J Agric. Res., 2017, Vol. 55(2):279-289
ISSN: Online: 2076-7897, Print:0368-1157
http://www.jar.com.pk

PERFORMANCE EVALUATION OF UPLAND RICE VARIETIES IN SOUTH WESTERN AREAS OF ETHIOPIA

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ABSTRACT

A study was conducted at Guraferda and Gojeb Research Sub Stations, Ethiopia in 2013 cropping season. Nine rice varieties were tested for their adaptability. Land preparation, sowing, weeding and fertilizer application were conducted based on the recommendations. The treatments were replicated three times using RCBD. Apart from yield components, half of varieties relatively headed earlier in Gojeb than in Gurafera. Based on the result of ANOVA and LSD, effective tillers number per plant, total tillers number per plant and paddy yield (qt/ha) were significantly affected by varietal difference. At Guraferda, variety Getachew (AD01) gave the highest effective tillers (5.13) and total tillers (5.53) followed by NERICA 3 (4.87, 5.26) and Tana (AD048) (4.47 and 4.87). At Gojeb, higher effective tiller numbers per plant was recorded by Local Check (10.93) against the least by SUPARICA 1 (6.0). Local check also excelled in total tillers number (11.07) being similar Kokit (IRAT-209) (8.93). At both locations varieties did not differ significantly on panicle formation potential. However, the highest Panicle formation (99.98%) was recorded in NERICA 3 Gojeb. At Guraferda Local Check gave the highest paddy yield (55.14 qt/ha) followed by NERICA 3 (54.62 qt/ha) NERICA and IRAT-209 produced 51.24 and 50.06 qt/ha, respectively. At Gojeb, maximum paddy yield 59.41qt/ha was recorded from (59.41 qt/ha followed by IRAT-209 (51.08qt) and NERICA 3 (50.71 qt). Minimum yield was produced by Tana (AD048) (37.85 qt) and Kallafo (FOFIFA3737), (35.34 qt) at Guraferda and Gojeb, respectively. Almost all varieties especially those introduced and registered in Ethiopia scored better yield than their national average paddy yield. Based on the results, NERICA 4 proved to be best suited for the study areas. However NERICA 3 and Kokit are alternatives if NERICA 4 not available.

KEYWORDS: ***Oryza sativa;*** **upland rice; varieties; agronomic characters; yield; Ethiopia.**

INTRODUCTION

Rice (*Oryza sativa)* is one of the most important food crops in the world and feeds over half of the global population (16). It is generally associated with Asia but it is also an integral part of the history and culture of Africa, where it

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is grown for over 3000 years (12). Rice is a staple food in many countries of Africa and constitutes a major part of the diet in many others. During the past three decades, crop has shown consistent increases in demand and its growing importance is evident in the strategic food security planning policies of many countries. With the exception of a few countries that have attained self-sufficiency in rice production, rice demand exceeds production and its large quantities are imported to meet demand at a huge cost (20).

Many factors contribute for low production status of the crop. Lack of high yielding and suitable varieties for specific environments, backward technologies and practices are major problems among others. More work is still needed in defining what varieties in terms of farmers need for various ecosystems in which rice is grown under current and future climate scenarios and that respond to consumer demand (7, 10, 13).

In Africa, in the presence of diversified agroecology and genetic diversity of rice, farmers are able to produce rice under adverse conditions (16). Especially Ethiopia is endowed with a suitable climate where many different kinds of crops can successfully be grown. Especially rice, which is considered as a “millennium crop”, is taking important consideration. In the country, a total of 30 million hectares of land is suitable for rain-fed rice production (7, 19). In the process of attaining food self sufficiency at farmers level; improved crop technologies play a significant role. Crops that could be grown and giving reasonable yield under unfavorable conditions are important (6, 7).

South western part of the country is known by longer period and high amount of rainfall. In this area especially in some localities of SNNPR rice is coming to the area’s crop production system. Especially in Guraferda and Gimbo (Gojeb) areas upland rice is cultivated for decades. However, existing rice cultivation system is not supported with new and better technologies like high yielding varieties and cultivation practices (7, 19, 20). These conditions make evaluation of different rice varieties important to create a better future of crop in the area. Therefore, this trial was conducted to evaluate the adaptability and performance of released upland rice varieties and select suitable ones for the area.

MATERIALS AND METHODS

This study was conducted at Guraferda and Gojeb Research Sub-stations, South Western areas of Ethiopia. Specifically Guraferda site is situated at 1138 m.a.s.l. and has a good rainy season. Similarly Gojeb testing site has

1223 m.a.s.l. with good rainy season in addition to enough surface water during growing season. The soil status of the sites is almost equivalent with slight differences. The pH of Guraferda is 5.67, available P 19.3 ppm, N 0.34% and available K 2.69 meq k/100 g. At Gojeb the pH was 5.27 with 2.28 ppm available P, 0.28% N and 0.4 meq K/100 g. The soil texture of both sites was sandy clay loam at top surface.

Normal experiment procedures were followed in the process. Nine existing varieties included were; NERICA 3 (WAB-450-I-B-P-28-HB), NERICA 4 (WAB-450-I-B-P-91-HB), SUPARICA 1 (WAB-4507), Kallafo (FOFIFA-3737), Getachew (AD01), Andassa (AD012), Tana (AD048), Kokit (IRAT-209), and local check. Trial was conducted in RCBD reptioned thrice. Land preparation was conducted at optimum level prior to demarcation of experimental area. Germination test was conducted in Bonga before weighing the required amount of seeds for the experiment. Based on the result obtained from germination test, seeds were prepared for each plot.

Crop was sown sowing was conducted on June 1, 2013 in Guraferda and on July 18, 2013 in Gojeb stations in lines according to farmer's sowing schedule. Total size of individual plot was 3 m x 4 m. Plots and replications were separated by 1 m and 1.5 m, respectively. Row spacing was 25 cm and drilling was done in rows using seed rate of 60 kg per hectare. Data were collected based on predetermined procedures.

Harvesting was done on October 17, in Guraferda and November 8, 2013 in Gojeb after collecting pre harvest data. Samples were taken for data collection from the central rows of plots with excluding all direction of borders. Similarly, harvesting was conducted in 3.5 x 2.5 m sized area (8.75 m^2) of a plot by excluding border rows and plants found in either side of plots. Following harvesting, each of the harvested variety was threshed by biting on the provided plastic sheets on the ground. Average moisture content of paddy was taken after three consecutive measurements with Mini Gac moisture tester following cleaning of the harvested grain from dirt and unwanted plant parts. The data obtained from the experiment were transformed in to analyzable data form. Then the transformed data were analyzed using SAS version 9.00 (11) program.

RESULTS AND DISCUSSION

Agronomic traits

According to the results, all varieties showed different adaptability features having difference in their 50% heading date (Table 1).

Table 1. Mean days to 50% heading of rice varieties in Guraferda and Gojeb testing sites

No.	Variety	Days to 50% heading	
		Guraferda	Gojeb
1.	NERICA 3 (WAB-450-I-B-P-28-HB)	73	76
2.	NERICA 4 (WAB-450-I-B-P-91-HB)	73	78
3.	SUPARICA 1 (WAB-4507)	84	82
4.	Kallafo (FOFIFA-3737)	73	77
5.	Getachew (AD01)	95	89
6.	Andassa (AD012)	91	86
7.	Tana (AD048)	86	89
8.	Kokit (IRAT-209)	83	75
9.	Local check	95	88

At Guraferda heading took 73-95 days after emergence, but in Gojeb it took 75-89 days. At Guraferda, both NERICA varieties headed in 73 days after emergence. Similarly SUPARICA 1 and Kallafo also headed within 84 and 73 days, respectively (Table 1). Local variety headed in 95 days after emergence. All varieties especially the new ones delayed in heading when compared with the varieties registration data in the country.

According to MoARD (4, 5), in Guraferda, heading date of both NERICA varieties' was delayed by 3 days. At Gojeb, varieties headed later than those at Guraferda's. Nationally, NERICA 3 and 4 headed in 70 days of sowing, however 6 and 8 heading delay was observed in these varieties respectively. In Guraferda, SUPARICA 1 heading also delayed by 9 days but, at Gojeb it was delayed for 7 days from national average (75 days). In contrast, at both locations, Kallafo was headed in its range of heading days compared with national range (70-80 days) (Table 1).

Similarly, other varieties showed different heading date at both locations. At Guraferda, 14 days lateness was observed on Getachew as compared with 81 days in national report. Similarly an 8 day's heading delay was recorded in Gojeb. In Guraferda, Andassa scored relatively a similar heading date (91 days) as in the national report (93 days). In contrast, at Gojeb, a 7 days heading earliness was observed. Tana scored a 6 days earlier heading date as compared with national reported date (92 days) at Guraferad. Similarly, 3 days earliness was observed in Gojeb. Exceptionally, at both locations Kokit headed late, by 16 and 8 days than national reported date (67 days) at Guraferda and Gojeb, respectively.

Based on the result obtained, heading delayed at Guraferda. Similarly, it was also prolonged at Gojeb even though it was not alike with the varieties heading date reported nationally. According to Sikuku et al. (18), water availability significantly affected rice heading and flowering. This implies the difference of moisture availability may delay heading date of varieties. In both experimental areas water shortage was not observed. However the areas agronomic feature is quite different in availability of soil moisture. Guraferda's topography and soil conditions are typically upland and experimental field was slightly sloppy. At Gojeb, growing condition is relatively different from Guraferda. Especially, the experimental field was situated on level land where plenty of moisture is existed for rice growing period. In this condition more than half of the varieties in Gojeb headed earlier than Guraferda.

Yield components

Tillers number: The result of analysis of variance revealed that there was significant ($P<0.05$) difference between panicle bearing (effective), tillers number per plant and total tillers number at Guraferda and Gojeb testing sites (Table 2).

Table 2. Yield and yield components of rice varieties at Guraferda and Gojeb testing sites in 2013 cropping season

Treatment	Effective (panicle bearing) tiller number per plant		Total tiller number per plant	
	Guraferda	Gojeb	Guraferda	Gojeb
NERICA 3 (WAB-450-I-B-P-28-HB)	4.87ab	7.4bc	5.26a	7.47bc
NERICA 4 (WAB-450-I-B-P-91-HB)	3.73bc	7.07bc	3.93b	7.37bc
SUPARICA 1 (WAB-4507)	4.13abc	6.00c	4.47ab	6.40c
Kallafo (FOFIFA-3737)	3.87bc	7.20bc	4.13b	7.73bc
Getachew (AD01)	5.13a	8.40b	5.53a	8.60b
Andassa (AD012)	3.60c	8.26b	4.00b	8.47bc
Tana (AD048)	4.47abc	8.07bc	4.87ab	8.27bc
Kokit (IRAT-209)	3.67c	8.73b	3.93b	8.93ab
Local check	3.87bc	10.93a	4.13b	11.07a
LSD	1.16*	2.19*	1.12*	2.17*
CV	16.24	15.82	14.57	15.22
Treatment	**Panicle formation potential (%)**		**Paddy yield (qt/ha)**	
	Guraferda	**Gojeb**	**Guraferda**	**Gojeb**
NERICA 3 (WAB-450-I-B-P-28-HB)	91.98	99.12	54.62a	50.71ab
NERICA 4 (WAB-450-I-B-P-91-HB)	94.87	96.36	51.24ab	59.41a
SUPARICA 1 (WAB-4507)	92.48	94.22	44.87abc	44.47bc
Kallafo (FOFIFA-3737)	93.42	92.61	49.08abc	35.34c
Getachew (AD01)	92.81	97.71	41.05bc	44.47bc
Andassa (AD012)	90.87	97.59	44.34abc	47.42abc
Tana (AD048)	91.64	97.51	37.85c	47.73abc
Kokit (IRAT-209)	93.04	97.69	50.06ab	51.08ab
Local check	93.34	98.79	55.14a	46.20bc
LSD	NS	NS	11.478*	12.473*
CV	4.83	4.38	13.93	15.19

*Significant at 5% probability level, NS=Non Significant, Means with same letters are not significantly different

At Guraferda, the highest effective tillers number (5.13) was recorded on Getachew (AD01); however it did not significantly differ from NERICA 3 (4.87), Tana (4.47) and SUPARICA 1 (4.13). Minimum (3.6) effective tillers number was recorded from Andassa but it is not significantly different from the other varieties which did not lie in first category. At Gojeb, score of effective tillers number was increased. Significantly higher (10.93) effective tiller number was scored by Local check. All remaining varieties were categorized in the second performance grouping, except SUPARICA 1 (6.00).

At both locations, status of total tiller number was different but it was significantly affected by varietal difference. At Guraferda, Geachew scored higher (5.53) total tillers number than others even though it was not significantly different from NERICA 3 (5.26), Tana (4.87), and SUPARICA 1 (4.47). At Gojeb, Local Check surpassed (11.07) total tiller number being statistically at par with Kokit (8.93). Except these two varieties, other varieties fell in same grouping. However, Getachew and SUPARICA 1 gave significantly different tillers number (8.60 and 6.4). Except from local checks used in testing sites, other varieties exhibited varietal difference in making of tillers.

The data on effective tiller and total tiller number per plant revealed difference at both locations. This was due to soil type and water regime observed on the testing sites. Similar performance has been reported earlier (9) according to which tiller number is affected by nutrient condition of the soil. Similarly, Kano- Nakata et al. (10) reported that, varieties treated in water logged condition exhibit more tiller production as compared with varieties treated under relatively water deficit soil; and this was clearly observed in Gojeb testing site where almost all treated varieties gave higher number of total and effective tillers number.

Tillering of rice is predominantly affected by spacing, light, nutrient supply, and other environmental and cultural conditions (8). Especially phosphorus deficiency or deep planting impair tillering (22). A study (2) reported that tillers within a plant significantly contribute for a positive response of yield components in rice (2). In addition more tillering is expected in transplanted rice, but in this kind of experiment or where direct sowing is practiced small number of tillers (1-7) is expected from rice plant (1, 14, 17). In this experiment with some exceptions, all varieties produced tillers in the expected range.

All varieties under study showed non-significant (P>0.05) differences for panicle production potential.

Grain yield

The result of analysis of variance indicated significant difference (P<0.05) between grain yields of varieties at both Guraferda and Gojeb testing sites. At Guraferda, local variety gave the highest yield (55.14 qt/ha) and ranked at par with remaining varieties except Getachew (41.05 qt/ha) and Tana (37.85 qt/ha) which gave significantly lower yields. At Gojeb, Local Check (brown coloured rice variety) gave a moderate yield (46.2 qt/ha) when it is compared with other varieties (Table 2). Significantly highest paddy yield (59.41qt/ha) was recorded from NERICA 4 which did not differ significantly from Kokit (51.08 qt/ha), NERICA 3 (50.71 qt/ha), Tana (47.73 qt/ha) and Andassa (47.42 qt/ha). Remaining varieties also gave comparable yield and laid on the same yield category except Kallafo which gave significantly less paddy yield (35.34 qt/ha). Both Getachew and Tana varieties gave lower yields.

The varieties when compared based on paddy yield advantage, showed a significant yield difference. At Guraferda Local check gave a 17.29 qt yield advantage over Tana. Similarly it gave 0.52-14.09 qt/ha yield advantage when it is compared with the rest varieties. At Gojeb NERICA 4 gave 24.07 qt/ha paddy yield advantage over least yielded variety Kallafo (35.34 qt/ha). When compared with other rest varieties it showed 8.33-14.94 qt/ha paddy yield advantage (Table 2).

Except from local checks, best performing and alternative varieties were identified as a result of evaluation of a number of varieties in two different locations. NERICA 4 and 3 are the two top varieties which gave relatively the highest paddy yield. Similarly, in both locations Kokit also performed better and in addition to this it was selected by farmers who visited the variety during experimental period. It is among the top yielding varieties and gave 12.21 and 15.74 quintals yield advantage over the least yielding varieties Tana and Kallafo, respectively (Table 2).

According to MoARD (4) NERICA 4 can give upto 48 and 30 quintals per hectare in research and farmers fields, respectively. Similarly NERICA 3 also can give 45 quintals per hectare in research field. It has also given 29 quintals per hectare in farmer’s field. Table 2 show that at both locations both varieties gave the highest yield and scored better yield than national average paddy yield.

The other varieties also gave comparable yield with their national average. Kallafo had given 65 and 50 quintals of paddy per hectare nationally in research and farmers field, respectively. In present experiment it gave 49.87 and 35.34 qt /ha at Guraferda and Gojeb, respectively. On average basis, paddy yield decreased by 22.79 qt/ha. It was understood that, in this experiment Kallafo performed less in water logged than dry condition. The variety performance proved as such where it has been released and cultivated in arid Eastern Ethiopia under irrigation (7). Similarly SUPARICA 1 can give upto 51qt/ha at national level however, in average it gave 6.33 qt/ha less yield when compared with this experiment result. However, rest varieties scored highest paddy yield when compared with their national average. Andasssa, Tana and Getachew showed 7.88, 1.79 and 24.76 qt/ha yield advantage over the national average, respectively. In both cases the local variety performed well even though varieties used at both locations were basically different. Getachew, Andassa and Tana gave comparable yield with some of the treated varieties; however these were heavily affected by disease at field as compared with the other varieties. Brown spot was observed on them for during growing period of growing time. They have typically reddish brown rice color; in addition this trait is not wanted by farmers.

In general, yield performance of the varieties was the highest as compared with the national average. This could be the result of better growth conditions because maximum yield is predetermined by the potential of a variety and the environment (14). Weather condition, cultural management and nutrient supply greatly influence each yield component of a variety. For this specific experiment, all required conditions were met for increment of yield and yield components. Especially the land of experiment was good enough to give the required nutrients at a time. According to a research result (21), genotypes tested under rainfed condition exhibited yield and yield component differences and that helped to identify best performing varieties for drought stress conditions.

According to the correlation coefficient result, total tillers number per plant was strongly and positively related with effective tillers per plant at Guraferda (0.97784*) and Gojeb (0.98685*) testing sites. The increase in effective tillers number is resulted from the presence of increased tillers number per plant. In contrast the other parameters did not exhibit strong relationship between them (Table 3).

Table 3. Pearson correlation coefficients (r) among yield and yield components upland rice at Guraferda (above diagonal) and Gojeb (below diagonal)

Parameters	ETNP	TTNP	PEP	PY
ETNP	1	0.97784*	0.19993	-0.17597
TTNP	0.98685*	1	-0.00688	-0.17101
PFP	0.34335	0.18780	1	-0.01634
PY	0.13419	0.14376	-0.00152	1

ETNP = Effective Tiller Number per Plant, TTNP = Total Tiller Number per Plant, PFP = Panicle Formation Potential, PY = Paddy Yield

CONCLUSION AND RECOMMENDATIONS

Apart from yield attributes, the varieties perform differently other components. Except from the local checks and reddish brown coloured rice varieties, NERICA 3, 4 and Kokit performed well relatively in all parameters. In yield aspect, NERICA 4 surpassed all remaining rice varieties except the Local Check, even though it was not statistically different from NERICA 3 and Kokit. Kokit is also another competent variety based on its yield potential because it gave the highest paddy yield as compared with NERICA 3. Despite its yield potential, Kallafo did perform well in Guraferda but it was not better art Gojeb where it scored the least paddy yield. Based on the above main evaluation criteria, NERICA 4 is best suited for future production scheme. In second place NERICA 3 and Kokit are alternatives if NERICA 4 is not available.

ACKNOWLEDGMENTS

The author is highly thankful for the services rendered by M/S Abate Setie Aragaw, Abayneh Kacharo Kampe and Fikadu Ejigu Kassa for their assistance in field work and data collection.

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Received: August 31, 2015 ***Accepted: June 22, 2016***

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