On-farm evaluation of upland rice genotypes at Bajhang district, mid western hills of Nepal

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Abstract

A set of eight rice (*Oryza sativa* L.) genotypes in upland condition were evaluated in Bhajhang district. They were compared with popular local and standard check varieties of upland rice with an objective of selecting them to be suited to Bhajhang and similar agro-ecological domains. The genotypes included were; Tauliya, Chhomroung, Kalo Nathre, Rato Ghaiya, Pakhe Jhinuwa, Radha- 32, IR78877-208-B-1-2, and CT- 65110-24-1-1. They were evaluated in a Randomised Complete Block Design (RCBD) with four replication at Rayal VDC-3, Deura, Bajhang, Nepal during 2010 upland paddy growing season. Highly significant variation was observed for traits recorded. Grain yield ranged from 2.1 kg/plot (Radha- 32 and Rato Ghaiya) to 0.52 kg/plot (Pakhe Jhinuwa). Radha- 32 and Rato Ghaiya were found superior to Local checks. Likewise, significant variation was also observed in the morpho-physiological traits such as days to anthesis and days to maturity which varied from 100 days (Tauliya) to 114 days (CT 65110-24-1-1) and 126 days (Tauliya) to 148 days (CT 65110-24-1-1), respectively. Genotype Tauliya was early maturing while CT 65110-24-1-1 was late maturing one. There was a variation in grain filling period which ranged from 24 days (Pakhe Jhinuwa) to 36 days (Chhomroung and IR 78877-208-B-1-2) after anthesis to physiological maturity. Similarly, significant variation was also recorded for plant height, panicle length, and peduncle length. Highly significant positive correlation (r = 0.85, 0.69, 0.54 and 0.83) was found for panicle length, peduncle length, grain filling period and numbers of grains/panicle with grain yield. Likewise, significant positive correlation was found between days to maturity and grain filling duration (0.81), numbers of grains/panicle and panicle length (0.81), 1000 seeds weight, and grain filling duration (0.53). The result of the study revealed that Radha- 32 and Rato Ghaiya were found as the best genotypes so far as farmers and breeders are concerned in the tested site of Bajhang.

Key words: Upland rice, yield, variation, yield components

Introduction

Rice is one of the leading food crops in the world and stands in second position after wheat. It is the staple food crop of more than 60 % of the world population. In Nepal, it is the principal cereal food crop and is grown in 1555,940 ha of land with the productivity of 2.91

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t/ha (AICC, 2010). It nearly contributes about 20.75% to the agriculture gross domestic products (MOAC, 2010) and provides more than 50% of the caloric requirements of the Nepalese people (NARC, 2008). In Nepal, rice is grown in wide range of environments from flat lands in altitude less than 60 m with tropical climates to highest rice growing altitude of the world (3050 m) with temperate climate (ABD, 2008). Upland rice refers that rice grown on both flat as well as sloping fields, which are not bunded, and fields are prepared and seeded under dry conditions, and the moisture content of the field depends on rainfall (De data, 1975). Upland rice mainly **Ghaiya Dhan** is grown in uplands of Nepal. At least 9 % constituting a total of about 126,000 ha of the total rice area in Nepal is covered by upland rice. This crop plays a significant role in household food security of subsistence farmers where the possibility of irrigation facilities or of a more profitable alternative crop is unlikely in foreseeable future. It is the crop of socially and economically disadvantaged ethnic communities. Bajhang district is one of the remote and poor districts. Most of the people of this district are very poor and the per capita income is Rs 4930, it is too low as compared to per capita income of Nepal is Rs 7673 (ADO, 2008 and WUPAP, 2008). Most of the agricultural lands of this district are upland type, unproductive and sloppy. Rice is the leading food crop and grown in low as well as uplands. Farmers grow recommended as well as local genotypes of rice but majority of the farmers grow local landraces of upland rice. Local landraces of upland rice is grown in 2890 ha of land and the production is 4335 tons.

These figures present that the productivity is very low that is 1.5 t/ha (ADO, 2008) which is lower than national average. These cultivated landraces are low yielder and farmers have wanted high yielding upland rice. Participatory crop improvement (participatory varietal selection (PVS) and participatory plant breeding) has been emphasized as effective tool for research and extension of varieties suitable for adverse situations in marginalized communities (Craufurd *et al.*, 2004, Witcombe *et al.,* 1998, Kshirsagar *et al.*, 1997 and Sperling *et al.*, 1993). Hence, this project was conducted with an aim to select best genotypes through breeders and participatory approaches which might fulfill the farmers' need and, it may be one of the ways that can help in alleviating poverty of the people of that region.

Methodology

Experimental materials and design

Bajhang district is located at 29^0 29' to 30^0 9' north latitudes and 80^0 to 81^0 34' east longitudes. Experiment was conducted in Rayal VDC-3, Deura, Bajhang in 2010. Eight genotypes viz., Tauliya, Chhomroung, Kalo Nathre, Rato Ghaiya, Pakhe Jhinuwa, Radha-32, IR-78877-208-B-1-2 and CT- 65110-24-1-1 were included on the basis of their performances. Experiment was conducted in Randomised complete block design with four replications. The net plot size was 10 m^2/plot (5 m x 2 m).

Seeds sowing and inter cultural operations

Land preparation was done as per need of the farmers' practice. Fertilization of field was done with manures only as per farmers' practice. Seeds were sown @ 80kg/ha in May 16, 2010 by evenly broadcasting in the field. Two hand weeding and hoeing were practiced. First weeding/hoeing was performed 30 days after sowing (DAS) whereas second was done 60 DAS.

Data collection

Observation on effective tillers/plant, days to anthesis, days to maturity, plant height, peduncle length, panicle length, number of grains/panicle, grain filling duration, thousand seeds weight and yield were recorded.

Training

Before sowing seeds, training was conducted by selecting 19 progressive farmers from host and its neighboring VDCs for letting farmers about the experiment in their location

Farmers' visit and workshop

Two farmers' visits and a workshop were conducted in he experimental site. First visit was held at tillering stage and a workshop was organized at maturity stage of rice. Sixteen progressive farmers representing Rayal and its neighboring VDCs were selected for visit and workshop.

Grain yield recording

Grain yield was recorded from the whole plot followed by threshing and sun dried properly.

Data analysis

Data recorded from the experiment were analyzed by using Microsoft Office Excel, Gen Stat, and Minitab programs.

Results and discussion

Morpho-physiological traits

A highly significant variation was found between genotypes for all morpho-physiological traits (Table 1). Variability differed from genotype to genotype. Variations among genotypes might partially reflect their different genetic backgrounds. Results indicated that genotypes responded differently for different traits suggesting the importance of their in order to identify the best genetic make up for a particular environment.

Plant height

A highly significant variation was found for plant height (Table 1). The mean plant height was found 98 cm. Plant height ranged from 61 cm (Pakhe Jhinuwa) to 123 cm (Rato

Ghaiya) (Table 1). This result was in contrast to previous findings (Ojha *et.al*., 2010 and Ojha, 2010) suggesting a genotype x environment interaction among the tested genotypes. Genotype CT- 65110-24-1-1, IR-78877-208-B-1-2 and Pakhe Jhinuwa were found inferior to both checks. Rato Ghaiya and Radha-32 did not differ with Chhomroung.

Days to anthesis and days to maturity

Anthesis refers the first opening of a flower. Highly significant variation was found for these traits (Table 1). The mean days to anthesis and maturity were found 106 and 137 days, respectively. Days to anthesis and maturity varied from 100 days (Tauliya) to 114 days (CT-65110-24-1-1) and from 126 days (Tauliya) to 148 days (CT- 65110-24-1-1), respectively (Table 1). Kalo Nathre and Radha-32 did not differ significantly to Tauliya for days to anthesis and flowered earlier than others. The CT- 65110-24-1-1 was found superior to both checks for both traits and flowered and matured most lately. This finding was found in agreement with the previous findings (Ojha *et.al*., 2010 and Ojha, 2010). Tauliya and Kalo Nathre appeared similar for days to maturity and matured earlier than others.

Panicle length

Panicle length is one of the important traits in rice. Generally it is said that higher the panicle length of the plant higher will be the number of grains/panicle and it ultimately gives higher yield. Highly significant variation was found for panicle length (Table 1). Panicle length varied from 19 cm (Pakhe Jhinuwa) to 24 cm (Radha-32 and Rato Ghaiya) (Table 1). The mean panicle length was recorded 22.1 cm. None of the genotype was found superior to both checks. This finding was found in agreement with the previous findings (Ojha *et.al*., 2010 and Ojha, 2010).

Peduncle length

Highly significant variation was observed for peduncle length (Table 1). Peduncle length ranged from 28 cm (Pakhe Jhinuwa) to 42 cm (Rato Ghaiya) (Table 1). The mean peduncle length was found 34.7 cm. None of the genotypes were found superior to both checks. Rato Ghaiya did not differ significantly to Chhomroung for peduncle length.

Grain filling duration

Like panicle length, grain filling duration is one of the prime traits of rice. In general, longer grain filling duration results higher yield. A highly significant variation was found for grain filling duration (Table 1). Grain filling duration varied from 24 days (Pakhe Jhinuwa) to 36 days (Chhomroung and IR-78877-208-B-1-2) (Table 1). The mean grain filling duration was found 32 days. Radha-32 and IR-78877-208-B-1-2 did not differ significantly with Chhomroung. This result was found in accordance with previous findings (Ojha *et.al*. 2010 and Ojha, 2010).

Yield and yield components

Economic yield is the most valuable trait of all the crops. It is a complex trait and affected by environment. This trait is governed by many genes, regarded as polygenes. Heritability of this trait is very low. Selection of individual plant is not effective for yield. There are a large number of yield attributing traits. Proper selection of these traits can help increase in yield of a given crop in crop improvement programme. Variability differed with genotype to genotype. Highly significant variation was observed for number of effective tillers/plant, number of grains/panicle; test weight and grain yield (Table 2). Variations among genotypes might partially reflect their different genetic backgrounds. Results indicated that genotypes responded differently for different yield and yield enhancing traits suggesting the importance of the assessment of genotypes in order to identify the best genetic make up for a particular environment.

Number of effective tillers/plant and number of grains/panicle

Significant variation was found for number of effective tillers/plant and number of grains/panicle (Table 2). Number of effective tillers/plant and number of grains/panicle ranged from 3.4 (Kalo Nathre) to 6.5 (Pakhe Jhinuwa) and from 57 (Pakhe Jhinuwa) to 190 (Radha-32), respectively (Table 2). The mean effective tillers/plant and number of grains/panicle were recorded 4.8 and 120, respectively. Pakhe Jhinuwa was recorded a superior genotype to both checks for these traits. This result was found similar to the previous findings (Ojha *et.al*., 2010 and Ojha, 2010). Chhomroung and Rato Ghaiya did not differ significantly for number of tillers/plant. Radha-32 and Rato Ghaiya were found superior to both checks. This result supported the previous findings (Ojha *et.al*., 2010 and Ojha, 2010). Pakhe Jhinuwa, CT- 65110-24-1-1 and IR-78877-208-B-1-2 were found inferior to both checks for number of grains/panicle.

Thousand seed weight

Weight of 1000 seeds is known as test weight. Thousand seeds weight is one of the most important yield enhancing traits of rice. Significant variation was found for 1000 seeds weight (Table 2). This trait varied from 20.8 g (Pakhe Jhinuwa) to 28.3 g (Chhomroung) (Table 2). The mean test weight was found 23.5 g. None of the genotypes was found similar or superior to Chhomroung. This result was found in accordance to the previous findings (Ojha *et.al*., 2010 and Ojha, 2010). Pakhe Jhinuwa gave the lowest 1000 seeds weight and this findings was found in contrast to previous findings (Ojha *et.al*., 2010 and Ojha, 2010).

Grain yield

Grain yield is the end result of many complex morphological and physiological processes occurring during the growth and development of crop. Highly significant result was found for yield (Table 2). Yield differed from genotypes to genotypes and ranged from 0.52 kg/plot (Pakhe Jhinuwa) to 2.1 t/ha (Radha-32 and Rato Ghaiya) (Table 2). The mean grain

yield was found 1.59 kg/plot. Radha-32 and Rato Ghaiya were found superior to both checks for yield. This finding was found in agreement with the previous findings (Ojha *et.al*., 2010 and Ojha, 2010). CT- 65110-24-1-1 and Pakhe Jhinuwa were appeared inferior to both checks.

Correlation analysis

Highly significant positive correlation (r = 0.85, 0.69, 0.54 and 0.83) was found for panicle length, peduncle length, grain filling period and number of grains/panicle with yield respectively (Table not shown). This finding was found in agreement with the previous findings (Ojha, *et.al*., 2010; Ojha, 2010; Ojha, 2009; Ojha, 2007; Sharma *et.al*., 2007 and Ojha and Sharma, 2005). Likewise, a significant correlation was found between days to maturity and grain filling duration (0.81), number of grains/panicle and panicle length (0.81) and 1000 seeds weight and grain filling duration (0.53) suggesting longer panicle length can help produce more number of grains/panicle and longer grain filling duration can help store more assimilates to the storage organs. This result was found similar to the previous findings (Ojha, *et.al*., 2010; Ojha, 2010; Ojha, 2009 and Ojha and Sharma, 2005).

Table 1. Mean values of morpho-physiological traits of eight upland rice genotypes tested at Rayal-3, Deura, Bajhang in 2010

S N	Genotypes	Plant height (cm)	Panicle length (cm)	Peduncle length (cm)	Days to anthesis (DAS)	Grain filling duration (DAS)	Days to maturity (DAS)
1	Tauliya (Local check)	99 [e*]	23 [a]	37.3 [bc]	100 [d]	26 [c]	126 [e]
2	Chhomroung (Standard check)	120 [a]	23 [a]	39 [ab]	106 [bc]	36 [a]	142 [b]
3	Pakhe Jhinuwa	61 [e]	19 [c]	28 [e]	109 [b]	24 [d]	133 [d]
4	IR-78877-208-B-1-2	78 [d]	20.8 [b]	30.8 [de]	107 [b]	36 [a]	143 [b]
5	CT- 65110-24-1-1	79 [d]	21.5 [b]	30.5 [e]	114 [a]	34 [b]	148 [a]
6	Kalo Nathre	109 [b]	21 [b]	34 [cd]	101 [d]	27 [c]	128 [e]
7	Radha-32	116 [ab]	24 [a]	36 [bc]	103 [cd]	35 [ab]	138 [c]
8	Rato Ghaiya	123 [a]	24 [a]	42 [a]	106 [bc]	34 [b]	140 [bc]
	Mean	98	22.1	34.7	106	32	137
	F-test	**	**	**	**	**	**
	LSD (0.05)	7	1.3	3.3	3	1	3
	CV (%)	4	4	6.3	2	2	2

Where, ** = highly significant (P<0.01), * Means followed by the same letter in a column are not significantly different

Table 2. Mean values of yield and yield components of eight upland rice genotypes tested at Rayal-3, Deura, Bajhang in 2010

SN	Genotypes	No. of Tillers/plant	No. of Grains/Panicle	Test Weight	Yield
1	Tauliya (check)	3.7[e*]	163[b]	22.4[c]	1.84[b]
2	Chhomroung (check)	5.2[bc]	117[c]	28.3[a]	1.58[cd]
3	Pakhe Jhinuwa	**6.5[a]**	**57[e]**	**20.8[d]**	**0.52[e]**
4	IR-78877-208-B-1-2	4.4[d]	90[d]	25.3[b]	1.63[c]
5	CT- 65110-24-1-1	5.0[c]	64[e]	22.7[c]	1.45[d]
6	Kalo Nathre	**3.4[e]**	103[cd]	25.1[b]	1.53[cd]
7	Radha-32	4.8[cd]	**190[a]**	22.4[c]	**2.1[a]**
8	Rato Ghaiya	5.6[b]	180[a]	22.1[d]	**2.1[a]**
	Mean	4.8	120	23.5	1.59
	F-test	**	**	**	**
	LSD (0.05)	0.56	14	0.45	0.14
	CV (%)	7.8	8	5	6

Where, ** = highly significant (P<0.01), Means followed by the same letter in a column are not significantly different

Participatory variety selection

Farmers' participatory approach for the identification or breeding of improved crop cultivars can usefully be categorized into participatory varietal selection (PVS) and Participatory plant breeding (PPB). The PVS is more rapid way of identifying farmers preferred cultivars, which is a suitable choice of cultivars. If this is impossible through the PVS programs, then the more resource consuming PPB programs are applied. The PPB can use, as parents, cultivars that were identified in the successful PVS program (Sthapit *et al.,* 1996). Farmers pointed out the positive and negative aspects of different genotypes during visits and workshops. They liked tall genotypes to feed culms to cattle and buffalo. Similarly, they preferred genotypes having good plant population, longer panicle length, more number of grains/panicle; good seed size and color, full and shine grain, which ultimately can give higher grain yield. Based on these over all criteria, farmers preferred Radha-32 and Rato Ghaiya compared to other genotypes in the study.

Conclusion

Majority of people in Bajhang district were poor and the per capita income was too low. Most of the agricultural lands in this district are upland type, unproductive, and sloppy. Rice is the main staple crop in the district. Considering this, the study was conducted with a view to select suitable rice genotypes for upland condition. Genotypes were selected by applying breeders' and farmers' criteria. Farmers preferred Radha-32 and Rato Ghaiya based on plant

height, panicle length, number of grains/panicle, seed color, and yield. Breeders selected Radha-32 and Rato Ghaiya the most suitable genotypes to be grown for this area based on yield, yield attributing and morpho-physiological traits. Radha-32 and Rato Ghaiya gave the highest yield (2.1 kg/plot). Similarly, highest number of grains/panicle (190) and panicle length (24 cm) were found in Radha-32. Rato Ghaiya was similar to Radha-32 for panicle length and it was found the tallest genotype (123 cm) and gave the longest peduncle length (42 cm). The findings of the study revealed significant genotypic effects for all traits and an array of variation was found among genotypes for each trait. Therefore, it was concluded that Radha-32 and Rato Ghaiya were the most suitable genotypes that can be grown successfully in upland condition of Bajhang district.

Acknowledgements

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