Assessment of Yield and Yield Attributing Characters of Drought Tolerant Rice Cultivars under Different Crop Management Practices in Central Terai of Nepal

Bishal Dhakal[1*], Samjhana Khanal[2], Lal Prasad Amgain[3]

[1]Regional Agricultural Research Station (RARS), Bhagetada, Dipayal, Doti, Nepal

[2]Institute of Agriculture and Animal Science (IAAS), Sundarbazar, Lamjung, Nepal

[3]Institute of Agriculture and Animal Science (IAAS), Sundarbazzar, Lamjung, Nepal

Abstract: *Proper selections of resource conservation technologies and drought tolerant cultivars are being potential strategies determining yield of rice in drought prone areas. Thus, a field experiment was accomplished in central-terai of Nepal during 2014 to assess the yield and yield attributing characters of drought tolerant rice cultivars under different crop management practices. The experiment was carried out in strip-plot design with three replications consisting four drought tolerant rice cultivars and three crop management practices. The analyzed data revealed that SRI (System of Rice Intensification) produced significantly higher grain yield (5.28 t ha^{-1}) than other management practices. The yield attributing characters viz. effective tillers per m^{-2}, filled grains per panicle, panicle length and panicle weight were also significantly higher in SRI. However, cultivars had no influence on grain yield and yield attributing characters except panicle length and panicle weight. Thus, SRI management practice can be adopted as adaptation approach for obtaining higher grain yield in central terai and similar agro-climatic regions of Nepal.*

Keywords: Crop management practices, rice, SRI

1. Introduction

Rice is the second most important staple food for more than half of the world's population [1, 2]. Being a most important staple food of Nepalese people, rice ranks first crop for both acreage and production and production amounts to half of the total cereal grains in the country [3]. In Nepal, rice is grown in about 1.42 million hectares with total production about 4.50 million tons, and 3.17 t ha^{-1} productivity [4]. The share of agriculture and forestry for national gross domestic product (GDP) is 33.03%, and therein rice alone contributes 20.75% of the agriculture gross domestic product (AGDP) and 10.2% of total GDP [5].

In Nepal, more than 70% of the total rice area is grown under rainfed condition [6], whereas only 21 % rice production is under partially or fully irrigated conditions [7]. Rice production relies on ample water supply and thus is more vulnerable to drought stress than other crop. The temperature of Nepal has increased by 0.04-0.06 ℃ annually on an average during 1977-2005 [8]. Increase in temperature due to climate change has resulted an increase in evidences of drought stress in crop production including rice [9]. According to statistics, the percentage of drought affected lands areas more than doubled from the 1970s to the early 2000s worldwide [10]. Further, increased temperature may decrease rice potential yield up to 7.4% per degree increment of temperature [11]. Several other factors like weeds, low factor productivity and reducing resource use-efficiency due to deteriorating soil health are causing the lower productivity of rice in Nepal. Among various approaches to climate change adaptation in drought prone areas, proper selections of resource conservation technologies like (SRI, ICM, etc.) [12] and drought tolerant rice cultivars [13] are potential strategies determining yield of rice. Thus, the present investigation is planned, executed and accomplished with the objective of pursuing the grain yield and yield attributing characters of various drought tolerant rice cultivars under different crop management practices in central terai of Nepal.

2. Materials and Methods

This study was carried out at Dhauwadi VDC, Nawalparasi (235 masl) from June to October 2014. The experimental site is situated at 27°48'43" N latitude and 84°4'58" E longitude, where it received 1045 mm of rainfall during the experimental period. The experiment was carried out using a strip plot design, in the fields of three farmers, considering each farmer as a replication. The treatment consists of combination of the column factor (three rice management practices: System of Rice Intensification-SRI, Integrated Crop Management-ICM and Puddled transplanted-conventional) and row factor (four rice cultivars: Sukkha-3, Sukkha-4, Sukkha-5 and Hardinath-2). The size of each plot was 12 m^2, and the net plot was determined after leaving one border row in each side, one destructive sampling row and one guard row. The space between two plots was 0.5 m, and the bund of 0.5 m was made between each management practices to check the flow of water and nutrients between them. The experiment on three management practices were set up considering the production factors (Table 1). Vermicompost was used as a source of organic manure, whereas Urea, DAP and MOP were used as sources of N,

P_2O_5 and K_2O, respectively. Full doses of phosphorus and potassium and half dose of nitrogen were applied as basal dose at the time of transplanting. The remaining half dose of nitrogen was applied in two split doses: one-fourth N at 30 DAT and the remaining one-fourth at booting stage. The crop from net plot area was harvested manually with the help of sickles. The whole plant was cut at 2 cm above ground for all varieties, except Hardinath-2 that was harvested by hand picking of panicles due to heavy rainfall during harvesting period. The grains were weighted at their exact moisture content and were adjusted at 14% moisture level. The biometric observations (plant height, tillers number per square meter, LAI, above ground dry matter), yield attributing characters and yields of all the treatments were recorded. These recorded datas were tabulated in MS-Excel which was subjected to ANOVA [14], after analysis through Mstat-C and mean separation for significant variables were done by Duncan's Multiple Range Test (DMRT) at 5% level of significance.

Table 1: Production factors considered in different management practices

Production factors	SRI	ICM	Conventional
Crop geometry	25cm × 25cm	20cm × 20cm	20cm × 15cm
Seed rate	7.5 kg ha^{-1}	20 kg ha^{-1}	40 kg ha^{-1}
Seedling age	14 days old	21 days old	28 days old
Seedling/hill	1	2	3
Organic manure	10 t ha^{-1}	5 t ha^{-1}	None
NPK	20:15:10 kg ha^{-1}	40:30:20 kg ha^{-1}	80:60:40 kg ha^{-1}
Water management	Alternating wetting and drying	Intermediate condition	Flooded condition

3. Results and Discussions

3.1 Grain yield

The grain yield was significantly influenced by management practices, but the cultivars and its interaction with management practices had no influence on grain yield (Table 2). The grain yield of SRI management practice (5.28 t ha^{-1}) was significantly higher than conventional management practice (4.49 t ha^{-1}), but it was statistically at par with ICM management practice (4.73 t ha^{-1}). The grain yield of ICM was also significantly higher than under conventional management practice. The higher grain yield of SRI management practice was because of higher number of effective tillers than ICM and conventional management practices (Table 2). Panicle weight, panicle length and filled grains per panicle of SRI management practice were also higher than ICM and conventional management practices. Further, sterility percentage was lower in SRI than all other management practices. Higher number of effective tillers, panicle weight and filled grains per panicle were reported in SRI than conventional management practice [15],[16],[17],[18]. The higher grain yield of SRI was also due to higher LAI as compared to other management practices. The grain yield of rice is also determined by assimilates deposited mainly in vegetative stage, which is directly contributed by leaf area. Carbohydrates produced before heading mainly accumulate in the leaf sheath and stem and translocate to the panicles during grain filling [19]. The contribution of carbohydrates produced before heading to the final grain yield appeared to be in range of 20-40 % [20].

It was revealed that SRI practice produced 17.49% more yield than conventional practice. Although SRI and ICM practices were statistically similar, SRI produced 11.63% more yield than ICM practice. Moreover, ICM produced 5.35 % more grain yield as compared to conventional management practice. The increase in grain yield of 11.8 % was reported under SRI management practice over conventional [21]. Similarly, increase in grain yield under SRI and ICM management practices was 209.9 % and 185.4 % higher, respectively over conventional management practices [16]. Moreover, 100-200 % increase in grain yield was also reported under SRI compared to conventional management practice [22].

Table 2: Grain yield and yield attributes of various cultivars of rice as affected by management practices at Dhauwadi VDC, Nawalparasi, Nepal, 2014

Treatment	Grain yield (t ha^{-1})	Effective tillers (m^{-2})	Panicle Length (cm)	Panicle Weight (g)	Filled grain panicle^{-1}	Sterility (%)	Test weight (g)
Management							
SRI	5.28 [a]	317.7 [a]	26.46 [a]	4.340 [a]	167.0 [a]	14.97 [b]	24.12
ICM	4.73 [ab]	287.1 [a]	25.93 [b]	3.823 [ab]	143.8 [b]	15.13 [b]	22.76
CON	4.49 [b]	227.7 [b]	24.83 [c]	3.337 [b]	128.3 [b]	16.23 [a]	22.23
SEm(±)	0.145	13.990	0.066	0.141	3.940	0.253	1.012
LSD$_{(0.05)}$	0.57*	54.94*	0.26**	0.55*	15.48**	0.99**	ns
Cultivars							
Sukkha-3	4.79	280.2	26.13 [a]	3.911 [a]	146.0	15.23	23.34
Sukkha-4	4.73	263.2	24.98 [b]	3.889 [a]	141.7	15.09	22.49
Sukkha-5	5.16	318.9	26.90 [a]	4.189 [a]	165.0	15.48	24.17
Hardinath-2	4.64	247.7	24.95 [b]	3.344 [b]	132.6	15.97	22.14
SEm(±)	0.236	18.260	0.258	0.146	6.270	0.277	0.974
LSD$_{(0.05)}$	ns	ns	0.89**	0.50*	ns	ns	ns
CV (%)	10.8	10.4	4.2	12.0	12.1	5.7	9.6
Grand Mean	4.83	277.5	25.74	3.833	146.4	15.44	23.03

(Treatment means followed by common letter/letters within column are not significantly different among each other based on DMRT at 0.05; **= significant at 0.01 level, *= significant at 0.05 level and ns= non-significant at 0.05 level)

3.2 Yield attributing characters

3.2.1 Effective tillers per square meter

The number of effective tillers per square meter among the management practices was significantly different with the highest value in SRI (317.7 m^{-2}) and the lowest in conventional (227.7 m^{-2}). It was found that the number of effective tillers per square meter in ICM (287.1 m^{-2}) was at par with effective tillers number per square meter of SRI, but was significantly higher than conventional management practice (Table 2). SRI practice had higher tiller producing capacity as compared to other management practices. Higher number of effective tillers per square meter in SRI might be due to wider spacing in SRI which results less competition in space, nutrition and other factors for growth, which had helped for vigorous root growth and more tillering. Higher number of effective tillers per square meter in SRI was agreed by earlier experiments [16],[17],[23].

3.2.2 Filled grains per panicle

The influence of management practices on filled grain per panicle was highly significant, with the highest mean in SRI (167.0) and the lowest mean in conventional management (128.3) (Table 2). The filled grains per panicle in SRI were also significantly higher than ICM (143.8). Higher filled grains per panicle in SRI might be due to better translocation of carbohydrates, produced before heading and accumulated in leaf sheath and stem, to the panicles during grain filling. Moreover, optimum plant population and geometry under SRI might have led to availability of more resources to the plants that resulted in higher filled grain per panicle. Increased number of filled grains per panicle has been attributed to an increased dry matter translocation percentage from vegetative organs to the grains [24]. Higher filled grains per panicle in SRI were also supported by various previous experiments [16],[17],[23]. However, the filled grains per panicle were not influenced by cultivars and the interaction of cultivars and management practices.

3.2.3 Test weight

There was no influence in test weight by cultivars, management practices and their interactions. No difference in test weight among the management practices was reported by previous researchers [25].

Others yield attributes like panicle weight and length and sterility percentage were significantly influenced by cultivars and management practices (Table 3). It was revealed that the longest panicle length and weight and the lowest sterility percentage were recorded in SRI practice, which was also supported by earlier experimental findings [15],[18],[25],[26],[27].

4. Conclusion

The results showed that grain yield was significantly influenced by management practices, where SRI management practice recorded the highest grain yield than other management practices. But, the rice cultivars and the interaction of management practices and cultivars had no influence on grain yield and major yield attributing characters. Thus, SRI management practice can be adopted as adaptation approach for obtaining higher grain yield in central terai and similar agro-climatic regions of Nepal.

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