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Research Article

Varietal Improvement of Rice for Rainfed Lowland Agro-Environment of Eastern Terai

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Abstract

Regional varietal trial of rainfed lowland medium (RVT-RLM) rice was carried out at Regional Agricultural Research Station (RARS), Tarahara, Sunsari, Nepal in 2014 and 2015. The RVT-RLM was composed by selecting superior genotypes from coordinated varietal trials. The experiments were laid out in randomized complete block design the experiments were replicated three times in both years. Total 21 and 22 genotypes were included in experiments of 2014 and 2015 respectively. Out of the tested genotypes in 2014-15, CH-2 produced the highest grain yield (4716 kg/ha) followed by IR 82635-B-B-47-1 (4675 kg/ha). These genotypes recorded 37-39 and 2-3 percent higher grain yield than the yield of national average (3394 kg/ha) and local check variety, Kanchhi Masuli (4589 kg/ha) respectively. These promising genotypes CH-2 and IR 82635-B-B-47-1 recorded more than 27 percent higher grain yield than the grain yield of other two standard check varieties Swarna (3678 kg/ha) and Tarahara-1 (3647 kg/ha). Maturity period of these promising genotypes were observed 136 and 125 days respectively whereas IR 74371-70-1-1, IR 8836-10-1-1-2 and IR 74371-54-1-1 were found the most early maturing (123 days) genotypes, but grain yield was 11-34 percent lower than IR 82635-B-B-47-1. The difference in days to maturity and grain yield was found significant among the genotypes and the tested years.

Keywords: RVT-RLM; grain yield; significant; kg/ha; genotype; promising.

Introduction

Rice (*Oryza sativa* L) is the major staple cereal crops of the country. It occupies 42.72 percent cultivated area (1.49 million hectares) of the total cultivated area of the cereal crops (3.48 million hectares) and 52.78 percent production (5.048 million tons) of the total production (9.56 million tons) of the cereal crops of the country. Out of the total rice cultivated area of the country, 36 percent area is under unirrigated rice cultivation. The average rice productivity of the nation is 3394 kg/ha whereas it is 3586 kg/ha of the eastern Terai region (MOAD, 2014).

Rice cultivated area and production of the country is dominated by Terai region. About 68 percent rice cultivated area and 70 percent rice production is contributed by Terai region (MOAD, 2014). Agriculture of the country is mostly rainfed and subsistence. More than half rice production is utilized for household consumption (Ghimire *et al*, 2013).

More than half of the world population is relying on rice for their staple food (IRRI, 2006). Globally about 26 percent area of rice production is under rainfed lowland which accounts 17 percent rice production (Crosson, 1995). More than 50 percent rice production should be increased by 2025 to meet the food demand of increasing population (Fisher, 1996). About 21 percent of such increased production should come from rainfed lowland agriculture system (Scobie *et al.*, 1993). Rice provides 20% of the per capita energy and 13% of the protein consumed worldwide (Juliano, 1994).

Plants may suffer from stress for root growth and nutrients availability due to not control water movement in rain fed lowland rice farming system (Garrity *et al.*, 1986). Wade *et al*, 1999 reported that water supply is the major limitations for yield improvement in rainfed lowland ecosystem. The largest drought affected area of Asia is in India and its adjoining area of Nepal, with more than 17 million hectare of rainfed rice area (Huke and Huke, 1997).

Annual productivity of irrigated rice is estimated to be 5 % more than that of rainfed rice (Fairhurt and Dobermann, 2002). Liu *et al* (2006) reported that reproductive stage is more vulnerable to stress and cause spikelet sterility. Maximum temperature in Nepal has increased by 1.8^{o}C over the period 1975 to 2006 and precipitation has become more erratic (Shrestha *et al.*, 1999; Baidya *et al.*, 2008).

These experiments were carried out in Regional Agricultural Research Station (RARS), Tarahara, Sunsari, Nepal in 2014-15. This research station is located at 26^{o} 42' North latitude, 87^{o} 16' East longitude and 136 meter above seas level. The climate of the research farm is sub-tropical. The soil texture is dominated by clay loam and pH of the soil ranges from 6.5-7.0 (Anonymous, 2014 and 2015). The minimum and maximum temperature of this Station was recorded 9.3^{o}C (January) and 35.5^{o}C (April) in

2014 while it was 9.8°C (January) and 33.5°C (July) in 2015 respectively. There was higher precipitation in 2015 (2031.1 mm) than 2014 (1653.8 mm). The occurrence of rainfall from rice transplanting to flowering was higher (1281.8 mm) in 2015 whereas it was 916.2 mm in 2014.

Effective agriculture research and extension is one of the key components in increasing agriculture productivity (ADS, 2014). Positive change in agriculture of today became possible through technology development. These experiments were designed to identify high yielding genotypes of rainfed lowland medium rice for the farmers of eastern Terai.

Materials and Methods

RVT-RLM experiments were conducted under rainfed environment at Regional Agricultural Research Station, Tarahara during 2014-15. Randomized complete block design was applied for seeding the experiments in both years and it was replicated three times in each year. Plot size of 10 m^2 was maintained with the spacing of 20 cm^2 for row to row and plant to plant. The fertilizer was applied at the rate of 80:40: 30 NPK kg/ha in both years. The seeding and transplanting was done in 26 June 2014 and 30 July 2014 respectively in 2014. Total 21 genotypes namely, IR 74371-70-1-1, IR 88836-10-1-1-2, IR 80973-B-186-41-2, IR 78937-B-20-B-B-4, IR05N-445, IR 87761-51-1-1-4, IR 70210-39-CPA-7-1-1-4-2, IR 8461-B-7-1, CH-2, IR 88793-2-2-1-2, IR 83376-B-B-130-3, IR 80411-B-28-4, RP 34467-3-1-1-2-1, IR 82635-B-B-47-1, IR 86815-23-4-1-2, IR 82635-B-B-47-2, IR 74371-54-1-1, Tarahara-1, TCA-80-4, Swarna and Kanchhi Masuli were included in the experiment of 2014.

Similarly, seeding and transplanting of RVT-RLM experiment in 2015 was done in 29 June 2015 and July 25, 2015 respectively. Total 22 genotypes namely, IR 74371-70-1-1, IR 88836-10-1-1-2, IR 80973-B-186-41-2, IR 78937-B-20-B-B-4, IR05N-445, IR 87761-51-1-1-4, IR 70210-39-CPA-7-1-1-4-2, IR 8461-B-7-1, CH-2, IR 80411-1B-28-4, RP 34467-3-1-1-2-1, IR 82635-B-B-47-1, IR 86815-23-4-1-2, IR 82635-B-B-47-2, IR 74371-54-1-1, NR 2167-63-1-1-5-1, WAS-191-10-3-FKRI, NR 2160-31-1-2-2-2-1, NR 2165-131-3-1-1-1, Tarahara-1, Swarna and Kanchhi Masuli were included in the experiment of 2015.

Days to heading and maturity, plant height, panicle length, number of tillers/m2, filled and unfilled grains in panicle and grain yield were studied in RVT-RLM experiments of both years. MSTAT-C and Excel software were used to analyze the data.

Result and Discussion

Total 21 genotypes were included in RVT-RLM experiment of 2014. Among them, IR 88836-10-1-1-2 was found early maturing genotype (121 days) whereas check variety Swarna was observed most late (147 days). In case of plant height, highest and lowest was of IR 70210-39-CPA-7-1-1-4 (122 cm) and Swarna (84.66 cm). The shortest and longest panicle length was observed in Swarna (21.00 cm) and RP 34467-3-1-1-2-1 (27.66 cm). The difference of tiller number/m^2 was not significant due to genotypes. Regarding grain yield, the highest grain yield was produced by IR 82635-B-B-47-1 (5083 kg/ha) followed by IR 80411-B-28-4 (4916 kg/ha) and IR 973-B-186-41-2 (4875 kg/ha). These high yielding genotypes produced 3-8 percent more yield than check variety Kanchhi Masuli (4708 kg/ha) and 44-50percent higher grain yield than national yield of rice. The maturity period of these superior genotypes was found 127, 140 and 128 days respectively. So, these genotypes identified as superior genotypes in RVT-RLM experiment of 2014. In addition to these superior genotypes, other nine genotypes produced more than 4.5 t/ha grain yield. The lowest yield (2958 kg/ha) was produced by IR 88836-10-1-1-2. All the tested characters except tiller number/m^2 were found significantly different due to genotypes (Table1).

Out of the genotypes included in the RVT-RLM experiment of 2015, IR 88836-10-1-1-2 was found early (117 days) whereas the maturity period of NR 2160-31-1-2-2-2-1and Swarna was observed 145 days, that is most late among the tested entries. The lowest (93.80 cm) and highest (128 cm) plant height was observed in Swarna and NR 2167-63-1-1-5-1genotype respectively. NR 2165-131-3-1-1 and IR 87761-51-1-1-4 genotypes had longest panicle length (27.2 cm) whereas Swarna had shortest panicle (22.5 cm). The highest grain yield was produced by NR 2167-63-1-1-5-1 (5153 kg/a). Similarly, the grain yield of NR 2160-31-1-2-2-2-1, CH-2 and NR 2165-131-3-1-1-1 genotypes was found at par (4781 kg/ha). These high yielding genotypes recorded 42-52 percent higher grain yield than national yield and 7-12 percent than check variety, Kanchhi Masuli (4470 kg/ha). All the tested characters in the experiment except tiller number/m^2 was found significantly different among the genotypes (Table 2)

Total eighteen genotypes were included in over year (2014-15) analysis of RVT-RLM. IR 74371-54-1-, IR 74371-70-1-1 and IR 88836-10-1-1-2 identified as early maturing (123 days) and Swarna was the most late (146 days) genotypes. Similarly, highest and lowest plant height was observed in IR 70210-39-CPA-7-1-1-4-2 (123.83 cm) and Swarna (89.23 cm) respectively. Maximum and minimum grain filling was observed in Kanchhi Masuli (90.10 %) and RP 34467-3-1-1-2-1(78.68 %). Regarding grain yield, CH-2 recorded higher grain yield (4716 kg/ha) and IR 82635-B-B-47-1identified as second top yielding (4675 kg/ha) genotype in over year analysis of RVT-RLM. These high yielding genotypes recorded 2-3 and 37-39 percent higher grain than check variety, Kanchhi Masuli

and national yield of rice respectively. Similarly, these produced more than 27 percent higher grain yield than the grain yield of other check varieties, Swarna (3678 kg/ha) and Tarahara-1 (3647 kg/ha). Among the genotypes included in over year analysis, RP 34467-3-1-1-2-1 identified as low yielding (3397 kg/ha) genotype. Akhtar *et al.* (2012) and Sah *et al.* (2014) also reported that CH-2 was found high yielding genotype in Regional Agricultural Research Station, Parwanipur, Bara agro-environment of Nepal. The maturity period of these promising genotypes was found 136 and 125 days respectively. The difference in flowering and maturity days, plant height and grain yield was found significant due to genotypes and year whereas panicle length and grain filling was found significant among the genotypes only (Table 3).

Table 1: Grain yield and other ancillary characters of RVT-RLM in 2014

S.N.	Genotypes	Flowering days	Maturity days	Plant height (cm)	Tillers/m2	Panicle length (cm)	Grain yield (kg/ha)
1	IR 74371-70-1-1	98.67	127.00	107.33	193.60	23.33	3791.00
2	IR 88836-10-1-1-2	92.00	121.00	103.00	175.00	24.66	2958.00
3	IR 973-B-186-41-2	99.33	128.66	118.33	217.30	23.00	4875.00
4	IR 78937-B-20-B-B-4	102.33	131.33	107.33	199.60	24.66	4158.00
5	IR 05N-445	108.66	137.00	103.00	203.00	26.00	4250.00
6	IR 87761-51-1-1-4	104.00	133.00	102.66	205.30	26.00	4666.00
7	IR 70210-39-CPA-7-1-1-4	98.00	127.66	122.00	210.30	24.66	4625.00
8	IR 8461-B-7-1	99.33	128.66	115.33	208.00	24.00	4625.00
9	CH-2	108.33	137.33	115.00	220.30	24.00	4583.00
10	IR 88793-2-2-1-2	105.66	134.66	103.33	219.60	25.66	4000.00
11	IR 83776-B-B-130-3	101.33	130.33	110.33	217.00	23.33	4541.00
12	IR 80411-B-28-4	112.00	140.66	106.66	211.00	25.66	4916.00
13	RP 34467-3-1-1-2-1	104.00	133.66	109.66	214.66	27.66	4500.00
14	IR 82635-B-B-47-1	98.00	127.33	114.66	285.33	26.66	5083.00
15	IR 86815-23-4-1-2	100.66	130.00	111.00	204.33	26.66	4083.00
16	IR 82635-B-B-47-2	97.33	126.33	109.66	292.00	24.66	4750.00
17	IR 74371-54-1-1	98.66	128.00	116.66	284.66	25.00	3958.00
18	Tarahara-1	112.33	141.00	103.00	182.00	23.66	3280.00
19	TCA 80-4	119.33	137.33	121.00	219.66	22.00	4666.00
20	Swarna	120.33	147.66	84.66	219.66	21.00	3958.00
21	Kancchi Masuli	111.66	140.66	110.33	210.66	22.86	4708.00
	Grand Mean	103.66	132.75	109.92	204.63	24.43	4330.00
	F test	**	**	**	NS	**	**
	CV %	5.50	1.53	5.34	13.92	4.41	10.59
	LSD	12.56	4.472	12.94		2.374	1012.00

Note: ** = p <0.01, * = p <0.05

Table 2: Grain yield and other ancillary characters of RVT-RLM in 2015

S.N.	Genotypes	Flowering days	Maturity days	Plant height (cm)	Tillers/m2	Panicle length (cm)	Grain yield (kg/ha)
1	IR 74371-70-1-1	92.00	120.00	109.26	181.33	24.00	3970.00
2	IR 88836-10-1-1-2	88.67	117.00	109.46	148.33	25.73	3555.00
3	IR 80973-B-186-41-2	95.67	124.00	123.13	194.33	22.60	4327.00
4	IR 78937-B-20-B-B-4	95.67	123.67	106.13	152.33	23.60	4061.00
5	IR05N-445	104.33	132.33	108.00	165.66	25.00	4164.00
6	IR 87761-51-1-1-4	98.00	126.00	105.60	158.33	27.13	3752.00
7	IR 70210-39-CPA-7-1-1-4-2	97.00	121.33	118.53	147.33	26.00	3877.00
8	IR 8461-B-7-1	96.00	124.00	113.46	191.66	23.20	4138.00
9	CH-2	107.67	135.33	123.46	174.33	24.66	4783.00
10	IR 80411-B-28-4	107.00	135.00	103.60	197.33	24.13	4162.00
11	RP 34467-3-1-1-2-1	99.33	127.00	107.80	165.33	26.46	2294.00
12	IR 82635-B-B-47-1	96.00	124.00	116.40	175.66	25.00	4268.00
13	IR 86815-23-4-1-2	94.00	122.00	114.80	158.00	25.93	4116.00

S.N.	Genotypes	Flowering days	Maturity days	Plant height (cm)	Tillers/m2	Panicle length (cm)	Grain yield (kg/ha)
14	IR 82635-B-B-47-2	93.67	121.67	120.46	151.33	26.20	3662.00
15	IR 74371-54-1-1	91.67	119.33	116.46	160.33	25.33	4425.00
16	NR 2167-63-1-1-5-1	110.67	138.67	128.00	173.66	25.86	5153.00
17	WAS191-10-3-FKRI	95.67	123.67	96.93	167.00	25.73	4315.00
18	NR 2160-31-1-2-2-2-1	117.67	145.00	121.16	172.66	23.73	4788.00
19	NR 2165-130-3-1-1-1	108.33	136.33	121.93	164.00	27.20	4781.00
20	Tarahara-1	112.67	140.00	98.13	168.33	24.26	4045.00
21	Swarna	118.33	145.67	93.80	208.00	22.53	3399.00
22	Kanchhi Masuli	108.67	135.67	115.20	194.00	23.46	4470.00
	Grand Mean	101.30	128.98	112.53	171.33	24.89	4114.00
	F test	**	**	**	NS	**	**
	CV %	1.41	1.44	5.55	18.46	4.96	13.28
	LSD	3.145	4.058	13.75		2.720	1203

Note: ** = $p < 0.01$

Table 3: Combined analysis of grain yield and other ancillary characters of RVT-RLM 2014-15

S.N.	Genotypes	Flowering days	Maturity days	Plant height (cm)	Tillers/m2	Panicle length (cm)	Grain filling (%)	Grain yield (kg/ha)
1	IR 74371-70-1-1	95.00	123.50	108.37	187.50	23.67	89.57	3881.0
2	IR 88836-10-1-1-2	95.17	123.66	104.73	168.83	24.53	84.59	3465.0
3	IR 80973-B-186-41-2	97.50	126.33	120.73	205.83	22.80	86.98	4392.0
4	IR 78937-B-20-B-B-4	99.00	127.50	106.83	176.00	24.13	85.54	4110.0
5	IR05N-445	106.50	134.67	105.60	184.33	25.50	83.40	4209.0
6	IR 87761-51-1-1-4	101.00	129.50	104.13	165.16	26.57	83.43	4209.0
7	IR 70210-39-CPA-7-1-1-4-2	97.50	124.50	123.83	192.16	25.33	87.59	4497.0
8	IR 8461-B-7-1	97.67	126.33	114.40	199.83	23.60	87.13	4381.0
9	CH-2	108.00	136.33	119.23	195.33	25.80	82.60	4716.0
10	IR 80411-B-28-4	109.50	137.83	104.07	204.33	25.30	86.34	4590.0
11	RP 34467-3-1-1-2-1	101.67	130.33	108.73	190.00	27.07	78.68	3397.0
12	IR 82635-B-B-47-1	97.00	125.67	115.53	180.50	25.50	84.35	4675.0
13	IR 86815-23-4-1-2	97.00	126.00	112.90	181.17	25.97	79.34	4099.0
14	IR 82635-B-B-47-2	95.50	124.00	116.73	171.67	25.43	85.99	4356.0
15	IR 74371-54-1-1	95.17	123.67	116.57	172.50	25.17	86.82	4191.0
16	Tarahara	112.50	140.50	100.57	175.17	23.96	83.36	3647.0
17	Swarna	119.33	146.67	89.23	197.17	21.76	79.95	3678.0
18	Kanchhi Masuli	110.11	138.17	112.76	219.00	23.06	90.10	4589.0
	Grand Mean	101.97	130.28	110.27	187.02	24.73	84.76	4171.0
	F test Genotype	**	**	**	NS	**	**	**
	Year	**	**	*	NS	NS	NS	**
	Genotype x year	NS	NS	NS	NS	NS	NS	**
	CV %	3.09	2.48	5.32	16.56	5.65	6.14	12.06
	LSD	4.823	4.944	8.972		2.134	7.955	768.9

Note: ** = $p < 0.01$, * = $p < 0.05$

Conclusion

CH-2 and IR 82635-B-B-47 genotypes recorded 2-27 percent higher grain yield than the yield of check varieties Kanchhi Masuli, Swarna and Tarahara-1. Similarly, they produced more than 37 percent higher grain yield than national average. The maturity period of these promising genotypes was found 2-15 days early than check varieties. So, it is recommended to include these promising genotypes in farmers' field trial for further verification of their performance in farmers' managed condition and different agro-environments of eastern Terai.

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