ISSN: 2224-0616
Int. J. Agril. Res. Innov. Tech. 13(1): 38-41, June 2023
DOI: https://doi.org/10.3329/ijarit.v13i1.67971
OPEN ACCESS
Available online at https://ijarit.webs.com
https://www.banglajol.info/index.php/IJARIT

Evaluation of irrigated rice (*Oryza sativa* L.) varieties under irrigation condition at Dasenech Distinct, South Omo Zone

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Received 23 March 2023, Revised 6 June 2023, Accepted 27 June 2023, Published online 30 June 2023

A B S T R A C T

Rice crop is essential in a country. Still, the production and productivity are low due to uncovering a suitable area for rice production and the shortage of improved and unedited well-adapted variety. To solve this problem, the study was conducted in Dasenech district during (2020/21 and 2021/22) cropping seasons to select well-adapted varieties. The study contains 6 varieties (Gode, Shebele, Chewaqa, Kallafo, Nerica-15, and Pawe-2). For this study used a randomized complete block design with three replications. Yield and other trait data were collected and subjected to analysis of variance. The result of the analysis of variance showed that all parameters were significantly affected among tested rice varieties. The Pawe-2 variety gave the highest grain production (6284.7 kg ha^{-1}) among the tested varieties. Based on the study result, it can be suggested that variety Pawe-2 perform well and is suitable for agro-pastoral in the Dasenech area under irrigation condition and its similar agro-ecology.

Keywords: Irrigated, Rice varieties, Grain yield

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Cite this article as: Tadesse, A. and Jerjero, T. 2023. Evaluation of irrigated rice (*Oryza sativa* L.) varieties under irrigation condition at Dasenech Distinct, South Omo Zone, Southern Ethiopia. *Int. J. Agril. Res. Innov. Tech.* 13(1): 38-41. https://doi.org/10.3329/ijarit.v13i1.67971

Introduction

Rice production in a country is recent when related to other cereal crops. In the Fogera and Gambela regions, it was first introduced in the 1960s (Gebey *et al*., 2012). In a rice grain, there are 75–80% starches, 12% liquids, and 7% proteins (Hossain *et al*., 2015). Moreover, it is an essential source of minerals (magnesium, phosphorus, and calcium) (Oko *et al*., 2012). It is also a gluten-free food, and rice benefits from the growing popularity of gluten-free diets (Topper, 2014). Not only is rice used as food, but it also has byproducts (straws and husks) that can be utilized as a source of fertilizer and substitutes. According to a study by Halos-Kim (2015), "Ethiopian rice cultivation has a big potential for guaranteeing food security and reducing imported rice. Rice is one of the most significant food crops in Ethiopia. Rice in the country was cultivated on around 57,575.72 ha of land covered, and 170,630.1 tons were produced with an average productively of 2.96 tons ha^{-1} in 2019/20 cropping season (CSA, 2019/20). Unfortunately, this yield is huge between the yield potential of rice (4.0 to 5.8 tons ha^{-1}) (MOANR, 2021). There are different factors for rice production. Among them, shortage of improved rice variety, inappropriate agronomic management, and unidentified soil fertility for rice) for a specific location are the main issues limiting rice production (Abebaw, 2018). One of the biggest challenges in rice-growing countries is the lack of adaptable and high-yielding improved rice varieties. This study was conducted to select well-performed irrigated rice variety/ies under irrigation conditions at Dasenech distinct.

Methodology

The study site

The study was conducted at Dasenech distinct (Omorate) for two years of cropping season from 2020/21 and 2021/22. It is located at an altitude of 365 above meter see level and is situated b/n 54°37′ 25′′ & 4°48′ 16′′ North & 35°56′ 12′′ and 36°20′ 34′′East. A main rainy season, from March to May, and a mild, minor rainy season, from September to December, characterize the area's bimodal rainfall distribution. Temperatures that average 30°C for the minimum and 40°C for the highest each month. Long-term averages are used for all of the metrological information provided above.

Treatments and experimental setup

Six rice varieties Gode, Shebele, Chewaqa, Kallafo, Nerica-15, and Pawe-2 were used for this investigation. For this study used a randomized complete block design (RCBD) with 3 replications.

Experimental management and procedure

The land was ploughed, disked and harrowed. The well-prepared land was ridged by a tractor at a ridge of 0.6 meters; it was manually corrected. Pots and replications were two meters apart. Seven rows could fit on the plot, 16.8 m^2 (4.2 x 4.0) meters, at 0.3-meter intervals, on ridges with two rows. Sixty (60) kg ha^{-1} seed rate were manually drilled into rows. At a rate of one hundred (100) kg ha^{-1} of NPSB were applied at planting, and one hundred fifty (150) kg ha^{-1} of urea was applied twice, once at the tillering and once during the heading stage.

From planting through heading, the furrow method was used to furrow irrigation water at 5-7 day intervals. From flowering to physiological maturity, the furrow method was used each 8–10 days, based on the weather. 20 days, 40 days, and 60 days following emergence, the 1st, 2nd and 3rd weddings were carried out.

Collected data

Phenology, growth, yield and yield components parameters were collected. Under phenology and growth parameter, Days to 85% maturity and Plant height (cm) were recorded. Under yield and yield components parameter, Panicle length (cm), Number of productive tillers per plant, Number of filled grains per panicle, Total above-ground dry biomass yield (kg), Hundred seed weight (g) and Grain yield were recoded.

Data analysis

All collected data were analyzed using SAS software version 9.3 (SAS, 2009). This means separation was carried out by using LSD at 5%.

Results and Discussion

Analysis of variance

Before the combined analysis of variance, the homogeneity of error variances was tested, and all of the traits showed homogeneous error variances. Having this confirmation, the data were pooled across years and a combined analysis of variance over two years average was performed.

Phenology and growth parameters

The pooled analysis of variance showed that days to physiological maturity, lodging incidence and productive tiller were influenced by rice varieties. Combined mean values, the highest days (140.7) and (139.1) of maturity were recorded from Gode and Shebele varieties, while the lowest days (111.8) of maturity were recorded from Pawe-2 variety (Table 1). This result agreed with the report of (Zelalem *et al.*, 2019), who reported that days to maturity were significantly affected by rice varieties. Effects of pooled analysis for lodging incidence ranged from 35.8% - 5.0% for Chewaqa and Pawe-2, respectively. This might have occurred due to genetic variation in the rice varieties. Combined analysis results for productive tillers ranged from 16.5 for Nerica-15 variety to 21.9 for Pawe-1 variety (Table 1). The results conform to Alemu and Assefa (2016).

Table 1. Means values of phenology and growth parameters.

	Days to maturity %			Lodging incidence %			Productive tiller		
Varieties	2020	2021	Combined	2020	2021	combined	2020	2021	combined
Gode	141.7^{a}	139.8^{a}	140.7^{a}	5.0^{c}	20.0^{a}	12.5^{c}	31.1^{a}	9.8	20.5^{a}
Shebele	140.0^{a}	138.3^{a}	139.1^{a}	5.0^{c}	11.7^{bc}	8.3c^{d}	32.2^{a}	10.4	21.3^{a}
Kallafo	102.6^{b}	122.3^{bc}	112.5^{bc}	36.7^{b}	16.7^{ab}	26.7^{b}	27.4^{ab}	11.3	19.4^{ab}
Chewaqa	103.0^{b}	126.7^{b}	114.8^{b}	50.0^{a}	21.7^{a}	35.8^{a}	29.1^{a}	11.2	20.2^{a}
Nerica-15	104.0^{b}	120.6^{c}	112.3^{bc}	5.0^{c}	16.6^{ab}	10.8^{c}	22.2^{b}	10.8	16.5^{b}
Pawe -2	102.0^{b}	121.6^{bc}	111.8^{c}	5.0^{c}	5.0^{c}	5.0^{d}	32.0^{a}	11.8	21.9^{a}
CV (%)	1.88	2.54	1.29	6.63	15.6	14.53	10.03	18.13	8.72
LSD (0.05)	3.95	5.94	2.86	2.144	8.08	4.37	5.29	4.92	3.18

Plant height and panicle length

The study revealed significant variances among rice varieties in plant height and panicle length (Table 2). Kallafo and Chewaqa gave the tallest 128.1 cm and 126.6 cm plant height, and Gode variety was significantly the shortest (92.2 cm) plant height. The result was consistent with those of Khatun (2001) and Das *et al.* (2012), who observed variable plant height among the rice varieties. The longest panicle length (27.9 cm) was obtained from Pawe-2 variety, while the lowest yield was obtained (24.2 cm) from Gode variety. This result is in line with the finding of Altaye and Awel (2021).

Table 2. Mean values growth and yield components.

Varieties	Plant height (cm)			Panicle length (cm)		
	2020	2021	Combined	2020	2021	combined
Gode	100.8^{c}	83.6^{d}	92.2^{c}	26.9^{bc}	22.2^{b}	24.6^{cd}
Shebele	116.2^{b}	104.8^{bc}	110.5^{b}	23.6^{c}	21.4^{b}	22.5^{d}
Kallafo	119.4^{b}	136.7^{a}	128.1^{a}	26.7^{bc}	24.1^{ab}	25.4^{bc}
Chewaqa	139.0^{a}	114.1^{b}	126.6^{a}	32.0^{a}	21.8^{b}	26.9^{ab}
Nerica-15	120.2^{b}	111.9^{b}	116.1^{b}	27.9^{b}	24.1^{ab}	26.0^{abc}
Pawe -2	119.3^{b}	101.6^{c}	110.4^{b}	30.1^{ab}	25.8^{a}	27.9^{a}
CV (%)	3.88	4.83	2.76	7.17	7.32	4.75
LSD (0.05)	8.42	9.55	5.72	3.63	3.09	2.21

Yield and yield components

The pooled analysis of variance showed a significant difference in number of filled grains per panicle and above-ground dry biomass (Table 3). Variety Pawe-2 (236.2), followed by Chewaqa (158.9) was the highest variety for the number of filled grains per panicle, while Nerica-4 (151.6) was the lowest number of filled grains per panicle variety. This result was in line with the finding of Almu and Assefa (2016), who found that the number of filled grains per panicle was significantly affected by rice varieties. The highest above-ground dry biomass (20197 kg ha^{-1} for Gode variety, 19563 kg ha^{-1} for Shebele variety and 18710.5 kg ha^{-1} for Pawe-2 variety, while the lowest above-ground dry biomass (13375 kg ha^{-1}) was recorded form Chewaqa variety (Table 3). This result was in agreement reported by aligns Altaye (2019).

Table 3. Mean values of yield components.

	Filled grain per panicle			Above-ground dry Biomass (kg ha^{-1})		
Varieties	2020	2021	Combined	2020	2021	Combined
Gode	244.2^{b}	173.7^{ab}	209.0^{b}	21540^{a}	18854^{a}	20197^{a}
Shebele	209.2^{cd}	145.4^{bc}	177.4^{c}	19333^{b}	19792^{a}	19563^{a}
Kallafo	202.1^{cd}	134.9^{c}	168.6^{c}	17833^{c}	14063^{b}	15948^{b}
Chewaqa	184.6^{d}	133.1^{c}	158.9^{c}	12500^{e}	14250^{b}	13375^{d}
Nerica-15	212.9^{c}	142.4^{c}	177.7^{c}	15631^{d}	13688^{b}	14659^{c}
Pawe -2	271.4a	200.9^{a}	236.2^{a}	19150^{b}	18271^{b}	18710^{a}
CV (%)	6.77	10.38	7.77	8.82	5.39	3.42
LSD (0.05)	27.175	29.29	26.57	758.15	1526.50	1037.70

Grain yield, thousand seed weight and harvest index

The combined analysis of variance showed significant differences in grain yield, thousand seed weight, and harvest index among tested varieties (Table 4). The highest grain yield (6284.7 kg ha^{-1}) was recorded from variety Pawe-2, and the lowest grain yield (3928.0 kg ha^{-1}) was recorded from Chewaqa. This result agreed with Ullah *et al.* (2016), who observed variable grain yield among the rice varieties. Similarly, significant variations in grain yield were reported by Mulugeta *et al.* (2012), who tested rice under rain-fed conditions. The highest thousand seed weight (34.6 g) was recorded for variety Pawe-2, and the lowest thousand seed weight (25.1 g) was recorded for variety Shebele (Table 4). The variation in thousand seed weight might be due to the differences in length and breadth of the seeds that were partly controlled by the genetic makeup of the genotypes (Rahman *et al.*, 2018). This result is in line with Wubale *et al.* (2015), who obtained minimum and maximum values for 1000 seed weights 26.15 and 35.41 g, respectively. The highest harvest index (0.39) was recorded from variety Pawe-2-1 and followed (0.21) by variety Shebele while the lowest harvest index (0.26) was recorded from variety Selam (Table 4).

Table 4. Means values of grain yield and yield components

	Grain yield (kg ha^{-1})			Hundred seed weight (g)			Harvest index %		
Varieties	2020	2021	Combined	2020	2021	Combined	2020	2021	Combined
Gode	5241.2^{b}	3642.1^{b}	4441.7^{b}	29.0^{c}	29.0^{c}	29.0^{c}	0.24^{d}	0.19^{c}	0.22^{e}
Shebele	4342.1^{c}	3595.7^{b}	3969.0^{c}	25.7^{d}	24.5^{d}	25.1^{d}	0.23^{d}	0.18^{c}	0.21^{e}
Kallafo	5687.3^{b}	3529.9^{b}	4608.3^{b}	34.7^{a}	28.8^{c}	31.8^{b}	0.46^{a}	0.25^{b}	0.36^{b}
Chewaqa	4337.5^{c}	3518.9^{b}	3928.0^{c}	30.3^{c}	35.0^{a}	29.6^{c}	0.24^{d}	0.25^{b}	0.25^{d}
Nerica-15	5181.3^{b}	3584.8^{b}	4383.0^{b}	33.5^{b}	31.5^{b}	32.5^{b}	0.33^{c}	0.26^{b}	0.30^{c}
Pawe -2	7431.3^{a}	5138.1^{a}	6284.7^{a}	34.7^{a}	34.5^{a}	34.6^{a}	0.40^{b}	0.38^{a}	0.39^{a}
CV (%)	7.76	3.59	3.66	2.93	1.53	1.18	6.93	7.65	4.64
LSD (0.05)	758.15	250.56	306.83	1.66	0.86	0.6626	0.041	0.035	0.025

Conclusion

A significant cereal crop in Ethiopia is rice. However, the production and productivity are low due to uncovering suitable areas for rice production and the shortage of improved and unedited, well-adapted varieties. To solve this problem, the study was conducted in the Dasenech district during (2020/21 and 2021/22) cropping seasons with the objective of selecting well-adapted varieties/ies. Of the investigated treatments, the Pawe-2 variety's grain production (6284.7 kg ha^{-1}) was the greatest. We saw field visits for this variety, which indicates that agro-pastoralists are interested in it as well. Since grain and animal feed is made from its stalk and leaves. As a result, Pawe-2 variety can be advised to prompt in the study area.

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