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Agronomic evaluation of rain fed rice varieties in Seke - Banza area, Democratic Republic of Congo

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ABSTRACT

Six rain fed rice varieties from INERA (National Institute for Agronomic Study and Research) YANGAMBI center were cultivated at INERA GIMBI station. The objective was to get high yield rain fed rice varieties adapted to Seke-Banza area conditions in view to increase farmers' production and to reduce import of rice in the country. This evaluation will also permit the diversification of rain fed rice varieties in investigation area. Randomized bloc design with four replications was used to evaluate the height of plant at the end of flowering (cm), number of days for plant flowering, number of maturity days, diseases resistance, number of panicles per square meter, weight of 1000 grains (g), grains yield (t/ha) and panicle length (cm). Compared to control (NERICA4), significant difference was detected between tested materials ($P \geq 0.05$). All varieties produced high values of evaluated parameters than control. Three varieties were more effective: NERICA11 (4.942 t/ha), LIENGE (4.514 t/ha) and WAB 897-B-B-B-B-2 (4.183 t/ha). Evaluated materials were found to be resistant to diseases but susceptible to attacks of borer insects. Weight of 1000 grains was correlated to the plants height, the panicles length and the grains yield. Number of panicles/m² was correlated to grains yield and to panicles length. A positive correlation was observed between grains yield and panicles length. Number of days for plants flowering was correlated to number of maturity days. Tested materials can be cultivated in Seke-Banza area conditions in order to improve farms rain fed rice production, increase their income and contribute to reduce rice import in the country.

Keywords: Rain fed rice variety, high yield, climate condition.

INTRODUCTION

In Democratic Republic of the Congo, rice culture, particularly rain fed rice, is very important, for people feeding. But, local production, especially provided by the peasants does not cover the continual needs of consumers (Kasongo et al., 2003; Bangata et al, 2013a). In 2010, DRC produced 317,231 tons of rice, whereas 102,747 tons were imported to satisfy consumption need (SNSA, 2012). National statistics show increasingly growing import of rice since 2005 to nowadays in view to fill the gap created by low local production. Chausse et al. (2012) showed a decrease in national paddy production for 17.22% due to the lack of high performance seeds, while consumption was increasing, particularly in urban areas.

In the country in general, and in Seke-Banza area particularly, rice is one of the staple foods consumed, after cassava and maize (SNSA, 2012). Its production, largely

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depending on the plant materials used (Koné et al., 2008 ; Alom et al., 2013), is not able to satisfy consumers need. Improved seeds of rain fed rice used show a low average production which does not allow farmers and all business operators making profits (Liu et al., 2013). This leads local farmers of Seke-Banza to produce just for their own consumption on small areas. But this approach cannot allow people to achieve food security or to reduce imports with all their consequences on the national economy (Abu, 2011). Hence, there is a necessity of obtaining high performance seeds of rain fed rice varieties in order to raise farmers' income and local production,, thus to reduce national import of rice in the country.

At INERA Yangambi centre, successful rain fed rice varieties with high production level and resisting to diseases were setting up. Their utilization at Gimbi station would contribute to improve the grain yield. Although soil and climate conditions are not the same, it would be essential to evaluate their adaptation capability in Gimbi area for it large utilization by the farmers.

These varieties would play an important role in the valorization of local production and in the diversification of rain fed rice seeds in the area.

MATERIALS AND METHODS

Experimental area

Experiment was conducted under two seasons of culture, the season A (from mid-September to mid-December 2015) and the season B (from mid-February to mid-May 2016), in INERA GIMBI station situated on 5°22'531''south latitude, 13°22' longitude East, 339 m of altitude, in DRC (Figure 1). Experimental site has the following characteristics: 13°20'883'' longitude East, 53°11'21'' south latitude, 409 m altitude, clay-sandy soil classified in the group of ferrasol on alkaline rock, climate type AW5 according to Koppen classification, mean annual pluviometry 1185.24 mm (Muderhwa, 2009; SENAFIC, 2011).

Tested varieties came from INERA YANGAMBI centre situated at 24°29' longitude East, 0°48' North latitude and 470 m of altitude. Its climate type is A_f according to Koppen classification and in class B according to Thornthwaite. Soil is a ferrasol belonging to Y1 series in the classification of INERA. Its fertility level is low, but favors to rice culture (Kasongo et al., 2003)

During the present study, plants benefited 600 mm of rain in season A, with average relative moisture of 91.9%; temperature varied between 21.6 and 29.7 °C. In season B, plants benefited 615 mm of rain and relative moisture of 92.1%; temperature varied from 21.9 to 30 °C.

Plant material

Six rain fed rice varieties from INERA YANGAMBI Centre (IR47686-13, LIENGE, NERICA11, WAB569-35-1-1-1-HB, WAB781-140-1-1-HB, WAB897-B-B-B-B-2), and one improved variety (NERICA 4) used as control, were tested in the experimental site of INERA GIMBI.

Methods

Two grains of rice per planting hole were direct- seeded on 8 October 2015 (season A) and on 23 mars 2016 (season B), spacing 20x40 cm for 2 - 3 cm as depth. Manual weeding was regularly carried out to keep clean the field. Randomized block design with four replications in the parcel of 5x2 m was arranged. Neither chemical nor organic amendment was applied. Plants density was controlled respecting number of plants per seed hole.

Daily observations were carried out and following information were collected: number of days for plant flowering, plant height at the maturation (cm), resistance to diseases, panicle length (cm), number of days at physiological maturity, number of panicles per square meter, weight of 1000 grains (g), yield (t/ha). Data was collected on 20 plant samples chosen randomly in each experimental plot. Weight of 1000 grains was obtained using FH200-500 (F-2000/0.1g) precision balance. Plants height was measured from soil surface to the tip of the tallest panicle thanks to graduated rule, whereas panicles length was measured from panicle exsertion to the tip of panicle using the same

material. Plants maturity days and plants flowering days were numbered respectively from seedling day to the day where 85% of grains are mature for the first and to the day where 50% of tillers produce panicles (IRRI, 2015).

Statistical analysis

Collected data were submitted to analysis of variance (ANOVA) using Statistix software. Main effects were separated by least significant difference (LSD) test ranged at 5% level.

RESULTS

Means of measured parameters (height of plant at the end of flowering (cm), number of days for plant flowering, number of maturity days, number of panicles per square meter, weight of 1000 grains (g), grains yield (t/ha) and panicle length (cm)) are contained in Table 1. Correlations between collected characteristics are presented in Table 2.

Weight of 1000 grains

Average weight of 1000 grains varied between 26.50 to 33.0 g. LIENGE Variety obtained high value (34.30 g) and was followed by WAB897-B-B-B-B-2 (33.00 g) and WAB569-35-1-1-1-HB (30.25 g). All the tested varieties presented high values than that of the control (28.00 g), except IR47686-13 (26.50 g).

Plants height

The average height of plants varied between 77.50 and 141.00 cm. The variety LIENGE dominated (141.00 cm) and was followed by WAB569-35-1-1-1-HB (140.75 cm) and WAB897-B-B-B-B-B-2 (131.25 cm). Control recorded 88.15 cm.

Panicle length

Panicle length varied between 17.75 cm (WAB781-140-1-1-HB) and 30 cm (WAB897-B-B-B-B-2). Variety used as control (18.00 cm long) presented the average values comparable to the variety IR7686-13 (18.50 cm).

Number of days at physiological maturity and days of Plants flowering

The average number days to get ripen varied between 90 and 139 days after seedling. The higher value was obtained with WAB781-140-1-1-HB, followed by WAB569-35-1-1-1-HB and IR47686-13, with respectively 138.75 days, 138.50 days and 120 days for flowering after seedling. The control presented the mean of 108.75 days. NERICA 11 was earlier (90 days), followed by WAB897-B-B-B-B-2 (100 days).

Average plants flowering days at 50 % varied between 57 days for NERICA11 and 100 days for WAB569-35-1-1-1-HB. The control attained its ear emergency at 84 days after seedling.

Number of panicle/m^2

This variable indicates the tillering capability of each variety and can provide precise indication on variety productivity. It determines the crop yield. Mean of this variable situated between 151, 25 and 229, 25 panicles/m^2. Higher number of panicle per m^2 was recorded with NERICA11, followed by LIENGE and WAB897-B-B-B-B-2. These three varieties yielded respectively 229, 201 and 197 panicles /m^2. Beside, NERICA4 and IR47686-13 presented the lowest values (151 and 161 panicles/m^2).

Grain yield

On this point of view, all evaluated materials produced higher values than the control which recorded the smallest mean value. Globally, the mean varied from 4.942 t/ha to 2.807 t/ha. NERICA11 (4.942 T/ha) was the most successful. It was followed by LIENGE and WAB897-B-B-B-B-2 (4.514 t/ha and 4.183 t/ha respectively).

Resistance to diseases

Observations during all experimentation period did not reveal any development of disease. However, tested varieties showed sensitivity to the attacks of borer insects that provoked whitehead.

Table 1: Characteristics of tested varieties.

Varieties	W1000 (g)	PH (cm)	PL (cm)	PM (days)	Y (t/ha)	PF 50% (days)	P. N /m^2
IR47686-13	26.50f	88.50d	18.50d	120.00b	2.829e	83.25c	161.25cd
LIENGE	34.30a	141.00a	25.50c	108.00c	4.514ab	75.25b	201.00b
NERICA11	29.25d	77.50e	29.00ab	90.00e	4.942a	57.00f	229.25a
NERICA4	28.00e	88.25d	18.00d	108.75c	2.807e	78.50c	151.25d
WAB569-35-1-1-1-HB	30.25c	140.75a	28.00b	128.50a	3.679cd	90.75a	158.50d
WAB781-140-1-1-HB	30.00cd	126.75c	17.75d	108.75a	3.066de	72.00d	171.00c
WAB897-B-B-B-B-2	33.00b	131.25b	30.00a	100.00d	4.183bc	68.00e	197.00b
LSD 0.05	0.80	0.16	0.11	0.54	0.33	0.58	2.10

Number with the same letter within the column are not significantly different according LSD (5%).
Legend: W1000 (g): weight of 1000 grains (gr); PH (cm): plant height (cm); PL: panicles length (cm); PM (days): physiological maturity (days); Y(t/ha): yield (t/ha); PF50%: Plants flowering 50% (days); P. N /m^2: panicles number per square meter.

Table 2: Correlations of Pearson between evaluated parameters.

	PH	PL	MP	Y	W1000	PF 50%	P.N /m^2
PH	1						
PL	0.3007	1					
Y	0.4667	-0.4198	1				
RDT	0.1339	0.7394	-0.5048	1			
W1000	0.7482	0.5822	-0.1584	0.6611	1		
PF à 50%	0.4983	-0.1455	0.6017	-0.3085	0.0457	1	
P.N /m^2	-0.O840	0.6264	-0.6788	0.7818	0.04278	-0.6227	1

PH: Plants height (cm), PL: panicles length (cm), PM: Physiological maturity (days), Y: yield (t/ha), W1000: Weight of grains (gr), PF50%: Plants flowering 50% (days), P. N /m^2: panicles number per square meter.

DISCUSSION

Evaluation of all considered parameters revealed a significant difference between studied varieties. Genetic characteristics of each variety, their reaction relatively to pedoclimatic conditions of the field and cultural techniques utilized can induce an influence on culture yield (Hassan et al., 2012 ; Bangata et al., 2013a). Atchen et al. (2010) reported that there is some interaction between varieties and environment. This idea was supported by Coulibaly et al. (2015) while studying the influence of pedoclimatic conditions on yield components of *Jatropha curcas* (L) in north savannah and south forest of Ivory Coast. Study of Rao et al. (2001) revealed that the diversity of varieties is a major asset to get high production; this is one of hypothesis motivating our research.

Weight of 1000 grains is one of the production parameters used as criteria of variety choice. Mean obtained in the present study varies between 26.50 and 33.00 g. These values are comparable to those obtained by Bangata et al. (2013b) in the conditions of Kinshasa with NERICA varieties in low land area. These authors reported weight varying between 29.83 and 30.43 g, the minimum standard value is 32 g (Angladette A., 1966). However, average values obtained in the present study are lower than the values

reported by Kasongo et al. (2003) with eight rain fed rice lines tested at Yangambi. They found the values varying between 31.6 and 39.3 g. Mahabubur et al. (2013) reported lower values in Bangladesh conditions.

Height of plants is one of the soil fertility indicators (Surekha et al., 2004). It is also related to genetic characteristics of a variety. Average value obtained in this study is lower than the one of Bisne and Sarawgi (2008) and Bangata et al. (2013b) studies. These authors obtained values varying from 146.6 to 180 cm and 97.76 to 112.9 cm respectively. The height of LIENGE (141 cm) and WAB 569-1-1-1-HB (140.75 cm) makes them susceptible to lodging while considering violent wind occurring in Seke-Banza area.

About panicles length, present study got the average value varying between 18 and 30 cm. These results are higher than the one reported by Akkas et al. (2012). Rita and Sarawgi (2008) got panicles length varying between 24.4 and 30.00 cm in Bangladesh conditions, comparable to the one gotten in the present study. Bangata et al. (2013a) obtained 23.35 and 26.1 cm in the conditions of Kinshasa for the same parameter.

About physiological maturity, NERICA11 and WAB897-B-B-B-B-2 revealed early with 90 and 100 days respectively. In the context of agriculture totally depending on rain, and because of climate change, the earlier varieties have to be encouraged in SEKE-BANZA. WAB 569-35-1-1-1-HB and IR47686-13 were late in maturation (128 and 120 days after seedling respectively) must not be taken in account on this point of view.

Subba et al. (2001) demonstrated that rice maturity depends on both environmental factors and genetic characteristics of varieties.

While studying agro-morphology and quality characteristics of aromatic rice in India, Saha et al. (2009) and Akkas et al. (2012) got yield values above the one reported in the present study, whereas Bisne and Sarawgi (2008) reported the lower values than ours. Organic matter in the soil and own potential of varieties count as factors influencing yield (Diallo et al., 2010).

Average panicles number per m^2 varied from 151.25 to 229.25. The control (NERICA4) produced the low values. Koné et al. (2008) got 123 -196 panicles/m^2 in Benin, whereas Kasongo et al. (2003) obtained 144.5 - 185.3 panicles/m² with eight hybrid lines of rice at INERA Yangambi centre, in DRC. Result produced in this investigation is lower the one reported by IRRI (2015). This institution reported number of panicle/m² varying between 300-400 panicles/m² in under irrigation rice system.

Number of days for 50% flowering is one of the main indicators of earlier varieties. In the present study, this number varied between 57 and 91 days after seedling. In their study, Bangata et al. (2013b) reported the flowering days varying between 81 - 85 days after seedling in conditions of Kinshasa.

Following scale defined by Kabuyaya (2001), LIENGE, NERICA11 and WAB897-B-B-B-B-2 are the most successful varieties. Their flowering duration at 50% is comprised between 76 and 85 days. This quality can favor repetition of the culture along the year and get good productivity (PNR, 1997).

Conclusion

The main objective of the present study was to identify the high yield rain fed rice varieties adapted to climate conditions of Seke - Banza in Democratic Republic of the Congo, in view to increase farmers production and thus to reduce import of rice in the country.

Three varieties were detected to be successful among which LIENGE variety is already labeled. Utilization of these varieties in agricultural system of Seke-Banza can help to upgrade farmer production and contribute to reduce rice import in the country. The two varieties, NERICA11 and WAB897-B-B-B-B-2, not yet catalogued, need the additional tests to enter in national label.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS CONTRIBUTION

FNT conceived the subject, performed culture, collected data and analyzed it statistically, proposed manuscript; financiered the publication; VTM gave technical orientations, corrected and translated manuscript; LIENGE Patrice provided seeds.

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