Journal of Experimental Agriculture International

43(1): 51-62, 2021; Article no.JEAI.65884
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Comparative Study of Growth and Yield of NERICA and PNR Rice Lines in Rainfed Ecosystem in the Eastern Interland of Kinshasa, DR Congo

Mitashi Kimvula Jules[1*] and Lukula Lukwera Firmin[2]

[1]Faculté des Sciences Agronomiques, UNIKIK, DR. B. P. 76 Kikwit, Congo.
[2]Institut des Études Agronomiques, ISEA-Kiyaka, Congo.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2021/v43i130631
Editor(s):
(1).Süleyman Korkut , Duzce University, Turkey.
Reviewers:
(1).Miftahur Rizqi Akbar, IPB University, Indonesia.
(2).Satya Nugroho , Indonesian Institute of Sciences , Indonesia.
(3).Shohel Rana, Bangladesh Institute of Nuclear Agriculture, Bangladesh.
Complete Peer review History: http://www.sdiarticle4.com/review-history/65884

Original Research Article

Received 10 December 2020
Accepted 18 February 2021
Published 13 March 2021

ABSTRACT

The developing countries are rife with blatant pauperization. The agricultural sector, provider of food and a strong economy, has been in the hands of artisanal farmers for several decades. As a result, the yield is low to meet the needs of a rapidly growing population. Thus, in order to help support food security in tropical countries including the Democratic Republic of the Congo, a study was conducted on the comparison of growth and yield of 15 lines / varieties of rice under natural conditions. On the Bateke plateau (Kinshasa, DRC) during season B, from January to June 2004. The number of tillers per plant, the number of tassels per plant, the height and flowering at 50% plant, the weight of a thousand kernels as well as the yield in kg / ha were used as observation variables to evaluate the performance of the plant. Each variety under study for 4 months following a randomized full block device with 3 replicates.From our observations, it emerges that although season B was less productive than season A, a few lines / varieties of rice have shown very distinct performances. Indeed, the varieties NERICA 7, P8.20.B3. 2.1. C1, PNR 1, NERICA 5 showed good height growth while NERICA 7, P10. 100. B1. N1B1, P10. 77. B2. N2. B3, P10. 51. B1. N1. gave a high dry grain yield.Therefore, given their high yield in dry grains, these lines / varieties would be a

**Corresponding author: E-mail: julesmitashi@gmail.com*

better substitute for the varieties already in circulation (PNR 1, IRAT 112, and IRAT 341) to increase the country's rice production and thus overcome the problem of low yield experienced by the DRCongo.

Keywords: Rained ecosystem; lines and varieties; efficient rice lines.

1. INTRODUCTION

Rice is one of the staple foods in the human diet. It is the staple food for more than a third of the world's population [1].In the Democratic Republic of Congo, it is the second cereal consumed after corn [2].

In the Democratic Republic of Congo, rice cultivation is mainly the activity of the traditional sector which practices 97% rainfed agriculture, of the extensive and itinerant slash-and-burn type; using local varieties characterized by low yields of around 800 kg / ha nationally [3].

The DRC faces a challenge of availability of reliable demographic data since the last population census dates from 1994. This situation does not facilitate the work of planning and programming of the economic, social and environmental development of the country [4].

According to statistical studies carried out by UNDP / UNOPS [5], the overall needs of the Congolese population were estimated at 131,879 T in 2001, given the recorded population growth.

Thus, to meet the country's needs, the F.A.O had recommended for the 2000-2010 horizon to increase agricultural areas by 20% and improve the yield per hectare by 115%.

However, in recent decades, extensive shifting agriculture has been considered to be one of the culprits of deforestation and desertification [6].

Conversely, according to DANSO and ESKEW [7], more than half of the increased production recorded can be attributed to the increased use of inorganic fertilizer. Thus, to meet future food needs it will obviously continue to rely more and more on inorganic nitrogen fertilizers according to the same authors. However, these are expensive and eventually risk polluting the environment [7], degrade ecosystems and disrupt human health [8, 9,10].

Moreover, surveys carried out on Congolese rice cultivation by the national rice program (PNR) in 2000 showed that the use of improved varieties is a simpler and faster solution for increasing the country's production and more economical in terms of the areas to be sown.

NERICA (new rice for Africa) rice is the result of a hybridization between African and Asian rice species which adapts to the local constraints of African rice and which presents the high potential yield of Asian rice (increase of 50% without fertilizer and of more than 200 % with fertilizer) [11,12, 13]. The PNR is the hybridization product of Congolese rice produced by the national rice program that performs well in rainy conditions [14].

Thus, this study aimed to select more efficient rice lines, which are productive under natural conditions, in order to alleviate the concern of low yield commonly deplored.

2. MATERIALS AND METHODS

We conducted our test on the Bateke plateau during season B, from January to June 2004. It is located at an altitude of over 800 m and 75 km from Kinshasa, Congo.

The Bateke Plateau enjoys an AW4 type climate according to the KOPPEN classification [15]. It has a humid tropical climate, with a dry season of 4 months and a rainy season of 8 months. The year has a bimodal distribution of precipitation: two phases of dry seasons and two phases of rainy seasons of unequal duration. The average annual rainfall is in the range of 1500 to 1600 mm [15].

The soil in our experimental environment is sandy, deep, loose, permeable and has good porosity as well as an interesting proportion of fine elements (colloids). We don't meet any stone. As a result, it is easily mechanized.

Sys et al. (1961) cited by LUKOKI [16] report that the soils of the Bateke plateau are homogeneous with regard to the original material which rests on the sandy substrate belonging to the Kalahari system. They consist of fine sands and a clay

content generally less than 20%. They are hydro-xero-arenoferals characterized by a low organic content and a very low exchange capacity and degree of saturation of the absorbent complex.

In the tropical subdivision, the Bateke plateau belongs to the Guinean-Congolese region, central domain, transitory district of the Bateke plateaus and the Kalahari-karroo contact zone, which constitutes the Guinean-Zambezian transitory zone [16]. It is a savannah plateau dominated by poaceae such as Loudetia demeusei*, Hyparrhenia diplandra,* H. Familiaris [17].

2.1 Experimental Material

For the experiment, we had 15 rice genetic materials, including six promising lines from the PRERP / PNR crosses and six other NERICA lines from the INGER (International Rice Genetic Assessment Network) circuit. These lines were tested with three elite varieties already distributed by the PNR (PNR 1, IRAT 112 and IRAT 341). Of these three local varieties, PNR 1 is taken as a control and the inclusion of the IRAT 341 variety was valid for the comparison of the others to its high grain yield performance in view of the results of previous trials [3]. All the plant material studied is presented in Table 1 while the characterization of the lines are shown in Table 2.

2.1.1 Conduct of the test

The soil preparation was done in two mechanical plows while the staking was manual. The first plow was deep and was followed by two sprayings while the second was light and was followed by two harrows. The trial was manually weeded before the run, the 45th day of the trial, and only once from sowing to harvest.

The experimental set-up used was the full randomized block design with three repetitions. The total dimensions of the test were 58m x 13m or 754m². Each block contained 15 plots of dimensions 4m x 3m or 12m² of which the total number of rows sown was 16 and the total number of pockets in the row was 21. The dimensions of the useful plot were 3.6m x 2.6m or 9.6m². The alleys between the blocks and the plots were 0.5m. Each variety was a treatment. The 15 plant materials under study were: NERICA 1, NERICA 2, NERICA 3, NERICA 4, NERICA 5, NERICA 7, P10. 100. B1. N1B1, P10.53. B2. N2. A2., P8. 20. B3. 2.1.C1, P10. 77. B2. N2. B3, P10. 51. B1. N1., P14. 13. B3. N3. A2, PNR 1, IRAT 112, IRAT 341.
Sowing mode.

The seeds were sown directly in the plots at a rate of 5 to 7 seeds per pocket. The adopted spacings were 20cm x 20cm.

2.1.2 Assessment parameters

The number of tillers per plant, the number of tassels per plant, the height and flowering at 50% plant, the weight of a thousand kernels as well as the yield in kg / ha were used as observation variables to evaluate the performance of the plant. Each variety under study for 4 months following a randomized completely block design with 3 replicates.

2.1.3 Data analysis

The data collected were subjected to analysis of variance using the IRRISTAT software (version 92-1). The comparison of means from various treatments was obtained using Duncan's tests at the 5% probability threshold.

3. RESULTS AND DISCUSSION

The average number of tillers per plant in this trial varies between 5.3 and 11.3 (Table 3). Analysis of variance at the 5% threshold shows that the difference between lines / varieties is significant.

The tillering ability of line P10. 51. B1. N1 is qualified as strongest followed by NERICA 3, 4, 5 and 7, P10. 100. B1. N1B1, P10.53. B2. N2. A2, P10. 77. B2. N2. B3, P8. 20. B3. 2.1.C1, IRAT 341 and IRAT 112 is average. The PNR1 shows lowest tillering followed by NERICA 1 and P_8. 20. B_3. 2.1.C_1. This is consistent with the results of the IRRI [18] experiment taken up by the PNR [18] as shown in Table 4.

3.1 Panicle Production

Regarding the number of panicles per plant, statistical analysis showed that the difference between the lines / varieties is significant at the 5% level for the NERICA 3, NERICA 4, P10 lines. 100. B1. N1B1 and IRAT 341, for the P10 lines. 77. B2. N2. B3 and P10. 51. B1. N1, it is significant at the 1% level while for the rest it is not significant. Compared to the average, the lines / varieties NERICA 3, 4 and 7 and P10. 100. B1. N1B1, P10.53. B2. N2. A2, P10. 77. B2. N2. B3, and P10. 51. B1. N1 spoke well.

Table 1. Identification of the rice lines considered in our trial

Entrance	Lines/varieties	Genetic origin	Geographic source
V_1	NERICA 2 (WAB 450-11-1-P31-1-HB)	ADRAO (COTE D'IVOIRE)	Ivory Coast
V_2	NERICA 3 (WAB 450-2-B-P-28-HB)	ADRAO (COTE D'IVOIRE)	Ivory Coast
V_3	NERICA 4 (WAB 450-I-B-91-HB)	ADRAO (COTE D'IVOIRE)	Guinea
V_4	NERICA 7 (WAB 450-i-b-p-20-HB)	ADRAO (COTE D'IVOIRE)	Ivory Coast
V_5	P_{10}. 100. B1. N_1B_1	Lignées PRERP/PNR	PNR/RDC
V_6	P_{10}.53. B_2. N_2. A_2	Lignées PRERP/PNR	PNR/RDC
V_7	P_8. 20. B_3. 2.1.C_1	Lignées PRERP/PNR	PNR/RDC
V_8	P_{10}. 77. B_2. N_2. B_3	Lignées PRERP/PNR	PNR/RDC
V_9	P_{10}. 51. B_1. N_1	Lignées PRERP/PNR	PNR/RDC
V_{10}	P_{14}. 13. B_3. N_3. A_2,	Lignées PRERP/PNR	PNR/RDC
V_{11}	PNR 1	PNR	PNR/RDC
V_{12}	IRAT 112	PNR	PNR/RDC
V_{13}	IRAT 341	PNR	PNR/RDC
V_{14}	NERICA 1 (WAB 450-I-B-P38-HB)	Line ADRAO-circuit INGER	Ivory Coast
V_{15}	NERICA 5 (WAB 450-11-1-1-P31-Hb)	Line ADRAO-circuit INGER	Ivory Coast

Source : PNR [3]

Table 2. Technical specifications (a) of the lines / varieties studied

Entrance	Lines/varieties	Yield (T/ha)	Cycle to semi-flowering (j)	Length for cycle to maturity (j)	Plant height (cm)	1000 grain weight (g)
V_1	NERICA 2 (WAB 450-11-1-P31-1-HB)	1.5-2.0	65	95	87.4	23.1
V_2	NERICA 3 (WAB 450-2-B-P-28-HB)	1.0-105	70	100	85	24.8
V_3	NERICA 4 (WAB 450-I-B-91-HB)	1.5-20.	80	110	90	29.1
V_4	NERICA 7 (WAB 450-i-b-p-20-HB)	2.0-3.0	68	100	102.8	28.7
V_5	P_{10}. 100. B1. N_1B_1	1.5-2.3	80	110	100	29.0
V_6	$P_{10.}$53. B_2. N_2. A_2	1.5-2.5	75	100	100	29.0
V_7	P_8. 20. B_3. 2.1.C_1	1.2-2.0	65	95	120	28.0
V_8	P_{10}. 77. B_2. N_2. B_3	1.2-2.5	72	100	90	32.0
V_9	P_{10}. 51. B_1. N_1	1.5-2.5	70	100	90	30.0
V_{10}	P_{14}. 13. B_3. N_3. A_2,	1.2-2.0	70	100	65	26.0
V_{11}	PNR 1	1.2-1.5	80	110	125	32.0
V_{12}	IRAT 112	1.0-1.4	65	100	105	36.0
V_{13}	IRAT 341	2.0-3.0	90	120	87	30.0
V_{14}	NERICA 1 (WAB 450-I-B-P38-HB)	1.0-1.5	65	100	90	24.3
V_{15}	NERICA 5 (WAB 450-11-1-1-P31-Hb)	1.0-1.5	63	95	90	23.5

(a) In low fertility condition Source : PNR [3]

Table 3. Average number of tillers per plant of 15 rice lines

Entries	Lines/variétés	Number of tillers
V_1	NERICA 2 (WAB 450-11-1-P31-1-HB)	7.7 abc
V_2	NERICA 3 (WAB 450-2-B-P-28-HB)	8.7 bcd
V_3	NERICA 4 (WAB 450-I-B-91-HB)	9.0 bcd
V_4	NERICA 7 (WAB 450-i-b-p-20-HB)	9.0 bcd
V_5	P_{10}. 100. B1. N_1B_1	8.3 a-d
V_6	P_{10}.53. B_2. N_2. A_2	9.3 cd
V_7	P_8. 20. B_3. 2.1.C_1	7.0 abc
V_8	P_{10}. 77. B_2. N_2. B_3	10.0 cd
V_9	P_{10}. 51. B_1. N_1	11.3 d
V_{10}	P_{14}. 13. B_3. N_3. A_2,	6.0 ab
V_{11}	PNR 1	5.3 a
V_{12}	IRAT 112	8.0 abc
V_{13}	IRAT 341	8.7 bcd
V_{14}	NERICA 1 (WAB 450-I-B-P38-HB)	6.0 ab
V_{15}	NERICA 5 (WAB 450-11-1-1-P31-Hb)	8.0 abc
	Average	8.2
	C.V (%)	19.6
	PPDS (0.05)	(2.7)

In the column, values with the same letter are not significantly different at level 5%

Table 4. Protocol explaining the differences between the classes for the trait "aptitude for tillering".

Character	Expression
Aptitude for tillering	Very strong: if the number of tillers per plant (clump) ≥ 14 Strong: if the number of tillers per plant is 11-13 Average: if the number of tillers per plant is 7-10 Low: if the number of tillers per plant is 4-6 Very low: if the number of tillers per plant is 1-3

Source: PNR (2004)

Table 5. Average number of panicles per plant

Entries	Lines/varieties	Number of panicles/plant
V_1	NERICA 2 (WAB 450-11-1-P31-1-HB)	5.7 abc
V_2	NERICA 3 (WAB 450-2-B-P-28-HB)	7.3 b-e
V_3	NERICA 4 (WAB 450-I-B-91-HB)	8.0 cde
V_4	NERICA 7 (WAB 450-i-b-p-20-HB)	7.0 b-e
V_5	P_{10}. 100. B1. N_1B_1	7.7 cde
V_6	P_{10}.53. B_2. N_2. A_2	7.0 b-e
V_7	P_8. 20. B_3. 2.1.C_1	7.0 b-e
V_8	P_{10}. 77. B_2. N_2. B_3	9.0 e
V_9	P_{10}. 51. B_1. N_1	8.7 de
V_{10}	P_{14}. 13. B_3. N_3. A_2,	4.0 a
V_{11}	PNR 1	4.7 ab
V_{12}	IRAT 112	6.7 a-e
V_{13}	IRAT 341	7.3 b-e
V_{14}	NERICA 1 (WAB 450-I-B-P38-HB)	6.0 a-d
V_{15}	NERICA 5 (WAB 450-11-1-1-P31-Hb)	6.7 a-e
	Average	6.8
	C.V (%)	22.4
	PPDS (0.05)	(2.6)

In the column, values with the same letter are not significantly different at level 5%

Table 6. Height of rice plants in a comparative trial at the bateke plateau

Entrance	Lines/varieties	Plant height
V_1	NERICA 2 (WAB 450-11-1-P31-1-HB)	67.1 bcd
V_2	NERICA 3 (WAB 450-2-B-P-28-HB)	65.4 bc
V_3	NERICA 4 (WAB 450-I-B-91-HB)	67.0 bcd
V_4	NERICA 7 (WAB 450-i-b-p-20-HB)	81.2 f
V_5	P_{10}. 100. B1. N_1B_1	72.9 de
V_6	P_{10}.53. B_2. N_2. A_2	64.4 bc
V_7	P_8. 20. B_3. 2.1.C_1	75.1 ef
V_8	P_{10}. 77. B_2. N_2. B_3	62.2 b
V_9	P_{10}. 51. B_1. N_1	62.6 b
V_{10}	P_{14}. 13. B_3. N_3. A_2,	52.2 a
V_{11}	PNR 1	75.7 ef
V_{12}	IRAT 112	65.6 bc
V_{13}	IRAT 341	53.8 a
V_{14}	NERICA 1 (WAB 450-I-B-P38-HB)	69.9 cde
V_{15}	NERICA 5 (WAB 450-11-1-1-P31-Hb)	80.8 f
	Avearage	67.7
	C.V (%)	5.4
	PPDS (0.05)	(6.1)

In the column, values with the same letter are not significantly different at level 5%

Table 7. Number of days at 50% flowering

Entries	Lines/varieties	Number of days
V_1	NERICA 2 (WAB 450-11-1-P31-1-HB)	63.0 a
V_2	NERICA 3 (WAB 450-2-B-P-28-HB)	70.0 de
V_3	NERICA 4 (WAB 450-I-B-91-HB)	88.3 i
V_4	NERICA 7 (WAB 450-i-b-p-20-HB)	70.3 de
V_5	P_{10}. 100. B1. N_1B_1	80.0 g
V_6	P_{10}.53. B_2. N_2. A_2	76.3 f
V_7	P_8. 20. B_3. 2.1.C_1	67.0 bc
V_8	P_{10}. 77. B_2. N_2. B_3	71.3 de
V_9	P_{10}. 51. B_1. N_1	69.3 cd
V_{10}	P_{14}. 13. B_3. N_3. A_2,	72.3 e
V_{11}	PNR 1	85.0 h
V_{12}	IRAT 112	66.3 b
V_{13}	IRAT 341	72.7 e
V_{14}	NERICA 1 (WAB 450-I-B-P38-HB)	68.7 bcd
V_{15}	NERICA 5 (WAB 450-11-1-1-P31-Hb)	67.0 bc
	Average	72.5
	C.V (%)	2.2
	PPDS (0.05)	(2.7)

In the column, values with the same letter are not significantly different at level 5%

3.2 Plant Height

The height of the plants varies between 52.2 and 81.2 cm (Table 6). Analysis of variance showed that the difference between the lines / varieties is not significant for the NERICA 4, NERICA 7, P8 lines. 20. B3. 2.1.C1, NERICA 1 and NERICA 5 while for the rest it is significant at the 1% level. However, compared to the normal height of 100 cm measured from the ground to the end of the upright panicle, lines / varieties P8. 20. B3. 2.1.C1, PNR 1, NERICA 5 and 7 whose height is between 76 and 100 cm are short while the rest of the material (height <75 cm) tested is very short which matches the results of the IRRI [18].

3.3 Number of Days at Mid-Bloom

Statistical analysis of this parameter shows that the difference between varieties / lines is only significant at the 5% level for V3, while the rest is at the 1% level (Table 7). According to the PNR report [18], varieties / lines in which the number of days at mid-flowering for 50% of the plants is

less than 65 days are said to be very early; those whose number of days between 66 and 75 days are early; those with a number of days between 76 and 85 are average; those with a number of days between 86 and 95 days are said to be late, while those with a number of days greater than 95 are said to be very late. It therefore emerges from this study, four categories of rice according to the number of days from sowing to flowering at 50% (of flowers appearing). Thus, the V1 entry is very early, the V2, V4, V7, V8, V9, V10, V12, V13, V14 and V15 entries are early, and the V5 and V6 entries are medium while the V3 and V11 entries are late.

3.4 Thousand Grain Weight

The rice genetic material under study (Table 8) shows significant differences in the weight of a thousand kernels. The lowest weight was observed in the NERICA 2 line as opposed to entry 8 which gave the highest weight (28.8g / 1000 kernels). Compared to the PNR 1 control, apart from NERICA 1 which was equal to it, the NERICA 3, P14 lines. 13. B3. N3. A2, he was significantly above the probability threshold of 5%. The NERICA 1 line is not superior to him while the others are superior to him at the threshold of 1%.

It should be noted that the V3 and V11 entries, although depending on the number of days at mid-flowering are said to be late, they have a higher weight than the V1 entry, the earliest and V15, early. This would indicate that the number of days at mid-bloom would not affect the kernel weight.

3.4.1 Yield

The difference between the lines / varieties of rice compared is very significant from the point of view of yield at the 0.5% threshold for the NERICA 3, NERICA 4 and P8 lines. 20. B3. 2.1.C1 (Table 9). NERICA 2 lines / varieties, P14. 13. B3. N3. A2, and IRAT 341 are not different, while the rest is different at the 1% level. The difference between the rice lines / varieties compared varies between 625 and 2725 kg / ha. Compared to the varieties already in circulation (PNR 1, IRAT 112 and IRAT 341), the lines / varieties NERICA 7, P10. 100. B1. N1B1, P10.53. B2. N2. A2, P10. 77. B2. N2. B3, P10. 51. B1. N1 and IRAT 112 showed high performance among the others. However the IRAT 341 variety showed lower yield than all the others, yet in previous PNR trials it often performed well. Failure to apply inorganic fertilizers to the test soil would sometimes justify its poor yield behavior as it adapts better to high fertility[18].

Despite the ecoclimatic constraints that prevailed during the trial, it should be noted that the trial performed well for the yield parameter, because the average yield of this trial (5551.9 kg / ha) is higher when compared to that of other previous experiments in rainfed ecosystem (650 to 1200 kg / ha; [14].

Table 8. Thousand grain weight per line / variety of rice studied on the bateke plateau

Entries	Lines/varieties	Weight (gr)
V_1	NERICA 2 (WAB 450-11-1-P31-1-HB)	18.06 a
V_2	NERICA 3 (WAB 450-2-B-P-28-HB)	20.36 bc
V_3	NERICA 4 (WAB 450-I-B-91-HB)	20.17 b
V_4	NERICA 7 (WAB 450-i-b-p-20-HB)	24.53 d
V_5	P_{10}. 100. B1. N_1B_1	26.86 efg
V_6	P_{10}.53. B_2. N_2. A_2	28.28 g
V_7	P_8. 20. B_3. 2.1.C_1	26.57 ef
V_8	P_{10}. 77. B_2. N_2. B_3	28.56 g
V_9	P_{10}. 51. B_1. N_1	28.47 g
V_{10}	P_{14}. 13. B_3. N_3. A_2,	20.29 bc
V_{11}	PNR 1	21.95 c
V_{12}	IRAT 112	25.56 de
V_{13}	IRAT 341	28.03 fg
V_{14}	NERICA 1 (WAB 450-I-B-P38-HB)	21.94 c
V_{15}	NERICA 5 (WAB 450-11-1-1-P31-Hb)	19.12 ab
	Average	23.92
	C.V (%)	2.9
	PPDS (0.05)	(1.57)

In the column, values with the same letter are not significantly different at level 5%

Table 9. Average dry grain yield (kg / ha) of the fifteen lines / varieties tested in the Bateke plateau

Entries	Lines/varieties	Yeld (kg/ha)
V_1	NERICA 2 (WAB 450-11-1-P31-1-HB)	1045.0 abc
V_2	NERICA 3 (WAB 450-2-B-P-28-HB)	1233.3 bc
V_3	NERICA 4 (WAB 450-I-B-91-HB)	1295.0 c
V_4	NERICA 7 (WAB 450-i-b-p-20-HB)	2135.0 efg
V_5	P_{10}. 100. B1. N_1B_1	2725.0 g
V_6	$P_{10.}$53. B_2. N_2. A_2	1668.3 c-f
V_7	P_8. 20. B_3. 2.1.C_1	1335.0 cd
V_8	P_{10}. 77. B_2. N_2. B_3	2575.0 g
V_9	P_{10}. 51. B_1. N_1	2208.3 fg
V_{10}	P_{14}. 13. B_3. N_3. A_2,	625.0 ab
V_{11}	PNR 1	654.7 ab
V_{12}	IRAT 112	1553.3 cde
V_{13}	IRAT 341	596.7 a
V_{14}	NERICA 1 (WAB 450-I-B-P38-HB)	1683.3 c-f
V_{15}	NERICA 5 (WAB 450-11-1-1-P31-Hb)	1945.0 def
	Average	5551.9
	C.V (%)	22.1
	PPDS (0.05)	(574.2)

In the column, values with the same letter are not significantly different at level 5%

Table 10. Observed characteristics of lines / varieties of rice obtained after study at the bateke plateau

Entries	Lines/varieties	Yeld(T/ha)	Cycle to semi-flowering (j)	Length cycle to maturity (j)	Plant height (cm)	1000 grain weight (g)
V_1	NERICA 2 (WAB 450-11-1-P31-1-HB)	1.0	63	93	65.02	18.06
V_2	NERICA 3 (WAB 450-2-B-P-28-HB)	1.2	70	100	65.36	20.35
V_3	NERICA 4 (WAB 450-I-B-91-HB)	1.2	88.33	110.33	66.96	20.16
V_4	NERICA 7 (WAB 450-i-b-p-20-HB)	2.1	70.33	100.33	81.16	24.53
V_5	P_{10}. 100. B1. N_1B_1	2.7	80	110	72.9	26.85
V_6	P_{10}.53. B_2. N_2. A_2	1.6	76.33	106.33	64.36	28.28
V_7	P_8. 20. B_3. 2.1.C_1	1.3	67	97	75.06	26.57
V_8	P_{10}. 77. B_2. N_2. B_3	2.5	71.33	101.33	62.23	28.55
V_9	P_{10}. 51. B_1. N_1	2.2	69.33	99.33	62.6	28.47
V_{10}	P_{14}. 13. B_3. N_3. A_2,	0.6	72.33	102.33	52.23	20.28
V_{11}	PNR 1	0.6	85	115	75.66	21.94
V_{12}	IRAT 112	1.5	66.33	96.33	65.63	25.55
V_{13}	IRAT 341	0.5	72.66	102.66	53.76	28.02
V_{14}	NERICA 1 (WAB 450-I-B-P38-HB)	1.6	68.66	98.66	69.86	21.94
V_{15}	NERICA 5 (WAB 450-11-1-1-P31-Hb)	1.9	67	97	80.8	19.12

3.5 Distinctive Features of Rice Varieties

Distinctive features of the genetic material of rice are shown in Table 10. In the light of the synoptic table of specifications (Table 2), we noted that with regard to the weight of a thousand grains, the results obtained were lower for some lines. However, the performance of the P10 lines / varieties. 100. B1. N1B1, P10.53. B2. N2. A2, P8. 20. B3. 2.1.C1, P10. 51. B1. N1 and IRAT 341 were close to those of Table 2.

Thus, with regard to cycle length and semi-flowering cycle, the values remain close to those in Table 2.

In terms of yield, the set of rice lines / varieties obtained after study at the Bateke plateau (Table 8) is in the same range of quantity produced as that of Table 2 with the exception of NERICA 2, P14. 13. B3. N3. A2,PNR 1and IRAT341.

4. CONCLUSION

It emerged from this study that, although season B was less productive than season A, some lines /varieties of rice showed very distinct performances. Indeed, the varieties NERICA 7, P8.20.B3. 2.1. C1, PNR 1, NERICA 5 showed good height growth while NERICA 7, P10. 100. B1. N1B1, P10. 77. B2. N2. B3, P10. 51. B1. N1. gave high dry grain yield.

Thus, given their high dry grain yield, these lines / varieties would be a better substitute for varieties already in circulation (PNR 1, IRAT 112, and IRAT 341) to increase the country's rice production and thus overcome the problem of low yield experienced by the DR Congo. In addition, these high performance lines alone improve yield to over 115% as recommended by FAO; and this without increasing the sown land to 20% and without resorting to inorganic fertilizers. This shows that these lines / varieties would also solve the problem of deforestation for which extensive shifting agriculture was responsible and that of inaccessibility to inorganic fertilizers experienced by artisanal farmers.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Goyon A, Mestres C. Le riz : Bénéfices et risques pour la santé. Cahiers de nutrition et de diététique ; 2017. Available :http://dx.doi.org/10.1016/j.cnd.2017.03.005
2. Kasongo KM, Walangululu MJ, Bantodia KM, Likoko B, Mbuya K. Étude du comportement et des performances de huit lignées hybrides de riz pluvial à cycle moyen sélectionnées à Yangambi. Tropicultura. 2003;21(3):112–116.
3. PNR. Rapport d'activités. 1998;28.
4. UNSDCF. Plan cadre de coopération des nations unies pour le développement 2020-2024. République Démocrtique du Congo; 2019.
5. PNUD/UNOPS. Programme de recherche du secteur agricole et rurale (1997-2001). Méthodelogie, tableau et carte. 1997;III.
6. Laurie Clark. Terry Sunderland. The key non-timber forest products of Central Africa : State of the Knoledge; 2004.
7. Danso SKA et Eskew DL. Comment renforcer la fixation biologique de l'azote. FAO/AIAE bulletin col. 1985 ;26(2):29-37.
8. Ramade. Eléments d'écologie appliqué : Action de l'homme sur la biosphère. 5ème édition. Sciences internationales. 1985;621.
9. Gomgnimbo Alain PK, Savadogo Paul W, Nianogo Aimé J, Millogo-Rasolodimby J. Usage des intrants chimiques dans un agrosystème tropical : diagnostic du risque de pollution environnementale dans la région cotonnière de l'est du Burkina Faso. Biotechnol. Agron. Soc. Environ. 2009;13(4):499-507.
10. Kanda M, Djaneye-Boundjou G, Wala K, Gnandi K, Batawila K, Sanni A, et al. Application des pesticides en agriculture maraichère auTogo. VertigO. 2013;13(1).
11. Koudjega T, Aboa K, Tossah BK, Tsatsu KD. Détermination des doses optimales d'azote pour l'amélioration des rendements de cinq variétés de riz de bas fond. Afria Rice Center *(WARDA)*. 2006;12(2):17-23.
12. Kone B, Etiene JB, Amadji G, Diata S. Caractérisation de la tolerance de NERICA à la secheresse de mi-saison en riziculture pluviale. African Crop Science Journal. 2008;16(2):133-145.

13. Cissoko M, Boisnard A, Rodenburg J, Press MC, Scholes JD. New Rice for Africa (NERICA) cultivars exhibit different levels of post-attachement resistance against the parasitic weeds striga hermontica and striga *Asiatica*. New phytol. 2011;192(4):952-963.
14. PNR. Observation sur quelques variétés de riz (*Oryza sativa*) diffusé par le PNR en RD Congo ; 2002.
15. Bultot. Techniques rurales en Afrique. Paris, notes de la carte des zones climatiques du Congo Belge et Rwanda-Burundi, ARSC. Bruxelles. 1954;25.
16. Lukoki. Cartographie de la végétation et esquisse d'aménagement de la ferme de DUMI. Mémoire. 1973;116.
17. Lubini. les sols de jachère et les pâturages de centre agricole de Mbakana, Henns-Seidel, Kinshasa; 1988.
18. IRRI. Stand Evaluation System for rice, p Annexe; 1996.
In PNR. Rapport annuel; 1997.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/65884