The effect of the method and the timing of the propagation on the growth, earliness and productivity of sweet corn

INTERNATIONAL JOURNAL OF HORTICULTURAL SCIENCE

AGROINFORM Publishing House, Hungary

Hodossi S.[1], Kovács A.[2] and Besenyei E.[1]

[1]Tessedik Sámuel College, Department of Horticulture, H-5540 Szarvas, Szabadság u. 1–3.
[2]Kecskemét College of Horticulture, H-6000 Kecskemét, Erdei Ferenc tér 1–3.

Key words: sweet corn, early production, plastic sheet covering, seedling, growth, leaf area, yield harvest time

Summary: Direct sowing in 16 cm deep trench covered with perforated plastic sheet (for 3 weeks), transplant using, and uncovered direct sowing (control) was tried on 2 locations, with 2 varieties (very early *Kecskeméti korai extra,* and middle early *Kecskeméti SC-370)* in Szarvas on loamy soil, and in Kecskemét on sandy soil in 1996 – after a preliminary trial concerning perforated plastic covered trench sowing in Szarvas, in 1995.

The plant height (weekly), the average leaf number/plant, the total leaf area (once), the total yield, the quality of cobs, and the earliness was measured. ***The results are:***

1. *Kecskeméti korai extra* during the first 6 week period the transplanted plants were the highest, but from the 7th week the plants which were sown in trench and than were covered with perforated plastic sheet (for 3 weeks) were the highest.

K. SC-370: The transplanted plants were the highest-until the end of plant height development.

The plant height development stopped at the 9th week of the measurement by early, - and stopped at the 10th week by middle early variety. The average leaf number/plant varied between 9,25–10,50 and was not influenced either by variety or by the treatment. The total leaf area was (on 5th of June) the largest by transplanted plants, which was followed by plants that were sown in trench and then were covered with perforated plastic film (for 3 weeks).

2. The highest yield was observed by plants, which were sown in trench, and then were covered with perforated plastic film (for 3 weeks). Transplanted plants followed it.

3. Quite the total yield (98,3%) of transplanted *Kecskeméti korai extra* variety plants were harvested on 4th July. 89% of the total yield was picked up of trench sown and then with perforated plastic covered plants. The harvest of uncovered control started on 15th July.

The harvest of transplanted *K. SC-370* plants started 19th July, when more than half of the total yield (57%) was picked. The uncovered control was harvested 29th July.

4. The weight and the measure of cobs generally were not influenced by the treatments, but the average weight of the cobs of the transplanted *Kecskeméti korai extra* plants (0,21–0,18 kg) are less than the requirement.

Proposition

The beginnings of growing sweet corn dates back to 1779 to the American continent. (*Nonnecke*, 1989). Even today, though since then corn is cultivated in other parts of the world, a considerable part of the sowing area lies here (*Rubatzky & Yamaguchi,* 1997).

In Hungary in the beginning of the century corn occupied only a few hectares, but by 1996 the sowing area had grown to16500 ha. Despite the decline in 1997 (*Mártonffy & Fodor,* 1997). Hungary produces the most sweet corn in Europe after France (Kovács, 1996). The size of sowing has continued to grow and in 1998 it exceeded 21000 ha (*Mártonffy & Fodor,* 1999).

The most decisive is producing raw material for the canning industry. But the appearance of types with higher sugar content (the so-called nugat with the se gene and the so-called dessert types containing the sh_2 gene) led to an increase in the consumption of fresh sweet corn, to a start of early growing and to the development of solid seasonal prices.

Literary review

In the US one dozen (1 dozen – 12 pieces) sweet corn costs 2,5–3 USD while the bulk costs 2 USD (*Aylswirth,* 1996). In Hungary in 1994 the start-out price is 30 HUF/piece, and the bulk was 10 HUF/piece (*Rimóczi*, 1995). The attempt to have the highest start out price possible increases the interest in the methods of achieving early ripening with sweet corn.

These were summarised by *Wonneberger* in 1994 as follows:

- growing in cold houses (less economic method)

- setting the stock by growing seedling and transplanting
- direct sowing and covering it temporarily with perforated plastic sheet
- covering the soil in between the rows with plastic sheet mulch.

At present two of these methods are the most widely used. One is the method of covering the sowing temporarily with plastic sheet. To achieve even earlier ripening the method of setting the stock with planting seedlings.

The size of the area where the method of using plastic sheet mulch is not decisive. Growing in cold houses, however, has so far remained only a possibility.

As *Waligora* (1995) reported, the light coloured plastic mulch quickened spring, shortened growing time and increased the weight of the crop.

In the US a variety of the method of covering the sowing with (light coloured) plastic sheet mulch is in general practice.

As an advantage of this method *Melnick* (1996) points out that under the light coloured covering springing is more uniform and faster which are important factors in achieving earliness.

Wayett and Mullins (1989) tried the effects of growing transplants in soils of different nourishment (module tray, peat pot). According to their results – though there were differences between varieties – with this method two week earliness could be achieved (compared with direct sowing at the same time). They noted, however, that the growing – and the quality of the crop – was poorer and weighed less than the transplanted crop.

The ideal temperature for growing sweet corn is 12–15 °C (at 20 °C the room should be aired). The poorer vegetation and the shorter length of sweet corn is due to the temperature higher than the favourable at the time of growing the transplants (*Anonym,* 1996).

Salisbury and Ross (1992) suggested measuring the growth as the most important factor of productivity. *Rogers & Lomman* (1988) looked into the connection of the length of the crop and its marketability. They pointed out that the big (0,33 kg) and medium sized (0,25 kg) cobs can always be sold. The cobs of smaller size (0,20 kg) can only be sold at a reduced price, while on imbued markets they cannot be sold at all.

Materials and method

Experiments have been made – following the preliminary trial of 1995 made in Szarvas – in 1996 in Szarvas in the show garden of DATE on a loamy soil (A_K: 51, humus % 2,7) and in Kecskemét in the experiment garden of KÉE on a sandy soil (A_K: 26, humus % 0,65).

In 1995 as uncovered control we sowed the seeds of *Kecskeméti korai extra* on plain area, and in 14 cm long trench that was covered with perforated plastic sheet until the plants reached the cover. The date of sowing was April 11 and May 4. In 1996 when the following preparations were done.

1) Setting the stock by planting transplants.

Planting: April 29.

Transplants had been grown in KITE trays (175 holes, diameter: 2.5 cm, depth: 6 cm) in moderately heated glass house in 21 days. At the time of planting, the seedlings were 10–12 cm high and had 3–4 leaves.

2) Sowing in trenches and covering them temporarily with perforated plastic sheet.

Sowing: April 22.

Depth of trench: 15 cm. The rate of air holes on the sheet: 4%.

The seeds sprang on the 6th–7th day following sowing. The sheet remained as long as it did not hinder them in growing. The sheet was removed on the 22th–24th day following sowing.

3) Uncovered control sowing

Sowing: April 29. (On the day of planting the seedlings following the American practice.)

The seeds started to spring on the 8th–9th day following sowing.

Types: In the experiment – with divided parcel method - we used two types, *Kecskeméti korai extra,* and the middle early *K. SC-370.*

The weather during the time of breeding

The quantity of moisture and the temperature were overall acceptable to the plant. Rainfall and temperature were around the many years' average that of May exceeded the average. As to the beginning of June it was the same.

The second half of June and the beginning of July were however dry and cooler than the average.

According to relevant publications, so far vegetation has been given little attention when estimating methods that aim to increase earliness. And it showed clearly which variety is the most favourable to the needs of the plant. This is the reason for our having considered it important to measure factors of vegetation in the time of breeding especially in the beginning.

1. Measuring the plant height weekly at appointed plant of average development. This was done until they ceased growing. (We stopped measuring when the height was the same as the week before.)

2. Registering weekly the number of leaves at the plants appointed for height measuring. (We did this until no new leaf developed.)

3. Measuring the total leaf area once (June 5) with an LVM-2 planimeter, which gives the results in cm^2 (measuring the size of projection).

4. Measuring the time of appearance, the gross weight of the crop and examine its quality.

Results and their discussion

The results of the preliminary trials completed in 1995 are shown in *Table 1.* The data show clearly the relative advantage of the plants sowed in trench and then covered

Table 1 Plant height (cm) *(Szarvas, 1995)*

Variety: Kecskeméti korai extra

Sowing: April 11			Sowing: May 4		
Date of measuring	Uncovered control	Covered with foil	Date of measuring	Uncovered control	Covered with foil
Emergence:	April 25	April 23	Spring:	May 13	May 11
	Plant height (cm)			Plant height (cm)	
May 2	5	10	May 16	4	6
May 9	9	17	May 23	8	11
May 16	11	21	May 30	14	24
May 29	18	25	June 6	30	35
June 6	50	57	June 13	49	65
June 19	67	92	June 20	80	94
June 27	160	150	June 27	120	126
July 4	158	165	July 4	145	163
July 11	166	168	July 11	160	176
			July 18	165	178

Table 2 The results of plant height weekly measurement (cm) *(Szarvas, 1996)*

Date of measuring	Plant height (cm)					
	Kecskeméti korai extra			Kecskeméti SC-370		
	Transplanted	Covered with foil	Uncovered control	Transplanted	Covered with foil	Uncovered control
May 11	18,25	15.00	6.25	19.00	17.25	7.75
May 17	27.00	23.25	14.50	29.75	29.50	16.25
May 24	44.75	38.50	25.25	49.00	47.50	28.25
May 31	60,00	52.25	36.00	65.00	56.75	41.25
June 7	112.00	90.75	70.25	113.25	97.75	79.25
June 14	137.25	127.50	98.50	142.75	134.50	116.75
June 21	149.25	153.75	145.00	163.00	165.00	150.00
June 28	151.25	173.75	170.25	221.25	215.00	206.25
July 5	151.25	177.50	173.00	230.75	224.50	212.50
July 12	–	177.50	173.00	231.50	227.50	214.50
July 19	–	–	–	231.50	227.75	214.50
July 23	–	–	–	–	227.75	–

temporarily with perforated plastic sheet compared with the uncovered control plants.

In the trials completed in 1996 in Szarvas detailed and in Kecskemét additional measuring took place. The weekly growth of plant height is shown in *Table 2*. It shows that despite certain tendency, growth differs with the type.

In case of the type *Kecskeméti korai extra* in the first six weeks of registration the relative order of methods according to plant height was transplanted plants, the plants covered temporarily with perforated plastic sheet and the uncovered control plants reached the smallest height. However, in the 7th week of registration this order changed. The uncovered control plants remained the smallest, but the plants covered temporarily with perforated plastic sheet grew higher than the transplanted plants. It was in the 8th week that the final order of growth formulated. The plants that had been temporarily covered grew the highest. The second highest plants were the uncovered control plants and the transplanted plants grew the smallest. The highest temporarily covered plants reached an average height of 177,5 cm while the control plants were 173 and the transplanted plants were 151,25 cm. The transplanted plants ceased to grow already in the 9th week of registration. The plants of the other two methods continued to grow until the 10th week.

The transplanted plants regarding their final height were 26,25 cm and 22,75 cm smaller than the temporarily covered plants and the uncovered plants respectively. In case of the type *K. SC-370* the transplanted plants were the highest until the 6th week of registration. In the 7th week the temporarily covered plants exceeded the transplanted ones in height. In the 8th week, however, the transplanted plants grew as high as to exceed the temporarily covered ones in height. With this the final relative order was formed: transplanted, temporarily covered and uncovered control plants.

The transplanted and the control plants ceased to grow in height a week earlier than the temporarily covered ones.

The plants of the transplanting method were higher only 3,75 and 17 cm than the temporarily covered and the uncovered control plants respectively.

From the data of *Table 2* it can be concluded that the type itself determined the development of growth and the final height of the plants. However, the method of breeding is a

Table 3 The average leaf number/plant (weekly measurement) *(Szarvas, 1997)*

Date of registration	Average number of leaves/plant (piece)					
	Kecskeméti korai extra			Kecskeméti SC-370		
	Transplanted	Covered with foil	Uncovered control	Transplanted	Covered with foil	Uncovered control
May 11	6.50	5.50	2.75	6.75	5.75	3.25
May 17	7.75	7.00	5.00	8.00	7.50	5.25
May 24	8.00	8.00	6.50	8.50	8.50	6.75
May 31	9.75	9.50	7.00	10.00	9.50	7.50
June 7	10.00	9.75	8.75	10.25	10.00	9.00
June 14	10.00	10.00	9.25	10.50	10.00	10.25
June 21	–	10.00	9.25	10.50	–	10.25

modifying aspect. The growth of the transplanted crops with short yielding time was definitely weaker. This tendency was not valid in case of the crops with longer yielding time.

The methods of sowing the seeds in trenches and covering them temporarily with perforated plastic sheet both resulted in rapid growth with both plants. With the type of *Kecskeméti korai extra* it brought about the longest crops. In the case of *K. SC-370* with medium long yielding time however, the crops were 3,75 cm shorter than that of the method of transplantation, but the difference is not significant.

The height of control plants in the case of the early type was basically the same as of those covered temporarily with plastic sheet (they were only 4,56 cm shorter). The plants of mid-early types grew the shortest.

On the basis of the above data, it can be concluded that setting the crop by transplantation – in the case of the early types – can cause significant stress. At the same time, the method of sowing the seeds in trenches and covering them temporarily can be qualified as an early yielding method that has no negative effect on the plants.

The data of *Table 3* shows that the average leaf number per plants conformed to the height of the plants. Neither the type, nor the breeding method, nor the timing had an effect on it. The final leaf number varied between 9,25–10,50 leaves/plant and the rapidity of growth showed no significant difference either.

The differences arising from the timing and method of breeding levelled up already in the 5th and 6th weeks of registration.

The size of total leaf area of 5th April is shown in *Table 4*. It shows clearly, that – since the date was set down in the 6th and 7th week of registration when the transplanted plants' growing faster was apparent – this method brought about the biggest growth in both groups. The second biggest total leaf area could be measured with the plants sowed in trenches and covered temporarily with plastic sheet. The smallest total leaf area could be measured with the control plants.

Table 4 The total leaf area (June 5) (The values of secondary shots in brackets)

Method	Total leaf area	
	Kecskeméti korai extra	Kecskeméti SC-370
Transplanted	1718 (540)	2163 (611)
Covered with foil	1552 (328)	2038 (526)
Uncovered control	755 (133)	1138 (221)

Taking the average total leaf area of the control plants of the early type as 100, the same data with the transplanted plants was 227 while 205 could be measured with the plants covered temporarily with perforated plastic sheet. In case of the plants with middle production – following the same method of measuring – the control plants taken as 100, the same data with the transplanted plants was 190; with the plants covered with plastic sheet were 178. Within the total leaf area the rate of secondary shots were 17–31% in case of the *Kecskeméti korai extra,* 19–28% with the *K. SC-370.* With both types the transplanted plants showed the biggest (28 and 31%) and the control plants showed the smallest rate (17 and 19%). The rate of leaf area of secondary shots was the same as the total leaf area.

Table 5 The total yield

A) Variety: Kecskeméti korai extra, kg

Method	Repetition		Treatment (total)	Average
	1.	2.		
Transplanted	552	501	1053	526,5
Covered with foil	636	568	1204	602,0
Uncovered control	453	436	889	444,5
Repetition (total)	1641	1505	3146	

Factor	SQ	FG	MQ
Total	2,86 E+04	5	
Repetition	3082,66	1	
Method	24820,33	2	12410,16
Error	6.74 + 02	2	337.16

"t" trial's critical values	p=10 %	p=5 %	p=1 %	p=0,1 %
LSD	2,92	4,3	9,93	31,6
	43,78	64,47	148,88	473,77

B) Variety: Kecskeméti SC-370

Method	Repetition			Treatment (total)	Average
	1.	2.	3.		
Transplanted	1190	1288	1271	3749	1249.7
Covered with foil	1651	1397	1326	4374	1458,0
Uncovered control	871	848	811	2530	843,3
Repetition (total)	3712	3533	3408	10653	

Factor	SQ	FG	MQ
Total	6,52 E+05	8	
Repetition	15564,66	2	
Method	586324,66	2	293162
Error	5,01E+04	4	12537

"t" trial's critical values	p=10 %	p=5 %	p=1 %	p=0,1 %
LSD	2.13	2.78	4.6	8.61
	194.73	254.15	420.54	787.13

Table 5 shows – in terms of the different varieties – the total weight of the cobs, the relevant variation tables and the results of the "t" trial and the smallest significant differences (LSD). These data show that the most crops were brought about in case of both varieties – by the plants where the seeds were sown in trenches and the seedlings were covered with plastic sheet. The uncovered control plants grew the least cobs.

In the case of *Kecskeméti korai* extra between the uncovered control plants, the covered plants and the transplanted plants p = 1% difference in the cobs showed.

The real difference was 164 and 315 kg. The measures of the "t" trial calculated to p = 1% was 148,88 which was exceeded by both measures.

The two methods aiming to achieve earliness showed 151 kg differences the total weight of cobs. This proved real difference in the total weight of cobs calculated p = 0,1%.

In the case of *K. SC-370* the three methods showed significant differences. It's reliability between the transplanted and the temporarily covered plants was p = 1%, while between these two methods and the uncovered control plants was p= 0,1%.

ches and the seedlings are covered with perforated plastic sheets. The total weight of cobs of the transplanted plants was significantly less. However, both methods aiming earliness brought about a significant increase in the total weight of cobs compared with the uncovered control plants. This latter shows that the earliest possible open-air sowing does not ensure acceptable conditions to the plants.

The harvest time of the plants grown with the different methods aiming early yielding is shown in *Table 6.* This shows that in case of both types the earliest yielding was achieved by the method of transplanting. Almost all the crops (98,3%) of the *Kecskeméti korai extra* could be harvested at the time of the first picking. The mid-early *K. SC-370* type started to ripen two weeks later but more than half (57,2%) of the transplanted plants could be harvested at the first picking.

The *Kecskeméti korai* extra sowed in trenches and covered temporarily with perforated plastic sheet ripened 6 days later than the transplanted plants but 5 days earlier than the uncovered control plants. At the time of the first picking 89,1% of the crop could be harvested. The *K. SC-370* could be harvested 4 days later than the transplanted plants, but then all the

Table 6 The dates of harvest time (%)

Variety: Kecskeméti korai extra							
Method /Date of harvest	July 4	July 10	July 15	July 19	July 23	July 29	Total
Transplanted	98,3	1,7					100
Covered with foil		89,1	10,9				100
Uncovered control			100				

Variety: Kecskeméti SC-370							
Method /Date of harvest	July 4	July 10	July 15	July 19	July 23	July 29	Total
Transplanted				57,2	42,8		100
Covered with foil					100		
Uncovered control						100	100

Table 7 The cob quality values, Szarvas, 1997

Method	Kecskeméti korai extra		
	Weight of cobs (dkg)	Circle of cobs (cm)	Length of cobs (cm)
Transplanted	21,00	15,60	21,50
Covered with perforated foil	25,30	18,00	24,30
Uncovered control	26,60	17,20	34,70
	Kecskeméti SC-370		
Transplanted	27.80	16.00	26.90
Covered with perforated foil	29.20	16.50	28.10
Uncovered control	31.90	18.00	27.60

The difference in yield between the transplanted and the control plants was 1219 kg, while between the control and the covered plants it was 1844 kg. The LSD measures calculated to p = 0,1% was 787,13 kg. The difference in yield between the transplanted and covered plants was 625 kg, that exceeded the LSD measure of 420,54 kg calculated to p = 1%.

The results of total weight of cobs proved clearly the advantage of the method when the seeds are sowed in trenches and the seedlings are covered with perforated plastic sheets. The total weight of cobs of the transplanted plants was significantly less. However, both methods aiming earliness brought about a significant increase in the total weight of cobs compared with the uncovered control plants. This latter shows that the earliest possible open-air sowing does not ensure acceptable conditions to the plants.

The harvest time of the plants grown with the different methods aiming early yielding is shown in *Table 6.* This shows that in case of both types the earliest yielding was achieved by the method of transplanting. Almost all the crops (98,3%) of the *Kecskeméti korai extra* could be harvested at the time of the first picking. The mid-early *K. SC-370* type started to ripen two weeks later but more than half (57,2%) of the transplanted plants could be harvested at the first picking.

The *Kecskeméti korai* extra sowed in trenches and covered temporarily with perforated plastic sheet ripened 6 days later than the transplanted plants but 5 days earlier than the uncovered control plants. At the time of the first picking 89,1% of the crop could be harvested. The *K. SC-370* could be harvested 4 days later than the transplanted plants, but then all the crops could be harvested. Compared to the uncovered control plants this was 6 day earlier.

We also measured the length, weight and circumference of the cobs of both types one by one, and averaged the data. The results are shown in *Table 7.* It is shown clearly that the transplanted plants grow cobs, which were smaller in length, weight and cirumference. This tendency showed more clearly with the early types than with the mid-early types.

The data, registered in Kecskemét – in spite of their being defective – complete and reinforce the data registered in Szarvas. The height of the plants was measured on the same day both in Kecskemét and in Szarvas (June 28). At that time in Szarvas regarding plant height the relative order of the plants grown with different methods in case of the *Kecskeméti korai extra* was sowing the seeds in trenches then covering them with perforated plastic sheet, second heights was the uncovered control and the third were the transplanted plants. In Kecskemét, the transplanted plants grow the heights that were followed by the plants covered temporarily with plastic sheet. The control plants grow the smallest. The same was the

Table 8 The data of Kecskemét measurements

Methods	Plant height (cm)*		Number of cobs/area units				Average weight of yield	
			Cobs ofweight (kg/m²)		Number of cobs (db/m²)		(kg)	
	K. korai extra	K. SC-370	K. korai extra	K. SC-370	K. korai extra	K. SC-370	K. korai extra	K. SC-370
Transplanted	145.5	190.5	1.3	2.1	7.0	8.4	0.18	0.25
Sowed in trench, overed with perforated foil	127,5	195.7	1.5	2.6	6.1	9.4	0.25	0.29
Uncovered control	104.0	140.7	1.0	2.0	4.8	9.0	0.20	0.23

*Measuring: June 28

order of the *K. SC-370* plants while in Kecskemét the plants grown in trenches and covered temporarily with plastic sheet. Were the highest though the transplanted plants were only 5,2 cm smaller which was not significant.

The amount of crops also showed the same tendency. In Kecskemét the data were given in cobs/m², in Szarvas they were given in kg. The biggest amount of cobs with both types could be achieved with the method of sowing the seeds in trenches and covering the seedlings temporarily with plastic sheet. It was followed by the transplanted plants and the uncovered control plants.

The average weight of the cobs was higher in Szarvas, but on both locations the transplanted *Kecskeméti korai extra* plants had the lowest average cob weight. On the basis of this it can be concluded that the slow growing very early yielding plants, like *Kecskeméti korai extra* – when grown with the method of transplanting – will grow small cobs.

Upon the basis of the data registered on the two locations in connection with both types of sweet corn it can be concluded that when aiming earliness the method of transplantation is only a forced solution. It results in such little cobs that they can only be sold in average market environment – as part of the earliest harvest. In case of high standard (and full market) it runs the risk of being impossible to sell.

The method of sowing the seeds in trenches and later covering the seeds with perforated plastic sheets, however, increases earliness in a way that does not deteriorate the quality of the cobs, but results in an increase of cob weight.

References

Anonym (1986): Zuckermais als Pflanze. Die industrielle Obst- und Gemüseverwertung. 71.6: 257-262

Aylswirth, J. D. (1996): Harvest sweet corn by the fourth (July). American Vegetable Grower. 34.2: 37-38.

Kovács F. (1996): Növekszik a vetésterület. Kertészet és Szőlészet. 45.9: 18.

Mártonffy B. & Fodor Z. (1997): Részletek az Országos Zöldség Terméktanács 1996. évi információs jelentéseinek összefoglalójából. Hajtatás, Korai Termesztés. 28.1: 5-15.

Mártonffy B. & Fodor Z. (1999): A zöldségágazatok helyzete Magyarországon 1998-ban. Hajtatás, Korai Termesztés 30.2: 1-9.

Melnick, R. (1996): Clear (plastic) options for sweet corn production. American Vegetable Grower. 44.2: 17-18.

Nonnecke, L. (1989): Vegetable production. AVI. Reinhold, New York. 657 p.

Rimóczi I. (1995): Két héttel korábban. Kertészet és Szőlészet. 44.25: 23.

Rogers, I. S. & Lomman, G. J. (1988): Effects of plant spacing on yield, size and kernel fill of sweet corn. Australian Journal of Experimental Agriculture. 28:287-292.

Rubatzky, V. E. & Yamaguchi, M. (1997): World Vegetables, Principles, Production and Nutritive Values. 2nd ed. I.T.P. New York etc. 843 p.

Salisbury, F. B. & Ross, C. W. (1992): Plant Physiology. 4th ed. Wadsworth, Belmont. 682 p.

Waligora, H. (1995): Rozwoj i plonowanie kukurydzy cukrowej uprawianej na glebie przykytej folia. Prace z Zakresu Nauk Rolniczych. 7951-156.

Wayett, J. E. & Mullins, J. A. (1989): Production of sweet corn from transplants. HortScience. 24.6:1039.

Wonneberger, Ch. (1984): Zuckermais – eine alte Sonderkultur. Deutscher Gartenbau. 38.32: 1370-1371.