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Research Article

Analysis of Growth and Yield Attributing Characteristic of Direct Seeded Upland Rice Genotypes in Western Hills of Nepal

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Abstract

Rice is the major cereal crop in Nepal. It ranks first in area and production among all cereal crops of Nepal. The most of rice cultivation of Nepal are rainfed condition. The farmers depend on rainfall for production of upland rice mostly in western Nepal. The varietal performance of rainfed rice with agronomic manipulation was evaluated at farmers' field during 2005/2006. Ten different local and improved genotypes were evaluated in direct seeded upland conditions. The design of experiment was Randomized Completely Block Design (RCBD) with plot size of 7 x 3 m2 in 4 replications. Measurement of growth and yield attributing data were taken and these data were found significantly different among the treatments. The maximum grain yield (3.79 t/ha) was obtained in Ghaiya-2 followed by IR 55435-5 (3.69 t/ha), Radha-32 (3.48 t/ha) and the minimum grain yield was recorded in cultivar Rato Kanake (2.26 t/ha). Higher grain yield was recorded in improved genotypes than local. While genotypes namely Pakhe Jhinuwa, which is used as local check perform well as compared to other local genotypes in terms of yield.

Keywords: Upland Rice; Rainfed; Growth and Yield Attributing Characters

Introduction

Rice is the staple food of more than 60% of the world's population. About 92% of global rice is produced and consumed in Asian region (Singh, 1997). Rice (*Oryza sativa* L.) is most important crop of Nepal as it ranks first crop for both acreage and production [1]. In Nepal, agriculture contributes 31.7% of total GDP and rice alone contributes more than 20% of the agricultural GDP with prestigious cultural value [2]. Upland rice refers to rice grown on both flat and sloping fields that are not bunded andfields are prepared and seeded under dry conditions and that depends on rainfall for moisture [3]. Upland rice, known as Ghaiya Dhan in Nepali, is mainly grown on Tars and also in, marginal hillside terraces or hillsides newly cleared of forest cover in Nepal. Tars are actually ancient alluvial fans now formed into flat basins with agricultural importance.

Most of the areas of tested site were rainfed. This implies that the farmers depend on rainfall for the cultivation of rice (direct seeded upland rice and transplanted lowland rainfed rice) and mostly they use local cultivars which give lower yield. So, this research was designated and implemented to identify suitable direct seeded upland genotypes for those agro-ecological zones. The research is intended to include a larger number of landraces in the study to ensure greater choices for the community. This research also helps to identify landraces that had disappeared in some communities but cultivated by others, to maintain crop diversity too.

Materials and Methods

The experiment was laid out in Randomized Complete Block Design (RCBD) with 10 treatments (10 genotypes) and four replications having the plot size of 7 x 3 m2. The genotypes used in a trial block was brought from National Rice Research Program (NRRP), Hardinath, Dhanusa and local genotypes were collected from rural areas of Tanahun and Lamjung district of Nepal. The row to row and plant to plant spacing was 20 cm x 20 cm maintained in trial block. Randomly selected 15 plants were used for the measurement of growth attributing characters. The flag leaf angle, plant height, number of effective tillers/m^2, panicle length was taken just before harvesting and mean were calculated. Number of filled and unfilled grains was counted to determine the number grains/panicle. Thousand grains were counted from the grain yield of net plot and weighed with the help of portable automatic electronic balance.

The soil of experimental field was clay and medium acidic in nature. The soil organic matter and soil available phosphorus were found high but total nitrogen and soil available potassium were found medium in the fields. The dose inorganic fertilizer 60:30:20 kg NPK/ha was applied in the field. Farm yard manure was applied as farmers' practice. Half dose of N and full dose of P_2O5 and K_2O (30:30:20 kg NPK/ha) was applied at final land preparation as basal dose. Remaining half dose of N was applied in two split doses one at active tillering stage and the next at panicle initiation stage. The data were tabulated treatment wise in MS-EXCEL and then data were processed to fit into MSTAT-C Micro Computer Programs (1990). Analysis of Variance (ANOVA) was developed. Under the rejection of null hypothesis Duncan's Multiple Range Test (DMRT), a mean separation technique was applied. The details of genotypes used as a treatment is listed below (Table 1).

Results and Discussion

The experimental findings were analyzed and an effort has been made to elicit the influences of various treatments on the growth and yield attributing characteristic of direct seeded upland rice genotypes. The results are expressed through table and graphs.

Growth and Growth Attributing Characters

Seedling vigour

Direct seeded upland rice germinates within 5 to 6 days after seeding. There was lots of variation seen in germination in the field. The seedling vigour was also found different among the tested varieties. There was significant difference in germination and vigourness of the seed as seen in table 2. Local varieties like Tauli had higher germination percentage (95.71%) followed by Chiuri (93.67%) and Pakhe jhinuwa (91.62%) while Rato Kanake had poor germination (72.57%). In case of improved genotypes, IR 55435-5 had higher germination percentage (88.90%) while Radha-32 had poor germination percentage (78.10%). Vigourness of the seeds had found higher in Tauli followed by Radha-32 and IR 55435-5. Local cultivar Parampyuri and Rato Kanake gave poor performance (Table 2).

S. No.	Genotypes	Seed Source	Remarks
1	IR 55435-5	NRRP, Hardinath, Dhanusa	Improved varieties
2	Ghaiya -2	NRRP, Hardinath, Dhanusa	Improved varieties
3	Radha-32	NRRP, Hardinath, Dhanusa	Improved varieties
4	Pakhe Jhinuwa (Local Check)	Tanahun/Lamjung	Popular Local varieties
5	Bandana	NRRP, Hardinath, Dhanusa	Pipeline varieties
6	Bindeshwori	NRRP, Hardinath, Dhanusa	Improved varieties
7	Parampyuri	Tanahun/Lamjung	Local varieties
8	Chiuri	Tanahun/ Lamjung	Local varieties
9	Tauli	Tanahun/ Lamjung	Local varieties
10	Rato Kanake	Tanahun/ Lamjung	Local varieties

Table 1: List of varieties included in experiments.

S. No.	Genotypes	Average leaf length (cm)	Average leaf width (mm)	Average leaf number	Average germination (%)
1	IR- 55435-5	5.000[a†]	2.850[abc]	4.000[a]	88.90[abc]
2	Ghaiya- 2	4.403[abc]	2.867[abc]	3.750[ab]	78.24[cd]
3	Radha-32	5.457[a]	2.598[c]	4.000[a]	78.10[cd]
4	Pakhe Jhinuwa (Local Check)	4.673[ab]	3.015[ab]	4.000[a]	91.62[ab]
5	Bandana	4.577[ab]	2.550[c]	3.500[ab]	88.19[abc]
6	Bendeswari	3.568[bcd]	3.165[a]	3.750[ab]	80.81[bcd]
7	Parampyuri	3.253[d]	2.733[bc]	3.250[b]	89.95[abc]
8	Chiuri	3.605[bcd]	3.017[ab]	3.500[ab]	93.67[a]
9	Tauli	5.090[a]	3.085[ab]	4.000[a]	95.71[a]
10	Rato Kanake	3.375[cd]	2.700[bc]	3.750[ab]	2.57[d]
	S.Em ±	0.3553	0.1214	0.1897	3.896
	LSD (0.05)	1.031	0.3524	0.5506	11.31
	CV%	16.52	8.53	10.13	9.09

Table 2: Evaluation of seedling vigour of direct seeded upland rice genotypes in 2005/06.

† Figure in column with the same letter are not significantly different (p = 0.05) according to Duncan's Multiple Range Test, S.Em ± = Standard Error of Mean Difference, LSD: Least Significant Difference, CV: Coefficient of Variation.

Total number of tillers/m² and chlorophyll content

There was statistically significant difference on number of tiller/m². The total number of tillers/m² was ranging from 165 to 329 (Table 3). The maximum and minimum number of tillers/m²was found in Radha-32 (329.0) and Parampyuri (165.0), respectively. The local varieties Pakhe jhinuwa, Parampyuri, Chiuri, Tauli and Rato Kanake were found statistically at par. It is interesting to note that the number of tillers/m² was less in case of indigenous varieties compared to all the tested improved varieties. Dutta., *et al.* [4] recorded the same nature of finding in rainfed condition.

Tillering usually begins with the emergence of the first tillers when seedlings have 5 leaves. This first tiller develops between the main stem and the second leaf from the base of the plant. Subsequently, when the 6th leaf emerge the 2nd tiller forms between the main stem and 3rd leaf from the base. Numerous environmental factors also affect tillering including spacing, light, nutrient supply and cultural practices [5].

Tillering starts in vegetative stage and takes about 22 to 60 days after seeding in medium duration varieties of rice. Tillers are continuously produced depending upon tillering ability of a variety [6].

The chlorophyll content was measured maximum at vegetative stage. It was measured by Minolta Chlorophyll Meter (SPAD-502). There was significant difference in chlorophyll content of the leaf (Table 3). Improved genotypes Radha-32 had higher (36.40) chlorophyll content in leaf followed by Bindeshwari (36.30) while Parampyuri had less (31.73) chlorophyll content in the leaf. The genotypes namely Pakhe Jhinuwa, Bandana, Chiuri and Tauli were found statistically at par. The improved variety had recorded the higher chlorophyll content than local variety [7]. The higher yield in tested improved genotypes might be due to the higher amount of net accumulation formed in the leaf of high chlorophyll containing leaves .

S. No.	Genotypes	Avg. No. of tiller/m²	Chlorophyll content (SPAD reading) at vegetative stage
1	IR- 55435-5	268.8 b†	33.83 abc
2	Ghaiya- 2	312.3 ab	36.20 a
3	Radha-32	329.0 a	36.40 a
4	Pakhe Jhinuwa (Local Check)	181.3 c	32.25 bc
5	Bandana	300.5 ab	32.35 bc
6	Bendeswari	263.5 b	36.30 a
7	Parampyuri	165.0 c	31.73 c
8	Chiuri	176.5 c	32.13 bc
9	Tauli	165.8 c	32.83 bc
10	Rato Kanake	166.0 c	35.45 ab
	S.Em±	15.63	1.052
	LSD (0.05)	45.35	3.052
	CV%	13.42	6.20

Table 3: Evaluation of leaf chlorophyll content and average number of tillers/m² of direct seeded upland rice genotypes in 2005/06.

† Figure in column with the same letter are not significantly different (p = 0.05) according to Duncan's Multiple Range Test, S.Em±= Standard Error of Mean Difference; LSD: Least Significant Difference; CV: Coefficient of Variation.

Days to heading

In rice crop generally heading starts three weeks after panicle initiation [8]. There were nonsignificant differences on days to heading among treatments (Table 4). Average heading started from 92 to 102.0 DAS. Generally, heading was completed within a week. Early heading was obtained in Bandana (92 days) and late in IR 55435-5 (102 days). Choudhary., *et al.* [9] have also found late heading in IR 55435-5 at RARS Nepalgunj under upland condition. In general, heading was significantly earlier in improved genotypes except IR 55435-5 and the local varieties were about one week late in maturity than improved genotypes except Pakhe Jhinuwa. Table on heading days has been presented in table 4.

Days to maturity

Maturity days were found different among the treatments. There were significant differences on days to maturity among the tested genotypes. Average maturity ranges from 114.5 to 136 days (Table 4). Early maturity was found in Bandana (114.5 days) and late in IR 55435-5 (136 days). But, Choudhary., *et al.* [9] have recorded 95 days maturity for cultivar Bandana and 108 days maturity for IR 55435-5 at RARS Nepalgunj under upland condition. While local varieties at Nepalgunj also showed almost similar pattern on days to maturity as obtained in this experiment.

Plant height

Plant height is one of the important parameters of rice as it determines or modifies the yield attributing characters and finally shapes the grain yield. For the ideal rice variety, the height of the plant should be medium type [10]. The analyzed data (Table 4) showed that there was significant difference on plant height among treatments at 5% level of significance. The plant height was ranged from 66.19 cm to 133.2 cm. The maximum plant height was found in Rato Kanake (133.2 cm) followed by Chiuri (132.2 cm), Tauli (130.4) and Parampyuri (129.6 cm). The local varieties were found taller as compared to improved genotypes. In case of improved genotypes, Bandana recorded the highest (114.3 cm) plant height whereas Ghaiya- 2 recorded the lowest (66.19 cm) plant height. The plant height of local varieties Pakhe jhinuwa, Parampyuri, Chiuri, Tauli and Rato Kanake were found statistically at par. Although the traditional upland varieties have large and thick culms, their leaves and culms reached senescence quickly before physiological maturity. Because of their tall structure and quick senescence, most upland varieties were susceptible to lodging before maturity. There was highly significant correlation (r = 0.872**) between plant height and panicle length. Sah., *et al.* [11] also found the highest plant height of traditional varieties (local varieties) in Chambas, Tanahun in farmers' field trial.

Flag leaf angle and chlorophyll content

The flag leaf angle was also recorded significantly difference among the tested genotypes. The flag leaf angle ranged from 5.750^0 (Bindeshwari) to 42.50^0 (Tauli) whereas, SPAD reading has also shown the significant difference among the tested varieties. Higher chlorophyll content in flag leaf before harvesting determines the higher grain yield of rice. It ranged from 10.27 (Tauli) to 19.74 (IR 55435-5) (Table 4). The chlorophyll content of leaf of varieties Ghaiya-2, Radha-32, Pakhe Jhinuwa, Bandana, Parampyuri and Chiuri were found to be statistically at par. There was highly significant correlation (r = 0.876**) between leaf angle and plant height. Flag leaf area and chlorophyll content during grain filling stage is proportional to grain yield [7].

Grain yield

Grain yield is the end product of treatment effect in the experiment and is the result of combined effect of growth, development and yield attributes. These parameters are governed by the heredity of the particular genotype, but at the same time the level of management and the environment to which the crop is exposed also modify them. Table 5 presents the performance of grain yield, straw yield, biological yield and harvest index of tested varieties in the experiment. The data pertaining to the grain yield of different varieties showed that all the tested genotypes showed significant differences at 5% level of significance. The maximum grain yield (3.79 t/ha) was obtained in Ghaiya-2 followed by IR 55435-5 (3.69 t/ha), Radha-32 (3.48 t/ha) andthe minimum in variety Rato Kanake (2.26 t/ha) (Fig. 2). However, the yields of improved genotypes namely Ghaiya-2 (3.79 t/ha), IR- 55435-5 (3.69 t/ha), Radha-32 (3.48 t/ha), Bandana (3.42 t/ha) and local check Pakhe Jhinuwa (3.28 t/ha) was found to be statistically at par. Bhurer and Gharti [12] also found the highest grain yield of Ghaiya-2 at ARS Bardiya condition.

The grain yield was not satisfactory in case of local varieties except Pakhe jhinuwa. Less number of tillers, poor grain setting andlodging could be the reasons for low yields of local varieties except Pakhe jhinuwa. Damage of plants and grains by field rats and birds was maximum in case of local varieties such as Chiuri, Tauli, Pakhe jhinuwa, Rato Kanake etc. This might be due to their attractive and drooping type of panicles, drooping flag leaf and lodging behavior. Most of the improved varieties were semi dwarf and did not lodge. The damage of grains by birds was less in the genotypes having erect flag leaf (improved genotypes like IR 55435-5, Radha-32, Ghaiya-2 etc.) than the varieties with drooping flag leaves (Local cultivars like Rato Kanake, Chiuri, Parampyuri etc.). The weed infestation was also higher in local varieties than improved varieties. The major yield attributing characters viz: length of panicle, 1000 grain weight and effective tillers/m^2 were also high in improved genotypes. The effective tillers/m^2 had significant correlation with grain yield (r = 0.733*). The contribution of grain yield by effective tiller/m2 was about 53%. The relationship between grain yield and effective tillers/m2 of direct seeded upland rice is presented below .

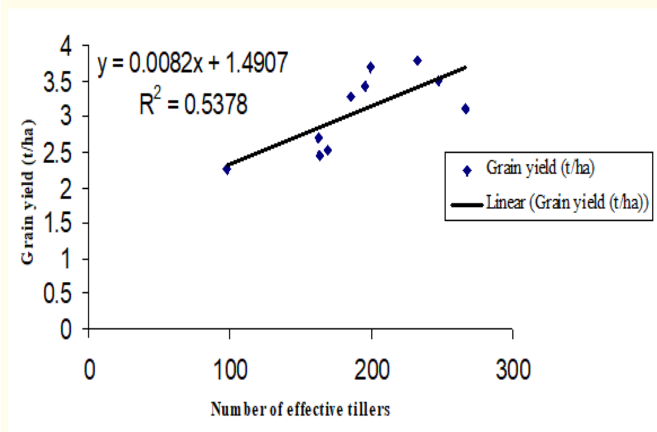

Figure 1: Relationship between grain yield and effective tillers/m^2 of direct seeded upland rice during 2005/06.

Conclusion

From the above, mentioned results, it can be concluded that, there is a significant difference among the tested genotypes in terms of growth and yield attributing characteristics. Local cultivar like Tauli, Chiuri, Pakhe Jhinuwa had higher germination percentage than improved cultivars. While local cultivar Rato Kanake (72.57%) had poor germination. Vigourness of the seeds was

S. No.	Genotypes	Total tillers/m²	No. of effective tillers/m²	Panicle length (cm)	Total grains/panicle	Test weight (g)	Grain yield (t/ha)
1	IR 55435-5	226.8 abc	199.3 bc	20.98 cd	91.00 cd	27.80 a	3.690 a†
2	Ghaiya-2	236.8 ab	232.8 ab	19.14 de	84.75 d	24.15 b	3.790 a
3	Radha-32	266.8 a†	247.5 a	20.38 cde	80.00 d	21.15 cd	3.483 ab
4	Pakhe Jhinuwa (Local Check)	203.5 bc	185.8 c	23.21 ab	166.0 a	20.80 cd	3.280 abc
5	Bandana	204.5 bc	195.3 bc	20.53 cde	125.5 bc	23.25 b	3.420 abc
6	Bindeshwori	270.3 a	266.5 a	18.94 e	72.75 d	19.85 d	3.112 abcd
7	Parampyuri	178.0 c	162.8 c	23.21 ab	128.8 b	21.15 cd	2.703 bcd
8	Chiuri	189.5 bc	168.8 c	23.61 a	167.5 a	21.38 c	2.523 cd
9	Tauli	176.5 c	163.3 c	21.56 bc	126.3 bc	23.30 b	2.477 cd
10	Rato Kanake	102.0 d	97.50 d	24.74 a	179.0 a	21.67 c	2.263 d
	S.Em±	15.41	14.35	0.6012	11.89	0.4390	0.291
	LSD (0.05)	44.73	41.63	1.745	34.51	1.274	0.845
	CV %	15.01	14.95	5.56	19.47	3.91	18.93

Table 5: Yield and yield attributing characters of direct seeded upland rice genotypes in 2005/06.

† Figure in column with the same letter are not significantly different (p = 0.05) according to Duncan's Multiple Range Test, S.Em±= Standard Error of Mean Difference; LSD: Least Significant Difference; CV: Coefficient of Variation.

found higher in Tauli followed by Radha-32 and IR 55435-5. It is interesting to note that, the number of tillers per square meter was less in case of indigenous/local cultivar compared to all the improved varieties. Leaf chlorophyll content was measured by Minolta Chlorophyll Meter (SPAD-502). The improved varieties had higher chlorophyll content than local varieties. Average heading started from 92 to 102 DAS. In general, heading was significantly earlier in improved varieties except IR 55435-5 and the indigenous genotypes were about one week late than improved genotypes except Pakhe Jhinuwa. While, maturity days were found different among the tested genotypes. The plant height ranged from 66.19 cm to 133.2 cm. The traditional varieties were found taller as compared to improved varieties. It is observed that, the length of panicles is higher in local cultivars than the improved cultivars. Test weight was found significantly different among tested genotypes. The flag leaf angle and its chlorophyll content was also found significantly different among the treatments. Higher chlorophyll content in flag leaf before harvesting determines the higher grain yield of rice. Effective tillers/m2 was found significantly different. Similarly, the number of grains per panicle was obtained maximum in most of the local genotypes as compared to improved genotypes. But the grain yield of these local cultivar was obtained less as compared to improved genotypes which is due to less number of tillers per unit area. The grain yield was not satisfactory in case of local cultivars except Pakhe Jhinuwa which is taken as local check. Less number of tillers, poor grain setting and lodging could be the reasons for low yields. Damage of field rats and birds was maximum in case of local varieties such as Chiuri, Tauli, Pakhe Jhinuwa, Ratokanake. Among the yield attributing characters (length of panicle, 1000 grain weight and effective tiller/m^2), grain yield had strong positive correlation with effective tillers/m^2 (r = 0.733*).

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