THE SEED PRODUCTION OF EARLY MATURITY ZP MAIZE HYBRIDS
IN STUBBLE CROP SOWING

PROIZVODNJA SEMENA RANIH ZP HIBRIDA KUKURUZA U
POSTRNOJ SETVI

Dr. Milovan PAVLOV, Dr. Živorad VIDENOVIĆ, Zoran STANIŠIĆ, Dr. Dragica IVANOVIĆ
Maize Research Institute, Zemun Polje, Belgrade-Zemun
Institut za kukuruz "Zemun Polje", Beograd-Zemun

SUMMARY

A modern technological process of the maize seed production is developed in Serbia. This production is supported by favourable climatic and soil conditions, very skilled staff, contemporary processing plants and three laboratories that test seed according to international ISTA standards. A need for greater areas on which this production can be successfully organised occurs sometimes. Therefore, the Maize Research Institute, Zemun Polje, for the first time, organised the seed production of ZP maize hybrids of early maturity (FAO 200) in stubble crop sowing in the estate “Eliksir Agrar” in Prigrevica near Sombor in 2008.

The production of hybrids ZPTC 209 and ZPTC 260 was established on the area of 40 ha each. Climatic conditions in 2008 were satisfactory in relation to the temperature, but the precipitation distribution was unfavourable, hence six irrigations with the norm of 30 mm were applied. Total of 218 t of ZPTC 209 ears with 44% grain moisture and 203 t of ZPTC 260 ears with 42-44% grain moisture were harvested. Due to a very high grain moisture content the duration of drying was from 157 to 165 hours and energy consumption was greater by approximately 60-70% and twice as much time was used, than when maize is dried with the grain moisture content of 20-25%. The obtained average seed yield amounted to 2.1 t ha⁻¹ and 1.8 t ha⁻¹ in ZPTC 209 and ZPTC 260, respectively. The hybrid ZPTC 209 had 68% seed fractions of 6.5-8.4 mm and 32% fractions of 8.5-11.0 mm.

Key words: maize, stubble crop sowing, yield, hybrid maize, ZPTC 209, ZPTC 260.

INTRODUCTION

The maize seed production in Serbia has a 60-year long tradition. During this period a modern technological process of the maize seed production was developed; crop control was performed in the field by the authorised independent institutions; the process of drying, processing and packing was modernised; seed quality testing was carried out according to the international standards. The seed production in our country was strongly developed in the 1970s and 1980s and during this period a basis for participation of Serbia in the international seed trade was established. The seed production is supported by favourable climatic and soil conditions, as well as, very skilled staff. Many areas are under conditions of irrigation. Moreover, ten processing plants are equipped with contemporary devices, hence seed processing and packing meet the up-to-date market requirements.

Seed quality testing in Serbia dates from 1892 (Seed testing station was established in Topčider). The application of international rules for seed testing was initiated in 1931 when the first ISTA (International Seed Testing Association) Rules were issued. Today in Serbia, there are as many as 15 accredited laboratories out of which three were accredited by ISTA.

Due to all stated, Serbia is one of the greatest seed maize producers in south-eastern Europe. Thanks to this, almost all leading world seed companies organise the maize seed production in Serbia. A significant amount of this seed is exported (Sešaković et al. 2006). Such trend is favourable for our agriculture as it employs human and production resources and thereby significant capital goods are provided. Therefore, a need for a greater production areas than those on which a successful seed maize production can be organised occurs.

Considering all stated, in 2008, the Maize Research Institute, Zemun Polje, organised the seed production of the early maturity ZP maize hybrids (FAO 200) in stubble crop sowing in the agricultural estate “Eliksir agrar” in Prigrevica in the vicinity of Sombor. In such a way, additional possibilities are provided for increasing areas intended for the maize seed production. The authors of the present study estimated that such maize seed production technology deserved to be better analysed. Therefore, the objective of this study was to point out to the specificity of growing practices of early maturity maize hybrids in stubble crop sowing, as well...
as, to certain characteristics of drying, processing, levels of obtained yields and seed quality.

**MATERIAL AND METHOD**

The seed production of the hybrids ZPTC 209 and ZPTC 260 was established on 40 ha each. Soil was alluvial chernozem, a barley variety "Maskara" as a preceding crop was harvested in the period from June 22 to June 24, and obtained yield amounted to 6.8 t ha⁻¹. The harvest residues were chopped by a combine and ploughed down. Ploughing was performed from June 22 to June 24 with a Lemken three-furrow plough to the depth of 18-20 cm. The seed-bed preparation was done with a bededer conditioner on June 23 and 24. Prior to sowing, fertilising was done with a mixed mineral fertiliser N-8; P-16; K-24 in the amount of 300 kg ha⁻¹ and Urea (46%) in the amount of 200 kg ha⁻¹. In such a way, the following rates of nutrients were prepared: N-116 kg ha⁻¹, P2O5-48 kg ha⁻¹ and K2O-72 kg ha⁻¹.

The female component (♀) of the hybrid ZPTC 260 was sown on June 23, 24 and 26, while male (♂) inbred line was sown on June 29 and 30 and July 3. The female component (♀) of the hybrid ZPTC 209 was sown on June 28, 29 and 30, and male (♂) inbred line was sown on July 3 and 4. The sowing depth amounted to 4.5 cm. The sowing density of the female, i.e. male component was 65,000, i.e. 55,000 plants ha⁻¹, respectively. Sowing was performed with a six row Nodet sowing machine. The ratio of ♀ : ♂ rows was 4:2, hence the female component covered 66% of areas of both hybrids. Herbicides atrazine (1 l ha⁻¹) and Acetogal (2 l ha⁻¹) were applied after sowing but prior to emergence, while herbicides Motivel (1.25 l ha⁻¹) and Calisto (0.25 l ha⁻¹) were applied in the 5-6 leaf stage. The inter-row cultivation was done in the 4-5-leaf stage. This weed control system was successful.

The female component of the hybrid ZPTC 260, i.e. ZPTC 209 emerged from June 28 to June 30, i.e. on July 3, respectively. The male component of the hybrid ZPTC 260, i.e. ZPTC 209 emerged on July 4 and 5, i.e. July 10, respectively. Roughing (1-2% off-type plants) was done manually in the 6-8-leaf stage.

Detasseling of the female component of the hybrid ZPTC 260, i.e. ZPTC 209 started on August 11, i.e. August 20, respectively. The process lasted 10 days and was performed with a Castrix detasseler three times, and the control was carried out, and the remaining tassels and/or their parts were detasseled manually. The male component was mechanically removed 15 days after pollination, and the residues were left in the field as mulch.

The crop was six times irrigated by the sprinkler during the growing season. The first irrigation with 30 mm was applied immediately after sowing in order to provide moisture to the soil and to prevent the formation of the soil crust, so that emergence would not be disturbed. When drought occurred, each 7-10 days another five waterings with 30 mm were performed.

The hybrid ZPTC 209, i.e. ZPTC 260, was harvested with the Burgoin maize picker form November 3 to November 5, i.e. from October 24 to November 3, respectively. Maize husk was still green and with a great extent of moisture, hence the picker performed the harvest with more husk than it is common. Furthermore, husker shredders in a drying plant were not able to perform complete husking, hence it was necessary to carry out this process manually. To a certain extent this can be considered a favourableness as kernels covered with husk are less prone to damages during transport, processing and drying. On the other hand, attention has to be paid to drying, which has to be done immediately, because a longer accumulation of ears in piles leads to the temperature increase that results in the germination reduction.

The ear drying regime was as follows: so-called indirect drying at 30°C was carried out for 30 h, then air at 42°C was blown in from the bottom side of the bin for 70 h and from the upper side of the bin for 57-65 h. In such a way, drying of the whole amount of ears in bin was provided. Seed drying and processing was performed at the processing plant of the Maize Research Institute, Zemun Polje (442 t - 85% of the total amount), and in the processing plant in Ruma (76 t - 15% of the total amount).

Seed quality testing was done at the Seed Testing Laboratory of the Maize Research Institute, Zemun Polje, by the application of standard ISTA (2008) methods.

**Agrometeorological conditions during 2008**

The basic agrometeorological parameters, precipitation and temperature, during 2008 and their long-term mean in the region in which the production of seed maize in stubble crop sowing was done are presented in Tables 1 and 2.

Table 1. Precipitation sum (mm) and average daily air temperatures in 2008 and a long-term mean X in the agricultural estate "Eliksir agrar" in Prigrevica

<table>
<thead>
<tr>
<th>Pokazatelji Parameters</th>
<th>Period Period</th>
<th>Meseci / Months</th>
<th>Ukupni Total</th>
<th>Prosek Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Padavine (mm) Precipitation</td>
<td>2008</td>
<td>44,0  13,0  91,2</td>
<td>90,0 65,0  86,4</td>
<td>27,4 417,0</td>
</tr>
<tr>
<td>Temp.vazduha (°C) Air temp.</td>
<td>2008</td>
<td>48,8  56,5  79,4</td>
<td>71,4  60,5  57,5</td>
<td>31,2 407,3</td>
</tr>
<tr>
<td>Meseci / Months</td>
<td>VII</td>
<td>VIII</td>
<td>IX</td>
<td>X</td>
</tr>
<tr>
<td>I</td>
<td>II</td>
<td>III</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>13,1</td>
<td>10,5</td>
<td>66,4</td>
<td>7,2</td>
<td>0,0</td>
</tr>
<tr>
<td>22,7</td>
<td>22,0</td>
<td>20,4</td>
<td>22,7</td>
<td>22,7</td>
</tr>
</tbody>
</table>

According to presented data (Tables 1and 2) it is observable that the precipitation sum for the April-October period in 2008 was insignificantly higher than the long-term mean (by only 9.7 mm). Based on this it can be concluded that the conditions for the seed maize production were favourable. However, data in Table 2 indicate to the precipitation deficiency during the first two decades of July (with participation sum of 13.1 mm and 10.5 mm), then during the first two decades of August (7.2 mm and 0.0 mm) and also during the first decade of September (4.0 mm). Besides, temperatures were high in the stated periods and therefore evapotranspiration was increased. It means that plants used more water, and that moisture was lost by evaporation. Therefore, the irrigation was performed so that rapid emergence could have been disturbed. When drought occurred, each 7-10 days another five waterings with 30 mm were performed.
be provided, as well as, sufficient moisture for the vegetative and generative development of plants. When there is a lack of water, sterile maize inbreds are very susceptible (Urs et al. 2002).

In case of our study it can be emphasised that the temperature sum and relative air humidity were not limiting factors for the seed maize production in stubble crop sowing, hence pollination was satisfactory. Somewhat lower temperatures during the second and the third decade of September decelerated the maize seed maturation and harvest was carried out at the end of October and the beginning of November according to weather forecasting. The absence of early Autumn frosts that usually occur in the third decade of October and significantly affect the reduction in seed germination, was the considerable favourableness during the investigation year.

RESULTS AND DISCUSSION

Table 3 shows that 218 t maize ears of the hybrid ZPTC 209 with 44% grain moisture were harvested from 40 ha and that 203 t maize ears of the hybrid ZPTC 260 with 42-44% were harvested from also 40 ha. The participation of husk amounted to 18.0% and 19.4% in the hybrids ZPTC 209 and ZPTC 260, respectively. It is almost double in comparison with hybrids sown in April. The maize seed is physiologically mature in this stage (Pavlov et al. 2005). Due to a very high moisture content, grain drying lasted 157, i.e. 165 hours in ZPTC 209, i.e. ZPTC 260, respectively. The duration of this period was 6-7 days, what is an important data for drying of maize seed with such a high moisture content. Due to the stated, the consumption of energy and time was higher by 50-60% and 100%, respectively in comparison with maize seed with 20-25% moisture content. This is a very important data for such a method of maize seed production. The production conditions in stubble crop sowing are to a certain extent stressful, Duvick (2005).

Table 3. ZP maize hybrids seed yield (t) in stubble crop sowing in the agricultural estate "Eliksir agrar" in Prigrevica in 2008

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Sa kom.</th>
<th>With husk</th>
<th>Seed weight (%)</th>
<th>Moisture content</th>
<th>Količina prim. do- rad. semena (t)</th>
<th>Quantity of primarily processed seed</th>
<th>Frakcija semena Seed fraction</th>
<th>Viability</th>
<th>Germination viability</th>
<th>Germination</th>
<th>Klijavost (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPTC 209</td>
<td>252</td>
<td>203</td>
<td>42-44</td>
<td>165</td>
<td>74</td>
<td>1.8</td>
<td>43</td>
<td>58</td>
<td>31</td>
<td>42</td>
<td>95</td>
</tr>
<tr>
<td>ZPTC 260</td>
<td>266</td>
<td>218</td>
<td>44</td>
<td>157</td>
<td>85</td>
<td>2.1</td>
<td>58</td>
<td>68</td>
<td>27</td>
<td>32</td>
<td>91</td>
</tr>
<tr>
<td>Ukupno (t)</td>
<td>518</td>
<td>421</td>
<td>81</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>94</td>
</tr>
</tbody>
</table>

CONCLUSION

Based on presented data on the seed production of early ZP maize hybrids (FAO 200), in stubble crop sowing in 2008, the following conclusions can be drawn:

- Climatic conditions in 2008 were satisfactory in regard to temperatures, but the precipitation distribution was unfavourable, hence six irrigations of 30 mm each were performed, and a total of 180 mm water was applied.

- Total of 218 t of ZPTC 209 ears with 44% grain moisture and 203 t of ZPTC 260 ears with 42-44% grain moisture were harvested from 40 ha each. Due to a very high grain moisture content the duration of drying was from 157 hours in ZPTC 209 to 165 hours in ZPTC 260 and energy consumption was greater by approximately 50-60% and twice as much time was used than when maize was dried with the grain moisture content of 20-25%.

- The average seed yield obtained in the hybrid ZPTC 209, i.e. ZPTC 260 was 2.1 t ha⁻¹, i.e. 1.8 t ha⁻¹, respectively. The hybrid ZPTC 209 had 68% seed fractions of 6.5-8.4 mm and 32% frac-
tions of 8.5-11.0 mm. The corresponding values for the hybrid ZPTC 260 were 58% and 42%. Hybrids under such conditions had a somewhat greater percent of a small seed fraction in comparison with the production performed in April.

Seed germination and viability of the 6.5-8.4-mm, i.e. 8.5-11.0-mm fraction of the hybrid ZPTC 209 were 91%, i.e. 92%, respectively. The corresponding values for the hybrid ZPTC 260 were 95% and 94%.

According to obtained results it can be stated that stubble crop sowing of early maturity seed maize hybrids can be organised, but the irrigation is compulsory. This production needs a longer drying period (6-7 days) and maize seed quality is somewhat lower (by 3-5%) in relation to hybrids sown in April. This production will be significantly more successful if it is established up to the mid of June.

LITERATURE
