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Response of Jhelum Rice Variety to Different Crop Management Practices towards Morphological and Yield Parameters in Temperate Kashmir Valley.

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Abstract— Field experiment were conducted to compare the System of Rice Intensification (SRI) Practices with the Conventional management Practices (CMPs) or farmers' practices of rice (Oryza sativa L.) in context of Morphological and yield production parameters at district Kulgam of J&K(2016). The investigational variables included combinations of seedling number and age (10 day-old single vs. 21 day-old), spacing (25 x 25 cm vs. 20 x 10 cm), irrigation (intermittent irrigation vs. continuous flooding), and weed control (cono-weeding vs. manual weeding) however for both sets of methods, the organic manure (mixture with cow dung and straw) was applied along with chemical fertilizers at the same rate. The test was laid out in randomized factorial design. Highest grain yield (637.9 gm–2) were obtained from SRI practices (planting 10 days-old seedlings hill–1 at 25 x 25 cm spacing + intermittent irrigation and cono-weeding). Yield under CMP (planting 21 day-old single seedlings at 20 x 10 cm + continuous flooding and manual-weeding: 448.9gm-^{2}) was lower than that of SRI practices. Thus the overall results indicated that all the cultivars under study performed better under SRI as compared to other traditional practices with respect to different morphological and yield traits including grain yield. All the cultivars exhibited increased leaf area, leaf area index and Crop Growth Rate (CGR) under SRI practice as compared to CMP cultivation practice.

Keywords— System of Rice Intensification (SRI), Conventional Management practices (CMP)/Farmers practices, Productivity.

I. INTRODUCTION

The System of Rice Intensification (SRI) was conceptualized by Henri de Laulanie, a French missionary priest, in Madagascar during the early 1980s as a complementary suite of rice (Oryza sativa L.) management practices. The main components of SRI include vigilant transplanting of single young seedlings at wider spacing, water management that keeps the soil moist but not continuously flooded, early and frequent (3 to 4 times) mechanical/manual weeding before canopy closure, and ensuring adequate nutrient supplies (Laulanie, 1993) . SRI attracted attention because of its apparent success in increasing rice yields in experimental situations (Uphoff and Randriamiharisoa, 2002) and farmers' fields (Rafaralahy, 2002). Uphoff (2002) claimed that under SRI methods rice yields may go up to 15 to 20 Mg ha–1. Stoop et al. (2002) reported that the synergies among these unconventional management practices unlock the physiological potential of rice, with results that challenge the prevailing notions of yield barriers in rice. (Namara et al., 2003). Management of plants, soil, water & nutrients: (a) to produce larger, more effective, longer-lived root systems, and (b) to enrich the life in the soil to achieve more productive, healthier phenotypes from any genotype.

Keeping the above in sight the present work was taken on SRI to assess its performance in comparison to other traditional cultivation practices in relation to the productivity of rice crop under different cultivation practices. This evaluation was conducted with the Jhelum rice; a high yield rice variety (Produced by SKUAST-Srinagar 1990) over 6 months to assess the performance of same rice plants. This study examines the extent to which making certain changes in crop management practices, can alter phenotypical characteristics and induce physiological changes in rice plants, assessing the effects, in any, of alternative management/common practices on root growth and activity, canopy development, light interception and its utilization, which contribute to differences in yield and components of yield. However some studies have reported on the considerable genetic variability that is available for producing differences in the morphological traits that govern root structural design, e.g., spatial configuration of the root system, number and length of laterals (Mouchel et al. 2004; Fitz Gerald et al. 2006). Other researchers have documented the inconsistency in the physiological traits of roots which contribute to dry matter production, e.g., root oxidizing activity rate (Zhang et al. 2008).

About 3.3% of total geographical area of the state Jammu & Kashmir is under cultivation, of which 60% is rain fed with regular moisture stress. The state has about 0.3 million ha under rice cultivation which is high altitude rice, both under irrigated and upland situation. The state average productivity is about 2 tonnes/h. The major constraints of rice cultivation are low temperature during flowering and maturity, widespread phosphorus and zinc deficiency and Rice blast. The *Shalimar Rice-1* and *Jhelum* are cold tolerant Rice-varieties.

Many parts of Kashmir like Kulgam, Srinagar & pulwama districts have suffered a drastic decline in rice production due to low land availability, occurred by industrialization and population growth although Kulgam district was considered as Rice Bowl of J&K. In the present context of decreased water availability, System of rice intensification (SRI) can be a suitable method of cultivation. Many farmers in Kashmir likewise the other states namely Chattisgarh, M.P., U.P including Maharashtra are unable to plant their rice due to unavailability of water for puddling. Fields towards the end of irrigation channel (far from the source of water) had converted to the rainfed (unirrigated) lands due to reduced volume of water in the streams.

SRI will become more eye-catching as water scarcity becomes a more pervasive agricultural constraint. Droughts are becoming more frequent and serious. As weather fluctuations particularly in Kashmir are becoming greater, SRI methods by inducing rice plants to grow much larger and deeper root systems give SRI plants more resistance to impact of drought enabling farmers to reduce their irrigation requirements.

SRI gives small farmers additional opportunities to increase the productivity of their land, while trying to meet their staple food requirements. In Kashmir, SRI will become the best solution for its food deficit problems and for enhancing food security in other remote areas, where modern inputs are costly and difficult to obtain. The performance of SRI raises the hope among policy makers, development workers and farmers of solving this national problem (Uprety, 2006). It is repeatedly stated that SRI increases rice production and raises the productivity of land, labour, water and capital through different practices for management (Laulanié, 1993; Uphoff, 2001).

The main components of the SRI are;

(1) Early transplanting of seedlings at 8-12 days,
(2) Transplanting of single seedlings with wide spacing, from 25x25 up to 50x50 cm^2,
(3) Mechanical weeding with a rotary push weeder,
(4) Water management with no continuously standing water during the vegetative growth phase, and
(5) Use of compost.

II. MATERIALS AND METHODS

Experimental site and soil;

The field experiment was conducted in the Research Farm of the Krishi Vigyan Kendra, Kulgam of J&K, from June to October, 2016. The altitude of the experimental site is 1739 meters (5705 feet) above main sea level. Geographically, it is located at 33°38’24’’North latitude and 75°01’12’’ East longitudes and the laboratory works were carried out in the Soil Testing Laboratory at same institute(KVK-Kulgam) and in the Department of Botany at Dr. C.V. Raman University Bilaspur s(C.G).

Experimental design and cultural practices;

The experiments were conducted using randomized complete block designs with two replicates and plot sizes of 5 × 5 m (25m²). Both the plots were bordered by 50-cm wide bunds to prevent lateral seepage between plots, with 50-cm wide channels for irrigation and drainage. The used plant material was Jhelum-a high yielding rice variety, is a medium-duration (100–135 days) semi-dwarf & hybrid variety. This improved variety was grown under the two alternative systems of crop management: the SRI practice and conventional practice (Farmers practices). Nursery were established adjacent to the experimental field so that transplanting could be performed rapidly to minimize seedling injury. In the SRI plots, 12-day-old seedlings were transplanted on 1st June from established nursery in 2016 at Kulgam Kashmir, while in the conventional rice plots, seedlings from the same nursery, (when 21 days old) were transplanted on 10th June in 2016, respectively. The respective seedlings were planted into the main field at different times. The plan was to have the plants under both treatments reaching similar stages of growth at the same time, receiving similar sunshine hours, day length, and temperatures, and with harvesting on the same date of 1st October 2016. Conventional Rice Plots (CRP) were kept continuously flooded and irrigated whenever required in order to maintain a ponded layer of 5–6 cm depth during the vegetative stage. SRI plot soils were kept saturated but with no standing water during the vegetative stage. Stagnant rain water (same for both plots) from these plots was drained out. After panicle initiation, both sets of plots had 2–3 cm depth of water maintained on them, and plots were drained 15 days prior to harvest. Weeding in SRI plots was performed by cono-weeder to incorporate weeds into the soil and for soil aeration, CRP were hand-weeded. Plants from each plot were randomly chosen for recording observations on the growth parameters i.e plant height, root length, number of tillers & panicles hill^{-1}, leaf area index and four yield traits i.e. number of panicles m^{-2}, number of grains/panicle, 1000-grain weight and grain yield ha^{-1} etc.

III. RESULT & DISCUSSION

Plant Dry Weight

Root growth rate were measured at the crop's grain depth expansion stage (early ripening stage) which is when active grain-filling starts. Roots per hill were nearly twice as heavy, were deeper, more than double the length and double the volume in SRI plants than CMP's plants. The dry weight of aboveground parts of individual hills under SRI was notably greater than that of CMP hills, when compared between the two cultivation methods. (Table-1)

Grain yield, Crop growth rate (CGR) & Harvest index

The grain yield obtained was 17.39% more in SRI than in CMP. Further, harvest index was significantly higher for SRI than CMP. Differences in grain yield between these two methods of cultivation were mainly due to differences in the harvest index rather than because of differences in dry matter production. (Table-2)

Crop growth rate (CGR)

CGR was higher in CMP than in SRI up to 60 Days after Germination (DAG) and after this CGR in CMP declined compared to that observed in SRI (Figure-1) and showed a continuously increasing trend throughout the vegetative stage.

Number of panicles & Tillers per hill (plant)

The number of panicles per hill was significantly greater in SRI (average: 16.9 hill−1; range: 12–30 hill−1) than in hills under CMP (average: 8.6 hill−1; range: 4–12 hill−1) (table below). The average panicle length in SRI (21.61 cm) was, however significantly higher than panicles in CMP (18.77cm). The longer SRI panicles carried many times more number of grain compared to panicles obtained from CMP plots. (Table-3)

The number of tillers per hill in SRI varied from 13 to 36 (average: 17.9 tillers hill−1) whereas in CMP the number ranged from 6 to 16 (average: 9.7 tillers hill−1). (Table-3)

Leaf area index (LAI)

The number of leaves and the leaf area per hill in the SRI treatment were significantly higher than in CMP. SRI hills had more than twice the number of leaves and three times the total leaf area of each hill compared to hills under CMP (table-4) but there were no major differences between treatments on a per unit area basis. However, SRI crops had a significantly higher LAI, mainly because of an increase in the area of single leaves than did CMP leaves. (Table 4)

Table 1; Comparison of the root length & root dry weight in SRI and CMPs crops at ripening stage of Jhelum rice variety at Kulgam ,Kashmir (2016)

Cultivation Methods	Root Length upto (cm)	Root Dry Weight (g hill-^{1})	Total Dry Matter(gm) at 95 (Days)
SRI	3.11	2.05	259.7
CMP	2.74	1.06	230.4

Table 2. Grain yield production & Harvest index by Jhelum rice variety grown under SRI and CMP methods at Kulgam, Kashmir, 2016

Cultivation Method	Grain Yield (gm^{-2})	Harvest Index
SRI	637.9	0.47
CMP	448.9	0.3

Table 3: Grain yield components in the on-station experiment at Kulgam, Kashmir (2016)

Cultivation Method	Ave. Panicles no. $hill^{-1}$	Ave. Panicle Length (cm)	Grains $Panicle^{-1}$	Ave. Tiller no. $hill^{-1}$
SRI	16.9	21.61	91	17.9
CMP	8.6	18.77	13	9.7

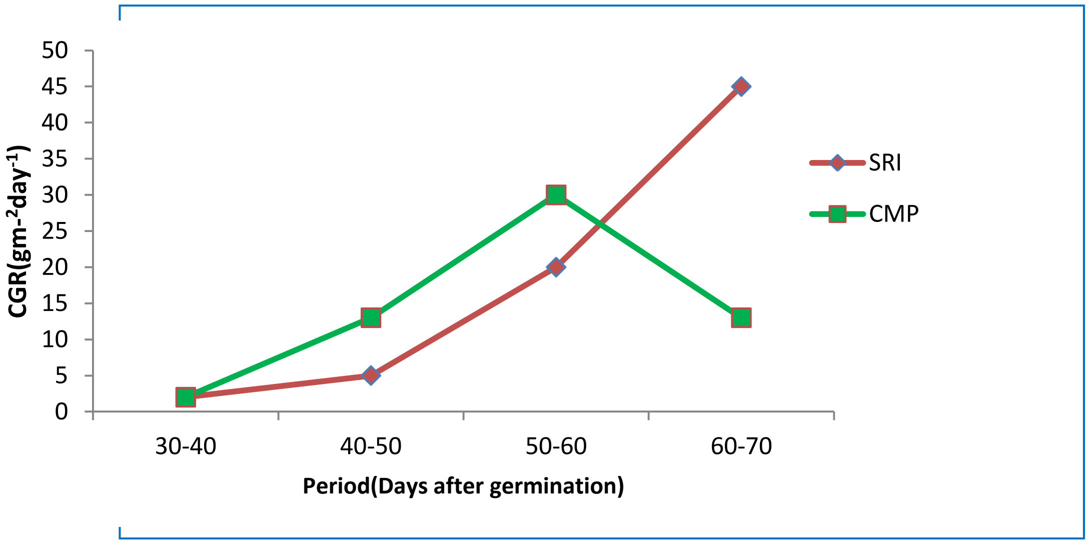

Figure 1. Changes in crop growth rate (CGR) with SRI & CMP methods during vegetative Stage of Jhelum Rice Variety at Kulgam, Kashmir (2016)

Table 4. Comparison of leaf number, Leaf area, leaf area index (LAI) in SRI & CMP

Cultivation Method	Leaf No. $hill^{-1}$	Area of Single Leaf (cm^2)	Leaf Area Index(LAI)
SRI	103.0	14.72	3.91
CMP	55.0	9.18	2.34

Table 5, Effect of SRI Methodology (Spacing) on Sterility % (yield attributes) of Rice during 2016 at Kulgam, J&K

Cultivation Practice	Spacing (cm)	No. Of unfilled Grains	Total No. of Grains	Sterility Percentage
SRI	25x25	18	110	16.36
CMP	20x15	20	101	19.80

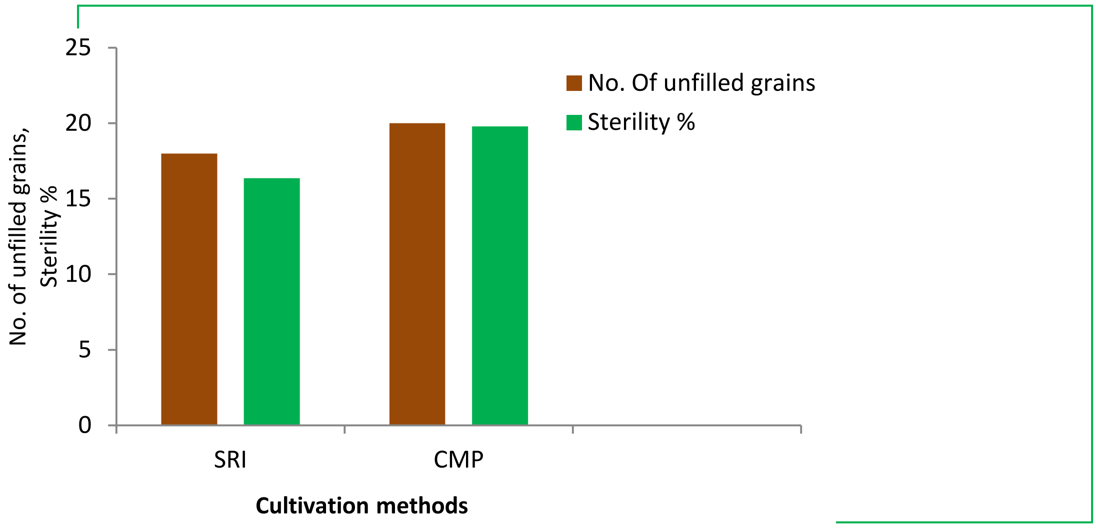

Figure 5. Showing Sterility % & No. of unfilled grains cultivated under SRI & CMP methods at Kulgam, J&K

Sterility percentage

The observed sterility percentage is shown in Table 5. It shows that effect of spacing were not much significant in sterility percentage. However, the lowest sterility percentage of 16.96% was observed in wider spacing of 25 cm × 25 cm as compared to highest 19.80% in 20 cm × 15 cm spacing, though the observations are at par.(table-5) The difference was suggestive that wider spacing was conducive to supporting desirable yield attributing. Features in rice plant. (Figure-5)

Thousand grain weight (TGW)

Thousand grains were counted randomly from both plots separately and weighed with the help of portable automatic electronic balance. The TGW of SRI & CMP plants was 29.43 and 26.12 respectively however it showed a meagre difference of 3.31 g. Planting two 12 day-old seedlings significantly increased the grain (18.9%) compared to planting 21 day-old single seedlings. However Thiyagarajan et al. (2002) reported that use of younger seedlings is not necessary for higher yields, even under SRI management.

As per the present findings twelve days old seedlings had consistently higher leaf area index and tiller number than 21 days-old seedlings (Table-3&4). Growth parameters such as plant height, tiller production, and dry matter production during early growth period also followed a similar pattern i.e. higher in SRI as compared to CMP. As can be seen from Table 5, wider spacing (25 x 25 cm) gave higher grain yield than closer spacing (15 x 20 cm). This may be due to the higher number of tillers & panicles m^{-2} in the wider spacing treatment than closer spacing one.

Irrigation treatments did not substantially alter the growth and yield parameters of rice. Mathew et al. (2003) also reported that intermittent irrigation was as good as continuous submergence, but may save about 50% of irrigation water use. Weed count and weed dry matter, however, were significantly more in the intermittent irrigation treatment owing to the generally favourable conditions for weed growth prevailing under that treatment, compared to continuous flooding (Latif et al., 2005). Overall, the highest grain yield (4467 kg ha–1) and net returns (Rs 17745 ha–1) were obtained when a combination of conventional crop management practices (planting two 20 day-old seedlings hill-1 at 20 x15 cm spacing: KAU, 2002) and SRI techniques (intermittent irrigation and cono-weeding) were adopted.

CONCLUSIONS

The SRI practices resulted in increased productivity and profitability of rice compared to farmer's practice. The key management principles stated in SRI such as age of seedling (12 day-old) and wider spacing (25 x 25 cm) had significant effects on rice productivity, discontinuous irrigation, however, was equally effective as continuous flooding. By employing cono-weeding, the labour required for weeding could be reduced by 35 man-days ha^{-1} and labour cost by Rs. 3125 ha^{-1} .This study support the notion that the multiple SRI component practices act synergistically under temperate conditions , implying that the yield benefits of SRI practices was superior to that of the conventional or Farmers management practices. On farm experiments revealed that planting one or two, 10 to 12 days-old seedlings hill^{-1} at 25 x 25 cm spacing and employing cono-weeding and intermittent irrigation are economically feasible technologies. In general, the SRI practices outperformed farmers' practices, implying the need for sustained extension support for ensuring adoption of superior technologies like SRI.

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