Influence of System of Rice Intensification (SRI) Methods on Productivity and Yield Components of Jasmine Rice Variety in Al-Muthanna Province, Iraq -- Season 2008

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Abstract

Field experiments were conducted during summer season 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 influence of System of Rice Intensification (SRI) practices on the grain yield and yield components of Jasmine rice.

SRI methods had favorable and significant impacts on plant height and panicle length and also showed significant differences in the yield components of grain number in panicles and percent sterility. There were not 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}.

SRI methods gave their highest grain yield at the first site (7,257 kg ha^{-1}) and 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}).

Introduction

Rice 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 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 at 70,000 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; Willingham et al., 2008).

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 conventional 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-Muthana Province to carry out evaluations of the SRI methodology: Al-Rumatha and Al-Warkaa districts, and Al-Mijd and Al-Najmi sub-districts with four locations at each site having donum of land (2500 m^{-2}) for each location. 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 ton ha^{-1} mixed in with the soil during ploughing. Ploughing of the soil was 10cm in depth. Jasmine rice 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 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 were the usual conventional method (non-SRI), considered are 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}). 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. 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, and also 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.

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 (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.

Table 1: Plant height (cm)

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*

SRI practice gave significantly longer panicle length, 22.26 cm average while non-SRI practice gave 19.59 cm long panicles on average (Table 2). This corresponds to the increased plant height due to good growing conditions and spacing between plants.

Table 2: Panicle length (cm)

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 are not observed significant differences in this characteristic due to the number of plants per sq. m. with farmer method (non-SRI) being four times more than the SRI plant density. The number of tillers per unit areas was higher but not significantly higher (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.

Table 3: Tiller number m^{-2}

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%) (Table 4). This result may attributed to more shading between plants and less nutrient uptake due to greater competition among non-SRI plants which grow more closely together.

Table 4: Sterility ratio (%)

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 (Table 5). This result may be attributed to the nutrient and light availability for plants with SRI practice compared to non-SRI management.

Table 5: Filled grains per panicle

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 also no significant difference between SRI and non-SRI practice, with little different in average 1000-grain weight (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.

Table 6: 1000-grain weight (gm)

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 t ha^{-1} from non-SRI rice production methods in al-Muthanna province (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.

Table 7: Grain yield (kg per hectare)

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

SRI system is an agriculture system that is consistent with conservation agricultural (CA) and sustainable agriculture (SA) while contributing to the conservation of natural resources like land and water and reducing chemical pollution in the environment. 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., 2008). Also, in neighboring Iran, there has been similar validation of SRI methods as at MRRS (Larijani, 2006), also in northern Afghanistan (Thomas and Ramzi, 2009).

SRI is a new practice for rice-growing farmers in Iraq and is 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. 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 also 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-Mutthana 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 was the fact that this was achieved with reduced water requirements and lower costs of production which offers even greater benefits for farmers and the country.

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