Research Article **AJAR (2016), Vol. 1, Issue 02**

American Journal of Agricultural Research (ISSN:2475-2002)

Behavior of improved varieties and creoles of rice (*Oryza sativa L.*) at the Baixada Maranhense

Ivaneide de Oliveira Nascimento1*, Antônia Alice Costa Rodrigues1, Raimunda Nonata Santos de Lemos1, Maria Rosangela Malheiros Silva1, Francisco de Assis dos Santos Diniz1, Leonardo de Jesus Machado Gois de Oliveira1 and Erlen Keila Cândido e Silva1

1 Post-Graduation Program of Agroecology, Maranhão State of University, Campus São Luís, São Luís, Maranhão State, Brazil.

ABSTRACT

This study aimed to evaluate the performance of the different varieties of creole and improved seeds of rice regarding the productive aspects and disease resistance in the experimental field of the Farm School of São Benedito and in area of farmer in Arari -MA. It was used improved seeds of rice (Primavera, Emeralds, Sertaneja, BR Irga 420, Serra Dourada, Arariba), and creoles (Palha Murcha, Rice Vermelho and Come Cru), which constituted the treatments in a randomized block design with four replications, plots of 10 m2 useful area of 2.70 m2. In the aspect of grain yield, the creole varieties Palha Murcha and Rice Vermelho presented respectively mean grain yield (= 1.472 kg ha-1; =1.374 kg ha-1), within the average expected for Maranhão and equal to the variety improved Arariba, in the municipality of Arari. In São Bento, the varieties Palha Murcha, BR Irga 420, Arariba, Sertaneja, Esmeralda and Primavera produced above average (1.580 kg ha-1) for Maranhão. As for the resistance to diseases, all varieties were moderately resistant to diseases brown spot and Grains spots. The varieties Primavera, Esmeralda, Sertaneja, BR Irga 420, Serra Dourada, Arariba and Palha Murcha had a high susceptibility to leaf scald in São Bento. There was incidence of narrow spot at the improved varieties Arariba and Br Irga 420, with behavior moderately resistant, the other varieties were resistant to this disease in Arari. Therefore, the rescue of creole seeds is important and enables the development of agro agriculture.

Key words: Varieties of rice; productive performance; resistance to disease.

***Correspondence to Author:**
Ivaneide de Oliveira Nascimento
Post-Graduation Program of Agroecology, Maranhão State of University, Campus São Luís, São Luís, Maranhão State, Brazil. E-mail: ivaneide_agro@yahoo.com.br

How to cite this article:
I. O. Nascimento1*, A. A. C. Rodrigues, R. N. S. Lemos, M.R. M. Silva, F. A. S. Diniz, L.J.M. Oliveira and E. K. C. Silva. Behavior of improved varieties and creoles of rice (Oryza sativa L.) at the Baixada Maranhense. American Journal of Agricultural Research, 2016,1(2): 0010-0019.

eSciencePublisher
eSciPub LLC, Houston, TX USA.
Website: http://escipub.com/

INTRODUCTION

Rice is cultivated in all Brazilian states. In spite of the rice being a common culture in almost the entire country, the vast majority of production occurs in five states: Rio Grande do Sul, where irrigated rice concentrates 65.8 % of the production of 2013/14, Santa Catarina, 8.7 % of production, Maranhão, 5.4 %, Mato Grosso, 5.2 % and Tocantins with 4.4 % of national production. The production designed for 2023/24 is 13.6 million tons, and a consumption of 12.2 million tons (Brazil, 2015). The upland rice or high land occupies an area of 1.1 million hectares in Brazil, with average yield around 2,200 kg ha^{-1} while the irrigated rice takes up 1.35 million ha with average yield of 6,950 kg ha^{-1} (CONAB, 2013).

The system of production of upland rice has advantages due to its low production cost, reduced water consumption and reduced negative effect on the ozone layer. But there is a gap between the productive potential of cultivars genetically improved and the production achieved in the field, which has been attributed mainly to the occurrence of diseases and the lack of response of the plant to inputs when in crops for planting in successive years (Pinheiro et al., 2006).

In Maranhão, rice is cultivated in almost all cities, predominantly the ecosystem of irrigation or high land, which accounts for about 95% of production and for 98 % of the cultivated area (Zonta; Silva, 2014). The average productivity of rice in Maranhão is stabilized between. 1350 and 1580 kg ha^{-1}, a value much lower than the national average, which revolves around 4,500 kg/ha. The State also stands out for the consumption per capita of rice which varies between 60 to 82 kg/person/year (Embrapa, 2015). The average productivity is still low, among the reasons it stands out the occurrence of several diseases caused by fungi, bacteria and nematodes. Their productivity is reduced by these diseases, where the greatest damage is related to fungi, especially in Maranhão state to rice blast (*Pyricularia grisea*), brown spopt (*Dreschslera oryzae*) (sin. *Bipolaris oryzae*), leaf scald (*Microdochium oryzae*), e and spots of grain (*Phoma* sp., *Dreschlera oryzae*, *Curvularia lunata*, *Nigrospora oryzae*, *Alternaria* sp., *Fusarium* sp.)

The use of resistant varieties in the control of plant diseases is the least onerous and ideal method, but it occurs high variability of the pathogen that reduces the life span of these cultivars from two to four years. Other advantages of the use of resistant varieties are less damage to the environment compared with the use of agrochemicals, the farmer who is less exposed to pesticides and the consumer can consume products without pesticides (Bespalhok; War; Oliveira, 2016). For the control of rice blast, it has already been identified 13 genes in rice varieties that confer resistance to this disease, including exotic cultivars. Among the resistance genes, only Pi - z^{t} offers resistance to all races in Brazil. The genes *Pi* –a, *Pi* –k, *Pi* –m, *Pi* –ta are not so effective because of the pre-existence of virulences in pathogen populations throughout the Brazilian territory (Prabhu; Filippi, 2006).

As not all varieties of rice produced in the state have a good yield, the introduction of varieties that are more productive is happening as an alternative, to improve production. However, the substitution of local material for improved varieties, represents a loss of genetic reserves. Based on an agroecological perspective, the use of creole varieties is a determining factor for a management of healthy and sustainable ecosystems, because this strategy enables the employment of genotypes locally adapted, which are able to convert available abiotic resources at the agroecosystems in biomass of economic interest (Petersen et al., 2013). The objective of this work was to evaluate the behavior of the different improved varieties and creoles of rice on the productive performance and disease resistance in the experimental field of the Farm School of São Bento and in the area of rural producer in Arari, in Maranhão State, Brazil.

MATERIAL AND METHODS

Two experiments were conducted in the rainy season, in the system of planting in dry farming (highlands). The first experiment was conducted in the experimental area of the Farm School of São Bento /CCA/UEMA. Located at coordinates: 2º 40’ north latitude and 44º43’ West longitude. The second experiment was carried out in an area of rural producer in Arari -MA, at the geographical coordinates: 32º7’21’’ north latitude and 44º49’52’’ West longitude. The precipitation and temperature varied from month to month according to Table 1a.

In the two experiments it was adopted randomized blocks with seven treatments (varieties of rice) and with nine treatments (varieties of rice) and four replications, respectively. The plots consisted of 5.0 m x 1.80 m, with spacing of 0.45 m between rows, with booth total of 360 thousand plants per hectare. The usable area of the plot corresponded to 2.70 m^2; the two side rows and 2.0 m from each end of the central rows were used as borders.

In the first experiment, planting was conducted in March 2015. Being used seeds of improved species and of creole rice (Spring, Emerald, the Sertão, BR IRGA 420, Serra Dourada, Arariba and Palha Murcha). In the second experiment the implantation was performed in January 2016, using improved varieties e creole s of rice (Primavera, Esmeralda, Sertaneja, BR Irga 420, Serra Dourada, Arariba, Palha Murcha, Come Cru and Arroz Vermelho). Prior to deployment of the experiments it was conducted chemical and physical analyze of soil. The soil of São Bento - MA presented: M.O: 10 g dm^{-3} , pH 4,3, P: 4 mg dm^{-3}, K: 3,5 $mmol_c$ dm^{-3}, Ca: 12 $mmol_c$ dm^{-3}; Mg: 10 $mmol_c$ dm^{-3}, CTC: 48,5, V: 53% and 1,5 mg dm^{-3} of silicon; textura loamy sand**.** And the soil form Arari-MA M.O: 17 g dm^{-3}, pH 4,3, P: 4 mg dm^{-3}, K: 0,0 $mmol_c$ dm^{-3}, Ca: 27 $mmol_c$ dm^{-3}; Mg: 22 $mmol_c$ dm^{-3}, CTC: 87,0, V: 56% and 3,4 $mgdm^{-3}$ of silicon; textura loamy sand**.** It was later performed a NPK fertilization at the plantation: 180 kg ha^{-1} of the formulation 5-30-15 and topdressing of 30 kg Na^{-1}, using 91 kg ha^{-1} of urea at the area from São Bento – Ma and 220 kg ha^{-1} of the formulation 5-30-15 and topdressing of 30 kg N ha^{-1} in Arari - MA, forty-five days after planting.

For evaluation of the productive performance (germination, plant height, number of panicles, dry weight of plants and productivity of grain) and the resistance to diseases (leaf scald, Brown Spot, narrow Spot and Grain spots) of cultivars, we used the useful area of 2.70 m^2 (three center lines 0,45 x 2,0 m^2) within each plot. The count of the number of germinated seeds occurred after the emergence of the seedlings at 21 days in São Bento - MA and at 7, 14 and 21 days in Arari-MA. The data of plant height, dry weight, number of panicles and yield were obtained at the end of the crop cycle. It was considered ten plants per plot for obtaining the height and dry weight of the plant, for the number of panicles and grain yield it was used all plants within the area of the plot. Plant height was measured with a tape measure, by measuring the stem to the insertion of the last leaf. The collected plants were dried in a forced air circulation at 50^0C until a constant weight, subsequently it was performed the weighing of the same and the grains in precision scale. In order to obtain the number of panicles it was performed the counting of the number of panicles at the useful area. The result regarding the number of panicles per 2.7 m^2 was expressed in units and the weight of the grains was expressed in kg ha^{-1}, with water content corrected to 130 g kg^{-1}.

The resistance of the cultivars was evaluated through the severity of diseases, based on grading scale. The assessment of leaf scald was performed at the stage of floral differentiation and brown spot and narrow spot at 103 days after planting (end of the cycle). For both leaf scald and brown spot and narrow spot it was observed 10 leaves selected at random with symptoms of the disease in each parcel using the scale of notes of CIAT (Centro Internacional de Agricultura Tropical, 1983) in which it is attributed the grades: 0 = healthy plant; 1 = less than 1 % of leaf sick area ; 3 = 1 to 5 % of the leaf sick area; 5 = 6 to 25 % of leaf sick area; 7 = 26 to 50 % of leaf sick area ; 9 = more than 50 % of leaf sick area. For the evaluation of the severity of leaf scald it was considered the length of the lesion in relation to the total area of the leaf examined. In the evaluation of the narrow spot at the leaves it was adopted the grading scale, in which it is assigned the following grades: 0 = healthy leaves; 1 = 1 to 5 % of the leaf area sick; 2 = 5 to 25 % of the leaf area sick; 3 = above 25 % of the sick leaf area. For the assessment of severity of grain spots, it was collected eight panicles of each area and from these 400 grains were removed which were evaluated with the use of the grading scale from Silva-Lobos et al (2011), in which: 0 = without spots; 1 = 1 to 25 % of the surface of the grain with spots 2 = 26 to 50 % of the surface of the grain with spots; 4 = 51 to 75 of the surface of the grain with spots.

All parameters evaluated were submitted to analysis of variance and the averages were compared by the Scott Knott test at 5% level of significance using the statistical program Sisvar

5.6. For the severity of the diseases data were transformed into (), before being subjected to analysis of variance.

RESULTS AND DISCUSSION

The results indicate genetic variability of improved varieties and creoles regarding agronomic and disease resistance in the municipalities of São Bento and Arari – MA by climatic conditions and soil type of each locality. Similar results were found by Guimarães et al. (2008), who found differences among cultivars in all characteristics evaluated, as a result of genetic variability, which has different architecture of plants, cycle and adaptation to rain fed conditions.

Regarding the results of the germination of seeds, improved varieties Primavera and Serra Dourada presented respectively the highest averages (397.3 and 394.3) of seed germination and the creole variety Palha Murcha did not differ statistically from the improved Esmeralda, BR Irga 420 and Sertaneja, in the municipality of São Bento (Table 1). Whereas in Arari, the creole cultivars palha murcha, arroz vermelho and the improved Arariba and BR IRGA were statistically equal, and showed the highest rates of germination (134.75, 115.25, 101.00 and 90.00, respectively) (Table 2). These data reflected in the number of panicles and productivity of the cultivars. In São Bento - MA, the varieties that exhibited the highest production of panicles were: BR Irga 420 (false= 440,50) and Primavera (false= 397,75), which are among those that had the highest germination of seeds. The other varieties were statistically equal in number of panicles (Table 1). In Arari the cultivars with higher number of panicles were: BR Irga 420 (false= 234,5), Arariba (false= 209), arroz Vermelho (false= 161,5) and Palha Murcha (false= 154) which do not differ statistically among themselves (Table 2). As for the production of grains in São Bento - MA, the seven varieties: BR Irga 420, Arariba, Sertaneja, Esmeralda, Primavera, Palha Murcha and Serra Dourada, show no statistical difference among themselves, but the greatest means of production were the cultivars BR IRGA 420 (false= 2583,04 Kg ha^{-1}) and Arariba (false= 2161,74 Kg ha^{-1}) and the lowest average production was Serra Dourada (false= 1173,07 Kg ha^{-1}) (Table 1). In the municipality of Arari - MA the greatest yields were obtained by the varieties: Arariba (false= 1607 Kg ha^{-1}), Palha Murcha (false= 1472 Kg ha^{-1}), Arroz Vermelho (false= 1374 Kg ha^{-1}), BR Irga (false= 1.622 Kg ha^{-1}) and Come Cru (false= 1000 Kg ha^{-1}) which do not differ statistically among themselves and the smallest production were Esmeralda rice, Sertaneja, and Primavera, which are statistically equal. It is observed that in São Bento and Arari the creole varieties showed similar performance to the improved ones on germination and production (Table 1 and Table 2).

As for the height of the plants, in São Bento - MA the six improved varieties analyzed did not differ statistically from the variety cabocla Palha Murcha, which presented a greater mass of dry plant. And the smallest mass of dry plant was the cultivars BR IRGA, Serra Dourada and Primavera (Table 1). In Arari – MA, the three creole varieties: Palha Murcha (false= 98,03 cm), Arroz Vermelho (false= 83,87 cm) and Come Cru (false= 80,02 cm) had a higher height and larger mass of dry plant differentiating themselves from the improved ones (Table 2). It is known that the desirable is less aerial part and increased productivity, but the creole varieties, despite of presenting the greatest aerial part, the productivity was similar to the improved varieties. The increase in productivity can be achieved with the reduction in plant height, which implies in indirect selection for lower production of dry matter in the aerial part and, consequently, higher production of grains (Khush, 1995). Another aspect of influence was to climatic and soil conditions, in both municipalities, in experimental areas, the soils had sandy texture, high acidity, low content of phosphorus and potassium, however, they are eutrophic soils, with oxygen saturation level above 50 %, rich in calcium and magnesium and cation exchange capacity from medium to good, these characteristics enable a good development in rice. However, in the municipality of São Bento, the varieties BR Irga 420, Arariba, Sertaneja, Esmeralda, Primavera, Palha Murcha and Serra Dourada showed grain yield greater than in the municipality of Arari, it can be inferred that the potassium content was a determinant factor, the deficiency of this element has reduced the growth of the plant, in São Bento where the content of this element was higher than in the soil of Arari. In this context, according to Villar et al.. (2001), Baixada Maranhaense has important participation in the production of rice, mainly

Table 1. Evaluation of the productive performance of varieties of seeds creoles and improvement of rice in the municipality of São Bento, MA, season 2014/2015.

Variety	GM Number of seeds	AP Cm	NP Um	MPS Kg ha^{-1}	PROD Kg ha^{-1}
Arariba	165.0 b	49.35 a	304.75 b	569.16 b	2161.74 a
Palha murcha	243.0 b	91.35 a	257.75 b	1232.28 a	1832.74 a
BR Irga 420	262.5 b	62.81 a	444.50 a	445.68 c	2538.04 a
Esmeralda	262.5 b	64.92 a	242.75 b	610.92 b	1977.71 a
Sertaneja	279.3 b	62.81 a	227.75 b	734.76 b	2026.15 a
S.Dourada	394.3 a	57.19 a	322.25 b	418.68 c	1173.07 a
Primavera	397.3 a	62.17 a	397.75 a	453.60 c	1934.67 a
CV (%)	23.56	9.40	22.14	19.45	36.30
P	0.0012	0.1651	0.0022	0.0000	0.2862

*Average of four replicates; averages followed by the same letter, do not differ among themselves by Scott and Knott Test at 5% probability; GM=germination; AP=height; NP=number of panicle; MSP=mass of dry plant; Prod.=productivity.

Table 2. Evaluation of the productive performance of varieties of seeds creoles and improved of rice in the municipality of São Bento, MA, season 2015/2016.

Variety	GM Number os seeds	AP Cm	NP Unit	MPS Kg ha^{-1}	PROD Kg ha^{-1}
Arariba	101.00 a	68.06 c	209.75 a	1091 a	1607 a
Palha Murcha	134.75 a	98.03 a	154.00 b	1227 a	1472 a
BR Irga 420	90.00 a	57.93 c	234.50 a	603 b	1202 a
Esmeralda	34.25 b	55.25 c	89.00 c	615 b	431 b
Sertaneja	20.00 b	59.50 c	61.00 c	698 b	543 b
Serra Dourada	51.50 b	57.93 c	114.25 c	536 b	660 b
Primavera	38.25 b	65.20 c	63.00 c	528 b	304 b
Come Cru	54.00 b	80.02 b	92.75 c	1378 a	1000 a
Rice Vermelho	115.25 a	83.87 b	161.50 b	1065 a	1374 a
CV (%)	35.72	12.13	33.02	27.74	41.98
P	0.0000	0.0000	0.0000	0.0000	0.0002

*Average of four replicates; averages followed by the same letter, do not differ among themselves by Scott and Knott Test at 5% probability; GM=germination; AP=height; NP=number of panicle; MSP=mass of dry plant; Prod.=productivity.

by high productivity that can reach up to 4,200 kg/ha, almost in its entirety practiced by family farmers in systems and traditional crops. According to the results despite of the productivity achieved by each of the improved varieties being below the indicated by the Brazilian Agricultural Research Corporation (Embrapa, 2015), the average grain yield of the cultivars: BR Irga, Arariba, Sertaneja, Esmeralda, Primavera and Palha Murcha in the municipality of São Bento is above the average grain yield expected for Maranhão, whereas in Arari the varieties that showed the production of grains within the average to Maranhão were: Arariba (false= 2607 Kg ha^{-1}), Palha Murcha (false= 1472 Kg ha^{-1}), Arroz Vermelho (false= 1374 Kg ha^{-1}). The creole varieties Palha Murcha and Arroz Vermelho produced above the productivity achieved by family farmers in Igarapé do Meio and Viana. The rainfall influence on grain yield, in São Bento the average rainfall during the crop cycle was 319.9 mm per month, while in Arari the monthly average of precipitation during the crop cycle was 195.00 mm, there was in this case a water deficit for rice (Table 1).

In relation to the occurrence of diseases, there was variation in the two municipalities. All varieties showed symptoms of brown spot and grain spots in both locations. Leaf scald only occurred in São Bento in seven varieties and the narrow spot only in Arari in the varieties Arariba and BR Irga 420.

The nine varieties tested showed a reaction moderately resistant to brown spot and grains spot. In São Bento, the severity of brown spot was greater in the variety Palha murcha and the Sertão improved, and lower in cultivars Arariba, Serra Dourada, Esmeralda, Primavera and BR Irga. The lesions on the leaves caused by this disease corresponded from 1 to 5 % of the leaf area (Table 3). Whereas in Arari, the severity of brown spot was greater in improved varieties Arariba, Sertaneja Br Irga and at the creoles Palha Murcha, Come Cru and Arroz Vermelho, which showed no significant difference among themselves. The Varieties Serra Dourada, Esmeralda and Primavera had lower severity. In this municipality, the severity of brown spot on the leaves in different varieties was lower than in São Bento, because the injured areas of the leaves with this disease are below 1 % and 5 % of the leaf area (Table 4). The occurrence of brown spot is associated with the cultivation of rice in soils deficient in potassium, which was observed in the soils of São Bento and Arari – MA. The potassium deficiency causes accumulation of soluble amino acids, which are nutrients of pathogens, slows the healing of wounds, there is an accumulation of putrescine on the leaves borders causing leaf senescence of cells in this region and favoring penetration and development of necrotrophic microorganisms and, mainly, Saprophytic ones. (Paiva et al, 2013).

As the grains spots, in São Bento the severity was greater in the varieties Arariba and Palha Murcha. The cultivars Serra Dourada, Sertaneja, Primavera, Esmeralda and Br Irga 420 showed the lowest severity. The spots present in grains of rice are between 1 to 50 % of the surface of the grain (Table 3). In Arari, the improved varieties Primavera, Serra Dourada, Esmeralda and Sertaneja showed the highest degrees of severity, the average severity was lower in creole varieties: Palha Murcha, Come Cru and Arroz Vermelho, which proved to be statistically equal to the improved cultivars Arariba and Br Irga 420. In all varieties the surface area of the grain with spots corresponded to 1 to 25 % of the surface of the grain (Table 04). There was a relationship between the severity of brown spot and the severity of the grain spots, generally the varieties with greater severity of brown spot also showed greater severity of grain spots. The severity of grain spots found in the present study were lower than the results obtained by Barros et al. (2010).

There was an incidence of leaf scald in seven varieties tested in the municipality of São Bento, which were highly susceptible to this disease. Improved varieties Arariba, Serra Dourada, BR Irga 420 and the creole Palha Murcha do not differ statistically among themselves and presented the lowest severity of leaf scald, whereas the variety improved Sertaneja, Primavera and Esmeralda had similar results and the highest grades of severity of leaf scald. The injured areas of the leaves with leaf scald ranged between 26 to 50 % and above 50 % of the leaf area (Table 3). The occurrence of this disease is favored by high rainfall during the emission and formation of grains, fact that occurred in São Bento - MA. In situations that are very favorable, the severity of leaf scald can be increased even for cultivars that have a good resistance to the disease (Mo-

Table 3. Assessment of the severity of disease on leaves and grains of rice (*Oryza sativa* L.) in different varieties in São Bento - MA, season 2014/2015.

Variety	MP	Reaction	ESC	Reaction	MG	Reaction
Arariba	1.67 b	MR	7.27 b	AS	1.76 a	MR
Serra Dourada	2.15 b	MR	7.85 b	AS	0.55 b	MR
Esmeralda	1.75 b	MR	8.30 a	AS	0.83 b	MR
Primavera	2.47 b	MR	8.17 a	AS	0.75 b	MR
BR Irga 420	2.00 b	MR	7.43 b	AS	1.00 b	MR
Sertaneja	3.00 a	MR	8.55 a	AS	0.65 b	MR
Palha Murcha	3.97 a	MR	7.55 b	AS	1.32 a	MR
CV (%)	11.94		6.55		9.76	
P	0.0154		0.0181		0.0068	

*Average of four replicates; Averages followed by the same letter, do not differ by Scott and Knott Test at 5% probability. MP=brown spot; Esc.=leaf scald; Mg=Grains spots; MR=moderately resistant; The=highly susceptible.

Table 4. Assessment of the severity of disease on leaves and grains of rice (*Oryza sativa* L.) in different varieties in Arari – MA season 2015/2016.

Variety	MP	Reaction	ME	Reaction	MG	Reaction
Arariba	1.30 a	MR	0.93 a	MS	1.76 a	MR
Serra Dourada	0.75 b	MR	0.00 c	R	0.55 b	MR
Esmeralda	0.73 b	MR	0.00 c	R	0.83 b	MR
Primavera	0.93 b	MR	0.00 c	R	0.75 b	MR
BR Irga 420	1.45 a	MR	0.75 b	MS	1.00 b	MR
Sertaneja	1.55 a	MR	0.00 c	R	0.65 b	MR
Palha Murcha	1.70 a	MR	0.00 c	R	1.32 a	MR
Come Cru	1.35 a	MR	0.00 c	R	0.374 a	MR
RiceVermelho	1.30 a	MR	0.00 c	R	0.281 a	MR
CV (%)	7.55		2.10		1.76 b	
P	0.0019		0.0000		0.55 a	

*Average of four replicates; Averages followed by the same letter, do not differ by Scott and Knott Test at 5% probability. MP=brown spot; ME= narrow stain; Mg=Grains spots; MR=moderately resistant; MS=moderately susceptible; R=resistant rais et al., 2005).

The disease narrow spot occurred in Arari, only in varieties Arariba and BR Irga 420, which are moderately susceptible, the lesions on the leaves are below 5 % of the leaf area. The other varieties (Primavera, Esmeralda, Sertaneja, Serra Dourada, Palha Murcha, Come Cru and Arroz Vermelho) are resistant to this disease (Table 4). Unlike Barros et al. (2010), there was significant difference between the genotypes evaluated in relation to the narrow spot. This disease has no significant damage, the relevance of the damage is dependent on the use of varieties very susceptible and favorable conditions for pathogen survival, temperature and moisture (Funck et al., 2005).

As for the resistance of varieties of rice to diseases, the improved ones and the creoles presented similar behavior in the face of various diseases and the cultivation area. The severity of each disease in rice varieties was higher in São Bento than in Arari – MA. This fact may be related to the silicon content in the soil, because Arari has silicon content (3.4 mg dm^{-3}) greater than in São Bento (silicon content of 1.5 mg dm^{-}), despite of the two municipalities having soils with silicon content below 20 mg $dm^{-3,}$ in this case are the ones that most often respond to the application of silicon sources (Korndorfer et al. 2001). Another fact is that there is an interaction between genotype and environment for the incidence of rice blast diseases on the leaf and on the neck, Brown Spot, grain Spot and leaf scald (Reis et al, 2007).

According to the results the occurrence of diseases did not interfere with the productivity of cultivars. In São Bento, the varieties Palha Murcha and Sertaneja showed greater severity of brown spot, and the varieties Arariba and Palha murcha greater severity of grain spots, and high susceptibility to leaf scald. However, the mean grain yield of these cultivars is above the average grain yield expected for Maranhão. Whereas in Arari the varieties that showed the production of grains within the average to Maranhão such as Arariba, Palha Murcha, Rice Vermelho, were the varieties that had greater severity of brown spot and grains spots. It should be emphasized that all varieties tested were moderately resistant to brown spot and grains spots, which contributed so that these diseases did not interfere in the production of grains of the varieties mentioned.

In the current context, family farmers depend on varieties of plants that have been subjected to processes of improvement toward high productivity and highly dependent on the use of inputs (Mooney, 1987). In a way, it makes the producers dependent on external inputs and results in more financial investment, being a barrier to family farmers with low incomes who do not have access to these inputs. In addition to these aspects, others should be considered, because according to Didonet (2007), the high cost of seed from new varieties, the impoverishment of farmers, the protective laws, the delay in the multiplication and distribution cause great concern to producers, limiting access to quality seeds. The results of this study point to the importance of rescuing creole seeds with production potential, as well as resistance to disease, which can be performed from the community production of seeds under a technical orientation. On the other hand, to the production system of agroecological family agriculture to creole seeds are adapted and are not dependent on external inputs. And according to Alves et al. (2014), they are the beginning and the end of peasant production. As well, the creole cultivars are cheaper than the hybrid ones and have high nutritional value (Franco et al., 2013). Varieties of rice locations in the State of Maranhão have high efficiency in the use of nitrogen compared with improved varieties. These results indicate that these varieties have developed mechanisms that become more efficient in the acquisition and use of this nutrient resulting in maximum and quality of protein in grains than those found in improved varieties (Santos, 2006; Carvalho, 2002; Malheiros, 2008).

CONCLUSIONS

There was a genetic variability of improved varieties and creoles regarding agronomic and disease resistance in the municipalities of São Bento – MA and Arari – MA. In the aspect of grain yield, the creole varieties palha murcha and Rice vermelho presented respectively mean grain yield, within the average expected for Maranhão and equal to the variety improved Arariba, in the municipality of Arari. In São Bento, the varieties Palha Murcha, BR Irga 420, Arariba, Sertaneja, Esmeralda and Primavera produced above average for Maranhão.

As for the resistance to diseases, all varieties were moderately resistant to diseases brown spot and Grains spots. The varieties Primavera, Esmeralda, Sertaneja, BR Irga 420, Serra Dourada, Arariba and Palha Murcha had a high susceptibility to leaf scald in São Bento. There was incidence of narrow spot at the improved varieties Arariba and Br Irga 420, with behavior moderately resistant, the other varieties were resistant to this disease in Arari. Therefore, the rescue of creole seeds is important and enables the development of agro agriculture.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGEMENTS

We would like to thank Maranhão Foundation for the Protection of Research and Scientific and Technological Development (FAPEMA), Coordination of Improvement of Higher Education Personnel (CAPES), and National Research Council (CNPq) for the grants, project resources and for the scholarships.

REFERENCES

Alves SA; Marques GP, Mendonça MR (2014). A produção de sementes de variedades creoles e a construção da autonomia camponesa no movimento camponês popular – MCP – no Brasil. Disponível em: http://observatoriogeograficoamericalatina.org.mx/egal14/Geografiasocioeconomica/

Geografia agrícola/64.pdf. Acesso em: fev. 2016.

Araújo ES. Diversidade genética e acúmulo de proteína de reserva em arroz da baixada maranhense-MA. 2002. Tese (Doutorado em Agronomia) - Universidade Federal do Rio de Janeiro, Rio de Janeiro. 2002. 60p.

Barros LS, Rudnick VAS, Polizel AC, Solino JS, Bruscke EL (2010). Reação em genótipos de arroz de terras altas às doenças fúngicas. Enciclopédia Biosfera. 6(11):1-6.

Bespalhok FJC, Guerra EP, Oliveira R (2016). Melhoramento para resistência a doença. In: Bespalhok FJC, Guerra EP, Oliveira R. Melhoramento de plantas. Disponível em www.bespa.agrarias.ufrpr.br, p.1-9, 2016. Acesso em: 10 de julho de 2016.

Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Projeções do Agronegócio: Brasil 2014/2015 a 2024/25, projeções de longo prazo. Brasília-DF: MAPA, 6.ed., 2015.

Centro Internacional de Agricultura Tropical (CIAT) (1983). Sistema de evaluación estandar para arroz. 2 ed. Cali, 61 p.

Conab, Companhia Nacional de Abastecimento (2013). Acompanhamento de safra brasileira: grão, maio, 2013. Conab. Brasília: Conab, 36p.

Embrapa. Portal Embrapa. Instituições públicas e privadas buscam fortalecer a cadeia produtiva do arroz no Maranhão. Reportagem de 21.05.2015. https://www.embrapa.br/.../instituicoes-publicas-e-privadas-buscam-fortal. Acesso: em 10 de outubro de 2015.

Didonet AD (2007). Produção comunitária de sementes: segurança alimentar, desenvolvimento sustentável e cidadania. Santo Antônio de Goiás: Embrapa Arroz e Feijão.

Franco CD, Corlett FMF, Schiavon G (2013). de A. Percepção de agricultores familiares sobre as dificuldades na produção e conservação de sementes crioulas. Cadernos de Agroecologia. 8(2): 1-5.

Funck GRD, Alves RC, Del PONTE, EM (2005). Grandes Culturas. Arroz. In: Fitopatologia.net - herbário virtual. Departamento de Fitossanidade. Agronomia, UFRGS. 2005.

Guimarães CM, Stone LF, Neves PCF (2008). Eficiência produtiva de cultivares de arroz com divergência fenotípica. Revista Brasileira de Engenharia Agrícola e Ambiental. 12(5):465-470.

Khush GS (1995). Aumento do potencial genético de rendimento do arroz: perspectives e métodos. In: Conferência Internacional de Arroz para a América Latina e o Caribe, 1994, Goiânia. Arroz na América Latina: perspectivas para o incremento da produção e do potencial produtivo. Goiânia: EMBRAPA-CNPAF, 1995.p. 13-29.

Korndorfer GH, Snyder GH, Uchoa, Datnoff LE (2001). Calibration of soil and plant silicon analysis for rice production. Journal of Plant Nutrition. 24(7): 1071 – 1084.

Malheiros, M. G., Acúmulo e remobilização de NO3- e eficiência de uso de nitrogênio em variedades tradicional e melhorada de arroz (Oryza sativa L.). Dissertação do Instituto de Agronomia. Seropédica: UFRRJ. 2008. 70p.

Mooney PR. O Escândalo das Sementes: o domínio na produção de alimentos. Trad. Adilson D. Paschoal. São Paulo: Nobel, 1987, 145p.

Morais OP, Castro EM, Soares AA, Guimarães EP, Chatel M, Ospina Y, Lopes AM, Pereira JA, Utumi MM, Cordeiro ACC (2005). BRSMG Curinga: Cultivar de Arroz de Terras Altas de Ampla Adaptação para o Brasil. Embrapa Arroz e Feijão. Comunicado Técnico 114. Santo Antônio de Goiás – GO.

Paiva RF (2013). Nutrição e fitossanidade. In: SILVA, J. C.; SILVA, A. A. S.; ASSIS, R. T. Sustentabilidade produtiva e inovação no campo. Uberlândia: Composer, p. 45-56.

Petersen P, Silveira L, Dias E, Curado F, Santos A (2013). Sementes ou grãos? Lutas para desconstrução de uma falsa dicotomia. Agriculturas. 10(1): 36-45..

Pinheiro BS, Castro EM, Guimarães EP (2006). Sustainability and profitability of aerobic rice production in Brazil.Field Crops Research. 97(1):34-42.

Prabhu AS, Filippi M. CC. Controle genético, progresso e perspectivas. Santo Antônio de Goiás: Embrapa Arroz e Feijão, 2006. 388p.

Reis MS, Soares AA, Cornélio VMO, Soares PC, Guedes JM, Costa Júnior GT (2007). Comportamento de genótipos de arroz de terras altas sob sistemas de plantio direto e convencional. Pesq Agropec Trop. 37(4):227-232.

Santos LA. Absorção e remobilização de NO3- em arroz (Oryza sativa L.): Atividade das bombas de prótons e a dinâmica do processo. Tese de Mestrado, 68UFRRJ: Seropédica, Brasil, 2006.

Silva-Lobos VL, Lacerda MG, Filippi MC, Silva GB, Prabhu AS (2011). Influência da adubação nitrogenada, época de plantio e aerosporos sobre a severidade da mancha de grãos em arroz de terras altas. Summa-Phytopathologica. 37(3):110-115.

Villar PM, Del DA, Ferreira NLS et al. Cadeia produtiva do arroz no Estado do Maranhão. Teresina: EMBRAPA Meio-Norte/CIRAD, 2001. 136p.

Zonta JB, Silva FB (2014). Dinâmica da orizicultura no Maranhão. Revista de Política Agrícola. Ano XXIII, (2).

Table 1a. Climatological data from the municipalities of São Bento and Arari - MA, during the months of conducting the experiments.

Months	São Bento (2015)		Arari (2016)	
	Precipitation (mm)	Temperature (°C)	Precipitation (mm)	Temperature (°C)
January	55.2	32.50	185.2	31.00
February	107.4	31.90	238.6	33.39
March	331.4	30.55	254.2	32.42
April	407.0	31.09	247.9	34.41
May	336.4	31.68	49.1	33.98
June	204.8	32.14	15.6	34.83