

THE BEHAVIOUR OF SOME LATE CORN HYBRIDS UNDER THE PEDO-CLIMATIC CONDITIONS OF THE CRISURILOR RIVER PLAIN

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Summary. The paper presents the results of a study related to the behaviour of late and half-late corn (*Zea mays*) hybrids in field trials on the Crisuri River Plain, 1998–2001. The hybrids Olt (half late, FAO 400–500), Opal (half late FAO 400–500), and F376 (late FAO 500–600) were compared with the three way hybrid Turda Super (half early FAO 200–300). Under a drastic drought during the year 2000, all hybrids presented a significant reduction in yield. The hybrids in the FAO group 400–500 showed a significant increase in yield (15–25%) compared with the Turda Super as control. So, the hybrids are recommended in the conditions of the Crisuri River Plain.

Key words: behavior, climatic indices, correlation, corn, hybrids, yields

Abbreviation: q/ha – quintal per hectare, ICD – Domuta Climatic Index, IDM – Martonne Aridity Index

Introduction

The Crisuri Plain is an integral part of the Western Plain and it is characterized by favorable conditions for the corn crop (Balteanu, 1979).

From a thermal point of view, the area has a high potential, the annual total of the temperatures (higher than 10°C) is 3400–3500°C. The quantities of precipitation during the year vary from 500 to 700 mm.

A problem that frequently appears on the brown luvisc soil in this area is the preservation of water reserves at optimal values. Thus, the excess of humidity is followed by a deficit, especially in July and August.

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The lack of water in soil, during the critical periods of corn growth and development may have negative effects upon corn yield.

Some experiences regarding the behaviour of some hybrids belonging to different classes of precociousness have been made at Oradea since 1964. The experiments made by Pipie and Banciu in 1964–1968 show that the semi-late and late hybrids have realised on average 54.4 q/ha and they haven't been exceeded by any other hybrid under the conditions found in Oradea.

The aim of the experiment was to test the adaptability of the later hybrids in comparison with a precocious hybrid representative for the studied area and to make evident the correlations among yields and the main climatic elements.

Materials and Methods

The research took place in an experimental field belonging to the Agricultural and Development Research Station from Oradea, in 1998–2001, on a brown luvic soil. The research station is placed in the Crisurilor River Plain and is representative for this area.

The brown luvic soils are characterised by alluvial processes of clay from the superior layers and their iluviation to a depth of 40–60 cm. At this depth, soil has a high bulk density and reduced hydraulic conductivity. As a result, the phenomena of temporary excess of humidity are very frequent during the cold and beginning of the spring period (Ciobanu, 1996).

The experimental material was made of 4 hybrids belonging to different FAO classes of maturity.

- Turda Super – a double, semi-early hybrid from FAO 200–300 group
- Olt and Opal – simple, semi-late hybrids from FAO 400–500 group
- F376 – a simple, late hybrid from FAO 500–600 group

During the vegetation period, the following biometric parameters were studied: the total height of the plant, the insertion height of the corn cob, the grain percent, prematurely dried leaves, sterile plants, broken plants and the mass of 1000 grains.

The basic criterion for hybrid evaluation was that of the yield differences between later hybrids and precocious hybrids distributed in a certain area.

The processing of information was made through the analysis of some series of monofactorial experiments with annual plants on a longer period of time (some years) and through the settling of correlations between the hybrid yield and some climatic elements represented by the dryness index of Martone (IDM) and climatic index of Domuta (ICD) in Table 1.

Martone aridity index (IDM) was calculated according to the formula:

$$IDM = 12P/(t+10),$$

Table 1. Characterization of climate during the corn vegetation period using climatic indices.

Year	IV	V	VI	VII	VIII	IX	IV-VII	V-VIII
Aridity index Martone(IDM)								
1998	34.9	28.9	36.9	83.9	13.1	65.1	43.8	40.7
1999	36.2	40.5	30.8	28.3	41.3	15.1	32.0	35.2
2000	29.0	12.0	12.5	21.4	1.6	8.2	14.2	12.0
2001	58.9	7.7	78.3	25.4	22.2	76.5	44.8	23.4
Domuta climatic index(ICD)								
1998	14.46	10.51	11.72	24.76	4.60	23.61	13.21	12.90
1999	13.73	12.94	10.15	8.81	12.62	5.88	11.65	11.13
2000	10.79	4.18	1.91	7.19	1.24	4.16	5.06	3.63
2001	19.48	2.10	23.68	8.17	7.36	28.78	12.16	10.32

where, P = precipitation, mm; t = average temperature °C.

The interpretation limits for IDM are: 15–24 semidry; 24.1–30 moderately dry; 30.1–35 moderately humid I; 35.1–40 moderately humid II; 40.1–50 humid; 50.1–60 very humid; 60.1–187 excessively humid.

Domuta climatic index (ICD) was calculated according to the formula:

$$ICD = (100W + 12.9A) / (\Sigma t + D.ss),$$

where: W = water (precipitation, irrigation), mm; A = air humidity, %; Σt = temperature total, °C; D.ss = shining period of the sun, hours.

Interpretation limits for ICD are: <3 = excessively dry; 3.1–5 = very dry; 5.1–7 = dry; 7.1–9 = middle dry; 9.1–12 = middle humid; 12.1–15 = humid I; 15.1–18 = humid II; 18.1–25 = humid III; >25 = excessively humid;

The climatic conditions during the experimental period were favorable for the corn crop, excepting year 2000, which was a very dry one. This year, there were recorded the lowest precipitation and the highest temperatures, especially during the critical periods for corn in May, June and August.

Results

Biometric Parameters of the Studied Hybrids

During the vegetative and harvesting period, some observations and measurements have been made upon corn plants, cobs and grains. Besides the yields obtained they allow a better evaluation of the studied hybrid behaviour. For a better comparison,

the data are presented as the mean for the 4 years of the experimental period 1998–2001 (Table 2).

The total height, the highest being 220 cm, was recorded by the plants of the Olt hybrid, being followed by Opal's with 210 cm, F376's with 190 cm and Turda Super's with 175 cm. The insertion height of the cob is positively correlated with the total height of plants (79–74–63–54 cm).

The highest grain percent (82.4%) was obtained for the F376 hybrid, being closely followed by the other hybrids. F376 hybrid, being the latest, had the highest humidity during harvesting (28.3%) while the Turda Super hybrid, which matured earlier, had a grain humidity during harvesting of only 25.5%. Olt and Opal hybrids had humidity close to that of the F376 hybrid.

Taking into account all the 4 years, observations such as: the ratio of prematurely dry plants (PDP), of sterile plants (PS) and broken plants Olt and F376 hybrids were resistant while Opal and Turda Super had a more reduced resistance.

The reduced level of soil water supply, in 2000, delayed the process of springing a lot. The temperatures of over 35°C in July and August, associated with an extremely reduced relative humidity and with a marked soil drought determined the sterility of many corn plants. These phenomena determined very low yields for all the hybrids of that year.

Yields

The Average of the Experiment

The level of hybrid average yields recorded during the experimental period is shown in Table 3. It shows very clearly the superiority of later hybrids in comparison with the semi-early Turda Super hybrid.

Among the later hybrids, in comparison with Turda Super hybrid, the best yield of 96.5 q/ha was obtained for Olt hybrid, being followed by Opal's of 90.6 q/ha and by F376's of 88.3 q/ha; Turda Super's was of 77.1 q/ha. The yield differences of late hybrids in comparison with the semi-late ones are very significant, being on average 15 – 25% higher.

The significance of the variants-year's interaction is very significant for the Olt hybrid and significant for Opal and F376 hybrids. These differences highlight the very good behaviour of later hybrids, which under the conditions of the Crisurilor Rivers Plain, can give a very high production yield in comparison with earlier hybrids.

Annual Yields

The statistical analysis of the yield results highlights significant and very significant differences between later hybrids and early hybrid during the experiment period (Table 3).

In 1998, in the first year, the best yields and the biggest differences between later hybrids in comparison with Turda Super were obtained. Thus, for a production of

Table 2. Biometric parameters of the hybrids studied, Oradea, 1998-2001

No crt	Hybrid	Total height-cm		Grain percent	Humidity when harvesting, %	Prematurely dried plants(PUP)	Sterile plants(SP)	Broken plants(BP)	Mass of 1000 grains
		Total	Insertion height of the corn cob						
1	Turda Super	175	54	81.7	25.5	5.6	1.8	0.5	382
2	Olt	220	79	81.6	27.6	4.5	1.3	1.1	404
3	Opal	210	74	81.3	27.5	6.3	1.9	1.3	386
4	F376	190	63	82.4	28.3	2.4	1.2	0.1	440

Table 3. Yields of Corn Hybrids under the Conditions from Oradea, 1998-2001

No crt	Hybrid	The average of experiment						
		1998-2001, q/ha	Relative yield, %	1998	1999	2000	2001	
		Average yield	Relative yield	Average yield	Average yield	Average yield	Relative yield	
1	Turda Super	77.1	100	92.4	100	92.6	100	90.5
2	Olt	96.5	125	133.5	145	115.4	125	99.7
3	Opal	90.6	117	121.8	132	114.4	124	96.7
4	F376	88.3	115	115.1	125	108	117	88.3

133.5 q/ha (the best yield of the whole experiment for the Olt hybrid), we recorded a difference of 45% in comparison with a production of 42.4 q/ha for Turda Super hybrid. The other hybrids gave differences of 32% (Olt) and 25% (F376)

In 1999 the yield differences ranged between 17–25%, the best hybrid being Olt, which gave a production of 115.4 q/ha. For the Opal hybrid, we recorded an yield of 114.4 q/ha and for F376's of 108.0 q/ha. The yield of Turda Super hybrid (92.6 q/ha) was almost the same as that of the previous year.

In 2000. This year was less favorable for the corn crops due to the reduced precipitation during summer. The yields didn't exceed 40 q/ha. This year, late F376 hybrid showed the the best behaviour; its yield was of 38.4 q/ha, being followed by Olt with a yield of 37.5 q/ha. The differences, in comparison with Turda Super, have been very significant this year, too. Even if Olt hybrid had a good behaviour in the previous years, it proved to be the least resistant to drought in 2000, recording a great number of sterile or prematurely dried plants. Its yield of 29.5 q/ha was inferior even to the Turda Super hybrid.

In 2001. The yield differences of later hybrids were very significant for the Olt hybrid, significant for Opal and non-significant for F376. The best yield of 99.7 q/ha was recorded for Olt, being followed by Opal's of 96.7 q/ha, by Turda Super's of 90.5 q/ha, the least yield being of 88.3 q/ha for F376.

Correlations between Climatic Elements and Hybrid Yields

Correlations between Yields and Hybrids

The research done on a global level highlighted a direct relationship between the water consumption and yield.

In order to establish the correlations, the precipitation fallen from sowing till 15th of August was analyzed. According to the correlations presented in Fig. 1, Turda Super hybrid (a) is the most dependent on precipitation recorded during the period of sowing – 15th of August. In this case, the regression coefficient R^2 is statistically very significant in comparison with the other hybrids (b, c, d) which have distinctively significant coefficients.

Correlations between Climatic Indices and Yield

The mathematical expression of the relationship between climatic indicators and crop yields is provided differently according to the used indicator, crop, year's character (Domuta, 2000).

By including the vegetation factor along with precipitation and the temperature under the form of Martone aridity index (IDM), we can obtain better correlations in comparison with the *precipitation-yield* correlations, especially for late hybrids (Table 4).

The quantifying of more vegetation factors (precipitation, air humidity, temperature, sunshine hours) under the form of Domuta climatic index(ICD) determined the

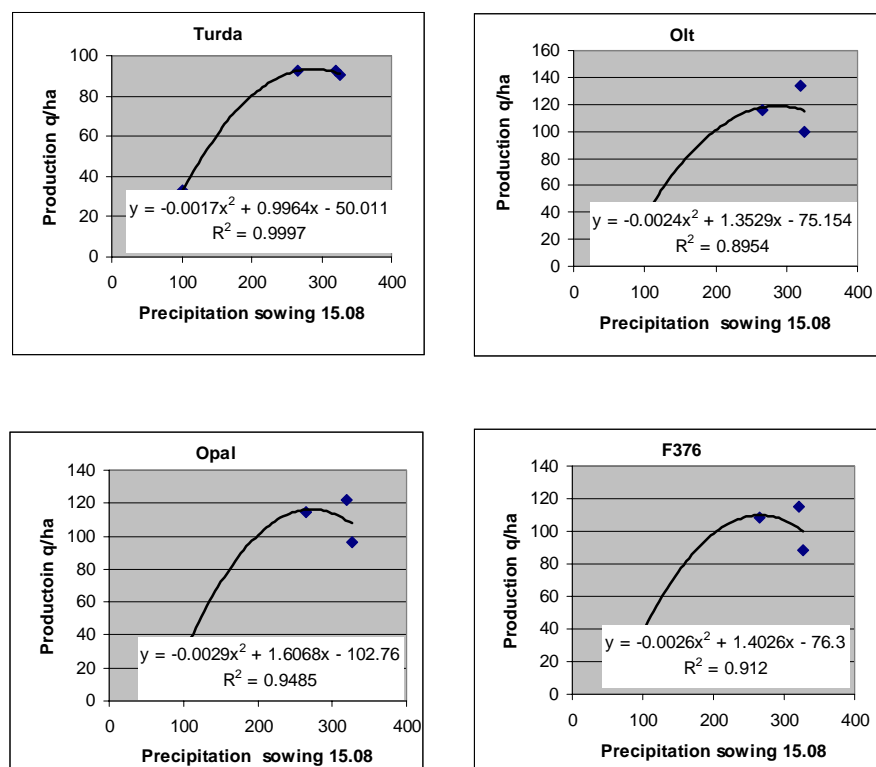


Fig. 1. Correlation between Precipitation Recorded during the Sowing Period 15.08 and the yield of Corn Hybrids

Table 4. Correlation between Climatic Indices and Yield

Nr.crt	Correlation	Regression function	Correlation coefficient
<i>Martonne aridity index (IDM) x hybrid yield</i>			
1	IDM x Turda Super	$Y = -0.1557x^2 + 10.124x - 64,965$	0.9765
2	IDM x Olt	$Y = 75.333 \ln(x) - 14653$	0.9756
3	IDM x Opal	$Y = -0.1402x^2 + 10,465x - 74.854$	0.9903
4	IDM x F376	$Y = -0.0907x^2 + 7.3772x - 36.484$	0.9962
<i>Domuta climatic index (ICD) x hybrid yield</i>			
1	IDM x Turda Super	$Y = -0.8549x^2 + 20.546x - 30.39$	0,9986
2	IDM x Olt	$Y = 10.399x^{0.9897}$	0.9965
3	IDM x Opal	$Y = 6.7249x^{1.1493}$	0.9953
4	IDM x F376	$Y = 12.482x^{0.8685}$	0.9879

achievement of some better coefficients not only in the case of correlations with precipitation but also with IDM (Table 4).

Discussions

Under the conditions of the Crisurilor Rivers Plain, the corn crop finds favorable conditions for growth and development. But due to the high temperatures during July and August and to the reduced precipitation associated with the reduced humidity of the air determine reduced yields for the unsuitable hybrids.

Among the hybrids most suitable for this area is the semi-early Turda Super hybrid (FAO 200–300), which, due to its more reduced vegetation period reaches the maturity stage before the critical period from July – August. During the experiment period (1998–2001), the average mean of this hybrid was of 77.1 q/ha; in the favorable years it was 92.6 q/ha (1999) and in 2000, it was just of 32.9 q/ha.

In order to increase the yield per ha in this area, it is necessary to introduce into the crop some hybrids with a higher productive potential, such as the late hybrids. The late hybrids tested in this experiment (Olt, Opal and F376) gave very significant yield differences in comparison with Turda Super hybrid. On an average in the 4 years and on each year, the best hybrid was Olt. The maximum yield of 133.5 q/ha was realized in 1998 and the minimum of 37.5 q/ha in 2000 with an average mean of 96.5 q/ha for the whole period of testing. Even if the Opal hybrid has a productive potential very close to Olt's, under the stress conditions of year 2000 gave very reduced yields. The average production of the experimental period was 90.6 q/ha.

F376 hybrid generally gave lower yields in comparison with Olt or Opal, but at the level of year 2000, under the conditions of drought, resisted very well. The average yield of the testing period was 88.3q/ha.

The correlations established among hybrid yields and climatic elements made evident a close dependence of Turda Super hybrid on precipitation.

The late hybrids are best correlated with the climatic indices which include besides precipitation many other factors (temperature, air humidity, sunshine hours) under the form of Martone index (precipitation, temperatures) or Domuta climatic index (with all the factors); the last one recording the best correlation coefficients.

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