Yield Response of Late Planted Spring Sugarcane to Direct Set Sowing and Transplanting

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ABSTRACT

Sugarcane farmers in Egypt are currently delaying the spring season planting date to mid April or mid May instead of March to allow for a full-winter crop harvest such as broad bean or wheat. This process reduces cane growing season length and severely affects tillering pattern and net cane at the end of the season. This work was carried out to investigate yield response of some sugarcane varieties to transplanting as a method to overcome delayed spring planting. The work was carried out at El-Mattana Research Station, Luxor Governorate, Egypt (Latitude 25° 18´ N) in 2010-2011 and 2011-2012 seasons. Three varieties; i.e. G.T.54-9, G.98-28 and G.84-47 were planted using five planting methods namely; direct sowing on mid-March, mid-April and mid-May; along with two transplanting dates on mid-April and mid-May. Single eye cuts used for transplants were sown on March 1st in both seasons. A split plot arranged RCBD, in four replications, was used for the experiment. The three varieties were randomly distributed to the main plot while the five planting methods were assigned to sub-plot .

The results indicated the variety G.T.54-9 was superior to the two other varieties in both seasons in number of millable cane/ha, cane length, cane diameter, cane weight, as well as cane and sugar yields. As for planting methods, direct sowing on March along with transplanting on April were superior in number of millable cane/ha, cane length, cane diameter, cane weight, as well as cane and sugar yields in both seasons. This indicates that transplanting in April could be used without any reduction of yield of cane while allowing for harvesting winter crop such as broad bean.

Key Words: Crop rotation, Delayed planting, Sugarcane transplanting.

INTRODUCTION

The liberalization of Egypt's agricultural economic system led to major changes in farmers' behavior. Due to its limited water resources, the available area for farming is used in a rotation including more than one crop per year. The case is different in sugarcane growing area where the crop remains in soil for the whole year. A newly emerged problem is currently affecting spring planted crop. The growers intentionally delay sugarcane

spring planting till the harvest of the preceding crop (broad bean or wheat) instead of growing temporary cover crop that can be cleared off the field in late February to plant sugarcane in March. As sugarcane growers are bound with contracts with the cane sugar company, they should start harvest of spring planted cane in a schedule that is prepared by the company. This causes a severe reduction in yield because of the decrease about three months in crop age. Many workers investigated the effect of decreasing growing season length on sugarcane yield. Duhra *et al*. (1993) stated that late-planted sugarcane (mid-April) showed higher pest incidence than early planted (mid-February). Their results indicated that differences in cane yield were wider for delay from mid-March to mid-April planting dates, as compared to that delay from mid-February to mid-March planting dates. Tripathi and Pandey (1993) planted sugarcane cv. Co 1148, CoS 802, CoS 767 and CoS 7918 in the middle of Feb., Mar., Apr. or May. Cane yield decreased from 86.9 to 38.2 t/ha with delay in planting date and was the highest from cv. CoS 7918 (69.5 t) and the lowest in CoS 767 (57.9 t). Commercial cane sugar yield decreased with delay in planting date from 15 Feb. to 15 April. Shiv and Srivastava (1993) found that mid-March was the optimum planting time for cane yield, which decreased with delaying planting for all cultivars except CoH77. The cultivar CoH35 produced the highest cane yield in March planting date (98.4 t/ha). Cane and ratoon yields of CoH77 increased from March to May planting date from 68.5 to 79.9 t/ha and from 48 to 61.1 t/ha, respectively. Jhansi and Rao (1996) pointed out that delaying the planting date led to reduction in cane yield. Dilip *et al.* (1998) planted sugar cane cv. Co 419 on 15 March or 15 April. They found that mean cane yield was the highest 61.3 t/ha when sugar cane was planted on 15 March.

In Egypt, El-Gergawy and El-Shafai (2000) found that delaying planting date from March up to April resulted in a significant reduction in stalk height, diameter, cane, and sugar yields. Later, Mohamed and El-Taib (2007a) evaluated fourteen sugarcane genotypes plant crops under two planting dates (26 March and 26 April). They reported that, genotypes; and genotypes by growing seasons interaction; had significant effect on sugar recovery. Mohamed and El-Taib (2007b) also reported that it is possible to maintain higher cane and sugar yield all over the milling season by selecting proper growing season for each genotype. However, reducing the growing season by delaying planting date reduced sugar yield as a results of reduction

in cane yield throughout the reduction in number of millable cane. They also reported that the increase in sugar yield as a result of extending growing season by delaying harvesting did not compensate for the reduction resulted from late planting date.

Transplanting was tested as a measure to overcome the negative effects of delayed planting. Basher *et al.* (1993) tested yield performance of spaced transplanting and conventional planted sugarcane. Their results revealed that age has a negative relation with yield performance of both spaced transplanting and conventional cane. However, yield of spaced transplanting cane was found much higher than conventionally planted cane. The work of Rahman *et al.* (1993) on the performance of transplanted sugarcane compared with conventional planting under growers' conditions. Planting methods were; conventional (three budded sets placed end to end in trench), spaced transplanting of soil bed settlings (STP-SBS) and spaced transplanting of polybag settlings (PBS). Significantly higher yield was produced by STP-PBS in all sites over the other two methods. The highest yield of 113.9 t ha^{-1} was produced by STP-PBS at Jaipurhat site and the mean yield of three sites of this method was 91.1 tons ha^{-1}. The second highest yield (98.4 tons ha^{-1}) was found in STP-SBS method, at Jaipurhat site, mean yield of three sites of this method was 78.4 t/ ha^{-1}. The highest yield of STP-PBS cane was obtained through higher yield attributes such as higher tillers and millable canes. Ishimine *et al.* (1994) carried out Field experiment to compare sett planting and settling transplanting system of sugarcane. They reported that sett planted sugarcane took longer time for complete emergence (50 days) with about 19% failed germination causing gaps in the rows which enhanced growth of vigorous weed population in sett planting field. In addition, millable cane and stalk length were reduced by 24%, 36% and 45%, respectively in sett planted cane compared with transplanted cane. They suggested that settling transplanting is one of the important agronomic practices that could enable weed control and better yield of sugarcane. Hiyane *et al.* (2006) tested transplanting time for various sugar cane cultivars. The seedlings of cv. NiF8, Ni15 and Ni17 were transplanted into a test field in various periods. They reported variability in varietal response to transplanting dates. Their results showed that the best transplanting period for the 'April seedlings' was May-July for cv. NiF8, and May-June for cv. Ni15. The best transplanting periods for the 'June seedlings' were June-August for cv. Ni15, and July for cv. Ni17. For the

'September seedlings', the best transplanting periods were December-March for cv. NiF8, October-March for cv. Ni15, and September-March for cv. Ni17. Galal *et al.* (2012) indicated that seasonal differences in temperature influenced varietal response to the planting methods, in terms of tillering pattern, only in the late ages of both seasons. However, the major contributing factor was the planting methods. Transplanting did not severely affect tillering pattern. They suggested that farmers could utilize this technique to enable them to fully plant and harvest a preceding crop prior to planting spring cane.

This work aims to investigate the yield and yield components response of some sugarcane varieties; i.e. G.T.54-9, G.98-28 and G.84-47as affected by transplanting in comparison with direct sowing in the field.

MATERIALS AND METHODS

The present study was carried out at El-Mattana Research Station, Luxor Governorate, Agricultural Research Center, Egypt (Latitude 25^{o} 18′ N). Soil type of the experimental location was sandy loam with an average pH of 8.1, available N of 20 ppm, Available P of 11 ppm, and available K of 516 ppm. The work was conducted during the two plant crop seasons of 2010/2011 and 2011/2012 to examine tillering pattern of three sugarcane planted using direct sets planting (DS) vs. seedling transplanting (ST) under different spring planting dates. The tested varieties were G.T.54-9, G.98-28 and G.84-47. Data of temperature records of both growing season is given in table 1.

Direct sets planting took place in the main field on mid-March, mid-April and mid-May using 126-3 budded sets/plot. Transplants preparation started at the same dates of direct seeding. Single budded chips from healthy cane stalks were planted in the nursery using polythene bags of 25x20cm filled with soil. Settlings were maintained in the nursery until transplanting. Transplanting took place at two dates i.e., mid-April and mid-May. 108 transplants were planted per plot at a distance of 40cm. The experimental plot area was 42 m^2. All recommended fertilization regimes were applied accordingly.

Bartlett test of variance homogeneity was conducted on individual seasons data it revealed that single season analysis is feasible for this work than combined analysis. A split plot with four replications was used for the experiment as outlined by Gomez and Gomez (1984). The three varieties were randomly distributed to the main plot. The five planting methods

(3 direct sowing and 2 transplanting methods) were assigned to the sub-plot. Duncan multiple range test was used for means comparisons.

Table (1)
Average bi-weekly recorded temperature measurements during the two experimental seasons.

Period	Temp. (°C)					
	2010-2011			2011-2012		
	High	low	Average	High	low	Average
15- 31 March	30.3	16.8	23.2	26.7	11.6	19.0
1-15 April	34.2	17.5	25.6	29.1	16.6	22.0
16-30 April	35.7	20.7	28.0	32.1	19.4	23.4
1-15 May	38.0	22.0	29.9	36.3	22.0	28.8
16-31 May	39.3	25.2	32.0	37.8	22.6	30.0
1-15 June	40.4	26.0	32.7	39.9	25.0	32.1
16-30 June	42.0	27.2	34.4	39.3	25.4	32.0
1-15 July	42.0	27.9	34.8	41.5	27.0	34.1
16-31 July	41.8	28.2	34.7	41.8	28.8	35.3
1-15 August	42.8	28.8	35.4	40.5	27.9	33.9
16- 31 August	42.1	28.8	35.2	39.7	25.5	32.3
1-15 September	39.7	25.5	32.1	38.0	25.5	31.5
16-30 September	40.9	25.6	32.7	36.9	23.4	35.0
1-15 October	38.4	23.5	30.8	36.0	22.2	28.9
16-31 October	37.9	21.7	29.6	36.0	19.7	26.7
1-15 November	32.5	18.1	25.0	28.8	14.0	21.0
16-30 November	31.7	16.8	14.1	25.3	11.1	18.2
1-15 December	26.7	11.8	19.0	23.6	8.4	15.9
16-31 December	25.2	9.6	17.3	23.2	8.2	15.4
1-15 January	21.8	8.7	15.0	19.3	6.0	12.6
16-31 January	22.5	7.9	15.1	20.4	6.0	13.0
1-15 February	27.5	14.0	20.4	23.2	9.2	16.0
16-(28/29) February	25.8	12.3	18.9	26.3	12.7	18.4
1-15 march	26.1	12.1	19.3	24.7	9.9	17.0

Source: Central Laboratory for Agricultural climate, ARC Egypt.

The recorded data:

At harvest (15th March in both seasons), a stalk sample was taken from a one-meter portion per plot to determine the mean values of stalk characteristics. In addition, four guarded rows of each plot were harvested, topped, and cleaned to estimate cane yield and supply the quality analysis sample per plot:

1. Number of millable cane was counted per plot then converted into 1000/ha.
2. Millable cane length (cm) was measured from soil surface to the top visible dewlap.
3. Millable cane diameter (cm) was measured at the middle part of millable stalk.
4. Millable cane weight (kg) was determined by dividing cane weight of the one meter sample by its corresponding number of millable cane.
5. Sugar recovery percentage was calculated according to Yadav and Sharma equation (1980) as follows:
   Sugar recovery % = [sucrose % - 0.4 (brix % - sucrose %) × 0.73],
   Where B = Brix reading, S = Sucrose percentage, 0.4 and 0.73 constants.
6. Cane yield (tons/ha) was determined from the weight of the four middle guarded rows of each plot converted into value per ha.
7. Sugar yield (tons/ha) was estimated by multiplying cane yield (tons/ha) by sugar recovery%.

RESULTS AND DISCUSSION

1. Number of millable canes/ha:

The statistical analysis for number of millable canes/ha measured at harvest in both seasons is given in table 2. Varietal differences were significant in both seasons. Planting methods effects were significant only in the first season while the interaction was significant in the second season only. Variability in response in the two seasons maybe attributed to the variability in recorded temperature during tillering stage in both seasons (table 1).

Means listed in table 3 indicates that varietal response in terms of number of millable canes per ha varied according to season. However, G.T.54-9 dominated both seasons while G.84-47 was superior only in the

second one. Varietal response could vary according to the dominated weather conditions during early parts of the growing season. It also indicated that varietal differences were marginal. Thus, the differences reported in the final count of millable cane could be attributed to different mortality rates of tillers based on the weather conditions and the genetic makeup of the tested varieties. Varietal differences in millable cane number were reported earlier by Shafshak *et al*. (2005), Sinha *et al*. (2005) and Manjunath *et al*. (2007).

Table (2)
Mean squares for some characteristics of sugarcane varieties affected by planting methods and their interaction in 2010-2011 and 2011-2012 Seasons.

SOV	DF	Number of millable canes 1000/ha	Stalk length (cm)	Stalk diameter (cm)	Stalk weight (kg)	Sugar recovery %
2010-2011						
Rep	3	1499.4 *	532.33 Ns	0.014 NS	0.0056 Ns	0.46 Ns
Var.	2	2265.0 *	1703.61 *	0.257 **	0.4376 **	2.46 Ns
Error a	6	269.4	248.55	0.007	0.0025	1.85
Planting method	4	1256.6 *	1933.85 **	0.033 **	0.0355 **	10.43 **
Var. x PM	8	212.9 Ns	279.82 Ns	0.034 **	0.0096 *	0.72 Ns
Error b	36	380.8	141.75	0.007	0.004245	0.51
2011-2012						
Rep	3	997.2 Ns	116.15 Ns	0.006 Ns	0.0027 Ns	0.07 Ns
Var.	2	7035.0*	182.71 Ns	0.741 **	0.0748 *	0.36 Ns
Error a	6	930.5	70.45	0.012	0.0084	0.77
Planting method	4	1085.8 Ns	11881 **	0.046 **	0.2088 **	2.63 **
Var. x PM	8	1943.3*	706.50 **	0.013 *	0.0871 **	0.56 Ns
Error b	36	648.6	121.32	0.004	0.0158	0.37

*, **: significant and highly significant at 0.05and 0.01 probability level.
Ns: insignificant.

Planting methods effects on number of millable cane also differed between seasons. The highest values were obtained from transplanting on April in the first season. Direct sowing along with transplanting in April or

May were statistically higher than late direct sowing in April or May in the first season. However, the lowest value was obtained from direct seeding in March of the second season. The remained treatments were statistically similar in the second season. It is well known that cool night temperature is the most effective factor controlling tillering of sugarcane. Transplanted cane in April was planted in the nursery on mid March and was exposed to cool nights more effectively than direct sown cane in March as the plastic bags are more exposed to cool nights than the plants in the permanent field. Thus, the response to cool nights was clearer in seedlings transplanted in mid-April cane in the first season. In contrary, the second season's direct sown cane in mid- April germinated within 10 days and was exposed to relatively cooler nights in the second season as compared to the same period of the first season. This is supported by the findings of Galal *et al.* (2012). The temperature records of both seasons in table 1 indicated that late May minimum temperature degrees of the second season were less than that of the first season.

The interaction effects were controlled by varietal and planting methods treatments in the second season, whereas, G.T.54-9 direct sowing in April produced the highest value.

Table (3)
Average number of millable canes 1000/ha of the evaluated sugarcane varieties, planting methods, and their interaction in 2010-2011 and 2011-2012 seasons.

Planting methods	2010-2011				2011-2012			
	G.T.54-9	G.84-47	G.98-28	$\bar{X}$	G.T.54-9	G.84-47	G.98-28	$\bar{X}$
DS. March	167.5 a	155.0 a	140.0 a	154.2 AB	160.0 ab	117.5 ab	110.0 b	129.2 B
DS. April	142.5 a	145.0 a	125.0 a	137.5 B	185.0 a	130.0 ab	145.0 ab	153.3 A
ST. April	180.0 a	150.0 a	157.5 a	162.5 A	157.5 ab	182.5 ab	100.0 b	146.7 AB
DS. May	147.5 a	142.5 a	132.5 a	140.8 B	140.0 ab	147.5 ab	120.0 ab	135.8 AB
ST. May	167.5 a	145.0 a	145.0 a	152.5 AB	152.5 ab	127.5 ab	132.5 ab	137.5 AB
$\bar{X}$ Var.	161.0 A	147.5 B	140.0 B	149.5	159.0 A	141.0 A B	121.5 B	140.5

Means with the same letter within each main effects each season are not significantly different at 5% level according to Duncan multiple range test.

2. Millable cane length:

Mean square differences for stalk length were significant for varietal effects and highly significant for planting methods in the first season (table 2). However, in the second season, both varietal differences and their interaction with planting methods approach significant level.

Means listed in table 4 indicated that the variety G.T.54-9 produced the tallest stalks in the first season. However, the three tested varieties were similar in the second season. Differences and similarity of varieties were reported by many workers including Abo El-Ghait (2000), and El-Geddawy *et al.* (2002). Direct set planting in March gave the highest values of stalk length in both seasons. This is logic since the plants sown on this date had a longer growing season in the permanent field as compared with the other planting methods. Delaying direct set planting reduced the length of growing season by one or two months. Furthermore, transplanted cane needs some time spent trying to adapt its root system into the permanent field conditions before elongation of plant accelerates. In addition, the interaction of varieties x planting method was insignificant in the first season and highly significant in the second one. Such variability could be a result of the variability of temperature conditions of both seasons. The insignificant response is attributed mainly to a parallel pattern of response for the tested varieties in the first season. However, both G.T.54-9 and G.84-47 under direct seeding in March gave the highest values of stalk length in the second season.

Table (4)
Average millable stalk length (cm) of the evaluated sugarcane varieties, planting methods, and their interaction in 2010-2011 and 2011-2012 seasons.

Planting methods	2010-2011				2011-2012			
	G.T.54-9	G.84-47	G.98-28	$\bar{X}$	G.T.54-9	G.84-47	G.98-28	$\bar{X}$
DS. March	298.5 a	286.5 a-d	277.2 a-d	287.4 A	297.0 ab	319.0 a	285.7 bc	300.6 A
DS. April	293.5 ab	272.5 a-d	268.2 a-d	278.0 AB	280.75 bcd	280.7 b-e	275.5 b-f	279.0 B
ST. April	275.5 a-d	280.0 a-d	268.2 a-d	274.5 B	244.25 f-k	229.2 g-l	257.5 c-h	243.7 C
DS. May	290.0 abc	253.5 bcd	263.2 bcd	268.9 B	247.50 d-j	250.2 d-i	258.2 c-g	252.0 C
ST. May	257.5 bcd	249.2 d	252.7 cd	253.1 C	218.50 i-l	205.2 l	235.2 g-l	219.7 D
$\bar{X}$ Var.	283.0 A	268.3 B	265.9 B	272.4	257.60 A	256.9 A	262.4 A	259.0

Means with the same letter within each main effects each season are not significantly different at 5% level according to Duncan multiple range test.

3. Millable cane diameter (cm):

The statistical analysis for stalk diameter (cm) measured at harvest in both seasons were highly significant for varieties, planting methods, and their interaction except for the interaction in the second season, which was significant only (table 2).

The varieties G.T.54-9 and G.98-28 had the thickest stalk in the first season. The same two varieties maintained the highest values of this trait in the second season (table 5).

Table (5)
Average millable stalk diameter (cm) of the evaluated sugarcane varieties, planting methods, and their interaction in 2010-2011 and 2011-2012 seasons.

Planting methods	2010-2011				2011-2012			
	G.T.54-9	G.84-47	G.98-28	$\bar{X}$	G.T.54-9	G.84-47	G.98-28	$\bar{X}$
DS. March	2.90 a-e	2.80 b-e	2.92 a-e	2.87 AB	2.94 a-g	2.53 k	2.88 b-i	2.78 B
DS. April	3.01 abc	2.72 cde	3.07 a	2.93 A	3.08 ab	2.65 k	2.97 a-f	2.90 A
ST. April	2.82 a-e	2.69 de	2.91 a-e	2.80 B	3.09 a	2.72 h-k	3.01 a-d	2.94 A
DS. May	2.82 a-e	2.64 e	2.96 a-d	2.80 B	3.06 abc	2.71 h-k	2.91 a-h	2.89 A
ST. May	3.03 ab	2.77 b-e	2.77 b-e	2.85 AB	2.87 b-i	2.64 k	2.99 a-e	2.83 B
$\bar{X}$ Var.	2.91 A	2.72 B	2.92 A	2.85	3.01 A	2.65 B	2.95 A	2.87

Means with the same letter within each main effects each season are not significantly different at 5% level according to Duncan multiple range test.

Over both seasons, planting method showed highly significant effect on stalk diameter. Direct set planting in April was superior in the first season while seedling transplanting in April was the best method in the second season. The thinnest stalks were produced from transplanted cane in April or from the latest direct set planting in May, in the first season. However, the trend of response differed in the second season where direct seed cane in March along with transplanted cane on May had the thinnest stalks. The interaction responses were mainly dominated by varietal effects rather than planting methods. All interactions involving G.84-47 were less in their measure of thickness as compared to the interactions of the other two varieties. Here it is clear that varietal difference are the major contributer to this effect as outlined earlier by El-Geddawy *et al*. (2002), and Saleh *et al*. (2006).

4. Millable cane weight (kg):

All tested factors were significant or highly significant in both seasons in terms of stalk weight at harvest (table 2).

Means listed in table 6 indicates that varietal response in terms of average stalk weight differed in the two experimental seasons. Sugarcane G.84-47 variety recorded the least values in both seasons. This could be attributed to its recorded values of stalk diameters (table 5). Planting methods also varied in their effects on stalk weight in both seasons. Direct set planting in March maintained superiority in both seasons. However, it was similar to both of direct set and transplanting in April, in the first season. Meanwhile, transplanting on Mid April was statistically similar to March sown plants in the second season. Such superiority of direct set planting is attributed to its high values recorded for stalk length (table 4) and to the longer available growth period in the permanent field as compared to the remained methods. The interaction of varieties with planting methods was dominated by varietal response *per se*. However, under early planting dates, *i.e.* direct set in March and April, the three varieties responded similarly in both seasons. As planting dates were delayed further, most values recorded from G.84-47 interactions were lower than those obtained from the interactions involving the two other varieties as shown in table 6. Varietal differences in stalk weight were observed by Rahman *et al*. (2004), Manjunath *et al*. (2007) and Bell *et al*. (2008).

Table (6)
Average stalk weight (kg) of the evaluated sugarcane varieties, planting methods, and their interaction in 2010-2011 and 2011-2012 seasons.

Planting methods	2010-2011				2011-2012			
	G.T.54-9	G.84-47	G.98-28	$\bar{X}$	G.T.54-9	G.84-47	G.98-28	$\bar{X}$
DS. March	1.31 abc	0.99 ef	1.15 a-f	1.15 A	1.27 ab	1.33 ab	1.34 ab	1.31 A
DS. April	1.33 a	0.95 f	1.13 b-f	1.14 A	1.02 b	1.10 b	0.98 b	1.03 C
ST. April	1.32 ab	1.08 def	1.06 def	1.15 A	1.35 ab	1.02 b	1.52 a	1.30 A
DS. May	1.20 a-e	0.94 f	0.94 f	1.03 C	1.22 ab	0.94 b	1.00 b	1.05 C
ST. May	1.21 a-d	0.98 f	1.07 def	1.08 B	1.29 ab	1.16 ab	1.06 b	1.17 B
$\bar{X}$ Var.	1.27 A	0.99 C	1.07 B	1.11	1.23 A	1.11 B	1.18 A	1.17

Means with the same letter within each main effects each season are not significantly different at 5% level according to Duncan multiple range test.

5. Sugar recovery percentage:

Sugar recovery % was affected in a highly significant manner by planting methods in both seasons (table 2).

Data in table 7 revealed that early planting on March or April, despite of the planting method itself, had the highest percentage of sugar recovery in both seasons. As the length of the growing season increased, the recorded recovery percentages values increased. This is due to longer span where photosynthesis took place in March and April -planting as compared to May planting. Increasing sugar recovery due to longer growth season was observed by Alexander and Mathew (2003), Mohamed and El-Taib (2007a) and White *et al*. (2010).

Table (7)

Average sugar recovery % of theevaluated sugarcane varieties, planting methods, and their interaction in 2010-2011 and 2011-2012 seasons.

Planting methods	2010-2011				2011-2012			
	G.T.54-9	G.84-47	G.98-28	$\bar{X}$	G.T.54-9	G.84-47	G.98-28	$\bar{X}$
DS. March	13.02 ab	13.28 a	12.1 abc	12.79 A	12.35 ab	12.8 a	12.03 ab	12.39 A
DS. April	12.06 a-d	11.08 bcd	11.71 a-d	11.61 B	12.03 ab	12.02 ab	12.14 ab	12.06 A
ST. April	11.88 a-d	11.83 a-d	11.42 a-d	11.70 B	12.18 ab	12.03 ab	11.98 ab	12.06 A
DS. May	10.93 bcd	10.42 cd	10.54 cd	10.62 C	11.54 ab	11.93 ab	10.69 b	11.38 B
ST. May	11.00 bcd	10.89 bcd	9.631 d	10.50 C	11.32 ab	11.01 ab	11.63 ab	11.32 B
$\bar{X}$ Var.	11.78 A	11.5 A	11.08 A	11.452	11.88 A	11.96 A	11.69 A	11.84

Means with the same letter within each main effects each season are not significantly different at 5% level according to Duncan multiple range test.

6. Cane yield/ha:

Mean squares listed in table 8 indicated that varietal differences and planting methods had highly significant and significant effect on cane yield / ha in the first and second seasons, respectively. However, their interaction was insignificant in both seasons.

Table (8)
Mean squares for cane and sugar yield /ha of the evaluated sugarcane varieties, planting methods, and their interaction in 2010-2011 and 2011-2012 seasons.

SOV	DF	cane yield		sugar yield	
		2010-2011	2011-2012	2010-2011	2011-2012
Rep	3	1040.7 *	920.1 Ns	16.9 Ns	12.1 Ns
Var.	2	10919 **	7209.9 *	187.6 **	107.5 *
Error a	6	209.8	695.2	5.9	12.1
Planting method	4	1789.2 **	1226.5 *	57.9 **	29.7 **
Var. * pl	8	111.9 Ns	98.2 Ns	1.6 Ns	2.2 Ns
Error b	36	207.2	461.1	3.5	7.5

*, **: significant and highly significant at 0.05and 0.01 probability level.
Ns: insignificant.

The results in table 9 showed G.T.54-9 produced 41.8 and 39 tons of cane higher than those gained by G. 84-47 or G. 98-28, respectively, in the 1st season. In the 2nd season, G.T.54-9 recorded 26.9 and 36.7 tons of canes over those given by the same two varieties, successively. The superiority of G.T.54-9 over the other two varieties is probably attributed to its highest values of number of millable canes per ha, stalk weight (tables 3 and 6) compared to the other to varieties. Moreover, it was found that the differences between G. 84-47 and G. 98-28 in cane yield were insignificant in both seasons. Such differences in varietal response are due to their variable interaction with environmental conditions. El-Geddawy *et al.* (1997), and El-Sogheir and Abd El Fattah (2009) reported such observation on varietal yield differences. Furthermore, March direct sowing and April transplanting were superior in yield in both seasons. These results can be due to higher values of number of millable canes/ha and heavier stalks produced by these two methods (table 3 and 6). However, the means of April transplanted cane was higher than those of March planting in both seasons with an excess amount of 7.5 and 9.4 tons in the first and second season, respectively. This could be attributed to the higher number of stalks produced by April transplanted cane than that of March sown cane in both seasons (table 3). In addition, other methods were statistically similar to the abovementioned methods leaving the late direct sown cane in May at the

last rank of cane tonnage. Such response could be explained by the facts that all superior treatments spent longer time in the permanent field.

It is well established that longer growing season causes an increase in cane tonnage as reported by many workers Bashar *et al*. (1993), Shiv and Srivastava (1993), Jhansi and Rao (1996) , Kabir *et al*. (1999), Arumugam *et al*. (2002), Pannerselvam and Durai (2004), Mohamed and El-Taib (2007-b). However, if delayed transplanting until May is practiced, a full harvested previous crop such as wheat could compensate the reduced yield of cane. The estimated reductions of yield due to delayed direct sowing from March to April were 15.3 and 7.9 tons of canes /ha in the first and second seasons, respectively. This loss was increased to reach 23.4 and 18.1 tons when direct sowing was delayed to May in the first and second seasons, respectively. Transplanting in May reduced such lose to 8.1 and 5.3 tons / ha in the first and second seasons, respectively. Varietal response pattern to planting methods were similar in trend as shown in table 9.

Table (9)
Average cane yield (tons/ha) of the valuated sugarcane varieties, planting methods, and their interaction in 2010-2011 and 2011-2012 seasons.

Planting methods	2010-2011				2011-2012			
	G.T.54-9	G.84-47	G.98-28	$\bar{X}$	G.T.54-9	G.84-47	G.98-28	$\bar{X}$
DS. March	154.3 ab	107.8 cd	113.0 bcd	125.0 AB	141.8 a	110.2 a	102.8 a	118.3 AB
DS. April	133.2 a-d	96.7 cd	99.2 cd	109.7 CD	132.1 a	99.8 a	99.4 a	110.4 AB
ST. April	167.1 a	113.6 bcd	116.9 bcd	132.5 A	145.9 a	130.5 a	106.6 a	127.7 A
DS. May	123.4 bcd	93.9 d	87.5 d	101.6 D	119.6 a	96.9 a	84.1 a	100.2 B
ST. May	142.5 abc	99.5 cd	108.8 cd	116.9 BC	136.1 a	103.8 a	99.1 a	113.0 AB
$\bar{X}$ Var.	144.1 A	102.3 B	105.1 B	117.1	135.1 A	108.2 B	98.4 B	113.9

Means with the same letter within each main effects each season are not significantly different at 5% level according to Duncan multiple range test.

7. Sugar yield/ha:

Mean squares given in table 8 revealed that varietal response and planting methods had a significant or highly significant effects on sugar yield /ha in both seasons. However, their interaction was insignificant in either season.

Means in table 10 indicated that G.T.54-9 sugar production /ha was superior to the two other varieties in both seasons, where it produced 5.2 and 5.4 tons of sugar/ha higher than those given by G.84-47 and G.98-28,

respectively, in the 1st season, corresponding to 3.1 and 4.5 ton/ha, in the 2nd one. Such increase is mainly due to the superiority of this variety in cane yield /ha as the three tested varieties were similar in theoretical sugar recovery % as shown in table 7.

Table (10)
Average sugar yield (tons/ha) of the evaluated sugarcane varieties, planting methods, and their interaction in 2010-2011 and 2011-2012 seasons.

Planting methods	2010-2011				2011-2012			
	G.T.54-9	G.84-47	G.98-28	$\bar{X}$	G.T.54-9	G.84-47	G.98-28	$\bar{X}$
DS. March	20.1 a	14.3 b-e	13.6 cde	16.0 A	17.5 ab	14.1 ab	12.3 ab	14.6 AB
DS. April	16.0 abc	10.7 cde	11.5 cde	12.7 B	15.8 ab	11.9 ab	12.0 ab	13.2 ABC
ST. April	19.7 ab	13.4 cde	13.3 cde	15.5 A	17.8 a	15.7 ab	12.8 ab	15.4 A
DS. May	13.5 cde	9.8 de	9.2 e	10.8 C	13.8 ab	11.5 ab	9.0 b	11.4 C
ST. May	15.7 a-d	10.8 cde	10.5 cde	12.3 BC	15.4 ab	11.4 ab	11.5 ab	12.8 BC
$\bar{X}$ Var.	17.0 A	11.8 B	11.6 B	13.4	16.0 A	12.9 B	11.5 B	13.4

Means with the same letter within each main effects each season are not significantly different at 5% level according to Duncan multiple range test.

As for planting methods, direct sowing in March along with transplanting in April produced maximum sugar yield /ha in both seasons. However, direct sowing in April in the second season was statistically similar to the abovementioned superior treatments. The insignificant difference in sugar yield/ha between sugarcane directly sown by cuttings in March and that planted using transplants in April proved the possibility and the success of using transplanting technique in sugarcane planting to compensate for the delay in planting of spring cane. Here also, the effect was mainly associated with both of cane tonnage and % sugar recovery, which are the component of the extracted sugar yield.

In conclusion, this work suggests that transplanting of sugarcane can be a useful tool to overcome the problem of reduced cane and sugar yields associated with delayed planting of spring plant cane when another crop such as broad bean is grown before it.

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استجابة محصول قصب السكر الربيعي المتأخر لزراعة العقل المباشرة والشتل

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الملخص

يقوم مزارعو قصب السكر في مصر حاليا بتأخير موعد زراعة القصب الربيعي إلى منتصف أبريل أو منتصف مايو لحصاد محصول شتوي سابق مثل الفول البلدي أو القمح. تؤدي هذه العملية إلى إقلال مدة مكث القصب في الحقل وتؤثر سلبا على معدل إنتاج الأشطاء مما يخفض المحصول في نهاية الموسم. أجري هذا البحث لدراسة استجابة بعض أصناف قصب السكر للشتل كوسيلة للتغلب على تأخر موعد الزراعة الربيعي. نفذ البحث بمحطة بحوث المطاعنة بمحافظة الأقصر عند خط عرض ´18 25° شمالا في موسمي 2010- 2011 و2011- 2012. زرعت ثلاثة أصناف هي جيزة-تايوان 54 - 9 وجيزة 98 - 28 وجيزة 84 - 47 بخمسة طرق مختلفة هي الزراعة المباشرة في منتصف مارس وفى منتصف أبريل وفي منتصف مايو بالإضافة إلى الشتل في منتصف أبريل ومنتصف مايو. زرعت عقد قصب فردية البراعم في أكياس بلاستيكية في منتصف مارس. استعمل توزيع القطع المنشقة في تصميم القطاعات العشوائية الكاملة لتنفيذ التجربة، حيث وضعت الأصناف في القطع الرئيسية وطرق الزراعة في القطع المنشقة.

أوضحت النتائج أن الصنف جيزة- تايوان 54 - 9 تفوق على الصنفين الآخرين في كلا الموسمين في صفة عدد السيقان القابلة للعصير وقطر الساق ومحصول القصب والسكر للهكتار. وبالنسبة لطرق الزراعة فقد كانت الزراعة في الموعد الأصلي في مارس بالإضافة إلى زراعة الشتل في أبريل هي الأفضل في صفات عدد السيقان القابلة للعصير وطول وقطر الساق ومحصول القصب والسكر للهكتار في كلا الموسمين.

وتوضح النتائج أن الشتل في منتصف أبريل يمكن أن يستعمل كطريقة زراعة لا تسبب أي انخفاض حقيقي لمحصول القصب وبما يمكن من الحصول على محصول كامل من الفول البلدي قبل زراعة القصب.

الكلمات المفتاحية: تأخير الزراعة، تعاقب المحاصيل، شتل قصب السكر.