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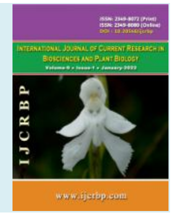

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Behavior of six rice varieties endowed with the rymv1-2 allele of resistance to rice yellow mottle in the irrigated rice ecology of Niger

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Abstract

This study consisted of: (i) evaluating six varieties of irrigated rice, endowed with the resistance allele rymv1-2, under the agronomic conditions of Niger Republic, and by participatory varietal selection (PVS), (ii) identifying the preferred varieties of farmers, and (iii) determining the performance of improved lines. To achieve these objectives the improved varieties' behavior towards the RYMV was first evaluated in the greenhouse and then their agronomic performance evaluations were conducted in multi-local trials. The results showed a biological diversity of Niger-RYMV, with the prevalence of a resistant breaking isolate (NG3) from the Toula perimeter. Five of the six improved varieties have good production potential and are adapted to the ecological and epidemiological conditions of the Niger Republic. Indeed, in addition to their high level of resistance to RYMV, the varieties ARC39-135-VL-5, ARC39-130-EP-4, ARC37-16-1-5-G, ARC39-145-E-P-3 and ARC 39-155-L-2 expressed the best agronomic characteristics with yields ranging between 6 and 9 T/ha vs 4 to 5 T/ha for the Kogoni 91-1 variety which is the most productive in the studied area. These high-potential varieties will help in the intensification of rice cultivation and rice yellow mottle disease control.

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Introduction

Rice (*Oryza* spp.) is a cereal mainly grown for its grains and straw that are used in food and feed as well as in industry and crafts (Thibaud and Bonneau, 2001). It is the food base of many populations around the world (Kam et al., 2017; Issaka et al., 2021). In the Niger Republic, rice is the food whose consumption (2.4 to 52.7 kg per person per year, average 20 kg/person/year) is increasing day by day, in particular thanks to urbanization and ongoing economic and social changes (Faivre-Dupaigre et al., 2006). National annual production, estimated at 256,649 tons of paddy in 2020, represents only 20% of the country's consumption (SNDR, 2021). This recorded gap is explained on the one hand by the insufficiency of cultivated areas not exceeding 40,000 ha and on the other hand, by the effects of numerous abiotic and biotic constraints that considerably annihilate rice production (Issaka et al., 2012a). These constraints include the rice yellow mottle due to the *Rice yellow mottle virus* (RYMV), which causes significant economic losses.

Indeed, African countries in general, and the Niger Republic in particular, have been facing for several years a strong pressure of rice yellow mottle, a disease confined to the African continent alone (Kouassi et al., 2005; Traoré et al., 2009). This disease appeared in the Niger Republic in the 1990s, following the intensification of rice cultivation, with the introduction of exotic and productive varieties from Asia to the detriment of African varieties with an acceptable level of resistance/ tolerance (N'djiondjop et al., 2001; Kouassi et al., 2005; Issaka, 2013). The disease is present in all irrigated areas with crop losses exceeding 70% (Issaka et al., 2012a) and sometimes forcing farmers to abandon their plots altogether (Personal observations). Even more recently, the presence of isolates of the virus responsible, breaking the resistance of rice (RB isolates) including that of resistance alleles rymv1-2 and/or rymv1-3, has been reported in nearly 30% of irrigated rice fields in the Niger Republic (Issaka et al., 2012b).

In the absence of very reliable and effective means of control against RYMV, a control arsenal has been developed to reduce or even avoid crop losses due to the virus (Zouzou et al., 2008; Amancho et al., 2009; Rakotamalala et al., 2019). Nowadays, the fight against the disease is mainly based on prophylactic methods (consisting in reducing the rate of inoculum) and on the use of resistant varieties, in an integrated management system.

Plant material resistant or tolerant to the virus (WITA 8 and IR47686-15-1) was created and made available to the National Institute of Agronomic Research of Niger (INRAN) by AfricaRice (Basso et al., 2010; Oladuré et al., 2016). However, after a few years of exploitation, this plant material is susceptible to RYMV (Basso et al., 2010). Also, the four main varieties are sown in the Niger Republic (IR1529-683-1, Wita8, Guiza, and KassoumMo) were all found to be susceptible to the virus (Issaka et al., 2012a), This is a major handicap to the development of rice cultivation in the country. Other high-yielding varieties of irrigated rice resistant to RYMV must then be selected, offered to Nigerien producers, and popularized to contribute to increasing the productivity of this important cereal, through the control of its main biotic constraint (Issaka et al., 2012b). These new varieties must be endowed with at best lasting resistance by the accumulation of complete resistance genes or the exploitation of partial resistance one.

Several rice resistance genes to RYMV have been identified in recent years (N'djiondjop et al., 2001; Sorho et al., 2005; Amancho et al., 2009) and two types of natural resistance to the virus have been characterized by evaluation of many varieties of cultivated and wild rice (Oladuré et al., 2016; Kam et al., 2017). These are high monogenic resistance and polygenic partial resistance (Ndjiondjop et al., 2001). High resistance is conferred on both rice species (*O. sativa* and *O. glaberrima*) by the RYMV1 gene (Ioanidou et al., 2000; Albar et al., 2003; Rakotomalala et al., 2008; Thiémélé et al., 2010; Pidon et al., 2017). It has four recessive alleles of resistance including the rymv1-2 allele of Giganté and Bekarossaka and the rymv1-3, rymv1-4, and rymv1-5 alleles, present in the TOGs accessions (Tropical *Oryza glaberrima*): Tog5681, Tog5672, Tog5674, Tog5691, and Tog5307.

The rymv1-2 resistance allele has been transferred, by marker-assisted selection (SAM), to certain improved varieties of irrigated rice called NERICA (New Rice for Africa, developed by AfricaRice). Some of these varieties, endowed with the rymv1-2 gene, have been distributed by AfricaRice (Bouet et al., 2013) in most countries of the West African Monetary Union (UEMOA), through the West, East and Central Africa Council for Agricultural Research Development (WECARD).

The present study falls within the scope of these regional varietal tests. It consisted in evaluating, agronomically and by participatory varietal selection (PVS), a range of these varieties, to identify and make available to users, varieties with good production potential and adapted to the ecological and epidemiological conditions of the Niger Republic.

Materials and methods

Rice genotypes and virus isolates used

The plant material tested consisted of 15 varieties including six (6) improved genotypes each with the rymv1-2 resistance allele and obtained by Marker-Assisted Selection (SAM), their parents (4), three (3) local controls, and two (2) international controls (Table 1). The viral material consists of twelve (12) isolates representative of the geographical diversity of the RYMV, collected in the rice fields of Niger; Each isolate is named NG followed by a numbering code (Table 2). Other equipments such as 2 l pots, markers, alcohol, mortars, watch glasses and hydrophilic gloves were also used.

Table 1. Identity of tested varieties.

N° Variety	Varieties name	Origin	Parent	Pedigree	Resistance/profile
V1	SAHEL 208	AfricaRice	International control		Unknown
V2	ALEWA	Massal selection	unknown	Unknown	Unknown
V3	ARC36-2P-2	AfricaRice	FKR48	FKR48 X Giganté	*rymv1-2*
V4	ARC37-16-1-5-G	AfricaRice	SAHELIKA	SAHELIKA X Giganté	*rymv1-2*
V5	ARC39-130-EP-4	AfricaRice	IR64	IR64 X Giganté	*rymv1-2*
V6	ARC39-135-VL-5	AfricaRice	IR64	IR64 X Giganté	*rymv1-2*
V7	ARC39-145-E-P-3	AfricaRice	IR64	IR64 X Giganté	*rymv1-2*
V8	ARC 39-155-L-2	AfricaRice	IR64	IR64 X Giganté	*rymv1-2*
V9	FKR28	INERA	Parent of ARC36-2P-2		Unknown
V10	GIGANTE	AfricaRice	Parent of ARC36, ARC37, and ARC39		*rymv1-2*
V11	IR1529- 680-3-1	AfricaRice	Local control of sensibility		*rymv1-1*
V12	IR64	AfricaRice	Parent of ARC39 (130, 135, 145, 155)		*rymv1-1*
V13	JUMBO	Massal selection	Unknown	Local control	Unknown
V14	SAHELIKA	AfricaRice	Parent of ARC37-16-1-5-G		Unknown
V15	WITA4	AfricaRice	FARO52	International control	Partial

Table 2. References of isolates used.

Name /isolate	Locality	Origin	GPS coordinates
NG1	Bonféba	Cultivated rice	N 14° 22.286'; E 1° 12.318'
NG2	Gaya amont	Weeds	N 11° 53.468' ; E 13° 29.155'
NG3	Toula	Cultivated rice	N14°11'49''; E1°27'60''
NG4	Say1	weeds	N13°06'28''; E2°21'46''
NG5	Daikaina	Cultivated rice	N14°10'37''; E1°28'37'
NG6	Say2	Cultivated rice	N13°05'55''; E2°22'24''
NG7	Daibéri	Cultivated rice	N 14° 9.353'; E 1° 30.252'
NG8	Gaya amont	Cultivated rice	N 11° 53.468' ; E 13° 29.15'
NG9	N'dounga	Cultivated rice	N13°21'02''; E2°15'00''
NG10	Sébéri	Cultivated rice	N13°17'56''; E2°20'57''
NG11	Diambala	Cultivated rice	N14°15'05''; 1°25'55''
NG12	Bonféba	Cultivated rice	N 14° 22.286'; E 1° 12.318'

Greenhouse screening of rice varieties against RYMV

Before the implementation of agronomic trials with the study varieties, their behavior towards the RYMV was evaluated in greenhouses. The trial was conducted in the dry season at the National Institute of Agronomic Research / Regional Center for Agricultural Research (INRAN/CERRA) in Kollo. It consisted of: (i) sowing the 15 varieties of rice (Table 1) in pots, (ii) inoculating the three-week plants with the grinding of the collected RYMV geographical isolates (Table 1), (iii) and observing the symptoms of the disease three weeks after inoculation. The plants were inoculated using the following method: The virus is first multiplied by inoculation of the sensitive rice variety IR1529-630-1. Fourteen (14) days after inoculation (DAI), 10 g of fresh leaves of this sensitive inoculated variety are crushed with mortar after the addition of fine sand. The grind is then suspended in 1L of sterile water. After homogenization, the suspension is filtered to serve as an inoculum.

The inoculation involved soaking both fingers in the inoculum and smoothing the leaves from bottom to top. It was provided by 12 people, one individual per isolate. Five (5) to 10 plants per genotype were treated in this way. The behavior of each of the evaluated varieties was obtained using the rice yellow mottle symptom rating, at 21 days after Inoculation (DAI). The rating was made using the IRRI (2009) rating scale 0 to 9 where 0 corresponds to a healthy plant and 9 total plant death.

Evaluation of the agronomic performance of rice varieties in multi-local trials

Experimental design, maintenance, and field monitoring

The experimental design was a randomized block, with three repetitions. The 15 varieties evaluated were sown in the nursery and the plants obtained were transplanted in the field of experimentation, at 21 DAS (days after sowing) and at the rate of 1 or 2 plants per pocket, during the wet season; the pockets being 20 cm apart from each other. Each repetition consists of 3 blocks each containing 15 elementary plots of 2x2 m2.

Manual or herbicide weeding was done as needed and chemically controlled insect pests if necessary. The mineral fertilizer was provided according to the following doses: (i) Basal: 200 kg ha^{-1} of NPK 15-15-15 at transplanting, (ii) 1st intake of urea at the rate of 100 kg ha^{-1}, 15 days after transplanting and after weeding, and (iii) 2nd intake of urea at the rate of 100 kg ha^{-1}, 40 days after transplanting. Agronomic evaluation trials were implemented in two endemic localities (hot spots) of the rice yellow mottle: Gaya and Sébéri.

Data collection and analysis

The following data were collected: (i) the Total Number of Tillers at 60 days after transplanting (DAT), (ii) the Height of the seedlings at the end of the spruce, (iii) the Number of panicles at the end of spruce, and (iv) the Yield in paddy at harvest.

The collected data statistical analysis was done with the XLSTAT version-2016.02.28451 software and the MS Excel made it possible to calculate the averages. The number of tillers was counted on five seedlings per variety and per elementary plot. Similarly, the height of the seedlings (in cm) was measured at maturity on 5 plants per variety / elementary plot. The impact of rice yellow mottle on the varieties tested was also assessed by counting the number of diseased plants per elemental plot. The incidence (I) of the disease was calculated using the following formula:

$$I (\%) = (\text{No. of diseased plants} / \text{Total no. of plants}) \times 100$$

Finally, the yield (in T/ha) at harvest of all varieties was estimated, by weighing the harvests of each of the 3 repetitions corresponding to each variety.

Evaluation of the agronomic performance of varieties by Participatory Varietal Selection (PVS)

It consisted of organizing peasant visits commented in the agronomic trials at two major stages of plant development, namely the tillering and flowering / maturity stages. Scorecards have made it possible to evaluate the performance of the varieties, through a peasant classification of said varieties; four choices are asked of each of the 30 producers chosen by their peers based on their experience in rice practice. The criteria for peasant choice of varieties are very good, good, fairly good, and bad tillering/Flowering/Maturity, respectively for the first, second, third, and fourth choice.

Results

Behavior of varieties vis-à-vis the RYMV

The reaction profile of the varieties tested against RYMV (Table 3) shows three (3) distinct varietal groups: (i) Group 1 (SAHEL 208, ALEWA, FKR28, IR1529-80-3, IR64, JUMBO, SAHELIKA, and WITA4), consisting of very sensitive varieties that have developed typical symptoms of virus disease, regardless of the isolated inoculated; (ii) Group 2 (ARC37-16-1-5-G, ARC39-130-EP-4, ARC39-135-VL-5, ARC39-145-

EP-3, ARC39-155-L-2, and GIGANTE), formed by resistant varieties (including Gigante which is the resistance control) that have not expressed any symptoms of the disease; (iii) Group 3 which consists solely of the ARC36-2P-2 variety whose resistance has been overcome by Toula NG3 isolate.

Table 3. Tested varieties responses to the 12 RYMV isolates.

N° Variety	Variety name	Isolates											
		NG1	NG2	NG3	NG4	NG5	NG6	NG7	NG8	NG9	NG10	NG11	NG12
1	SAHEL 208	+	+	+	+	+	+	+	+	+	+	+	+
2	ALEWA	+	+	+	+	+	+	+	+	+	+	+	+
3	ARC36-2P-2	-	-	+	-	-	-	-	-	-	-	-	-
4	ARC37-16-1-5-G	-	-	-	-	-	-	-	-	-	-	-	-
5	ARC39-130-EP-4	-	-	-	-	-	-	-	-	-	-	-	-
6	ARC39-135-VL-5	-	-	-	-	-	-	-	-	-	-	-	-
7	ARC39-145-E-P-3	-	-	-	-	-	-	-	-	-	-	-	-
8	ARC 39-155-L-2	-	-	-	-	-	-	-	-	-	-	-	-
9	FKR28	+	+	+	+	+	+	+	+	+	+	+	+
10	GIGANTE	-	-	-	-	-	-	-	-	-	-	-	-
11	IR1529- 680-3-1	+	+	+	+	+	+	+	+	+	+	+	+
12	IR64	+	+	+	+	+	+	+	+	+	+	+	+
13	JUMBO	+	+	+	+	+	+	+	+	+	+	+	+
14	SAHELIKA	+	+	+	+	+	+	+	+	+	+	+	+
15	WITA4	+	+	+	+	+	+	+	+	+	+	+	+

(-) = severity score less than or equal to one ; (+) = symptom severity score, greater than or equal to five (5).

Agronomic results

Agronomic performance of the varieties evaluated in Seberi

Principal component analysis (PCA) of agronomic data reveals three distinct varietal groups (Fig. 1). These were: (i) Group 1 consisting of varieties very sensitive to rice yellow mottle (IR1529-630-1, IR64, WITA4, and SAHELIKA), with incidences varying between 17 and 27%, (ii) Group 2 composed of varieties with high tillering and/or high panicle numbers (ARC39-130-EP-4, ARC39-135-VL-5, ARC39-145-EP-3, ARC39-155-L-2, and ALEWA), the number of tillers varying from 16 to 21 and the number of panicles from 14 to 19, and (iii) Group 3 consisting of very productive and/or very large varieties (ARC37-16-1-5-G, ARC36-2P-2, SAHEL 208, FKR28, JUMBO, and GIGANTE), with yields of 6 and 8.5 T/ha and heights of 98 to 116 cm.
Agronomic performance of the varieties evaluated in Gaya.

The PCA of agronomic data collected at Gaya (Fig. 2) revealed three distinct varietal groups including (i) Group 1 consisting of varieties sensitive to rice yellow mottle and/or very large (IR1529-630-1, IR64, WITA4, SAHELIKA, SAHEL 208, FKR28, GIGANTE, ALEWA, and JUMBO), with an incidence between 2 and 5% and a height varying between 115 and 130 cm; (ii) Group 2 composed of highly productive varieties (ARC39-145-EP-3, ARC39-155-L-2, and ARC37-16-1-5-G) with a yield between 6 and 9 T/ha, and (iii) Group 3 consisting of high-tillered and/or a high number of panicle varieties (ARC39-130-EP-4, ARC39-135-VL-5, and ARC36-2P-2), the number tiller was between 13 and 15 and the panicle one from 12 to 15.

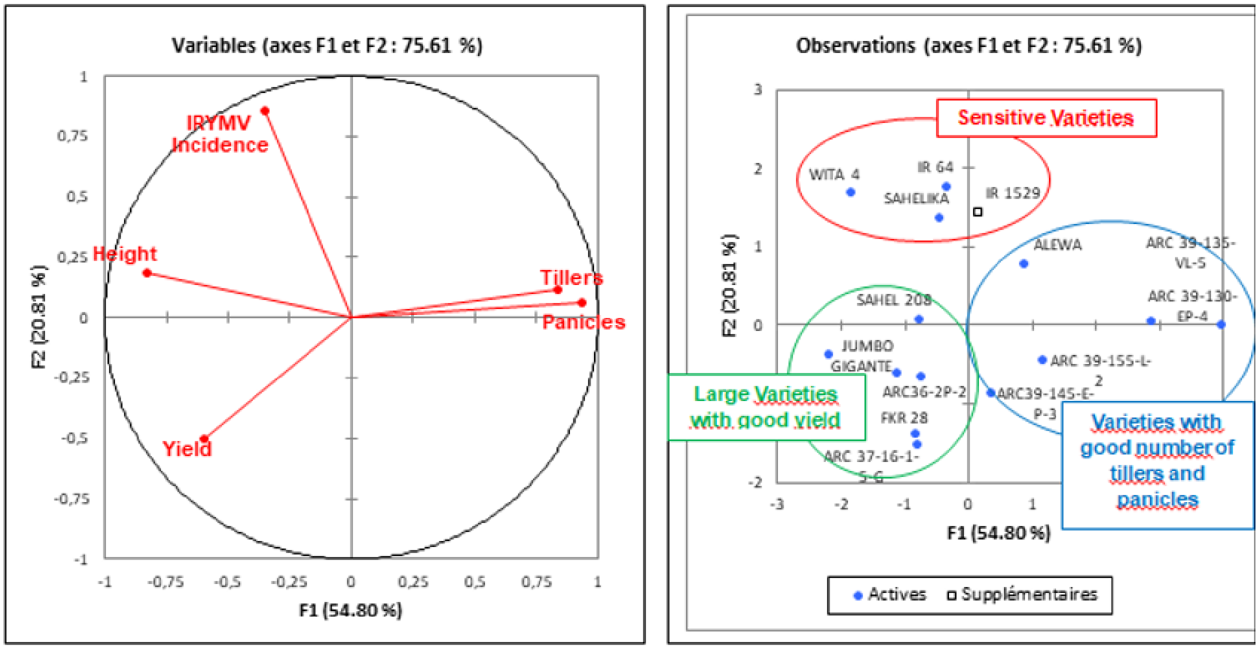

Fig. 1: Results of ACP analysis of agronomic data collected in the site of Seberi.

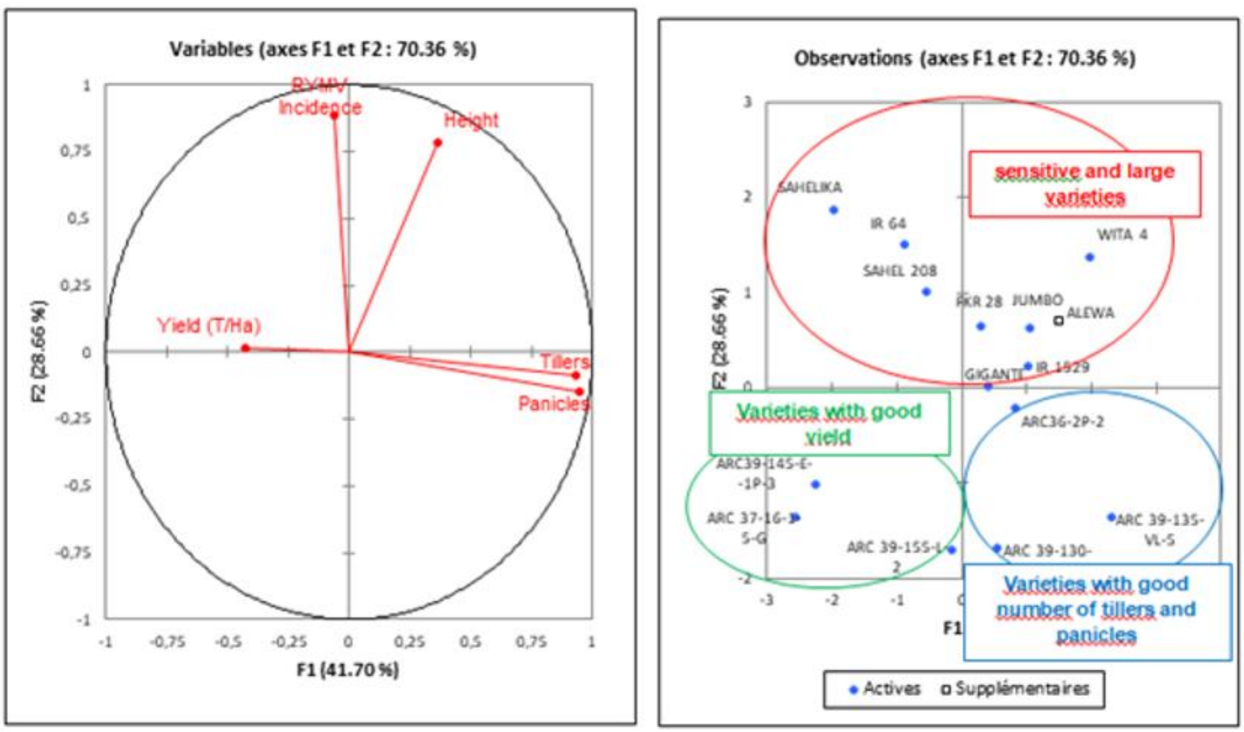

Fig. 2: Results of ACP analysis of agronomic data collected in the site of Gaya.

Participatory Varietal Selection results

Producers preference for tillering

The ACP of PVS tillering data collected in Séberi and Gaya gave two categories of varieties in each of the two sites.

These were the categories of varieties chosen by farmers and non-selected varieties (Fig. 3 and Fig. 4).

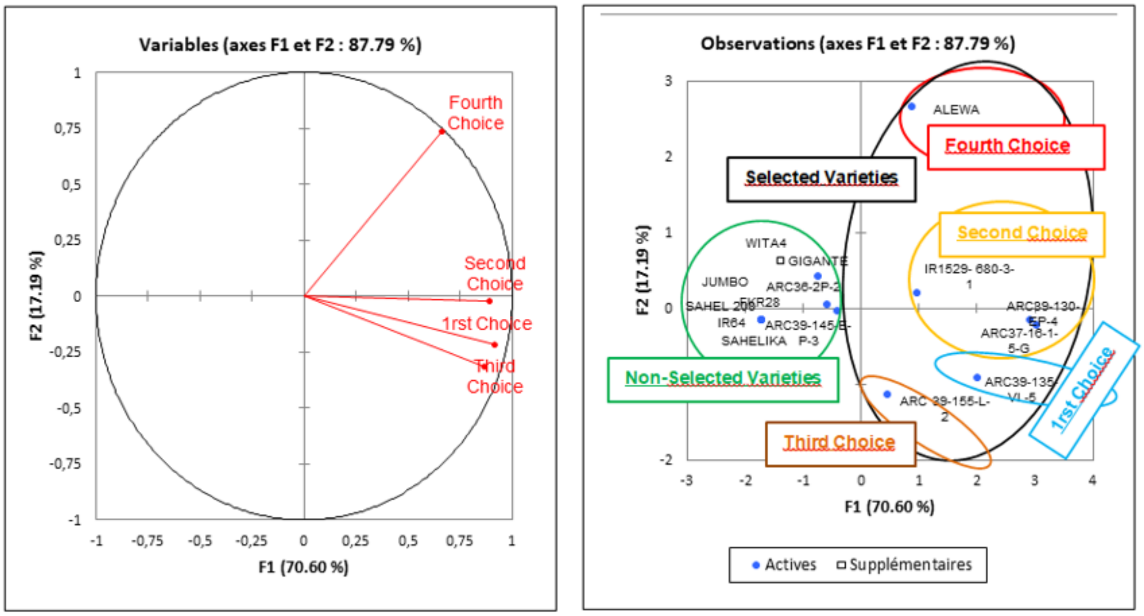

Fig. 3: Classification of rice varieties in Tillering according to producers from Seberi.

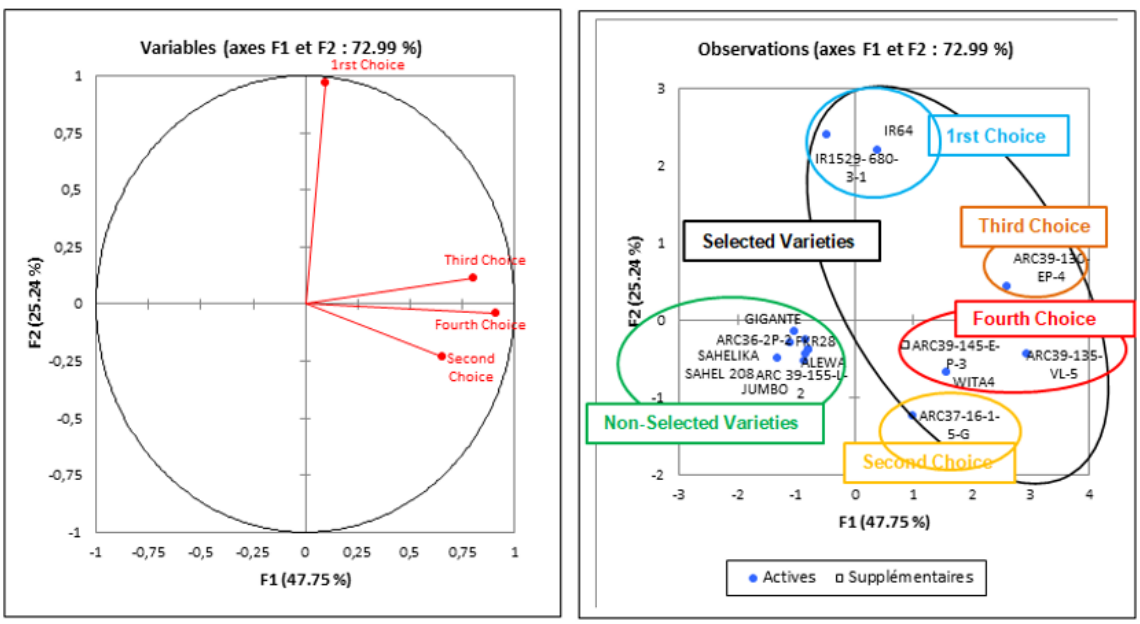

Fig. 4: Classification of rice varieties in Tillering according to producers from Gaya.

The category of selected varieties is subdivided into four classes. Thus, in Sébéri, there is (Fig. 3): (i) the class of first choice varieties (ARC39-135-VL-5 alone), (ii) the class of second choice varieties (ARC39-130-EP-4, ARC37-16-1-5-G, and IR1529-630-1), (iii) the class of third choice varieties (ARC 39-155-L-2 alone), and (iv) the class of fourth choice varieties (ALEWA alone). At the Gaya site, it was observed (Fig. 4): (i) the class of first choice varieties (IR1529-630-1 and IR64), (ii) the class of second choice varieties (ARC37-16-1-5-G alone); (iii) the class of third choice varieties (ARC39-130-EP-4 alone), and (iv) the class of fourth choice varieties (ARC39-145-E-P-3, ARC39-135-VL-5, and WITA4). The first, second, third, and fourth choices of the producers correspond respectively to very good, good, fairly good, and bad tillering.

Producers' preference for flowering/maturity

The PCA of the flowering/maturity PVS data collected in Sébéri and Gaya also gave two categories of varieties per site: the varieties chosen by the producers and those not chosen (Fig. 5 and Fig. 6). Among the varieties chosen, four preferences were observed.

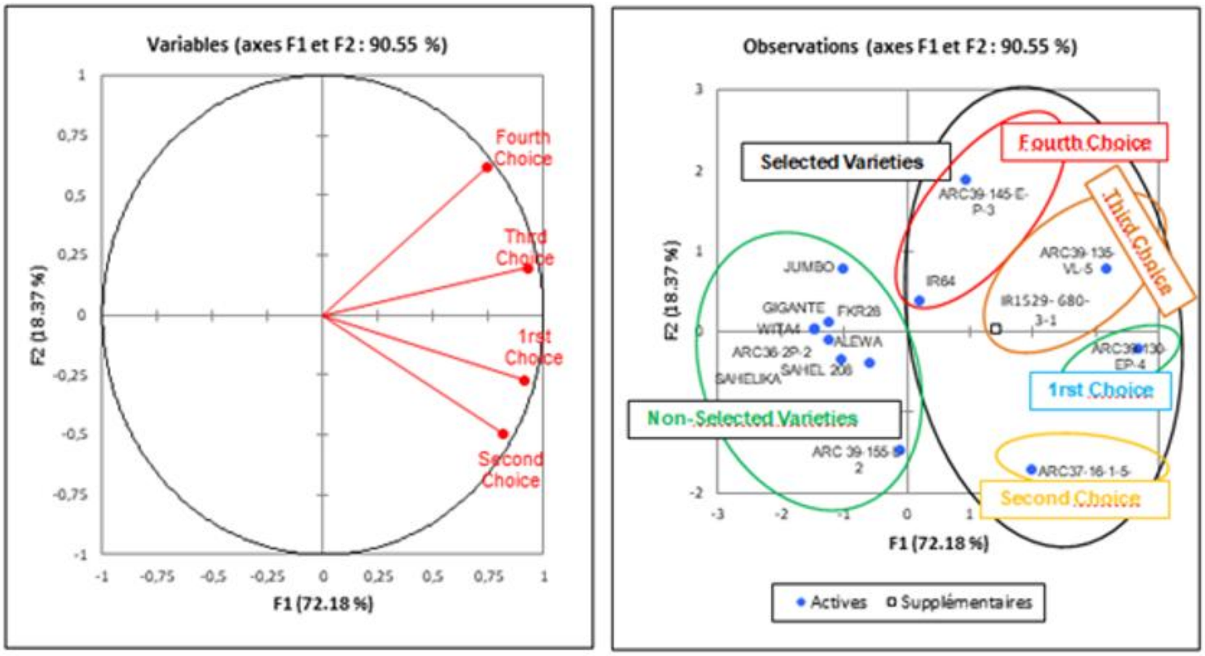

Fig. 5: Classification of rice varieties in Flowering / Maturity according to producers from Seberi.

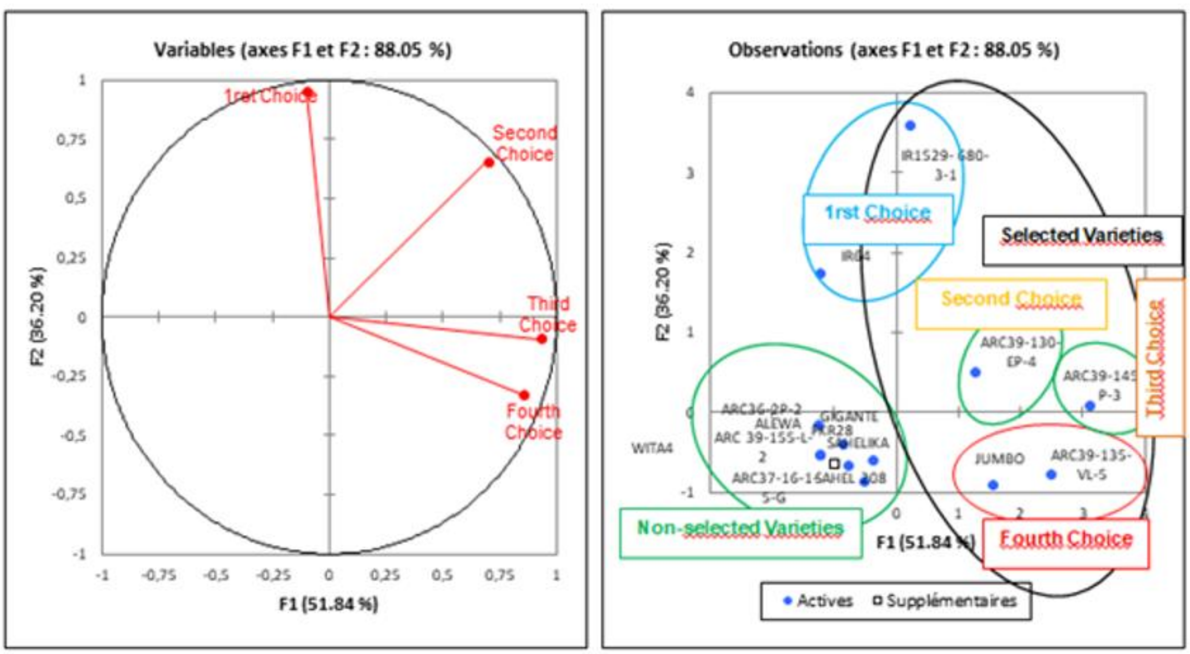

Fig. 6: Classification of rice varieties in Flowering / Maturity according to producers from Gaya.

Thus, in Sébéri (Fig. 5), it was retained: (i) the class of first choice varieties (ARC39-130-EP-4 alone) having a very good flowering/maturity, (ii) the class of varieties of the second choice (ARC37-16-1-5-G alone) characterized by good flowering/maturity, (iii) the class of varieties of third choice (ARC39-135-VL-5 and IR1529-630-1) marked by a fairly good flowering / Maturity, and (iv) the class of fourth-choice varieties (ARC39-145-E-P-3 and IR64) with poor flowering/ maturity.

At the Gaya site, there was (Fig. 6): (i) the class of first-choice varieties IR1529-630-1 and IR64), (ii) the class of second-choice varieties (ARC39-130-EP-4 alone); (iii) the class of third choice varieties (ARC39-145-E-P-3 alone), and (iv) the class of fourth choice varieties (ARC39-135-VL-5 and JUMBO). As in Sébéri, the choice of varieties corresponds to very good, good, fairly good, and bad flowering / Maturity.

Discussion

The reaction profile of the mechanically inoculated varieties in the greenhouse gave three (3) varietal groups including that of Toula NG3 isolate having overcome the resistance of the rymv1-2 allele of the ARC36-2P-2 variety. This indicates a biological diversity of Niger-RYMV; suggesting on the one hand that NG3 isolate is an RB-Giganté isolate, i.e overcoming the high resistance of this variety, and on the other hand, that the rymv1-2 allele resistance is likely to be broken at Toula; the presence of RB isolates is being reported for the first time in this environment.

This result is explained by the continuous monoculture of the susceptible variety IR1529-630-1 in the dry season and that of Kogoni 90-1, partially resistant, in the wet season, which favored the widespread of RYMV and the advent of resistance breaking on the said perimeter. Our results are in harmony with those of Issaka et al. (2012a) and Issaka et al. (2012b) reporting the existence of isolates overcoming the high resistance of Giganté and/or Tog5681 in Niger irrigated rice fields. These authors reported the presence of 20% of RB isolates, distributed in 30% of the country's rice perimeters. The spatial distribution of RB isolates in Niger has even been mapped to better prepare the deployment of resistance genes in irrigated rice fields (Personal Communication). Also, results of the presence of RB isolates in rice-growing ecologies of Burkina Faso, Mali, Côte d'Ivoire, and Benin were reported by Traoré et al. (2010) and Oladuré et al. (2016); results related to the use of the cultivation of resistant varieties having, unfortunately, at times, the particularity of leading to the overcoming of said resistant (Ochola and Tsiime, 2011).

However, the ARC36-2P-2 variety, although attacked in greenhouses under artificial inoculation conditions, was not affected by the disease in the peasant field. As for the other five varieties with the rymv1-2 resistance allele, they have all been shown to be resistant to RYMV both in greenhouses and in farmers' fields, hence their yield potential and their high adaptation to the epidemiological and ecological context of the Niger Republic. Similar results were reported in rice-growing ecologies of Benin, Togo, Burkina Faso, Niger Republic, and Côte d'Ivoire by Oladuré et al. (2016), who reported that Giganté's high resistance related to the rymv1-2 allele remains effective in said ecologies; as none of the isolates originating in these countries have been able to overcome the resistance of this variety. ARC varieties, identified as resistant with good agronomic performance, could be advised to effectively control *Rice yellow mottle virus* in different rice ecologies similar to that of Niger republic, as suggested by Pinel-Galzi et al. (2016).

In terms of participatory variety selection, it emerged that all varieties with rymv1-2 resistance allele, except the ARC36-2P-2 variety, are preferred by farmers especially on the Sébéri perimeter where the pressure of the disease was stronger. The result is a good expression of their potential in terms of resistance to rice yellow mottle disease. This resulted in better phenological characteristics and substantial production. It, therefore, appears that the varieties ARC39-135-VL-5, ARC39-130-EP-4, ARC37-16-1-5-G, ARC39-145-E-P-3, and ARC 39-155-L-2 are adapted to both the epidemiological environment and the irrigated ecology of the Niger Republic's rice fields. The level of adaptation of varieties with rymv1-2 resistance allele, developed by AfricaRice, in rice-growing environments in other countries of the West African Economic and Monetary Union (UEMOA) has been previously tested. For sale, in Côte d'Ivoire, four isogenic lines (NIL) with the rymv1-2 allele (NIL2, NIL16, NIL54, NIL130) showed a high level of resistance to the biological diversity of RYMV, and two lines (NIL130 and NIL2) have distinguished themselves at the agronomic level (Bouet et al., 2013).

In addition, despite their preference by producers and their good agronomic and phenological performance, the ALEWA, JUMBO, and WITA4 varieties, all popular with consumers, have shown themselves to be sensitive to rice yellow mottle disease, which makes them unsuitable for the epidemiological context of Niger Republic. Indeed, despite the assets at their disposal, their epidemiological status would make them potential sources of contamination of rice fields, especially in the wet season when the rate of inoculum is very important with many other sources and routes of spread of the virus (Issaka et al., 2012a). On the other hand, the five ARC varieties identified and having acquired the farmer's preference could largely contribute to reducing the rate of inoculum in the field. They should then be widely deployed in rice-growing areas without RB-Giganté isolates, to effectively control this variant of RYMV.

Conclusions

Niger Republic's irrigated rice ecology is marked by a biological diversity of RYMV, with the prevalence of an RB-Giganté isolate (NG3). This isolate was able to overcome only the high resistance of the ARC36-2P-2 variety. However, all five other ARC varieties were found to be both resistant to rice yellow mottle disease, agronomically very efficient, and preferred by producers. Also, the deployment of these varieties in similar rice-growing ecologies will help to fight efficiently against the virus responsible; the deployment must be done by the spatial distribution map of the RYMV RB isolates.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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