_{33}$, which achieved the lowest average of 5.52 tons. ha^{-1}. This difference between varieties can be explained by genetic differences and the extent to which they are affected by environmental conditions. thus, affecting growth processes as well as being affected by agricultural processes. The superiority of $Furat_1$ in the characteristics of the number of panicles.m^2 (table 5) and the weight of 1000 grains (gm) (table 7), all of which contributed to an increase in the yield per ha. This is consistent with what was found by [15, 17, 19, and 25].

Results showed that there were no significant differences in the interaction between cultivation methods and varieties, and this is due that each factor (cultivation methods and varieties) was independent in its influence on Grains Yield.

Table 8. Grains Yield (ton. ha^{-1}) by effect of cultivation methods, varieties and the interaction between them.

	S_1	S_2	S_3	S_4	Mean
$Anmbar_{33}$	4.36	4.51	6.23	6.96	5.52
Yasmine	5.20	6.02	5.35	6.82	5.85
$Furat_1$	8.03	7.19	8.52	9.28	8.25
L.S.D ≤0.05		N. S			1.522
Mean	5.86	5.91	6.70	7.69	6.54
L.S.D ≤0.05			0.871		

Conclusions

Under the present-day constraints and scarcity of irrigation water the results of the experiments clearly showed that seedling transplanting under raised bed method adopting water saving irrigation was found optimum to achieve higher production, productivity of rice.

Thus, the above sowing practices can be recommended.

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