

Productivity Assessment of Drought Tolerant Rice Cultivars under Different Crop Management Practices in Central Terai of Nepal

Bishal Dhakal^{1*}, Samjhana Khanal², Lal Prasad Amgain³

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

^{2,3}Institute of Agriculture and Animal Science (IAAS), Sundarbazar, Lamjung, Nepal

*Corresponding author: dhakal.bishal14@gmail.com

Abstract— Proper selections of resource conservation technologies and drought tolerant cultivars are being potential strategies determining productivity of rice in drought prone areas. Thus, a field experiment was accomplished in central-terai of Nepal during 2014 to assess the productivity 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 straw yield of SRI (5.12 t ha^{-1}) was also significantly higher than other management practices. The cultivars had no influence on grain yield, but the straw yield was significantly influenced by cultivars, with the highest straw yield in Sukkha-3 (5.21 t ha^{-1}). Thus, SRI management practice can be adopted as adaptation approach for obtaining higher productivity in central terai and similar agro-climatic regions of Nepal.

Keywords— Crop management practices, Productivity, Rice, SRI.

I. 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 $0.04\text{-}0.06 \text{ }^\circ\text{C}$ 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 productivity of various drought tolerant rice cultivars under different crop management practices in central terai of Nepal.

II. 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 $27^\circ 48' 43''$ N latitude and $84^\circ 4' 58''$ 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 m², 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, P₂O₅ and K₂O, 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 data's 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	25 cm × 25 cm	20 cm × 20 cm	20 cm × 15 cm
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

III. 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 practice was also significantly higher than conventional (228 m²) management practice. The higher grain yield of SRI management practice was because of significantly higher number of effective tillers (318 m⁻²) than ICM (387 m⁻²) and conventional management practices. Panicle weight, panicle length and filled grains per panicle of SRI management practice were also significantly higher than ICM and conventional management practices. Further, sterility percentage was significantly lower in SRI (14.97%) than ICM (15.13%) and conventional (16.23%) management practices. Further, it was revealed that there was positive correlation between grain yield and effective tillers per square meter ($r=0.75$) (Figure 1), filled grain per panicle ($r=0.91$) (Figure 2), panicle length ($r=0.82$) (Figure 3) and panicle weight ($r=0.71$) (Figure 4). 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].

TABLE 2
GRAIN YIELD, STRAW YIELD AND HARVEST INDEX OF VARIOUS CULTIVARS OF RICE AS AFFECTED BY MANAGEMENT PRACTICES AT DHAUWADI VDC, NAWALPARASI, NEPAL, 2014

Treatment	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Harvest Index (%)
Management			
SRI	5.28 ^a	5.12 ^a	46.96
ICM	4.73 ^{ab}	4.73 ^b	46.14
CON	4.49 ^b	4.06 ^c	49.02
SEm (±)	0.145	0.057	0.885
LSD (0.05)	0.57	0.23	ns
Cultivars			
Sukkha-3	4.79	5.21 ^a	44.06
Sukkha-4	4.73	4.43 ^b	47.94
Sukkha-5	5.16	4.49 ^b	50.02
Hardinath-2	4.64	4.42 ^b	47.48
SEm (±)	0.236	0.108	1.30
LSD (0.05)	ns	0.37	ns
CV (%)	10.81	5.1	6.7
Grand Mean	4.83	4.64	47.37

(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)

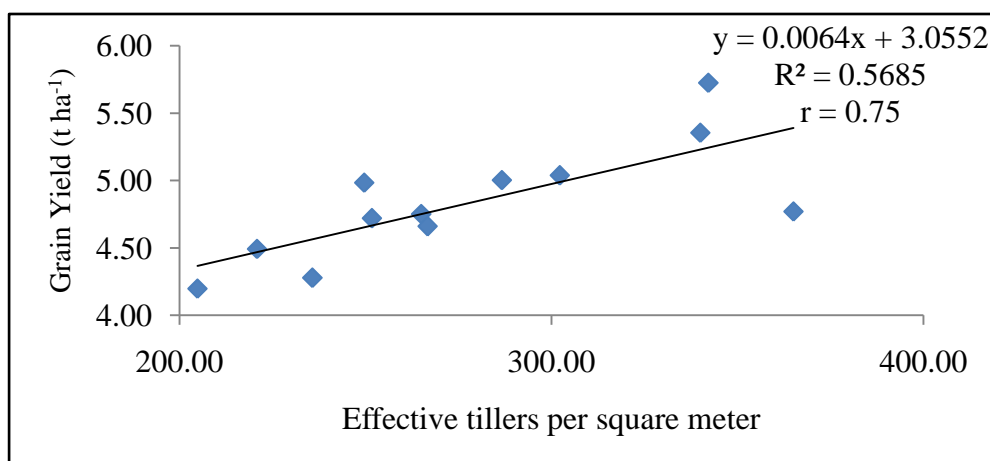


FIGURE 1: LINEAR REGRESSION BETWEEN GRAIN YIELD AND EFFECTIVE TILLERS PER SQUARE METER

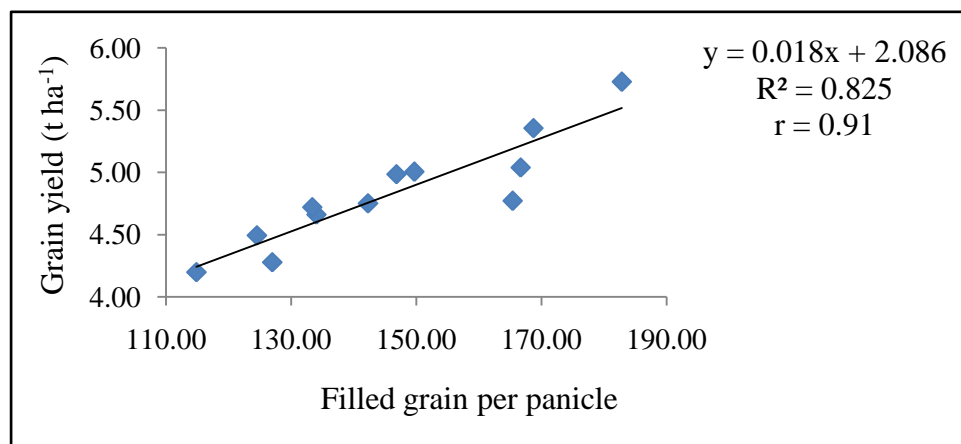


FIGURE 2: LINEAR REGRESSION BETWEEN GRAIN YIELD AND FILLED GRAIN PER PANICLE

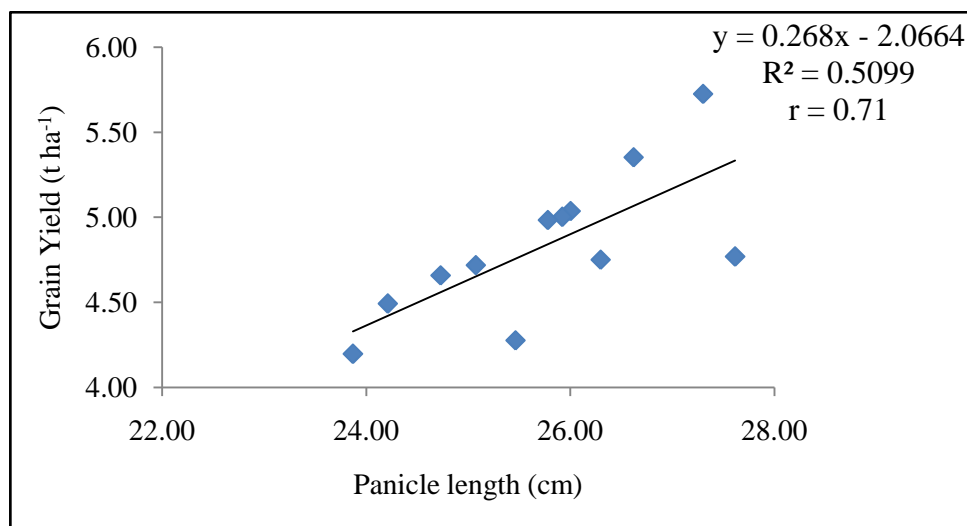


FIGURE 3: LINEAR REGRESSION BETWEEN GRAIN YIELD AND PER PANICLE LENGTH

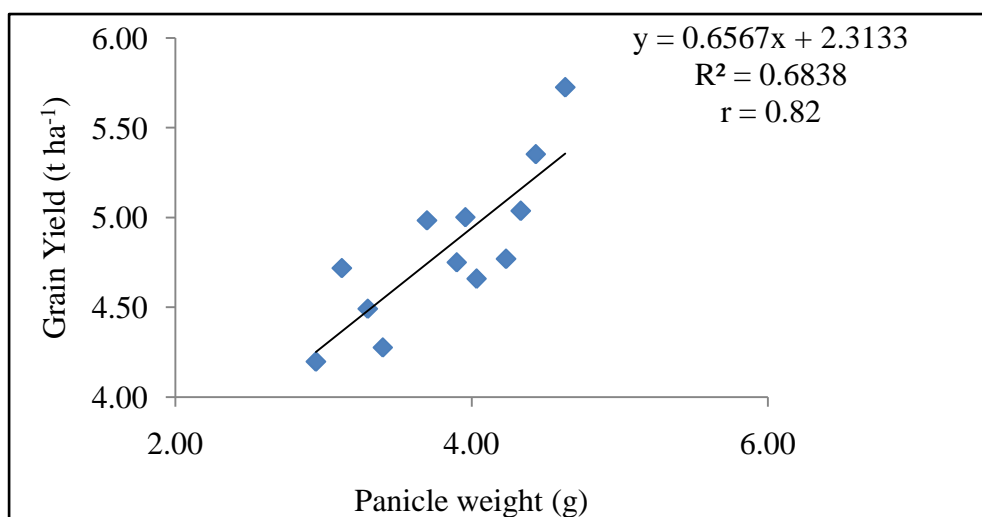


FIGURE 4: LINEAR REGRESSION BETWEEN GRAIN YIELD AND PER PANICLE WEIGHT

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].

3.2 Straw yield

The straw yield (5.12 t ha⁻¹) of SRI practice was significantly higher than ICM (4.73 t ha⁻¹) and conventional practices (4.06 t ha⁻¹). The straw yield of ICM practice was also significantly higher than conventional practice. This might be due to longer plant height in SRI and ICM management practices over conventional management practices. Moreover, early vigorous growth due to wider spacing which resulted less competition in space, nutrition and other factors for growth might have resulted higher straw yield in SRI management practice. Further, the higher straw yield in SRI might also be due to higher number of tillers in SRI than other management practices [23]. The significant higher straw yield in SRI than in conventional management practices was also reported in earlier experiments [23], [24].

The straw yield of Sukkha-3 (5.21 t ha⁻¹) was significantly higher than other varieties, whereas the straw yield of other cultivars were at par (Table 2). Higher straw yield of Sukkha-3 might be due to longer plant height of this cultivar. Higher straw yield in the cultivars with longer plant height was also reported in earlier experiment [25]. Higher dry matter accumulation in Sukkha-3 might also had contributed to its higher straw yield. Further, there was significant influence of interaction of cultivars and management practices in straw yield. The mean straw yield was found highest in Sukkha-5 with

SRI (5.66 t ha⁻¹), followed by Sukkha-3 with ICM practices (5.31 t ha⁻¹). The lowest mean straw yield (3.56 t ha⁻¹) was observed in Sukkha-5 with conventional practice.

3.3 Harvest Index

The harvest indexes of all the management practices were statistically at par. Similarly, the cultivars also had no any significant influence on harvest index.

IV. 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. 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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