



Comparison of Growth Performance and Yield Potential of Selected Rice Varieties in Garasballey District, Somalia

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Abstract

Rice production is increasingly important for ensuring food security in Somalia, yet local rice cultivation is constrained by low-yielding traditional varieties, limited agronomic research, and challenging growing conditions. This study compared the growth performance and yield potential of three rice varieties, R22, R24, and the local landrace Shondhay, under irrigated conditions in Garasballey District, Benadir region, Somalia. A randomized complete block design with three replications was used, and key growth parameters, including plant height at 25, 50, 75, and 100 days after sowing and number of tillers per plant, together with yield components including panicle length, grain yield per plant, grain yield per plot, total grain yield per hectare, and 1000-grain weight, were evaluated using analysis of variance and least significant difference tests at the 5 percent significance level. R22 outperformed the other varieties across most measured parameters, recording the tallest early plant height and the highest tiller number (16.93 per plant), both significantly greater than in the local landrace, together with significantly longer panicles (23.08 cm) and higher grain yield per plant (125.73 g) than both other varieties, culminating in an estimated yield of 7,544 kg per hectare compared with 5,496 kg per hectare for R24 and 5,160 kg per hectare for the local landrace Shondhay. No significant varietal differences were found in 75- and 100-day plant height or 1000-grain weight. These results indicate that R22 offers a substantial yield advantage over both an alternative improved variety and the local landrace under Somalia's irrigated semi-arid conditions, and they support its wider promotion to reduce Somalia's dependence on imported rice and strengthen national food security.

Keywords: Rice varieties; Growth performance; Yield potential; Varietal comparison; Food security; Somalia

1. Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops globally, feeding more than half of the world's population and providing livelihoods for millions of smallholder farmers, particularly in developing countries (Muthayya et al., 2014). Rice is cultivated in more than 120 countries and across a wide range of environments, from irrigated lowlands to rainfed uplands and flood-prone areas, reflecting the crop's exceptional environmental adaptability (Seck et al., 2012). Asia dominates global production and consumption, accounting for approximately 90 percent of both, with China and India alone contributing nearly half of the world's rice supply (Muthayya et al., 2014), while rice is becoming an increasingly important staple in parts of Latin America and Africa as consumption patterns shift (Seck et al., 2012).

In Africa, rice has become an increasingly important urban staple, with Nigeria, Madagascar, Senegal, and Mali leading continental production. African production nonetheless continues to lag behind demand, so that a substantial share of the rice consumed on the continent is imported (Seck et al., 2012). Limited access to quality seed, poor irrigation infrastructure, and high input costs remain significant barriers to expanding production, alongside climate-related pressures such as drought and flooding, although initiatives such as the Coalition for African Rice Development are working to promote high-yielding varieties and more sustainable farming practices across the continent (Balasubramanian et al., 2007; Futakuchi et al., 2021).

Rice farming in Somalia is relatively recent compared with traditional cereals such as sorghum and maize. Rice projects were first introduced in the Shebelle and Juba river basins in the 1960s and 1970s, mainly around Jawhar, but production was later undermined by state price controls and subsequently by the Somali civil war, which sharply reduced cultivation (Said & Ibrahim, 2023). Renewed efforts to rehabilitate irrigated farmland along the two rivers over the past decade have brought fresh interest in rice as a food security crop (Said & Ibrahim, 2023), yet Somalia still relies on imports for the great majority of the rice it consumes (FAO, 2023). Boosting local production could meaningfully reduce this import dependence, generate rural employment, and strengthen household food security.

The varieties evaluated in the Somali context to date have generally been introduced through donor-funded rehabilitation projects along the Shebelle and Juba rivers rather than through a systematic, locally led breeding or selection programme, which means that farmers and extension agents have had little independent local evidence on which to base variety choice. Seed of improved varieties such as R22 and R24 has in many cases been distributed alongside broader irrigation rehabilitation efforts, with limited accompanying agronomic trial data to confirm how these varieties actually perform relative to one another, or relative to the local landraces that farmers have grown for generations, under Somalia's specific soil, water, and climatic conditions. This evidentiary gap increases the risk that farmers either continue growing lower-yielding traditional varieties out of familiarity, or adopt improved varieties without a clear understanding of the yield gains, or trade-offs, involved, underscoring the value of structured on-station comparisons of the kind undertaken in this study.

Rice production in Somalia nonetheless faces substantial constraints. Farmers commonly rely on traditional, lower-yielding varieties and have limited access to research-based information on how different cultivars perform under local agroecological conditions (Said & Ibrahim, 2023). Inadequate irrigation and mechanisation infrastructure, pest and disease pressure from organisms such as rice blast and stem borers, and the effects of political instability on input access all further constrain productivity (Said & Ibrahim, 2023). Water scarcity and climate change add further risk, as the Shebelle River periodically experiences seasonal drying, and developing rice varieties able to perform reliably under these conditions is essential to sustaining local production (Said & Ibrahim, 2023). Closing the gap between actual and potential rice yields in Somalia therefore depends on identifying varieties that combine strong agronomic performance with adaptability to local growing conditions, a gap that comparative varietal trials such as the present study are well placed to address.

Comparative varietal trials of this kind form the backbone of applied rice breeding and agronomy worldwide, since the genetic yield potential of a cultivar is realised only when its growth habit, tillering capacity, and grain-filling characteristics are matched to the soil, water, and climate conditions of a specific production environment (Khush, 2013). Improved varieties developed and released for one agroecological zone frequently underperform or overperform expectations when moved to another, which is why national and regional rice programmes routinely conduct multi-location and multi-season adaptive trials before recommending a cultivar for widespread release (Futakuchi et al., 2021). In Somalia, where formal varietal

testing infrastructure remains limited and where farmers often continue to grow whatever seed is locally available regardless of its documented performance, this kind of systematic, on-station comparison is particularly valuable because it generates the evidence base that extension services need to make informed variety recommendations rather than relying on anecdote or habit.

Beyond genetic potential, rice varieties differ markedly in their responsiveness to agronomic inputs such as fertiliser, irrigation scheduling, and plant density, and these interactions can substantially alter the ranking of varieties observed under different management regimes (Balasubramanian et al., 2007). A variety that performs well under high-input, well-irrigated conditions may show little advantage, or may even underperform, under the resource-constrained conditions typical of much smallholder farming in Somalia. Evaluating candidate varieties under representative local management practices, as undertaken in the present study, therefore provides a more reliable guide to on-farm performance than relying solely on results generated in other countries or under research-station conditions that smallholders cannot replicate.

This study compares the growth performance and yield potential of three rice varieties, an improved variety R22, an alternative improved variety R24, and the local landrace Shondhay, under irrigated conditions in Garasballey District, Somalia. The specific objectives were to assess the growth and yield performance of the three varieties under controlled field conditions, to evaluate their yield potential including grain yield per hectare, and to identify the best-performing variety or varieties for sustainable rice farming in the study area. The findings are intended to provide an evidence base for farmers, extension services, and policymakers seeking to identify rice varieties capable of improving productivity and strengthening food security in Somalia.

2. Materials and Methods

2.1 Study Area

The study was conducted in Garasballey District, Benadir region, Somalia, an area with a tropical semi-arid climate receiving 400 to 600 mm of annual rainfall and typical temperatures of 25 to 35 degrees Celsius. The predominant soil type in the study area is clay loam, which is well suited to irrigated rice cultivation because of its favourable water-holding capacity and structural stability under prolonged flooding. The trial was conducted between January and June 2025, a period spanning the Jilaal dry season and the Gu rains, during which irrigation, rather than rainfall, supplied the majority of the crop's water requirement, allowing water application to be standardised across all treatment plots through the drip system described below (Figure 1).

Prior to trial establishment, composite soil samples were collected from the experimental field at a depth of 0 to 20 cm and used to guide the fertiliser regime applied during the trial, ensuring that nutrient inputs were matched to the baseline fertility status of the site rather than applied uniformly without reference to local soil conditions. This site characterisation step is a standard precondition for interpreting varietal trial results, since it allows any observed differences among varieties to be attributed to genotype rather than to unrecognised spatial variation in underlying soil fertility.



Figure 1. Rice plants under drip irrigation at the Garasballey District trial site, Somalia.

2.2 Experimental Design and Treatments

The study used an experimental research design, specifically a randomized complete block design with three replications, to obtain accurate and unbiased comparisons among the three rice varieties while minimising environmental variability. The three varieties evaluated were R22, R24, and the local landrace Shondhay, each assigned to a 1 by 3 metre plot with plants spaced 30 cm apart within and between rows. Plots were irrigated using a drip irrigation system to ensure accurate water application, minimise water waste, and maintain consistent soil moisture. Land was ploughed and levelled prior to planting, and certified seed was used throughout; a balanced NPK fertiliser regime was applied in split doses at the basal, tillering, and panicle initiation stages based on prior soil test results, and weeds, pests, and diseases were managed manually and, where necessary, with targeted herbicide and pest control measures. Seedlings were raised in a nursery bed for approximately three weeks prior to transplanting into the main experimental plots, a practice widely used in irrigated rice systems to improve stand establishment and reduce the period during which young plants are exposed to weed competition in the field. Rice was harvested by hand once plants reached physiological maturity, indicated by at least 80 percent golden colouration of the panicles, to ensure consistency in harvest timing across varieties.

The experimental population comprised all rice plants grown across the nine plots (three varieties by three replications), totalling 162 plants at a density of 18 plants per plot. A representative sample of five plants per plot (approximately 28 percent of the plants in each plot) was selected using simple random sampling, giving 45 sampled plants in total, from which growth and yield measurements were recorded.

Randomisation of variety to plot within each of the three blocks was performed independently to account for any underlying gradient in soil fertility or micro-topography across the trial area, a standard precaution in field agronomy that allows environmental

variation to be statistically separated from the treatment effect of variety. Buffer rows were maintained between adjacent plots to minimise border effects, including shading, root competition, and cross-plot water movement, that could otherwise confound comparisons among varieties. Irrigation volumes delivered through the drip system were monitored and adjusted to maintain broadly comparable soil moisture across all plots regardless of variety, so that any differences observed in growth or yield could be attributed to genotype rather than to unintended differences in water availability.

2.3 Data Collection and Statistical Analysis

Growth parameters, comprising plant height and number of tillers per plant, were recorded at 25, 50, 75, and 100 days after sowing using a measuring tape and standard field observation. Plant height was measured from the base of the stem at soil level to the tip of the tallest leaf or, at later growth stages, to the tip of the tallest panicle, and tiller counts were taken by direct enumeration of all above-ground shoots arising from the base of each sampled plant. Yield parameters, comprising panicle length, grain yield per plant, grain yield per plot, total grain yield per hectare, and 1000-grain weight, were recorded at harvest using a calibrated weighing balance, with grain moisture content standardised prior to weighing to ensure comparability across varieties and replications. Grain yield per plot was calculated as the mean grain yield of the sampled plants multiplied by the 18 plants in each plot, and grain yield per hectare was extrapolated from plot yield on the basis of the 3 m² plot area.

Data were analysed using analysis of variance to test for significant differences among varieties, with mean separation performed using the least significant difference test at the 5 percent significance level ($p \leq 0.05$). Coefficient of variation was calculated for each parameter to assess the precision of the experiment, and treatment means sharing the same letter within a column were considered not significantly different. All statistical analyses were carried out using Statistix 8.1, and results are presented as treatment means with associated significance levels and coefficients of variation in Tables 1 and 2.

3. Results

Table 1 presents the effect of variety on plant height at four growth stages and on tiller number. At 25 days after sowing, R22 recorded the tallest plants (47.33 cm), significantly taller than Shondhay (38.46 cm), with R24 intermediate (44.80 cm). At 50 days after sowing, R22 (66.93 cm) and R24 (66.53 cm) were both significantly taller than Shondhay (56.80 cm). By 75 and 100 days after sowing, plant height no longer differed significantly among varieties, converging in the range of 71 to 78 cm at 75 days and 89 to 93 cm at 100 days. Tiller number differed significantly among varieties, with R22 producing the most tillers per plant (16.93), significantly more than Shondhay (11.00), while R24 was intermediate (12.80).

Table 1. Effect of Variety on Plant Height and Tiller Number

Variety	25 DAS Height (cm)	50 DAS Height (cm)	75 DAS Height (cm)	100 DAS Height (cm)	Tillers per Plant
R22	47.33 a	66.93 a	77.66 a	92.66 a	16.93 a
R24	44.80 ab	66.53 a	75.60 a	91.40 a	12.80 ab
Shondhay	38.46 b	56.80 b	70.93 a	89.46 a	11.00 b
Significance	*	*	NS	NS	*
CV (%)	7.13	3.98	5.10	6.59	17.95

Table 2 presents the effect of variety on yield components. R22 produced significantly longer panicles (23.08 cm) than R24 (22.62 cm) and Shondhay (22.19 cm), and significantly higher grain yield per plant (125.73 g) than R24 (91.60 g) and Shondhay (86.00 g). This advantage was consistent at plot scale, with R22 producing the highest grain yield per plot

(2,263.2 g) and the highest estimated total grain yield per hectare (7,544.0 kg), compared with 1,648.8 g per plot and 5,496.0 kg per hectare for R24, and 1,548.0 g per plot and 5,160.0 kg per hectare for Shondhay. No significant differences were observed among varieties in 1000-grain weight, which ranged from 19.33 g to 21.33 g.

Table 2. Effect of Variety on Panicle Length, Grain Yield, and 1000-Grain Weight

Variety	Panicle Length (cm)	Grain Yield per Plant (g)	Grain Yield per Plot (g)	Total Yield (kg/ha)	1000-Grain Weight (g)
R22	23.08 a	125.73 a	2263.2 a	7544.0 a	21.33 a
R24	22.62 b	91.60 b	1648.8 b	5496.0 b	19.66 a
Shondhay	22.19 c	86.00 c	1548.0 c	5160.0 c	19.33 a
Significance	**	**	**	**	NS
CV (%)	1.92	1.81	1.81	1.81	9.23

Taken together, the results in Tables 1 and 2 show a consistent ranking across nearly all measured traits, with R22 performing best, R24 intermediate, and the local landrace Shondhay performing weakest, and with the gap between R22 and the other two varieties most pronounced for tillering and final yield. The coefficients of variation for the yield-component traits in Table 2 were comparatively low, ranging from 1.81 to 1.92 percent for panicle length, grain yield per plant, grain yield per plot, and total yield per hectare, indicating a high degree of precision in these measurements (plot and hectare yields are derived from per-plant yield and therefore share its coefficient of variation) and lending confidence to the reliability of the observed varietal differences. The larger coefficient of variation observed for tiller number (17.95 percent) is consistent with the naturally higher plant-to-plant variability typical of tillering traits in rice and does not undermine the statistical significance of the overall varietal effect detected for this trait.

4. Discussion

The results demonstrate clear varietal differences in both growth performance and yield potential among the three rice varieties tested in Garasballey District. R22 consistently outperformed R24 and the local landrace Shondhay across most agronomic traits measured, including early plant height, tillering, panicle length, grain yield per plant, and estimated yield per hectare. At the early vegetative stages, 25 and 50 days after sowing, R22's superior plant height suggests stronger seedling establishment and early vigour, traits associated with more effective weed suppression and nutrient capture during the critical early growth window. Although height differences converged by 75 and 100 days after sowing, a pattern consistent with the reallocation of plant resources from vegetative growth to reproductive development as panicles form, this early advantage appears to have translated into stronger tillering, with R22 producing significantly more tillers per plant than Shondhay.

Because tiller number is a key determinant of productive panicle number in rice, R22's tillering advantage plausibly underlies much of its yield superiority. This is reinforced by the panicle length and grain yield data, where R22 again outperformed both comparator varieties, and the yield advantage held consistently from the individual plant scale through to the plot scale, indicating that R22's superior yield traits are stable rather than an artefact of within-plot variability. The resulting estimated yield of 7,544 kg per hectare is consistent with yields reported for well-managed improved rice varieties elsewhere in sub-Saharan Africa (Balasubramanian et al., 2007; Futakuchi et al., 2021), and is consistent with varietal trial results from lowland rice systems in Ghana, where improved varieties yielded approximately 92 percent more than local varieties (Ulzen et al., 2023), lending further support to the

conclusion that R22's advantage in this study reflects a genuine varietal effect rather than a site-specific anomaly.

The absence of significant varietal differences in 75- and 100-day plant height and 1000-grain weight is informative in its own right. It suggests that R22's yield advantage arises primarily from a larger number of productive tillers and panicles rather than from larger individual grains, since grain size, approximated by 1000-grain weight, did not differ significantly among varieties. This distinction matters for breeding and selection purposes, since it indicates that R22's superiority is a function of canopy-level productive capacity rather than grain morphology, and it implies that milling characteristics and market grain-size preferences are unlikely to differ substantially between the varieties tested. The comparatively weaker performance of Shondhay, the local landrace, across nearly all measured parameters reinforces the case made elsewhere in the literature for replacing lower-yielding traditional varieties with improved cultivars in irrigated and lowland rice systems (Ulzen et al., 2023), while R24's intermediate performance suggests it may remain a reasonable alternative where farmer preference, seed availability, or local adaptability considerations favour it over R22.

These findings should be read in light of the study's scope. The trial was conducted at a single site over a single growing season, so performance under Somalia's other agroecological zones, and across seasons with differing rainfall and temperature patterns, remains to be established. Pest and disease pressure, while managed during the trial, could not be entirely eliminated and may have introduced some variability not attributable to variety. Multi-season, multi-location trials would strengthen confidence in the generalisability of R22's yield advantage and are a logical next step building on these results.

From a practical standpoint, the magnitude of R22's yield advantage carries direct economic significance for Somali rice farmers. An additional 2,048 kg per hectare relative to R24, and 2,384 kg per hectare relative to the local landrace Shondhay, translates into a substantial increase in marketable output per unit of land, input cost, and irrigation water applied, all of which are scarce and costly resources for smallholders operating in Somalia's semi-arid riverine zones. Given that land and water, rather than seed, are typically the binding constraints on production in these systems, a variety that extracts more grain from the same land and water allocation offers a particularly attractive return on the limited resources available to farmers, and this argument strengthens the case for prioritising R22 seed multiplication over incremental improvements to irrigation infrastructure alone.

The results also carry implications for Somalia's broader agricultural policy, which has identified import substitution in staple cereals as a national priority given the country's heavy reliance on imported rice (FAO, 2023). Scaling the adoption of high-performing varieties such as R22 through coordinated extension, seed certification, and farmer training programmes would directly support this objective, and the consistency of R22's performance across nearly every growth and yield parameter measured in this trial suggests that the variety is a credible near-term candidate for such a scale-up effort, pending confirmation through the multi-season and multi-location trials recommended above.

For local breeding and variety-selection programmes, the finding that R22's advantage stems mainly from superior tillering and panicle development, rather than from larger individual grains, offers a useful selection criterion for future varietal screening in Somalia. Breeders and agronomists evaluating additional candidate lines could prioritise early tillering vigour and panicle number as efficient proxy indicators of likely yield performance, potentially allowing promising lines to be identified earlier in the selection process than would be possible from grain-weight measurements alone, which in this trial did not differentiate meaningfully among varieties. This approach would complement the wider genetic improvement efforts documented for rice in sub-Saharan Africa (Futakuchi et al., 2021) and could help Somalia's nascent varietal evaluation efforts make efficient use of limited research capacity and trial land.

Finally, the trial's use of a drip irrigation system, rather than the conventional flood or basin irrigation more commonly practised along the Shebelle and Juba rivers, merits comment. Drip irrigation allowed water application to be standardised precisely across all plots regardless of variety, which strengthens the internal validity of the varietal comparison reported here, but it also means the absolute yield levels recorded may not translate directly to farmers using flood irrigation, where water distribution is typically less uniform and where periodic waterlogging or drought stress between irrigation events can affect varieties differently. Future work comparing R22's performance under drip and conventional flood irrigation side by side would help clarify how much of its demonstrated advantage is attributable to the variety itself as opposed to the precision of water management under which it was tested, and would provide more directly applicable guidance for the majority of Somali rice farmers who do not currently have access to drip infrastructure.

5. Conclusion

This study compared the growth performance and yield potential of three rice varieties under irrigated conditions in Garasballey District, Somalia, and found clear and consistent differences among them. R22 demonstrated superior growth vigour, higher tiller numbers, longer panicles, and the highest grain yield per hectare (7,544 kg/ha) of the three varieties tested, outperforming both the alternative improved variety R24 and the local landrace Shondhay. This consistent performance indicates that R22 is well suited to Somalia's irrigated rice systems and offers farmers a viable route to higher productivity and reduced reliance on imported rice. Realising this potential at scale will depend on coordinated support across several fronts: extension services and policymakers prioritising the multiplication and distribution of R22 seed to farmers in suitable irrigated areas, farmer training programmes covering land preparation, transplanting, nutrient management, and irrigation scheduling, continued multi-season and multi-location trials to confirm R22's adaptability and stability under Somalia's varied growing conditions, reliable access for farmers to certified seed, affordable fertiliser, and pest management support, and sustained investment in irrigation infrastructure and water management to secure the consistent water supply that irrigated rice production in semi-arid zones requires. Pursued together, these measures would allow the demonstrated yield advantage of improved varieties such as R22 to translate into a meaningful contribution to Somalia's food security and the broader development of a sustainable domestic rice sector.

Author Contributions

Salmaan Abdulkadir Ahmed: data curation, formal analysis, writing, original draft. Abdiweli Kahiye Ali: investigation, data curation. Abdiaziz Abdullahi Mohmed: investigation, methodology. Hussein Mohamed Ali: investigation, resources. Isse Abdirahim Isse: investigation, writing, review and editing. Hussein Mohamed Osman: conceptualisation, supervision, writing, review and editing. All authors read and approved the final manuscript.

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Conflict of Interest Statement

The authors declare no conflict of interest.

Data Availability Statement

The field data supporting the findings of this study are available from the corresponding author upon reasonable request. This includes the raw plant-level measurements of height, tiller number, panicle length, grain yield, and 1000-grain weight recorded across the nine experimental plots, as well as the associated analysis of variance and least significant difference test outputs generated in Statistix 8.1, which underpin the summary statistics reported in Tables 1 and 2.

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