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Ntanos D., Roupakias D.G.

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Intercorrelation among market quality characters in genetic material selected with two breeding methods from two F_2 rice populations

D. Ntanos, NAGREF, Cereal Institute, Thermi-Thessaloliniki (Greece)
D.G. Roupakias, Aristotelian University of Thessaloniki (Greece)

Abstract. The effectiveness of two selection methods (honeycomb pedigree and single panicle descent) for yield and four quality characters (total milling yield, vitreosity, grain length and grain ratio length/width) was studied in two rice populations (No. 1992 and No. 2002). After six cycles of selection, the best five lines from each population and method were further evaluated in a complete randomized block design with four replications together with F_1 and the rice control variety Strymonas.

It was found that, in both populations, there were no significant differences for total milling yield between the genetic material selected with the two methods. Significant differences, however, were noticed for the rest of the studied quality characters. Honeycomb pedigree selection was more effective for the characters vitreosity, grain length and grain ratio length/width. The single panicle descent method was also effective for the improvement of characters vitreosity and grain ratio length/width but at a lower degree. In population No. 1992, total milling yield was not correlated with the other quality characters when the selection was done during the first generations, while it was negatively correlated with vitreosity (r=-0,64**) when the selection was done during the 6th generation by the single panicle descent method. In population No. 2002, total milling yield was correlated with vitreosity (r=0,49**) when the honeycomb pedigree method was applied and with the grain ratio length/width (r=0,70**) when the single panicle descent method was used. No correlation was observed between vitreosity and grain length although there was a significant correlation between vitreosity and grain ratio length/width (r=0,46* for population No. 1992 and r=0,74** for population No. 2002) only when the honeycomb pedigree method was applied. Grain length and grain ratio length/width were also correlated on the first population after the application of the honeycomb pedigree method.

I – Introduction

Application of a parallel selection for yield and quality characters should be the aim of the rice breeder. Fasoulas (1993) mentioned that application of the honeycomb pedigree selection in an F_2 population (without competition) should be effective for both yield and quality characters. In addition, Simmonds (1979) reported that the classical pedigree selection was also effective in early generation selection (under competition) for characters with high heritability such as grain size.

The objective of this study was: a) to evaluate the effectiveness of the honeycomb pedigree selection (without competition) and the single panicle descent (under competition) in a parallel selection for yield and four quality characters (i.e. total milling yield, vitreosity, grain length and grain ratio length/width) in two F_2 rice populations; and b) to investigate the intercorrelation among the four quality characters in the genetic material selected after application of the aforementioned two methods.

II – Materials and methods

The F_2 populations used were obtained from the American rice hybrids No. 19 and No. 2002. The work was carried out in the experimental station of Kalochori-Thessaloniki. During the year 1989, 1607 F_2 plants from the first population and 963 F_2 plants from the second population were grown in a honeycomb design with an interplant distance of 1 m. Application of honeycomb selection for yield (selection pressure 5,3% for the first and 14,3% for the second population, respectively) had as a result the selection of 79 and 113 plants, respectively. These plants were evaluated for four quality characters: total milling yield, vitreosity, grain length, and grain ratio length/width. Only plants with a good yielding ability and good quality characters were advanced in the next generations. The F_3, F_4, F_5 and F_6 generations were made up from 28 F_2, 30 F_3, 30 F_4 and 20 F_5 plants, respectively. The rice variety Strymonas (*Japonica* type) was used as a control for both populations. Finally, the best five lines from each population were selected for further evaluation of the F_7 generation.

In parallel with the Honeycomb Pedigree (HP) selection, the Single Panicle Descent (SPD) method (Brim, 1966) was also used. For this, seeds of one panicle from each F_2 plant in each population were planted in one line. In the year 1990, 1,567 F_3 lines from population No. 1992 and 810 lines from population No. 2002 were grown, while in the year 1991, 1,333 F_4 lines were grown from the first population and 673 from the second one. The row length was 1 m and the distance among the rows was 0.40 m. Negative selection was applied only for plant types with late maturity and disease susceptibility. In the year 1992, 892 and 568 F_5 lines of the first and second population, respectively, were grown in rows. Every 10th row was sown with the control (variety Strymonas). The 15% higher yielding lines were selected after application of the moving average. In the following year (F_6 generation), 135 and 85 lines from the population No. 1992 and No. 2002, respectively, were planted in a similar contiguous control experiment. Application of the moving average had as a result the selection of 40 and 23 lines from the first and second population, respectively. The selected lines outyielded the moving average by at least 10%. These lines were further evaluated for the aforementioned quality characters. The best five lines from each population were selected for further evaluation in the F_7 generation.

In the year 1994, two experiments (one for each population) were carried out. Each experiment included the best five lines selected from each selection method, the F_1 and the rice variety Strymonas as a control. The complete randomized block design with four replications was used. The yield and the quality characters: total milling yield, vitreosity, grain length and grain ratio length/width were studied.

The quality evaluation was done on grains with 14 % moisture content. The total milling yield was estimated from two samples 100 g each of pure rough rice. The vitreosity was estimated on two samples of 30 milled grains. For this, the grains were placed on a glassy table lighted with a 60 W light intensity. Grains with short spots of pearl were considered as chalky. The above characters were expressed in percent. The grain length and width were evaluated from two samples of 30 milled grains each with a micrometer, thus the ratio length/width was finally obtained.

Orthogonal comparisons were applied on the above quality characters between the two genetic materials resulted from the aforementioned selection methods as well as between them and the control Strymonas and F_1 (Steel and Torrie, 1960).

III – Results and discussion

The realized gain for the characters studied in the selected material is given in *Table 1.*

No significant differences were observed for total milling yield between the genetic material selected after application of the two methods in both populations *(Table 2)*. This may indicate that total milling yield is a rather complicated quality character and its selection could be postponed for later generations. Significant differences, however, were noticed for the rest of the quality characters studied. From this data, one could conclude that the honeycomb pedigree selection was more effective for the characters vitreosity, grain length and grain ratio length/width. The single panicle descent method was also effective for the improvement vitreosity and grain ratio length/width but at a lower degree. The selection was more effective during the first generations (honeycomb pedigree) because it has been shown that the three above characters manifest high heritablility (Juliano, 1985 ; Kaul *et al.*, 1982).

The intercorrelations among the four quality characters of the genetic material studied are given in *Table 3*. In population No. 1992, total milling yield was not correlated with the other quality characters studied when selection was done during the first generations, while it was negatively correlated with vitreosity (r=-0,64**) when selection was applied during the 6th generation (single panicle descent method). In population No. 2002, total milling yield was correlated with vitreosity (r=0,49**) when the honeycomb pedigree method was applied and with the grain ratio length/width (r=0,70**) when the single panicle descent method was used. It is indicated therefore, that selection for vitreosity during the first generations might have a positive effect on the total milling yield. No correlation was observed between vitreosity and grain length although there was a significant correlation between vitreosity and grain ratio length/width (r=0,46* for population No. 1992 and r=0,74** for population No. 2002) only when the honeycomb pedigree method was applied. This may indicate that early selection for grain ratio length/width could have a positive effect on the improvement of vitreosity. Grain length and grain ratio length/width were also correlated on the first population after application of the honeycomb pedigree method. This is in agreement with data reported by other researchers (Carreres, 1988).

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Table 1. Realized Gain (R.G.) after selection for Total Milling Yield, Vitreosity, Grain Length and Grain Ratio Length/Width in six successive generations by two methods in rice.

Genetic Material (G.M.)	Total Milling Yield				Vitreosity				Grain Length				Grain Ratio Length/Width			
	Population No 1992		Population No 2002		Population No 1992		Population No 2002		Population No 1992		Population No 2002		Population No 1992		Population No 2002	
	Total Milling Yield %	R.G. % of Control	Total Milling Yield %	R.G. % of Control	Vitreosity %	R.G. % of Control	Vitreosity %	R.G. % of Control	Grain Length mm	R.G. % of Control	Grain Length mm	R.G. % of Control	Grain Ratio L/W	R.G. % of Control	Grain Ratio L/W	R.G. % of Control
G.M. after H.P. selection	68,49	100,4	68,35	100,6	80,60	172,9	62,80	139,9	6,47	101,9	6,47	101,4	2,95	122,9	2,92	120,7
G.M. after S.P.D. selection	68,69	100,7	68,67	101,1	65,78	141,1	56,33	125,5	6,40	100,8	6,40	100,3	2,84	118,3	2,86	118,2
F_1	68,40	100,3	68,18	100,3	46,66	100,1	41,50	92,5	6,35	100,0	6,34	99,4	2,77	115,4	2,70	111,6
Control variety	68,20	100,0	67,95	100,0	46,63	100,0	44,88	100,0	6,35	100,0	6,38	100,0	2,40	100,0	2,42	100,0

Table 2. Orthogonal comparisons for four quality characters between the Genetic Material (G.M.) selected with Honeycomb Pedigree (H.P.) selection, Single Panicle Descent (S.P.D.) and F_1 and a Control variety in rice.

Comparisons	Total Milling Yield		Vitreosity		Grain Length		Grain Ratio Length/Width	
	Mean Square		Mean Square		Mean Square		Mean Square	
	Population No 1992	Population No 2002	Population No 1992	Population No 2002	Population No 1992	Population No 2002	Population No 1992	Population No 2002
G.M. of H.P. vs G.M. of S.P.D.	0,42 NS	1,26 NS	2168,26 **	419,26 **	0,050 **	0,041 **	0,133 **	0,062 **
G.M. of H.P. vs F_1	0,02 NS	0,08 NS	4314,00 **	1512,30 **	0,039 **	0,059 **	0,144 **	0,018 **
G.M. of H.P. vs Control variety	0,27 NS	0,47 NS	3847,67 **	1071,00 **	0,046 **	0,027 **	1,018 **	0,881 **
G.M. of S.P.D. vs F_1	0,28 NS	0,85 NS	1491,08 **	732,60 **	0,004 NS	0,016 **	0,016 **	0,078 **
G.M. of S.P.D. vs Control variety	0,80 NS	1,78 *	1222,40 **	437,00 **	0,007 NS	0,002 NS	0,637 **	0,631 **
M.S.Error	0,32	0,34	9,01	5,78	0,002	0,002	0,001	0,001

* Significant at $P \leq 0,05$
** Significant at $P \leq 0,01$

Table 3. Intercorrelation among Total Milling Yield, Vitreosity, Grain Length and Grain Ratio Length/Width in the genetic material selected after application of Honeycomb Pedigree selection and Single Panicle Descent in two F_2 rice populations

Variables			Population No 1992				Population No 2002			
			Honeycomb Pedigree		Single Panicle Descent		Honeycomb Pedigree		Single Panicle Descent	
Total Milling Yield	x	Vitreosity	0,32	NS	-0,64	**	0,49	*	-0,39	NS
Total Milling Yield	x	Grain Length	0,14	NS	-0,21	NS	-0,02	NS	-0,02	NS
Total Milling Yield	x	Grain Ratio Length/Width	0,29	NS	0,16	NS	0,09	NS	0,70	**
Vitreosity	x	Grain Length	0,44	NS	0,36	NS	-0,38	NS	-0,06	NS
Vitreosity	x	Grain Ratio Length/Width	0,46	*	0,16	NS	0,74	**	-0,52	*
Grain Length	x	Grain Ratio Length/Width	0,88	**	0,43	NS	-0,28	NS	0,28	NS

* Significant at $P \leq 0,05$
** Significant at $P \leq 0,01$