Varietal Evaluation and Preference Analysis of Sixteen Released Rice Varieties in Bhojad, Chitwan, Nepal

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Abstract**—** *A study on varietal selection trials for different varieties of rice (Oryza sativa L.) was conducted in the field of Nepal Polytechnic Institute, Bhojad, Chitwan, Nepal with the objective of identifying suitable, high yielding promising rice varieties for the interest of the farming community. The experiment was carried out using 16 different treatments of released rice varieties in Randomized Complete Block Design (RCBD) with the identity on growth parameters like plant height, several tillers per meter square, panicle length, and yield parameters like effective tillers per meter square, filled grains per panicle, sterility percentage thousand-grain in weight, grain yield, straw yield, and Harvest Index were recorded. Data was entered and tabulated using MS-Excel while Analysis of variation and mean separation was done using R-Studio. The variation among varieties was observed for various traits. The variety Bahugunidhan-2 produced the highest grain yield (5.9 t/ha) followed by Ramdhan with the yield of (5.25 t/ha). The statistical analysis showed that the variety Sukha Dhandhan-3 was found earlier in 50% heading (84.67days), and maturity (125days). It was closely followed by Sabitri and Ramdhan which took 87.67 days to 50% heading and 139 and 138 days respectively for days to attain maturity. The information on variation for the traits among studied rice varieties will be helpful to plant breeders in constructing their breeding materials and implementing selection strategies in the future. Inappropriate varietal evaluation and selection in our country have led to the less development of variety with high yield potential. Improvement and participatory selection of promising rice varieties by studying genetic variability, character association between yield traits, and farmer preference analysis help in rice breeding for the selection of best rice varieties in the Chitwan district of Nepal.*

Keywords— Harvest Index, Grain yield, Drought, Test weight, Maturity Indices.

I. INTRODUCTION

Rice is the principal staple food for more than 3.5 billion people worldwide (IRRI, 2017). Rice (*Oryza sativa L.)* belonging to Family Poaceae, Sub-family Oryzoideae, tribe Oryzae with chromosome number 24 is a perennial, self-pollinated, and semi-aquatic plant. Rice ranks third most staple crop after Maize & Wheat in the world in terms of production (*FAOSTAT*, n.d.). Its annual production in the world is 755473800 tons and the yield of 4661kg/ha in the year 2019(*FAOSTAT*, n.d.). Rice occupies first place in terms of area coverage, production, productivity, and preferences in Nepal and it contributes 15.35% to the AGDP (MOALD, 2020). With the increasing population, the global rice demand will rise to about 765 million tons by 2030 (Akon et al., 2015). Rice contributes nearly 20% to the agricultural gross domestic product (AGDP) and almost 7% to GDP, as well as it supplies 40% of food calorie intake (Neupane & Khadka, 2019). Nepal is one of the important centers of rice genetic resources (MoAD, 2015), having over 1,700 landraces of rice. Rice is cultivated under diversified agro-climatic zones in Nepal from terai (50masl) to mid-hills and high mountains valley (3050masl) in Jumla (the highest altitude of rice growing location in the world) (Kandel, 2018).

The intensity of use of improved seeds and inorganic fertilizers in cereals is very low in Nepal (Report, 2010), resulting in less exploitation of the land production potential. We cannot deny the fact that the use of new, high-yielding varieties, instead

of traditional rice varieties brought huge gains in yield, but the planting of a single variety over large areas year after year may compromise genetic resistance to pests (Khanal, 2017). IDespite65.6% of Nepalese people engaged in agriculture, the major problem here is food insecurity. There is significant role of rice farming in poverty reduction and food security, but ignoring this fact the investment made in the study and research of this crop is very low. As a result, rice yield growth has been negligible in the past two decades. The development of a nation is paced by agricultural development and rice is the most important sub-sector of agriculture in Nepal (Mahato & Adhikari, 2017). The country which used to export rice in the past, now imports about one milliotonson of milled rice every year. This causes a serious challenge to rural poverty reduction as well as to food and nutrition security in the country. The problem will become more serious in coming decades.

The attainable yield could not be achieved due to lack of efficient exploitation of use of varieties suitable in accordance to agro ecological niches, in accordance to soil fertility gradient and extent of use efficiency of major fertilizers results in low production of rice (Sarwar et al., 2011). Besides this the, rice cultivating area is decreasing due to human activities like urbanization and industrial expansion. Increasing the productivity of rice is the only option as there is no further chance for bringing more area under cultivation (Lamsal et al., 2018). The production and productivity of rice has not geared up as much as required with traditional system of cultivation despite a lot efforts are being made. By inviting farmers to make decisions in the research process, it is assumed that they will not only adopt but also, more importantly, adapt the available technology to their own needs and environment (Rice & Ashby, 2007). Moreover, varietal assessment leads to the study of yield and yield attributing traits which together with the farmer preference analysis helps in more effective crop breeding program. Also, there is a need to move forward from the Green Revolution to a 'gene revolution,' which is more productive and more 'green' in terms of conserving natural resources and the environment (Atkins & Bowler, 2020).

II. MATERIALS AND METHODS

The research entitled **'Varietal evaluation and performance analysis of promising rice genotypes in Bhojad, Chitwan, Nepal'** was carried out during rainy season of 2020. The trial was carried out at Bharatpur -11, Bhojad, Chitwan, Nepal located between longitudes 83°54' 45''to 84°48'15''E and latitudes 27°21'45'' to 27°52' 30''N. Research domain is Rain-fed lowland (Upto 250masl) with rice – mustard – maize / vegetables system. The experiment was laid out in one factorial Randomized Complete Block Design (RCBD) with three replications including 16 treatments with plot size: Gross: 3m × 2m = $6m^2$. Nursery was managed in the field of Nepal Polytechnic College which was raised with the sloppy surface at the middle so as to drain the water after rainfall quickly and the 30cm distance was kept between two consecutive beds. A total of 30 days old seedlings and 2 seedlings per hill were planted in the geometry of 20cmx20cm. The spacing between two consecutive plots was maintained 1m. All the necessary cultivation process and techniques were conducted by taking in consideration to maintain uniform plant population in each plots. Also the recommended application of inputs were done. Data were collected and observed as phenological observation and biometric observations. When most of the treatments reached 80% maturity, all of the varieties were subjected to an evaluation technique called "Preference Analysis" by farmers, extension workers, breeders and other stakeholders, inclusive of both men and women. The preference analysis (PA) of genotypes was done by casting votes for that genotype. The voting box was placed in each plot and sixteen cards i.e. 8 rights and 8 wrong were given in the hands of the farmers (male and female farmers) separately for casting votes. The right vote denotes the superior characters possessed by the genotypes to fit under local conditions while wrong denotes the inferior character. The preference index was calculated for each genotype by using the following formula.

$$\text{Preference index} = \frac{\text{No. of positive votes} - \text{No. of negative votes}}{\text{Total votes cast}}$$

Data entry and tabulation was done by using MS-Excel 2013 and for word processing MS-Word 2013 used. Statistical analysis for the yield and yield attributes were done through F-test and R-test and preference analysis was done on CGIAR model.

III. RESULTS AND DISCUSSION

3.1 Yield and yield attributing traits

The performance of different genotypes for yield and yield attributing traits is presented in table number 1 and 2. Results for effective tiller/m^2 was highest in Lakla basmati which is followed by the variety Sabitri, Ramdhan, Sukha Dhan-3, Samba

mansulisub-1, Sudodhan kalanamak, Sugandhit Dhan. The tallest plant height was recorded to be variety Sudodhan Kalanamak (165.11cm) followed by lalka basmati, Sugandhit dhan and the shortest height was found in Samba mansulisub-1 (93.22cm). The minimum maturity days was recorded in variety Hardinath-1. It was found that lalka basmati had largest panicle length i.e. 30.11 cm which is statistically at par with variety sabitri, Ram Dhan, Sukha Dhan-3 and Sukha Dhan-4. The variety Chaite-2 had significantly highest 1000 seed weight i.e. 25.6 gram followed by Bahugunidhan-1, Bahugunidhan-2, Sabitri, Ramdhan, Samba mansulisub-1, Sukha Dhan-4, Radha-4 Sukha Dhan-3. Bahugunidhan-1 had highest grain yield i.e. 5.96 ton/hector followed by Ram Dhan (5.25) and Sudodhan Kalanamak had the lowest grain yield i.e. 2.33 ton/hector. Bahugunidhan-2 had highest straw yield i.e. 10.4 kg which is statistically at par with Chaite-2 and Sukha Dhan-3 had the lowest straw yield i.e. 6.6 ton/hectare. Likewise, Bahugunidhan-1 had highest biological yield i.e. 16.4 ton/hector and Sukha Dhan-3 had the lowest biological yield i.e. 10.3 ton/hector. Moreover, Mithila Dhan has highest harvest index i.e. 40.

3.2 Preference Analysis

The preference score of different rice varieties on participatory varietal selection were presented in table 4.4. The total preference score was found highest in Radha-14 followed by Sugandhit-dhan and Bahuguni-2. Female preference score is highest in all 3 of the variety. According to them, the reason behind this preference is due to early maturity, long panicle, and shorter the plant height. In addition to this the filling nature of grain also ranked it in topmost. The preference score is minimum in Sudo-dhan Kalanamak followed by hardinath-1 and lalka basmati. Preference score is minimum in Sudodhan Kalanamak is due to its late maturity and lodging nature. However, grain yield was maximum in Bahuguni-2, the preference score was maximum in Radha-14 on participatory varietal selection. This indicates Radha-14 have some gene of farmer interest. The preference score and yield of Sudodhan Kalanamak was minimum. This was due to longer growth period of variety. Variation in test weight was proven statistically significant. It may be due to environment factor i.e. temperature effect seed weight and also correlated with moisture percentage (Nirmaladevi et al., 2016).

TABLE 1
YIELD ATTRIBUTING TRAITS OF DIFFERENT RICE GENOTYPES

Treatment	Effective tillers/m^2	Panicle length(cm)	Plant height (cm)
Lalka Basmati	424^{a}	30.11^{a}	154.46^{a}
Sabitri	410^{ab}	29.24^{ab}	125.47^{bc}
Ram Dhan	409^{ab}	29.03^{ab}	116.2^{cd}
Sukha Dhan-3	404^{abc}	28.94^{abc}	133.59^{b}
Sukha Dhan-4	401^{abcd}	28.84^{abc}	108.13^{d}
Samba mansulisub-1	399^{abcd}	28.77^{bc}	93.22^{e}
SudodhanKalanamak	398^{abcd}	28.7^{bc}	165.11_{a}
SugandhitDhan	397^{abcd}	28.57^{bc}	155.35^{a}
MithilaDhan	381^{bcd}	28.55^{bc}	123.41^{bc}
Radha-14	367^{cde}	27.68^{cd}	118.23^{cd}
Chaite-2	363^{de}	27.02^{d}	127.8^{bc}
Bahugunidhan-1	341^{ef}	26.92^{d}	126.28^{bc}
Radha-4	313^{fg}	26.46^{d}	132.8^{b}
Bahugunidhan-2	312^{fg}	24.9^{e}	124.3^{bc}
Hardinath-1	312^{fg}	24.2^{e}	106.99^{de}
Swarna-sub1	297^{g}	24.16^{e}	124.01^{bc}
F test	***	***	***
CV(%)	**6.2**	**2.87**	**6.6**
LSD (0.05)	**38.24**	**1.32**	**14.1**
Grand Mean	**370.4**	**27.63**	**127.2**

TABLE 2
YIELD AND YIELD ATTRIBUTING TRAITS OF DIFFERENT RICE GENOTYPES

Treatment	Grain yield ton/ha	Straw yield ton/ha	Biological yield ton/ha	HI	Test weight(g)
Lalka Basmati	3.05^{efg}	8^{cdef}	11.1^{fghi}	27.3	18^{de}
Sabitri	4.58^{abcd}	7.8^{cdefg}	12.4^{def}	36.1	22.4^{abc}
Ram Dhan	5.25^{ab}	8.4^{bcde}	13.6^{bcd}	37.9	22.2^{abc}
Sukha Dhan-3	3.76^{cdefg}	6.6^{h}	10.3^{i}	36.2	21^{bcd}
Sukha Dhan-4	2.5^{fg}	8.5^{bcd}	11^{ghi}	22.4	21.4^{bcd}
Samba mansulisub-1	4.05^{bcde}	7.5^{defgh}	11.6^{efghi}	34.8	21.6^{bcd}
SudodhanKalanamak	2.33^{g}	8.1^{cdef}	10.4^{i}	22.1	15.3^{e}
SugandhitDhan	$3.41d^{efg}$	7.1^{fgh}	10.5^{hi}	32.3	20.1^{cd}
MithilaDhan	4.55^{abcd}	6.7^{gh}	11.2^{fghi}	40.4	21.4^{bcd}
Radha-14	4.53^{abcd}	7.3^{efgh}	11.8^{efgh}	38.2	22.3^{abc}
Chaite-2	4.58^{abcd}	9.5^{ab}	14.1^{b}	32.4	25.6^{a}
Bahugunidhan-1	5.2^{abc}	8.5^{bcd}	13.7^{bcd}	25.4	24.3^{ab}
Radha-4	3.36^{defg}	8.6^{bcd}	11.9^{efg}	28.1	21.3^{bcd}
Bahugunidhan-2	5.96^{a}	10.4^{a}	16.4^{a}	36.2	23.1^{abc}
Hardinath-1	3.91^{bcdef}	8.6^{bcd}	12.6^{cde}	31	20.7^{bcd}
Swarna-sub1	5.03^{abc}	8.8^{bc}	13.9^{bc}	36.1	20.8^{bcd}
F test	**	***	***	**NS**	**
CV%	**21.5**	**8.71**	**6.43**	**27.04**	**10.5**
LSD (0.05)	**1.48**	**1.18**	**1.31**	**14.5**	**3.74**
Grand Mean	**4.13**	**8.1**	**12.3**	**32.35**	**21.3**

TABLE 3
PREFERENCE RANKING OF TESTED VARIETIES IN THE EXPERIMENT DURING 2020 (MALE=11, FEMALE= 14)

T.N	Varieties	Good		Total	Bad		Total	PI	Rank
		Male	Female	PS	Male	Female	NS		
T_1	Lalka Basmati	1	2	3	20	16	36	-0.0325	14
T_2	Sabitri	2	1	3	7	10	17	-0.0175	14
T3	Ram Dhan	6	6	12	0	4	4	0.02	10
T_4	Sukha Dhan-3	9	6	15	0	0	0	0.0375	7
T_5	Sukha Dhan-4	5	6	11	5	2	7	0.0225	9
T_6	SamaMansuli	4	5	9	9	12	21	-0.0075	13
T_7	SudodhanKalanamak	1	0	1	12	23	35	-0.055	17
T_8	SugandhitDhan	9	14	23	0	4	4	0.0475	3
T_9	MithilaDhan	4	8	12	2	0	2	0.03	8
T_{10}	Radha-14	8	20	28	2	0	2	0.07	2
T_{11}	Chaite-2	7	4	11	12	9	21	0.005	11
T_{12}	Bahugunidhan-1	9	10	19	0	1	1	0.045	5
T_{13}	Radha-4	9	8	17	0	0	0	0.0425	6
T_{14}	Bahugunidhan-2	9	10	19	2	0	2	0.0475	3
T_{15}	Hardinath-1	2	5	7	10	22	32	-0.0375	16
T_{16}	Swarna-sub1	3	7	10	7	9	16	0.0025	12
	Total ballots	88	112	200	88	112	200	0.22	

Note: PS=Preference Score, each farmer provided 8 good & 8 bad ballots, Preference index = (No. of positive votes – No. of negative votes)/ (Total votes cast)

IV. CONCLUSION

From the study, we can mitigate that a proper varietal assessment trial involving participatory preference selection can be proved to be an essential step towards food security and improvement of rice breeding program. As the varieties Bahugunidhan-2 (ranked 3rd in preference ranking) and Ramadhan (ranked 7th in preference ranking) showed higher grain yield per hectare as comparison to others so I, as a researcher suggest for cultivation for high yielding as well as preferred varieties. Likewise, Radha-4 ranked 1st in preference ranking and also had, moderate yield and test weight can also be suggested for cultivation in Chitwan. However, the farmers nowadays took key interest in traits such as plant height, days to maturity, disease pest resistance along with yield components. So, all these factors should be taken into consideration in any kind of research.

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AUTHORS DECLARATION

The authors declare that there is no any conflict of interest. Mr. Bishnu Bilas Adhikari designed the layout and work plan for this research while Babita Dhungana performed cultivation practices, recorded the data, Aakash Adhikari and Babita Dhunagana performed statistical analysis of data, revised the first draft minutely and elaborated the final manuscript for publication. All the authors have read the manuscript and approve the final version.

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