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EFFECT OF POLYETHYLENE GLYCOL (PEG) AND PLANTING METHODS ON SWEET CORN PRODUCTIVITY

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ABSTRACT

This study was conducted in loamy soil at Qaha Experimental Station, Horticulture Research Institute, ARC, Kalubia governorate, during 2002/2003 and 2003/2004 seasons to study the effect of PEG and planting methods on sweet corn productivity. The obtained results indicated that GSS 9377 F₁ hybrid plants produced vigorous growth and higher early and total yield than those of Endeavor F₁ hybrid. Direct seeding in the open field or under tunnels increased plant height, stem diameter, number of leaves/plant, plant fresh weight, unhusked ear weight, husked ear weight and total yield compared to transplanting methods. Transplanting produced the higher early yield either with open field or under tunnels. Primed seeds of sweet corn F₁ hybrids (GSS 9377 and Endeavor) in PEG 6000 dalton for 6 hours at the concentration of 400 g/L produced taller plants with thicker stem diameter, higher number of leaves/plant and greater fresh weight, higher unhusked and husked ear weight, ear length, higher TSS as well as early and total yield compared to check untreated seeds

INTRODUCTION

Fresh sweet corn (*Zea mays*, L. var. *Saccharata*) is a recently promising vegetable crop grown in Egypt. As an annual crop, the time from planting to seedling emergence or transplant establish-

ment is a crucial phase in the production cycle. The uniformity and percentage of seedlings emergence of the direct seeding or percent of transplant stand can have major impacts on the final yield and quality, particularly when faced with physical stresses such as extreme temperatures. **Bradford (1986)** listed the results of osmotic seed priming on several vegetable crops and mentioned that there were generally positive results for many crop species indicated that there is potential for using seed priming to improve emergence under field conditions. It was added that the obstacle for the commercial application of seed priming is the variability of results among species, varieties and even seed lot. **Waters et al. (1990)** stated that use of transplants generally had little impact beyond decreasing percent of survival and plant height compared to direct-seeding. Whereas, **Wyatt and Akridge (1993)** reported that transplanting brought forward the harvesting date by 12-20 days compared with direct sowing. In general, direct sown sweet corn produced larger plants, higher yield and larger ears than transplanted sweet corn. **Vik and Susort (1990)**, on sweet corn, mentioned that polyethylene tunnels reduced time for sowing or transplanting to harvest and this was the most important factor in increasing yield and plant quality. On average, tunnels increased yield by 29.4%, increased the first grade yield by 28% and decreased the growing season by 16 days. **Welbaum et al (2001)** worked on methods of transplanting comparing with direct-seeded production, found that the direct-seeded plants were taller with better root development than those of transplants, in all years. Transplants produced smaller, lower-quality ears than did direct-seeded plants.

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This study was, therefore, performed to investigate the influences of seed priming, growing under low tunnel and transplanting on the early production of sweet corn.

MATERIAL AND METHODS

This study was conducted at Qaha Experimental Station, Vegetables Research Department, Ministry of Agriculture, during 2002/2003 and 2003/2004 seasons in loam soil. Sweet corn seeds of Endeavor F₁ hybrid (sh₂) (obtained from Asgrow co. (USA)) and GSS9377 F₁ hybrid (sh₂) (obtained from Syngenta co., Holland) were used in this experiment.

A preliminary experiment was conducted to find out the optimum method for seed priming under the experimental conditions as described by **Bradford (1986)**. The obtained results indicated that PEG 6000 dalton at 400 g/L and soaking for 6 hr was the best treatment and it was chosen for further experiment.

The objective of this experiment was to determine the performance of the most favorable priming treatment of sweet corn seeds at early planting date, i.e., low temperature conditions. Besides to examine the influence of some planting methods on seed performances, plant growth, earliness, yield and quality of ears under such field conditions.

Sweet corn seeds of both hybrids were primed at 400 g/L PEG 6000 dalton for 6 hours and rinsed with distilled water five times till the traces of PEG were disappeared. On February 8 of 2003 and 2004, moist seeds of primed or check (unprimed) treatments were then sown in dry soil in hills, 4 seeds per hill, spaced 25 cm apart on one side of ridge of 70 cm apart. Irrigation was applied immediately after sowing; after emergence, the germinated seeds were thinned leaving two per hill.

As for transplanting, primed and check untreated sweet corn seeds were sown on the same day of direct seed treatments (February 8) in trays contained a mixture of peat moss and vermiculite (1:1 v/v). The mixture was enriched with macro and microelements and treated with Benlete (1 g/L) according to the recommendations of the Egyptian Ministry of Agriculture "the recommended transplant production media for protected cultivation. The trays were kept under a plastic house for 15 days before replanting. Plants were hardened by subjecting them for 3 days to the open field conditions. In 2003 and 2004 seasons,

the eighteen-day old plants were set up in the field at 25 cm apart on ridges of 70 cm width.

Half plots of the direct seed and transplant treatments were covered with transparent polyethylene tunnels (60 micron thickness) on the same day of sowing (February 8) or transplanting (February 26), the polyethylene tunnels were removed on March 18. The other half of plots of direct sowing and transplanting treatments were not covered with polyethylene, i.e., grown under the field conditions. The other agricultural management conducted according to the recommendation of Egyptian Ministry of Agriculture.

The experimental design

The experiment was factorial with three factors distributed in randomized complete block design with four replicates. The studied factors were hybrids (Endeavor F₁ and GSS9377 F₁), seed priming (primed and check), and planting methods (direct seed and transplanting) in the open field or under tunnels. The plot area was 12.25 m², which consisted of 5 rows 70 cm apart and 3.5 m length.

Data recorded

Fifteen plants were randomly taken at harvest from each plot and number of leaves/plant, plant height (cm) from the stalk base to tassel top, stem diameter (cm) at the fourth node and plant fresh weight were recorded:

At harvest stage "in the milky stage", thirty ears from each plot were taken randomly to record ear length (ear base to top), husked and unhusked ear weight and TSS measured by a hand refractometer. Starch, total, reducing and non reducing sugars were measured colorimetrically using spectrophotometer Model 6305 UV/visible range with 520 nm wavelength according to **Somogyi (1952) and Nelson (1974)**. Dry matter percent was determined by weighting one hundred gram of fresh kernels and then dried at 70°C until a constant weight. Early and total yield were also recorded as kg/feddan.

Statistical analysis was performed according to **Snedecor and Cochran (1989)**.

RESULT AND DISCUSSIONS

Vegetative growth

Plants of GSS 9377 F₁ hybrid were taller than those of Endeavor F₁ hybrid in both seasons, but the difference was not significant in the second

season (**Table, 1**). Direct seeding either in the open field or under tunnel resulted in increasing the plant height compared to transplanting either in the open field or under tunnels in both seasons. No statistical differences were noticed between growing the plants either in the open field or under tunnel, regardless of using direct seeding or transplanting methods. These results were true in both seasons. This result agrees with that of **Wyatt & Mullins (1989)** and with **Wyatt and Akridge (1993)**.

Regarding the effect of seed priming, results indicated that the application of PEG gave the taller plants in both seasons compared to check treatment. Concerning the effect of the tested interactions, the interaction between cultivar and planting methods showed that GSS 9377 F₁ hybrid which was direct seeded in the open field gave the tallest plants in 2003 season, but Endeavor F₁ hybrid which was direct seeded under tunnel gave the tallest plants in 2004 season. The rest of interactions were not significant.

As for stem diameter, plants of GSS 9377 F₁ hybrid had higher values of stem diameter than those of Endeavor F₁ hybrid in both growing seasons (**Table, 1**).

Direct seeding either in open field or under tunnel gave thicker stems compared to transplanting in the open field or under tunnels, in both seasons. No significant differences were detected neither between the two direct seeding treatments nor the two transplanting ones.

Regarding the seed priming, seeds treated with PEG gave plants with the higher values of stem diameter compared to check treatment.

These results are in agreement with those of **Bennett (1986)**, who stated that hydration increased the size of plants cut at 2 to 4 leaf stage. The interaction between cultivar and planting method indicated that plants of GSS 9377 F₁ hybrid planted with direct seed in the open field had the highest values of stem diameter in both seasons compared to any other interaction treatment. No significant differences were noticed for the rest of interactions.

With respect to number of leaves, plants of GSS 9377 F₁ hybrid produced higher number of leaves than those of Endeavor F₁ hybrid in both seasons (**Table, 2**). Direct seeded plants grown in the open field or under tunnel significantly gave higher number of leaves than those transplanted in the open field or tunnel treatments.

Concerning seed priming, seeds treated with PEG produced plants with high number of leaves

compared to those of check treatment in the two growing seasons. All tested interactions were not statistically significant except the interaction between cultivar and planting method in the second season where Endeavor F₁ hybrid with direct seeding under tunnel gave plants with the highest number of leaves.

As to fresh weight, plants of GSS 9377 F₁ hybrid had higher fresh weight compared with those of Endeavor F₁ hybrid in both studied seasons (**Table, 2**). Direct seeding either in the open field or under tunnels was more favourable for the simulation of fresh weight production compared to transplanting either in the open field or under tunnels. No significant differences were observed between the two transplanting methods in both seasons, but the direct seed in the open field significantly increased the plant fresh weight compared to direct seed under tunnels, only in the first season. Regarding the effect of seed priming with polyethylene glycol (PEG), the plant fresh weight increased by seed priming compared to check (dry seed) treatment in both seasons. This result agrees with that of **Bennett and Waters (1987b)**, who stated that the plant size of sweet corn was increased by using hydration treatments at an early (2 to 4 leaf) vegetative stage.

The interaction among the tested factors were not significant except for the interaction between cultivar and planting method, where the obtained data showed that GSS 9377 F₁ hybrid with direct seeding in the open field was the best treatment for increasing the fresh weight of sweet corn plants whereas transplanting the Endeavor in the open field gave the lowest values. Generally, direct seeding method increased plant fresh weight compared to transplanting method. Similar results were reported by **Aguyoh et al (1999)**.

It could be concluded that GSS 9377 F₁ hybrid produced plants with vigorous growth, expressed as plant height, stem diameter, leaf number and fresh weight, more than those of Endeavor F₁ hybrid. This might be attributed the genetical differences between the two hybrids.

Seed priming with PEG resulted in higher vegetative growth compared to the check treatment. This may be due to improving the seedling growth at early stage of plant development under cold weather which may enhance the final plant growth.

Transplanting reduced the plant height and all vegetative growth parameters and this may be attributed to the restricting of root growth and development in the root cell trays compared to direct

Table 1. Effect of hybrid, planting method and seed priming on plant height and stem diameter of sweet corn F₁ hybrids in 2002/2003 and 2003/2004 seasons.

Planting method		2002/2003			2003/2004		
		GSS	Endeavor	Mean	GSS	Endeavor	Mean
Plant height (cm)							
D. seed open	Priming	175.24	147.94	161.59	145.63	139.12	142.37
	Check	167.32	137.38	152.35	142.01	135.38	138.69
	Mean	171.28	142.66	156.97	143.82	137.25	140.53
D. seed Tunnel	Priming	161.19	149.14	155.16	143.88	169.73	156.80
	Check	158.68	144.26	151.47	134.03	143.99	139.01
	Mean	159.93	146.70	153.31	138.95	156.86	147.90
Transplanting open	Priming	159.81	139.91	149.86	136.66	117.73	127.19
	Check	149.82	126.26	138.04	131.45	116.59	124.02
	Mean	154.81	133.08	143.94	134.05	117.16	125.60
Transplanting tunnel	Priming	154.27	141.21	147.74	131.73	125.29	128.51
	Check	147.26	130.84	139.05	127.43	114.21	120.82
	Mean	150.76	136.02	143.39	129.58	119.75	124.66
Mean	Priming	162.63	144.55	153.59	139.47	137.97	138.72
	Check	155.77	134.68	145.22	133.73	127.54	130.63
	Mean	159.19	139.62		136.60	132.75	
LSD at 5% level for Hybrid (H)			4.34		NS		
Planting method (PM)			6.14		8.34		
Seed priming (SP)			4.34		5.89		
H × PM			8.67		11.77		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		
Stem diameter (mm)							
D. seed open	Priming	20.44	17.95	19.19	20.63	17.20	18.91
	Check	18.67	17.34	18.01	18.39	16.95	17.67
	Mean	19.55	17.64	18.59	19.51	17.07	18.29
D. seed Tunnel	Priming	18.82	19.04	18.93	19.39	17.87	18.63
	Check	17.16	17.68	17.42	17.33	17.36	17.34
	Mean	17.99	18.36	18.17	18.36	17.61	17.98
Transplanting open	Priming	18.71	15.19	16.95	17.41	15.31	16.36
	Check	17.30	14.98	16.14	15.95	14.70	15.32
	Mean	18.01	15.08	16.54	16.68	15.01	15.84
Transplanting tunnel	Priming	18.44	15.76	17.10	16.69	16.25	16.46
	Check	17.16	15.15	16.15	15.31	13.78	14.54
	Mean	17.80	15.45	16.62	16.00	15.01	15.50
Mean	Priming	19.10	16.98	18.04	18.53	16.66	17.59
	Check	17.57	16.29	16.93	16.74	15.69	16.21
	Mean	18.34	16.64		17.64	16.18	
LSD at 5% level for Hybrid (H)			0.57		0.45		
Planting method (PM)			0.81		0.64		
Seed priming (SP)			0.57		0.45		
H × PM			1.14		1.14		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		

Table 2. Effect of hybrid, planting method and seed priming on number of leaves/plant and plant fresh weight of sweet corn F₁ hybrids in 2002/2003 and 2003/2004 seasons.

Planting method		2002/2003			2003/2004		
		GSS	Endeavor	Mean	GSS	Endeavor	Mean
Number of leaves per plant							
D. seed open	Priming	10.86	9.88	10.37	9.50	9.09	9.29
	Check	10.49	9.49	9.99	9.01	8.66	8.83
	Mean	10.67	9.69	10.18	9.25	8.87	9.06
D. seed Tunnel	Priming	10.59	10.20	10.39	9.23	9.96	9.59
	Check	10.10	9.59	9.84	8.68	9.35	9.01
	Mean	10.34	9.89	10.11	8.95	9.65	9.30
Transplanting open	Priming	10.21	8.97	9.59	8.48	6.73	7.60
	Check	9.79	8.51	9.15	7.97	6.17	7.07
	Mean	10.00	8.74	9.37	8.22	6.45	7.33
Transplanting tunnel	Priming	9.62	9.10	9.36	8.04	7.35	7.69
	Check	9.45	8.03	8.74	7.42	6.30	6.86
	Mean	9.53	8.56	9.05	7.73	6.82	7.27
Mean	Priming	10.32	9.54	9.93	8.81	8.28	8.54
	Check	9.96	8.90	9.43	8.27	7.62	7.94
	Mean	10.14	9.22		8.54	7.95	
LSD at 5% level for Hybrid (H)			0.34		0.15		
Planting method (PM)			0.48		0.22		
Seed priming (SP)			0.34		0.15		
H × PM			NS		0.31		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		
Plant fresh weight (g)							
D. seed open	Priming	319.85	270.12	294.98	372.91	282.36	327.63
	Check	301.37	176.65	239.01	296.00	245.51	270.75
	Mean	310.61	223.38	266.99	334.45	263.93	299.19
D. seed Tunnel	Priming	245.26	279.89	262.57	323.77	339.04	331.40
	Check	216.70	236.13	226.41	259.04	292.82	275.93
	Mean	230.98	258.01	244.49	291.40	315.93	303.66
Transplanting open	Priming	279.18	191.17	235.17	215.03	180.43	197.73
	Check	220.91	146.63	183.77	179.48	151.79	165.63
	Mean	250.04	168.90	209.47	197.25	166.11	181.68
Transplanting tunnel	Priming	239.09	208.39	223.74	210.28	199.20	204.74
	Check	188.55	152.11	170.33	162.63	160.14	161.38
	Mean	213.82	180.25	197.03	186.45	179.67	183.06
Mean	Priming	270.84	237.39	254.11	280.49	250.26	265.37
	Check	231.38	177.88	204.63	224.29	212.56	218.42
	Mean	251.36	207.64		252.39	231.41	
LSD at 5% level for Hybrid (H)			11.95		15.77		
Planting method (PM)			16.89		22.30		
Seed priming (SP)			11.95		15.17		
H × PM			23.84		31.48		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		

seeding which permits more root extension and development. Therefore, the plant growth was enhanced with direct seeding compared to transplanting. Similar results were reported by **Bennett (1986)**; **Bennett & Waters (1987a & b)**; **Wyatt & Mullins (1989)**; **Wyatt & Akridge (1993)** and **Aguyah *et al* (1999)**.

Ear quality

The unhusked ear weight of GSS 9377 F₁ hybrid was heavier compared to that of Endeavor in both seasons (**Table, 3**). Direct seeding in the open field gave the heaviest ears compared to the other methods in both seasons. However, no significant difference was observed between direct seeding in the open field and under tunnel in the first season, this may be attributed to the recovery time needed in replanting processes. Similar results were reported by **Wyatt & Akridge (1993)** and **Welbaum *et al* (2001)**, who found that direct seeding produced larger ears compared to transplanting method.

Seed priming enhanced the unhusked ear weight compared to check treatment in both seasons. As for the studied interactions, the hybrid combined with planting method was significant. The heaviest ears were produced from GSS 9377 F₁ hybrid when direct seeded in the open field compared to the remainder treatments, in both seasons. No significant differences were noticed in both seasons between cultivar, planting method and seed priming. However, the heaviest unhusked ear weight was insignificantly recorded for GSS 9377 F₁ hybrid when seeds were primed with PEG and planted directly in the open field.

Respecting the husked ear weight, plant of GSS 9377 F₁ hybrid produced heavier husked ear weight compared to that of Endeavor F₁ in both seasons. Plants produced by direct seeding in the open field gave the heaviest husked ear compared to the other treatments. However, the difference was not significant in first season. The husked ears obtained from seed-primed plants were heavier than those of check treatment, although the difference was insignificant in the second season.

As for the interactions, all tested interactions were insignificant in both seasons, except for the interaction between hybrid and planting method in the first season, ears of GSS 9377 F₁ hybrid were the heaviest when primed seeds were sown in the open field.

As for ear length, the ears of GSS 9377 F₁ hybrid were taller than those of Endeavor F₁ hybrid in both seasons (**Table, 4**). No significant differ-

ences in ear length were noticed among the investigated planting methods in both seasons. Treating the seeds with PEG resulted in higher ear length compared to check treatment; however, the difference was insignificant in the first season.

As to the interactions, the only significant one was between hybrid and planting method. The highest values of ear length were recorded for those of GSS 3977 F₁ hybrid when seeds were directly sown in the open field compared to the other treatments. This held true in both seasons. It could be concluded from the previously mentioned results on ear characters that using the GSS 9377 F₁ hybrid, direct seeding in the open field or seed priming significantly improved the weight of husked and husked ear. Seed priming improved also ear length and diameter.

Chemical characters of kernels

Non reducing sugar (sucrose)

Data presented in **Table (5)** showed that no significant difference between hybrids was found in the first season but GSS 9377 F₁ hybrid recorded significantly higher sucrose percent compared to Endeavor F₁ hybrid in the second season. Similarly no significant difference was noticed among the planting methods in 2003 season but in 2004 season direct seeding methods either in the open field or under tunnel significantly improved the non reducing sugar percent compared to the transplanting methods. Seeds primed with PEG produced plants having higher non reducing sugars in their kernels compared to check treatment in both seasons.

Concerning the interaction between hybrid and planting methods, GSS 9377 F₁ hybrid with direct seeding under tunnel or Endeavor F₁ hybrid with direct seeding in the open field recorded the highest sucrose percent compared to other treatments. Seed priming with GSS 9377 F₁ hybrid gave the highest significant values in sucrose percent in the second season. No significant differences were found with the interaction between planting methods and seed priming as well as among hybrid, planting method and seed priming, in both seasons.

Reducing sugars

Kernels of GSS 9377 F₁ hybrid recorded significantly higher reducing sugars than those of Endeavor F₁ hybrid in both seasons. No significant

Table 3. Effect of hybrid, planting method and seed priming on unhusked and husked ear weight of sweet corn F₁ hybrids in 2002/2003 and 2003/2004 seasons.

Planting method		2002/2003			2003/2004		
		GSS	Endeavor	Mean	GSS	Endeavor	Mean
Unhusked ear weight (g)							
D. seed open	Priming	319.44	255.87	287.65	337.79	239.27	288.53
	Check	305.63	241.25	273.44	320.20	236.85	278.31
	Mean	312.53	248.56	280.54	328.99	237.85	283.42
D. seed Tunnel	Priming	274.47	273.33	273.90	281.38	262.41	271.89
	Check	265.96	263.62	264.79	267.68	234.78	251.23
	Mean	270.21	268.47	269.34	274.53	248.59	261.56
Transplanting open	Priming	279.39	245.27	262.33	279.85	247.14	263.49
	Check	261.07	235.59	248.33	255.76	233.35	244.55
	Mean	270.23	240.43	255.33	267.80	240.24	254.02
Transplanting tunnel	Priming	273.79	250.01	261.89	273.12	248.92	261.02
	Check	270.93	244.24	257.58	261.88	223.52	242.70
	Mean	272.36	247.12	259.74	267.50	236.22	251.86
Mean	Priming	286.77	256.12	271.44	293.03	249.43	271.23
	Check	275.89	246.17	261.03	276.38	232.02	254.20
	Mean	281.33	251.15		284.71	240.73	
LSD at 5% level for Hybrid (H)			9.90		12.90		
Planting method (PM)			14.01		18.24		
Seed priming (SP)			9.90		12.90		
H × PM			19.76		25.75		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		
Husked ear weight (g)							
D. seed open	Priming	228.79	184.84	206.81	213.43	174.27	193.85
	Check	212.20	176.09	194.14	198.67	169.41	184.04
	Mean	220.49	180.46	200.47	206.05	171.84	188.94
D. seed Tunnel	Priming	202.48	195.68	199.08	191.76	180.72	186.24
	Check	196.07	194.91	195.49	181.77	163.77	172.77
	Mean	199.27	195.29	193.05	186.76	172.24	179.50
Transplanting open	Priming	207.06	179.05	193.05	188.73	172.98	180.85
	Check	183.60	176.28	179.94	186.48	166.78	176.63
	Mean	195.33	177.66	186.49	187.60	169.88	178.74
Transplanting tunnel	Priming	203.61	182.46	193.90	183.78	179.04	181.41
	Check	194.57	173.23	188.46	171.34	160.09	165.71
	Mean	199.09	177.84	197.99	177.56	169.56	173.56
Mean	Priming	210.48	185.51	188.37	194.42	176.75	185.58
	Check	196.61	180.13		184.56	165.01	174.78
	Mean	203.55	182.82		189.49	170.88	
LSD at 5% level for Hybrid (H)			8.61		7.47		
Planting method (PM)			NS		10.56		
Seed priming (SP)			8.61		NS		
H × PM			17.19		NS		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		

Table 4. Effect of hybrid, planting method and seed priming on ear length of sweet corn F₁ hybrids in 2002/2003 and 2003/2004 seasons.

Planting method		2002/2003			2003/2004		
		GSS	Endeavor	Mean	GSS	Endeavor	Mean
Ear length (cm)							
D. seed open	Priming	20.45	16.35	18.40	20.45	16.59	18.52
	Check	19.84	16.18	18.01	19.65	16.26	17.95
	Mean	20.14	16.26	18.20	20.05	16.42	18.23
D. seed Tunnel	Priming	17.79	18.25	18.02	19.45	18.34	18.89
	Check	17.23	18.09	17.66	18.59	17.14	17.86
	Mean	17.51	18.17	17.84	19.02	17.74	18.38
Transplanting open	Priming	20.46	16.29	18.37	20.12	17.24	18.68
	Check	18.98	16.06	17.52	19.13	16.77	17.95
	Mean	19.72	16.17	17.94	19.62	17.01	18.31
Transplanting tunnel	Priming	17.61	17.23	17.42	19.45	17.44	18.44
	Check	17.56	17.20	17.38	18.41	16.54	17.47
	Mean	17.58	17.21	17.41	18.93	16.99	17.96
Mean	Priming	19.08	17.03	18.05	19.87	17.40	18.63
	Check	18.40	16.88	17.64	18.94	16.68	17.81
	Mean	18.74	16.96		19.41	17.04	
LSD at 5% level for Hybrid (H)			0.44		0.39		
Planting method (PM)			NS		NS		
Seed priming (SP)			NS		0.39		
H × PM			0.87		0.78		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		

Table 5. Effect of hybrid, planting method and seed priming on non-reducing and reducing sugars (g/100 g fresh weight) in kernels of sweet corn hybrids in 2002/2003 and 2003/2004 seasons.

Planting method		2002/2003			2003/2004		
		GSS	Endeavor	Mean	GSS	Endeavor	Mean
Non-reducing sugars (g/100 g fresh weight)							
D. seed open	Priming	4.16	4.27	4.21	4.76	4.37	4.56
	Check	3.34	4.14	3.74	3.06	3.91	3.48
	Mean						
D. seed Tunnel	Priming	4.48	3.94	4.21	5.33	3.64	4.48
	Check	4.44	3.47	3.95	4.19	2.76	3.47
	Mean	4.46	3.70	4.08	4.76	3.20	3.98
Transplanting open	Priming	3.97	4.30	4.13	3.38	3.69	3.53
	Check	3.46	3.98	3.72	2.93	3.07	3.00
	Mean	3.71	4.14	3.92	3.15	3.38	3.26
Transplanting tunnel	Priming	4.43	4.12	4.27	3.91	3.02	3.46
	Check	3.89	3.24	3.56	3.09	2.59	2.84
	Mean	4.16	3.68	3.92	3.50	2.80	3.15
<i>Mean</i>	Priming	4.26	4.16	4.21	4.14	3.68	3.91
	Check	3.78	3.71	3.74	3.32	3.08	3.20
	Mean	4.02	3.93		3.73	3.38	
LSD at 5% level for Hybrid (H)			NS		0.19		
Planting method (PM)			NS		0.27		
Seed priming (SP)			0.29		0.19		
H × PM			0.59		0.38		
H × SP			NS		0.26		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		
Reducing sugars (g/100 g fresh weight)							
D. seed open	Priming	1.46	1.02	1.24	1.64	1.02	1.33
	Check	1.69	0.95	1.32	1.89	0.89	1.39
	Mean	1.57	0.98	1.28	1.76	0.95	1.36
D. seed Tunnel	Priming	1.32	1.08	1.20	1.44	1.22	1.33
	Check	1.26	1.25	1.25	1.18	1.45	1.31
	Mean	1.29	1.16	1.22	1.31	1.33	1.32
Transplanting open	Priming	1.28	0.94	1.11	1.51	1.11	1.31
	Check	1.53	0.85	1.19	1.70	0.87	1.28
	Mean	1.40	0.89	1.50	1.60	0.99	1.29
Transplanting tunnel	Priming	1.10	0.98	1.04	1.47	1.19	1.33
	Check	1.16	1.19	1.17	1.29	1.31	1.30
	Mean	1.13	1.08	1.10	1.38	1.25	1.31
<i>Mean</i>	Priming	1.29	1.01	1.15	1.51	1.13	1.32
	Check	1.41	1.06	1.23	1.51	1.13	1.32
	Mean	1.35	1.03		1.51	1.13	
LSD at 5% level for Hybrid (H)			0.18		0.18		
Planting method (PM)			NS		NS		
Seed priming (SP)			NS		NS		
H × PM			NS		0.36		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		

differences were noticed among planting methods, seed priming and all studied interactions on the reducing sugar content of ears in both seasons, with one exception, i.e., the interaction between hybrids and planting methods in the second season.

Total sugars

As presented in **Table (6)**, kernels of GSS 9377 F₁ hybrid contained higher total sugar percent compared to those of Endeavor F₁ hybrid in 2003 and 2004 seasons. Concerning planting method, direct seeding methods either in the open field or under tunnel gave higher total sugar percent compared to transplanting methods either in the open field or under tunnel. But the difference was not significant in the first season. Similarly, insignificant increase was observed for seed priming in 2003 season but seed priming increased significantly total sugars percent in 2004 season.

Concerning the interactions, no significant differences were recorded for all tested interaction except for hybrid combined with planting methods in the second season. GSS 9377 F₁ hybrid with direct seeding under tunnel recorded the highest value of total sugar percent.

Starch

Data presented in **Table (6)** showed that there were no significant differences in starch values for any tested factor or their possible interactions. This result was true for both seasons.

Dry matter

There was no significant difference in dry matter percent of kernels between the studied hybrids in the first season, whereas Endeavor F₁ hybrid showed higher dry matter percent than GSS 9377 F₁ hybrid in the second season (**Table, 7**). Concerning planting methods, no significant difference was recorded among the planting methods in the first season while transplanting methods either in the open field or under tunnel recorded the highest value in dry matter in the second season. Regarding seed priming, the obtained data showed that seed priming increased dry matter percent in kernels compared with check treatment in both season.

Concerning the interactions, no significant differences were recorded for the investigated interactions of the three studied factors.

Total soluble solids (TSS)

Data in **Table (7)** indicated that GSS 9377 F₁ hybrid kernels recorded higher values of TSS compared to those of Endeavor F₁ hybrid in both seasons. As for planting methods, no significant difference in TSS was found among the investigated direct seeding and transplanting methods in both seasons. The obtained data indicated also that seed priming increased the TSS values of kernels compared with check treatment in both seasons.

Concerning the studied interactions of the three tested factors, no significant differences were recorded in both seasons, except for the interaction between hybrid and planting methods in the second season. GSS 9377 F₁ hybrid with transplanting under tunnel was the best treatment in increasing TSS in the second season.

Yield

Early yield

Plants of GSS 9377 F₁ hybrid recorded higher early yield compared to Endeavor F₁ hybrid for both seasons. GSS 9377 F₁ hybrid increased the early yield by 26.27% and 27.54% compared to Endeavor F₁ hybrid in 2003 and 2004 seasons, respectively (**Table 8**). Transplanting methods either in the open field or under tunnels gave higher early yield compared to direct seeding methods for both seasons. Similar results was reported by **Miller (1972)**; **Wyatt & Mullins (1989)**; **Vik & Susort (1990)**; **Waters et al (1990)**; **Felczynki et al (1994)** and **Welbaum et al (2001)**, who found that transplanting gave higher early yield than direct seeding.

Concerning seed priming, seeds treated with PEG enhanced the early yield significantly in both seasons compared to the check treatment. Seed priming increased early yield by 26.91% and 24.58% in 2003 and 2004 seasons, respectively.

Regarding the interactions, plants of GSS 9377 F₁ hybrid transplanted under tunnel recorded the highest early yield compared to other treatments. The interaction among hybrid, planting method and seed priming showed that GSS 9377 F₁ hybrid transplanted under tunnels using primed seeds produced significantly the highest early yield in both seasons.

Total yield

GSS 9377 F₁ hybrid plants produced higher total yield than those of Endeavor F₁ hybrid as

Table 6. Effect of hybrid, planting method and seed priming on total sugars % and starch % in kernels of sweet corn F₁ hybrids in 2002/2003 and 2003/2004 seasons

Planting method		2002/2003			2003/2004		
		GSS	Endeavor	Mean	GSS	Endeavor	Mean
Total sugars (g/100 g fresh weight)							
D. seed open	Priming	5.62	5.29	5.45	6.40	5.39	5.89
	Check	5.03	5.09	5.06	4.96	4.81	4.88
	Mean	5.32	5.19	5.25	5.68	5.10	5.38
D. seed Tunnel	Priming	5.79	5.02	5.40	6.77	4.88	5.82
	Check	5.70	4.72	5.21	5.37	4.21	4.79
	Mean	5.74	4.87	5.30	6.07	4.54	5.30
Transplanting open	Priming	5.25	5.24	5.24	4.89	4.81	4.85
	Check	4.99	4.84	4.91	4.64	3.93	4.28
	Mean	5.12	5.04	5.07	4.76	4.37	4.56
Transplanting tunnel	Priming	5.53	5.10	5.31	5.13	4.21	4.67
	Check	5.05	4.43	4.74	4.38	3.90	4.14
	Mean	5.29	4.76	5.02	4.75	4.05	4.40
Mean	Priming	5.55	5.16	5.35	5.79	4.82	5.30
	Check	5.19	4.77	4.98	4.84	4.21	4.52
	Mean	5.37	4.97		5.32	4.52	
LSD at 5% level for Hybrid (H)			0.40			0.29	
Planting method (PM)			NS			0.41	
Seed priming (SP)			NS			0.29	
H × PM			NS			0.59	
H × SP			NS			NS	
PM × SP			NS			NS	
H × PM. × SP			NS			NS	
Starch (g/100 g fresh weight)							
D. seed open	Priming	1.84	1.44	1.64	1.80	1.71	1.75
	Check	2.04	1.48	1.76	1.97	1.76	1.86
	Mean	1.94	1.46	1.70	1.88	1.73	1.80
D. seed Tunnel	Priming	1.35	1.75	1.55	1.50	1.81	1.65
	Check	1.79	2.38	2.08	1.91	2.09	2.00
	Mean	1.57	2.06	1.81	1.70	1.95	1.82
Transplanting open	Priming	1.52	1.86	1.69	1.46	1.76	1.61
	Check	1.68	2.65	2.16	1.97	2.06	2.01
	Mean	1.60	2.25	1.92	1.71	1.91	1.81
Transplanting tunnel	Priming	1.66	2.01	1.83	1.69	1.73	1.71
	Check	2.03	2.06	2.04	1.89	2.10	1.99
	Mean	1.84	2.03	1.93	1.79	1.91	1.85
Mean	Priming	1.72	1.76	1.74	1.61	1.75	1.68
	Check	1.88	2.14	2.01	1.93	2.00	1.96
	Mean	1.80	1.95		1.77	1.88	
LSD at 5% level for Hybrid (H)			NS			NS	
Planting method (PM)			NS			NS	
Seed priming (SP)			NS			NS	
H × PM			NS			NS	
H × SP			NS			NS	
PM × SP			NS			NS	
H × PM. × SP			NS			NS	

Table 7. Effect of hybrid, planting method and seed priming on dry matter % and TSS in kernels of sweet corn F₁ hybrids in 2002/2003 and 2003/2004 seasons.

Planting method		2002/2003			2003/2004		
		GSS	Endeavor	Mean	GSS	Endeavor	Mean
Dry matter %							
D. seed open	Priming	20.49	16.35	18.42	23.34	21.78	22.56
	Check	19.84	16.18	18.01	17.21	21.65	19.43
	Mean	20.16	16.26	18.21	20.27	21.71	20.99
D. seed Tunnel	Priming	17.79	18.25	18.02	21.53	20.46	20.99
	Check	17.23	18.09	17.66	21.34	19.46	20.40
	Mean	17.51	18.17	17.84	21.43	19.96	20.69
Transplanting open	Priming	20.46	16.29	18.37	21.34	24.81	23.07
	Check	18.98	16.06	17.52	21.04	23.40	22.22
	Mean	19.72	16.17	17.94	21.19	24.10	22.64
Transplanting tunnel	Priming	17.61	17.23	17.42	25.15	25.56	25.35
	Check	17.56	17.20	17.38	20.11	23.85	21.98
	Mean	17.85	17.21	17.40	22.63	24.70	23.66
Mean	Priming	19.09	17.03	18.06	22.84	23.15	22.99
	Check	18.40	16.88	17.64	19.92	22.09	21.01
	Mean	18.74	16.96		21.38	22.62	
LSD at 5% level for Hybrid (H)			NS		1.19		
Planting method (PM)			NS		1.69		
Seed priming (SP)			0.89		1.19		
H × PM			NS		NS		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		
Total soluble solids							
D. seed open	Priming	16.07	13.15	14.61	15.50	13.99	14.74
	Check	15.07	12.98	14.02	13.11	13.95	13.53
	Mean	15.57	13.06	14.31	14.30	13.97	14.13
D. seed Tunnel	Priming	16.04	13.25	14.64	15.01	14.29	14.65
	Check	15.90	11.74	13.82	14.73	13.75	14.24
	Mean	15.97	12.49	14.23	14.87	14.02	14.44
Transplanting open	Priming	15.25	13.53	14.39	14.03	14.58	14.30
	Check	14.67	12.56	13.61	13.56	14.13	13.84
	Mean	14.96	13.04	14.00	13.79	14.35	14.07
Transplanting tunnel	Priming	15.72	12.45	14.08	15.98	13.94	14.98
	Check	15.52	12.00	13.76	14.89	13.63	14.26
	Mean	15.62	12.22	13.92	15.43	13.78	14.61
Mean	Priming	15.77	13.09	14.43	15.13	14.20	14.66
	Check	15.29	12.32	13.80	14.07	13.86	13.96
	Mean	15.53	12.71		14.60	14.03	
LSD at 5% level for Hybrid (H)			0.49		0.53		
Planting method (PM)			NS		NS		
Seed priming (SP)			0.49		0.53		
H × PM			NS		1.63		
H × SP			NS		NS		
PM × SP			NS		NS		
H × PM. × SP			NS		NS		

Table 8. Effect of hybrid, planting method and seed priming on early yield of sweet corn F₁ hybrids in 2002/2003 and 2003/2004 seasons.

Planting method		2002/2003			2003/2004		
		GSS	Endeavor	Mean	GSS	Endeavor	Mean
Early yield ton/feddan							
D. seed open	Priming	8.34	8.54	8.44	7.61	6.89	7.25
	Check	6.82	6.43	6.62	9.53	5.98	7.75
	Mean	7.58	7.48	7.53	8.57	6.43	7.50
D. seed Tunnel	Priming	10.77	6.57	8.67	8.89	6.38	7.63
	Check	8.73	5.85	7.29	6.78	6.12	6.45
	Mean	9.75	6.21	7.98	7.63	6.25	7.04
Transplanting open	Priming	9.00	9.49	9.24	10.47	10.16	10.30
	Check	7.18	6.60	6.89	8.61	6.65	7.63
	Mean	8.09	8.04	8.06	9.54	8.40	8.97
Transplanting tunnel	Priming	11.76	7.23	9.49	11.26	9.33	10.29
	Check	8.90	5.94	7.42	10.24	6.03	8.13
	Mean	10.33	6.58	8.45	10.75	7.68	9.21
Mean	Priming	9.97	7.96	8.96	9.56	8.19	8.87
	Check	7.91	6.21	7.06	8.04	6.19	7.12
	Mean	8.94	7.08		9.17	7.19	
LSD at 5% level for Hybrid (H)			0.33			0.34	
Planting method (PM)			0.46			0.48	
Seed priming (SP)			0.33			0.34	
H × PM			0.66			0.67	
H × SP			NS			NS	
PM × SP			NS			0.67	
H × PM. × SP			0.93			0.95	
Total yield (ton/feddan)							
D. seed open	Priming	15.12	14.42	14.77	23.04	13.38	18.21
	Check	13.79	12.88	13.33	22.32	11.27	16.79
	Mean	14.45	13.65	14.05	22.68	12.32	17.50
D. seed Tunnel	Priming	18.62	13.79	16.20	23.67	11.50	17.58
	Check	12.67	12.79	12.73	18.39	9.75	14.07
	Mean	15.64	13.29	14.46	21.03	10.62	15.82
Transplanting open	Priming	13.45	12.52	12.98	16.25	11.82	14.03
	Check	9.61	9.44	9.52	14.41	11.30	12.85
	Mean	11.53	10.98	11.25	15.33	11.56	13.44
Transplanting tunnel	Priming	14.58	10.98	12.78	17.10	10.74	13.92
	Check	10.27	9.04	9.65	15.72	9.83	12.77
	Mean	12.42	10.01	11.21	16.41	10.28	13.34
Mean	Priming	15.44	12.93	12.93	20.02	11.86	15.94
	Check	11.58	11.04	11.04	17.71	10.54	14.12
	Mean	13.51	11.98		18.86	11.19	
LSD at 5% level for Hybrid (H)			0.79			0.92	
Planting method (PM)			1.12			1.30	
Seed priming (SP)			0.79			0.92	
H × PM			1.12			NS	
H × SP			NS			1.84	
PM × SP			NS			NS	
H × PM. × SP			NS			NS	

shown in **Table (8)**, such increase amounted to 12.77% and 68.54% in the first and second seasons, respectively. Direct seeding either in the open field or under tunnels recorded higher total yield compared to transplanting methods in both seasons.

Similar results were reported by **Vik & Susort (1990)** and **Wyatt & Akridge (1993)**. Treating seeds with PEG increased the total yield by 17.12% and 12.89% compared to those of check treatment in 2003 and 2004 seasons, respectively. Concerning the interactions, direct seeding plants of GSS 9377 F₁ hybrids grown either in the open field or under tunnels recorded the higher total yield compared to those of transplanting, in both seasons. However, the difference was not significant in the second season. Seed priming of GSS 8377 F₁ hybrids gave the highest total yield in both seasons compared to the other treatments of hybrids and seed priming interaction. The other interactions were not significant.

It could be concluded that the GSS 9377 F₁ hybrid recorded the higher values in early and total yield. This might be due to increasing the plant growth parameters which might be reflected on the final performance in early and total yield or may be attributed to the genetic differences between the two hybrids.

Transplanting gave higher early yield compared to direct seeding. This might be attributed to that transplanting method permits more protection for plants during the cold weather at the early stage of plant growth. On the other hand, direct seeding methods increased the total yield compared to transplanting. This might be attributed to the stimulation of plant growth parameters due to direct seeding.

Also, seed priming increased the early yield and total yield through improvement of germination percent under stress condition and increasing the stand establishment, in addition to increasing the plant growth.

From this experiment we can conclude that regardless of the genetic differences in the two cultivars the effect of the planting methods coupled with seed priming by PEG treatments resulted in an economic impact per unit area in practical application.

In economic point of view about PEG treatments, it worth to mention that the Egyptian local price of 1 kg from PEG 6000 dalton equals 35 LE. (Egyptian pound), as we know one feddan take from 6-7 kg / grain seeds for planting, seed priming by use PEG 6000 dalton was (400g/L. of wa-

ter) therefore, we can using about 1.6 kg PEG/ Fed., that coast 65 Egyptian pound to enhanced the early and total yield based on the results of the present study.

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مجلة اتحاد الجامعات العربية
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تأثير المعاملة بالبولي إيثيلين جليكول وطرق الزراعة علي إنتاجية الذرة السكرية

[١٣]

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الغلاف وكذلك المحصول الكلي وذلك عند مقارنتها بطرق زراعة الذرة السكرية بالشتل. الشتل أنتج أعلى محصول مبكر سواء بالزراعة في الحقل المكشوف (بدون تغطية) أو بالزراعة تحت أنفاق. البذور المنقوعة في محلول البولي إيثيلين جليكول من النوع 6000 دالتون لمدة 6 ساعات وبتركيز 400 جم/ لتر أنتجت أكثر النباتات طولاً مع أكبر سمك لساق النبات مع أكبر عدد لأوراق النبات وأعلى وزن طازج، أكبر وزن للكيهان سواء بالغلاف أو بدون الغلاف، أطول كيزان وأعلى نسبة من المواد الصلبة الذائبة الكلية وأعلى محصول كلي ومبكر عند مقارنتها بالبذور غير المعاملة.

أجريت هذه الدراسة في تربة طميية بالمحطة التجريبية بقها التابعة لمعهد بحوث البساتين مركز البحوث الزراعية خلال أعوام ٢٠٠٢/٢٠٠٣ و ٢٠٠٣/٢٠٠٣. لدراسة تأثير المعاملة بالبولي إيثيلين جليكول وطرق الزراعة علي إنتاجية الذرة السكرية وأوضحت النتائج أن نباتات هجين الذرة السكرية (GSS9377) أعطت أفضل قوة في النمو وأعلى محصول مبكر وكلي عند مقارنتها بنباتات الهجين انديفور. الزراعة بالبذرة مباشرة في الأرض المستديمة سواء في الحقل المكشوف (بدون تغطية) أو الزراعة تحت أنفاق أدت إلي زيادة كلاً من : ارتفاع النبات ، قطر النبات ، عدد الأوراق للنبات ، الوزن الطازج ووزن الكوز بالغلاف و—ون

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