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Use of recurrent selection of early flowering in late maize synthetic population. Results of second cycle of breeding

N. Petrovska*, V. Valkova

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Abstract. During the period 2012 – 2014, a second cycle of recurrent selection of early flowering in a synthetic maize population “Exotic-07” was conducted and finished on the experimental field of Maize Research Institute – Knezha. The experiments are carried out by a block method, on a test plot of 10 m², with three replications, and the respective for the region agricultural equipment. Twenty-three progeny from the first and second cycle, the source and improved exotic maize populations, as well as their testcrosses with the lines XM 4416 and PAU 1617 are tested. A phenotypic cycle assumes a leading position in terms of dates of plant silking as the forms of the earliest flowering are used as pollen in the population. The selected early flowering forms are sown for inbreeding and forming an improved maize population. As a direct result of the work of improvement, progeny with a period of days until silking averagely shorter with 5 days and grain moisture lowered by 1.1% are obtained. The aim of this study is to point out inbred lines with a shorter vegetative period and use them as parental forms for obtaining high-yielding mid-late maize hybrids.

Keywords: synthetic maize population, recurrent selection, days till silking

Introduction

According to a number of researches, the exotic populations of the late maturity group are more adaptive to various agroclimatic conditions and the hybrids obtained by such populations follow the tendencies of early maturation and a vegetative period that is a few days shorter than the parental forms. The inclusion of late synthetics in programs of recurrent selection for shortening the vegetative period allows the creation of earlier materials which carry the favourable of the late populations in terms of productivity (Hallauer, 1972, 1991; Troyer and Larkins, 1985; Vales, 2001; Suprunov et al., 2013).

After a phenotypic cycle of early flowering is conducted, donors of early maturity and a change of the continuation of the separate stages of maize development are obtained (Lemeshtenko and Suprunov, 2012). Synthetics from the collection of the State University – Iowa are introduced and multiplied in the Maize Research Institute, Knezha, after which they are included in various breeding programs (Genova, 1988). Later Petrov (1997) establishes a good plasticity of exotic populations from CIMMYT under the conditions of Central North Bulgaria. The direct use of synthetic populations is inadvisable due to their relatively low productivity, but as a source material, they prove to be one of the most valuable sources. On the one hand, they constitute stable ecosystems of higher plasticity in terms of mutable and stressful conditions. On the other hand, their wide genetic bases and high genetic variability allow an effective cycle in terms of properties and indices (Mitev, 1995, 1998).

The current study shows the results of a second cycle of breeding of a recurrent selection of early maturity in a late exotic maize population, with the aim of pointing out inbred lines with a shorter vegetative period and using them as parental forms for obtaining high-yielding mid-late hybrids.

Material and methods

A late synthetic maize population “Exotic-07”, group by FAO above 600, has been included in the research. The line was created in 2007 and encompasses 11 inbred lines of exotic origin that have been selected after an analysis of yield stability of testcrosses in the source population Exotic was conducted. The level of stability has been defined by means of an index of stability – Y by Kang (1993) and it is an object of study of a previous publication (Dimova et al., 2014). The data on the origin, productivity, improved selection and testing of the source population, that have been used for the current study, are an object of a previous study as well (Genov et al., 2006).

Synthetic, E-07* – Cm, Cc, and Cc*, source and improved maize populations, obtained by the method of recurrent selection of an early flowering by Hayes and Garber (1919) were included in a research during 2012 – 2014. In 2012, 2400 plants were sown in terms of higher for the maturity group density (8 000 plants/ha). Thirty-five of the earliest flowering plants were pollinated with mixed pollen. The progeny of twenty-one of them were selected in the next year by the ear-row method for a new cycle and a chain re-pollination. In 2014 on an experimental field in the Maize Research Institute, Knezha, twenty-three progeny from the first and second cycle, source and improved exotic maize populations were tested by a block method, on a test plot of 10 m², with three replications. Parallel to the testing, thirty plants from the stock of the selected early flowering forms were sown for inbreeding.

A phenotypic cycle assumes a leading position in terms of dates of plant silking as the forms of the earliest flowering are used as pollen in the population. The date of the silking is defined by the emergence of silk of 75% of the plants in the replications and the grain moisture at harvest is calculated by an electronic hygrometer.

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Results and discussion

Table 1 shows results of testing the improved maize population compared to the source population and the first cycle of recurrent selection. The period growing-silking has been defined as the days until the flowering of the reproductive organs is an index of high inheritability and is directly linked to the length of the vegetative period.

Thus, it becomes evident that the progeny of the improved population have a shorter vegetative period and lower grain moisture at harvest. Sixteen of the progeny have a period of growing-silking from 52 to 55 days and the grain moisture is from 14 to 15.3%.

As a result of the recurrent selection of early flowering, the progeny in the new population tend to silk within a period shorter by 5 days on average than the source population and the grain moisture is lowered by 1.1%. In some progeny the period until silking was defined to be 52 days and grain moisture – lowered to 14.0%. In the source population some of the variants reach a period of growing-silking of 71-72 days and the grain moisture is shown to be 29.2%. The best results are displayed by the variants E2-14, E2-19, E2-9, E2-1 and E2-7 from a second cycle of breeding and their grain moisture at harvest is 14.0 to 14.9%, respectively, and the period until silking – 55 days. Lines from the stock of these three progeny were selected for inbreeding, recurrent selection and testing. They can be used as donors of early maturity and drought-resistance in other selection programs in this direction as they carry the favourable alleles for productivity of late maize, while they follow tendencies of early maturity and shortening of the vegetative period. Furthermore, for the aims of practical selection the obtained inbred lines are valuable material for direct heterosis work and their use as parental components in forming mid-late maize hybrids with a high tempo of giving off grain moisture at harvest is recommended.

Figure 1 graphically represents the results of the testing of the source and improved synthetic population in terms of vegetative period and grain moisture at harvest. Drawing upon such an outcome, their stock will be used for forming a new cycle of breeding. The index of variation (CV%) in terms of vegetative period in the improved maize population is almost preserved within the same boundaries, at the expense of the highly lowered variability of the grain moisture index.

The low grain moisture that has been pointed out by the testing of the improved population, its lowering as well as the short vegetative period show that the inclusion of late synthetics into programs of recurrent selection of early flowering leads to a shortening of the vegetative period and subsequent lowering of grain moisture. The results confirm the previous researches of the two-sided improvement of the synthetic population in a breeding of early flowering.

Table 1. Results from testing of improved maize population year 2014

<table>
<thead>
<tr>
<th>Self-pollinated progenies of synthetic E07-C1</th>
<th>Vegetation period (days till silking)</th>
<th>Moisture E07-C1 (%)</th>
<th>Self-pollinated progenies of synthetic E07-C2</th>
<th>Vegetation period (days till silking)</th>
<th>Moisture E07-C2 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 1/1</td>
<td>67</td>
<td>19.5</td>
<td>E2/1</td>
<td>55</td>
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<td>E 1/4</td>
<td>69</td>
<td>19.6</td>
<td>E2/2</td>
<td>53</td>
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<td>19.4</td>
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<td>15.4</td>
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<tr>
<td>Mean</td>
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<td>19.45</td>
<td>-</td>
<td>55</td>
<td>16.2</td>
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</table>

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maturity as a result of which the grain moisture at harvest is lowered as well (Petrov, 2005, 2005a).

The opportunities of combining low grain moisture at harvest and drought-resistance have been researched by other breeders (Ignatiev, 2011). The lowering of the plant height and the lower sowing of the first ear in the improved populations, compared to the source populations may serve as marker indices in the phenotypic cycle but they need to be further and more thoroughly studied.

In 2013 lines from the second cycle of breeding were sown on an isolated filed with two inbred lines XM 4416 and PAU 1617 for testing. The testcrosses were tested in 2014 for grain yield, length of vegetative period, moisture content and combining ability, after which the progress of the recurrent selection will be evaluated.

**Conclusion**

The recurrent selection of an early flowering is an effective selection method for shortening the vegetative period in late exotic populations. The purposeful selection of early maturity leads to lowering the grain moisture content at harvest in the obtained progeny. As a direct result of the work of improvement, progeny with a period of days until silking shorter by 5 days on average and grain moisture lowered by 1.1% were obtained. They form a new improved maize population which sets out to continue the selection of improvement.

**References**


Hallauer AR and Sears JH, 1972. Integrating exotic germplasm into
corn belt maize breeding programs. Crop Science, 12, 203-206.


Ignatiev AS, 2011. Evaluation of new source material in creating mid-early and mid-late maize hybrids with an intensive type of giving off grain moisture. Thesis for PhD, Russia, Zernograd, GNU “I.G. Kalinenko” (Ru).


Lemeshtenko RA and Suprunov AI, 2012. Study of the new inbred maize lines of the central area of the Krasnodar territory. Corn and sorghum, 2, 7-10 (Ru).


Mitev P, 1998. Use of exotic germplasm to expand the genetic base of maize. Thesis for PhD, University Ruse (Bg).


Suprunov AI, Valerevich RL, Chistjakov SN and Pavlova NS, 2013. The creation of new source material for selection of early lines of maize. Corn and sorghum, 2, 6-10 (Ru).


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