

Effect of Varieties, Phosphorus and Boron Fertilization on Sugar Beet Yield and its Quality

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ABSTRACT

The present study was conducted at a private Farm, Kalabsho, Belqas Center, Dakahlia Governorate during the two successive seasons of 2014/2015 and 2015/2016. This investigation was layout to find the effect of Cultivars (Gloria and Diamond), phosphorus (0, 12, 24, 36, 48 kg P₂O₅ fed⁻¹ as a mono-super phosphate) and boron (0, 0.750 and 1.125 kg Borax fed⁻¹) and their interaction on yield, yield components and sucrose of sugar beet plants (*Beta vulgaris*, L.). A split-split-plot design with four replicates was done. Experimental unit (sub-sub plot) was 10.5 m² (1/400/fed) "3x3.5 m" including 5 ridges each of 60 cm apart and 3.5 long. The importance findings can be summarized as follows: The highest values of top yield could be obtained from diamond in the 1st season and Gloria Cultivar in the 2nd one. The optimum phosphorus fertilizer treatments were 48 kg P₂O₅ fed⁻¹, thereby it caused a significant increase and the greatest values of top yield. Moreover, the response of sugar beet top yield to the interaction varietal effects X boron fertilizer levels was significant in the two seasons. Phosphorus at a rate of 48 kg P₂O₅ was the best treatment among other phosphorus treatments, which resulted in the maximum root yield in the 1st and 2nd seasons. Furthermore, control treatment (without addition) recorded the lowest mean in the 1st and 2nd seasons, respectively. With expecting the impact of boron fertilizer effects on root yield, increasing its levels from 0 to 1.125 kg H₃PO₄ fed⁻¹ tended to increase root yield in the two growing seasons. Generally, the highest total yield achieved from Gloria cultivar with mean 30.72 Mg fed⁻¹ while, Diamond cultivars recorded 28.44 Mg fed⁻¹ in the first season. Meanwhile, in the second season the same trend was observed for cultivars Gloria which surpassed cultivars Diamond. Phosphorus showed a significant increase in sucrose % and increasing boron fertilizer levels from 0 to 0.750 and 1.125 kg Borax/fed tended to increase sucrose % from 16.82 to 16.89 and 16.98 in the first season and 20.17, 20.23 and 20.30% in the second season, respectively. It could be concluded that all used treatments significantly affected on sugar beet yield and its component. The interaction between Gloria cultivars, phosphorus fertilizer at the rate of 48 kg P₂O₅ fed⁻¹, boron at the rate of 1.125 kg fed⁻¹ recorded the best in all used treatments.

Keywords: sugar beet, phosphorus, boron, sucrose %, total yield

INTRODUCTION

Improving sugar beet productivity is a serious demand to meet sugar consumption or at least to decrease the Egyptian gap between production and consumption. In Egypt, sowing sugar beet usually takes place during the period extended from Sept. to Nov.. Many investigators showed the effect of phosphorus and boron fertilizer levels on growth, yields and quality characteristics of sugar beet Cultivars. Shalaby *et al.* (2011) reported that Kawemira variety significantly surpassed on the others in root fresh weight/plant, sucrose and roots and yields/fed. Ali *et al.* (2012) reported that Samba variety had the highest values of root and sugar yields /fed as well as sucrose and purity percentages. Mehanna (2017) declared that Samba variety was the superior in root characters i.e. length, and diameter and yield of roots and sugar/fed.

Besides, phosphorus is a major element in plant nutrition that is the most important component of nucleic acids and lipids and is important in the production and transport of sugars in sugar beet plant. Phosphorus is effectiveness in sugar beet early root development. It is a critical macronutrient required for numerous functions in the plant, including energy generation, nucleic acid synthesis, photosynthesis, glycolysis, respiration, carbohydrate metabolism and nitrogen fixation.

Ismail *et al.* (2007) and Ouda (2007) reported that fresh and dry weights, leaf area index and root and sugar yields, as well as sucrose % and sugar loss to molasses were increased as P rate increased up to 30 kg P₂O₅ fed⁻¹.

Abdou *et al.* (2008) stated that increasing phosphorus fertilizer levels from 0.0 up to 30 kg P₂O₅ fed⁻¹, markedly increased root weight by 10.80 and 10.82 %, root yield (Mg fed⁻¹) by 17.56 and 17.72 % and sugar yield (Mg fed⁻¹) by 29.31 and 29.52 % in the first and second seasons, respectively. Marinković *et al.* (2008) showed that increasing P₂O₅ from 50 to 100 and 150 kg ha⁻¹ resulted in

marked increases in root and sugar yields/ha. Seadh (2012) stated that application of 30 kg P₂O₅ fed⁻¹, produced the highest values of growth characters and the highest values of the root, top and sugar yields fed⁻¹, in both seasons. Abdou *et al.* (2014) found that adding 31.0 kg P₂O₅ fed⁻¹ and thinning at the age of 20 days was the suitable recommendation to maximize sugar beet root yield and quality under the environmental conditions of Dakahlia Governorate. Hussain *et al.* (2014) declared that the addition of P1 (the first rate) and P2 (the second rate) increased beet yield by 37 and 47% over control. The shoot phosphorus (mmol kg⁻¹) was achieved as 55.2, 73.6 and 84.3 at P0, P1 and P2, respectively.

Boron is by far the most important of the trace elements needed sugar beet because, without an adequate supply, the yield and quality of roots are very depressed. Soil application, as well as, a foliar spray of boron is equally effective, hence the fresh root weight, sucrose %, root and top yields significantly increased by increasing boron levels. Armin and Asgharipour (2012) reported that the highest root yield and sucrose concentration was obtained by spraying with 12% boric acid. Soliman *et al.* (2014) showed that boron as a foliar application significant responses in the two seasons with respect to growth characters of sugar beet. Increased boron foliar application from 0 to 0.4 g L⁻¹, increasing growth characters of sugar beet at the first and second seasons. Application of boron spray exerted a significant increase in sugar, juice purity and crude protein percentage. Mekdad (2015) reported that Application of P1 and P 2 ppm boron significantly improved root yield and its attributes, percentage of gross and white sugar. On contrarily Na, K, α -amino N, loss sugar percentages, harvest index and loss sugar yield were decreased. Maximum root, top, sugar yield fed⁻¹ and root quality was produced by 140 (N2) kg N/fed and 120 and /or 150 ppm boron.

The present investigation aimed study the effect of two Cultivars(Gloria and Diamond), phosphorus(0, 12, 24, 36 and 48 kg P₂O₅ fed⁻¹ as a mono-super phosphate) and boron (0 . 0.750 and 1.125 kg Borax fed⁻¹) and their interaction on yield, yield components and quality of sugar beet

MATERIALS AND METHODS

The present investigation was conducted at aprivate Farm, Kalabsho, Belqas Center, Dakahlia Governorate during seasons of 2014/2015 and 2015/2016. This study was layout to find the effect of cultivars (Gloria and Diamond), phosphorus and boron effects and their interaction on yield, yield components and quality of sugar beet plants (*Beta vulgaris*, L.). The cultivars were introduced from Dakahlia Company for sugar.

Experimental design

A spli-split plot design with four replicates was used. The main plots were assigned for the following cultivars i.e, Gloria and Diamond. The sub-plot was

devoted to the phosphorus fertilizer rates in the form of mono-super phosphate (15.5% P₂O₅) were used in one time addition after planting. In addition, the sub-sub plots including spraying boron in the form of Borax in two equal portions : 1.125 kg fed⁻¹ and 0.750 kg fed⁻¹.

The sugar beet seeds were sown on 26th August and 23rd August in the two seasons, respectively. Sugar beet seeds were hand sown (dry sowing method) on one side of the ridge in hills 20 cm apart at the rate of 3-5 balls/hill. The plots were irrigated immediately after sowing. After one month, plants were thinned to two plants/hill and singled to one plant/hill after 30 days from sowing. The recommended agricultural practices were kept in the same normally practiced according to the recommendation of ARC. The experimental unit (sub-sub plot) was 10.5 m² "3x3.5m" including five ridges each of 60 cm apart and 3.5 long. The preceding summer crop was watermelon in both seasons. Some Pphysical and chemical properties of the field experimental samples are shown in Table (1).

Table 1. Some physical and chemical properties of the experimental soil.

	Particle size distribution					O.M g kg ⁻¹	CaCO ₃ %	pH*	EC** dS m ⁻¹			
	Coarse sand%	Fine sand%	Silt %	Clay %	Texture							
1 st	1.45	10.34	22.28	65.93	Clayey	2.49	1.33	8.30	2.18			
	Soluble Cations and anions*, cmolc kg ⁻¹							Available mg kg ⁻¹				
	Cations					Anions						
	Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	CO ₃ ⁻⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻	N	P	K	B
7.00	5.00	7.83	1.93	0.00	2.21	6.84	12.71	15.00	4.50	390	0.2	
2 nd	Particle size distribution					O.M g kg ⁻¹	CaCO ₃ %	pH*	EC** dS m ⁻¹			
	Coarse sand%	Fine sand%	Silt %	Clay %	Texture							
	1.09	11.23	21.67	66.01	Clayey	2.51	1.41	8.1	5.32			
	Soluble Cations and anions*, cmolc kg-l							Available mg kg ⁻¹				
Cations					Anions							
Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	CO ₃ ⁻⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻	N	P	K	B	
2.95	2.81	11.21	0.27	0.00	1.59	12.02	3.63	16.7	5.23	401	0.22	

The soil of the experiment was clay in texture. Soil samples were taken from 15 to 30 cm depth in the experimental sites before soil preparation to measure the important chemical and physical properties of soil according to Black (1965).

Yield components:

At maturity (210 days from planting), five plants were chosen at random from the central of ridges of each sub-sub plot to determine the following characters:

1. Root fresh weight (Mg fed⁻¹)
2. Top fresh weight (Mg fed⁻¹)
3. Root diameter (cm)

Quality: Sucrose percentage (%): It was determined Polarimetrically on lead acetate extract of fresh macerated roots according to the method of Le-Docte (1927).

Yield (Mg fed⁻¹): At harvest i.e. 210 days from planting, plants of the three ridges were pulled up and yield were estimated.

Statistical analysis

All data were statistically analyzed according to the technique of analysis, variance (ANOVA) , the least significant difference and was used to compare the differences between the means of studied treatments values

according to methods described by Gomez and Gomez (1984). All measured investigations were performed utilizing a examination fluctuation procedure by method of CoSTATE PC programming.

RESULTS AND DISCUSSION

Top fresh weight (Mg fed⁻¹):

Data related to the effect of cultivars, phosphorus, boron and their interactions on top yield (Mg fed⁻¹) during 2014/2015 and 2015/2016 seasons are shown in Table 2

Cultivars effects:

Cultivars had a significant effect on top yield (Mg fed⁻¹) during the two growing seasons of study . By Dwelling obtained data, the highest values of top yield (9.398 and 10.042 Mg fed⁻¹) in the first and second seasons, respectively) could be obtained from diamond in the 1st season and Gloria in the second season. On the contrary of that, the lowest means in this terms (6.777 and 9.807 Mg fed⁻¹) in the first and second seasons, respectively) were obtained from Gloria cultivars in the 1st season and Diamond cultivars in the second one. The differences between the two cultivars in the studied characters may be due to hereditary differences. This result

was in line with those reported by, Shalaby (1998), Ali (2000) and Shalaby *et al.* (2011).

Effect of phosphorus fertilizer:

Phosphorus treatments caused a significant increase in top yield per feddan. The optimum phosphorus fertilizer treatments were 48 kg P₂O₅, thereby it caused significant increase and the greatest values of top yield, which registered data were (8.926 and 12.412 Mg fed⁻¹) in the first and second seasons, respectively (Table 2). However, 36 kg P₂O₅ treatment came in the second rank after the aforementioned treatment and then the control treatment recorded the lowest values in the two seasons. The effect of phosphorus which stimulates vegetative growth and consequently top yield per feddan. A positive association of phosphorus treatments for top yield per feddan has been reported by Abo El-Goud (2000) and Abdou *et al.* (2008).

Table 2. Effect of Cultivars, phosphorus and boron fertilizers on top fresh weight of sugarbeet.

Characters	Top fresh weight (Mg fed ⁻¹)	
Treatments	2014/2015	2015/2016
1. Cultivar effects:		
Diamond	9.398	9.807
Gloria	6.777	10.042
F-test	**	**
2. Phosphorus effects (kg P ₂ O ₅ fed ⁻¹)		
0	6.816	7.197
12	7.486	9.171
24	8.323	10.017
36	8.889	10.828
48	8.926	12.412
F-test	**	**
LSD 0.05	0.485	0.169
LSD 0.01	0.708	0.248
3. Boron effects (g fed ⁻¹)		
0	7.712	9.435
750	8.190	9.919
1125	8.362	10.516
F-test	*	**
LSD 0.05	0.307	0.107
LSD 0.01	0.448	0.157
4. Interaction effects		
VxP	NS	NS
VXB	NS	NS
PXB	NS	**
V X P XB	NS	NS

** Highly significant (P<0.01) NS Not significant , Mg = 1000 kg

Effect of boron fertilizer levels:

Surpassing boron fertilizer levels from 0 to 1.125 kg in the second season tended to increase top yield from 9.435 to 10.516 Mg fed⁻¹ while in the first season the third level recorded the highest meanwhile the control treatment ranked the second. A similar trend was established by Soliman *et al.* (2014) who they reported that increasing boron foliar application from 0 to 0.4 g per litter increased growth characters of sugar beet at the first and second seasons, respectively. Also, Dewedar *et al.* (2015) reported the same trend. As shown from tabulated data in Table 2, phosphorus and boron combination levels exhibited no remarkable differences on top yield (Mg fed⁻¹) in the first

season. On the other hand, the interaction effects had a significant effects except cultivars* Phosphorus* boron.

The response of top yield to the interaction between phosphorus and boron treatments was significant in the second season (Table3). It can be considered the highest values of top yield were obtained due to the fifth level of phosphorus and the third levels of boron 9.55 and 13.20 Mg fed⁻¹ (in the first and second seasons, respectively) while, the lowest values 6.55 and 5.85 t/fed recorded from control treatments for phosphorus and boron in the 1st and 2nd seasons, respectively.

The effect of the interaction among all factors under study on top yield was insignificant in the two seasons. It can be concluded that highest values of top yield (10.833and 13.533Mg fed⁻¹ in the first and second seasons, respectively) were produced from Gloria cultivars which treated with high levels of phosphorus and the highest dose of boron.

Table 3. Effect of phosphorus and boron treatments on top fresh weight (Mg fed⁻¹)

Treatments	Boron effects (g fed ⁻¹)					
	2014-2015			2015-2016		
	0	750	1125	0	750	1125
Phosphorus treatments (kg P ₂ O ₅ fed ⁻¹)	g	g	g	g	g	g
0	6.55	6.87	7.03	5.85	7.43	8.30
12	7.30	7.45	7.712	8.77	9.16	9.57
24	8.17	8.33	8.46	9.77	9.96	10.31
36	8.70	8.92	9.04	10.50	10.79	11.18
48	7.83	9.39	9.55	11.80	12.22	13.20
F-test	NS			**		
LSD at 0.05	0.374			0.113		
LSD at 0.01	0.546			0.165		

Root yield (Mg fed⁻¹):

Means of root yield (Mg fed⁻¹) as affected by cultivars e.g. Diamond and Gloria, phosphorus fertilizer levels, boron effect and their interactions at 90 and 150 days from planting during 2014/2015 and 2015/2016 are presented in Table 4.

Effect of cultivars:

Cultivars of exhibited insignificant effect on root yield in the two growing seasons. Generally, the highest root yield achieved from Gloria cultivars with mean 21.507 Mg fed⁻¹ while, Diamond cultivars recorded 21.337 Mg fed⁻¹ in the first season. Meanwhile, in the second season the same trend was observed for cultivars Gloria which surpassed cultivars Diamond. These increment in root yield might be due to the differences among sugar beet varieties under study refers to the variation in the genes makeup and their response to the environmental condition.

The differences among sugar beet varieties were found by Osman (2005), Azzazy *et al.* (2007), El-Sheikh *et al.* (2009) and Hanan Y. Mohamed and M.A.T. Yasin (2013).

Effect of phosphorus fertilizer levels:

The collected data in Table (4) show that there were remarkable significant differences among phosphorus treatments on root yield per feddan during the two growing seasons. Noteworthy, 48 kg P₂O₅ was the best treatment among other phosphorus treatments, which resulted in the maximum root yield (28.909 and 34.154 Mg fed⁻¹) in the first and second seasons, respectively. Furthermore, control

treatment (without addition) recorded 15.272 and 17.590 Mg fed⁻¹ in the first and second seasons, respectively.

Addition of 36 kg P₂O₅ ranked the second treatment for root yield which recorded 23.724 and 30.538 (Mg fed⁻¹) in the two seasons. This effect of phosphorus treatments expressly may be ascribed to share in the bioactivities inside plants and increases the creating of carbohydrates like starch and sugars. Moreover, It helps in the division of plant cells and shares in forming ATP (Adenosine triphosphate) . Similar results were obtained by Ismail and Abo El-Ghait (2004) and Abdou *et al.* (2008) who reported that increasing phosphorus fertilizer level from zero up to 30 kg P₂O₅ fed⁻¹ markedly increased root weight g/plant.

Table 4. Effect of cultivars, phosphorus and boron treatments on root yield (Mg fed⁻¹)

Characters	Root yield Mg fed ⁻¹	
	2014/2015	2015/2016
1. cultivar effects		
Diamond	21.337	25.795
Gloria	21.507	27.040
F-test	**	**
2. Phosphorus effects (kg P ₂ O ₅ fed ⁻¹)		
0	15.272	17.590
12	18.267	22.999
24	20.938	26.807
36	23.724	30.538
48	28.909	34.154
F-test	**	**
LSD 0.05	0.463	0.356
LSD 0.01	0.676	0.520
3. Boron effects (g fed ⁻¹)		
0	20.966	24.968
750	21.347	26.405
1125	21.953	27.880
F-test	**	**
LSD 0.05	0.293	0.225
LSD 0.01	0.428	0.329
4. Interaction effects		
VxP	**	**
VXB	**	NS
PXB	**	**
V X P XB	**	**

Effect of boron fertilizer rates:

Data in Table (4) showed that there were significant differences in root yield. With expecting the effect of boron fertilizer effects on root yield, increasing its levels from 0 to 1.125 kg H₃PO₄ fed⁻¹ tended to increase root yield from 20.966 to 21.953 and 24.968 to 27.880 Mg fed⁻¹ in the two growing seasons. These findings may be attributed to boron plays an important function in sugar beet as maintaining the balance between sugar and starch; translocation of sugar and carbohydrates, standard cell division, nitrogen metabolism and protein formation, and cell wall configuration Also, it plays the main roles in the correct function of cell membranes and the transport of K⁺ to guard cells to the internal water balance control system they reported that Fertilizing sugar beet by mixture of potassium +Boron + Calcium recorded an important increase in root and extracted sugar yields/fed and sucrose% as compared to untreated. This findings are in the line with Bondok (1996); El-Hawary (1999) and Aly *et*

al. (2017) they reported that Fertilizing sugar beet by mixture of potassium +Boron + Calcium recorded an important increase in root and extracted sugar yields/fed and sucrose% as compared to untreated.

The effect of interaction between cultivars and phosphorus fertilizer levels:

Data in Table 5 represents the cultivars X phosphorus fertilizer levels and stated their was a significant effect in both seasons. Cultivars Gloria when treated with the fifth phosphorus levels recorded the highest mean of root yield (29.839 Mg fed⁻¹). On contrary, cultivars Diamond with the highest mean of phosphorus fertilizer rates recorded the highest mean of root yield (27.979 Mg fed⁻¹). These results were reported by Gobara and Mekki (2005).

Table 5. Effect of phosphorus and cultivars on suger beet root fresh weight (Mg fed⁻¹)

Treatments	Phosphorus effects (kg P ₂ O ₅ fed ⁻¹)									
	2014/2015				2015/2016					
	0	12	24	36	48	0	12	24	36	48
Cultivars										
Diamond	15.36	18.92	21.03	23.42	27.98	17.03	21.78	26.46	30.31	33.4
Gloria	15.18	17.62	20.85	24	29.84	18.15	24.22	27.16	30.76	34.91
F-test	**				**					
LSD 0.05	0.463				0.356					
LSD 0.01	0.676				0.52					

Regarding to the interaction between phosphorus and boron, data in Table 6 illustrate a significant differences and the highest root yield (32.86 and 36.27 Mg fed⁻¹) in the first and second seasons, respectively were recorded from 48 kg P₂O₅ and 1.125 boron kg fed⁻¹.

Table 6. Effect of phosphorus and boron treatments on root fresh weight (Mg fed⁻¹)

Treatments	Boron effects (g fed ⁻¹)					
	2014/2015			2015/2016		
	0	750	1125	0	750	1125
Phosphorus treatments (kg P ₂ O ₅ fed ⁻¹)						
0	13.71	15.4	16.73	15.9	17.51	19.4
12	17.13	18.4	19.32	21.5	23.28	24.2
24	19.86	20.9	22.06	25.5	26.91	28.06
36	23.23	23.7	24.21	29.6	30.58	31.48
48	25.34	28.5	32.86	32.5	33.75	36.27
F-test	**			**		
LSD 0.05	0.201			0.2		
LSD 0.01	0.294			0.291		

There were significant differences between the triple interactions between all treatments on root fresh weight.

Root diameter (cm)

The effect of varietal effects, phosphorus fertilizer treatments, boron effects on root diameter (cm) during 2014/2015, 2015/2016 seasons are presented in Table 7.

Root diameter exhibited significant differences in varietal effects in the two seasons. The thickest roots were produced from planting Diamond cultivar, results were 12.74 and 14.29 cm in the first, second and seasons, respectively. Whereas, the thinnest roots (11.98 and 14.09 cm) came out from Gloria cultivar in the two seasons.

The trend of these results is similar to those of root length and similar discussion could be cited. These differences in response could be attributed to the genetic makeup of the cultivars that controls assimilate distribution within the plants. Confirming these findings with El-Kammash *et al.* (2011) and Ali *et al.* (2012). Phosphorus

fertilizer treatments had a significant effect on root diameter in the two growing seasons of this research. Roots in the treatment of 48 kg P₂O₅ fed⁻¹ (14.61 and 16.36 cm) were significantly thicker than other treatments in the first, second and third seasons, respectively. Also, it can be noticed that 36 kg P₂O₅ treatment came in the second rank after aforementioned treatment with respect root diameter in all seasons. It can be cited that the increase in root diameter due to the same reason that led to the increase in root length as previously mentioned.

These results are in full accordance with those reported Abo-El-Goud (2000); Seadah (2012) and Abdou *et al.* (2014)

Increasing boron fertilizer levels from 0 to 0.750 and 1.125 kg fed⁻¹ (Borax) tended to increase root diameter from 11.87 to 12.35 and 12.85 in the first season and 13.69 to 14.22 and 14.67 cm in the second one. These findings are accomplished with those observed by the enhancing effect root diameter may be attributed to the increase in cell size and numbers as a result of the increasing division of cells as well as activating accumulation of metabolites in storage roots. These findings are accomplished with those recorded by Mekdad (2015); Dewedar *et al.* (2015) and Aly *et al.* (2017).

Table 7. Effect of cultivars, phosphorus and boron treatments on sugerbeet plant root diameter (cm)

Characters	Root diameter	
	2014/2015	2015/2016
1. cultivar effects:		
Diamond	12.74	14.29
Gloria	11.98	14.09
F-test	**	**
2. Phosphorus effects (kg P ₂ O ₅ fed ⁻¹)		
0	9.51	12.07
12	11.63	13.29
24	12.64	14.17
36	13.39	15.07
48	14.61	16.37
F-test	**	**
LSD 0.05	0.17	0.14
LSD 0.01	0.25	0.20
3. Boron effects (g fed ⁻¹)		
0	11.87	13.69
750	12.35	14.22
1125	12.85	14.67
F-test	**	**
LSD 0.05	0.16	0.09
LSD 0.01	0.11	0.13
4. Interaction effects		
VxP	**	*
VXB	**	NS
PXB	**	**
VXBXP	**	**

Effect of interactions:

The interactions between all treatments had a significant effect on root diameter in the two seasons (Table 8). Mohamed. Y. H. and M.A.T. Yasin (2013) came to similar results. Regarding to phosphorus fertilizer and boron combination had a significant effect. Using 48 kg P₂O₅ and 1.125 kg borax gave the highest mean in the

two season. While, the lowest mean could be observed from control treatment.

Sucrose percentage (%):

The effect of cultivars, phosphorus, boron and their interaction on sucrose% during 2014/2015 and 2015/2016 seasons are registered in Table 8.

Table 8 . Effect of cultivars, phosphorus and boron treatments on sugerbeet plant Sucrose percentage (%)

Characters	Sucrose percentage (%)	
	2014/2015	2015/2016
1. cultivar effects:		
Diamond	16.964	20.137
Gloria	16.827	20.334
F-test	**	**
2. Phosphorus effects (kg P ₂ O ₅ fed ⁻¹)		
0	15.818	19.423
12	16.505	19.827
24	16.912	20.123
36	17.256	20.578
48	17.987	21.228
F-test	**	**
LSD 0.05	0.050	0.043
LSD 0.01	0.073	0.063
3. Boron effects (g fed ⁻¹)		
0g	16.681	20.068
750g	16.907	20.237
1125g	17.099	20.402
F-test	**	**
LSD 0.05	0.032	0.027
LSD 0.01	0.046	0.040
4. Interaction effects		
VxP	**	**
VXB	NS	NS
PXB	**	**
V X P XB	NS	**

According to the analysis of variance of obtained data, it can be stated that varietal effects of sugar beet significantly affected sucrose % in the two seasons. Generally, it can be concluded that cultivars of beets showed a significant increase in sucrose % and produced the highest values, which data were 16.96 from cultivars diamond in the 1st season and 20.33 from cultivars Gloria in the 2nd season. The favorable effect of cultivars of sugar beet might be backed to genetic effects. Similar results are pertinence with those ElSheikh *et al.* (2009) and Aly *et al.* (2012).

As shown from data collected in Table8 , phosphorus fertilizer treatments had a significant effect on sucrose % in all growing seasons. Phosphorus caused a significant increase in sucrose % over all treatments and induced the highest values i.e. 17.98 and 21.23 % in the first and second seasons, respectively. The lowest means of sucrose content in roots (15.82 % and 19.42 % in the first and second seasons, respectively) were obtained on account of control treatment (without fertilization) in the first and second seasons season. It can be suggested that this increase in sucrose % may be reflected the role of phosphorus in improving growth and dry matter accumulation by increasing the uptake and availability of most nutrients, consequently enhancement sucrose content

in roots. Abdou *et al.* (2014) and El-Mansoub *et al.* (2014) suggested similar results.

Boron fertilizer treatments had a significant effect on sucrose % in all growing seasons. Increasing boron fertilizer levels from 0 to 0.750 and 1.125 kg Borax/fed tended to increase sucrose % from 16.68 to 16.90 and 17.09 in the first season and 20.07, 20.24 and 20.40% in the second season. The stimulation effects of micronutrients on quality traits may be attributed to the increase in sucrose%. Boron is essential for the formation of new cells in meristems in addition to a vital role in sugar translation to roots. Similar trend was obtained by Ab elaal *et al.* (2015) and Aly *et al.* (2017).

Regarding the effect of all treatments interactions on sucrose %, it was significant in the two growing seasons. The highest values of sucrose % (18.21 and 21.59%) resulted from utilizing phosphorus in the high rates besides in the third boron application in the first and second seasons, respectively. On the other hand, the lowest ones were obtained by no application of phosphorus or boron in all seasons.

Total fresh Yield:

Total fresh weight of sugar beet plants data (Mg fed⁻¹) as affected by cultivars, phosphorus, boron treatments during 2014/2015 and 2015/2016 seasons are presented in Table 9. Cultivars had a significant effect on total yield and Gloria variety surpassed Diamond variety of total fresh weight (30.724, 36.967 and 28.448, 35.855 Mg fed⁻¹) in the first and second seasons, respectively. The superiority of total yield may be due to these increment in root yield might be due to the differences among sugar beet varieties under study due to the variation in the genes makeup and their response to the environmental condition. These results are in harmony with those obtained by El-Sheikh *et al.* (2009) and Hanan Y. Mohamed and M.A.T. Yasin (2013).

On the other hand, the collected data in Table 9 show that there were remarkable significant differences among phosphorus treatments on total yield per feddan during the two growing seasons. Noteworthy, 48 kg P₂O₅ was the best treatment among other phosphorus treatments, which resulted in the maximum total yield (38.258 and 46.406 Mg fed⁻¹) in the first and second seasons, respectively. Addition of 36 kg P₂O₅ ranked the second treatment for total yield which recorded 32.593 and 41.290 Mg fed⁻¹ in the two seasons. This effect of phosphorus treatments expressly may be ascribed to share in the bioactivities inside plants and increases the creating of carbohydrates as starch and sugars. Moreover, It helps in the division of plant cells and shares in forming ATP (Adenosine triphosphate). Similar results were obtained by Abdou *et al.* (2008), they reported that increasing phosphorus fertilizer level from zero up to 30 kg P₂O₅ fed⁻¹ markedly increased root weight g/plant.

With expecting the effect of boron fertilizer effects on total yield, increasing its levels from 0 to 1.125 kg H₃PO₄/fed tended to increase root yield from 27.801 to 31.385 and 34.262 to 38.302 Mg fed⁻¹ in the two growing seasons. These findings may be attributed that boron plays an important function in sugar beet as maintaining the balance between sugar and starch; translocation of sugar and carbohydrates, standard cell division, nitrogen

metabolism and protein formation, and cell wall configuration. Also, it plays the main roles in the correct function of cell membranes and the transport of K⁺ to guard cells to the internal water balance control system they reported that Fertilizing sugar beet by mixture of potassium plus Boron plus Calcium recorded a important increase in root and extracted sugar yields/fed and sucrose% as compared to untreated. These findings are in line with Aly *et al.* (2017) they reported that fertilizing sugar beet by a mixture of potassium plus Boron plus Calcium recorded an important increase in root and extracted sugar yields/fed and sucrose% as compared to untreated.

Table 9. Effect of cultivars, phosphorus and boron treatments on sugarbeet plant total yield (Mg fed⁻¹) (%)

Characters	Total Yield (Mg fed ⁻¹)	
	2014/2015	2015/2016
Treatments		
1. Varietal effects:		
Diamond	28.448	35.588
Gloria	30.724	36.967
F-test	**	**
2. Phosphorus effects (kg P ₂ O ₅ fed ⁻¹)		
0	22.080	24.771
12	25.746	32.133
24	29.251	36.787
36	32.593	41.290
48	38.258	46.406
F-test	**	**
LSD 0.05	0.469	0.474
LSD 0.01	0.684	0.693
3. Boron effects (g fed ⁻¹)		
0	27.801	34.262
750	29.557	36.267
1125	31.385	38.302
F-test	**	**
LSD 0.05	0.296	0.300
LSD 0.01	0.433	0.438
4. Interaction effects		
VxP	**	*
VXB	**	NS
PXB	**	**
VXBXp	*	**

The interaction between cultivars and phosphorus fertilizer levels showed a a significant effect in the two seasons. Gloria cultivars which treated with phosphorus at the rate of 48kg p₂o₅ fed⁻¹, recorded the highest mean of total yield (38.532 Mg fed⁻¹). the These results were reported by Gobarah and Mekki (2005) and Aly *et al.* (2017).

Related the interaction between cultivars and boron there were significant differences and Gloria cultivars with boron at a rate of 1.125 kg fed⁻¹ recorded 32.289 Mg fed⁻¹ in the first season while, Diamond cultivars with untreated treatment achieved 26.412 Mg fed⁻¹

concerning to the interaction between phosphorus and boron, there were significant differences in the second season Table (10). The highest total yield/fed (42.402 Mg fed⁻¹) in the first season, respectively recorded from 48 kg P₂O₅ and 1.125 boron kg fed⁻¹.

Table 10 . Effect of the interaction between phosphorus and boron treatments on sugarbeet plant total yield (Mg fed⁻¹) (%)

Treatments Phosphorus treatments (kg P ₂ O ₅ fed ⁻¹)	Total Yield (Mg fed ⁻¹)					
	Boron effects (g fed ⁻¹)					
	2014/2015			2015/2016		
	0	750	1125	0	750	1125
0	20.182	22.235	23.740	15.858	17.513	19.398
12	24.410	25.793	27.035	21.522	23.273	24.192
24	28.022	29.210	30.522	25.452	26.905	28.058
36	31.908	32.642	33.228	29.557	30.583	31.478
48	34.485	37.903	42.402	32.452	33.745	36.265
F-test		**			**	
LSD 0.05		0.219			0.216	
LSD 0.01		0.341			0.336	

There were significant differences between the triple interactions between all treatments in the second season .

CONCLUSION

It could be concluded that all used treatment significantly affected on sugar beet yield and its component. The interaction between Gloria cultivars, phosphorus fertilizer at the rate of 48 kg P₂O₅ fed⁻¹, boron at the rate of 1.125 kg fed⁻¹ recorded the best in all used treatments.

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تأثير الأصناف والتسميد بالفوسفور والبورون على محصول وجودة بنجر السكر فاطمة عبدالرحمن غالي^١، محمد رضا عبد الهادي^٢، أحمد صلاح عبدالحميد^١ ومسلم الشحات أبو مسلم^١ ^١ قسم الأراضي - كلية الزراعة - جامعة دمياط - مصر ^٢ معهد بحوث الأراضي والمياه - مركز البحوث الزراعية - مصر

أقيمت تجربتان حقليتان بمزرعة خاصة بمنطقة قلبشو مركز بلقاس محافظة الدقهلية خلال الموسمين الزراعيين ٢٠١٤/٢٠١٥-٢٠١٦/٢٠١٥ بهدف دراسة تأثير أصناف بنجر السكر (جلوريا- دايموند) والتسميد الفوسفاتي (صفر، ١٢، ٢٤، ٣٦، ٤٨) وحدة خامس أوكسيد الفوسفور للقدان والتسميد بالبورون (صفر ، ٧٥٠ ، ١١٢٥) جرام للقدان وتأثير التفاعل وذلك على المحصول ومكوناته وجودته. كان التصميم المستخدم هو تصميم القطاعات المنشقة مرتين باستخدام أربع مكررات وكانت الوحدة التجريبية ٢م^{١٠} × ٣م^٣ (٤٠٠/١) فدان وكانت اهم النتائج كما يلي: حقق الصنف دايموند أعلى قيمة في وزن العرش في الموسم الأول فيما حقق الصنف جلوريا أعلى قيم في الموسم الثاني وكانت أفضل معاملات التسميد الفوسفاتي هي ٤٨ وحدة خامس أوكسيد الفوسفور حيث حققت أعلى زيادة معنوية في قيم العرش، كما كان لتأثير الأصناف مع البورون تأثير معنوي خلال الموسمين حقق التسميد الفوسفاتي بمعدل ٤٨ وحدة خامس أوكسيد الفوسفور للقدان أعلى القيم لجنور بنجر السكر خلال الموسم الأول والثاني بينما حقق قيم الكنترول (بدون معاملة) أقل القيم خلال الموسمين. أدبت زيادة التسميد بالبورون (صفر الي ١١٢٥ جرام/ فدان) بوراكس الي زيادة محصول الجنور خلال موسمي الزراعة حيث سجل الصنف جلوريا أعلى القيم للمحصول الكلي بكمية وقدرها ٣٠.٧٢٤ طن/ فدان بينما حقق الصنف دايموند ٢٨.٤٤٨ طن/ فدان في الموسم الأول بينما سجل نفس الاتجاه في الموسم الثاني. أظهر أصناف البنجر المستخدمة وجود زيادة معنوية في متوسط نسبة السكر في زيادة الفوسفور وكذلك أدبت زيادة البورون من (صفر الي ٧٥٠ ثم ١١٢٥) جرام للقدان الي زيادة نسبة السكر من ١٦.٨٢ الي ١٦.٨٩ ثم ١٦.٩٨ % في الموسم الأول و بينما كانت النسبة ٢٠.١٧ الي ٢٠.٢٣ ثم ٢٠.٣٠ % في الموسم الثاني. نستنتج من الدراسة أن كل المعاملات المستخدمة أثرت معنويًا علي محصول البنجر ومكوناته و كانت معاملة التفاعل بين صنف جلوريا مع التسميد الفوسفاتي ٤٨ وحدة خامس أوكسيد الفوسفور للقدان و١١٢٥ جرام بوراكس للقدان أفضل المعاملات المستخدمة لزيادة المحصول ومكوناته علاوة على نسبة السكر.