Performance of Two Rice (Oryza sativa L.) Genotypes Under Modern and Conventional Farming Methods in Three Locations in Iraq

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Abstract

The conservation of natural resources like soil and water and reduces chemical pollution in the environment is the desired goal of the directions of improving the performance of important crops for meeting the global food demand. However, System of Rice Intensification (SRI), is a rice cropping system that is consistent with Conservation Agricultural (CA) and Sustainable Agriculture (SA). The current study was aimed to investigate the effects of SRI method on grain yield and its components in two rice varieties compared with conventional practice in farmers’ fields (CFM) in different environmental conditions in Iraq. The study was conducted in the fields during the rice season 2019 in three provinces in the south of Iraq (Najaf, Diwaniya and Muthanna). Anber33 and Jasmine rice varieties were grown in each location and the traits were conducted at sites having 2 donum of land (5,000 m2). The trial was performed as a factorial experiment based on a randomized complete blocks design (RCBD) having three blocks. The results showed superior significant of SRI method compared to CFM method in traits (plant height and panicle length, number per panicle, and percentage of unfilled grains). Furthermore, SRI method gave higher grain yield as a percentage with both varieties in each province (25.6% in Muthanna, 24.5% in Najaf, and 13.2% in Diwaniya province) compared to CFM. However, grain yield in Jasmine variety was higher than on Anber33 approximately 50% in three locations in this study. Overall, our results suggest that SRI method is the most convenient method in Iraq conditions due to the increased grain yield in rice compared to the CFM method.

Keywords: Rice, Conventional (CFM), Modern farming method (SRI).

1.Introduction

Rice (Oryza sativa L.) is considered as a strategic crop, which contribute to providing the main food for most of the people in the world. Recently, world rice productivity was approximately estimated 495.78 million metric tons of grains which are grown in areas around 162.06 million hectares. India was harvested approximately 43.8 million hectares of rice and to be the leading global producer of rice [1]. In Iraq, Rice is considered one of the most important summer crop and occupying 5-6% of the cultivated area. The average rice-growing area of 125,000 ha-1, which produced 2018 season approximately 392,950 ton of grains, with a national production average reach 3,16 tons ha-1 from rice grains [2]. Najaf, Diwaniya, and Muthanna represent the first position for growing and production of paddy. The area planted in these three provinces constituted almost 70% of the total planted area in Iraq, and its production was approximately 75% of the total paddy in 2017. Most Iraqi farmers followed the traditional methods for rice cultivation which inherited from their parents, referred to here asconventional farming methods(CFM). This is essentially a dry method with large areas direct-seeded, using large amounts of seed approximately 160 kg per ha-1[3]. Although rice cropping in the summer in alternation with wheat or barley in the winter season assiststhe people to secure their food and income, this cropping system has been well established to lose the soil their major nutrients and rare minerals. It is worth noting another issue, which is weed control, as weeds have spread and become more problematic. Besides imposing high costs of weed control, these aspects (cases) resulting to cause environmental pollution especially in the case of using chemical herbicides [4,5].

Farmers’ traditional practice for rice production is by maintaining standing water on the soil to a depth of 5-20 cm above the soil surface throughout the rice growing season in the field [6]. Because water limited supply has become the major constraint on rice production, thus, there is needed to a new strategy to maintain high productivity of rice with less water use (increasing water use efficiency (WUE)). Subsequently, this creates a felt need to the new innovations such as the System of Rice Intensification method in the way to solve global rice production problems. System of Rice Intensification (SRI) is a rice cultivation method that was developed in Madagascar which increases rice productivity while reducing the need for external
inputs like inorganic fertilizers and herbicides[7,8]. Furthermore, SRI is a method of producing irrigated rice production with some counter-intuitive practices that involve more careful management in everything related to plants, soil, water, and nutrients [9]. Rice plants grown with SRI method have valuable phenotypes compared with the traditional method, such as more tillers, big and more spreader roots system that enables the plant to actively absorb more nutrients from the soil for plant growth requirements[10]. Obviously, SRI methods give more productivity with more robust phenotypes for used genotypes in order to increase the quality as well as quantity of rice.

Furthermore, the resulting rice plants by SRI are not only characterized with a high yield, but also their tolerance capacity to both biotic and abiotic stresses are accompanied by climate change [11]. According to SRI recommendation, rice seedlings are transplanted at an early stage at 15 days old or less (2 leaves phase). The seedling is transplanted with one seedling per hole in-depth (1-2 cm). Optimum spacing between the lines is placed in a square pattern (approximately 25×25 cm²). These measures enhance the growth rate of the rice plants such as better usage of water, sunlight, minerals, land area, nutrients, in addition to that decrease of weeding and pest management with moisturized soil [12].

SRI methods increase yields in rice 25% or more with reducing farmers’ costs of production. Subsequently, this increases their income per hectare by even more than their additional costs in final grain yield. Thus, the benefit to farmers is more than the contribution of increased yield, furthermore, the method reduces the quantity of water required to grow rice and gives higher efficiency of use water. SRI began spreading seriously in Asia, Africa, and Latin America only about a dozen years ago [13]. Its positive impact on rice crop performance has been shown in over 60 countries. The current study was undertaken to identify the effects of modern rice farming (SRI method) on grain yield and its components in two rice genotypes compared with conventional practice in farmers’ fields under some Iraq conditions.

2. Materials and Methods

The study was conducted in the field in The south of Iraq during the summer rice season 2019 in three locations (Najaf at Al Abbasiya district, Diwaniya at Al Shamiya district, and Muthanna at Al-Rumatha district) to compare the effects of modern rice farming (SRI) method and farmers’ conventional practice regarding grain yield and its components in two rice varieties. The trial was performed as factorial experiment (two varieties and two farming methods) based on a randomized complete blocks design (RCBD) having three blocks. The soil analysis of all application locations as shown in Table 1. Temperature was recorded during the rice growing season from June to November 2019 in Table 2.

Two rice genotypes (Anber 33 and Jasmine) were grown in the field with two donum (5000 m²) per location from three locations. Both rice genotypes are popular local genotypes with total growth duration of 140-150 days. The organic matter (OM) used for SRI methods was produced from the last crop season’s rice straw which mixed with animal residues two months before planting. The amount of OM was 10-ton ha⁻¹ that mixed with the soil during ploughing in-depth 10 cm.

Seedlings were prepared using plastic plats (size 3×28×58 cm) contented sieved soil. The seeds used was 20 kg ha⁻¹. The nursery plot prepared and levelled by size was 10×20 m². In addition, the fields were levelled with water and were designed as plots by size 20×25 m².

The SRI fields were transplanted with young seedlings (15 days old) by hand, one seedling per plant hole, with spacing (25×25 cm) between the seedlings. Irrigation was done according to SRI principles: intermittent irrigation during the vegetative stage, and then continuous flooding with just a thin layer of water (1-2 cm) during the reproductive stage. Soil fertilization, the compost adding 10 ton ha⁻¹ as noted above, with half the recommended amount of chemical fertilizer was applied 200 kg ha⁻¹ of NP (compound 18×18) which mixed with soil, and 160 kg ha⁻¹ of urea (46% nitrogen). Weeds Control was done by hand two times during rice growing season.

Seeds in the conventional method (CFM) are scattering directly onto the ploughed land using a high seed rate its reached (200 kg ha⁻¹), which sometimes is referred to as dry-method practices. Chemical fertilizer was applied: 400 kg ha⁻¹ of compound NP [18×18] and 280 kg ha⁻¹ of urea (46% nitrogen), also, No organic manure (OM) was added. The soil was kept continuously submerged with a layer of water covering the surface until the maturity stage. For field management, Stam F34 was added 10 L ha⁻¹ for weed control. Furthermore, manual weeding was done 3-4 times.

At the maturity stage, plants were sampled by 3 m² harvested areas per plot to estimate of grain yield. Also, 10 rice panicles randomly-selected were selected from each plot for estimating of rice yield components. Means of rice characters were tested by the least significance difference test (LSD) at the 5% level. Statistical tests were conducted using the GenStat program [14].
Table 1. Field soil analysis.

| Province | pH | EC | Soil texture           |
|----------|----|----|------------------------|
| Najaf    | 8.1| 2.2| Silty clay to clay loam|
| Diwaniya | 8.5| 2.8|                        |
| Muthanna | 8.4| 3.1|                        |

Table 2. Agro-meteorological data in three provinces, during the period of the study 2019.

| Province | Month | Air temperature °c | Evaporation from A pan (mm/month) |
|----------|-------|--------------------|-----------------------------------|
|          | Max.  | Min.  | Avg.  | Max.  | Min.  | Avg.  |                      |
| Najaf    |       |       |       |       |       |       |                      |
| June     | 43.50 | 26.71 | 35.11 | 264.80 |       |       |                      |
| July     | 42.02 | 26.58 | 34.30 | 255.10 |       |       |                      |
| August   | 42.34 | 27.77 | 35.06 | 225.20 |       |       |                      |
| September| 39.10 | 23.36 | 31.23 | 167.50 |       |       |                      |
| October  | 33.53 | 20.32 | 26.93 | 108.40 |       |       |                      |
| November | 26.01 | 11.32 | 18.67 | 96.50  |       |       |                      |
|          | Seasonal total mm | 1,117.5 |       |       |       |       |                      |
| Diwaniya |       |       |       |       |       |       |                      |
| June     | 40.05 | 24.38 | 34.40 | 323.00 |       |       |                      |
| July     | 44.04 | 24.32 | 34.18 | 339.90 |       |       |                      |
| August   | 45.21 | 26.18 | 35.69 | 279.90 |       |       |                      |
| September| 42.66 | 22.62 | 32.64 | 217.20 |       |       |                      |
| October  | 35.85 | 19.49 | 27.67 | 140.60 |       |       |                      |
| November | 25.89 | 10.58 | 18.24 | 82.00  |       |       |                      |
|          | Seasonal total mm | 1,382.6 |       |       |       |       |                      |
| Muthanna |       |       |       |       |       |       |                      |
| June     | 43.50 | 25.09 | 34.30 | 330.90 |       |       |                      |
| July     | 46.55 | 27.47 | 37.01 | 356.30 |       |       |                      |
| August   | 45.71 | 25.32 | 35.52 | 365.10 |       |       |                      |
| September| 43.43 | 23.20 | 33.32 | 259.50 |       |       |                      |
| October  | 36.64 | 20.19 | 28.42 | 195.50 |       |       |                      |
| November | 27.19 | 10.92 | 19.06 | 109.60 |       |       |                      |
|          | Seasonal total mm | 1,616.9 |       |       |       |       |                      |

Source: Agro-meteorological Centre, Ministry of Agriculture /Iraq.

3. Results and Discussion

3.1. Leaf area index

At the flowering stage, the average values of leaf area index character was measured for two rice genotypes growing under SRI and CFM methods in three locations. The results in Table 3 showed LAI of rice plants which are grown by SRI was 25% higher than in CFM. This may be attributed to the more nutrient absorption of plants grown by the SRI method, high vigorous root system, and higher light utilization efficiency. In a study of Hameed et al.[10] found that SRI has a higher leaf area index compared with CFM. However, Anber33 genotype gave more leaf area index with SRI than CFM in all three locations under study.

3.2. Plant height

The data in Table 3 showed that the highest plant height averages obtained by SRI practice which recorded 123.0 cm in Najaf province, whereas the lowest height by CFM was only 94.6 cm recorded in Diwaniya province. This result may be attributed to active growth conditions and wider spacing between plants that led to vigorous root growth for all directions by using SRI practice. The result is identical with Styger[15] by using SRI method. In Muthanna and Najaf provinces the highest plant height was Anber 33 compared to Jasmine. The average maximum plant height was produced by Anber33 (135.2 cm) in Muthanna province, followed by Jasmine (89.0 cm). While Anber33 with SRI methods in Najaf province gave the highest plant height than any other treatment.

3.3. Biological yield

There were significant differences in biological yield traits for two rice genotypes were grown under SRI and CFM practices in three different locations as seen in Table 3. The highest average of biological yield was 1,856 g m⁻² with SRI method in
Muthanna province, this value was higher by 40% than the CFM practice in Diwaniya province which recorded the lowest biological yield only 1.103 g m$^{-2}$. This result may be attributed to better growth conditions with more nutrients causing higher grain weight, tiller number, and above-ground biomass for rice that was grown in SRI. Similar results were reported by Azarpour et al. [16] mentioning that the highest biological yield was obtained with intermittent irrigation. However, the highest average biological yield was produced in Jasmine genotype (1.827 g m$^{-2}$) in Muthanna province, and the lowest was by Anber33 genotype (945 g m$^{-2}$) in Diwaniya province. Among the interactions, Jasmine genotype produced the highest yield with SRI in Muthanna province, reached 2,111 g m$^{-2}$.

3.4. Panicle Length

For panicle length in two rice genotypes, SRI produced significantly longer panicles 29 cm in Muthanna province than CFM 21.1 cm in Diwaniya province (Table 3). Panicles were on average 27.3% longer with SRI than with the conventional system. Long panicles with SRI methods might be due to higher dry biomass accumulation in the plant, higher photosynthetic rate, and better utilization of the nutrients. Both [17, 18] have reported similar findings of higher panicle length with SRI. This table also indicates that Anber33 produced the longest average panicles under SRI practice reached 28.85 cm in Muthanna province, followed by Jasmine genotype 24.5 cm in Najaf province. The shortest panicle length was to Anber33 only 24.1 cm in Diwaniya province. Considering interaction effects, Anber33 with SRI in Muthanna province gave the highest panicle length (32.4 cm) than the other treatments in all provinces.

3.5. Number of Filled Grains per Panicle

The results in Table 4 indicate that preforms of grain yield components in two rice genotypes that grown under two different farming practices in three different locations. However, SRI practice in Muthanna province produced a significantly higher number of filled grains panicle$^{-1}$ than CFM. Higher number of filled grains per panicle in SRI might be due to maximum utilization of solar radiation, availability of nutrients on the root zone and better uptake of nutrients by the developed root system, and longer lasting lower leaves in each hill remaining photosynthetically active. In the experiment by Ali et al. [19] obtained a similar result for filled grains per panicle in SRI. The maximum average number of filled grains panicle$^{-1}$ was produced with Jasmine and Anber33 genotypes in Muthanna province, 144.7 and 144.6, respectively under SRI. Whereas the conventional farming method showed the lowest average number of grains per panicle in Diwaniya province which recorded 129.4 and 120 for Anber33 and Jasmine, respectively. Among the interactions, Jasmine genotype with SRI practices produced the highest number of filled grains per panicle in Muthanna province (177.7) followed by Najaf province 163.2 grains per panicle with the same genotype. These results revealed that SRI method produced more filled grains per panicle than conventional methods with respect to either genotype.

3.6. 1000 Grain Weight

The 1000-grain weights of two rice genotypes with SRI and CFM in three locations are shown in Table 4. The averages of 1000-grain weight were slightly higher and not significantly different with SRI compared to CFM for the two genotypes. This result may be attributed to the more vigorous root growth in plants irrigated by the SRI method, making them better able to absorb available nutrients from the soil, when panicle initiation up to maturity. In different study, Hameed et al. [3] and Ali and Izhar [20] have similar findings. Anber33 and Jasmine gave the highest weight of 1000 grains in Muthanna province, 22.1 g and 21.9 g, respectively, while the lowest weights were 20.7 g and 20.7 g for Anber33 and Jasmine respectively in Diwaniya province.

3.7. Effective Tiller Number per m$^2$

The average highest number of effective tillers per m$^2$ was produced with SRI, which recorded 17.8%, 17.3%, and 13.6% higher than CFM method in three locations Muthanna, Najaf, and Diwaniya, respectively (Table 4). This is attributable to there are a higher number of tillers with SRI practice due to wider spacing between plants and more vigorous root growth. In experiments of [21] also report a similar finding regarding the higher number of effective tillers m$^{-2}$ in SRI. The genotypes, the highest number of effective tillers per m$^2$ was obtained with Jasmine genotype (322.1) in Muthanna province, while the lowest was in Diwaniya province for Anber33 genotype it is reached 158.8 tillers m$^{-2}$. Interaction analysis among three factors showed that the Jasmine genotype with SRI methods in Muthanna province gave higher tillers per m$^2$ than the other treatments, reaching 355 tillers, while Anber33 gave the lowest tillers m$^{-2}$ was 140 in Diwaniya province.

3.8. Sterility Ratio

The lowest average sterility percentage was found with SRI panicles in Muthanna province (7.5%), this was almost twice as low as with CFM in Diwaniya province (13.8%) as shown in table 5. The results above may be attributed to the greater shading of leaves in conventional plants and their lesser nutrient uptake due to greater competition when plants are grown more closely together. Ina study by [22] who reported similar findings on sterility ratio with SRI use in Afghanistan. The
average maximum sterility percentage with Anber33 was higher (15.6%) in Diwaniya province than with Jasmine (8.65%). The average minimum sterility percentage by genotype was 4.8% and 12.5% with Jasmine and Anber33, respectively. Regarding interaction, the result in the table indicates that the lowest sterility percentage was with Jasmine genotype in Najaf province (4.2%) followed by 4.3% in Muthanna province with SRI, while the maximum for this characteristic was found with Anber33 and CRM (17.9%) in Diwaniya province.

**Table 3.** Effect of two farming methods on plant growth traits of Anber33 and Jasmine rice cultivars in three locations.

|                | Najaf Province | Diwaniya Province | Muthanna Province |
|----------------|----------------|--------------------|-------------------|
|                | Leaf Area Index | Plant Height | Biological Yield | Panicle Length |
| Method         | Cultivars       | Mean             | Cultivars       | Mean             | Cultivars       | Mean             | Cultivars       | Mean             |
|                | Anber  | Jasmine  | Mean | Anber  | Jasmine  | Mean | Anber  | Jasmine  | Mean | Anber  | Jasmine  | Mean | Anber  | Jasmine  | Mean |
| SRI CFM Mean   | Anber  | 33       | 43.41 | Jasmine | 37.09 | 40.25 | Anber  | 33       | 145.7 | Jasmine | 100.3 | 123.0 | Anber  | 33       | 1271   | 2012  | 1641  |
|                | Anber  | 33       | 1271  | Jasmine | 2012  | 1641  | Anber  | 33       | 26.42 | Jasmine | 25.92 | 26.17 | Anber  | 33       | 26.42  | 25.92 | 26.17 |
| CF M Mean      | Anber  | 33       | 35.72 | Jasmine | 29.14 | 32.43 | Anber  | 33       | 121.6 | Jasmine | 76.3  | 98.9  | Anber  | 33       | 958    | 1580  | 1269  |
|                | Anber  | 33       | 958   | Jasmine | 1580  | 1269  | Anber  | 33       | 22.31 | Jasmine | 23.10 | 22.71 | Anber  | 33       | 22.31  | 23.10 | 22.71 |
| M Mean LS D 0.05 | Anber  | 33       | 39.56 | Jasmine | 33.12 | 88.3  | Anber  | 33       | 133.7 | Jasmine | 88.3  | 1114  | Anber  | 33       | 24.37  | 24.51 |
|                | Anber  | 33       | 133.7 | Jasmine | 1796  | 1114  | Anber  | 33       | 24.37 | Jasmine | 24.51 | 24.96 | Anber  | 33       | 24.37  | 24.96 |
|                | Anber  | 33       | 1.631 | Jasmine | 2.307 | 10.05 | Anber  | 33       | 160.3 | Jasmine | 160.3 | 226.8 | Anber  | 33       | 4.085  | 4.085 | 5.778 |
|                | Muthanna Province |                 |          |        |          |        |        |          |        |          |        |        |        |          |        |        |
|                | Leaf Area Index | Plant Height | Biological Yield | Panicle Length |
| Method         | Cultivars       | Mean             | Cultivars       | Mean             | Cultivars       | Mean             | Cultivars       | Mean             |
|                | Anber  | Jasmine  | Mean | Anber  | Jasmine  | Mean | Anber  | Jasmine  | Mean | Anber  | Jasmine  | Mean | Anber  | Jasmine  | Mean |
| SRI CFM Mean   | Anber  | 33       | 36.61 | Jasmine | 31.81 | 34.21 | Anber  | 33       | 138.6 | Jasmine | 94.6  | 116.6 | Anber  | 33       | 1144   | 1835  | 1489  |
|                | Anber  | 33       | 1144  | Jasmine | 1835  | 1489  | Anber  | 33       | 26.33 | Jasmine | 23.60 | 24.96 | Anber  | 33       | 26.33  | 23.60 | 24.96 |
| CF M Mean      | Anber  | 33       | 29.42 | Jasmine | 25.91 | 27.66 | Anber  | 33       | 114.0 | Jasmine | 75.2  | 94.6  | Anber  | 33       | 746    | 1460  | 1103  |
|                | Anber  | 33       | 746   | Jasmine | 1460  | 1103  | Anber  | 33       | 21.89 | Jasmine | 20.30 | 21.10 | Anber  | 33       | 21.89  | 20.30 | 21.10 |
| M Mean LS D 0.05 | Anber  | 33       | 33.01 | Jasmine | 28.86 | 126.3 | Anber  | 33       | 84.9  | Jasmine | 1647  | 945   | Anber  | 33       | 24.11  | 21.95 |
|                | Anber  | 33       | 945   | Jasmine | 1647  | 945   | Anber  | 33       | 24.11 | Jasmine | 21.95 | 24.96 | Anber  | 33       | 24.11  | 21.95 |
|                | Anber  | 33       | 3.147 | Jasmine | 3.451 | 4.451 | Anber  | 33       | 8.32  | Jasmine | 8.32  | 11.77 | Anber  | 33       | 85.8   | 85.8  | 121.3 |
|                | Anber  | 33       | 85.8  | Jasmine | 85.8  | 121.3 | Anber  | 33       | 2.418 | Jasmine | 2.418 | 3.420 | Anber  | 33       | 2.418  | 2.418 | 3.420 |
| 3.9. Grain yield

To summarize the yield parameters and its components, SRI was significantly more successful than CFM as shown in Table 5. This was attributable to wider spacing with less competition among plants below and above ground for better grain filling, slightly higher grain weight, and a greater number of filled grains per panicle. This in turn enhanced the production of the more total number of grains and filled grains per panicle [23]. The average highest grain yield per hectare obtained with SRI was 7.2 ton per hain Muthanna province, and the lowest was 4.65 tons ha$^{-1}$ in Diwaniya province. In Muthanna province, Jasmine genotype yield was (26%) with SRI compared with conventional farming method; and Anber33 yield was increased.
by 25% when using SRI compared with conventional farming methods. This result is consistent with the results obtained by [24,25]. Interaction analysis showed that the Jasmine genotype with SRI management gave the highest grain yield with modern farming methods (SRI) in Muthanna province. Effect of farming method on sterility ratio and grain yield of Anber33 and Jasmine rice cultivars.

Table 4. Effect of two farming methods on components of yield and Jasmine rice cultivars in three locations.

| Farming Method | Filled Grain No. | 1000 Grain Weight | Active Tiller No. |
|----------------|------------------|--------------------|------------------|
|                | Anber33          | Jasmine            | Mean             |
|                | Cultivars        | Cultivars          | Cultivars        |
| MFM (SRI)      | 147.3            | 163.2              | 155.2            |
| CFM            | 126.3            | 105.3              | 115.8            |
| Mean           | 136.8            | 134.3              | 115.8            |
| LSD (0.05)     | 9.45             | 9.45               | 13.37            |
|                | Cultivars        | Farming            | Interaction      |
|                | Anber33          | 21.66              | 21.53            |
|                | Jasmine          | 20.91              | 20.88            |
|                | Mean             | 21.25              | 21.22            |
|                | Cultivars        | Farming            | Interaction      |
|                | Anber33          | 21.02              | 21.11            |
|                | Jasmine          | 20.72              | 20.67            |
|                | Mean             | 20.91              | 20.70            |
|                | Cultivars        | Farming            | Interaction      |
|                | Anber33          | 21.54              | 21.53            |
|                | Jasmine          | 21.02              | 21.11            |
|                | Mean             | 21.54              | 21.53            |

Muthanna Province

| Farming Method | Filled Grain No. | 1000 Grain Weight | Active Tiller No. |
|----------------|------------------|--------------------|------------------|
|                | Anber33          | Jasmine            | Mean             |
|                | Cultivars        | Cultivars          | Cultivars        |
| MFM (SRI)      | 133.54           | 140.42             | 136.98           |
| CFM            | 125.31           | 99.61              | 112.46           |
| Mean           | 129.43           | 120.02             | 112.46           |
| LSD (0.05)     | 3.655            | 3.655              | 5.170            |
|                | Cultivars        | Farming            | Interaction      |
|                | Anber33          | 21.17              | 21.17            |
|                | Jasmine          | 21.17              | 21.17            |
|                | Mean             | 21.17              | 21.17            |
|                | Cultivars        | Farming            | Interaction      |
|                | Anber33          | 158.8              | 268.0            |
|                | Jasmine          | 158.8              | 268.0            |
|                | Mean             | 158.8              | 268.0            |
|                | Cultivars        | Farming            | Interaction      |
|                | Anber33          | 6.20               | 6.20             |
|                | Jasmine          | 6.20               | 6.20             |
|                | Mean             | 6.20               | 6.20             |

Diwaniya Province

| Farming Method | Filled Grain No. | 1000 Grain Weight | Active Tiller No. |
|----------------|------------------|--------------------|------------------|
|                | Anber33          | Jasmine            | Mean             |
|                | Cultivars        | Cultivars          | Cultivars        |
| MFM (SRI)      | 157.23           | 177.66             | 167.44           |
| CFM            | 132.11           | 111.61             | 121.86           |
| Mean           | 144.67           | 144.64             | 121.86           |
| LSD (0.05)     | 4.477            | 4.477              | 6.331            |
|                | Cultivars        | Farming            | Interaction      |
|                | Anber33          | 21.94              | 21.62            |
|                | Jasmine          | 21.94              | 21.62            |
|                | Mean             | 21.94              | 21.62            |
|                | Cultivars        | Farming            | Interaction      |
|                | Anber33          | 225.4              | 322.1            |
|                | Jasmine          | 225.4              | 322.1            |
|                | Mean             | 225.4              | 322.1            |
|                | Cultivars        | Farming            | Interaction      |
|                | Anber33          | 13.77              | 13.77            |
|                | Jasmine          | 13.77              | 13.77            |
|                | Mean             | 13.77              | 13.77            |
Table 5. Effect of two farming methods on sterility ratio and grain yield of Anber33 and Jasmine rice cultivars.

| Farming Method | Sterility Ratio | Grain Yield |
|----------------|-----------------|-------------|
|                | Anber33 | Jasmine | Mean | Anber33 | Jasmine | Mean |
| MFM (SRI)      | 12.77   | 4.16    | 8.47 | 4.30    | 8.00    | 6.15 |
| CFM            | 15.08   | 5.75    | 10.42| 3.10    | 6.30    | 4.70 |
| Mean           | 13.93   | 4.96    |      | 3.70    | 7.15    |      |
| LSD (0.05)     | Cultivars| Farming M| Interaction | Cultivars| Farming M| Interaction |
|                | 1.458   | 1.458   | 2.062| 0.837   | 0.837   | 1.183|

| Farming Method | Sterility Ratio | Grain Yield |
|----------------|-----------------|-------------|
|                | Anber33 | Jasmine | Mean | Anber33 | Jasmine | Mean |
| MFM (SRI)      | 13.33   | 7.57    | 10.45| 3.60    | 7.20    | 5.40 |
| CFM            | 17.89   | 9.72    | 13.81| 3.20    | 6.10    | 4.65 |
| Mean           | 15.61   | 8.65    |      | 3.40    | 6.65    |      |
| LSD (0.05)     | Cultivars| Farming M| Interaction | Cultivars| Farming M| Interaction |
|                | 1.461   | 1.461   | 2.066| 0.985   | 0.985   | 1.393|

| Farming Method | Sterility Ratio | Grain Yield |
|----------------|-----------------|-------------|
|                | Anber33 | Jasmine | Mean | Anber33 | Jasmine | Mean |
| MFM (SRI)      | 10.67   | 4.27    | 7.47 | 5.60    | 8.80    | 7.20 |
| CFM            | 14.31   | 5.31    | 9.81 | 4.20    | 6.50    | 5.35 |
| Mean           | 12.49   | 4.79    |      | 4.90    | 7.65    |      |
| LSD (0.05)     | Cultivars| Farming M.| Interaction | Cultivars| Farming M.| Interaction |
|                | 1.430   | 1.430   | 2.023| 0.658   | 0.658   | 0.931|

**Conclusion**

The results of this study showed that it is possible to getting higher yield 25% or more, with better plant performance and resilience when using the modern farming system of SRI system. At the same time, it reduces the water requirements for growing rice by 25% or more, which could be a major contribution to agriculture in Iraq by helping counter the severe shortages in water that are facing Iraq now and in the years to come. Herbicides were not necessarily due to weed control can be done effectively by hand. This reduces cost of labour but avoids the high cost of chemicals and less pollution of soil and water. Furthermore, if the rotary hoes recommended for SRI practice can be introduced into Iraq, this will reduce the cost of labour in rice production (these hoes are not very expensive), it also improve soil health and long-term fertility through active soil aeration. The major rice-producing countries in Asia which produce two-thirds of the world’s rice are China, India, Indonesia, Vietnam, and Cambodia, which are now having governmental support for SRI expansion, complemented by NGO, university and other institutional efforts. In Iraq, the System of Rice Intensification, a new set of practices for rice-growing farmers in Iraq, SRI has been tested and demonstrated in AL-Mishkhab Rice Research Station since 2005 with encouraging results as reported on the Cornell website: http://sri.cals.cornell.edu/countries/iraq/index.html. It has been considered as first step on the long road toward adopting modern methods of production to both reduce water consumption and raise food output. However, there is needed for extra studies and research and for support to expand this knowledge and practice into rice-growing areas in large scale. Our recommendation, SRI implementation over a large farming area and involvement of SRI pioneer farmers in other countries to transfer their experience in implementing SRI project for other rice farmers, making further advances in SRI methodology. This includes using transplanting machines instead of doing crop establishment by hand. This will reduce the cost of labour and speed up crop establishment. Mechanical SRI crop establishment is already being started in several countries such as Costa [26]. Looking into the potential of SRI as an environment-friendly, input-saving and yield-enhancing strategy. Recently, the Ministry of Agriculture of Iraq has included SRI methodology as one of the components of its National High Yielding Rice Seeds Production Program.

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