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Performance of some improved rice varieties under direct seeded rainfed upland condition of Nagaland

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ABSTRACT

A field experiment entitled "Performances of some improved rice varieties under direct seeded rainfed upland condition of Nagaland" was conducted to study the growth and yield performance under rainfed condition of Nagaland, at the School of Agricultural Sciences, Medziphema, Nagaland University, during kharif season of 2022-23. The experiment was laid out in Randomized Block Design (RBD) with three replications. Treatments viz., Kopilee, Jyoti Prasad, Dikhow, Joya, Chilarai, Kolong, Disang, Bishnu prasad, Luit, Lachit, and Leikhumo were studied. All the tested varieties were found to be semi-dwarf and dwarf varieties developed by Assam Agricultural University except Lekhimo (Nagaland local). In terms of growth and yield attributes, there were significant variations among different rice varieties. Leikhumo recorded significantly higher plant height (115.27 cm) among the tested varieties with the lowest, recorded in Bishnu prasad (74.01 cm). Chilarai showed superior parameters in terms of number of green leaves plant^{-1} (8.17), plant population m^{-2} (158), number of panicles m^{-2} (130), number of filled grains panicle^{-1} (124.33), test weight (25.55 g) and harvest index (42.95%), with Disang being the lowest viz., number of green leaves (6.06), plant population (110), number of panicles m^{-2} (91), number of filled grains (70.33), test weight (19.36 g) and harvest index (28%). In terms of crop growth rate and relative growth rate, Leikhumo performed the best whereas Disang variety was found inferior amongst all the varieties. Panicle length was also found to be highest in Leikhumo (26.20 cm) and the lowest in Disang (19.46 cm). Maximum grain yield was recorded in Chilarai (34.37 q ha^{-1}) followed by Joya (31.92 q ha^{-1}) and Leikhumo (29.62 q ha^{-1}).

Keywords: Growth, Upland, Direct seeded rice, Rainfed, Yield

INTRODUCTION

Rice (*Oryza sativa* L.) being an important staple food plays a key role for almost half of the world's population in terms of diet and food security. The socio and economic culture of rice is greatly intertwined in Asian countries, Asia; traditionally has the largest share in world rice production, with China (149.0 million metric tonnes) leading in production followed by India (132 million metric tonnes) (Anonymous, 2023). Rice all over the country is predominantly grown under two ecosystems; upland and lowland. In Nagaland, rice being a key diet crop is grown both in lowland and upland condition, cultivated over an area of 1, 22, 079 hectare with a production of 2, 40,924 metric tons (Nagaland Statistical Handbook, 2022). Upland ecosystem being the most diverse among the entire rice ecosystem is cultivated in permanent systems or Jhum/swidden cultivation or in block rotations wherein direct seeding is an inveterate form of sowing (i.e., broadcasting, seeding behind plough, drilling the seeds in small holes with minimum input (fertilizer, insecticide, fungicide and herbicide)). Direct seeding (DSR), known as the oldest know method of rice establishment dates back to more than a hundred years, is one of the most efficient, sustainable, and economically-viable system of rice production. Currently in Nagaland, about 90,740 acres of land is under direct-seeded cultivation, producing over 1,80,570 metric tonnes (Nagaland Statistical Handbook, 2022). DSR is a crop establishment system wherein rice seeds are sown directly into the field, as opposed to the traditional method of growing seedlings in a nursery and transplanting it into flooded fields. These direct seeding methods can be classified based on land preparation, seedbed condition, ways of sowing, and seed environment (aerobic or anaerobic) (Choudary *et al.,* 2023). Direct seeded rice system can be classified into: (1) Wet-DSR; In wet-DSR, pre-germinated seeds (radicle 1–3 mm) are broadcasted or sown in lines on wet/puddled soil (2) Dry-DSR; here,

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seeds are broadcasted or drilled in dry/ unpuddled soil. (3) Water seeding; Dry pre-germinated seeds are broadcasted in anaerobic standing water condition. Adoption of DSR can save water, labour and energy. It can also reduce greenhouse gas emissions and improve soil properties (especially soil physical properties) (Sen *et al*. 2021; Chaudhary *et al*. 2023).

DSR is imperative in agriculture context as it can provide food security, improve crop resilience under adverse climatic conditions and even give lucrative income, in areas with an assured water system. Jat *et al*. (2022) reported that adoption of DSR options significantly improved rice productivity and rice resilience and advanced seeding by 15 days. The role of DSR as a way to alleviate in-frequencies of water and labour forces, reduces environmental footprint and increase production and profitability (Jat *et al.,* 2019; Kumar *et al.,* 2021). Consequently, productivity and sustained environmental quality could be achieved through improved production (Nandan *et al.,* 2021). In regards to farmers growing low yielding land races and different rice cultivars, identification and selection of varieties suited for a particular location should be one of the foremost parameters to increase production and productivity of rice. This can serve as a paradigm to asses and address scarcity in specific areas, enabling provision for enough rice in the foreseeable future with sustainable approach.

MATERIALS AND METHODS

A field experiment was conducted at the experimental farm of SAS, Nagaland University, Medziphema campus, during the *kharif* season of 2022 to collate the performance of some improved rice varieties under direct seeded rainfed upland conditions. The research farm is situated in the foothill of Nagaland, Medziphema at an elevation of 305 meters above mean sea level with the geographical location at 200 45$^{/}$ 43$^{//}$ North latitude and 93^{0} 53$^{/}$ 04$^{//}$ East longitude. It lies in the mild tropical plain zone with the mean temperature ranges from 21^{o}C-23^{o}C during summer and rarely goes below 8^{o}C in winter due to high atmosphere humidity. The average annual rainfall ranges between 1500-2000 mm per annum. The soil of the experimental field was sandy loam in texture, well-drained having acidic reaction pH (4.5). Organic carbon was found to be high while N, P, and K content was found to be medium. The experiment was laid out in randomized block design with eleven (11) improved rice varieties grown in three replications. The different rice varieties used were V_1- Kopilee, V_2- Jyoti prasad, V_3- Dikhow, V_4- Joya, V_5- Chilarai, V_6- Kolong, V_7- Disang, V_8 -Bishnu prasad, V_9- Luit, V_{10}-Lachit, V_{11}- Leikhumo. Improved packages of practices were adopted in the field experiment. Data recorded on various growth and yield parameters of rice crop were analysed following standard statistical analysis of variance procedure.

RESULTS AND DISCUSSION

Growth attributes

The growth attributes of different rice varieties are presented in Table 1. The data showed that the growth parameters of different rice varieties differed significantly. Plant height was found to be the highest in Leikhumo (115.27 cm) followed by Kopilee (101.74 cm) and the lowest was found to be in Bishnu prasad (74.01 cm). Plant height ranged from 74.01cm to 115.27 cm. The increase in plant height might be due to better response of growth to the environment, increased inter node length, and genetic factors. Hussain *et al*. (2014) also reported that an increase in plant height is due to inter node elongation. An increase in plant height might also be due to different genotypes of rice varieties and plant environment during crop growing period which may be responsible for the difference in growth characters. This finding was in conformity with Singh *et al*. (2023) and Patel *et al*. (2019).

A significantly higher number of green leaves plant^{-1} (8.17) and plant population m^{-2} (158.67) was found in Chilarai and the lowest in Disang (i.e., 6.06 and 110.00, respectively). Crop growth rate at 20-40 DAS showed significant variation among different varieties tested. The superiority of crop growth rate at 20-40, 40-60 DAS was observed in cultivar Leikhumo (5.21 g m^{-2} day^{-1}), (7.12 g m^{-2} day^{-1}) respectively. The higher CGR in variety Leikhumo may be due to higher light interception, and higher production of dry matter. This result was in line with the findings of Hussain *et al*. (2014), Kikon *et al*. (2018) and

Patra *et al*. (2022) who reported that higher dry matter production resulted in higher crop growth rate. The lowest crop growth rate at 20-40, 40-60 DAS was observed in variety Disang (3.35 g m^{-2} day^{-1}), (3.86 g m^{-2} day^{-1}) respectively. Relative crop growth rate showed significant variation among the varieties tested. The superiority of RGR at 20-40, 40-60 DAS was observed in variety Leikhumo (0.037 g g^{-1} day^{-1}), (0.052 g g^{-1} day^{-1}) respectively. The lowest RGR at 20-40, 40-60 DAS was observed in variety Disang (0.015 g g^{-1} day^{-1}), (0.022 g g^{-1} day^{-1}) respectively.

Table 1: Growth parameters of different rice varieties

Variety	Plant height (cm)	No. of green leaves $plant^{-1}$	Plant population m^{-2}	Crop growth rate (g m^{-2} day^{-1}) DAS		Relative growth rate (g g^{-1} day^{1}) DAS	
				20-40	40-60	20-40	40-60
V_1-Kopilee	101.74	6.70	120.00	4.16	5.78	0.025	0.042
V_2-Jyoti Prasad	77.07	6.95	125.33	3.79	5.32	0.021	0.037
V_3-Dikhow	97.14	6.17	120.67	3.85	5.60	0.022	0.040
V_4-Joya	79.44	7.69	153.00	4.24	5.01	0.026	0.035
V_5-Chilarai	81.60	8.17	158.67	4.12	4.58	0.025	0.030
V_6-Kolong	89.54	6.27	119.67	3.90	4.78	0.022	0.044
V_7-Disang	89.20	6.06	110.00	3.35	3.86	0.015	0.022
V_8-Bishnu Prasad	74.01	7.31	148.67	4.08	4.94	0.025	0.042
V_9-Luit	90.95	6.40	125.00	3.60	3.98	0.018	0.023
V_{10}-Lachit	88.54	7.06	136.48	4.23	4.54	0.026	0.030
V_{11}-Leikhumo	115.27	7.50	130.00	5.21	7.12	0.037	0.052
SEm$\pm$	2.46	0.17	2.33	0.13	0.50	0.002	0.003
CD (P=0.05)	7.26	0.51	6.86	0.38	1.48	0.005	0.008

Yield attributes

The yield attributes of different rice varieties are presented in Table 2. The data showed that yield parameters of different rice varieties differed significantly. The number of panicles m^{-2} was found highest in Chilarai (130.00) which was statistically at par with Joya (123.32), Bishnu prasad (122.74), and Leikhumo (121.64). The lowest was observed in variety Disang (91.00). The variation in panicle m^{-2} might be due to the difference in number of effective tillers $plant^{-1}$. Similar results were also observed by Hossain *et al*. (2008) Mrudhula and Rao (2020) who reported that, effective tiller had a significant impact on a number of panicles m^{-2}. This result was also in accordance with the findings of Karthikraja *et al*. (2022) where significant differences in the number of panicles m^{-2} was observed among different rice varieties tested. The superiority of panicle length over another variety was found in Leikhumo (26.20cm), the lowest was observed in Disang (19.46cm). Variations in panicle length might be due to inherited traits of the varieties. Similar results were recorded by Shrestha *et al*. (2021) and Manickam *et al*. (2022). The highest number of filled grains $panicle^{-1}$ was observed in variety Chilarai (124.33) which was at par with Leikhumo (120.33) and the lowest number of filled grains $panicle^{-1}$ was observed in variety Disang (70.33). The genetic potential of the varieties might be the cause of varietal traits and variations in yield attributes. Similar findings were also observed by Ashrafuzzaman *et al*. (2009), and Giri *et al*. (2022). who reported the existence of variation in morphological and yield parameters in different rice varieties. Highest test weight was observed in variety Chilarai (25.55g) which was at par with Bishnu prasad (25.40g) and Leikhumo (25.27g). High test weight might be due to larger size of grains. Lowest test weight observed in variety Disang (19.36g), might be due to smaller seeds and fine grain type. This result was also in accordance with the findings of Halder *et al*. (2018) and Sundarrao and Roy. (2022). This variation could be due to difference in place of origin and genetic make-up of the genotypes (Roy and Roy, 2021)

The highest grain yield was observed in the variety Chilarai (34.37 q ha^{-1}), followed by Joya (31.92 q ha^{-1}) and Leikhumo (29.62 q ha^{-1}). Higher grain yield in variety Chilarai might be due to higher number of filled grains $panicle^{-1}$, number of panicles m^{-2}, test weight and low sterility percentage. Manickam *et al*. (2022) documented that yield was effectively contributed by number of productive tillers, grains panicle^{-1}, 1000 grain weight and spikelet fertility. Osman *et al*. (2012) also observed positive correlation of grain yield with percent filled spikelet and test weight, which was similar to the findings of Nayak *et al*. (2022) who observed an increased grain yield with higher number of filled grains. However, the lowest yield was observed in the variety Disang (17.00 q ha^{-1}) which might be due to poor grain filling ability and lower test weight. Similar finding was also observed by Bharali *et al*. (2017). Maximum straw yield was observed in cultivar Leikhumo (51.67 q ha^{-1}) and the lowest was observed in Jyoti prasad (33.66 q ha^{-1}). Higher straw yield may be due to its superiority in plant height, and profuse growth, which is correlated with poor dry matter partitioning to the sink. This result was in accordance with the findings of Shanta *et al*. (2020). The highest harvest index was observed in variety Chilarai (42.95%). However, it was at par with Joya, Bishnu prasad, Jyoti prasad, and Luit. The lowest harvest index was observed in variety Disang (28.00%). This result was also in conformity with the findings of Saha *et al*. (2017) and Tsukru *et al.* (2023) who reported significant variation in harvest index among different rice cultivars.

Table 2: Yield parameters of different rice varieties

Variety	No. of panicle m^{-2}	Panicle length (cm)	No. of filled grains panicle^{-1}	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
V_1-Kopilee	108.10	22.45	74.64	21.87	20.33	44.17	31.45
V_2-Jyoti Prasad	100.67	21.88	91.00	24.74	22.00	33.66	39.45
V_3-Dikhow	105.74	20.30	76.45	19.57	19.00	36.38	34.31
V_4-Joya	123.32	23.48	103.47	22.75	31.92	47.00	40.39
V_5-Chilarai	130.00	21.38	124.33	25.55	34.37	45.43	42.95
V_6-Kolong	105.71	20.54	75.81	22.64	21.50	40.65	34.35
V_7-Disang	91.00	19.46	70.33	19.36	17.00	43.58	28.00
V_8-Bishnu Prasad	122.74	22.58	93.74	25.40	29.10	39.07	42.67
V_9-Luit	115.67	22.14	80.74	23.57	23.00	35.00	39.55
V_{10}-Lachit	119.45	21.98	74.14	22.78	21.00	40.33	34.19
V_{11}-Leikhumo	121.64	26.20	120.26	25.27	29.62	51.67	36.45
SEm$\pm$	2.89	0.97	3.01	0.56	1.69	1.04	1.72
CD (P=0.05)	8.54	2.87	8.89	1.64	4.99	3.07	5.09

CONCLUSION

Based on the result of this experiment, the superiority of growth attributing characters were seen the best in Leikhumo, Chilarai and Joya. In contrast with the rest of varieties tested Chilarai, Joya and leikhumo gave higher yield attributes of which Chilarai (34.37 q ha^{-1}) produced the highest yield which was followed by Joya (31.92 q ha^{-1}) and Leikhumo (29.62 q ha^{-1}). Thus, it can be evidently concluded that variety Chilarai, Joya, and Leikhumo with its superior outcome were favourably suitable to be grown under direct seeded rainfed upland condition of Nagaland.

REFERENCES

Anonymous. (2022) Nagaland Statistical Handbook (2022) Directorate of Economics and Statistics, Government of Nagaland, Kohima.

Anonymous. (2023) World Agriculture Production.

Ashrafuzzaman, M., Islam, M. R., Ismail, M. R., Shahidullah, S. M. and Hanafi, M. M. (2009) Evaluation of six aromatic rice varieties for yield and yield contributing characters. *International Journal of Agriculture and Biology.* **11**: 616 - 620.

Chaudhary, A., Venkatramanan, V., Kumar, M. and Sharma. S. (2023) Agronomic and Environmental Determinants of Direct Seeded Rice in South Asia. *Circular Economy and Sustainability.* **3**. P 253–290.

Giri, D., Dhital, M., Chaudhary, B., Pandey, R., Bastakoti, B., & Shrestha, S. (2022) Effect of different nitrogen levels on yield and yield attributes of different rice varieties in DDSR conditon at Kanchanpur, Nepal. *Archives of Agriculture and Environmental Science*. **7**(3): 310-317.

Halder, J., Rokon, G. M., Islam, M. A., Salahin, N., and Alam, M. K. (2018) Effect of planting density on yield and yield attributes of local aromatic rice varieties. *Bangladesh Journal of Agricultural Research*, **43**(3):489-497.

Hossain MB, Islam MO, Hasanuzzaman M. (2008) Influence of different nitrogen levels on the performance of four aromatic rice varieties. *International Journal of Agriculture and Biology*. **10**: 693-696.

Hussain, S., Fujii, T., McGoey, S., Yamada, M., Ramzan, M., and Akmal, M. (2014) Evaluation of different rice varieties for growth and yield characteristics. *JAPS: Journal of Animal & Plant Sciences*. **24** (5): 1504-1510

Karthikraja, M., Sudhakar, P., Ramesh, S., and Kumar, B. S. (2022) Evaluation of rice varieties for growth and yield performance in aerobic cultivation. *International Journal of Plant & Soil Science*. **34**(20): 532-538.

Kikon, N., Gohain, T., Ezung, N. K., and Angami, T. (2018) Crop and weed growth in direct-seeded rice cultivars as affected by different weed management practices under rainfed conditions of Nagaland, India. *International Journal of Current Microbiology and Applied Sciences*. **7**(2): 590-601.

Kumar, R., Mishra, J.S., Mali, S.S., Mondal, S., Meena, R.S., Lal, R., Jha, B.K., Naik, S.K., Biswas, A.K. and Hans, H. (2021) Comprehensive environmental impact assessment for designing carbon-cum-energy efficient, cleaner and eco-friendly production. system for rice-fallow agro-ecosystems of South Asia. *Journal of Cleaner Production*. 331. 129973.

Jat. R., Meena, V., Kumar, M., Jakkula, V., Reddy, I. and Pandey, A. (2022) Direct Seeded Rice: Strategies to Improve Crop Resilience and Food Security under Adverse Climatic Conditions. *Land*. 11. 382. 10.3390/land11030382.

Jat, S., Parihar, C., Singh, A., Kumar, B., Choudhary, M., Nayak, H., Parihar, M., Parihar, N. and Meena, B. (2019) Energy auditing and carbon footprint under long-term conservation agriculture-based intensive maize systems with diverse inorganic nitrogen management options. *Science of the Total Environ*ment. 664. 659–668.

Manickam, S., Suganthy, M., Sunitha, R., Jansirani, R., Krishna, R. and Ganesh, R. (2022) Evaluation of traditional varieties of rice (*Oryza sativa* L.) for yield under Organic production system. *Indian Journal of Agricultural Research*. DOI: 10.18805/IJARe. A-5852

Mrudhula, K.A. and Rao, C. R. (2020) Effect of sowing window on growth parameters and yield of different rice varieties in Krishna western delta. *Journal of Pharmacognosy and Phytochemistry.* **9**(4): 1081-1085.

Nandan, R., Poonia, S.P., Singh, S.S., Nath, C.P., Kumar, V., Malik, R.K., McDonald, A. and Hazra, K.K. (2021) Potential of conservation agriculture modules for energy conservation and sustainability of rice-based production systems of Indo-Gangetic Plain region. *Environment Science and Pollution Research*. **28**: 246–261.

Nayak, K., Sar, K., and Mishra, G. (2022) Growth and yield of rice (*Oryza sativa* L.) varieties as influenced by nutrient management practices under irrigated-aerobic condition. *Indian Journal of Ecology*. **49**(5): 1710-1713.

Patel, J., Tiwari, R. K., Singh, S., and Namdeo, K. N. (2019). Response of rice (*Oryza sativa L.*) varieties to nitrogen under direct-seeded condition. *Annals of Plant and Soil Research.* 21(3): 285-288.

Patra, B., Jena, S., Mishra, P., kumar Sahoo, H., Gantayat, B.P. and Mangaraj, S. (2022) Dry matter partitioning of rice crop as infuenced by Date of planting and Nutrient Management. Research square. DOI:10.21203/rs.3.rs-1526659/v1.

Roy, M. and Roy, B. (2021) Establishment of alternative season for cultivation of photoperiod-sensitive traditional rice cultivars. *International Journal of Plant and Soil Science*. **33**(16):93-107.

Saha, B., Panda, P., Patra, P. S., Panda, R., Kundu, A., Roy, A. S., and Mahato, N. (2017) Effect of different levels of nitrogen on growth and yield of rice (*Oryza sativa* L.) cultivars under terai-agro climatic situation. *International Journal of Current Microbiology and Applied Sciences*.**6** (7): 2408-2418.

Sen, S., Kaur, R., Das, T. K., Raj, R., and Shivay, Y. S. (2021) Impacts of herbicides on weeds, water productivity, and nutrient-use efficiency in dry direct-seeded rice. *Paddy and Water Environment*. **19**(1): 227-238.

Shanta, C. M., Ramesha, Y. M., Krishnamurthy, D., Umesh, M. R. and Bhanuvally, M. (2020) Growth and yield response of direct seeded rice (*Oryza sativa* L.) to dates of sowing and varieties. *International Journal of Chemical Studies*. **8**(4):295-299.

Shrestha, J., Subedi, S., Kushwaha, U. K. S. and Maharjan, B. (2021) Evaluation of rice genotype for growth, yield and yield components. *Journal of Agriculture and Natural Resources*. **4** (2): 339-346.

Singh, Mahender., Banotra, M., Sharma, C., Sharma, R., Sharma, V. and Sharma, B.C. (2023) Weather based Agro indices and yield of direct seeded rice (*Oryza sativa*) as influenced by different dates of sowing and varieties in Union Territory of J&K, India. *Ecology Environment and Conservation*. pp. S124-S128.

Sundarrao. G. S. and. Roy, B. (2022) Morphological depiction of seeds of landraces of rice (*Oryza sativa* L.). *International Journal of Environment and Climate Change*. **12**(11): 3010-3025.

Tsukru, S., Singh, P.K., and Pandey, M. (2023). Effect of Nitrogen and Phosphorus levels on growth and yield of direct-seeded rice (*Oryza sativa* L.) under Nagaland conditions. *Annals of Plant and Soil Research* 25 (1): 120-126.