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Influence of various mineral supply on sweet corn root development

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Summary: Investigations into root strength have assumed particular importance with the emergence of American rootworm *(Diabrotica virgifera-virgifera)* as the number one pest, mainly as a result of monocultural production. Three treatments were applied in the trial: zero control treatment, treatment "A" (g/m2): 4, 47 N + 7, 89 P2O5 + 19, 74 K2O and treatment "B"(g/m^2): 8, 94 N + 15, 78 P_2O_5 + 19, 74 K2O. Measurements were made to find out whether the treatments had produced any significant difference between the root strength of the two varieties (normal sweet Puma F1 and super sweet Dessert R75 F1) at the two dates of measurement (tasseling, milk stage) in the year 2003. The treatments with a high phosphorous ratio resulted in an apparent increase in root strength with both varieties. There was a detectable difference in root strength also between the two points of measurement, suggesting that root development had remained stable. The treatments produced significant increase not only in the root strength but also in the yields of both varieties.

Key words: sweet corn, top dressing, root strength

Introduction

Currently, the most successful vegetable crop in Hungary is sweet corn which is produced on more than 30,000 hectares. Production in home gardens is also estimated to come to about 1000 ha (*Nigicser*, 2003). In contrast, in Transylvania, not counting those trained in agronomy, it is practically unknown among consumers, or more precisely, it is confounded with grain corn. Conditions for the advance of field cultivation are missing at the moment in Transylvania, on the other hand, a growing interest is shown by producers and consumers. Therefore, it would perhaps be reasonable to focus on the popularization of home garden production meeting the needs of fresh consumption. It is commonly known that corn, as being tolerant to monoculture, is often grown without rotation. It is particularly true of home garden production where crop rotation and thereby the isolation of pests in space are difficult to put into practice (*Daniel*, 1978). During the last few years, the greatest threat to monoculture corn production is the rapid spread of corn rootworm. The reason is that the larva, one of the development stages of American rootworm, is able to develop fully, i.e. to become an imago, if it keeps on feeding on corn roots. The feeding of the larva, due to severing the roots and consuming them, can lead to lodging which, accompanied by reduction of yield and quality, more over impairs mechanical harvest. Among the different degrees of leaning of the stalk it is the development of the "goose neck" curve which stage will cause already financial loss to growers.

The bending to an angle of 45 – 60o relative to the soil was considered by *Nagy* et al. (2003) a strong leaning.

The trial was set up with two varieties (normal sweet Puma F1 and super sweet Dessert R75 F1), because investigations of *Treat & Tracey* (1994) demonstrated difference between the root strength of varieties. Besides investigating the effect of nutrient supply on root strength we also studied as for its effect on yields.

Materials and methods

The trial was located at Nyárádkarácsonyfalva. The village is situated in the middle of the Transylvanian Basin, 15 km south of Marosvásárhely, along the lower section of the stream Nyárád.

The climatic conditions of the place of the experiments are listed in *Tables 1, 2 and 3*.

The long term yearly average air temperature is 9°C. The warmest month of the year is July with a long-term air temperature of 20.2°C, the coldest one is January when the long-term average is -3°C.

The year of the experiment, 2003 is notable for the exceptionally high mean temperatures occurring in the growing period. Especially in the period of May-July a 7.2°C higher temperature occurred relative to the long-term average.

The average total annual precipitation is 583 mm. The highest rainfall occurs in June, 109 mm, the lowest in February, 20.7 mm. Annual precipitation varied between 762 mm, and 376.2 mm.

In the year 2003, the high temperature values were accompanied by unusually low precipitation. The dry early spring was followed by an even drier late spring and in May

Table 1. Monthly average temperatures (Marosvásárhely)

Months	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
monthly averages in 2003 (°C)	-3,1	-7	2	8,6	19,3	20,6	20,8	20,8	14,1	7,6	4,7	-2,3
difference from the average (°C)	-0,1	-6	-2,4	-1,3	4,1	2,5	0,6	1,8	-0,5	-1,2	1,6	-0,8
averages of 1971–2003 (°C)	-3	-1	4,4	9,9	15,2	18,1	20,2	19	14,6	8,8	3,1	-1,5

Table 2. Monthly precipitation totals (Marosvásárhely)

Months	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
monthly averages in 2003 (mm)	55,7	18,5	15,5	32,5	26	30,8	105	27,2	42,2	74	29,5	24,2
difference from the average (mm)	31,9	-2,2	-8	-13,9	-41	-78,2	23,9	-33	-9,7	37,6	-3,9	-5,8
averages of 1971-2003 (mm)	23,8	20,7	23,5	46,6	66,7	109	81,1	60	51,9	36,4	33	30

Table 3. Actual sunshine duration (Marosvásárhely)

Months	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
monthly average in 2003 (h)	22,3	140,7	177,8	203,4	324	331	240,1	331,3	193,3	102,3	67,5	84,5
difference from the average (h)	44,7	47,2	25,9	30,9	111	92,3	18,9	77,7	7,7	-46,7	-9,6	39,3
averages of 1971–2003 (h)	70,0	93,5	151,9	172,5	213	238,7	259	253,6	185,6	149	77,1	45,2

the rainfall was only 1/3 of the average. In other years June is the rainiest month, but in 2003 this was not so. During the second month of the heat the fields received rainfall that was less than 1/3 of the monthly average. Relief came only in July when rainfall was 130% (105 mm) of the monthly average. If we accept the definition by *Gyuricza & Birkás* (2000) on the dry period according to which precipitation is 10-20% lower in the period examined relative to the long-term average, no doubt, that the period May-July 2003 with its 63% was an exceptionally dry period.

The long-term average of actual sunshine duration is 1908.9 hours. From astronomical considerations, the greatest amount of sunshine should arrive in June, however, due to the frequent occurrence of rain, which is typical of this period, on the long-term average the maximum is in July, 259 hours, the minimum in December, 45.2 hours. The year of the experiment abounded in sunshine.

The soil sample analysis was carried out at the Soil Laboratory of the Department of Vegetable and Mushroom Growing of the Faculty of Horticulture, Corvinus University of Budapest. The results of the soil analysis are shown in *Table 4*.

On the basis of the results of the analysis, the availability of the major nutrients in the soil is as follows: N medium, P low, K medium, Mg medium, EC low.

The trial was set up in a randomized block design.

PUMA F1: middle-early variety, with maturing similar to that of Wallaby. Ears are 20 cm long, 4.8 cm in diameter, with 18-20 kernel rows. Yield potential is superior to the average of the maturity group, received good judgment in the sensory evaluation develops strong tillers (*Kovács*, 2000).

DESSERT R75 F1: Sheba + 3–4 days, slightly tapering, very long, thick ear, kernels are smaller, drabbish and somewhat lighter in color, thick corncob, 18–20 kernel rows (*Kovács*, 2004).

The trial was carried out in a home garden, in settled alluvial soil, where the water table was at a depth of about 2–3 m, with carrots as pre-crop. After the harvest of the pre-crop, the soil was tilled 30 cm deep on November 30, which was followed by planking and harrowing in the spring. The soil had not become weedy by the sowing, therefore no weed control was required.

Sowing: seeds were sown 2–3 cm deep, in hills dug with a hoe 76x25 cm distant from each other. For the variety Puma F_1 3 seeds, for the variety Dessert R75 F_1 5 seeds per hill.

Cultivation: the first weed-hoeing was carried out in the 2 leaf phenophase of the plants. The thinning of plants was also performed at this time, producing the final plant number (5,26 plants/m^2)

The treatments were carried out at the same time as the thinning (May 16). 10 cm deep trenches were dug both on the right and left sides of the rows assigned for treatment, and the top dressing was applied in them.

The fertilizers applied were: N – ammonium nitrate (34%), P – superphosphate (20%), K – potassium sulphate (50%). The replication number was 2+2, which meant that 2–2 plots, i.e. 4-4 rows of the two varieties (Puma F_1 and DR 75 F_1) received the same treatment. After thinning and application of the fertilizer, weeds were hoed twice, till the time of the first observation. No pesticide application was made, as it was not necessary. Tillers were not removed.

The measurements were made in two phenophases: the first measurement at **tasseling (July 10)**, the second measurement at **milky stage (July 25).**

Table 4. Soil analysis results

Organic material	$CaCO_3$	pH	Soil plasticity index according to Arany	N	P_2O_3	K_2O	Mg	EC
				in aqueous soution in			Ca_2Cl	mS/cm
%				mg/100 g soil				
3.3	2.3	8	40	5	2.3	14	8.8	0.36

10–10 plants were examined with both varieties, both treatments and both phenophases. In accordance with the objective of the trial, the root strength of sweet corn was measured by means of a measuring spring with a range up to 30 kg and an apparatus constructed for the spring. The measurement was performed by joining the apparatus on the internode right below the juncture of the ear, which in response to the pull grasped the internode, and its upward slip was prevented by the node. In response to the tensile force the plant started to bend, the pull lasted until the first crack. This was when the value (kg) shown on the spring was read. After the crack the stems were bending to an angle of 45–60° relative to the soil, or the ear had arrived lower than 40 cm, which is, considered a strong leaning, according to *Nagy* et al. (2003). The plants were selected randomly.

The results were analyzed using the program *Statgraphics*, the comparison of the treatments and the measurement times within the varieties was performed using the *Friedman* test. The comparison of the varieties (pair by pair), was performed using the *Wilcoxon* test, which consisted in comparing only the values recorded at the same measurement times for varieties that had received the same treatment. These tests belong to the so-called non parametric tests and are applied when the parametric tests (U and t tests, variance analysis) are not possible to be carried out (*Harnos & Ladányi*, 2005).

Results and discussion

Table 5. **Effect of treatments on yields (corn ear weight, g)***

	Zero control	Treatment "A"	Treatment "B"
Dessert R75	252,2	274,8	313,6
Puma	247,4	271,2	306,8

Table 6. Values characterizing root strength **(N)***

	Zero control	Treatment "A"	Treatment "B"
1st measurement time			
Dessert R75	78.5	120.0	145.0
Puma	89.5	148.5	164.0
2nd measurement time			
Dessert R75	88.5	149.0	163.0
Puma	106.0	172.0	189.5

(* based on the average of 10–10 measurements.)

The measurement results are listed in *Tables 5. and 6.*

The variety Dessert R75 F1 responded to both fertilizer treatments (A and B) with a significant increment in root strength compared to the zero control. The higher dose produced higher strength. At the same time, good nutrient supply is also an important factor in mitigating drought because it increases the production in a greater degree than the water demand and consequently specific water consumption will diminish (*Márton*, 2004). The detection of a smaller difference in the milk stage between the treatments A and B was probably due to the fact that the abundant rainfall after the first measurement had provided good phosphorous supply (phosphorous utilization) for the roots penetrating deeper in the soil even in the case of the lower dose. Significant root strength increment was seen also with the variety Puma F_1 in response to both treatments compared to the zero control. Considerable difference can be seen also between the results of the two measurement times which can be explained with an increment in root strength. The results of the measurements are a clear demonstration of the superior adaptability of the normal sweet variety, as in the year of the experiment the measurement at tasseling happened in the dry period.

As considered the effects on yields, both treatments produced significant increment in (husked) ear weight of both varieties (making a comparison within the varieties).

Comparing the varieties, it becomes apparent that the root strength values measured for the normal sweet variety are superior to those of the super sweet variety. It seems that the normal sweet variety is able to tolerate non-irrigated conditions, comparing either the two zero control data, or those of the two treatments. It can be probably attributed to the fact that the normal sweet variety, which had developed greater root mass by that time, was able to utilize the nutrient reserves present in the soil (in the case of the zero control treatment) or the applied fertilizer treatments. It seems to bear out the finding of *Treat § Tracey* (1994) according to which normal sweet varieties have better rooting ability and higher root strength than super sweet varieties. This was made even more dominant by the fact that roots are able to penetrate deeper in well-aerated soils and also by the fact that ground water was 2 m deep at the site of the experiment.

The reasons for the susceptibility of the varieties to larva damage may probably originate from the following root characteristics: size, intensity of development and regenerating capacity (*Széll* et al, 2003). In order to be able to describe the susceptibility of the varieties to larva damage also by the different genotypes, it would be necessary to have, possibly independent experimental results from trials over several years; our trials are to be considered as an initiative in this direction.

In the choice of variety it is advisable to choose a variety with good rooting and root regeneration ability. This is important not only because it will make better use of the water and nutrient reserves in deeper soil layers, but it will ensure greater root strength thereby it will lodge to a lesser extent if larva damage should occur. This is a hard task, on the other hand, since market considerations often outweigh technical appropriateness in the competition between seed suppliers.

Literature

Daniel, L. (1978): A csemege- és pattogatni való kukorica termesztése. Mezőgazdasági Kiadó. Bp.

Gyuricza, Cs. & Birkás, M. (2000): A szélsőséges csapadékellátás hatása egyes növénytermesztési tényezőkre barna erdőtalajon, kukoricánál. Növénytermelés. 49: 691–706.

Harnos, Zs. & Ladányi, M. (2005): Biometria agrártudományi alkalmazásokkal. Aula Kiadó. Bp.

Kovács, F. (2000): Csemegekukorica. *In*: Kristóf L.-né (szerk.). Leíró fajtajegyzék. Országos Mezőgazdasági Minősítő Intézet. Bp.

Kovács, F. (2004): Támpontok a fajtaválasztáshoz. Kertészet és Szőlészet. 53. (18): 6–7.

Marosvárhelyi Meteorológiai Állomás adatai 1971–2003.

Márton, L. (2004): A csapadék, a műtrágyázás és néhány szántóföldi növény termése. Gyakorlati Agrofórum. 15. (1): 23–27.

Nagy, G., Komáromi, J. & Kiss, J. (2003): Az amerikai kukoricabogár lárvakártételének hatása a monokultúrában termesztett kukorica terméseredményére. Gyakorlati Agrofórum Extra. 14 (4): 9–11.

Nigicser, T. (2001): A sikeres csemegekukorica termesztés sarokpontjai. Gyakorlati Agrofórum. 12. (1): 21–29.

Széll, E. et al. (2003): Kukoricatermesztés környezetkímélő módon. Gyakorlati Agrofórum Extra. 14. (2): 4–8.

Treat, C.L., & Tracey, W.F. (1994): Endosperm type on biomass production and on stalk and root quality in sweet corn. Crop-Science. 34. (2): 396–399.