

## VARIABILITY PARAMETERS OF SOME MORPHOLOGICAL ATTRIBUTES AND PRODUCTION OF SWEET CORN

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**Abstract.** Yield and its stability components are major requirements for new sweet corn hybrids. The emphasis on improving and increases of yield for sweet corn new hybrids is due to climate change in recent years. Biological material used in this stage was represented by seven sweet corn hybrids, of which six are Romanian and one foreign. Among the analyzed properties, the diameter of the cob has the lowest values regarding coefficient of variation, indicating genetic stability, a variation indicating the pronounced genetic stability of this characteristic and the high contribution of the genotype in the phenotypic expression of this characteristic. The simple hybrid Estival M has the lowest fluctuations in the coefficient of variability (CV%) from year to year of 3.77 and 3.93, respectively. Other characteristics that were analyzed were represented by: plant height, weight of the sweet corn cob, number of grains (berries)/cob and the length of the cobs.

**Keywords:** sweet corn, coefficient of variability (CV%), genotype, phenotype.

### INTRODUCTION

Due to increasing markets demand for sweet corn, its culture has expanded into areas that do not always meet eco-physiological parameters that are optimal for this crop. Corn is a thermophilic plant in excellence, and the expansion of this culture in areas with limited thermal resources (cold and wet spring), such as northern Romania and the hills of Transylvanian Plain, have forced creation of hybrids adapted to these conditions. Given the destination of sweet corn production, characters sought during the breeding process are much more numerous than common maize with normal grain. In the heredity of characters with quantitative determinism in corn, after Hansen et al. (1977), additive effects on plant height, cob insertion height, number of grain rows on cobs and additive effects with partial domination effects were important for cobs length (Kaukis and Davis, 1986, Tracy, 1994, Haș, 2000). Sweet corn having the "SU" endosperm determined by the chromosome 4 allele is grown in South and Central America from the pre-Columbian period (Goodman and Brown, 1988). There are complex relationships of interdependence and integration between environmental factors and plants as well as among the factors themselves (Lee and Tollenaar, 2007), 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 (Singh et al., 2014).

In recent years, Romanian farmers pay special attention to sweet corn cultures, both for fresh consumption and for industrialization. Adaptability and stability of production and some morphological components of production are major requirements for new sweet corn hybrids (Suba and Suba, 2018).

## MATERIALS AND METHODS

In order to achieve the proposed objectives regarding the behavior of sweet corn hybrids in terms of variability of morphological features and production in the Transylvanian Plain, a two-site experience was set up, Turda and Viișoara consisting of seven sweet corn hybrids, of which six native First, Estival, Deliciul Verii, Dulcin, Delicios, Estival M) and a foreign one (Jubilee). Experimental period covered the years 2016 and 2017. Estimating the variability of some production characters allows for identification of hybrids with the best performances in terms of these attributes and possibly also with pronounced stability. Such hybrids could be recommended for crops in areas less favorable to this important vegetable crop.

Quantitative characters that were followed are represented by:

- Plant height;
- Cob insertion height;
- Cob weight;
- Cob length;
- Cob diameter;

Data were statistically processed, and for the variability parameters, the standard formulas were used.

## RESULTS AND DISCUSSIONS

**Plant height variability.** Parameters regarding plant height variability in the two localities and the two years are presented in Tables 1 and 2. Plant height records significant oscillations both at the level of hybrids as well as in years and locations. Coefficients of variation values indicate a more even behavior at the seven hybrids under this aspect in Viișoara. Therefore, it can be said that besides genotype, an important role in expressing this attribute is also the pedoclimatic factor (localities). By comparing the maximum values in the two years and the two locations, it can be observed that all hybrids reacted more favorably in 2016 regarding plants vegetative growth. In the same sense, values of the coefficient of variation suggest the existence of low plant variability in hybrids and a good fixation at genetic level of this characteristic.

**Cob insertion height variability.** By comparing average values from seven studied hybrids, in two years, regarding cobs insertion height, environment influence is visible in expressing this important technical characteristic. Thus, at all studied hybrids, in location Turda in 2016, the average of this characteristic, is much higher than in 2017.

Behavior of the trilinear hybrid Estival and the simple Estival M hybrid (mother) is suggestive. In the simple hybrid, values of variance coefficient are well below the value recorded at the trilinear hybrid Estival. This is explained by the greater uniformity of attributes to simple hybrids, which are heterozygous for all alleles, their variation being due only to the environment (Table 3). Same trend is noted in the situation of this hybrid in Viișosara (Table 4). Delicios hybrid has the lowest values variation coefficient in the two years and in the two localities, with an exception in 2017 when it ranks second on lowest values of this indicator (Table 3 and 4). More important variations of this important technological characteristic, with major implications in the practice of a mechanized harvest with low losses, are recorded in locality Viișoara reflected in the values of coefficients of

variation and in the differences between minimum and maximum. Hybrids Delicios and Estival M stand out with a high stability.

Table 1

## Parameters of plant height variability (cm) TURDA

Plant height Turda 2016							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estival M	Jubilee
<b>Average</b>	<b>198.46</b>	<b>188.73</b>	<b>194.73</b>	<b>222.23</b>	<b>235.1</b>	<b>200.86</b>	<b>224.1</b>
<b>Standard deviation</b>	11.51	10.74	14.84	12.07	9,84	12,13	9,68
<b>Rank</b>	44	42	69	43	48	56	39
<b>Minimum</b>	176	169	173	195	212	160	206
<b>Maximum</b>	220	211	242	238	260	216	245
<b>CV %</b>	<b>5.80</b>	<b>5.69</b>	<b>7.62</b>	<b>5.43</b>	<b>4.18</b>	<b>6.03</b>	<b>4.32</b>
Plant height Turda 2017							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estival M	Jubilee
<b>Average</b>	<b>155.86</b>	<b>146.93</b>	<b>158.9</b>	<b>187.5</b>	<b>209.7</b>	<b>160.23</b>	<b>199.4</b>
<b>Standard deviation</b>	10.19	5.64	7.26	19.12	6.20	17.73	7.34
<b>Rank</b>	59	21	25	111	26	78	28
<b>Minimum</b>	115	135	145	95	192	100	187
<b>Maximum</b>	174	156	170	206	218	178	215
<b>CV %</b>	<b>6.54</b>	<b>3.84</b>	<b>4.57</b>	<b>10.20</b>	<b>2.95</b>	<b>11.06</b>	<b>3.68</b>

Table 2

## Parameters of plant height variability (cm) VIȘOARA

Plant height Vișoara 2016							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estival M	Jubilee
<b>Average</b>	<b>173.13</b>	<b>163.73</b>	<b>167.43</b>	<b>188.36</b>	<b>198.6</b>	<b>179.66</b>	<b>203.6</b>
<b>Standard deviation</b>	13.17	8.73	10.55	11.82	13.08	12.87	15.03
<b>Rank</b>	65	36	48	50	46	52	75
<b>Minimum</b>	135	150	150	165	180	155	180
<b>Maximum</b>	200	186	198	215	226	207	255
<b>CV %</b>	<b>7.60</b>	<b>5.33</b>	<b>6.30</b>	<b>6.27</b>	<b>6.58</b>	<b>7.16</b>	<b>7.38</b>
Plant height Vișoara 2017							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estival M	Jubilee
<b>Average</b>	<b>127.36</b>	<b>125.73</b>	<b>133.4</b>	<b>167.83</b>	<b>174.96</b>	<b>142.26</b>	<b>17.43</b>
<b>Standard deviation</b>	8.66	10.17	7.0	11.34	9.20	7.48	11.33
<b>Rank</b>	34	33	30	42	356	31	43
<b>Minimum</b>	110	112	118	153	157	125	149
<b>Maximum</b>	144	145	148	195	192	156	192
<b>CV %</b>	<b>6.80</b>	<b>8.08</b>	<b>5.25</b>	<b>6.75</b>	<b>5.25</b>	<b>5.26</b>	<b>6.61</b>

## Variability regarding cob weight

From the analyzed genotypes, Deliciul Verii and Estival M are the most stable in terms of this attribute, which directly influences production, this being reflected in low oscillations of average values and the coefficient of variation in both years (Table 5). It is noted, through a strong heterosis, hybrid Estival M, which records the highest average values of cob weight in both experimental years in Turda locality. For the other hybrids, fluctuations

of this important productive property are much more significant, reflected in the average values obtained, and in the coefficients of variation in two years.

Under conditions of Vișoara, hybrid Estival M, which records the highest average cob weight performance in 2016, is again remarked and in 2017 and it's ranked fourth. Regarding the stability of this property seen through coefficients of variation, Hybrid Deliciul Verii (Table 6) again stands out in this location. In Vișoara, it is remarkable by high average values which are close enough in the two years to foreign hybrid Jubilee, which in 2017 a year less favorable to the sweet corn crop, recorded highest maximum values of cob weight.

Table 3  
Sweet corn parameters regarding main cob insertion height (cm) in TURDA

Insertion height Turda 2016							
Variability parameters	Prima HS	Estival HT	Deliciul V HS	Dulcin HT	Delicious HS	Estival M HS	Jubilee HS
<b>Average</b>	54	62	73	85	91	70	68
<b>Standard deviation</b>	7.74	11	9.71	9.23	9.18	8.53	6.72
<b>Rank</b>	37	45	35	39	53	36	30
<b>Minimum</b>	31	45	60	66	48	50	50
<b>Maximum</b>	68	90	95	105	101	86	80
<b>CV %</b>	14.45	17.77	13.37	10.83	10.09	12.27	9.86
Insertion height Turda 2017							
Variability parameters	Prima HS	Estival HT	Deliciul V HS	Dulcin HT	Delicious HS	Estival M HS	Jubilee HS
<b>Average</b>	34	37	51	57	65	48	51
<b>Standard deviation</b>	5.36	6.80	5.49	8	6.54	6.02	6.39
<b>Rank</b>	22	23	22	25	26	25	27
<b>Minimum</b>	20	24	40	45	55	35	40
<b>Maximum</b>	42	47	62	70	81	60	67
<b>CV %</b>	15.78	18.22	10.68	14	9.93	12.67	12.42

Table 4  
Sweet corn parameters regarding main cob insertion height (cm) in VIȘOARA

Insertion height Vișoara 2016							
Variability parameters	Prima HS	Estival HT	Deliciul V HS	Dulcin HT	Delicios HS	Estival M HS	Jubilee HS
<b>Average</b>	53.43	57.26	61.53	74.6	83.7	66.46	69
<b>Standard deviation</b>	8.73	11.08	7.74	7.79	8.38	9.33	10.53
<b>Rank</b>	30	43	30	34	30	34	60
<b>Minimum</b>	40	40	45	56	70	50	35
<b>Maximum</b>	70	83	75	90	100	84	95
<b>CV %</b>	16.34	19.35	12.58	10.45	10.01	14.04	15.27
Insertion height Vișoara 2017							
Variability parameters	Prima HS	Estival HT	Deliciul V HS	Dulcin HT	Delicios HS	Estival M HS	Jubilee HS
<b>Average</b>	25.93	32.46	41	48.43	47.6	37.56	41.46
<b>Standard deviation</b>	5.48	7.37	6.75	8.80	8.54	4.80	4.92
<b>Rank</b>	20	28	28	42	32	20	18
<b>Minimum</b>	15	22	25	30	28	25	32

Maximum	35	50	53	72	60	45	50
CV %	21.16	22.70	16.46	18.17	17.95	12.78	11.87

Table 5

## Variability parameters regarding sweet corn cob weight (g) TURDA

Cob weight (g) Turda 2016							
Variability parameters	Prima	Estival	Deliciu V	Dulcin	Delicios	Estival M	Jubilee
Average	172.28	219.01	228.26	202.45	172.42	240.16	219.21
Standard deviation	24.21	41.88	20.59	32.00	54.55	26.27	50.74
Rank	81.97	228.90	83.48	133.74	190.85	98.72	180.43
Minimum	132.52	75.96	187.13	133.28	69.78	175.82	122.98
Maximum	214.49	304.89	270.61	267.02	260.63	274.54	303.41
CV %	14.05	19.12	9.02	15.80	20.37	10.94	23.14
Cob weight (g) Turda 2017							
Variability parameters	Prima	Estival	Deliciu V	Dulcin	Delicios	Estival M	Jubilee
Average	192.72	221.20	230.75	213.60	221.80	243.82	226.04
Standard deviation	19.92	27.24	21.47	24.96	30.02	21.66	25.14
Rank	80.95	114.76	95.73	103.64	112.06	96.11	105.93
Minimum	149.2	162.37	183.92	165.83	169.35	194.97	167.28
Maximum	230.15	227.13	279.66	269.47	281.41	291.97	273.21
CV %	10.34	12.31	9.30	11.68	13.53	8.85	11.12

Table 6

## Variability parameters regarding sweet corn cob weight (g) VIIȘOARA

Cob weight (g) Viișoara 2016							
Variability parameters	Prima	Estival	Deliciu V	Dulcin	Delicios	Estival M	Jubilee
Average	180.95	238.13	227.12	216.58	205.91	239.54	210.30
Standard deviation	28.89	45.15	36.57	50.45	25.42	50.50	36.48
Rank	130.09	207.05	151.7	181.01	110.63	160.51	161.51
Minimum	126.28	101.34	142.24	121.1	135.83	155.71	138.64
Maximum	256.37	308.39	293.94	303.11	246.46	316.22	300.15
CV %	16.00	18.96	16.10	23.29	12.34	21.08	17.34
Cob weight (g) Viișoara 2017							
Variability parameters	Prima	Estival	Deliciu V	Dulcin	Delicios	Estival M	Jubilee
Average	144.79	201.90	190.48	204.64	209.72	203.93	213.07
Standard deviation	23.10	28.00	24.24	27.97	20.04	26.00	37.95
Rank	98.51	96.03	113.45	135.05	84.05	108.02	145.68
Minimum	86.37	160.84	157.75	140.82	169.59	148.75	145.31
Maximum	184.88	256.87	271.2	275.87	253.64	256.77	290.99
CV %	15.95	13.87	12.72	13.66	9.55	12.74	17.81

**Cob diameter variability.** Sweet corn cob diameter is a character with a more pronounced genetic determinism, compared to other morpho-productive properties of sweet corn. Values of cob diameter variation coefficients, in case of seven hybrids studied in Turda and Viișoara in both years do not exceed the percentage of 10% indicating a low variation. Estival M hybrid records lowest fluctuations regarding coefficient of variation from one year to the next in Turda, and in case of Viișoara, the most stable hybrid is Delicios (Table 7 and 8).

More pronounced stability of this attribute, in which cob size is reflected, is also somewhat suggested in the small differences between averages of the two localities. Also, reduced values of standard deviation in two locations indicate the important role of genotype in the phenotypic expression of this property. In other words, it can be said that improving this attribute and analyzing the behavior of different hybrid combinations does not require a large number of years.

Table 7

## Variability parameters regarding corn cob middle diameter TURDA

Middle diameter of corn cobs Turda 2016							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estival M	Jubilee
Average	4.05	4.58	4.66	4.42	4.30	4.54	4.22
Standard deviation	0.22	0.33	0.21	0.25	0.35	0.17	0.24
Rank	0.9	1.7	0.8	1.1	1.7	0.7	0.9
Minimum	3.7	3.5	4.2	3.7	3.4	4.2	3.8
Maximum	4.6	5.2	5	4.8	5.1	4.9	4.7
CV %	5.44	7.29	4.56	5.80	8.5	3.77	5.79
Middle diameter of corn cobs Turda 2017							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estival M	Jubilee
Average	4.37	4.67	4.46	4.25	4.48	4.46	4.33
Standard deviation	0.64	0.61	0.12	0.30	0.24	0.17	0.18
Rank	1.9	2	0.6	1.2	1.0	0.7	0.9
Minimum	3.5	3.5	4.2	3.8	4.0	4	3.8
Maximum	5.4	5.5	4.8	5.0	5.0	4.7	4.7
CV %	9.4	9.09	2.79	7.5	5.40	3.93	4.30

**Variability regarding cob length.** Highest values of cob length, in both locations and in both years, are recorded at hybrids, Estival M and Jubilee. Most stable hybrid in terms of this attribute expressed by the values of the coefficient of variation is Delicios hybrid, which both in Turda and Viișoara conditions records low values regarding this parameter (Table 9, Table 10). Except for a single hybrid (Dulcin) and in 2016 in Viișoara, all hybrids record variation coefficient values lower than 10%. In the two years, 2016 and 2017, hybrids Estival M and Jubilee achieve higher cob length values, with very significant positive differences compared to control (average of the experience). Earliest hybrids, Prima and Estival, record lowest values of variability coefficient in location of Turda both in 2016 and 2017.

Table 8

## Variability parameters regarding corn cob middle diameter VIIȘOARA

Middle diameter of corn cobs Viișoara 2016							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estival M	Jubilee
Average	4.1	4.80	4.5	4.36	4.48	4.38	4.23
Standard deviation	0.21	0.26	0.27	0.40	0.21	0.28	0.22
Rank	0.8	1.1	1.2	2.2	0.7	1	1.1
Minimum	3.7	4.1	3.9	2.7	4.1	3.9	3.6
Maximum	4.5	5.2	5.1	4.9	4.8	4.9	4.7
CV %	5.12	5.48	6.03	9.32	4.85	6.55	5.23
Middle diameter of corn cobs Viișoara 2017							

Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	EstivalM	Jubilee
Average	3.91	4.68	4.47	4.36	4.39	4.34	4.40
Standard deviation	0.37	0.28	0.23	0.28	0.16	0.27	0.25
Rank	1.5	1.3	1.1	1	0.7	1.3	1.3
Minimum	3	4	3.8	3.8	4	3.6	3.5
Maximum	4.5	5.3	4.9	4.8	4.7	4.9	4.8
CV %	9.53	6.07	5.21	6.51	3.75	6.44	5.88

Table 9

## Variability parameters regarding corn cob length TURDA (cm)

Corn cob length (cm) Turda 2016							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estivl M	Jubilee
Average	16.36	17.56	18.45	19.4	19.9	21.03	22.51
Standard deviation	0.85	1.07	1.14	1.52	1.25	1.32	1.98
Rank	3.5	5	4.5	6.5	5.5	5.5	9.5
Minimum	14	14.5	15.5	17	16.5	18	15.5
Maximum	17.5	19.5	20	23.5	22	23.5	25
CV %	5.19	6.10	6.21	7.87	6.30	6.32	8.81
Corn cob length (cm) Turda 2017							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estivl M	Jubilee
Average	16.4	16.6	19.3	20.08	19.65	21.78	21.3
Standard deviation	1.49	1.61	0.88	1.32	0.92	1.01	1.11
Rank	6	6	4.5	5.5	3.5	5.4	4.1
Minimum	14	12.5	16.5	7.5	18	18	19.5
Maximum	20	18.5	21	23	21.5	23.4	23.6
CV %	9.06	9.73	4.59	6.57	4.69	4.64	5.21

Table 10

## Variability parameters regarding corn cob length VIIȘOARA (cm)

Corn cob length Vișoara 2016							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estival M	Jubilee
Average	17.21	19.23	19.4	19.75	20.05	23.03	21.21
Standard deviation	1.36	2.06	1.38	2.60	1.11	1.90	1.69
Rank	6	10.5	7	11.5	4	9	7
Minimum	14.5	13	15.5	17	18	18	18
Maximum	20.5	23.5	22.5	28.5	22	27	25
CV %	7.95	10.74	7.14	13.20	5.57	8.25	7.99
Corn cob length Vișoara 2017(cm)							
Variability parameters	Prima	Estival	Deliciul V	Dulcin	Delicios	Estival M	Jubilee
Average	16.33	18.15	18.0	19.32	21.05	22.53	21.23
Standard deviation	1.34	1.08	0.75	1.42	0.71	1.02	1.22
Rank	5.5	5	3.5	6.5	3	4	5.2
Minimum	13.5	15.5	17	15.5	19.5	20	18.3
Maximum	19	20.5	20.5	22	22.5	24	23.5
CV %	8.21	5.97	4.17	7.36	3.40	4.54	5.79

## CONCLUSIONS

- Delicios and Estival M hybrids are distinguished by a high uniformity regarding cob insertion height, indicating their adaptation to mechanized harvesting.
- For the high production capacity, expressed by cobs weight and a significant stability of this attribute, hybrids Deliciul Verii and Estival M are distinguished. Also Estival M stands out along Delicios hybrid with low fluctuations regarding coefficient of variation in cob diameter in both years of study.
- Highest values regarding cob length in both locations and in both years are recorded at hybrids, Estival M and Jubilee.

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