

EFFECT OF HILL SPACING AND CEASE IRRIGATION BEFORE HARVESTING ON SOM SUGAR BEET VARIETIES UNDER SANDY SOILS.

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ABSTRACT

Two field trials were conducted during 2009/2010 and 2010/2011 seasons, in Tamia District, El-Fayoum Governorate, Egypt, to study the effect of two cease irrigation before harvest periods (10 and 20 days) and three spaces between hills (15, 20 and 25 cm) on performance of three varieties (Pleno, Samba and Lola). Cease irrigation 10 days before harvest significantly increased root and top fresh weight, while cease irrigation 20 days before harvest significantly increased sugar yield/fed, percentages of sucrose, TSS and purity. Root and sugar yield /fed, and sucrose% were significantly increased with reducing spacing hills. Spacing of 15 to 20 cm between hills had the best quality traits. Samba variety had the highest values of root and sugar yields /fed as well as sucrose and purity percentages. Ceasing irrigation and varieties interaction had a significant effect on quality traits, as well as root and sugar yields/fed. Under this study sugar beet can be cultivated on 20 cm hill spacing with cease irrigation at 20 days before harvesting to maximize sucrose% as well as yields of root and sugar yields/fed.

Keywords: Sugar beet, *Beta vulgaris*, L., hill spacing, cease irrigation and varieties

INTRODUCTION

Limited moisture stress to increase concentration without reducing or only slightly reducing gross sugar yield can be profitable practice. The length of the interval between the last irrigation and harvest can be tolerated will depend on local weather, soil type, soil depth, root distribution, and the extent to which the soil water reservoir is filled at irrigation cutoff. Bailey (1990) found that ceasing irrigation from 10 to 30 days before harvest decreased fresh weight of root and top, root yield and sugar yield. On the other hand, sucrose % was increased from 13.8 to 15.0%. Shalaby (1998) used different intervals (10, 17, 24 and 31 days) between the last irrigation and harvest date. He found that the interval of irrigation cut off 31 days, reduced top fresh weight per plant, individual root weight as well as root yield, top yield and sugar yield per feddan.

On the other hand, sucrose, purity percentages increased. Ramadan (1999-a) found that with holding irrigation 10 days before harvest increased root weight. Root yield increased by 2.4 and 3.00 tons as the last irrigation was delayed 20 to 10 days before harvest, respectively. Sucrose, purity were increased when irrigation was with-held 30 days before harvest. He added that the interaction between varieties and with holding irrigation reached the

least of significance in root, top reached weight/plant, purity and sucrose percentages, as well as roots and sugar yields/fed. Aly (2000) found that root yield/fed was increased when with-held 10 days before harvest, on the other hand, sucrose, purity percentages increased with-hold irrigation was in 20 days before harvest. However, some workers reported that sucrose and purity percentage decreased linearly as population density decreased. Yousef and Gholamrez (2011) found that increasing length of irrigation cutoff date from 10 to 40 days before harvest reduced root yield but increased purity% and sucrose% and sugar yield.

Studies carried out in Egypt demonstrated that the highest root and sugar yields were recommended spacing of 15 or 20 cm between hills and 60 cm between rows for the highest root and sugar yields. Kamel, *et al.* (1989) and Lauer (1995) obtained the highest sugar yield from 70 to 100 thousand plants/ha. Studies carried out in Egypt demonstrated that the highest root and sugar yields were obtained from 20X50 cm spacing. Ramadan, (1999-b) reported that sucrose content, purity percentages were linearly reduced with the reduction in plant density. While, root and sugar yields were maximized when beets were growing at 42000 plants/fed. Variety and plant density interaction had a significant effect on sucrose % . Nafei *et al* (2010) found that increasing plant spacing from 20cm to 30cm caused significant response in root length, diameter, fresh weight/plants, sucrose%, total soluble solids, phosphorus% in roots as well as top, root and sugar yield (ton/fed) in both seasons. Shalaby *et al* (2011) they found that significantly increase in root fresh weight, sucrose% and root and sugar yields/fed with increasing distance between hills from 15 to 25cm.

The differential response of sugar beet varieties to plant density has been reported by Hanna, *et al.* (1988) found a significant interaction between varieties and plant density for root yield and sugar content. Shalaby (1998) found a significant interaction between varieties x irrigation cut off for individual root weight, TSS% and sucrose %, as well as root and sugar yields/fed. Gradual reduction in root and sugar yield of both varieties was reported as the period of irrigation cut off before harvest was increased. Ramadan, (1999-b) reported that sucrose content, purity percentages were linearly reduced with the reduction in plant density. While, root and sugar yields were maximized when beets were growing at 42000 plants/fed, while interaction effect between varieties x plant density was significant on sucrose % and purity %. Aly (2000) found that varieties differed significantly in growth traits i.e. individual root weight, root yield and recoverable sugar yield. The variety Panther had the best one in these attributes. On the other hand the variety Kawemira had the highest percentage of recoverable sugar and top yield/fed. Moreover, the interaction between irrigation cut off X varieties had a significant effect on TSS%, sucrose % and purity%. Shalaby *et al* (2011) reported that Kawemira variety significantly surpassed on the others in root fresh weight/plant, sucrose and roots and yields/fed.

This study was conducted to determine the effect of the optimum time to cease irrigation before harvest and density population on performance of some sugar beet varieties in sandy soil.

MATERIALS AND METHODS

This investigation was carried out at Tamia district, El-Fayoum Governorate during 2009/2010 and 2010/2011 seasons to study the effect of cease irrigation (10 and 20 days before harvest) and three hill spaces 60×15 cm (46700 plants/fed.), 60×20 cm (35000 plants/fed.) and 28000 plants/fed (60×25 cm) on three sugar beet varieties, i.e (Pleno, Samba and Lola).

The soil was sandy loam with available nitrogen of 6 and 8 ppm, EC 3.06 and 2.77 mmhos/cm and pH soil paste 8.1 and 8.3 in the first and second season, respectively.

Treatments were arranged in a split plot design of three replicates. Cease irrigation days was placed in the main plots, while hill spaces treatments and sugar beet varieties were placed randomly in sub-plots. Each sub plot consisted of 5 rows, 6 m long, and 60 cm apart, the area of sub plot about 18m² (1/233) per feddan. Phosphorus at the rate of 30kg P₂O₅ fed⁻¹ and Potassium at rate of 24 kg K₂O fed⁻¹ were applied through preparing the soil. Nitrogen was applied as ammonium nitrate (33.5% N) at the rate of 100 kg N/fed as two equal doses after and after month later. The trials were planted on October 1th and October 3rd in 2009/2010 and 2010/2011, respectively.

Harvest was done after 7 months from planting. The sugar beets plants were hand harvested and hand topped. Roots were weighted to determine root yield /fed, number of harvested roots/fed. At harvest a sample of ten roots were taken at random each sub plot to determine root fresh weight, top fresh weight, sucrose % according to A.O.A.C. (1984), Total soluble solids (TSS%) percentage (measured by digital hand Refractometer) and Purity % (Sucrose % x100/TSS %). Also, root yield /fed., sugar yield /fed. (Root yield/fed x sucrose % /100) and number of harvested roots were recorded.

The collected data were subjected to the proper statistical analysis of variance as described by Snedecor and Cochran (1967). Treatment means were compared using LSD at 5% level of significance (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

1. Effect of ceasing irrigation before harvesting

Data presented in Table 1 reveal that ceasing irrigation before harvesting had a significant effect on all sugar beet characteristics in both seasons, except root and sugar yields in 2009/2010 season. Ceasing irrigation before harvesting at 10 days gave the highest root fresh weight, top fresh weight, and root yield. However, ceasing irrigation by 20 days before harvest gave the highest sugar yield, sucrose %, TSS% and purity %. So, to get maximum sugar yield of sugar beet in El-Fayoum, it is recommended to cutoff irrigation at 20 days before harvesting. Consequently, shorting the interval cutoff irrigation before harvesting become waste or unavailalable water. These results are in agreement with those obtained by Shalaby (1998), Aly (2000) and Yousef and Gholamrez (2011).

2. Effect of spacing hills.

Data in Table 1 show significant differences between spacing hills in all studied characters in both seasons, except, sucrose % in 2010/2011 season where differences did not reach the level of significance. Sowing sugar beet on 15 cm spacing hills gave the highest top fresh weight, root yield, sugar yield /feddan and sucrose % in both seasons. However, the 20 cm spacing hills gave the highest root fresh weight in 2009/2010 season and purity % in both seasons. Sowing sugar beet on 25 cm space hills gave highest TSS% in both seasons. Similar results were found with those obtained by Ramadan (1999-b), Nafei *et al* (2010) and Shalaby *et al* (2011).

Table (1a): Some sugar beet characteristics as affected by ceasing irrigation, spacing hills and sugar beet varieties in 2009/2010 and 2010/2011 seasons.

Treatments	Root fresh weight/ plant(kg)		Top fresh weight/ plant(kg)		Root yield (t/fed)		Sugar yield (t/fed)	
	2009/ 10	2010/ 11	2009/ 10	2010/ 11	2009/ 10	2010/ 11	2009/ 10	2010/ 11
Ceasing irrigation								
10 days	1.132	1.119	0.361	0.283	25.59	26.00	4.32	4.43
20 days	1.053	1.048	0.322	0.256	25.46	25.68	4.42	4.58
LSD at 5%	0.024	0.019	0.018	0.019	N.S	0.11	N.S	0.09
Spacing hills								
15 cm	1.042	1.065	0.355	0.298	31.52	32.40	5.45	5.63
20 cm	1.097	1.081	0.357	0.265	24.97	24.72	4.19	4.33
25 cm	1.091	1.104	0.313	0.245	19.97	20.39	3.47	3.54
LSD at 5%	0.017	0.029	0.016	0.019	1.51	1.18	0.16	0.29
Varieties								
Pleno	1.090	1.073	0.345	0.270	25.25	25.89	4.26	4.49
Samba	1.054	1.089	0.348	0.277	25.72	25.79	4.61	4.62
Lola	1.086	1.087	0.333	0.261	25.01	25.84	4.23	4.40
LSD at 5%	0.013	0.010	N.S	N.S	0.18	0.03	0.10	0.06

Table (1b). Some sugar beet quality characteristics as affected by ceasing irrigation, hill spacing and sugar beet varieties in 2009/2010 and 2010/2011 seasons

Treatments	Sucrose %		TSS %		Purity %	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
Ceasing irrigation						
10 days	16.52	17.01	19.99	20.82	84.41	81.74
20 days	17.60	17.84	20.73	22.12	84.89	84.38
LSD at 5%	0.17	0.25	0.27	0.31	0.16	1.03
Spacing hills						
15 cm	17.32	17.41	20.08	21.13	84.79	82.02
20 cm	17.17	17.49	19.95	21.20	85.47	84.19
25 cm	16.70	17.38	20.20	21.75	83.68	82.98
LSD at 5%	0.18	N.S	0.11	0.12	0.42	0.22
Varieties						
Pleno	16.53	17.36	19.80	21.52	85.05	82.49
Samba	17.87	17.88	20.33	21.17	84.77	83.81
Lola	16.78	17.04	20.10	21.40	84.13	82.89
LSD at 5%	0.35	0.26	0.15	0.08	0.45	0.36

3. Varietal differences.

As shown in Table 1 significant difference between sugar beet varieties at all characters under study in both seasons. The Samba variety was superior in root and top fresh weights, root and sugar yields, sucrose %, TSS % and purity% in both seasons. This result was in line with those reported by, Shalaby (1998), Aly (2000) and Shalaby (2011).

4. Ceasing irrigation and hill spacing interaction.

Data presented in Table 2 show that interaction between ceasing irrigation and spacing hills had significant effect on all studied characters in both seasons. Ceasing irrigation 10 days before harvest with sowing on 15 cm space between hills gave the highest top fresh weight, root yield /feddan in both season and sugar yield ton/feddan in 2nd season. However, ceasing irrigation at 10 days before harvesting with sowing on 25 cm spacing between hills gave the highest root fresh weight (kg) and gave the lowest sucrose and TSS percentage.

Table (2a): Some sugar beet significant characteristics as affected by interaction between ceasing irrigation and spacing hills in 2009/2010 and 2010/2011 seasons

Ceasing irrigation x hill spacing	Root fresh weight/ plant(kg)		Top fresh weight/ plant (kg)		Root yield (t/fed)		Sugar yield (t/fed)	
	2009/ 10	2010/ 11	2009/ 10	2010/ 11	2009/ 10	2010/ 11	2009/ 10	2010/ 11
10 days x 15 cm	1.073	1.119	0.386	0.317	31.78	33.87	5.35	5.81
10 days x 20 cm	1.112	1.108	0.381	0.279	24.83	23.57	4.07	4.00
10 days x 25 cm	1.118	1.129	0.317	0.252	19.93	20.55	3.53	3.47
20 days x 15 cm	1.011	1.010	0.325	0.279	31.27	30.92	5.54	5.45
20 days x 20 cm	1.083	1.055	0.333	0.251	25.11	25.88	4.30	4.66
20 days x 25 cm	1.064	1.078	0.309	0.238	20.01	20.24	3.42	3.62
LSD at 5%	0.042	0.067	0.041	0.055	2.89	3.12	0.87	0.68

Table (2b): Some sugar beet significant characteristics as affected by interaction between ceasing irrigation and hill spacing in 2009/2010 and 2010/2011 seasons

Ceasing irrigation x hill spacing	Sucrose %		TSS %	Purity%	
	2010/11	2009/10	2010/11	2009/10	2010/11
10 days x 15 cm	16.90	17.18	21.27	84.06	80.80
10 days x 20 cm	16.57	16.98	20.63	85.26	82.30
10 days x 25 cm	16.10	16.87	20.57	83.91	82.13
20 days x 15 cm	17.73	17.63	22.00	85.52	83.25
20 days x 20 cm	17.77	17.99	21.77	85.69	86.08
20 days x 25 cm	17.30	17.89	22.60	83.45	83.82
LSD at 5%	0.61	0.42	0.56	0.91	1.82

Ceasing irrigation at 20 days before harvest with 20 cm spacing between hills produced highest values of sucrose % and purity %. Ceasing irrigation at 10 days before harvest with 25 cm spacing between hills recorded the lowest sucrose % and TSS% however, ceasing irrigation at 20 days before harvest with 25 cm spacing between hills decreased top fresh weight, root yield /feddan and purity %.

5. Ceasing irrigation × Varieties.

Results in Table 3 show that interaction effect between ceasing irrigation treatments and sugar beet varieties was significant. The variety Samba under ceasing irrigation at 10 days before harvest gave the highest root fresh weight, root yield. However, the variety Lola under ceasing irrigation at 10 days before harvest gave the highest values of root fresh weight, root yield /feddan, sucrose % and purity% in 2nd season. Furthermore, the same variety under ceasing irrigation at 20 days before harvest gave the highest root fresh weight, root yield /feddan, sugar yield /feddan, TSS % and purity %. Similar results was found by Aly, (2000)

Table (3): Average values of sugar beet significant characteristics as affected by interaction between ceasing and varieties in 2009/2010 and 2010/2011 seasons

Ceasing irrigation(days) × Varieties	Root fresh weight (kg)		Root yield (t/fed)		Sugar yield (t/fed)		Sucrose %		TSS %	Purity %
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
10 days x Pleno	1.120	1.099	25.30	26.19	4.20	4.48	15.90	17.10	20.73	82.53
10 days x Samba	1.147	1.114	25.98	25.26	4.55	4.40	17.47	17.35	21.00	82.68
10 days x Lola	1.131	1.142	25.49	26.55	4.20	4.41	16.20	16.58	20.73	80.02
20 days x Pleno	1.061	1.048	25.20	25.58	4.33	4.51	17.17	17.62	21.37	82.46
20 days x Samba	1.056	1.064	25.46	26.32	4.66	4.84	18.27	18.40	21.67	84.94
20 days x Lola	1.041	1.031	24.54	25.13	4.27	4.39	17.37	17.50	20.42	85.75
LSD at 5%	0.073	0.059	0.46	0.51	0.21	0.26	0.93	0.79	0.55	2.44

6. Hill spacing × Varieties.

The results recorded in Table (4) show interaction effect between spacing hills and sugar beet varieties on sugar beet characters.

Table (4a): Significant yield characteristics of sugar beet as affected by interaction between hill spacing and varieties in 2009/2010 and 2010/2011 seasons

Hill spacing × Varieties	Root fresh weight/ plant(kg)		Sugar yield (t/fed)		Root yield (t/fed)	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
15cm x Pleno	1.086	1.011	5.34	5.68	32.11	32.93
15cm x Samba	0.978	1.128	5.62	5.55	30.76	30.91
15cm x Lola	1.063	1.056	5.37	5.66	31.71	33.45
20cm x Pleno	1.079	1.084	4.09	4.23	23.99	24.18
20cm x Samba	1.104	1.077	4.41	4.60	24.55	25.65
20cm x Lola	1.110	1.083	4.06	4.16	23.65	24.35
25cm x Pleno	1.107	1.125	3.35	3.56	19.66	20.54
25cm x Samba	1.082	1.064	3.80	3.70	21.84	20.91
25cm x Lola	1.085	1.122	3.27	3.37	19.67	19.72
LSD at 5%	0.041	0.055	0.45	0.53	1.22	1.35

Table (4b): Some significant quality characteristics of sugar beet as affected by interaction between hill spacing and varieties in 2009/2010 and 2010/2011 seasons

Hill spacing x Varieties	Sucrose %		TSS %		Purity%	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
15cm x Pleno	16.65	17.28	19.80	21.50	84.08	80.35
15cm x Samba	18.35	18.01	20.45	20.85	85.57	83.39
15cm x Lola	16.95	16.94	20.00	21.05	84.74	82.34
20cm x Pleno	16.55	17.48	19.69	21.45	85.55	83.31
20cm x Samba	17.95	17.89	20.10	21.10	85.27	83.98
20cm x Lola	17.00	17.10	20.05	21.05	85.61	85.27
25cm x Pleno	16.40	17.33	19.90	21.60	85.52	83.82
25cm x Samba	17.30	17.73	20.45	21.55	83.47	84.06
25cm x Lola	16.40	17.09	20.25	22.10	82.06	81.05
LSD at 5%	0.74	0.38	0.42	0.51	1.02	1.11

Sowing Pleno variety on 15 cm between hills gave the highest values of sugar yield ton/feddan in 2008/2009 season and root yield ton/feddan in 1st season. Samba variety with 15 cm spacing hills gave the highest values of root fresh weight kg in 2nd season, sugar yield ton/feddan, TSS% and purity % in 1st season and sucrose% in both seasons. On the other hand sowing variety Lola on 25 cm spacing hills gave the lowest values of sugar yield ton/feddan, root yield ton/feddan, sucrose % , TSS% and purity %. Similar results were in agreement by Hanna, *et al.* (1988) and Ramadan, (1999-b).

7. Ceasing irrigation x hill spacing x Varieties

Data tabulated in Table 5 show significant differences between ceasing irrigation, hill spacing and varieties on sucrose %, root yield ton/feddan and sugar yield ton/feddan in both seasons. Variety Samba when ceasing irrigation at 20 days before harvest with 10 cm between hills gave the highest value of sucrose % and sugar yield ton/feddan in 1st season, however, the lowest sucrose % was obtained when sowing Pleno variety on 15 cm spacing hills and stopped irrigation at 10 days before harvest. The lowest sugar yield was recorded when sowing Lola variety on 25 cm spacing hills and stopped irrigation at 20 days before harvest. The highest root yield (35.32 ton/feddan) was produced by sowing variety Lola on 15 cm spacing hills and stopped irrigation at 20days before harvest, however the lowest value of root yield (19.55 ton/feddan) was noticed at the treatment of 10 days ceasing irrigation before harvest x 25 cm spacing hills x Lola variety.

Table (5): Some sugar beet significant characteristics as affected by interaction among ceasing irrigation, spacing hills and varieties in 2009/2010 and 2010/2011 seasons

Ceasing irrigation X Spacing hills X Varieties	Sucrose%	Root yield (t/fed)	Sugar yield (t/fed)
	2009/10	2010/11	2009/10
10 days X 15cm X Pleno	16.20	34.95	5.23
10 days X 15cm X Samba	17.84	31.35	5.46
10 days X 15cm X Lola	16.50	35.32	5.36
10 days X 20cm X Pleno	16.80	23.27	4.03
10 days X 20cm X Samba	17.70	23.02	4.30
10 days X 20cm X Lola	16.54	23.43	3.88
10 days X 25cm X Pleno	17.02	20.35	3.34
10 days X 25cm X Samba	16.91	21.41	3.89
10 days X 25cm X Lola	16.33	19.89	3.35
20 days X 15cm X Pleno	17.10	30.91	5.46
20 days X 15cm X Samba	18.70	30.27	5.78
20 days X 15cm X Lola	17.40	31.58	5.39
20 days X 20cm X Pleno	17.30	25.10	4.15
20 days X 20cm X Samba	18.20	28.27	4.51
20 days X 20cm X Lola	17.80	24.26	4.24
20 days X 25cm X Pleno	17.10	20.74	3.37
20 days X 25cm X Samba	17.90	20.41	3.70
20 days X 25cm X Lola	16.90	19.55	3.18
LSD at 5%	1.07	4.92	1.11

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أثر المسافة بين الجور ومنع الري قبل الحصاد على بعض لأصناف بنجر السكر في الأراضي الرملية

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أجريت تجربتان حقليةتان خلال موسمي ٢٠١٠/٢٠٠٩ و ٢٠١١/٢٠١٠ في مركز طامية بمحافظة الفيوم وذلك لدراسة تأثير فترتي قطع الري قبل الحصاد (١٠ و ٢٠ يوم)، وثلاثة مسافات بين الجور (١٥، ٢٠ و ٢٥ سم) علي سلوك ثلاثة أصناف من بنجر السكر (بلينو، سامبا ولولا).
أدي الفطام عند ١٠ أيام قبل الحصاد الي زيادة معنوية في وزن العرش والجذر الغض/نبات، بينما أدي الفطام عند ٢٠ يوم قبل الحصاد الي زيادة معنوية في حاصل السكر/فدان و النسب المئوية للمواد الصلبة الذاتية، السكروز و النقاوة.
زاد المحصول من السكر والجذور/فدان والنسبة المئوية للسكروز مع صغر المسافة بين الجور. أعطت المسافتان ١٥ و ٢٠ سم بين الجور أفضل صفات جودة. أعطى الصنف سامبا أعلى القيم للمحصول من الجذور والسكر/فدان، وأيضاً النسبة المئوية للسكروز و النقاوة.
كان للتفاعل بين الفطام قبل الحصاد والمسافات بين الجور تأثيراً معنوياً علي صفات الجودة، كما كان للتفاعل بين الفطام قبل الحصاد والأصناف تأثيراً معنوياً علي محصول الجذور والسكر بالطن للفدان و النسبة المئوية للسكروز.
تحت ظروف هذه التجربة يمكن زراعة بنجر السكر علي ٢٠ سم مسافات بين الجور و الفطام عند يوم ٢٠ قبل الحصاد لتعظيم انتاجية السكر والجذور للفدان و زيادة النسبة المئوية للسكروز.

قام بتحكيم البحث

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