Application of System of Rice Intensification (SRI) Methods on Productivity of Jasmine Rice Variety in Southern Iraq

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ABSTRACT

Field experiments were conducted during the summer season of 2008 in Al-Muthanna province in southern Iraq at four sites (Al-Rumatha district and Al-Warkaa, Al-Najmi and Al-Majd sub-districts) to study the System of Rice Intensification (SRI) practices influence on the grain yield and yield components of Jasmine rice. The System of Rice Intensification (SRI) methods had favorable and significant impacts on plant height and panicle length and showed significant differences in the yield components of grain number and sterility percentage panicles. There were no significant differences in number of tillers m^{-2} as the conventional method, using larger amounts of seed for sowing, has higher density of plants m^{-2}. The System of Rice Intensification (SRI) methods gave the highest grain yield at the first site (7,257 kg ha^{-1}) and the lowest yield at the second site (6,692 kg ha^{-1}), while conventional methods (non-SRI) had their best grain yield at the fourth site (5,122 kg ha^{-1}) and lowest yield at the third site (3,616 kg ha^{-1}). In all cases SRI methods had favorable effect on grain yield/ha as compared to conventional method.

Keywords: SRI, Jasmine Rice, Southern Iraq.

INTRODUCTION

Rice (*Oryza Sativa L.*) as a staple food crop in Iraq comes after wheat in planting area and productivity. The area for rice cultivation in 2006 was 125,641 ha, producing 363,338 tons of paddy with an average yield 2,892 kg ha^{-1} (MOP, 2007). Iraqi rice farmers cultivate rice (conventional method) according to the cultural practices inherited from their parents, essentially a dry method with large areas, using large amounts of seed (about 160 kg ha^{-1}) and growing rice in alternation with wheat which has caused reduction in soil fertility (El-Hakim, 2009).

The conventional method of rice irrigation in Iraq is continuous submergence throughout the rice cycle, which requires large quantities of water (Saleh *et al.*, 1999) estimated at70,000 m^{-3} ha^{-1} according to a Japanese expert who was visited Iraq in 1963 (Ito, 1965). This also has a negative effect on the environment because of the disposal of large amounts of drainage water which contain residual agrochemicals and herbicides which cause pollution of water and soil (Awan *et al.*, 2004 and Willingham *et al.*, 2008).

In the areas of study, the farmers (total rice growing farmers in Muthanna province are 2462 with areas 4505 ha; it comes sixth of the rice growing provinces in planting area) suffered shortage of water and low rice production due to they were planted local rice variety Amber33, yielded of 2.8 t ha^{-1}, and not adapted new

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methods for rice cultivation. The farmers growing rice by the dry method which caused high density of weeds will share rice plants on nutrients. The areas of study are not fertile enough because the farmers not used organic manure or recycling plant residues for restoring of their soil fertility .

Accordingly, we should be thinking strategically about how to change this traditional method in rice growing. Iraqi farmers should be enabled to enhance their rice production while improving soil and environmental quality, making fewer demands on limited fresh water supplies, making rice production more skilled with a better agronomic understanding among rice farmers, and reducing their costs of production to further enhance income. This creates a felt need for an innovation such as the System of Rice Intensification (SRI) which was developed in Madagascar and extended to many other countries through cooperation with the Cornell International Institute for Food, Agriculture and Development (CIIFAD) (Uphoff and Kassam, 2009).

SRI results have been favorable in a wide variety of growing conditions.

- Large-scale evaluations of SRI carried out in **Indonesia** (N=12,133) over nine seasons (2002-2006) calculated an average yield increase of 81.4% in the wet season and 85.5% in the dry season, using alternating irrigation and drainage during the vegetative phase and applying just a thin layer of water in the surface of the soil for the reproductive phase (Sato and Uphoff, 2007).
- In an evaluation in **Cambodia** of SRI impacts for 142 farmers adapted its practices to their rainfed conditions found average rice yield raised from 1.06 ton/ha with convention

al methods to 4.02 tons/ha average, a four-fold increase (Lyman *et al*., 2007).

- In northern **Afghanistan**, farmers assisted by the Aga Khan Foundation in Baghlan province (N=42) in 2009 achieved average yields over 9 t ha^{-1} under difficult agroclimatic conditions, compared to 5.6 t ha^{-1} average with the same farmers and same soils (Thomas and Ramzi, 2009).
- In Timbuktu region of **Mali**, on the edge of the Sahara Desert in West Africa, farmers working with the NGO Africare (N=53) had average SRI yields of 9.1 t ha^{-1} compared to 5.5 t ha-1 on adjacent plots where they tried to achieve the best possible yields with their own favored methods (Styger, 2009).
- In controlled trials conducted in **China** in 2006, water use efficiency (WUE) was found to be increased by 100% with SRI methods (Zhao *et al*., 2009). In Iraq, WUE has already been found to increase by 2-3 times when intermittent irrigation was used compared with continuous submergence (Saleh, *et al*., 1999).

Materials and Methods

In 2008, four sites were chosen in al-Mutthana province to carry out evaluations of the SRI methodology: Al-Rumatha and Al-Warka districts, and Al-Mijd and Al-Najmi sub-districts (Al-Rumatha lies about 25 kms to the north of Samawa city center of Muthanna province"270 kms in south of Baghdad", Al-Warka lies about 30 kms to the east of samawa, Al-Majd lies about 10 kms to the north of Samawa, Al-Najmi lies about 15 kms to the east of Rumatha. All locations are located on the east branch of Euphorates) with four locations at each site having donum of land (2500 m^{-2}) for each location. The soil texture of the application areas was silty clay loam to clay loam with PH of 7.9 and EC of 3.8 ds/m(field soil analysis). The organic matter used for SRI methods was produced from last crop season's rice straw mixed with animal residues two months before planting. The amount of OM was 10 t ha^{-1} mixed in with the soil during ploughing. Ploughing of the soil was 10cm in depth.

Jasmine rice(The Jasmine features are: high yield, aromatic, medium of growth duration, and resistant for lodging) seedlings were prepared using plastic plats (3× 28× 58 cm in size), filled with sieved soil. The amount of seeds used was 20 kg ha^{-1}. Nursery plot size was 5×10 m, prepared and leveled. The fields were leveled with water and were designed as plots 20×25 m in size. The experimental design was Random Complete Block Design (RCBD).

The SRI fields were planted with young seedlings, 17 days old, in rows 25 cm apart and with 20 cm distance between plants within rows. The seedling age was a little older than usually recommended for best results with SRI, but younger seedlings could not be used in these trials. Irrigation was done according to SRI principles: intermittent irrigation during the vegetative phase, and then continuous flooding with a thin layer of water (1-2 cm) during the reproductive phase. For soil fertilization, in addition to the 10 tons ha-1 of compost noted above, half the usual recommended amount of chemical fertilizer was applied: 200 kg ha^{-1} of NP (compound 18×18) mixed with soil, and 160 kg ha^{-1} of Urea (46%). Control of weeds by hand was done two times.

Compared with SRI methods , the usual conventional method (non-SRI) is sometimes referred to as dry method practices. Seeds are broadcast directly onto the ploughed land using a large amount of seeds (200 kg ha^{-1}). A chemical fertilizer was applied (400 kg ha^{-1} of compound NP [18×18] and 280 kg ha^{-1} of Urea), as was 10 L ha^{-1} of Stam F34 for weed control. In addition, hand weeding was done 3-4 times. Not added organic manure. Soil was kept continuously submerged with a layer of water covering the surface until maturity stage.

At harvest, plants were sampled diagonally across 3 m^{-2} harvested areas per field to determine grain yield, further 10 randomly-selected rice panicles were sampled from each field for determination of yield components. Ten randomly-selected plants were sampled from each field for calculating average plant height. Means were compared by least significance difference(LSD) at the 5% level. Statistical procedures were conducted using (SAS 2001) analysis method .

Results and Discussion

1. Plant Growth Characteristics

1.1 *Plant Height*

There were clear and significant differences in this characteristic. Average plant height on the SRI plots was 87.69 cm, while non-SRI plots had 79.69 cm as average. The first SRI location gave highest in plant height was 93.75cm, while the second non-SRI gave highest in plant height was 83.75cm (Table 1). This difference may be attributed to good growth conditions and wider spacing between plants that led to vigorous root growth at all directions. The result is identical with (Styger, 2009).

Table 1: Effect of SRI methods on Plant height (cm) compare with non-SRI in four locations

Location / Treatments	First location	Second location	Third location	Fourth location	Average
SRI	93.75	91.25	87.5	86.25	89.69
Non-SRI	81.25	83.75	75.0	78.75	76.69
LSD	4.59				

1.2 *Panicle Length*

System of Rice Intensification(SRI) practice gave significantly longer panicle length, 22.26 cm average, while non-SRI practice gave 19.59 cm on average. The second SRI location gave highest in panicle length was 23.0cm, while the second non-SRI gave highest in panicle length was 20.75cm (Table 2). This corresponds to the increased plant height due to good growing conditions and spacing between plants. This result is identical with (Thomas and Ramzi, 2009; Styger, 2009).

Table 2: Effect of SRI method on Panicle length (cm) compare with non-SRI in four locations

Location / Treatments	First location	Second location	Third location	Fourth location	Average
SRI	22.75	23.0	22.37	20.5	22.16
Non-SRI	19.25	20.75	19.75	18.5	19.56
LSD	1.54				

1.3 ***Tiller Number m^{-2}***

There were no significant differences observed in this characteristic due to the number of plants per sq. m. with the farmer method (non-SRI) being four times more than the SRI plant density. The number of tillers per unit areas was higher and more significant, The third SRI location gave highest in tillers number was 343.5 per m^{-2}, while the second non-SRI gave highest in tillers number was 317.75 per m^{-2} (Table 3). With SRI method of crop establishment by transplanting, less seeds are used, about 20 kg ha^{-1} compared to 160-200 kg ha^{-1} -- 8-10 times more -- for non-SRI crop establishment. The result is identical with (Thomas and Ramzi ,2009; Kumar *et al*.,2007)

Table 3: Effect of SRI method on Tiller number m^{-2} compare with non-SRI in four locations

Location / Treatments	First location	Second location	Third location	Fourth location	Average
SRI	315	332.25	343.5	311.75	325.6
Non-SRI	287	317.75	262.75	285.25	288.2
LSD	46.94				

1.4 ***Sterility Ratio***

Considering this parameter affecting crop yield, the sterility percentage in SRI panicles was lower (9.24%) compared with non-SRI practice (13.59%). The first SRI location gave highest in sterility ratio was 10.75%, while the third non-SRI gave highest in sterility ratio was 16.37% (Table 4). This result may be attributed to more shading between plants and less nutrient uptake due to greater competition among non-SRI plants which grow more closely together. The result agreed with (Larijani, 2006).

Table 4: Effect of SRI method on Sterility ratio (%) compare with non-SRI in four locations

Location / Treatments	First location	Second location	Third location	Fourth location	Average
SRI	10.75	10.45	10.62	5.15	9.24
Non-SRI	16.12	12.25	16.37	9.62	13.59
LSD	2.83				

2. **Grain Yield and Components of Yield**

2.1 ***Number of Filled Grains per Panicle***

Filled grain number per panicle with SRI method was greater, with141.6 grains/panicle on average while with conventional methods (non-SRI). There were 106.6 grains/panicle, giving SRI panicles 32.8% more grains. The third SRI location gave highest in grain/panicle was 151.8, while the second non-SRI gave highest in grain/panicle was 118.6 (Table 5). This result may be attributed to the nutrient and light availability for plants with SRI practice compared to non-SRI management. The result identical with (Thomas and Ramzi, 2009; Kumar *et al.*,2007; Sato and Uphoff, 2007)

Table 5: Effect of SRI method on Filled grains per panicle compare with non-SRI in four locations

Location / Treatments	First location	Second location	Third location	Fourth location	Average
SRI	141.9	142.1	151.8	130.8	141.6
Non-SRI	98.7	118.6	99.1	109.9	106.6
LSD	24.5				

2.2 ***Grain Weight***

For this characteristic, there was no significant difference between SRI and non-SRI practice, with little different in average 1000-grain weight. The second and third SRI location gave the highest in 1000 grain weight was 19.25gm, while the second non-SRI gave highest in 1000-grain weight was 19 gm (Table 6). It was calculated that SRI grains were 5.7% heavier on average, but given the size of sample, this was not considered significant. The result is agreed with (Larijani, 2006).

Table 6: Effect of SRI method on 1000-grain weight (gm) compare with non-SRI in four locations

Location / Treatments	First location	Second location	Third location	Fourth location	Average
SRI	18.25	19.25	19.25	17.5	18.56
Non-SRI	17.5	19	17.25	16.5	17.56
LSD	1.17				

2.3 *Grain Yield*

According to this summary measure of crop performance, SRI practice was significantly more successful than non-SRI practice. SRI methods gave an average yield of 7,040 kg ha^{-1} compared with 4,660 kg ha^{-1} from non-SRI rice production methods in al-Muthanna province. The first SRI location gave the highest in grain yield was 7,257 kg ha^{-1}, while the fourth non-SRI gave the highest in grain yield was 5,122 kg ha^{-1} (Table 7). This increment of 50% resulted from a combination of factors including higher grain number per panicle and a lower sterility ratio due to good growing conditions and wider spacing between plants that affects the nutrients and sunlight available to SRI plants. Similar results have been reported from other studies (Lyman *et al*., 2007; Thomas and Ramzi, 2009; Kumar *et al*.,2007; Sato and Uphoff, 2007; Larijani, 2006).

Table 7: Effect of SRI method on Grain yield (kg per hectare) compare with non-SRI in four locations

Location / Treatments	First location	Second location	Third location	Fourth location	Average
SRI	7,257	6,692	7,130	7,077	7,040
Non.SRI	4,977	4,932	3,632	5,122	4,668
LSD	310.2				

Conclusions and Recommendations

The System of Rice Intensification(SRI) is an Agricultural System that is consistent with Conservation Agricultural (CA) and Sustainable Agriculture (SA) while contributing to the conservatioon of natural resources like land and water and reducing chemical pollution in the environment. The SRI system has been validated now in more than 3 dozen rice-producing countries (http://ciifad.cornell.edu/sri/). India plans to expand its use to 5 million hectares in coming five years (Kumar *et al*., 2007). Also, in neighboring Iran, there has been similar validation of SRI methods as at Mishkhab Rice Research Station(MRRS) (Larijani, 2006), also in northern Afghanistan (Thomas and Ramzi, 2009).

The system of Rice Intensification(SRI) is a new practice for rice-growing farmers in Iraq and a first step on the long road toward adopting of modern systems of production to reduce water consumption. It needs more research, systematic study, and solidarity efforts for spreading it in rice-growing areas of the country. Alternative water intervals were applied in SRI fields to reduce water use and hours employing water pumps, in addition to increasing the growth and activities of beneficial microorganisms in the soil. The best water management strategy for SRI under various Iraqi soil and climatic conditions remains to be determined, through carefully designed and measured studies.

It was seen that 80% of seeds could be saved, through greatly reduced plant populations, with ensuing improvements in plant performance and yield. The use of herbicides was found to be not necessary as weed control could be done effectively by hand. Further, if the rotary hoes recommended for SRI can be introduced into Iraq, this will reduce further the cost of labor in rice production with SRI (the hoes are not very expensive) while also improving soil health and long-term fertility through active soil aeration. Experiments and demonstrations with clover as a green manure crop between rice seasons, already undertaken by MRRS, are very promising, and this innovation could further add to the improvement of soil health.

For implementation of SRI over large farm area, we would recommend use of a transplanting machine instead of doing crop establishment by hand. This will reduce the cost of labor and speed up crop establishment. Mechanical SRI crop establishment is already being started in a number of countries such as Costa Rica and Pakistan (Sharif, 2009).

The results of this evaluation in al-Muthanna province confirmed that SRI practices can significantly increase grain yields under Iraqi conditions, to 7,040 kg ha^{-1} compared with non-SRI cultivation methods, which gave 4,668 kg ha^{-1} as an average. As important as the 50% increase in yield. There is a fact stating that this was achieved with reducing water requirements and lowering costs of production which offers even greater benefits for farmers and the country.

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تطبيق طرق نظام الزراعة الكثيفة لمحصول الرز(SRI) وتأثيرها على إنتاجية صنف الرز الياسمين في المنطقة الجنوبية للعراق

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ملخـص

أجريت تجارب حقلية خلال الموسم الزراعي الصيفي 2008 في محافظة المثنى في المنطقة الجنوبية من العراق وبأربة مواقع(قضاء الرميثة، ونواحي الوركاء، النجمي، والمجد) لدراسة تأثير تطبيقات نظام الزراعة الكثيفة للرز(SRI) على حاصل الحبوب ومكونات الحاصل لصنف الرز الياسمين.

طرق نظام الزراعة الكثيفة للرز(SRI) لها تأثيرات إيجابية ملحوظة على ارتفاع النبات وطول الدالية، وأيضاً لوحظت فروقات معنوية في مكونات حاصل عدد الحبوب ونسبة عقم الدالية. لا يوجد فرق معنوي في عدد التفرعات بالمتر المربع لأن الطريقة التقليدية استخدم فيها كميات كبيرة من تقاوي البذور ، ولها كثافة عالية من النباتات بالمتر المربع.

طرق نظام الزراعة الكثيفة للرز(SRI) أعطت أعلى حاصل حبوب في الموقع الأول (7,257 كغم.هـ$^{-1}$) ، وأقل حاصل في الموقع الثاني (6,692 كغم.هـ$^{-1}$) ، بينما الطرق التقليدية(Non-SRI) كان أفضل حاصل حبوب لها في الموقع الرابع(5,122 كغم.هـ$^{-1}$) ، وأقل حاصل في الموقع الثالث (3,616 كغم.هـ$^{-1}$). في كل الحالات، طرق SRI لها تأثير إيجابي على حاصل الحبوب بالهكتار بالمقارنة مع الطريقة التقليدية.

الكلمات الدالة: نظام الزراعة الكثيفة، صنف الرز الياسمين، جنوب العراق.

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