BREEDING AND EVALUATION FOR IMPROVED RICE VARIETIES IN MACEDONIA

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Abstract

Researches in this paper are continuity in breeding work on rice in Macedonia. The strategy of breeding program is orient towards follow the local, regional and global needs and trends in production and consumption on rice. Experimental material is result of the classic method for developing the genetic polymorphism, interspecies hybridization. A lot of hybrid combinations are produce between genetic divergent parental pairs, that have more positive properties. After evaluation on individual lines for length of vegetation, height and type of plant, characteristics of grain and other characteristics, the best perspective homozygous lines are tested for yield of paddy and white rice, together with two standard varieties (*monticelli* and *biser-2*). In period of 2005-2007 in repeated examinations for continuous evaluation, superiority in terms of two standard varieties showed genotype *79/22-2.* The researches at this genotype are extended in terms of its qualitative properties, as a precondition for his registration and recognition for introduction in production.

Key words: rice (Oryza sativa L.), breeding, genotype, yield.

Introduction

The rice crop is a small crop in Macedonia (between 3 000 ha and 3 500 ha in the last years), but it is very important because its production covers the domestic needs and the surplus is exported. Most of the area under rice is situated in regions on Kocani, Vinica, Blatec and Stip. The average yield of paddy varies between 4 500kg/ha and 5 500kg/ha.

Dominant position in production sortiment have Italian varieties *san andrea*, *P-76/6* and *monticelli*.

Two new domestic rice varieties (*prima riska* and *montessa)* are recognized in 2004. These two varieties are highly yield (Ilieva at all. 2005/2006) and more important place in the production sortiment takes especially the variety *prima riska*. Next to these, from domestic varieties in production, the variety *biser-2* can also be found in some regions.

Breeding program is a continuous project to create new rice genotypes with genetic potential for high and stable yield, high quality of grain, resistant of blast, lodging and grain-drop. In the realization of these aims a significant place has introduction of genetic material from other geographic areas. Besides the possibility of directly introducing on introduced varieties in production, after their acclimatization, with hybridization between them and the already available material are create new combinations and genotypes of rice, which are used as material for the creation of new productive and high quality rice varieties. The ultimate aim of those researches is to improve and expand the varietal composition in the widespread cultivation.

Material and methods

The starting material for the creation of variable populations, and realization on the pose aims with this research is selected from available collected material. Selected parental varieties are divergent and possess more positive properties.

In 2005 as parental varieties were used eight varieties of Italian origin (*cistella, ringo, kastelmochi, prometeo, drago, san andrea, P-76/6* and *monticelli*), and one originating from the U.S. (*lemont*). Besides the variety *lemont*, this belongs to the varieties indica, all other varieties belonging to variety japonica.

In 2006 as parental varieties were used old domestic varieties H^0*-51* and H^0*-69*, domestic populations *B-30-281* and *B-30-303* and Italian varieties *baldo* and *drago*. All varieties belong to japonica.

In 2007 as parental varieties two new recognized varieties are used (p*rima riska* and m*ontessa*), four varieties of Bulgarian origin (*LM-BP, kubrat, line-305,* and *dunav*) and two originating from Italy (*san andrea* and *monticelli*). All these varieties belong to varieties of japonica.

Breeding and assessment was conducted on a lot of number of hybrid individuals from previously and newly created hybrid material. Most superior homozygous genotypes were selected for further researches. The stabile new produced genotypes (*25/1-1-2-3-1, 54/1-1-2, 60/1-1, 79/22-2, 110/10, 125/1-1, 125 / 2, 60 / 4* and *78/12-3-1*), are tested for yield of paddy and white rice with two standard varieties *monticelli* and *biser-2*.

As a method for creation of variable population is used hybridization. Hybridization is realized in greenhouse "Bottle" - method. Resulting hybrid material is sprinkled in vegetative pots in greenhouse, and in phase of 2-3 leaves are transplanting in field's conditions. During the vegetation were carried necessary phenological observations. The choice of hybrid progenies is carried out with "pedigree" - method.

Comparative examinations at the most perspective new produced genotypes were carried out by a method of complete randomized block design in three repetitions, whit size of experimental plots 5 m^2. The yield of paddy was calculated in kg / ha with 15% moisture. Results obtained were statistically calculated by a method of variance analysis and tested with LSD test.

From each line, after the harvest, average samples were formed. Then from the each average sample are made after three repetitions from a 50g for determining dressing percentage of white rice. For this aim, paddy is hulled and milling with the laboratory mill, during the 3.5 minutes for each variety. From the obtained dressing percentage of white rice and the paddy yield is calculated and the total yield of white rice.

Applied agro technician measures are standard for the region.

Results and discussion

The breeding program each year includes varieties with more positive properties such as parental material for the creation of new combinations and genotypes. In the period 2005-2007 were created 44 new hybrid combinations (Tab. 1). Almost in all combinations the one parental variety is with high yield potential and the other with long and high quality grain. Most of the parental varieties are with shorter stems and medium late vegetation.

The number of parental forms and crosses which will be used to achieve the set aims is always question in implement a breeding program. Some breeders prefer to create a small number (4-5) crosses, with the largest population of any possible combination. Others, in contrast, prefer each year to create hundreds of hybrid combinations, but with a small number of plants in each of them. Both ways have their advantages and disadvantages.

Generally supply of larger hybrid populations, particularly in segregation generations, giving greater opportunities for obtaining desirable genotypes combined with more positive properties from both parents. However, material-technical and staffing opportunities often force breeders on smaller populations. According to literature data the most of crosses that are created by hybridization are "single crosses" (includes only two parent varieties). Complex combinations extend the selection process and are often avoided.

Although it requires a long time to develop a new variety, method of hybridization is still popular despite the application of other newer and faster methods (Kanter et all., 2007; Vozhehova, 2004; Moldenhauer et all., 2002).

The success of breeding programs mostly depends on the presence of the required properties in the initial material, methods of combining them in new improved genotypes, methods of selection of hybrid populations, methods for testing of selected lines, etc.

In growing hybrid populations and the application of the selection of those populations most breeding programs using "pedigree" method (Jennings et all., 1979). Basic requirement for the application of this method is the cultivation of hybrid progenies in rare within which will allow monitoring and selection of individual plants.

With the selection of promising genotypes is starting in F_2 generation. In F_3 generation is continuing the selection of individual plants but are selected whole lines. At rice is recommended selection in F_2 and F_3 generations to be done with respect to the type of plant, time of ripening, plant vigor and capacity of tillering. In the F_4 generation selection should be done in terms of form and translucent of grain and resistance blast. Choice in terms of yield of paddy and white rice are made between selected lines in the F_5 generation. To confirm the preliminary evaluation of the properties, at the uniform material from F_5 generation is conducted testing in terms of yield of paddy and white rice, resistance of lodging, adaptability to environmental conditions etc.

In 2005 in F_1 generation are examined 20 hybrid combinations with 320 hybrid units, and in the F_2 generation 18 hybrid combinations with a lot of number of hybrid units. From the hybrid material in F_3 and other generations for further examinations are selected 60 genotypes and lines from 11 hybrid combinations.

In 2006 are examined 16 hybrid combinations of F_1 generation with 130 hybrid units. In F_2 generation are observed many hybrid individuals from 14 hybrid combinations, which are selected promising genotypes for further evaluation. As a result of phenological observations and some laboratory analysis were selected a number of hybrid units in the F_3 and F_4 generations Of the remaining hybrid material for further monitoring are selected genotypes *60/1-1-5-3, 78/12-3-3, 78/12-3-5* and *100/6-2-4*.

In 2007 in F_1 are examined 12 hybrid combinations with 120 hybrid units and in the F_2 generation 16 hybrid combinations with 650 hybrid units. From the F_3 and other generations for further examinations are selected 27 genotypes and lines from 8 hybrid combinations. The results of the selected promising lines from the initial generation are given in table 2.

From stabilize positively evaluated lines, in 2005 were compared examined for yield of paddy and white rice seven lines with two standard varieties. Table 3 shows that the higher yield of the two standards is obtained from genotypes *79/22-2* and *110 / 10*. Obtained differences in genotype and *79/22-2* are statistically significant in terms of two standard varieties for the two levels of probability, and differences in genotype *110/10* are not statistically significant. Negative differences in other genotypes were statistically significant in terms of two standard varieties for the two levels of probability, except in genotype *54/1-1-2* whose negative difference is not statistically significant only in relation to the standard variety *biser-2* for two levels of probability.

As a results of milling of paddy, dressing percentage of whole grains is 51.14% at genotype *110/10* to 63.88% at genotype *125/2*. According as, the largest total yield of white rice is obtained from genotype *79/22-2* (5 559 kg/ha), which is greater than two standard, while all other genotypes have less total yield of white rice from the two standards. (Tab.3)

In 2006 five homozygous lines were compared examined with two standard varieties. Table 4 shows that the higher yield of the two standards is obtained only by genotype *79/22-2*. The obtained differences are statistically significant for both levels of probability in terms of the standard *monticelli,* while in terms of the standard *biser-2* the difference is statistically significant only for the level of probability of 0.05. Lower yield of other genotypes is statistically significant in terms of both standards. But the results of other researches on these lines indicate that are lines with medium and quality grain with high genetic potential for yield, medium long vegetation period, good resistance to diseases, lodging, resistance of grain-fall and other positive properties.

As a results of paddy to get white rice, dressing percentage of whole grains amount of 53.23% with genotype *110/10* to 68.39% at genotype *125/2*. According as, only from the genotype *79/22-2* is obtained higher total yield of white rice from two standards (Tab. 4).

In 2007 the test for paddy is done at five homozigous lines (*60/1-1-5-3, 78/12-3-3, 78/12-3-5, 79/22-2* and *100/6-2 -4*) compared with two standard varieties *monticelli* and *biser-2*. The analysis of the results of table 5 shows that the highest yield of paddy obtained from genotypes *78/12-3-3* and *79/22-2* (9 520 kg / ha). Obtained yield in these genotypes is equal to the yield of standard variety *biser-2*, and for 10.95% higher than the yield of *monticelli*. Higher yield of paddy in terms of the standard variety *monticelli* is obtained from genotype *78/12-3-5* (5.59% more), but it is 4.83% lower than yields of *biser-2.* Genotype *100/6-2-4* scored equal yield of paddy as *monticelli*, and 9.87% lower than the *biser-2*. Lower yield of paddy in terms of both standards is obtained with genotype *60/1-1-5-3*.

Higher yields at genotypes *78/12-3-3* and *79/22-2* in terms of standard *monticelli*, is statistically significant for both levels of probability. At genotype *78/12-3-5* the positive difference is not statistically significant and negative differences in genotype *60/1-1-5-3*. In terms of *biser-2* negative difference in genotypes *100/6-2-4* and *60/1-1-5-3* is statistically significant for both levels of probability, while at genotype *78/12-3-5* negative difference is not statistically reliable.

The least dressing percentage whole grains has standard *biser-2* (57.68%), and the largest at genotype *60/1-1-5-3* (66.92%). The least total yield of white rice is obtained from genotype *100/6-2-4* (5.182kg/ha), and the largest of the genotype *79/22-2* (6.026kg/ha) (Tab. 5).

Conclusion

Important breeding material is created with a broad genetic base that will continue to be used as a reservoir of potential new varieties. Although new varieties are not realized directly on the basis of preliminary examinations in earlier generations, these studies are important to continuously confirm evaluated values of perspective genotypes and to identify potential new varieties. Results obtained from these studies signal a satisfactory source of desirable properties at genotype *79/22-2*. The other tested genotypes are eliminated from further comparative trials. To be improved, the same will be involved in new hybrid combinations.

References

Ilieva Verica, Andreevska Danica, Andov, D., 2005/2006: Some more charakteristics of the new created rice varieties prima riska and montessa (Oryza sativa, L.). Yearbook of the Institute of Agriculyure Skopje, Volume XXIV/XXV, 51-59. Skopje.

Jennings, R., Coffman, R., Kaufman, E., 1979. Rice improvement. IRRI. Los Banos, Philippines. 186.

Kanter, D. G., T. C. Miller, W. L. Solomon, G. E. Baird III, and T. W. Walker. 2007. Mississippi Rice Variety Trials, 2006. Information Bulletin 432.

Moldenhauer, K., Gibbons, W., Lee, N., Norman, J., Bernhardt, L., Anders, A., Wilson, E., Rutger, N., Blocker, M., Tolbert, C., Bulloch, M., Taylor, K., Emerson, M., 2002. Breeding and Evaluation for Improved Rice Varieties - The Arkansas Breeding and Development Program. AAES Research Series 540. 93-98.

Vozhehova, R., 2004. Varieties and direction of rice breeding in Ukraine. Proceedings of the conference “Challenges and opportunities for sustainable rice-based production systems”. 13-15 September 2004, Torino, Italy. 303-306.

Table 1. Hybrid combinations created in the period 2005-2007

2005	2006	2007
Kastelmochi x Lemont	B-30-303 x Baldo	LM-BP x Prima riska
Lemont x Kastelmochi	Baldo x B-30-303	Kubrat x Prima riska
Kastelmochi x Drago	B-30-303 x Drago	Dunav x Prima riska
Drago x Kastelmochi	Drago x B-30-303	Line-305 x Prima riska
Cistella x Lemont	N^0-51 x Baldo	LM-BP x Montessa
Lemont x Cistella	Baldo x N^0-51	Kubrat x Montessa
Cistela x Drago	N^0-51 x Drago	Dunav x Montessa
Drago x Cistela	Drago x N^0-51	Line-305 x Montessa
Prometeo x Lemont	N^0-69 x Baldo	LM-BP x Monticelli
Lemont x Prometeo	Baldo x N^0-69	Kubrat x Monticelli
Prometeo x Drago	N^0-69 x Drago	Dunav x Monticelli
Drago x Prometeo	Drago x N^0-69	Line-305 x Monticelli
Ringo x Lemont		LM-BP x San Andrea
Lemont x Ringo		Kubrat x San Andrea
Ringo x Drago		Dunav x San Andrea
Drago x Ringo		Line-305 x San Andrea

Table 2. Results of examination on some of the selected hybrid units in F_2, F_3 and F_4 generations, 2007

Line	Number of productive tiller per plant	Number of fertilized grains at the main panicle	Mass of grains from the main panicle-g	Mass of grain of whole plant-g
F_2 generation				
Kastelmochi	9	138	3.96	32.00
1/05-4(Kastelmoshi x Lemont)	17	190	4.48	57.45
Lemont	13	194	4.97	55.11
2/05-2(Lemont x Kastelmochi)	17	236	6.02	98.28
2/05-5(Lemont x Kastelmochi)	15	163	6.35	71.00
Cistella	9	142	6.35	39.00
5/05-2 (Cistela x Lemont)	18	147	5.82	73.00
5/05-3 (Cistela x Lemont)	22	206	6.47	103.14
6/05-4 (Lemont x Cistela)	15	202	7.06	102.10
6/05-5 (Lemont x Cistela)	12	152	5.11	65.00
6/05-6 (Lemont x Cistela)	10	152	5.08	63.20
Prometeo	10	131	4.19	36.16
9/05-4 (Prometeo x Lemont)	12	208	7.53	110.10
10/05-4(Lemont x Prometeo)	10	188	4.62	58.55
11/05-3(Prometeo x Drago)	12	144	4.47	46.80
Drago	12	135	4.55	47.30
F_3 generation				
Dedalo	10	148	3.92	33.00
3/3-2-1 (Dedalo x Prima riska)	12	222	7.66	72.35
3/3-2-2 (Dedalo x Prima riska)	14	190	6.11	70.10
3/3-2-3 (Dedalo x Prima riska)	12	188	6.42	70.16
3/3-2-4 (Dedalo x Prima riska)	10	183	6.33	60.00
3/3-2-5 (Dedalo x Prima riska)	10	200	6.15	54.80
Prima riska	12	196	7.98	70.00
Montessa	11	203	6.37	53.70
20/1-2-1(Montessa x Andola)	12	208	6.35	55.60
20/1-2-2(Montessa x Andola)	14	196	6.15	65.33
20/1-2-3(Montessa x Andola)	14	257	8.20	95.38
20/1-3-1(Montessa x Andola)	14	233	7.70	95.55
20/1-3-2(Montessa x Andola)	11	200	6.12	52.30
20/1-3-3(Montessa x Andola)	10	196	6.00	53.54
Andola	8	170	5.35	32.14
F_4 generation				
Biser-2	9	135	5.62	40.00
8/03-1-2-1 (Biser-2 x Panda)	12	206	7.44	80.80
8/03-1-2-2 (Biser-2 x Panda)	10	216	6.80	64.12
Panda	10	220	5.80	48.22
9/03-1 (Biser-2 x L-202)	12	202	8.12	100.50
9/03-2 (Biser-2 x L-202)	10	190	6.30	52.30
L-202	10	151	4.46	30.38
16/03-1 (L-202 x Monticelli)	14	206	6.28	110.00
16/03-2 (L-202 x Monticelli)	15	203	6.00	71.12
Monticelli	13	152	4.75	42.20
20/03-1 (San andrea x L-202	14	171	6.24	70.00
San andrea	13	145	5.70	51.80

Table 3. Yield of paddy and white rice with some new rice genotypes (2005)

Genotype	Yield of paddy		Relative yield-%		Dressing percentage of white rice(whole grains)-%	Yield of white rice - kg/ha
	$kg/5m^2$	kg/ha	Monticelli	Biser-2		
1. 25/1-1-2-3-1	3.33	6 660	86.05	86.94	56.92	3 791
2. 54/1-1-2	3.40	6 800	87.85	88.77	62.28	4 235
3. 60/1-1	2.67	5 340	68.99	69.71	58.80	3 140
4. 79/22-2	4.60	9 200	118.86	120.10	60.42	5 559
5. 110/10	4.13	8 260	106.72	107.83	51.14	4 224
6. 125/1-1	3.33	6 660	86.05	86.94	52.48	3 495
7. 125/2	2.93	5 860	75.71	76.50	63.88	3 743
8. Biser-2 (st.)	3.83	7 660	98.97	100.00	57.85	4 431
9. Monticelli(st.)	3.87	7 740	100.00	101.04	63.91	4 947
$LSD_{0,05} = 0.31$ $_{0,01} = 0.43$						

Table 4. Yield of paddy and white rice with some new rice genotypes (2006)

Genotype	Yield of paddy		Relative yield-%		Dressing percentage of white rice(whole grains)-%	Yield of white rice - kg/ha
	$kg/5m^2$	kg/ha	Monticelli	Biser-2		
1. 60/1-1	3.03	6 060	79.74	67.78	60.70	3 678
2. 78/12-3-1	3.27	6 540	86.05	73.15	61.45	4 019
3. 79/22-2	4.67	9 340	122.89	104.47	66.28	6 190
4. 110/10	2.80	5 600	73.68	62.64	53.23	2 981
5. 125/2	2.67	5 340	70.26	59.73	68.39	3 652
6. Biser-2(st.)	4.47	8 940	117.63	100.00	61.29	5 479
7. Monticelli(st.)	3.80	7 600	100.00	85.01	66.20	5 031
$LSD_{0,05} = 0.20$ $_{0,01} = 0.28$						

Table 5. Yield of paddy and white rice with some new rice genotypes (2007)

Genotype	Yield of paddy		Relative yield-%		Dressing percentage of white rice(whole grains)-%	Yield of white rice - kg/ha
	$kg/5m^2$	kg/ha	Monticelli	Biser-2		
1. 60/1-1-5-3	4.04	8090	94.29	84.98	66.92	5414
2. 78/12-3-3	4.76	9520	110.95	100.00	59.12	5628
3. 78/12-3-5	4.53	9060	105.59	95.17	58.95	5341
4. 79/22-2	4.76	9520	110.95	100.00	63.30	6026
5. 100/6-2-4	4.29	8580	100.00	90.13	60.40	5182
6. Biser-2(st.)	4.76	9520	110.95	100.00	57.68	5491
7. Monticelli(st.)	4.29	8580	100.00	90.13	64.30	5517
$LSD_{0,05} = 0.31$ $_{0,01} = 0.43$						