DOI: 10.22620/agrisci.2021.30.011

USE OF RECURRENT SELECTION IN MIDDLE LATE SYNTHETIC MAIZE POPULATIONS. RESULTS OF THE FIRST CYCLE IN SYNTHETIC "1/2017"

Natalyia Petrovska, Valentina Valkova

Maize Research Institute - Kneja

E-mail:** ***natalya_hristova@abv.bg

Abstract

The present study shows the results of a completed first cycle of recurrent selection in a middle late synthetic population "1/2017" and the inbred lines PAU 1617 and B 113 are used as a recurrent parents. The aim of the improving selection is to obtain from the synthetic inbred lines which are later to be used as parental forms for receiving hybrids of this maturity group.

The experimental work was carried out in the period 2017 – 2019 when two hundred and ten testcrosses were tested. After the data was analyzed, eighty even inbred progeny variants displaying the best results have been included for crosspollination and a new cycle of breeding. The genetic variability in the synthetic has been preserved as the selected progeny represent 41,4 % of the initially chosen ones. The index of variability after recurrent selection is 12,2 % which allows for efficient testing in the subsequent stages of the improving selection.

As a direct outcome of the research, thirteen crosses have been pointed out – B 113 x 37/1, B 113 x 25/5, PAU 1617 x 71/3, B 113 x 29/1, B 113 x 33/1, PAU 1617 x 97/3, PAU 1617 x 85/3, B 113 x 71/5, B 113 x 71/6, B 113 x 53/1, B 113 x 55/1, B 113 x 77/3 and B 113 x 43/1. They exceed in grain yield the foreign standard in the maturity group respectively with 25.2, 20.0, 16.9, 16.6, 15.1, 15.0, 13.1, 12.5, 10.5, 9.0, 8.8, 8.8 and 8.2%. They are still tested in varietal and ecological trials.

Keywords: synthetic population, recurrent selection, cycle of breeding, inbred lines, combining ability.

Abbreviations: CA – combining ability, GCA – general combining ability, SCA – specific combining ability

INTRODUCTION

The establishment of synthetic populations and the application of periodic selection in them appears an effective method to overcome the fast genetic bases restriction in the exit materials (Genov, 2004; Russell, 1992; Russell et al., 1973; Smith, 1983). There is a better possibility for selection of lines with a high combining ability, and this is the main goal in heterosis selection. In recurrent selection the genetic variability is preserved and increases (Genova, 1991), while in pedigree selection it is the opposite – the intra-line variability is depleted due to the increasing homozygosity. Besides, favorable adaptive genes with different frequency depending on the selection intensity are accumulated in the population. After the best prodigies are re-pollinated as parents, in the population progressively are accumulated desired genes as a result of combinative variability. This allows a new effective selection cycle to be executed and gives the chance selfbred /self-pollinated/ lines with improved combinative variability to be produced (Chuprina, 2008; Novoselov, 2008; Suprunov et al., 2010).

MATERIALS AND METHODS

The experiment conducted in 2017 – 2019 includes synthetic "1/2017" (Fig. 1), the inbred lines PAU 1617 and B 113 as a recurrent parent and the testcrosses obtained by the method of recurrent selection for increasing CA (Hull, 1945). In 2018, on an experimental field, test plot of 0.2 ha, 2400 plants from the synthetic and the inbred lines PAU 1617 and B 113 are sown. Six hundred plants in the sowing of the recurrent parent are cross-pollinated manually and under an isolator by spreading pollen from the synthetic population on the cobs that have tasseled at the same time in the inbred line. The selected for pollinators progeny undergo inbreeding and selection for the subsequent stages.

In 2019, on the experimental field of the Maize Research Institute, Knezha, in eight preliminary trials, 210 corn progeny were tested. The block method was used on a test plot of 5 m^2, plant density 50000 pl/ha. Grain yield (kg/ha), grain moisture at harvest, days from germination to teaseling and performance index (Pi %) are evaluated and analyzed. The data was evaluated by ANOVA (Dimova, Marinkov, 1999).

RESULTS AND DISCUSSION

In 2018 this synthetic population was included in a recurrent selection program for increasing combinative ability and perspective lines receiving for the goals of maize heterosis selection. The improvement was carried out with valuable combinative lines from the Institute's collection, i.e. PAU 1617 and B 113. After the necessary number of crossbreds were received 300 experimental maize hybrids – 162 with the first line and 138 with the second line, respectively. In this synthetic population were simultaneously inbred the needed number of opposing plants.

The experimental hybrids were tested in 8 preliminary varietal tests. Their data are given in Table 1. Eighteen perspective crossbreds showed the best results compared to the test standard (Knezha 509), i.e. B 113 x 37/1, B 113 x 25/5, PAU 1617 x 71/3, B 113 x 29/1, B 113 x 33/1, PAU 1617 x 97/3, PAU 1617 x 85/3, B 113 x 71/5, B 113 x 71/6, B 113 x 53/1, B 113 x 55/1, B 113 x 77/3, B 113 x 43/1, PAU 1617 x 87/1, PAU 1617 x 97/2, PAU 1617 x 87/3, PAU 1617 x 89/2 и PAU 1617 x 69/1. They surpass the standard of this maturity group in grain yield with 25.2, 20.0, 16.9, 16.6, 15.1, 15.0, 13.1, 12.5, 10.5, 9.0, 8.8, 8.8, 8.2, 6.8, 4.9, 4.7, 3.0 and 2.8% respectively. The hybrids' testing continues in competitive and environmental varietal tests. Once attaining classification in them, these hybrids will be proposed for acknowledgement and enlistment in the country's varietal list. During the testing another 71 progenies showed equal or close results compared to the standard.

Fig.1, Fig.2 and Fig. 3 show the yield distribution curves of testcrosses with both recurrent parents after the first cycle completion of periodic selection. Their hybrids with them as pollinators attain comparatively high yields; have a low humidity content in the grain at harvest and a high performance index ($Pi \geq 5$). The crossbreeds with higher yield than the standard prove that in the population there are valuable combinative progenies. After inbreeding and selection these progenies could produce hybridization lines.

In 2020 all progenies were united with higher, equal or close to the standard results during the testing for yield and grain humidity. Their equal number of seeds was recurrently inbred in an isolation field and a new selection cycle formed. With their inclusion as parents there is a possibility for valuable genes' accumulation in the new population and for an increase of the desired recombinants at the recurrent pollination. A total of 87 lines were selected, this presents 41.4% of all tested in the exit synthetic population.

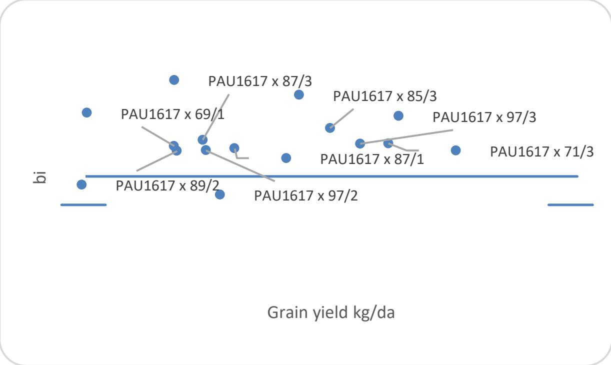

Fig. 1. Selected progenies for the second cycle of synthetic 1/2017 with line PAU 1617

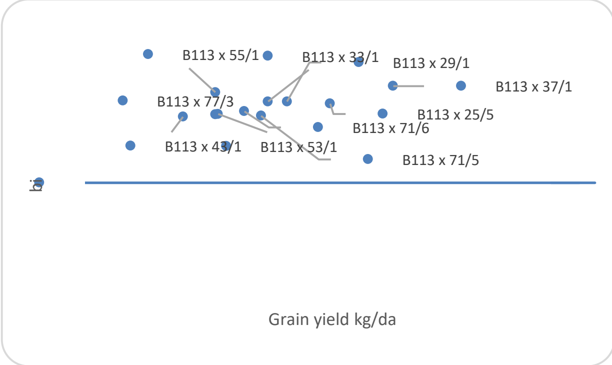

Fig. 2. Selected progenies for the second cycle of synthetic 1/2017 with line B113

The integration of these progenies allows the valuable genes to be accumulated in the new synthetic and desired recombinants to be achieved in a comparatively small in area and size population that is grown in the experimental and selection fields.

After the first cycle the variability index is 12,2% which allows the effective selection process and a long screening.

Table 1. Crosses of synthetic 1/2017 with the lines PAU 1617 and B113 with the best results (2019)

Variants/Parameters	Grain yield kg/dka	% to Standart	Moisture in the Grain %	Performance index Pi
B113 x 37/1	1249,2	125,2	15,2	8,2
B113 x 25/5	1198,2	120,1	15,7	7,6
PAU1617 x 71/3	904,0	116,9	14,8	6,1
B113 x 29/1	1163,3	116,6	15,1	7,7
B113 x 33/1	1148,0	115,1	14,9	7,7
PAU1617 x 97/3	889,7	115,1	14,6	6,1
PAU1617 x 85/3	874,4	113,1	13,2	6,6
B113 x 71/5	1142,4	112,5	15,8	7,2
B113 x 71/6	1128,8	110,5	15,3	7,4
B113 x 53/1	1107,6	109,0	15,2	7,3
B113 x 55/1	1105,4	108,8	13,8	8,0
B113 x 77/3	1105,4	108,8	15,2	7,3
B113 x 43/1	1079,2	108,2	15,0	7,2
PAU1617 x 87/1	825,8	106,8	13,9	5,9
PAU1617 x 97/2	811,2	104,9	13,8	5,9
PAU1617 x 87/3	809,6	104,7	13,0	6,2
PAU1617 x 89/2	796,5	103,0	13,6	5,9
PAU1617 x 69/1	795,0	102,8	13,2	6,0

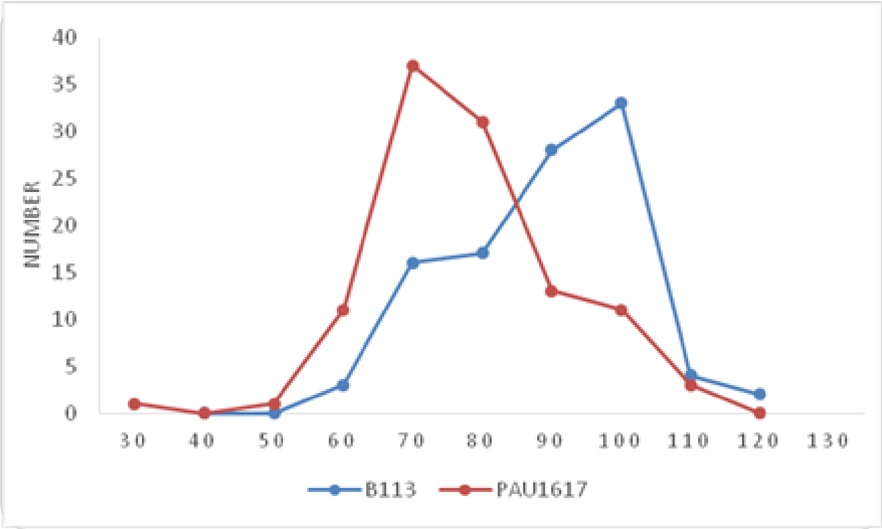

Fig. 3. Effects of breeding of the one completed cycle in the synthetic 1/2017

The results we received confirm previous studies and support the conclusions that the periodic selection allows to receive simultaneously valuable combinative lines and to preserve the genetic variety in the populations (Hallauer 1991). This appears to be the priority of recurrent selection to the pedigree one, where due to the increasing homozygosity the genetic base of exit material is restricted. After the selected progenies are recurrently pollinated in an isolation field, a second selection cycle with selected valuable lines of the exit population will be started. After that the effect of selection will be estimated.

CONCLUSIONS

After testing of the progenies in Synthetic "1/2017" with the inbred lines PAU 1617 and B 113, eighty seven crosses which exceed the standards in the maturity group are received.

For a second cycle of the selection, 41.4 % of the crosses – tested in the first cycle are selected. Genetic variability in the synthetic is preserved and allows efficient operation in the next cycles of selection.

The combination of the progenies with results (higher, equal or close to the standards) allows accumulation of valuable genes into new synthetic and obtaining of desired recombinants in relatively small in area and size population, grown in experimental and breeding fields.

Eighteen experimental hybrids which exceed the standards in grain yield by over five percent. They are still tested in varietal and ecological trials.

ACKNOWLEDGEMENT

This work was supported by the Bulgarian Ministry of Education and Science under the National Research Programme "Healthy Foods for a Strong Bio-Economy and Quality of Life" approved by DCM # 577 / 17.08.2018".

REFERENCES

Chuprina MA, 2008. Changes in synthetic populations of L and S defined as promising under the influence of reciprocal recurrent selection. Krasnodar, 1, 63-67 (Ru).

Dimova D and Marinkov E, 1999. Experimental Works and Biometry. Academic publishing house of High Institute of Agriculture, Plovdiv, p. 263

Genov MN, 2004. Opportunities for expanding the genetic basis for selection of maize (Plenary paper presented at the Scientific Session of the Maize Research Institute – 14. IX. 2004) (Bg).

Genova I, 1991. Breeding for improvement of synthetic maize populations and efficiency of the selection. I. Results of the first cycle of recurrent selection in the synthetics “SSS-1” and “L-2”. Genetics and Breeding, 24, 6, 402-408 (Bg).

Hallauer AR, 1991. Use genetic variation for breeding populations in cross-pollinated species, Symposium Plant breeding 1990-s, North Carolina State University, Raleigh, 10-14 march, 1-4.

Hull FH, 1945. Recurrent selection for specific combining ability in corn, Journal American Society Agronomy, 37, 134-145.

Novoselov CH, 2008. Reciprocal recurrent selection: theoretical basis and practical use (sweet corn in question), Krasnodar, Thesis for PhD (Ru).

Russell WA, 1992. Evaluation of a modified reciprocal recurrent selection procedure for maize improvement. Maydica, 37, l, 61 -68.

Russell WA, Eberhart SA, Urbana AV, 1973. Recurrent selection for specific combining ability for yield in two maize populations. Corp Conclusion Science, 13, 257-261.

Smith OS, 1983. Evaluation of Recurrent Selection in BSSS, BSCB1 and BS13 Maize Populations. Crop Science, 23, January February, 35- 40.

Suprunov AI and Chuprina MA, 2010. Recurrent selection in maize populations, Book: 68.35.29, Krasnodar, (Ru)