Rice Research-Open Access

Kinfe et al., J Rice Res 2017, 5:4
DOI: 10.4172/2375-4338.1000187

Research Open Access

Yield and Yield Related Performance of Upland Rice Genotypes in Tselemti district, North Ethiopia, 2015

Hailegebrial Kinfe*, **Yiergalem Tsehaye, Alem Redda, Redae Welegebriel, Desalegn Yalew and Welegerima Gebrelibanos**

Shire –Maitsebri Agricultural Research Center, Shire, Ethiopia

***Corresponding author:** Hailegebrial Kinfe, Shire-Maitsebri Agricultural Research Center, Shire, Ethiopia, Tel: +251914292749; E-mail: hailatkinfe@yahoo.com

Received date: November 16, 2017; **Accepted date:** November 29, 2017; **Published date:** November 30, 2017

Abstract

Rice (*Oryza sativa* L.) is one of the major staple food crops for about 65 % of the world's population. A rice field experiment was conducted at Tselemti district of North Ethiopia during the main wet cropping season 2015-16 and 2016-17. The current study was proposed to evaluate the adaptability and yield performance and to identify stable, high-yielding, disease-resistant and early maturing upland rice genotype(s) in local environments. Sixteen upland rice genotypes including the standard check were evaluated. The tested genotypes are both released and unreleased genotypes and gained from national rice research programs. The experiment was laid out in a randomized complete block design of three replications. Combined analysis of variance revealed significant variations in genotypes for most traits but there is non-significant for genotype by environment interaction based on the selected analyzed traits and this implied the genotypes were not affected by the environment and the superiority genotypes across environment is constant. The highest grain yield of 3.5 t ha^{-1} was recorded by *G4-Tana* (41.8 Qt ha^{-1}), followed by *G2-Getachew* (39.5 Qt ha^{-1}). So, even if the stability didn't analyzed the Genotype *Tana* and *Getachew* were relatively highest in mean grain yield across environments and hence, both genotypes could be recommended for cultivation by the farmers and this variety should be demonstrated and popularized in larger scale to make use of its merits.

Introduction

Rice (*Oryza sativa* L.) is the foremost staple food for more than 50% of the world's population. It is estimated that by the year 2025, farmers in the world should produce about 60% more rice than at present to meet the food demands of the expected world population at that time [1]. By 2025 the world population will reach eight billion people, with 80% of those are in developing countries, and these countries will require a rational and efficient production to meet the demand of this population [2]. Among the cereals of great social and economic importance in the world, highlights the rice (*Oryza sativa* L.), which is an energy source for two-thirds of the world population, providing about 20% of energy and 15% of the protein that human needs [3]. Between 2007 and 2010, rice consumption in Africa increased at a rate of 4.41% per year, despite the upsurge in rice price during the food crisis [4].

With this rice is the staple food for more than half of the world's population, contributing over 20% of the total calorie intake of humans [5]. The leading producers of this cereal are China, India, and Indonesia which together account for over 50% of the world's total production [6]. In sub-Saharan Africa (SSA), rice is currently one of the rapidly growing food crops in production and consumption. In a span of ten years the cultivated area has almost doubled reaching 10 million hectares with current annual production of approximately 23 million tons [6]. Rice grain produced is directly used for human consumption with average per capita consumption of 24 kg per year in SSA. Although significant increases in production have been realized, still consumption outstrips production resulting in huge deficits that are met through importation. Among the net rice importers in the region, West Africa is the leading, accounting for 74% of the total volume imports in SSA while East Africa accounts for 15% [7].

Rice can be grown in a wide range of locations and climates. It can grow from altitude of sea level to 3000 masl with rainfall range of 800-2000 mm and its optimum temperature also covered from 25-35°C. There are primarily four ecosystems where rice is grown: irrigated, rainfed lowland, upland, and flood-prone. Each of these environments has its own ideal growing conditions, as well as limiting factors. Rainfed Upland Rice is grown in Asia, Africa, and Latin America. About 14 million hectares of land is dedicated to upland rice, accounting 4% of global rice production.

This rice environment can be found in low-lying valley bottoms to undulating and steep sloping lands with high runoff and lateral water movement. In many places, including Indonesia, the Philippines, Southwest China, and Brazil, upland rice may be intercropped with maize. Also, some upland rice fields are frequently bunded in areas with scarce water. Upland rice is grown under dryland conditions in mixed farming systems without irrigation and without puddling.

In case of Ethiopia Rice is among the target strategic commodities that have received great focus and considered as the "millennium crop" expected to contribute in ensuring food security in Ethiopia [8]. The national average yield of rice in Ethiopia is 2.9 t ha^{-1} [9], which is much lower than the world's average rice yield of 4.54 t ha^{-1} [10]. This is due to insect pest and diseases occurrence (rice blast and brown spot), weeds and environmental fluctuations. In addition, poor agronomic practices; human and institutional capacity and shortage of adapted varieties for different agro-ecologies are the major rice production constraints in the country.

Efforts to introduction of rice had probably been started in Ethiopia when the wild rice (*O. longistaminata*) was observed in the swampy and waterlogged areas of Fogera and Gambella plains [11]. According to the report of MoARD [8] the potential rice production area in

Ethiopia is estimated to be about 30 million hectares, of which more than 5 million ha is highly suitable. There is an increasing trend in both area and production of the crop [9]. Currently, Amhara, SNNP, Oromiya, Somali, Gambella, Benu Shangul Gumuz, Tigray and Afar regions are rice producing regions in Ethiopia [8]. The amount of area under rice cultivation in Ethiopia is low as compared to the potential. Along with the increased level of production, there is increased volume of rice import. Though the grain production of rice increased from 71, 393.7 t (2009) to 131,821.9 t (2015), importing of rice increased dramatically form 30, 082 t (2009) to 277, 476.6 t (2015). This proved that the production and demand have huge gap and needs especial attention. Generally, rice has great potential and can play a critical role in contributing to food and nutritional security, income generation, poverty alleviation and socio economic growth of Ethiopia.

So, Development of varieties with high yield potential coupled with wide adaptability is an important plant breeding objective. The presence of genotype by environment (G × E) interaction expected to play a crucial role in determining the performance of genetic materials, tested at different locations and in different years, influencing the selection process. Therefore, the current study was initiated to select the best high yielder upland rice genotypes with high grain yield and yield related traits either for specific and/or wide area production depending on their differential responses to environments.

Materials and Methods

Tselemti wereda has an altitude range of 800 to 2870 masl and the altitude of the experimental site is 1350 masl. The agro-Ecological Zone of the Wereda is Hot to warm-moist lowlands (M1-7) and Tepid to cool-moist mid highlands (M2-5) with 2.65% Dega (cool highland), 19% Weinadega (mid highland) and 78.35% kola (hot lowland). The mean annual temperature ranges from a minimum of 16°C (November-January) to a maximum of 38°C (February-May). The annual rain fall is 670 mm with a variation between758-1100 mm and has a mono-modal pattern. Generally, rain fall starts in June and ends in September.

Fifteen rainfed upland rice plus one standard check (*Hidasie*, *Getachew*, *Andassa*, *Tana*, *N-3*, *N- 4*, *SUPERICA-1*, *Kokit*, *N-12*, *N-14*, *N-15*, *N-18*, *FOFIFA-4129*, *FOFIFA-3737*, *FOFIFA-373* and *Maitsebri-1* were evaluated in Tselemti districts of North Western Tigray from 2015-16 and 201-17 at Maitsebri experimental site (on station) and mezekire location. The experimental units were laid out using Randomized Complete Block Design (RCBD) with three replications. Each plot had six rows of 5 m length and spaced 0.2 m apart. Fertilizer was applied at the rate of 69/46 kg ha^{-1} of N/P_2O_5 in the form of urea and DAP, respectively. All plots were fertilized uniformly at the rate of 150 kg ha^{-1} Urea and 100 kg ha^{-1} DAP. All DAP and one third of urea at planting and the remaining two one third urea at mid tillering and panicle inition were applied according to the Shire-Maitsebri agricultural research center (2015) recommendation at each location. The seeds were sown at a depth of 2.5 cm with recommended seed rate of 70 kg ha^{-1} was used and seeds were sown using drilling method of planting in a row. Any other important agronomic practices were applied equally to all the plots at their proper time of application. The experimental area was kept weed free by hand pulling two times throughout the cropping season. All other cultural practices were applied uniformly to all plots as per standard recommendations for the crop.

Results and Discussion

Grain yield and some yield related traits

The analysis of variance for agro-physiological characters genotypes' and environments had high significant effect on yield and yield components at 0.01 probability (Table 1). Significant differences found among the genotypes for the traits such as days to heading and maturity, plant height grain yield and biomass but their genotype by environment interaction is non-significant across the locations. Grain yield varied among genotypes and locations. Across the locations and genotypes, the highest grain yield (41.8 Qt ha^{-1}) was obtained in *Tana* followed by *Getachew* (39.5 Qt ha^{-1}) and the lowest (28.04 t ha^{-1}) was in *FOFIFA-3737*(21.1 t ha^{-1}) (Table 1). The outstanding performance of those genotypes of *Tana* and *FOFIFA-3737* for grain yield seems due to its superiority for total number of tillers per plant, number of panicles per plant, heavier in grain weight, low sterility (%). Drought stress at the reproductive stage can have large effect on yield and yield components. Based on Boonjung and Fukai [12] reported that if drought stress develop soon after panicle initiation, the number of spikelet developed is decreased, and this may result in reduction in grain number per panicle , coupled with reduced grain weight, and hence a reduction in grain yield. It could be concluded that, in spite of drought stress at reproductive stage is the most damaging to rice crop by the reduction of dry matter production and therefore, reduction of productive tillers, these genotypes having more panicles/plant indicating that most of their tillers bear panicles under drought conditions. This may be due to the increase in nitrogen content in their shoot. Also, drought stress at booting and flowering stages reduced number of filled grains/panicle and induced sterility (%), whereas, these genotypes have high number of filled grains/ panicle and low sterility (%).

A Genotype by Environment interaction refers to differential ranking of genotypes across environments and may complicate the selection process and recommendation of a genotype for a target environment [13,14]. The combined analysis of variance for grain yield data is given in Table 1. All the sources except genotype × year and genotype × environment were significant. Significant interactions were resulted from the changes in the relative ranking of the genotypes or changes in the magnitudes of differences between genotypes from one environment to another. The non-significant G × environment effect demonstrated different responses of genotypes to the variation in environmental conditions of location indicating the unnecessary of testing upland varieties at multiple locations since the genotypes were less affected by the effect of environment. Grain yield in rice is a complex trait, product of components such as the number of panicles per plant, the number of grains per panicle and the mean grain weight. In line this with report of Anandan et al. [15] agreed and found the presence of genetic variability among the genotypes under study in most of the locations.

As Cooper and Somrith [16] reported early maturity has been shown to be an important trait under stress conditions because early flowering rice can escape from the late season drought stress. According to Dudley and Mol [17] days to flowering and days to maturity are highly and positively correlated, significantly correlated with plant height and not correlated with grain yield. However, Chakraborty et al. [18] noted a significant and positive correlation of grain yield with days to flowering and days to maturity.

Citation: Kinfe H, Tsehaye Y, Redda A, Welegebriel R, Yalew D, et al. (2017) Yield and Yield Related Performance of Upland Rice Genotypes in Tselemti district, North Ethiopia, 2015. J Rice Res 5: 187. doi:10.4172/2375-4338.1000187

Plant height is significantly and positively correlated with grain yield as mentioned report of Vange [19]. Plant height, in rice, can be highly heritable. Selection for reduced plant height can, therefore, be efficient. Maximum plant height was recorded in genotypes *Tana*, *FOFIFA- 3730* and *Andasa*, the values ranged from 106.67-107.98 cm) while shortest plant height was noted in genotype *N-15*(106.67 cm).

SN	Trt	Genotype	DH	DM	PHt	Gy kg/ha	BY kg/ha
1	T1	*Hidasie*	75.75	108	79.43	3430	8450
2	T2	*Getachew*	84.5	113.33	104.12	3952	11998
3	T3	*Andassa*	83.08	113.33	104.83	3892	11860
4	T4	*Tana*	83.83	112.83	107.98	4182	12088
5	T5	*N-3*	76	106.92	81.98	3517	8525
6	T6	*N-4*	75.5	107	80.6	3530	8057
7	T7	*SUPERICA-1*	78.25	109.33	88.93	3227	8332
8	T8	*Kokit*	78.08	109.5	82.36	3091	7640
9	9	*N-12*	77.42	109.75	86.56	3573	8501
10	10	*N-3(Maitsebri-1)*	77.08	110.25	83.11	3690	8545
11	11	*N-14*	74.75	109.5	80.59	3793	8932
12	12	*N-15*	71.58	106.67	85.71	3440	8040
13	13	*N-18*	74.42	108.25	85.67	3087	7670
14	14	*FOFIFA-4129*	73.67	107.67	87.72	2966	7544
15	15	*FOFIFA-3737*	76.5	108.67	88.33	2804	7698
16	16	*FOFIFA-3730*	83.75	113.5	107.85	3887	11060
F-Test		Mean	**	**	**	**	**
		Lsd (<0.05) genotype	**	**	**	**	**
		CV	**	**	**	**	**
		Genotype	**	**	**	**	**
		Year	**	**	**	**	**
		Environment	**	**	**	**	**
		Genotype × Year	Ns	Ns	*	Ns	Ns
		Genotype × Environment	Ns	Ns	Ns	Ns	Ns

Table 1: Listing of tested upland rice genotypes and their average performance in terms of grain yield and few other agronomic traits evaluated under four different environmental conditions from 2015 to 2016.

Conclusion

The study provided an evaluation of genotypic and environmental performance of sixteen rice genotypes over a range of environments across two years at Maitsebri experimental site and Mezekire location. The significant differences exhibited among the genotypes and environments for yield suggest a wide variability between the genotypes and the environments. Having yield stability and economic profitability is an important and complicated issue for breeders and farmers. Successful cultivars should be adapted to a broad range of environmental conditions to produce consistent yields everywhere. With this the information on genetic by environment interaction and stability is of paramount importance for rice breeders and farmers. The sixteen upland rice genotypes showed non-significant variation in most yield and yield related traits for genotype by environment and genotype by year interaction and this indicated consistency of genotype performance across the target environments. Hence, varieties *Tana* and *Getachew* scored reasonable yield performance, 41.8 Qt ha^{-1} and 39.5 Qt ha^{-1} respectively scored across the target environment and recommend demonstrating and popularizing in the rice growing Kebeles of Tselemti district.

References

1. Thakur AK, Rath S, Patil DU, Kumar A (2011) Effects on rice plant morphology and physiology of water and associated management

practices of the system of rice intensification and their implications for crop performance. Paddy Water Environ 9: 13-24.

2. Kennedy AC, Smith KL (1995) Soil microbial diversity and the sustainability of agricultural soils. In: Collins HP, Robertson GP, Klug MJ (eds) The Significance and Regulation of Soil Biodiversity. Developments in Plant and Soil Sciences, vol 63. Springer, Dordrecht.
3. Barberena DS, Medeiros RD, Barbosa GF (2011) Growth and Productivity of Irrigated Rice in Response to Different Doses of Phosphorus and Potassium in Lowland Soil of First Year in the State of Roraima. Sci and Agrotech 35: 462-470.
4. Africa Rice Center (Africa Rice) (2012). Africa Rice Center (AfricaRice) Annual report 2011: A new rice research for development strategy for Africa. Cotonou, Benin, 96pp.
5. Seck PA, Diagne A, Mohanty S, Wopereis MCS (2012) Crops that feed the world 7: rice. Food Sec 4: 7-24.
6. FAO (2015) Rice market monitor. Vol XVI1I: Issue No. 1.
7. WARDA (2005) Annual report for 2001-2005, West Africa Rice development Association, Bouake, Cotidevar.
8. MoARD (Ministry of Agriculture and Rural Development) (2010) National Rice Research and Development Strategy of Ethiopia. Addis Ababa, Ethiopia pp. 104-114.
9. CSA (2007-2016). Statistical Report on Area and Production of Crops. Addis Ababa, Ethiopia.
10. Food and Agricultural Organization (FAO) (2013) In feeding the world. FAO Statistical Yearbook.
11. Clarke N, Bizimana JC, Dile Y, Worqlul A, Osorio J, et al. (2017) Evaluation of new farming technologies in Ethiopia using the Integrated Decision Support System (IDSS). Agricultural Water Management 180: 267-279.
12. Boonjung H, Fukai S (1996) Effects of soil water deficit at different growth stages on rice growth and yield under upland conditions. 2. Phenology, biomass production and yield. Field Crops Research 48: 47–55.
13. Ebdon JS, Gauch HG (2002) Additive main effect and multiplicative interaction analysis of national turfgrass performance trials. Crop Sci 42: 497-506.
14. Gauch HG (2006) Statistical analysis of yield trials by AMMI and GGE. Crop Sci 46: 1488- 1500.
15. Anandan A, Eswaran R, Sabesan T, Prakash M (2009) Additive main effect and multiplicative interactions analysis of yield performances in rice genotypes under coastal saline environments. Advances in Biological Research 3: 43-47.
16. Cooper M and Somrith B (1997) Implications of genotype by environment interaction for yield adaptation of rainfed lowland rice. Influence of flowering date on yield variation. In: Breeding strategies for Rasin fed Lowland Rice in Drought prone Environments. Proceeding of an International Workshop held at Ubon Ratchatani. ACIAR, Canberra.
17. Dudley JW and Moll RH (1969) Interpretation and use of estimates of heritability and genetic variances in plant breeding. Crop Sci 9: 257-262.
18. Chakraborty R and Chakraborty S (2010) Genetic variability and correlation of some morphometric traits with grain yield in bold grained rice (Oryza sativa L.) gene pool of Barak valley. Am Eurasian J Sustain Agric 4: 26-29.
19. Vange T (2009) Biometrical studies on genetic diversity of some upland rice (Oryza sativa L.) accessions. Nature and Science 7: 21-27.