INFLUENCE OF THE SOWING TIME ON GROWING AND DEVELOPMENT OF SOME SWEET CORN HYBRIDS IN DIFFERENT LOCATIONS FROM ROMANIA

Anne Marie VOICU (ENESCU)[1]; Antonia IVAŞCU[2];
Ruxandra CIOFU[3], Teodor Dan ENESCU[4]

Abstract. The results presented the influence of sowing time on growth and development of sweet corn hybrids. Planting dates was determined according to experimental variations. For the first time to be considered when soil temperature was 8-10 ^{0}C. The most important phenophases of sweet corn growth and development have triggered differently depending on planting dates, location and hybrid. Romanian hybrids were better adapted to environmental conditions at the beginning of the vegetation is causing rising earlier than 2-6 days compared to foreign hybrids. Number of days required for each phenophases occurrence decreased continuously from the first time to third sowing time.

Key words: *Zea mays*, var. *rugosa* (Bonaf), convar. *Saccharata* Koprn (Sturt.), anthesis, silk emergence

Introduction

Sweet corn, *Zea mays*, var. *rugosa* (Bonaf),convar. Saccharata Koprn (Sturt) is native to submountainous area of Peru and Bolivia, where it arose soft corn grain. As a secondary center is Mexico, where southern indians, brought soft corn grain. Under the arid climatic conditions it appears the new type of corn with hard grain. Later, under repeated natural crosses appeared multiple forms like indurata, indentata and saccharata [1].

On the American continent sweet corn was made known over 3000 years ago. After discovery of America, was brought to Europe where it spread in all countries of the continent.

Sweet corn is grown for its milk stage grain. In this phenophase taste qualities are maximum and nutritious substances are best absorbed by human organism.

Sweet corn is a monoecious plant, which form at the tip of the stem a male branched panicle type inflorescence and at the armpit of the leaves it forms the female spadix

[1] PhD Candidate in Horticulture,USAMV Bucharest, Romania, e-mail: annemarie_u2@yahoo.com
[2] PhD in Horticulture, ISTIS Bucharest, Romania, coresponding member of Academy of Romanian Scientists, e-mail: ant_iva@yahoo.com
[3] PhD in Horticulture, USAMV Bucharest, Romania, e-mail: rciofu@gmail.com
[4] PhD in Horticulture, ISTIS Bucharest, Romania, e-mail: teonscu@yahoo.com

type inflorescences, called ears, covered with leaves (corn husks). A feature of many sweet corn hybrids is the ability to form shoots that may have ears.
This species has high demands to the factors of vegetation, especially to temperature and humidity. If the first period of vegetation, from seed emergence to anthesis, the most important growth factor is temperature, witch can speed up growth if is at optimum values. After anthesis the most important factor of vegetation becomes the humidity. High humidity during flowering and grain formation is crucial in achieving high yields of sweet corn.
Sweet corn is considered to be a real source of food, witch has proved to have a high caloric content and nutritional value compared to the usual corn. Fresh or preserved, provides a real vitamin, mineral and energy intake, and is an important source of micronutrients, especially magnesium (48mg/100g grains), which is usually missing from other vegetable products [2]. The energy value of sweet corn is 370 kJ/100g grains, being higher than green peas. Technological maturity, seeds contain 25-27% dry matter, 14-15% carbohydrates, 5-5,5% protein, 0,75% fat, aminoacids, significant amounts of vitamins: C, B, PP, E and minerals (K, P, Ca, Mg, Fe). [3].
Sweet corn is used in food industry as raw material for canning, but it is also eaten fresh in the milk stage as boiled corn or in the preparation of different corn mashes, garnishes for steaks, stewed fruits, cream-soups of corn and flour from sugar corn is in the composition of various pastries [1, 4].
The sweet corn culture in our country began to expand much later, one of the reasons being that the population used and is still using in consumption corn cultivars for grain that is consumed in the milk stage as boiled or fried corn.
Since lately, sweet corn began to sell in supermarkets, as fresh or preserved vegetable and the fact that this product is known and appreciated by the buyers, explains the need for further studies on the development of technological measures to allow expansion of the culture in Romania.
The paper presents results regarding the influence of hybrid and sowing time on growth and development of the plants.

Material And Methods

Experience was held in 2011 in two sites: Luduş, Mureş, county and Dâlga, Călăraşi county (table 1).
The biological material was represented by two Romanian hybrids: Deliciul verii and Prima and two foreign hybrids: Boston and H 702.
During the experiment, it was realized many observations, measurements and determinations, which were used specific working methods namely:

- Morphometric determinations (plant height, height of the first ear insertion point), on the variants and repetitions. It was made observations and determinations on 10 plants in 4 repetitions.

- Phenological determinations: sowing date, date of emerging, date of anthesis and date of silk emergence.

The technology used in the experiences was selected from the literature for sweet corn [2, 3].
Sweet corn harvesting occurs when they reach the maturity stage of consumption (milk-wax stage) when the cob is hard, well covered by leaves, and silk became brown and dry.

Table 1) The organization of experience

Experience	Hybrid	Location	Sowing time	Technological features		
				Method	Planting scheme (cm)	Density
Influence of the sowing time on growing and development of some sweet corn hybrids in different locations	Prima Deliciul verii Boston 702	LUDUŞ	I* - 24.IV	sown directly	70/24	60.000
			II -10.V			
			III – 17.V			
	Prima Deliciul verii Boston 702	DÂLGA	I*- 7. IV			
			II – 19.IV			
			III – 27.IV			

* sowing when the soil temperature has reached 8 - 10^0 C;

Results And Discussion

From meteorological data presented in figure 1, we can see that in Dâlga from november to august there were lowest temperatures in January (- 3,6 ^{0}C) and the warmest period was in July (25 ^{0}C).
Concerning the hydric regime can be observed that the dry month was March (2 mm) and the precipitation was highest in May (98.3 mm). It can be noted that during November 2010 to August 2011 was favorable hydric regime, providing enough water which helped for good soil preparation for sowing in the spring. Although March showed no precipitation, in April, May and June, hydric regime was favorable for growing sweet corn. However, we can see that in the early growing season, temperatures recorded were quite low, causing a slight stress which affected the processes of seed emergence and young plants growth.

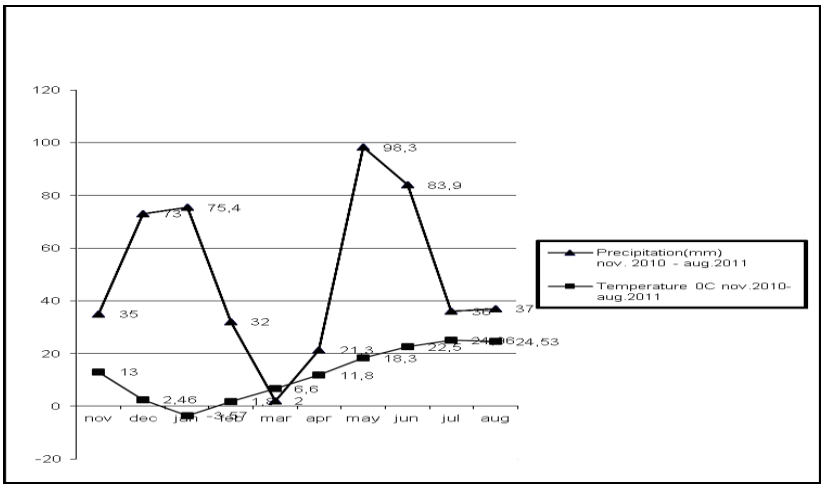


Figure 1. Weather conditions for Dâlga during nov. 2010-aug. 2011

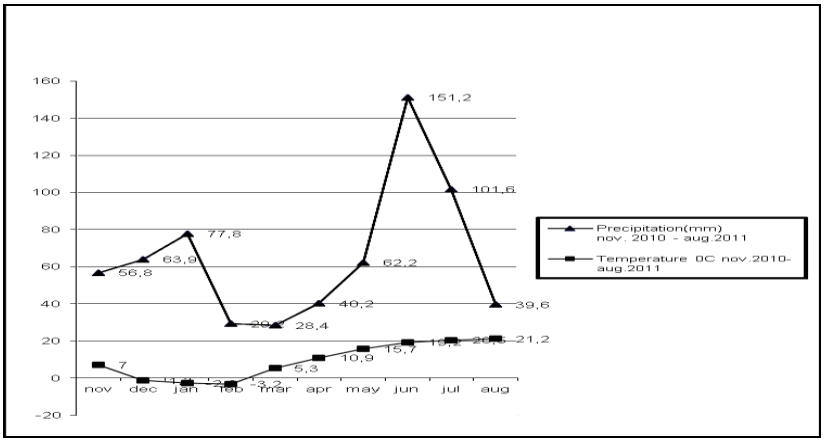


Figure 2. Weather conditions for Luduş during nov. 2010-aug. 2011

From meteorological data presented in Figure 2, it can be seen that in the Luduş area, from November 2010 to August 2011, the lowest monthly average temperatures were registered in February (-3.2 ^{0}C) and the warmest period was in August (21.2 ^{0}C).

In the hydric regime, we can observe that the month with the lowest precipitation was March (28.4 mm) and the highest precipitation was in June (151.2 mm). In the hydric regime, we can observe that the month with the lowest precipitation was March (28.4 mm), and the highest precipitation was in June (151.2 mm). It can be noted so that during November 2010 – January 2011 the hydric regime was favorable for good preparation of soil in the spring for sowing.

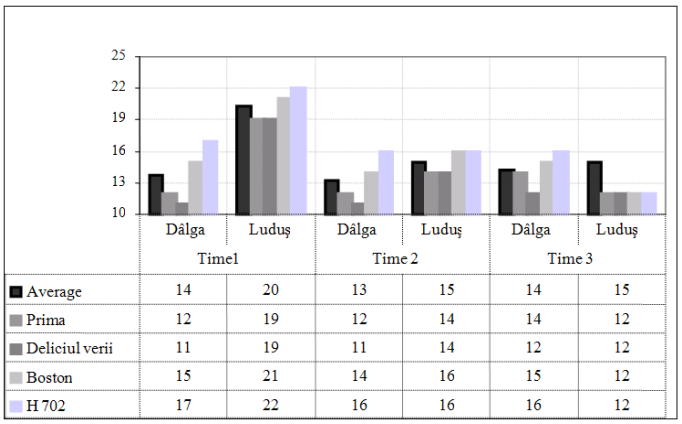
Concerning the influence of the time of sowing on the plant growing and development of the four corn hybrids which were taken for study in both locations (Luduş and Dâlga), it can be seen that the main climate factor which affect the number of days necessary for each phenophase is temperature (Table 2, 3, Figure 3 - 7). It may be noted that increased temperatures shortens the period until the appearance of the major phenophases: emergence, anthesis, silk emergence, harvesting stage.

Table 2) Results on the influence of sowing time on the development phenophases of sweet corn - Dâlga 2011

Hybrid	No. of days from sowing to emergence			No. of days from sowing to anthesis			No. of days from sowing to silk emergence			No. of days from sowing to harvest			Vegetation period		
	Time			Time			Time			Time			Time		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Average	14	13	18	73	61	58	79	68	64	110	98	93	96	85	76
Prima	12	12	17	71	59	54	75	63	58	107	95	90	95	83	73
Deliciul verii	11	11	15	67	57	54	72	62	57	107	95	90	96	84	75
Boston	15	14	18	71	59	58	74	63	62	107	95	90	92	81	72
H 702	17	16	19	81	69	67	95	83	80	118	106	101	101	90	82

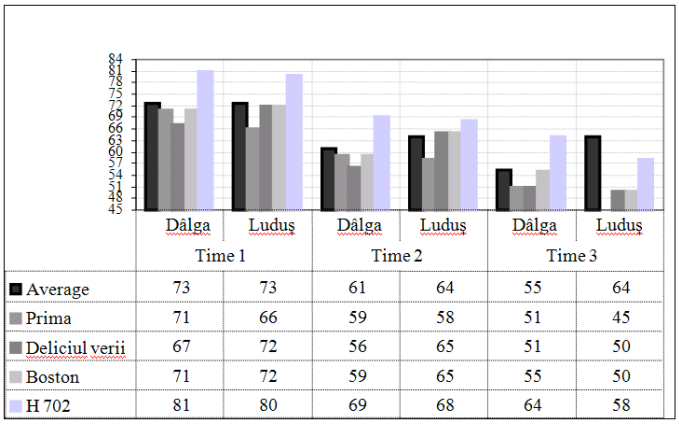
Tabel 3) Results on the influence of sowing time on the development phenophases of sweet corn – Luduş -2011

Hybrid	No. of days from sowing to emergence			No. of days from sowing to anthesis			No. of days from sowing to silk emergence			No. of days from sowing to harvest			Vegetation period		
	Time			Time			Time			Time			Time		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Average	21	15	12	74	64	62	76	66	64	97	88	85	76	73	73
Prima	20	14	12	68	57	59	71	60	60	91	81	81	71	67	69
Deliciul verii	20	14	12	73	65	62	75	66	63	96	88	84	76	74	72
Boston	22	16	12	73	65	63	75	67	64	96	89	85	74	73	73
H 702	23	16	12	81	68	65	83	70	67	104	92	88	81	76	76



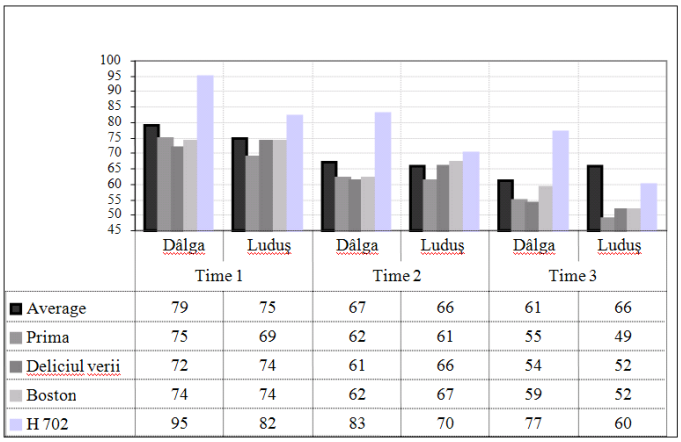
	Dâlga	Luduş	Dâlga	Luduş	Dâlga	Luduş
	Time1		Time 2		Time 3	
Average	14	20	13	15	14	15
Prima	12	19	12	14	14	12
Deliciul verii	11	19	11	14	12	12
Boston	15	21	14	16	15	12
H 702	17	22	16	16	16	12

Figure 3. Number of days from sowing to emergence



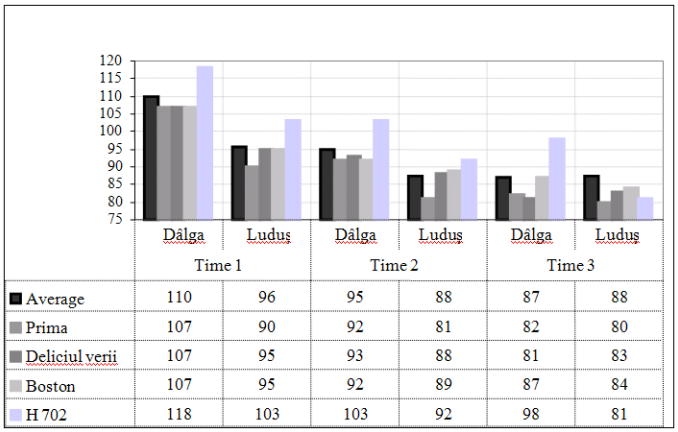
	Dâlga	Luduş	Dâlga	Luduş	Dâlga	Luduş
	Time 1		Time 2		Time 3	
Average	73	73	61	64	55	64
Prima	71	66	59	58	51	45
Deliciul verii	67	72	56	65	51	50
Boston	71	72	59	65	55	50
H 702	81	80	69	68	64	58

Figure 4 Number of days from sowing to anthesis



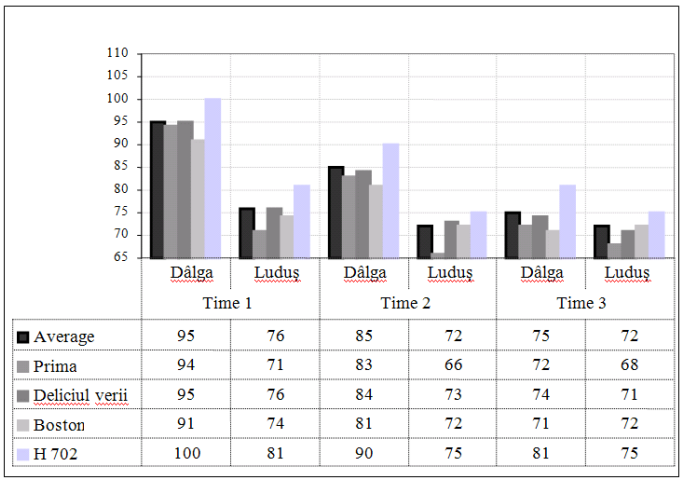
	Dâlga	Luduş	Dâlga	Luduş	Dâlga	Luduş
	Time 1		Time 2		Time 3	
Average	79	75	67	66	61	66
Prima	75	69	62	61	55	49
Deliciul verii	72	74	61	66	54	52
Boston	74	74	62	67	59	52
H 702	95	82	83	70	77	60

Figure 5 Number of days from sowing to silk emergence



	Time 1		Time 2		Time 3	
	Dâlga	Luduş	Dâlga	Luduş	Dâlga	Luduş
Average	110	96	95	88	87	88
Prima	107	90	92	81	82	80
Deliciul verii	107	95	93	88	81	83
Boston	107	95	92	89	87	84
H 702	118	103	103	92	98	81

Figure 6 Number of days from sowing to harvest



	Time 1		Time 2		Time 3	
	Dâlga	Luduş	Dâlga	Luduş	Dâlga	Luduş
Average	95	76	85	72	75	72
Prima	94	71	83	66	72	68
Deliciul verii	95	76	84	73	74	71
Boston	91	74	81	72	71	72
H 702	100	81	90	75	81	75

Figure 7 Vegetation period

At Dâlga in the first time of sowing (07.IV.2011), romanian hybrids Prima and Deliciul verii have sprung 2 or 3 days earlier than average of the experience, while the foreign hybrids (Boston and H 702) have sprung up with 1- 3 days laterthan the average. For the other two time of sowing (19.IV and 24.IV) the situation is similar. In the second time of sowing Romanian hybrids have sprung up with 1 or 2 days earlier and foreign hybrids emerge 1 or 3 days later than the average. In the third time of sowing the situation was similar, but the emergence for Prima occured after 17 days from sowing, like the average.

Between anthesis and silk emergence it was only few days, depending by the sowing time and hybrid. The periods from sowing to anthesis and to silk emergence were gradually reduced from first sowing time to second and to third sowing time.

Concerning the vegetation period and the number of days from sowing to harvesting it can be observed that in all sowing time the hybrid H 702 is the latest one. The vegetation period of H 702 ranged from 82-101 days depending on sowing time, all other hybrids being below average values.
At Luduş, emergence occurred at 20 days from sowing for Romanian hybrids, 22 days for Boston and 23 days for H 702. In the second sowing time Romanian varieties shave sprung up in 14 days, one day earlier than average and foreign ones in 16 days, one day later than average experience. In the third sowing time, because optimal conditions of temperature the hybrids behaved similarly and emergence occur in 12 days.
Further, in the other phenophases it can be seen that the length of period needed to reach each phenophase gradually decreased in every sowing time. It can be seen that the hybrid H 702 is later than the other hybrids, with a vegetation period from 76-81 days depending on sowing time.

Influence of planting time on plant growth - Dâlga area (table 4)
It can be noticed that plant height varies depending on sowing time.
The experience average for first sowing time was 199.6 cm. The highest value was recorded at H 702 (242.6 cm) and lowest one in Deliciul verii (180 cm). In the second sowing time the average value was of 195.5 cm, and the highest value was recorded at H 702 (244.0 cm) and the lowest one was in Deliciul verii (173.1 cm). At the third time we have an average of 191, cm, the highest value was recorded also at H 702 (243.5 cm) and lowest in Deliciul verii (170.7 cm).
Ear insertion height averages increased from the first time since the last one (60.1 to 66 cm). The greatest height was recorded in third sowing time at H 702 (84.0 cm) which exceeded the average with 18 cm. The lowest height was at Prima in the first sowing time (49.3 cm), 10,3 cm below experience average.
Also at the number of leaves per plant can be observed the same trend of declining average values from the first to third sowing time (10.5 to 10.3).

Table 4 Results on the influence of hybrid on the growing of the plants, Dâlga - 2011

Hybrid	Average height (cm)			Insertion height (cm)			No. of leaves /plant		
	Time			Time			Time		
	I	II	III	I	II	III	I	II	III
Averege	199,6	195,5	191,1	60,1	63,5	66,0	10,5	10,4	10,3
Prima	186,7	181,2	175,9	49,3	51,3	63,3	10,3	10,2	10,1
Deliciul verii	180,0	173,1	170,7	56,0	60,5	52,3	10,3	10,3	10,1
Boston	189,1	183,8	174,2	61,9	64,3	64,5	10,5	10,5	10,3
H 702	242,6	244,0	243,5	73,0	77,9	84,0	10,8	10,8	10,5

The analysis of the average values for the plant height at Luduş (Table 5) shows that these values varies discontinuously, the highest value being observed in the second sowing time (186,3), H 702 has the highest value (220,3 cm) in the second sowing time, above the average of 34 cm. The lowest value was given by Prima at first sowing time (133,3 cm). The height of insertion average of ear varies continuously and increasing from the first sowing time to one (49 to 55,6). The highest value was obtained by H 702 in third sowing time (77,0) exceeded control (average) by 21,4 cm.

The lowest height was at Prima in the first sowing time (40,5 cm), 8,5 cm below average.

In the number of leaves per plant can be observed that the average values vary discontinuously with the maximum value on the second sowing time.

Table 5 Results on the influence of hybrid on the growing of the plants, Luduş - 2011

Hybrids	Average height (cm)			Insertion height (cm)			No. of leaves /plant		
	Time			Time			Time		
	I	II	III	I	II	III	I	II	III
Average	167,3	186,3	177,8	49,0	52,8	55,6	10,2	10,3	10,2
Prima	133,3	178,0	170,5	40,5	44,3	47,0	10,0	10,0	10,0
Deliciul verii	153,8	164,5	159,5	41,8	45,0	47,3	10,0	10,2	10,1
Boston	171,0	182,5	170,5	42,8	45,8	51,0	10,3	10,3	10,2
H 702	211,3	220,3	210,5	71,0	76,0	77,0	10,5	10,5	10,3

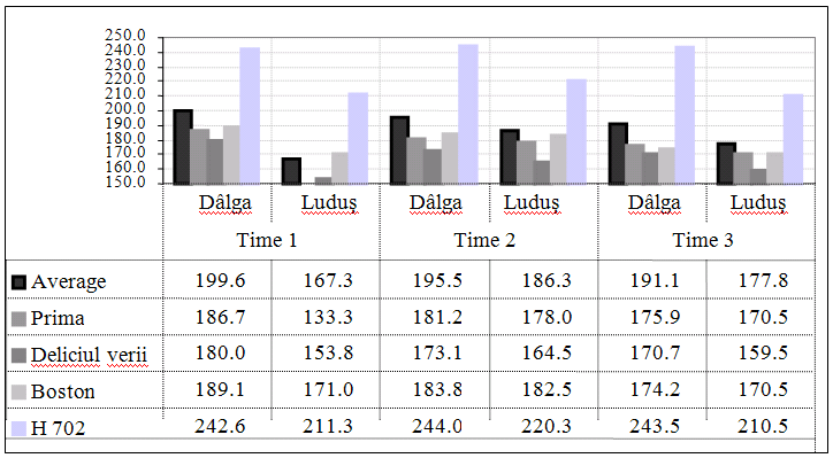


Figure 8 Average height (cm)

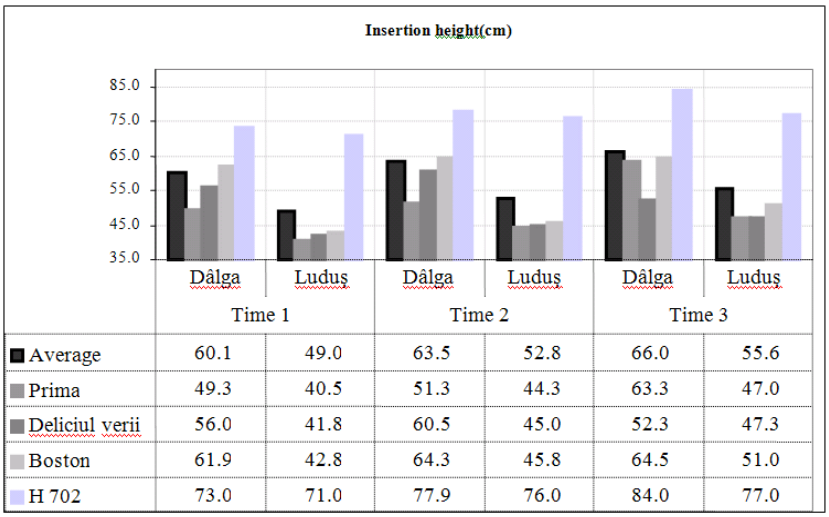


Figure 9 Insertion height (cm)

Table 6 Morphometric characteristics of ears for different hybrids of sweet corn – Dâlga 2011

Hybrids	Number of ears per plant			Ear length (cm)			Ear diameter (cm)			Number of rows			Number of grains /row		
	Time			Time			Time			Time			Time		
	I	II	III	I	II		I	II	III	I	II		I	II	III
Average	1.2	1.2	1.1	19	19	18	4.8	4.9	4.7	16	17	16	38	41	38
Prima	1.3	1.3	1.1	17	18	17	4.2	4.4	4.4	10	12	12	36	38	32
Deliciul verii	1.2	1.2	1.1	19	19	19	4.8	4.9	4.4	14	16	14	42	43	42
Boston	1.0	1.1	1.1	19	19	18	5.0	5.0	5.1	18	18	17	34	40	36
H 702	1.2	1.3	1.2	19	20	19	5.1	5.2	5.1	20	20	20	40	41	40

At Dâlga the average values for number of ears per plant varied in lower limits, between 1.1 to 1.2. The lowest values were recorded in Boston at first sowing time (table 6). The highest value of the ears length was made in the second sowing time for H 702 (20cm). Diameter of the ears varied strong enough with a minimum of 4,2 cm for Prima at the first sowing time and maximum was 5,2 cm in second sowing time at H 702. The number of rows of grains/cob varies from 10 to 20 the minimum was at first sowing time on Prima and the maximum on H 702. Number of grains per row ranged from 32 (Prima, third time) to 43 (Deliciul verii, second time).

Table 7 Morphometric characteristics of ears for different hybrids of sweet corn – Luduş 2011

Hybrids	Number of ears per plant			Ear length (cm)			Ear diameter (cm)			Number of rows			Number of grains /row		
	Time			Time			Time			Time			Time		
	I	II	III	I	II		I	II	III	I	II		I	II	III
Average	1.1	1.1	1.2	19	18	19	4.3	4.0	4.0	16	16	16	39	38	39
Prima	1.1	1.0	1.2	17	16	17	4.0	4.0	4.0	12	12	12	37	36	36
Deliciul verii	1.1	1.1	1.2	18	16	18	5.0	4.0	4.0	16	16	14	38	36	43
Boston	1.1	1.2	1.2	20	19	20	4.0	4.0	4.0	16	16	16	38	36	37
H 702	1.0	1.3	1.3	21	20	21	4.0	4.0	4.0	21	20	21	42	43	41

At Luduş number of ears per plant varied between 1,0 to 1,3 (average). The lowest values were reported for Prima hybrid (second time), H 702 (first time) (table 7). The highest value in the length of the ears was performed by H 702 (21cm). The diameter of the ears varied strong enough from 4,0 to 5,0 cm, the highest value was at Deliciul verii at first sowing time. Number of rows varies from 12 to 21 the minimum value was registered at Prima and maximum at H 702. Number of grains per row varied from 36 (Prima) to 43 (Deliciul verii, third time and H 702, second time).

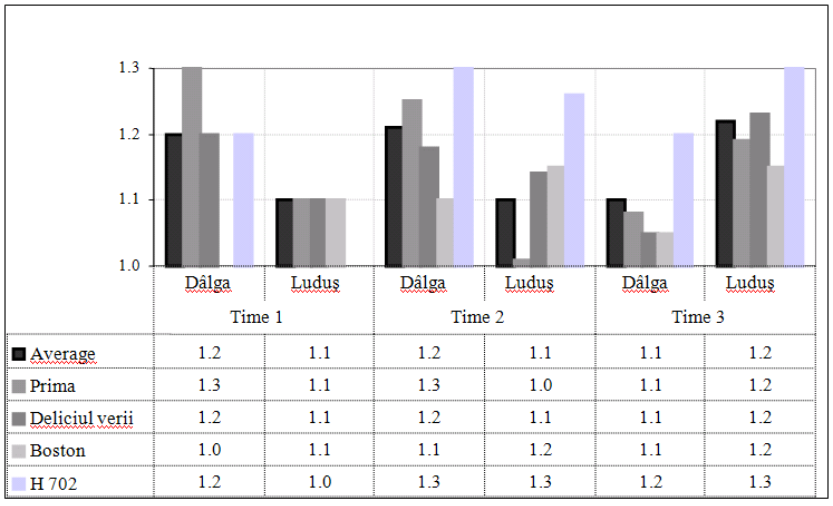
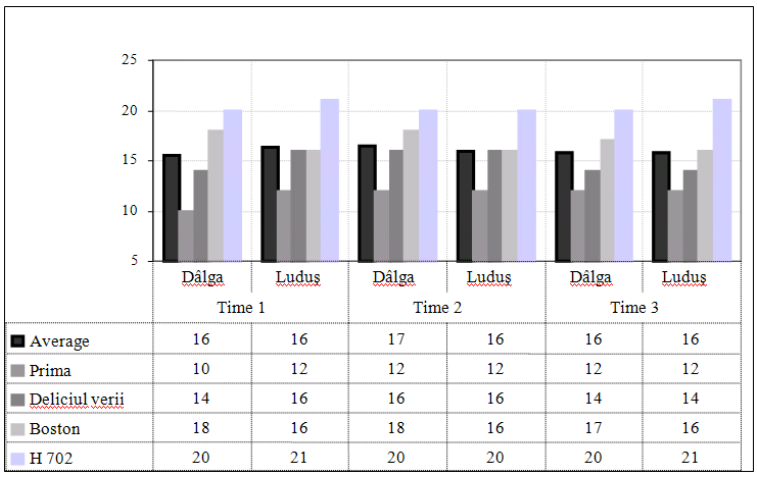


Figure 11 Number of ears per plant.



	Dâlga	Luduş	Dâlga	Luduş	Dâlga	Luduş
	Time 1		Time 2		Time 3	
Average	16	16	17	16	16	16
Prima	10	12	12	12	12	12
Deliciul verii	14	16	16	16	14	14
Boston	18	16	18	16	17	16
H 702	20	21	20	20	20	21

Figure 12 Number of grains/row

Conclusions

Concerning the influence of the sowing time on the plant growing and development of the four corn hybrids which were taken for study in both locations (Luduş and Dâlga), it can be seen that the main climate factor which affect the number of days necessary for each phenophase is temperature. It may be noted that increased temperatures shortens the period until the appearance of the major phenophases: emergence, anthesis, silk emergence, harvesting stage.

Romanian hybrids were better adapted to environmental conditions at the beginning of the vegetation period, occurring earlier emergence with 2-6 days compared to hybrids of foreign hybrids.

Planting dates also influenced total plant height values and ear insertion height.

The number of ears per plant varied from 1,0 to 1,3 for the two locations. The data presented in the results shows that there is a direct and inverse relationship between number of ears per plant and size of ears.

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