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EVALUATION OF COARSE RICE VARIETIES UNDER THE AGRO-ECOLOGICAL ZONE OF MANSEHRA, KHYBER PAKHTUNKHWA, PAKISTAN

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A B S T R A C T

The conducted research aims to compare coarse rice's performance under the Mansehra agro ecological zone. Two consecutive rice varieties i.e. Royal Early and Fakhr-e-Malakand (check variety) were planted. The experiment was conducted at Agriculture Research Station Baffa, Mansehra, during the 2022 rice-growing season. The experiment was designed in a randomized complete block design (RCBD) with three replications. Data were recorded on various morphological and yield attributing traits characters, i.e. days to emergence, number of tillers/m^2, plant height (cm), leaf area (cm), days to maturity, 1000 grain weight (g), and grain yield (kg ha^{-1}). Analysis of variance showed that all characteristics were significantly different among different rice varieties. The variety Fakhr-e-Malakand (check variety) recorded a maximum plant height of 81 (cm), the maximum 1000 grain weight (27.11 g), and has high grain yield (2888.43 kg ha^{-1}), followed by Royal Early (1046.63 kg ha^{-1}). Based on these results it is recommended that Fakhr-e-Malakand is more suited to the agro-ecological zone of Mansehra, showing superior performance in terms of growth and yield.

Keywords: Agronomic traits, Crop Performance, Morphology, Rice Verities, Yield Components.

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INTRODUCTION

Rice is the world's second-most important cereal crop after wheat, and it is used for more than (50%) of the food that the world's population foods. Asia produces and consumes about (90%) of the rice (Seck *et al*., 2012). Across the world, the remaining (10%) of rice land is dispersed. It is estimated that by 2025, the world population will reach 8 billion. Rice production is rising despite China producing (187.45 million tons) of rice across (33.1 million ha^{-1}) (Shah et al., 2020). Rice is a nutritious food that contains protein (6-12%), carbohydrates (70 80%), minerals (1.2-2%), vitamins, and lipids (Adnan et al., 2020; Qu et al., 2017). It is estimated that more than (80%) of the world's population depends directly or indirectly on it. Rice is grown in Pakistan as a food, cash crop, and the second most important export commodity after cotton. Rice planted area increased by (6.4%) from (2.724 million hectares) in 2017-18 to (2.899 million hectares) in 2018-19. In actuality, rice production increased by (8.7%) over the previous year, from (6859 thousand tons) to (7442 thousand tons). Exports of rice to Pakistan brought in (1.53 billion US dollars), or (0.7%) of its GDP (Hussain et al., 2022). The provinces of Punjab and Sindh, with Baluchistan, contribute 90% of the overall production and Khyber Pakhtunkhwa. The major rice-producing areas of Khyber Pakhtunkhwa are Malakand division, including D.I. Khan, Swat, Dir. Lower and Dir upper (Sabri et al., 2020). Seven percent of the global rice market is shared by Pakistan (Sharifi and Ebadi, 2018). Pakistani basmati rice is well known worldwide for its quality and aroma, and (94%) of it is produced in Punjab alone (Shah et al., 2020) Millions of farmers depend on rice farming as their main source of employment and income. The average yield of (2024 kg per hectare) is achieved by cultivating rice in an area of (55,255 hectares) in the Khyber Pakhtunkhwa (KPK) province (Ahamed et al., 2021). According to (Abid et al., 2014) , rice crop production

increased due to a comparable increase in per-hectare yield during the past few years despite a decline in the area under rice cultivation. Rice is also grown in the Mansehra region with a yield of (5.672 million tons) at an average yield of (2,448 kilograms per hectare) in an area of (2.317 million hectares) (Kamal Jan and Khan, 2019). Statistics clearly show that average yields at the district, provincial, and even national levels are relatively low. To quickly meet the needs of the growing population, it is imperative to replace low-yielding varieties with high-yielding and disease-resistant varieties. The Mansehra agro-ecological zone in Khyber Pakhtunkhwa, Pakistan, is a crucial area for rice cultivation, characterized by its different climatic and soil conditions. This region capability a range of temperatures and variable precipitation patterns, which can significantly influence rice growth and productivity (Ali *et al.,* 2021). Given rice's economic and nutritional importance, optimizing production in this region is vital for local food security and agricultural sustainability (Khan et al., 2018). Comparing the coarse rice varieties Royal Early and Fakhr-e-Malakand in this agro-ecological zone is essential for several reasons. Each variety has distinct characteristics that may influence its performance under the specific conditions of Mansehra. By evaluating these varieties, the study aims to identify which one is the best adaptability, yield potential, and disease resistance in this region (Shah et al., 2020; Kamal Jan & Khan, 2019). Therefore, the purpose of this study is as follows. To evaluate the performance of two coarse rice varieties, Royal Early and Fakhr-e-Malakand, in the Mansehra agro-ecological zone. By evaluating key agronomic traits such as days to emergence, plant height, leaf area, days to maturity, and grain yield, this study aims to determine which variety performs better under the local conditions. Assess the grain yield and overall productivity of Royal Early and Fakhr-e-Malakand under local growing conditions. Identify the rice variety that shows superior adaptability and performance in the specific agro-ecological conditions of Mansehra.

MATERIAL AND METHODS

The experiment was conducted at the Agricultural Research Station Baffa, Mansehra during the 2022 rice-growing season. Two rice genotypes were evaluated in the experiment, and these genotypes were named Royal Early and Fakhr-e-Malakand. The experiment was performed using a randomized complete block design (RCBD) with three replicates. Each plot measured 5m x 5m, and the spacing between rows and plants was maintained at 20 cm x 15 cm, respectively. The soil of the experimental site were loam with a pH of 6.5. The field were prepared using conventional tillage practices, including plowing, harrowing, and leveling. Seedlings were transplanted 25 days after nursery sowing at a density of 33 hills per square meter. Summertime temperatures fluctuate from 19.1^{o}C to 66.38^{o}F with annual rainfall (128.22mm). The soil is clay loam suitable for growing rice. The field watered to prepare for transplantation, and then water was applied to make puddles. After 35 days of sowing, the nursery was transplanted into a prepared paddy field (with water). The recommended dosage of fertilizer is NPK @ 120,60,0 kg ha^{-1}. Weed control was managed through manual weeding at 20 and 40 days after transplanting. Irrigation provided regularly to maintain a standing water depth of 5 cm throughout the growth period. Pest and disease management followed integrated pest management (IPM) practices, including the use of resistant varieties and bio pesticides. The data has been collected for various growth factors on days to emergence, number of tillers/m^2, plant height (cm), leaf area (cm), days to maturity, grain weight (g), and grain yield (kg ha^{-1}). During the growth phase, all the necessary agronomic procedures are carried out. Harvesting was performed manually when the grains reached full maturity, and the yield data were recorded from the central 3m x 3m area of each plot to avoid border effects. In the experimental material, no apparent disease onset was observed. The data was statistically analyzed using Microsoft Excel and Statistic 8.1 software according to the model for the randomized complete block. Means of different traits were separated at a probability level of 5% using the least significant difference (LSD) test (Steel and Torrie, 1980).

RESULTS

Significant differences were observed in rice authenticity for all parameters studied (Table 1 and Table 2). When (Riaz et al., 2014) conducted a trial to determine the correlation and level of significance between two rice varieties, namely Royal early and Fakher-e Malakand (cheek variety), they reported the same results (Ullah et al., 2016) also found highly significant correlations between the various traits.

50% Days to Emergence

Days to emergence were recorded when 50% of plants emerged in each plot. The results of ANOVA showed that there were significant differences in the emergence days of rice Genotypes from 16 to 21. Maximum days to emergence 21 were observed for Fakhr-e Malakand, while Minimum days to emergence 21 were recorded for Royal Early (Ali and Rahman, 2014) showed similar findings about the number of days before the emergence of multiple rice

genotypes.

Days to Maturity

When 50% of the plants in each plot matured, the number of days to maturity was noted. The days of maturity of the genotypes ranged from 108 to 113 days. The minimum days to maturity for Royal Early were 108, while the maximum days to maturity for Fakhr-e-Malakand was 113. As a result of genetic control, water scarcity, and rice maturity (Maurya et al., 2018) observed that the flowering phase of the plant is ultimately shortened.

Leaf Area (cm)

The primary source of nutrients for plants is their leaves. Measurement of the flag leaf is a crucial selection factor in programs for rice breeding. Flag leaf is the most significant source of photosynthesis products, according to (Makino et al., 2022), which translocates the filling stage and directly increases seed size. The flag leaf length among the genotypes varied from 17.43 to 22. The minimum flag leaf length of 17.43 was observed for Royal Early, while the maximum flag leaf length of 22.64 was recorded for Fakhr-e-Malakand.

Plant Height (cm)

Data on plant height was collected when the crop reached full maturity. All of the evaluated materials showed significant differences for these attributes, according to variance analysis. The results are also compared with (Shrestha et al., 2021) findings about variations in plant height among rice genotypes. Plant height among the genotypes varied from 78.38 to 107.05 cm. Royal Early manifested the minimum plant height of 78.38 cm, while the maximum plant height of 107.05 cm was measured for Fakhr-e-Malakand.

Table 1: Comparative analysis of various rice genotypes under agro-climatic growth parameter conditions for days to 50% emergence, days to maturity, flag leaf area index (cm), and plant height (cm).

Genotypes	Days to 50% emergence	Days to maturity	Leaf area (cm)	Plant height (cm)
Fakher-e-Malakand	21.0	113.00	22.64	81.00
Royal Early	16.00	108.00	17.43	75.00
LSD	1.43	2.48	2.48	2.48

Number of Tillers / m^2

Significant variations were observed for all studied genotypes. Twelve genotypes of coarse rice showed significantly significant variance in the number of tillers per plant, according to (Shrestha et al., 2021). The number of tillers /m^2 among the genotypes varied from 566.00 to 570.67 tillers. According to (Siddique et al., 2021) findings, the most productive tillers lead to the maximum yield. Minimum numbers of tillers/m^2 560.00 were observed for Royal Early while maximum numbers of tillers/m^2 570.67 were recorded for Fakhr-e-Malakand. These results were confirmed by (Suman et al., 2021), which showed that, according to the new plant type idea, cultivars with fewer tillers (20–25 tillers/plant) will produce higher yields than those with 15–17 tillers.

Panicle Length (cm)

The results showed that there were significant differences in the panicle length of different genotypes of rice, ranging from 18.66 to 23 cm. Royal Early manifested the Minimum panicle length of 18.66 while the maximum panicle length of 23.00 was measured for Fakhr-e- Malakand. Under climatic stress, the number of panicles is reduced, further demonstrating the impact of genetic variability on phenotypic performance. According to (Hussain et al., 2022), the evaluation of 13 genotypes revealed a strong correlation between high genetic advance genotypes and increased panicle weight and length.

1000-Grain Weight (g)

The result showed that the significant differences in rice genotypes for 1000 grain weight among the genotypes varied from 24.21 to 27.11. The rice genotype of Fakhr-e manifested maximum grain weights of 27.11- Malakand, while minimum grain weights of 24.21 were measured for Royal Early. Accordingly, statistical analysis by (Dash et al., 2022) revealed that the Flag leaf area affected the grain weight and correlation under study. The biotic and abiotic components such as (adaptability, temperature, soil fertility, transplantation season, and time) factors are responsible for the uniformity of this result and the thousand-grain weight. The association features of several genotypes of basmati rice, which are very significant and have high genetic variation for thousand-grain weights, are said to corroborate this finding, according to (Kharel et al., 2018).

Grain Yield (kg ha^{-1})

The primary factor that decides the future of breeding material is yield. There were discernible differences across the tested genotypes for the yield per hectare and other indices. The twelve genotypes of coarse rice were shown to differ significantly in grain yield (Khan et al., 2018). The environment may cause the variation in grain yield

(Debsharma et al., 2020) or the association between grain yield and other yield-contributing traits including soil fertility grains/panicle, full grains/panicle, and grain weight. Analysis of variance showed that there were significant differences in the yield of different rice genotypes, ranging from 1046.63 kg ha^{-1} to 2888.43 kg ha^{-1}. The Royal Early rice genotype had the lowest yield of 1046.63 kg ha^{-1} while the highest yield of Fakhr-e-Malakand was 2888.43 kg ha^{-1}.

Table 2: Comparative analysis of different rice genotypes under agro-climatic conditions of growth parameters for panicle length (cm), number of tillers/m^2, 1000-grain weight, and grain yield (kg ha^{-1}).

Genotypes	Panicl length (cm)	Number of tillers /m^2	1000-grain Weight (g)	Grain yield (kg ha^{-1})
Fakhr-e- Malakand	23.00	570.67	27.11	2888.43
Royal Early	18.66	566.00	24.21	1046.63
LSD	2.48	2.86	1.43	263.60

DISCUSSION

During the study, all plants were cultured using standard cultivation methods and plant protection measures were applied as needed. The findings indicated that the maximum effective days to maturity and the number of tillers per square meter could be influenced by several factors, including climate, temperature fluctuations, plant health, physical damage during planting, and other cultural practices. The study showed significant differences in the days required for 50% emergence among the rice genotypes. Specifically, the Fakhr-e-Malakand variety showed maximum emergence, while Royal Early had minimum days to emergence. Our finding is also in line with (Khan *et al.*,2018) noted similar findings regarding the variability in emergence times among different rice varieties.

Days to Maturity of Fakhr-e-Malakand had the maximum maturity period at 113 days, compared to Royal Early, which matured in 108 days. This longer duration means Fakhr-e-Malakand takes more time to fully develop, which could lead to better grain development and potentially higher yields. Our finding is also in line with by (*Khan et al.*,2018), this extended maturity period is significant among rice genotypes. Fakhr-e-Malakand is more suited to regions with longer growing seasons where it can mature completely without facing early frost, whereas Royal Early, with its shorter maturity time, is better for areas with shorter growing seasons.

Leaf Area of Fakhr-e-Malakand exhibited a larger flag leaf area (22.64 cm) compared to Royal Early (17.43 cm). A larger leaf area enhances the plant's capacity for photosynthesis, which is crucial for optimal grain filling and yield. The increased leaf area of Fakhr-e-Malakand can interpret into greater biomass accumulation and potentially higher grain yields, as it improves the plant's ability to capture sunlight and convert it into energy for grain development as similar finding with (Makino *et al.,* 2022).

Plant Height of Fakhr-e-Malakand, with a height of 81 cm, is maximum than Royal Early at 75 cm. This greater height indicates a more vigorous growth habit, which can enhance light capture and root development. However, taller plants are more prone to lodging, especially during severe weather or heavy rain our finding is also in line with (Shrestha *et al.*, 2021). Managing this height may require extra practices, such as staking or adjusting plant spacing, to minimize lodging and optimize performance.

Number of Tillers per/ m^2 of Fakhr-e-Malakand produced a higher number of tillers per square meter (570.67) compared to Royal Early (566.00). A greater number of tillers is generally associated with higher yield potential, as it can lead to an increased number of panicles and ultimately more grains per unit area. This characteristic suggests that Fakhr-e-Malakand might be more productive under conditions where increasing tiller number interprets directly into higher yields as similar findings with (Siddique *et al.,* 2021). However, the benefits of increased tillering must be balanced with considerations of plant density and competition among tillers.

Panicle Length of Fakhr-e-Malakand had a longer panicle length (23 cm) compared to Royal Early (18.66 cm). Longer panicles can support a higher number of grains per panicle, contributing to greater yield potential. The increased panicle length of Fakhr-e-Malakand aligns with findings by (Hussain *et al.* 2022), who reported that longer panicles are positively correlated with higher yield. This trait enhances the genotype's overall productivity.

1000-Grain Weight of Fakhr-e-Malakand's 1000-grain weight of 27.11 g was higher than Royal Early's 24.21 g. The larger grain weight indicates better grain-filling productivity and overall seed quality. This trait is crucial for determining the market value and processing quality of the rice. Higher grain weight in Fakhr-e-Malakand recommends that it may have superior grain-filling characteristics, which can contribute to its higher yield with findings by (Dash *et al.,* 2022).

Grain Yield of Fakhr-e-Malakand give maximum yield of 2888.43 kg ha^{-1}, significantly higher than Royal Early's 1046.63 kg ha^{-1}. This substantial difference underscores Fakhr-e-Malakand's superior productivity, which can be attributed to its extended maturity period, larger leaf area, increased plant height, higher number of tillers, longer panicles, and greater grain weight. The higher yield reflects the genotype's ability to perform well under favorable conditions, though its performance may vary based on environmental factors and management practices with findings by (Debsharma *et al.*, 2020).

CONCLUSIONS

It is concluded from the results Fakhr-e-Malakand showed maximum for 50% days to emergence (21 days) compared to Royal Early (16 days). Fakhr-e-Malakand showed a longer maturity period (113 days) compared to Royal Early (108 days), which might permit more thorough grain development and potentially higher yields. Fakhr-e-Malakand also had a greater plant height (81 cm) than Royal Early (75 cm), which can benefit light capture and root development but also makes it more susceptible to lodging under adverse weather conditions. Additionally, Fakhr-e-Malakand's larger leaf area 22.64 cm as compared to Royal Early 17.43 cm a higher photosynthetic capacity, crucial for grain filling and yield. With more tillers per square meter (570.67 compared to 566.00), Fakhr-e-Malakand shows a higher potential for grain production, and its higher 1000-grain weight (27.11g compared to 24.21 g) indicates better grain quality. Ultimately, Fakhr-e-Malakand showed a significantly higher grain yield (2888.43 kg ha^{-1}) compared to Royal Early (1046.63 kg ha^{-1}), making it the more suitable variety for cultivation in the Mansehra region due to its superior agronomic traits and yield potential. These findings showed that Fakhr-e-Malakand is a more suitable variety for cultivation in the Mansehra agro ecological zone due to its higher yield potential and superior agronomic traits. It is a recommended variety for local farmers aiming to improve yield and farm resilience.

CONFLICT OF INTEREST

The authors declare that there is no conflict in the publication of this article.

AUTHOR'S CONTRIBUTION

All the authors contributed equally in the manuscript.

REFERENCES

Abid, S., Shah, N.A., Hassan, A., Farooq, A., Masood, M.A., 2014. Growth and trend in area, production and yield of major crops of Khyber Pakhtunkhwa, Pakistan. Asian Journal of Agriculture and Rural Development 4, 149-155.

Adnan, M., Fahad, S., Zamin, M., Shah, S., Mian, I.A., Danish, S., Zafar-ul-Hye, M., Battaglia, M.L., Naz, R.M.M., Saeed, B., 2020. Coupling phosphate-solubilizing bacteria with phosphorus supplements improve maize phosphorus acquisition and growth under lime induced salinity stress. Plants 9, 900.

Ahamed, M.S., Chowdhury, M.R., Mas-Ud, M.A., Ahmed, S., Hossain, M.S., Matin, M.N., 2021. Analysis of genetic variability, heritability and correlation among Bangladeshi local rice cultivars (Oryza sativa L.). Pak J Agric Res 34, 356-361.

Ali, A.Z.N.A.A., Rahman, M.J.N.H.J., 2014. Performance of different rice genotypes in the cold climatic region of Malakand division.

Dash, D., Pattanaik, D., Panda, D., Dey, P., Baig, M., Rout, G., Paikray, R., Samal, K., Panda, R., Gupta, A.K., 2022. Effect of Low Light Stress on Plant Height, Tiller Number, Panicle Number, Leaf Area and Yield of Long Duration Rice (Oryza sativa. L) Varieties. International Journal of Environment and Climate Change 12, 1177-1183.

Debsharma, S., Disha, R., Ahmed, M., Khatun, M., Ibrahim, M., Aditya, T., 2020. Assessment of genetic variability and correlation of yield components of elite rice genotypes (Oryza sativa L.). Bangladesh Rice J 24, 21-29.

Hussain, T., Hussain, N., Tahir, M., Raina, A., Ikram, S., Maqbool, S., Fraz Ali, M., Duangpan, S., 2022. Impacts of drought stress on water use efficiency and grain productivity of rice and utilization of genotypic variability to combat climate change. Agronomy 12, 2518.

Kamal Jan, S.A., Khan, N., 2019. Determinants of Rice Productivity in District Lower Dir, Khyber Pukhthunkhwa, Pakistan. Sarhad Journal of Agriculture 35.

Khan, M., Sami, U., Rehman, A., 2018. Evaluation of various rice (Oryza Sativa L.) genotypes for yield and yield characters under agro ecological conditions of Peshawar. Adv Plants Agric Res 8, 491-494.

Kharel, L., Ghimire, S.K., Shrestha, J., KUNWAR, C.B., Sharma, S., 2018. Evaluation of rice genotypes for its response to added fertility levels and induced drought tolerance during reproductive phase: Rice genotypes responses to added fertility levels and drought.

Journal of AgriSearch 5, 13-18.

Makino, Y., Hirooka, Y., Homma, K., Kondo, R., Liu, T.-S., Tang, L., Nakazaki, T., Xu, Z.-J., Shiraiwa, T., 2022. Effect of flag leaf length of erect panicle rice on the canopy structure and biomass production after heading. Plant Production Science 25, 1-10.

Maurya, V., Prasad, R., Meen, S., Bisen, P., Loitongbam, B., Rathi, S., 2018. Assessment of genetic variability, correlation and path analysis for yield and yield related traits in rice (Oryza sativa L). International Journal of Agriculture, Environment and Biotechnology, 935-940.

Qu, M., Zheng, G., Hamdani, S., Essemine, J., Song, Q., Wang, H., Chu, C., Sirault, X., Zhu, X.-G., 2017. Leaf photosynthetic parameters related to biomass accumulation in a global rice diversity survey. Plant Physiology 175, 248-258.

Riaz, M., Akhter, M., Khan, R.A.R., 2014. Genetic criterion for selection of highly productive medium grain rice (Oryza sativa) lines. Journal of Agricultural Research 52.

Sabri, R.S., Rafii, M.Y., Ismail, M.R., Yusuff, O., Chukwu, S.C., Hasan, N.A., 2020. Assessment of agro-morphologic performance, genetic parameters and clustering pattern of newly developed blast resistant rice lines tested in four environments. Agronomy 10, 1098.

Shah, B.H., Hamid, F.S., Ahmed, N., Ahmad, F., Khan, N., 2020. Evaluation of elite rice (Oryza sativa L.) lines for yield and yield components.

Sharifi, P., Ebadi, A.A., 2018. Relationships of rice yield and quality based on genotype by trait (GT) biplot. Anais da Academia Brasileira de Ciências 90, 343-356.

Shrestha, J., Subedi, S., Kushwaha, U.K.S., Maharjan, B., 2021. Evaluation of growth and yield traits in rice genotypes using multivariate analysis. Heliyon 7.

Siddique, M.N.A., Mian, M.K., Sarker, U., 2021. Outcrossing characteristics and yield potentiality of restorer line of rice. Acta Scientific AGRICULTURE (ISSN: 2581-365X) 5.

Suman, K., Neeraja, C., Madhubabu, P., Rathod, S., Bej, S., Jadhav, K., Kumar, J.A., Chaitanya, U., Pawar, S.C., Rani, S.H., 2021. Identification of promising RILs for high grain zinc through genotype× environment analysis and stable grain zinc QTL using SSRs and SNPs in rice (Oryza sativa L.). Frontiers in plant science 12, 587482.

Ullah, S., Amin, A., Roy, T., Mandal, M., Mehraj, H., 2016. Effect of nitrogen sources for spikelet sterility and yield of Boro rice varieties. Adv Plants Agric Res 5, 00192.