Note

CROSSING RATE AND DISTANCE IN UPLAND RICE [1]

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ABSTRACT

Rice (*Oryza sativa* L.) is an autogamous species that shows natural crossing rates of up to 3%, where the variations are influenced by genotypes and environments. The present work aimed to evaluate the rates and distances of natural crossing between the upland rice cultivars Guarani and IAC 201. The study was done in the counties of Carpina and Recife, in the State of Pernambuco during the agricultural years of 2001 and 2002, respectively. The Guarani cultivar presents leaf pilosity conditioned by the dominant alleles HLHL and this character was used as a morphologic tracer. On the other hand, the IAC 201 cultivar does not show pilosity because it carries the recessive alleles (hlhl). The experiments were composed of four blocks, constituting of ten circunscribed rows of the cultivar under study, spaced 50 cm between themselves, and in the center of each block the Guarani cultivar was planted. The natural crossing rate and distance were evaluated in the plants resulting from the seeds of the IAC 201 cultivar from natural crossing, expressing pilosity in the leaves. After the evaluation of the plants arising from the first two rows of the experiment carried out in Carpina and the first three rows of the experiment done in Recife, it was concluded that in the first row (0.5 m) there were plants resulting from natural crossing. At this distance, the average crossing rate in Carpina was 0.30% while that in Recife was 0.35%.

Key words: *Oryza sativa* L, upland rice, natural crossing.

RESUMO

TAXA E DISTÂNCIA DE CRUZAMENTO DO ARROZ-DE-SEQUEIRO

O arroz (*Oryza sativa* L.) é uma espécie autógama com taxa de cruzamento natural de até 3%, sendo as variações influenciadas pelos genótipos e ambientes. O objetivo deste trabalho foi avaliar a taxa e a distância de cruzamento natural entre as cultivares de arroz-de-sequeiro Guarani e IAC 201. O estudo foi desenvolvido nos municípios de Carpina e do Recife, no Estado de Pernambuco nos anos agrícolas de 2001 e de 2002 respectivamente. Na cultivar Guarani observa-se pilosidade nas folhas condicionada por alelos dominantes HLHL e essa característica foi utilizada como marcador morfológico. Já na cultivar IAC 201 não, por ser portadora dos alelos recessivos (hlhl). Os experimentos foram compostos por quatro blocos, constituídos de dez linhas circunscritas da cultivar em estudo, espaçados a 50 cm entre si, e no centro de cada bloco plantou-se a cultivar Guarani. A taxa e a distância de cruzamento natural foram avaliadas nas plantas provenientes das sementes da cultivar IAC 201, oriundas do cruzamento natural, expressando pilosidade nas folhas. Após a avaliação das plantas referentes às duas primeiras linhas do experimento desenvolvido em Carpina e das três primeiras linhas do experimento de Recife, constatou-se que apenas na primeira linha (0,5 m) houve plantas resultantes de cruzamento natural. Nessa distância, verificou-se que a taxa média de cruzamento natural de 0,30% em Carpina e de 0,35% no Recife.

Palavras chaves: *Oryza sativa* L., arroz-de-sequeiro, cruzamento natural.

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Introduction

The cultivated rice species, *Oryza sativa* L., shows natural crossing rates which can vary from 0.0 to 1% (Taillebois and Guimarães, 1988), from 0.0 to 1.89% (Beachel et al., 1938) and up to 3% (Coste 1969). With these rates, the rice plant, as well as all species that presents less than 5% of natural crossing are classified as autogamous (Destro and Montalvan, 1999). The autogamy in this species is due to the non exposure of the stigmas during anthesis, while they remain between the palea and the lemma after this stage. Occasionaly, when the exposure of the stigmas occurs, normally the self-pollination has already taken place due to the phenomenom of cleistogamy, which is favoured by the lack of genetic incompactibility in the species (Yoshida, 1981).

Currently, all the activities developed in the breeding program of rice, as well as in the seed multiplication fields in Brazil, are carried out without taking into acount the genic flow arising from cross pollination. The natural crossing rate of rice as well as other higher plants is dependent upon genotype and environmental conditions. The available informations in relation to crossing rate of rice were obtained in other countries with genoptypes which are not adapted to the climatic conditions in Brazil.

The occurence of genic flow promotes the contamination of genetic and certified seed production fields due to genic segregation in the generations following crossing, which can compromise the seed production, causing economic losses. Furthermore, it must be considered that the occurence of genic flow during the lineage evaluation phases in the rice breeding programs, can delay or make it unviable the fixing of materials for release as a cultivar, which can compromise such programs. In that context, the knowledge about the natural crossing rate make those activities more efficient. In addition this information is essential for the correct sizing of barriers that prevent varietal contamination in the seed production fields, besides the adequate choice of the breding methods to be employed in the species.

Studies have been done on the natural crossing rate and the effective distance of pollen dispersion on several species, using different techniques and methodologies, depending upon the mechanism by which the species are pollinated. In the species in which anemophilly is predominant, as in the case of rice, the method of pollen tracing can be used. However the genic tracers, both molecular an morphologic have been more widely adopted. Among the most common morphologic tracers, those detectable in the seeds and hybrid plants stand out as, for example, the pilosity character, vegetative parts coloration, and the flower and fruit color.

In studies done on rice in five states in the US, Beachel et al. (1938), obtained a natural crossing rate varying from 0.0 to 1.89% using the genic tracer glutinose observed in the grains, where the variations observed were due to the year and location where the experiments were conducted. The utilization of morphologic genic tracers in similar studies have been done on other species. Paterniani and Stort (1974) studied the effective distance of pollen dispersion of corn (*Zea mays* L.) using the yellow endosperm variety Piracicaba, which is conditioned by the dominant homozigotous gene YY and plants of the white endosperm Perola Piracicaba variety, whichs is recessive homozigotous for the refered gene (yy). The pollination distance was evaluated by means of the rate of seeds with yellow endosperm observed in the cultivar Perola Piracicaba which was positioned at varying distances from a plant with the YY alleles grown in the center of each block. The yellow colored seeds observed were a result of the xenia effect in the triploid endosperm Yyy. Giordano et al. (1991), in order to evaluate the rate and natural crossing distance in peas (*Pisum sativum* L.), used as a morphologic genic tracer the dominant gene AfAfStSt, which conditions the phenotype of normal leaf and it's recessive afafstst, which conditions the "leafless" phenotype. In studies with the cowpea (*Vigna unguiculata* L. Walp) under the prevailing environmental conditions of the state of Ceara, Teofilo et al. (1999) used the cultivars Cara Suja-2 (violet flowers, dominant gene) and Branquinha (white flowers, recessive gene).

The present work aimed to estimate the rate and natural crossing distance among upland rice cultivars Guarany and IAC 201, in order to obtain informations to prevent contamination in certified seed production fields, as well as to optimize the fixing stages in rice breeding programs in northeast Brazil.

Material and Methods

The experiments were done in the years of 2001 and 2002, where in the first year they were conducted in the Estacão Experimental de Cana-de-acúcar of the Universidade Federal Rural de Pernambuco (EECAC / UFRPE), in the county of Carpina, located at 07° 51' 04" S, 35° 14' 27" W at an altitude of 178 m and in the second year they were developed in the campus of the UFRPE, located in the county of Recife at 08° 01' 01" S, 34° 56' 45" W and 10.3 m of altitude. For the installation of the experiments, seeds of the upland

rice cultivars Gurani and IAC 201, both originated from genetic seed production fields, were used in order to ensure varietal purity. The Guarani cultivar presents pilosity in the leaves conditioned by the dominant allele HL and was utilized as a genic and morphological tracer. The cultivar IAC 201, however, does not show pilosity in the leaves, being recessive homozigotous for the referred gene (hlhl).

The experiments were composed of four blocks , separated between themselves by a distance of 2 m, which had ten circumscribed rows at a spacing of 50 cm, planted to the cultivar IAC 201. In the center of the blocks, at a distance of 50 cm from the first row of the IAC 201 cultivar, in a circle of 20 cm radius, the cultivar Guarani was planted (Figure 1). In order to show flowering synchronization between both cultivars, 50 seeds of the Guarany cultivar were planted one week before the planting of the IAC 201, 100 seeds at the same day and 50 seeds one week later than the IAC 201 cultivar. Seeding density was 80 fertile seeds per linear meter for the IAC 201 cultivar and 200 seeds per linear meter of the Guarani seeded at the three dates.

During the experimental period, routine cultural practices were observed according to the technical recommendations for the rice crop given by BRESEGHELLO and STONE (1998), besides supplemental irrigation by sprinklers during dry spells.

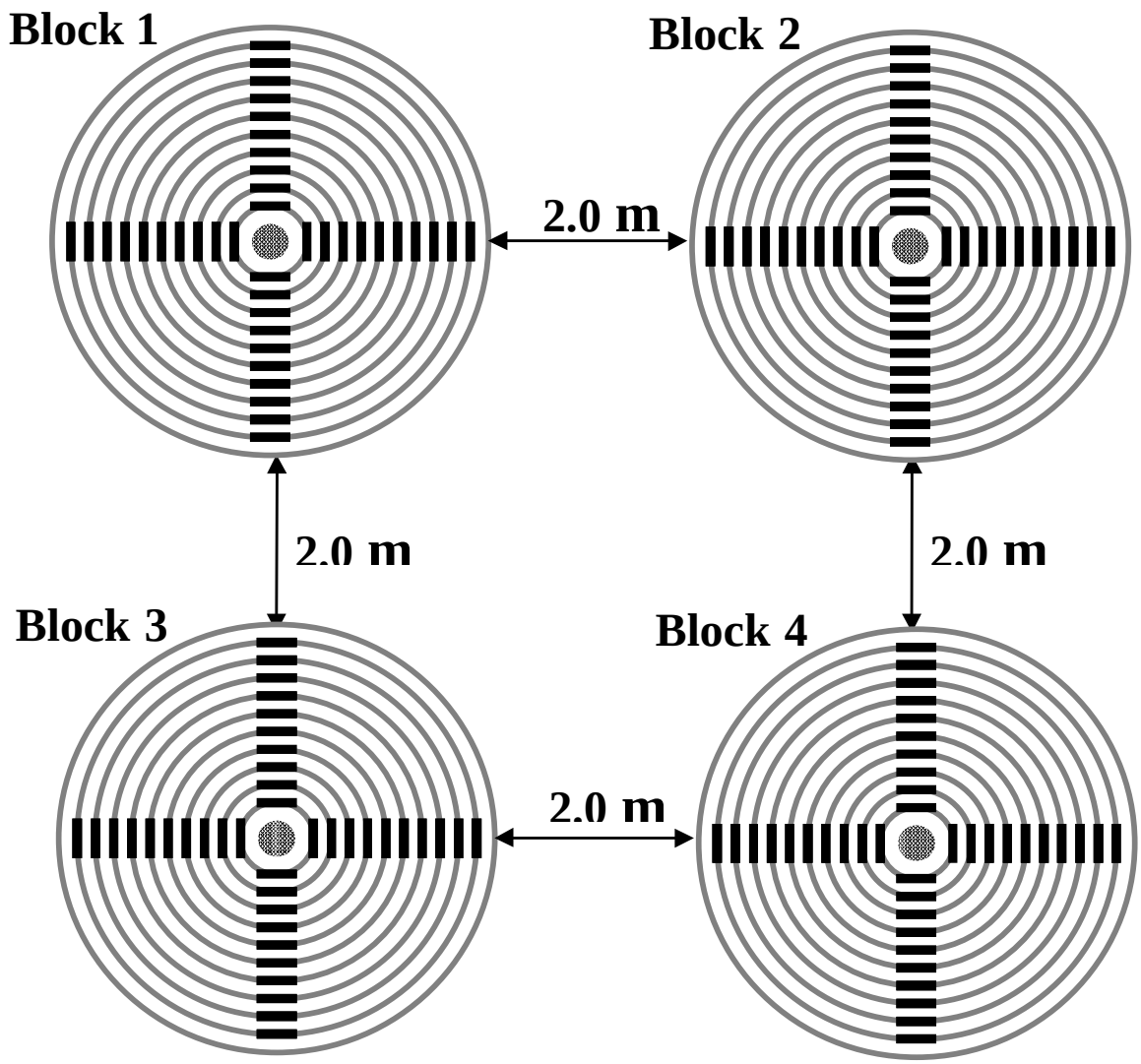

Figure 1. Experimental layout: circunscribed lines represents the planting location of the IAC 210 cultivar, the central circle the location of the Guarani cultivar, which carries the tracer alleles HLHL, and the marks displayed in the four cardinal positions represents the locations where the sampling for the evaluation of the seeds was done.

After the ripening of the cultivar IAC 201, all the seeds on a 0.5 m line on the four cardinal positions were harvested on each line on every block (Figure 1)

The seeds were cleaned, homogenized and air dried, and later a sample of 3000 seeds per line of each block was taken and planted in linear furrows for the evaluation of the presence or absence of pilosity in the leaves of the plants. The seeds of the cultivar IAC 201 resulting from cross pollination express the pilosity character in the leaves (HLhl), since this characteristic is due to dominant monogenic inheritance.

The evaluation of the presence or absence of hairs in the leaves was done manually on all the plants originated from the 3000 seeds planted from the IAC 201 cultivar which reached the development stage of the third definitive leaf. The plants were counted and those that showed leaf pilosity (HLhl genotipes) were separated. The values were then converted to percentages and the average of the four blocks of each experimental location were a representation of the natural crossing rates.

Results and Discussion

Carpina

The flowering of the two cultivars occurred from 05th to 12th of June 2001, in which period the accumulated rainfall, average temperature and relative humidity were 131.6 mm, 25 ^{o}C and 83% respectively. The rates of natural crossing were evaluated in plants resulting from sampled seeds from a 0.5 and 1.0 m distance of the genic tracer and the results are shown in Table 1.

At the 0.5 m distance four blocks were evaluated with a variable number of plants per block, for a total of 4212 plants, and the average rate of natural crossing was 0.30%, with a wide range of variation (0.00 to 0.72%). Consequently it can be concluded that in the distance of 0.5 m in Carpina, a cross pollination rate of up to 0.72% can be expected. At the distance of 1.0 m a total of 4602 plants were evaluated, for the sum of all four blocks, and no plants resulting from natural crossing were observed. In view of these results, distances from 1.5 m and higher were not evaluated.

Recife

In Recife, flowering occurred from 22nd to 29th of July, where in this period the accumulated rainfall, the average temperature and relative humidity were 78.8 mm, 25 ^{o}C and 84% respectively. Table 1 shows the results from the evaluation of the natural crossing rates of the plants arising from the seeds sampled at the distances of 0.5, 1.0, and 1.5 m. At the distance of 0.5 m between 1093 and 2122 plants per block were evaluated, where the average crossing rate was 0.35%. Similarly to what occurred in Carpina, there was also a wide range of variation in the crossing rate between blocks (0.0 to 0.82%). For the distance of 1.0 m a total of 5315 plants was evaluated from the four blocks, however no plants from natural crossing were observed.

At the distance of 1.5 m a total of 4776 plants were evaluated and also there was no plants resulting from natural crossing. As it was already known that there was no natural crossing between the varieties at a distance of 1.0 m, the evaluation done at the 1.5 m distance was performed in order to confirm the observations.

Carpina and Recife

The natural crossing rate in rice depends upon the genotype and the environment, that is, the local climatic conditions (Beachell et al. 1938), however, it has not been found in the literature rates higher than 3%. The results obtained from the experiments carried out in Carpina and Recife shows that natural crossing occurs up to a distance of 0.5 m. Even though there was great variation between blocks the rates of natural crossing were never higher than 0.82%. Thus, the results are similar to those described by Tailledois and Guimaraes (1988). However, it is lower than the pollination rate cited by Coste (1969). These results indicate that the variation that occurred in relation to the rainfall amount and the relative humidity of the air at the flowering period did not cause large alterations in the crossing rate and distance, since no natural crossing was observed at the distance of 1.0 m at both locations. Therefore, one meter of distance between both genotypes, interspaced by one row prevented the genic flow amongst themselves. It must be noted that there is no information available in relationship to the distance at which natural crossing can occur in rice.

Furthermore, in order to manage seed production fields or for the utilization of seeds from experimental plots for the advancement of generation in breeding programs in upland rice, for security measure, it is recommended to maintain 2 m of distance between neighboring genotypes interspaced by one or two border rows of each genotype to avoid contamination.

Table 1. Natural crossing rate variation between blocks at the distances of 0.5 and 1.0 m from the genic tracer in the experiment carried out in Carpina in 2001 and 0.5, 1.0 and 1.5 m in Recife in 2002

Distance	Block	Nº of evaluated plants	Nº of hybrid plants (HLhl)	Natural crossing rate %
		Carpina		
	1º	834	6	0.72
	2º	1056	0	0.0
0.5 m	3º	1513	2	0.13
	4º	809	3	0.13
Mean				0.37
	1º	952	0	0.30
	2º	1265	0	0.00
1.0 m	3º	1012	0	0.00
	4º	1373	0	0.00
Total		4602	0	0.00
		Recife		
	1º	2.122	18	0.82
	2º	1.093	0	0.00
0.5 m	3º	1.315	2	0.15
	4º	1.953	11	0.43
Mean				0.35
	1º	1.162	0	0.00
	2º	1.546	0	0.00
1.0 m	3º	1.485	0	0.00
	4º	1.122	0	0.00
Total		5.315	0	0.00
	1º	1.148	0	0.00
	2º	1.082	0	0.00
1.5 m	3º	1.312	0	0.00
	4º	1.234	0	0.00
Total		4.776	0	0.00

Conclusions

The average natural crossing rate of the upland rice cultivar Guarani to the IAC 201 at a distance of 0.5 m at the environmental conditions of Recife and Carpina counties, state of Pernambuco was never higher than 0.82%.The distance of 2.0 m interspaced by one or two rows offers security to avoid the genic flux between the two upland rice cultivars.

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