ISSN: 2467-9283

OPEN ACCESS

INTERNATIONAL JOURNAL OF GRADUATE RESEARCH AND REVIEW

Indexing & Abstracting

Open Academic Journals Index (OAJI), InfoBase Index, Cosmos, ResearchGate, CiteFactor, Scholar Stear, JourInfo, ISRA: Journal-Impact-Factor (JIF), Root Indexing etc.

Impact Factors*

IBI factor: 3

Impact factor (OAJI): 0.101

SEM-Biotech Publishing

*Kindly note that this is not the IF of Journal

Vol-3, Issue-4

November 2017

Research Article

Participatory Evaluation of Rice Genotypes under Irrigated Ecosystem in Mid-Eastern Terai of Nepal

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Abstract

Farmers' field trials were conducted for three consecutive years during 2014-16 rainy seasons at two locations, one in each Dhanusha and Mahottari districts of Nepal to identify farmers preferred high yielding rice genotypes for irrigated ecosystem. A total of ten rice genotypes were evaluated in a randomized complete block design with three replications. The tested genotypes were significantly different ($P \leq 0.01$) for growth duration and grain yield. The genotypes IR87615-9-3-1, IR78875-207-B and HUA 565 produced significantly higher grain yields across the locations and produced grain yield of more than 4 t ha^{-1}. The high yielding and farmers preferred genotypes were IR87615-9-3-1, HUA565 and Ciherang Sub1. The findings of the study show that these promising genotypes need to be disseminated to other locations of similar agro-climatic conditions to offer varietal options to the farmers.

Keywords: Irrigated ecosystem; on-farm trial; rice genotypes

Introduction

Rice is the staple food for about half of the world population and about 90% of the world's rice is produced and consumed in Asia. (Mackill *et al*., 2012). Rice is a major food crop in Nepal growing in diverse agro-ecosystems and rice area is classified on the basis of water regime as lowland, upland and deep water rice. The rice crop was grown in 1.36 million ha with annual production and productivity of 4.29 million ton and 3.15 t/ha, respectively in 2014 (MoAD, 2015). It is estimated that 51% of total rice area is under irrigation and out of total irrigated area only 28% has year round irrigation (MoAD, 2015). In Nepal, the food security is largely dependent on irrigated rice production ecosystem and contributes more than 75% of the total rice production. Thus, it is of great importance to enhance the yield potential of this ecosystem for food security in the country. There is a big gap between research station and on-farm yields mainly due to poor management practices adopted by farmers and limited varietal options of their preferences. Mostly Sabitri rice variety is grown during rainy season under irrigated and rainfed conditions and the variety is becoming susceptible to various biotic stresses. Evaluation of breeding materials in farmers' field conditions in such ecosystem, and with input from farmers, will ensure selection of proper genotypes and subsequent uptake and adoption. In this study, we conducted farmers' field trials at two locations of Dhanusha and Mahottari districts (one location in each district), Nepal over three consecutive years. The objective of the study was to identify high yielding rice genotypes suitable for irrigated conditions in rainy season and to understand farmers' preferences and criteria of varietal selection.

Materials and Methods

On-Farm Varietal Trials

Field experiments were carried out at farmers' field in two locations, Bagra and Tejnagar of Mahottari and Dhanusha districts, respectively during 2014-2016 rainy seasons (Fig. 1). The climate at the experimental sites was characterized by high monsoon rainfall in a warm and humid summer. Promising rice genotypes screened from coordinated varietal trials conducted at National Rice Research Program Hardinath, were evaluated along with a released variety "Sabitri" as a check (Table 1). Six genotypes were evaluated for all the trials except in 2014 and replicated three times in a randomized complete design. Plot size varied from 20 m^2 to 30 m^2 and spacing was 20 cm x 20 cm in all trials. Fertilizers were applied @ 100:30:30 NPK kg ha^{-1}. Full dose of phosphorus and potash was applied at the time of final land preparation and nitrogen was applied in three split doses. Data for days to 75% heading, days to maturity and grain yield (t ha^{-1}) adjusted at 14% moisture were recorded and analyzed with single site and combined analyses model of Cropstat V7.2 (IRRI, 2007).

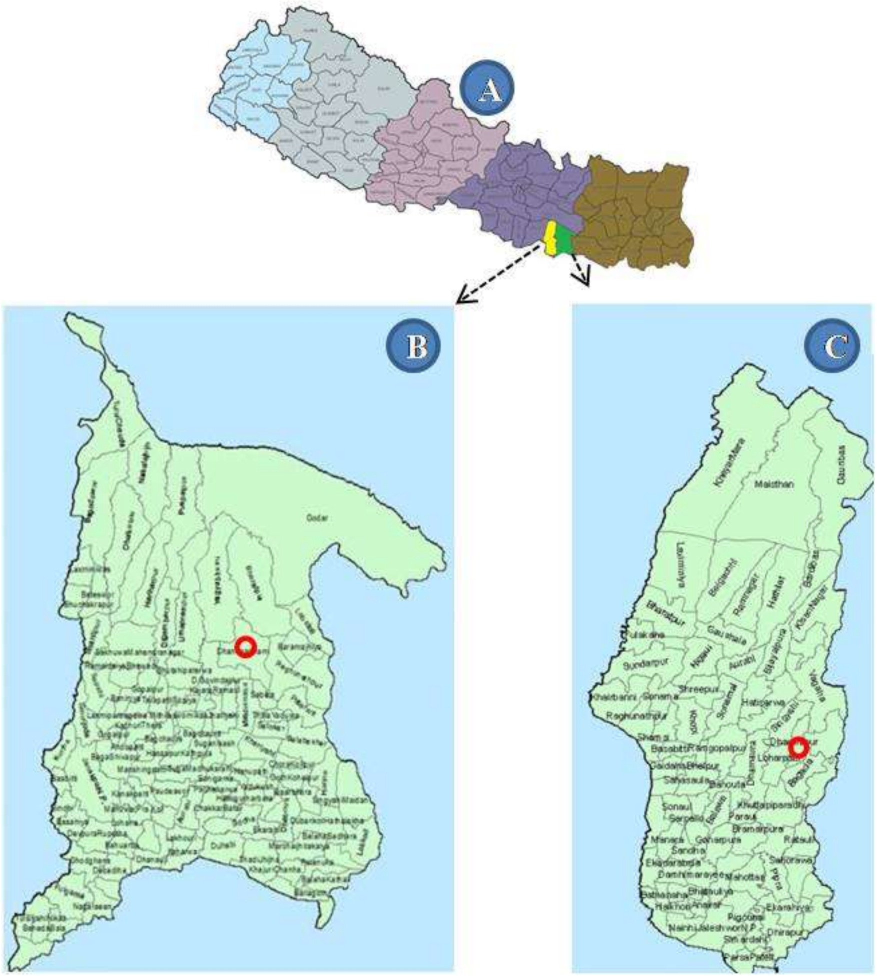

Fig. 1: Maps showing experimental sites. A, Nepal; B, Red circle indicates the experimental location in Dhanusha district; C, Red circle indicates the experimental location in Mahottari district

Table 1: Overview of rice genotypes included in coordinated farmer's field trials conducted during 2014-2016 rainy seasons

S.N.	Year		
	2014	**2015**	**2016**
1	HUA 565	HUA 565	HUA 565
2	IR77721-93	Ciherang Sub1	Ciherang Sub1
3	IR81826-B-B-5	IR78875-207-B	IR78875-207-B
4	IR87615-9-3-1	IR81826-B-B-5	IR81826-B-B-5
5	Sabitri (Check)	IR87615-9-3-1	IR87615-9-3-1
6	-	Sabitri (Check)	Sabitri (Check)

Preference Analysis

Preference analysis (PA) through casting votes was conducted during a pre-harvest period when most tested genotypes reached around 80% maturity (Paris *et al*., 2011). At each PA, a group of male and female farmers and researchers were invited to vote for three most preferred (positive votes) and three least preferred (negative votes) entries, using paper ballots and envelopes placed at the head of each plot. Names of entries were kept anonymous with codes used for each entry throughout the voting process. Votes were then counted to identify the most and least preferred rice genotypes and farmers interviewed to understand the reasons behind their choices.

Results

Growth Duration and Yield Performance of Tested Genotypes

The data on growth duration and grain yield of rice genotypes tested in farmers' field trials (FFTs) during 2014-

16 have been presented in Table 2, 3 and 4. The findings of FFTs in 2014 rainy season showed that all the tested genotypes differed significantly for days to heading and days to maturity at both locations and for grain yield at Bagra. The genotypes HUA 565, IR77721-93 and IR87615-9-3-1 were found earlier in days to heading and maturity as compared to check variety (Sabitri). The combined analysis over locations showed that the genotype IR81826-B-B-5 produced the highest grain yield at both locations with the mean grain yield of 4.38 t ha^{-1} followed by IR87615-9-3-1 (4.09 t ha^{-1}), IR77721-93 (4.02 t ha^{-1}), HUA 565 (3.70 t ha^{-1}) and Sabitri (3.50 t ha^{-1}). The genotypes IR81826-B-B-5 and IR87615-9-3-1 were statistically at par for grain yield.

The results of FFTs in 2015 showed that all the tested genotypes were significantly different for days to heading and days to maturity at both locations and for grain yield at Bagra. All the tested genotypes were earlier in days to heading and maturity as compared to Sabitri. The earliest maturity of 124.8 days was observed in HUA 565. The genotypes IR87615-9-3-1 and IR78875-207-B produced significantly higher grain yields at both locations with the grain yields of 4.03t ha^{-1} and 4.01 t ha^{-1} compared to other tested genotypes and check variety.

The results of FFTs in 2016 showed that all the tested genotypes were significantly different for days to heading and days to maturity and grain yield at both locations. The genotypes HUA 565, IR87615-9-3-1 and NR2157-122-1-2 were significantly earlier in heading and maturity periods as compared to Sabitri. The earliest maturity (117.5 days) was found in HUA 565. The genotypes HUA 565 and NR2157-122-1-2 produced significantly higher grain yields at both locations with the grain yields of 4.99 t ha^{-1} and 4.72 t ha^{-1}compared to other genotypes and check variety.

Table 2: Growth duration and grain yield of rice genotypes evaluated in farmer's field trials in Dhanusha district under irrigated ecosystem in 2014 rainy season

Genotypes	Days to heading			Days to maturity			Grain yield (t ha^{-1})		
	Bagra	Tejnagar	Combined	Bagra	Tejnagar	Combined	Bagra	Tejnagar	Combined
HUA 565	103.0	104.6	103.8	129.3	130.6	130.0	3.63	3.77	3.70
IR77721-93	103.0	104.3	103.7	130.3	133.0	131.7	3.93	4.10	4.02
IR81826-B-B-5	117.0	117.6	117.3	144.0	146.0	145.0	4.33	4.43	4.38
IR87615-9-3-1	101.0	102.0	101.5	130.0	132.3	131.2	3.97	4.20	4.09
Sabitri	112.0	113.0	112.5	145.0	145.0	145.0	3.40	3.60	3.50
Grand mean	107.2	108.3	107.8	135.7	137.4	136.6	3.85	4.02	3.94
CV%	1.83	2.12	1.98	1.23	1.81	1.55	8.30	3.16	6.18
$LSD_{0.05}$	3.70	4.32	2.61	3.14	4.69	2.59	-	0.23	0.29
F-test	**	**	**	**	**	**	ns	**	**

** Significant at 1% level of significance and ns = non-significant.

Table 3: Growth duration and grain yield of rice genotypes evaluated in farmer's field trials in Dhanusha district under irrigated ecosystem in 2015 rainy season

Genotypes	Days to heading			Days to maturity			Grain yield (t ha^{-1})		
	Bagra	Tejnagar	Combined	Bagra	Tejnagar	Combined	Bagra	Tejnagar	Combined
HUA 565	110.3	108.3	109.3	124.9	124.3	124.8	3.87	4.17	3.98
Ciherang Sub1	113.3	110.0	111.7	145.3	141.7	127.9	4.00	3.47	3.99
IR78875-207-B	112.7	111.0	111.8	143.3	143.3	145.5	4.07	4.13	4.01
IR81826-B-B-5	116.0	118.0	117.0	146.7	148.7	146.1	3.87	4.17	3.99
IR87615-9-3-1	113.0	110.3	111.7	141.7	141.3	145.9	4.20	4.33	4.03
Sabitri	120.3	115.0	117.7	151.0	144.3	147.9	3.90	3.33	3.94
Grand mean	114.3	112.1	113.2	144.9	142.8	145.8	3.99	3.93	3.99
CV%	0.7	0.9	0.8	1.0	0.9	0.9	5.36	7.41	6.46
$LSD_{0.05}$	2.2	3.0	2.3	4.2	3.8	3.6	-	0.82	0.63
F-test	**	**	**	**	**	**	ns	**	**

** Significant at 5% level of significance and ns = non-significant.

Table 4: Growth duration and grain yield of rice genotypes evaluated in farmer's field trials in Dhanusha district under irrigated ecosystem in 2016 rainy season

Genotypes	Days to heading			Days to maturity			Grain yield (t ha^{-1})		
	Bagra	Tejnagar	Combined	Bagra	Tejnagar	Combined	Bagra	Tejnagar	Combined
HUA 565	91.3	93.3	92.3	116.0	119.3	117.7	5.06	4.92	4.99
IR87615-9-3-1	95.7	97.3	96.5	124.7	122.3	123.5	4.40	4.30	4.35
NR2157-122-1-2	95.7	96.7	96.2	123.3	124.0	123.7	4.80	4.63	4.72
NR2167-41-1-1-3	106.7	109.0	107.8	132.7	131.7	132.2	4.35	4.30	4.33
NR2167-48-5-1-2-1	116.0	116.0	116.0	139.3	141.0	140.2	4.37	4.30	4.34
Sabitri	112.0	112.7	112.3	143.0	141.3	142.2	4.33	4.17	4.25
Grand mean	102.9	104.2	103.5	129.8	129.9	129.9	4.54	4.45	4.49
CV%	1.0	1.4	1.3	0.9	1.8	1.4	4.46	2.44	3.62
$LSD_{0.05}$	3.0	4.2	2.4	3.3	6.8	3.4	0.57	0.30	0.29
F-test	**	**	**	**	**	**	**	**	**

** Significant at 5% level of significance and ns = non-significant.

Table 5: Results of the preference analyses conducted during the rainy seasons of 2014-2016

Year	Sites	Ranking of most preferred genotypes		
		1st	2nd	3rd
2014	Bagra	IR81826-B-B-5	IR87615-9-3-1	HUA 565
	Tejnagar	IR87615-9-3-1	IR81826-B-B-5	HUA 565
2015	Bagra	IR87615-9-3-1	IR87615-9-3-1	Sabitri
	Tejnagar	IR87615-9-3-1	Ciherang Sub-1	Sabitri
2016	Bagra	NR2157-122-1-2	HUA 565	Ciherang Sub-1
	Tejnagar	HUA 565	Ciherang Sub-1	NR2157-122-1-2

Preferences of Genotypes

The participants in the preference analyses for selection of rice genotypes during 2014-2016 were 150 persons and of them 65%, 28% and 7% were male farmers, female farmers and researchers, respectively. Based on participants' preference scores, the three top ranking genotypes in each year from the preference analyses are presented in Table 5. Out of total entries, IR81615-B-B-5, IR87615-9-3-1, HUA 565, Sabitri and Ciherang Sub1 were ranked at least once among the top three entries. However, the most preferred entries differed across locations and years, and the most preferred entries in a preceding year were not always the most preferred in subsequent years. The most preferred varieties and breeding lines during the three years were IR87615-9-3-1 and HUA 565. The traits of preference for farmers in the rainy season included tall plants, long panicles with more grains, less infestation with pest and diseases, more number of tillers per plant, good grain type, overall good crop performance, optimum maturity period, and high grain yield.

Discussion

From the previous research findings, it is apparent that results from on-station and on-farm trials are significantly different. The high yielding and farmers preferred introduced varieties have the possibility of replacing the traditional/obsolete variety. Farmers normally adapt varieties that yield more than their locally adapted cultivars; and meet the preferred traits which differ from one community to another (Gowda *et al*., 2000). High yield and acceptable varietal characteristics have shown significant adoption which resulted to subsequent crop improvements elsewhere: maize and wheat (Gowda *et al*., 2000; Mugo *et al*., 2005; Matuschke *et al*., 2007) and rice (Dorward *et al*., 2007; Gyawali *et al*., 2007). Farmers are receptive to new varieties that have an added advantage over their current existing varieties.

The three genotypes, IR87615-9-3-1, HUA 565 and Ciherang Sub1, were identified as high yielding and farmers preferred genotypes. This study suggests that these promising genotypes need to be promoted to other locations of similar agro-climatic conditions to provide varietal options to the farmers.

Acknowledgements

This study was financially supported by Nepal Agricultural Research Council (NARC). The authors would like to express sincere gratitude to all collaborating farmers who directly or indirectly helped to conduct the trials by providing their land and other supports.

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