

Behavior and variability of some morphological attributes and production at a set of sweet corn hybrids

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Abstract Lately, Romanian farmers pay special attention to sweet corn cultures, both for fresh consumption and for industrialization. Based on these considerations, we have set up an experiment with seven hybrids of sweet corn in two locations in the Transylvanian Plain. Adaptability and stability of production and morphological components of production are major requirements for new sweet corn hybrids. Main morphological components analyzed were height of insertion of the first, corn cob length, weight and diameter of the corn cob. Height of insertion of first cob is very important because it represents an important parameter for mechanized harvesting. In this respect a major importance is the uniformity of corn cobs insertion height. Differences between averages of the seven hybrids in the two years regarding cob insertion height reflect the visible influence of the environment in expressing this important technical skill. Thus, in all the hybrids studied in 2016, the average of this attribute records values much higher than those of 2017. Delicios hybrid is obtained the lowest values of variation coefficient in the two years, indirectly suggesting the important heritability of this attribute to this hybrid and a relatively high uniformity of corn cob insertion.

Key words

sweet corn, cultivar, production, cob, variance

Sweet corn is an independent form (var. saccharata) within the manifold form group of corn (1). As regards biology of flowers, morphology and physiology it has equal characteristics as field corn and the requirements on climate and soil are principally similar (14). Corn cobs and corn grains are used, fresh, boiled, frozen or preserved (2). When the reserve material is deposited in nutritive tissue, sugars are produced in the first step and then are transformed into starch. The sweet corn or sugary gene (su1) slows down this process (10), sugar production continues, the content of sugar increases as a consequence of the slow transformation into starch, and thus the milky kernel has a distinctly sweet flavour (6). Sugar maize having the "SU" endosperm determined by chromosome 4 allele "su" is grown in South and Central America since Pre-Columbian period (7).

Area in which sweet corn had a real expansion is northeastern part of USA, whereupon the first bibliographic records appear since the beginning of eighteenth century (4). Simultaneously with improving and obtaining inbred maize lines, sweet corn amelioration works have also taken place, which shows the importance of sweet corn for American continent. (9).

In Europe, sweet corn was a relatively small economic crop at the beginning of 20th century, only after the Second World War came to the attention of researchers (5). Main concerns of Western European breeders have been channeled into increasing adaptability of sweet corn hybrids to an oceanic climate (13), but also their adaptation to areas with a less favorable climate for corn crops, cold spring areas (3).

There are complex relationships of interdependence and integration between environmental factors and plants as well as among the factors themselves (15), because they do not all share same frequency and area of action, same intensity, quality and duration, so it is difficult to determine the specific action of each; their action can compensate or conjugate (synergistic action) in achieving maximum biological productivity (8).

In recent years, Romanian farmers pay special attention to sweet corn cultures, both for fresh consumption and for industrialization (12). Adaptability and stability of production and some morphological components of production are major requirements for new sweet corn hybrids (11).

Material and Method

In order to achieve the proposed objectives regarding behavior of some sweet corn hybrids in Transylvanian Plain, experience was placed in two locations, Tuda and Vișoara. Seven sweet corn hybrids were tested, of which six natives (Prima, Estival, Deliciul Verii, Dulcin, Delicios, Estival M) and a foreign one (Jubilee). Experiences were conducted during the years 2016 and 2017.

Main morphoproductive and morphological characters that have been studied at seven sweet corn hybrids are represented by:

- cob length;
- corn cob weight;
- corn cob diameter;
- insertion height.

Data were processed using the polyfactorial program and for the variability analysis the standard formulas of variability parameters were used.

Results and Discussions

Morpho-productive characters

Sweet corn cob length

Of the three analyzed factors, it seems that the hybrid has greatest influence upon cob length and also records variance highest values. In fact, from "F" sample values corresponding to the three factors, only those of the hybrids are statistically assured as very significant. The values of "F" sample are also statistically assured in the case of simple interactions between the three factors (except the interaction A x L) and also in the triple interaction (Table 1).

Table 1

Variance analysis of sweet corn cob length (cm) (Turda and Vișoara 2016, 2017)

No.	Variance source	Sum of squares SSQ	Degrees of freedom GL	Average square S ²	Probe F
1.	Year (A)	1.01	1	1.01	3.22
2.	Localities (L)	3.59	1	3.59	4.93
3.	A x L	1.24	1	1.24	1.70
4.	Genotype (G)	279.99	6	46.60	141.90***
5.	A x G	4.40	6	0.73	2.24*
6.	L x G	13.21	6	2.20	6.70***
7.	A x L x G	7.61	6	1.27	3.86***
8.	Error A	0.62	2	0.31	-
9.	Error L	2.91	4	0.73	-
10.	Error G	15.76	48	0.33	-
	TOTAL	330.35	81	58.02	-

Of the seven largest hybrids, in terms of corn cob length with very significant differences compared to witness (experience average), occur in the case of Estival M and Jubileu cultivars. Earliest hybrid, Prima

records the lowest performance of this agronomic feature of production, the differences to experience average being very significant negative, followed by the Estival hybrid (Table 2).

Table 2

Hybrids behavior regarding corn cob average length in the two years of experience and the two localities

No.	Hybrid	Cob length (cm)	Selective value (%)	Difference	Significance
	Average	19.55	100.0	0.00	-
1.	Prima	16.57	84.7	-2.98	000
2.	Estival	17.90	91.6	-1.65	000
3.	Deliciul Verii	18.83	96.4	0.71	00
4.	Dulcin	19.63	100.5	0.11	-
5.	Delicios	20.17	103.2	0.62	*
6.	Estival M	22.11	113.1	2.56	***
7.	Jubilee	21.60	110.5	2.05	***

LSD 5 % 0.47 LSD 1% 0.63 LSD 0.1% 1.82

Small differences between length average of sweet corn cobs corresponding to the seven hybrids in the two locations reflect high hybrids stability regarding this attribute (Table 3). Best results, in terms of cob

length, are recorded by Jubilee hybrid and simple hybrid Estival M, with very significant differences compared to experience average in both localities. Prima and Estival, two early hybrids, are at the

opposite pole, recording very significant negative, or only distinctly negative, differences in the two

localities.

Table 3

Sweet corn cob length without husks (cm) of sweet corn hybrids cultivated in Turda and Viisoara (2016, 2017)

No.	Hybrid	Cob length	Turda		Cob length	Viisoara	
			Difference	Significance		Difference	Significance
1	Average	19.34	0.00	-	19.75	0.00	-
2	Prima	16.43	-2.91	000	16.70	-3.05	000
3	Estival	17.10	-2.24	000	18.69	-1.06	00
4	Deliciul Verii	18.95	-0.39	-	18.72	1.04	00
5	Dulcin	19.77	0.43	-	19.54	0.21	-
6	Delicios	19.78	0.44	-	20.55	0.80	*
7	Estival M	21.43	2.09	***	22.79	3.04	***
8	Jubilee	21.93	2.59	***	21.28	1.52	***

LSD 5 % 0.67 LSD 1% 0.89 LSD 0.1% 1.16

Sweet corn cob weight without husks

Marketing of fresh cobs on the market is done with husks, but for industrialization they are interested in their weight without husks. To assess studied hybrids behavior on this important direct component of production, it was considered that the weight of sweet corn cobs without husks is much more eloquent.

Behavior of the seven hybrids regarding corn cob weight at technical maturity was analyzed.

Insignificant differences of year factor in expressing this production attribute are probably due to stability of this attribute at the genotype level. Interaction between year and locality, significantly influences sweet corn cob weight. Contribution of the genotype factor, reflected in very significant values of test "F", shows the important role of genetic factor and the lower involvement of environment in conditioning this attribute. (Table 4)

Table 4

Variance analysis of sweet corn cob weight (g) without husks from Turda and Viisoara (2016, 2017)

No.	Variance source	Sum of squares SSQ	Degrees of freedom GL	Average square S ²	Probe F
1.	Year (A)	1648.14	1	1648.14	2.00
2.	Localities (L)	426.24	1	426.24	0.62
3.	A x L	10758.53	1	10758.53	15.71**
4.	Genotype (G)	32328.37	6	5388.06	6.35***
5.	A x G	10955.14	6	1825.86	2.15
6.	L x G	3359.31	6	559.80	0.66
7.	A x L x G	5101.37	6	850.23	1.01
8.	Error A	1667.53	2	833.77	-
9.	Error L	2731.00	4	682.75	-
10.	Error G	40729.42	48	848.52	-
	TOTAL	109705.04	81	23821.98	-

Weakest results regarding corn cob weight were obtained at Prima hybrid, having the lowest values. Strong point of this hybrid is the short period in which it reaches technological maturity. Highest values

were obtained at Deliciul Verii and Estival M hybrids, even if the differences are not statistically ensured (Table 5).

Table 5

Hybrids behavior regarding average sweet corn cob weight (g) in two years and the two localities

No.	Hybrid	Cob weight (cm)	Selective value (%)	Difference	Significance
	Average	212.75	100.0	0.00	-
1.	Prima	172.20	80.9	-40.55	00
2.	Estival	220.07	103.4	7.32	-
3.	Deliciul Verii	234.59	110.3	21.84	-
4.	Dulcin	209.46	98.5	3.29	-
5.	Delicios	202.38	95.1	10.37	-
6.	Estival M	231.87	109.0	19.12	-
7.	Jubilee	218.68	102.8	5.93	-

LSD 5 % 23.90 DL 1% 31.92 DL 0.1% 41.65

If in case of sweet corn cob length the amplitudes of variation between the two localities have been reduced, the same can't be said about corn cob weight were fluctuation of values is more significant. Prima Hybrid

records again lowest values regarding corn cob weight. Best values were obtained at Deliciul Veri and Estival M (Table 6).

Table 6

Average weight (g) of sweet corn cob at the seven corn hybrids in the two localities

No.	Hybrid	Cob weight	Turda		Cob weight	Viisoara	
			Difference	Significance		Difference	Significance
1	Average	215.00	0.00	-	210.50	0.00	-
2	Prima	182.52	-32.48	-	161.88	-48.62	00
3	Estival	220.10	5.10	-	220.05	9.55	-
4	Deliciul Verii	229.51	14.51	-	239.67	29.18	-
5	Dulcin	208.03	-6.97	-	210.90	0.40	-
6	Delicios	197.09	17.92	-	207.67	-2.82	-
7	Estival M	242.00	26.99	-	221.74	11.24	-
8	Jubilee	225.78	10.77	-	211.57	1.08	-

LSD 5 % 33.80 LSD 5 % 33.80
 LSD 1% 45.14 LSD 1% 45.14
 LSD 0.1% 58.90 LSD 0.1% 58.90

Corn cob diameter

Climatic factors (year and localities) have not significantly influenced phenotypic expression, regarding this attribute. From obtained values, as well as the significance of the sample "F", it can be said that

this attribute is closely related to genotype. Variation of this attribute and therefore its oscillations are greatly influenced by the hybrid factor (very significant) (Table 7).

Table 7

Variance analysis of sweet corn cob diameter without husks from Turda and Viisoara (2016, 2017)

No.	Variance source	Sum of squares SSQ	Degrees of freedom GL	Average square S ²	Probe F
1.	Year (A)	0.41	1	0.41	2.46
2.	Localities (L)	0.18	1	0.18	0.85
3.	A x L	0.09	1	0.09	0.42
4.	Genotype (G)	4.64	6	0.77	4.18***
5.	A x G	1.75	6	0.29	1.58
6.	L x G	0.39	6	0.06	0.35
7.	A x L x G	1.89	6	0.31	1.71
8.	Error A	0.34	2	0.17	-
9.	Error L	0.84	4	0.21	-
10.	Error G	8.86	48	0.20	-
	TOTAL	19.39	81	2.69	-

Of the seven hybrids analyzed, in particular Estival hybrid stands out with 4.9 cm diameter of huskless corn cob. This value is statistically assured as distinctly significantly positive compared to experience average. Earliest hybrid, Prima achieves the lowest values regarding huskless corn cob diameter with significant

negative differences compared to experience average. Among other hybrids there are no statistically ensured differences in this regard. However, Deliciul Verii hybrid can be remembered with values exceeding the control by approximately 11% (Table 8).

Table 8

Hybrids behavior regarding corn cob diameter average in two years and two localities

No.	Hybrid	Cob diameter (cm)	Selective value (%)	Difference	Significance
	Average	4.43	100.0	0.00	-
1.	Prima	4.07	91.9	-0.36	0
2.	Estival	4.90	110.6	0.47	**
3.	Deliciul Verii	4.54	102.4	0.11	-
4.	Dulcin	4.36	98.3	0.07	-
5.	Delicios	4.43	99.9	-0.01	-
6.	Estival M	4.43	99.9	-0.00	-
7.	Jubilee	4.30	97.0	-0.13	-

LSD 5 % 0.35 LSD 1% 0.47 LSD 0.1% 0.61

Under the conditions in Turda, Estival hybrid has significant positive values, compared to experience average. In Viisoara, same hybrid is ranked first, even if the differences are not statistically ensured. Estival hybrid is followed Deliciul Verii hybrid. Reduced differences regarding sweet corn cob diameter in the

two locations at the level of studied material, indicates high stability of this attribute and good hybrids adaptability. Therefore we can say that fluctuations of this attribute are mainly due to genetic factor and less the environment (Table 9).

Table 9

Corn cob average diameter at studied corn hybrids in Turda and Viisoara (2016, 2017)

No.	Hybrid	Diameter	Turda		Diameter	Viisoara	
			Difference	Significance		Difference	Significance
1	Average	4.48	0.00	-	4.39	0.00	-
2	Prima	4.20	-0.28	-	3.95	-0.44	-
3	Estival	5.06	0.58	*	4.75	0.36	-
4	Deliciul Verii	4.56	0.08	-	4.52	0.13	-
5	Dulcin	4.34	-0.14	-	4.38	-0.01	-
6	Delicios	4.42	-0.06	-	4.44	0.05	-
7	Estival M	4.50	0.02	-	4.36	-0.03	-
8	Jubilee	4.28	-0.20	-	4.32	-0.07	-

DL 5 % 0.50

DL 1% 0.67

DL 0.1% 0.87

DL 5 % 0.50

DL 1% 0.67

DL 0.1% 0.87

An important technological attribute, which is especially important when sweet corn cob harvesting is carried out mechanically, is corn cob height of insertion and especially the uniformity of this attribute. Table 10 presents the stability parameters of this attribute in the two years in Turda.

Of the seven hybrids analyzed, two are trilinear and the others are simple hybrids. Comparing averages of the

seven hybrids in the two years, regarding corn cob height insertion, influence of the environment is visible in the expression of this important technical skill. Thus, at all hybrids in 2016, average of this attribute, records values much higher than those in 2017. Behavior of trilinear hybrid Estival and simple hybrid Estival (mother) is suggestive.

Table 10

Corn cob insertion height (cm) at sweet corn analyzed hybrids (Turda 2016, 2017)

Insertion height in Turda 2016							
Variance Parameters	Prima HS	Estival HT	Deliciul V HS	Dulcin HT	Delicious HS	Estival HS	Jubilee HS
Average	54	62	73	85	91	70	68
Standard deviation	7.74	11	9.71	9.23	9.18	8.53	6.72
Rank	37	45	35	39	53	36	30
Minimum	31	45	60	66	48	50	50
Maximum	68	90	95	105	101	86	80
CV %	14.45	17.77	13.37	10.83	10.09	12.27	9.86
Insertion height in Turda 2016							
Variance Parameters	Prima HS	Estival HT	Deliciul V HS	Dulcin HT	Delicious HS	Estival HS	Jubilee HS
Average	34	37	51	57	65	48	51
Standard deviation	5.36	6.80	5.49	8	6.54	6.02	6.39
Rank	22	23	22	25	26	25	27
Minimum	20	24	40	45	55	35	40
Maximum	42	47	62	70	81	60	67
CV %	15.78	18.22	10.68	14	9.93	12.67	12.42

At simple hybrids, C.V. (coefficient of variability) is well below the value of trilinear hybrid Estival. This is explained by greater uniformity of attributes of simple hybrids, because they are totally heterozygous, variation in the attributes that can occur to them is due only to the environment. Delicious hybrid is distinguished by the lowest values of C.V in the two years, indicating a good uniformity of corn cob insertion. Lowest values in the two-year were obtained at Estival hybrid.

Conclusions

Reduced differences in corn cob diameter in the two locations at the level of the studied material indicates high stability of this attribute and good adaptability of the hybrids.

Hybrids Deliciul Verii and Estival, are distinguished by higher weight of sweet corn cobs, compared to witnesses (experience average) in both locations.

Delicious hybrid is noted through the lowest C.V values in two years, indicating a good uniformity of corn cob insertion on stem.

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