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Research Article

Participatory variety evaluation of lowland rice (*Oryza sativa* L.) under irrigation conditions at Dasenech District, South Omo Zone, Southern Ethiopia

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ABSTRACT

In Ethiopia, rice is an important cereal product. The lack of improved varieties that are suited to a particular area, however, is the primary reason why the yield of this crop is constrained. This field experiment was carried out in Omorate, South Omo Zone, Southern Ethiopia, during the 2020 and 2021 growing seasons to assess the production and yield components of rice varieties. Six different varieties were used in the experiment: Ediget, Shaga, GSR Candidate, PARC V1, Nerica-6, and Adet. A randomized complete block design with three replications was used to experiment. Days to maturity, plant height, productive tillers per plant, panicle length, filled grain per panicle, above-ground dry biomass and harvest index were collected. Using the SAS software, an analysis of variance was performed on all data. The combined findings of this research showed that all traits varied significantly ($p>0.05$ or $p>0.01$) between varieties. According to the study's findings and the agro pastoralists' feedback,the Ediget rice variety was the top preferred. The Ediget variety produced the greatest grain yield (7239.6 kg ha-1) out of all the tested treatments. Therefore, it can be recommended to be promoted in the study area and its vicinity.

Keywords:

Rice varieties, performance evaluation, grain yield

INTRODUCTION

Compared to other cereal crops, the production of rice is a relatively new occurrence in Ethiopia. It had been brought in the 1960s by North Koreans and Dutch people, respectively, in the Fogera and Gambela regions [1]. According to Hossain et al. [2], a rice grain includes 75-80% starch, 12% water, and 7% protein. It is also a significant provider of minerals like magnesium, phosphorus, and calcium as well as vitamins like thiamine, riboflavin, and niacin [3]. Because it is a gluten-free food, rice benefits from the growing popularity of gluten-free diets [4]. Not only is the rice used for sustenance, but it also produces byproducts like straws and husks that can be used as animal feed, fertilizer, building materials, and/or an alternative fuel source. According to Halos-Kim [5], Ethiopian rice production has significant potential for attaining food security and even earning foreign currency through its export. In Ethiopia, rice is one of the most significant food products.

With an average regional yield of 1.12 t ha-1, Ethiopian rice was grown on approximately 38,935.67 ha, from which approximately 121,419 tons will be generated [6]. However, this grain yield is much lower than the yield that can be achieved (3.8 to 6.8 t ha-1) with appropriate management practices [7]. The lack of appropriate agroecologies for rice production, a lack of improved varieties, poor crop management techniques, water requirements, and unbalanced soil fertility are the primary causes of the limited yield of rice [8]. The absence of adaptable and high-yielding improved rice types is one of the main obstacles in rice-producing regions. Therefore, in the lowland region of the South Omo Zone, this research was carried out to choose high-yielding lowland rice varieties under irrigation conditions.

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MATERIALS AND METHODS

Description of the Study Area

At Dasenech (Omorate), in the Southern Nations, Nationalities and People's Regional State's South Omo Zone, two trials were carried out during the crop season of 2019-2020. It is 365 above sea level and located between 54°37′ and 4°48′ N and 35°56′ and 36°20′ W. The region's rainfall is distributed bimodally, with the main rainy season occurring between March and May and the second small rain season occurring between September and December. the minimum and highest average monthly temperatures of 30 and 40 degrees Celsius, respectively. For the two sites, all of the metrological information provided above are long-term averages.

Experimental design and treatments

Six rice varieties namely:- Fogera-1, Nerical-1, Nerical-12, Azmera, Pawe-1 and Nerica-4 were used for the current study. This experiment was laid out using a randomized complete block design (RCBD) with three replications in two cropping seasons at Omorate.

Experimental procedure and management

The field was twice ploughed, once disked and harrowed, and then ridged with a tractor at a height of 0.6 meters before being corrected by hand. Replications and containers were spaced apart by 2 meters. The plot measured 16.8 m2 (4.2 m x 4 m) and could hold seven rows at 0.3 m spacing on two rows-tall ridges. At a rate of 60kg ha-1, seeds were manually drilled and distributed in rows. The fertilizer was applied at a rate of 150 kg of urea and 100 kg of NPSB per hectare. A single application of P2O5 NPSB was made at

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sowing time, and N2 (urea) was split into two applications: 50% at the seedling stage and 50% at the booting growth phases. From planting until flowering, irrigation water was applied using the furrow technique every 5-7 days, and then every 8-10 days until physiological maturity, depending on the weather. Twenty, forty and sixty days after emergence, the first, second, and third marriages, respectively, were held.

Data Collected

Phenology and growth parameters

Days to 85% maturity: The number of days from the date of emergence to the date when 85% of the crop stand stems, leaves, and floral bracts in a plot changed to light yellow color was recorded. Plant height (cm): The height of the plant in centimeters from the base of the main stem to the tip of the panicle was recorded as the average of five randomly taken plants in the middle five rows of each plot.

Yield and yield components

Panicle length (cm): The average of five arbitrarily selected plants in the middle five rows of each plot were used to determine the length of the panicle in centimeters, which was measured from the node where the first panicle branch begins to the tip of the panicle. The average number of productive tillers per plant: We counted the average number of productive tillers on five randomly selected sample plants from each plot's center in five rows. Number of filled grains per panicle: Five arbitrarily selected panicles' filled grain counts prior to physiological maturity were averaged. The weight of the entire harvest, including the seeds from the two center rows, was used to calculate the total above-ground dry biomass yield (kg). The biomass was then sun-dried on canvas to a constant weight. The weight of 100 randomly selected seeds from the two harvested center rows was converted to grams (g) and adjusted for 12% moisture content. Grain yield: Each plot's three center rows were harvested, dried in the sun, and threshed. Utilizing an electronic balance, the grain output in kg from each plot was weighed. Using a moisture meter (DRAMINSKI SN: 10-860 Olsztyn), the seed moisture content was determined. The cereal weight was then adjusted to a 10% hydration level content and converted to t ha-1.

Data analysis

Using SAS software version 9.2 [9] and a generalized linear model (GLM) procedure, the different data gathered were subjected to analysis of variance in a randomized complete block design (RCBD). The least significant differences (LSD) test was used to separate the means with a 5% threshold of significance.

RESULTS AND DISCUSSION

Analysis of variance

After performing a first analysis of variance for each year, it was discovered that there were significant differences between the varieties for the following traits at both locations: days to 90% of maturity, plant height, panicle length, number of productive tillers per plant, number of filled grains per panicle, total above-ground dry biomass yield, grain yield, thousand seed weight, and harvest index. Significant genetic differences between the tested varieties may be the cause of these changes, which could also explain why there are differences between the tested varieties' characters. The homogeneity of error variances was examined prior to the combined analysis of variance, and all characteristics revealed homogeneous error variances. After receiving this confirmation, the statistics were compiled over several years.

Phenology and growth parameters

The results of the combined analysis of variance revealed that types significantly affected the number of days until physiological maturity, the likelihood of lodging, and the productive tiller. The PARC V1 and Selam varieties, respectively, recorded the greatest days of maturity (107.3 and 108.5), while the Adet variety recorded the lowest days of maturity (100.2). (Table 1). This outcome was in line with the findings of [10], who found that rice variety had a significant impact on days to maturity. For Shaga and PARC V1, the results of the combined analysis for lodging incidence varied from 100% to 3.5%, respectively. This might have occurred due to genetic variation in the rice varieties. Results of the combined analysis for productive tillers ranged from 19.7 for the Shaga variety to 27.3 for the Ediget variety (Table 1). The results conform with Assefa et al. [11].

Plant height and panicle length

The findings of this research revealed notable variations in plant height and panicle length among rice varieties (Table 2). Nerica-6 provided the tallest (124.3 cm) plant height of the tested rice varieties, while the Adet variety was considerably the shortest (77.2 cm) plant height. This outcome was in line with the findings of Khatun [12] and Das et al. [13], who noted that different rice types had different plant heights. The variety PARC V1 had the largest panicles (27.5 cm), while Selam had the shortest yields (17.1 cm). This result agreed with Tiruneh and Besher [14] who found a significant difference among rice varieties and they obtained the longest (23 cm) and lowest (18.5 cm) panicle length.

Table 1: Means values of days to maturity, lodging incidence and productive tiller of lowland rice varieties tested at Dasenech 2020 and 2021 cropping season

Varieties	Days to maturity %			Lodging incidence %			Productive tiller		
	2020	2021	Combined	2020	2021	Combined	2020	2021	Combined
Ediget	101.3c	107.7ab	104.5b	10.0d	2.0d	6.0cd	31.2a	23.4a	27.4a
Shaga	100.7c	101.7c	101.2cd	100.0a	100.0a	100.0a	23.5b	16.4b	19.7b
Selam	107.0a	110.0a	108.5a	13.3c	2.0d	7.7c	25.0b	15.7b	20.3b
PARC V1	104.0b	110.7a	107.3a	5.0e	2.0d	3.5d	23.8b	15.9b	20.0b
Nerica-6	101.7c	105.7b	103.7bc	5.0e	50.0b	27.5b	23.5b	17.3b	20.3b
Adet	100.0c	100.7c	100.2d	20.0b	33.3c	26.7b	25.1b	16.6 b	21.0ab
Cv %	1.09	1.86	1.45	4.61	7.47	4.97	20.62	13.28	20.80
LSD(0.05)	2.039	3.59	2.76	2.14	4.29	2.58	12.75	4.23	7.10

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at a 5% level.

Yield and yield components

Filled grains per panicle and above-ground dry biomass

The combined analysis of variance in (Table 3) revealed a substantial difference in the above-ground dry biomass and the number of filled grains per panicle among the tested varieties. The variety with the greatest number of filled grains per panicle was PARC V1 (195,9), followed by the Ediget (179,3), and Shaga (151.6) had the fewest filled grains per panicle. This outcome was consistent with Assefa et al. [11] discovery that rice variety had a substantial impact on the number of filled grains per panicle. The highest above-ground dry biomass (20599 kg/ha) was recorded from Variety Ediget and the lowest above-ground dry biomass (12656 kg/ha) was recorded Shaga variety. The observed significant variety differences for above-ground dry biomass were due to the genotypic and environmental effects. For above-ground dry biomass, this result is in line with the finding of Tiruneh [15] who reported that significant difference among rice varieties.

Grain yield, thousand seed weight and harvest index

Significant differences in grain production, thousand seed weight, and harvest index were revealed by the combined analysis of variance for the tested varieties (Table 4). The variety Ediget produced the greatest grain yield (7240 kg/ha), while the Shaga variety produced the lowest (3036 kg/ha). The findings of Ullah et al. [16], who noted variable grain yield among the rice types, were supported by this outcome. When the rice was tested under rain-fed conditions, Seyoum et al. [17] found substantial variations in grain yield. The variety Ediget recorded the greatest thousand seed weight (35.0g), while the variety Selam recorded the lowest thousand seed weight (27.7g) (Table 4). The variance in thousand seed weight may be caused by variations in the length and breadth of the seeds, which were partially governed by the genotypes' genetic makeup [18]. This outcome is consistent with Tefera et al. [19], who discovered that the lowest and maximum values for 1000 seed weights were, respectively, 26.15 and 35.41 g. The variety Nerica-6 had the greatest harvest index (0.41), followed by the variety Ediget (0.37), and the variety Selam had the lowest harvest index (0.26) (Table 4).

Table 2. Means values of panicle length and panicle length of upland rice varieties tested at Dasenech 2020 and 2021 cropping season

Varieties	Plant height (cm)			Panicle length (cm)		
	2020	2021	Combined	2020	2021	Combined
Ediget	116.7a	116.1a	116.5ab	26.4b	21.0ab	23.7b
Shaga	110.4a	100.6b	105.6ab	22.6c	20.0b	21.3cd
Selam	101.7ab	96.6b	99.2b	22.3c	15.9c	19.1d
PARC V1	107.6a	104.2b	105.9ab	31.0a	24.0a	27.5a
Nerica-6	126.4a	122.1a	124.3a	29.9a	23.3ab	26.6a
Adet	71.5b	82.8c	77.2c	25.2bc	20.7ab	22.9bc
Cv %	15.78	5.93	10.46	6.77	10.20	10.50
LSD(0.05)	30.37	11.19	19.935	3.2336	3.86	2.39

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significant; LSD (0.05) = Least Significant Difference at 5% level.

Table 3. Means values of the number of filled grains per panicle and above-ground dry Biomass of lowland rice varieties tested at Dasenech 2020/21 and 2021/22 cropping season.

Varieties	Number of filled grains per panicle			Above-ground dry biomass (kg/ha)		
	2020	2021	Combined	2020	2021	Combined
Ediget	230.6ab	127.9	179.3ab	21875a	19323a	20599a
Shaga	180.6c	122.7	151.6d	6250c	10771cd	8510d
Selam	205.8bc	131.5	168.7bc	18750ab	12896bc	15823b
PARC V1	262.9a	128.8	195.9a	19375a	13667b	16521b
Nerica-6	212.5bc	125.7	169.1bc	9375c	10625d	10000d
Adet	184.0c	123.2	153.6cd	15625b	9688d	12656c
Cv %	8.79	10.2	5.43	13.42	9.68	7.42
LSD(0.05)	34.016	12.40	16.76	3713.6	2183.8	1864.5

Means in columns and rows followed by the same letter(s) are not significantly different at a 5% level of significance; LSD (0.05) = Least Significant Difference at a 5% level.

Table 4. Means values of days to grain yield, hundred seed weight and harvest index of lowland rice varieties tested at Dasenech 2020/21 and 2021/22 cropping season.

Varieties	Grain yield (kg/ha)			Hundred seed weight (g)			Harvest index %		
	2020	2021	Combined	2020	2021	Combined	2020	2021	combined
Ediget	7625a	6855a	7240a	36.00a	34.0a	35.0a	0.30b	0.41a	0.37ab
Shaga	3173d	2899d	3036c	24.83e	24.5d	24.2e	0.35b	0.27d	0.36abc
Selam	5427b	4111c	4024bc	26.83d	24.6d	25.7d	0.26b	0.32bcd	0.26c
Parc V1	5813b	4917b	5365b	31.67b	28.0c	29.8bc	0.53a	0.37ab	0.33abc
Nerica-6	4952bc	3270d	4111bc	29.33c	31.5b	30.4b	0.29b	0.30cd	0.41a
Adet	4042cd	3292d	3667c	30.00c	29.0c	29.5c	0.49a	0.34bc	0.29bc
CV %	13.07	5.56	16.65	3.00	2.47	1.53	19.9	9.68	16.9
LSD(0.05)	1230	427.46	1385.0	1.624	1.29	0.81	0.13	0.05	0.104

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level.

Table 5. Direct matrix ranking on rice varieties by a group of agro-pastoralist (on the field) at Dasenech in the 2020/21 cropping season.

	Grain Yield	Earliest maturity	Lodging resistance	Tillering capacity	Shattering	Panicle length	Total score	Rank
Varieties	3	3	3	2	2	2		
Ediget	5(15)	5(15)	5(15)	5(10)	4(8)	4(8)	86	1
Shaga	3(9)	5(15)	1(3)	4(8)	3(6)	3(6)	59	6
Selam	4(12)	3(12)	4(12)	4(8)	3(2)	3(6)	67	5
PARC V1	4(12)	4(12)	5(15)	5(10)	5(10)	5(10)	81	2
Nerica-6	4(12)	5(15)	5(15)	4(8)	3(6)	5(10)	78	4
Adet	4(12)	5(15	4(12)	4(12)	4(8)	4(8)	79	3

The total number of participants=26, 25=agro-pastoral (19M & 6F) and (1) kebele extension. Rating of performance of a variety for selection criteria: 5 = excellent, 4 =very good, 3 = good, 2 = poor and 1= very poor; Relative weight of selection criteria: 3 = Very important, 2 = important and 1 = less important. The numbers in the parenthesis indicate the product of the relative weight of the selection criterion and the performance of a variety given by agro-pastoral and kebele extension

Agro-pastoralists Evaluation of upland rice Varieties

During the evaluation, six women and nine males were grouped together. Grain yield, lodging resistance, tillering ability, panicle length, and earliness at the crop's maturity stage were the selection factors recommended by agropastoralists. The prioritization sequence of the agro-selection pastoralist's criteria was determined by direct matrix ranking. Based on an agro-Direct pastoralist's ranking of selection criteria, grain yield, earliness, and lodging resistance were suggested as being very significant criteria. This is consistent with the results of Tiruneh and Besher [13], who discovered that the most crucial farmer criteria for rice varieties were the same selection criteria. Agro-pastoralists selected rice varieties, Ediget over the other varieties due to its high grain yield and earliness. The results of the PVS agreed with the ANOVA result in identifying the varieties which suit best the Agro-pastoralists as well as the environment.

CONCLUSION

This field study was carried out in Southern Ethiopia, South Omo Zone, Dasenech District, and the 2020 and 2021 growing seasons to assess the production and yield components of different rice varieties. The six varieties included in the trial are Ediget, Shaga, Selam, PARC V1, Nerica-6, and Adet. A randomized complete block design with three replications was used to perform the experiment. SAS software was used to gather the data and perform variance analysis. The combined findings of this research showed that all traits varied significantly (P>0.05 or P>0.01) between varieties. The Fogera-1 improved rice variety was the one that agro-pastoralists favored the most, according to the study's findings and their assessment. It also demonstrated that the most crucial factor for agro-pastoralists to consider when selecting a variety was high cereal yielding with earliness of improved variety. The Ediget variety had the greatest grain yield (72400 kg ha^{-1}). As a result, it may be advised to be encouraged in the study area and its surroundings.

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