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Response of Sugar Beet Varieties to Foliar Treatments with Bio Stimulant Growth Substances under Sandy Soil Conditions

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Abstract: Greenhouse pot experiment was conducted to investigate the effect of foliar applied Nicotinamide on sugar beet varieties under sandy soil conditions. The results showed significant differences among sugar beet varieties in root length and diameter as well root weight and shoot weight per plant. The most superior variety was Sirona which possessed greatest values in root length and diameter as well as root and shoot yields. Root yield for the tested varieties was in the following order Sirona > Farida > Oscar Poly > Peti > Sau Cona > Samba. Foliar applied Nicotinamide to sugar beet varieties under sandy soil conditions resulted in insignificant increase in root length when sugar beet plants were sprayed with 50 ppm nicotinamide. While foliar spray with nicotinamide at 100 ppm significantly increased root diameter, root and shoot yields per plant. There were variability in photosynthetic pigments content in sugar beet varieties. Some varieties contained the greatest chl. a content when it was sprayed by 100 ppm Nicotinamide like PETI variety while others like Oscar Poly and Sau Cona contained the greatest chl. a when the plants were sprayed with 50 ppm. The leaves of Heba variety contained the greatest concentration of total sugars without Nicotinamide followed by the variety Oscar poly when it was sprayed with 50 ppm. Sirona variety contained the greatest total phenol concentration without spraying with Nicotinamide, while Heba variety possessed the greatest total phenol concentration when it was sprayed with 50 ppm Nicotinamide.

Key words: Sugar beet · Variety · Nicotinamide · Sandy soil

INTRODUCTION

Sugar beet (*Beta vulgaris* var. *saccharifera* L.) ranks as the second important sugar crops after sugar cane, producing annually about 40 % of sugar production all over the world. In Egypt, it is an important crop in the newly reclaimed sandy soils at the northern and southern parts of Egypt due to it could be cultivated without competition with other winter crops. In addition, it possesses some characters like its tolerance to salinity and ability to produce high sugar yield under saline conditions and limited water requirements in comparison to the other traditional winter crops. Moreover, it is considered the main alternative sugar crop for sugarcane which can decrease the pressure on water resources for its relatively low water requirements compared with sugarcane. Increasing sugar crops cultivated area and sugar production per unit area are considered the important national target to minimize the gap between sugar consumption and production. The total sugar beet cultivated area reached about 559744 feddan with an average of 20 ton fed^{-1} (Agricultural Economics of Egypt,

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2016). Recently, sugar beet has an important position in winter crops not only in the fertile soils, but also in poor, saline, alkaline and calcareous soils. Sugar beet is candidate to expand in the areas face some stress problems, i.e. salinity and insufficient of nutrient elements. Several studies are made to increase sugar beet productivity and quality in newly reclaimed soils [1]. The varietal differences among sugar beet due to growth habit or seed type which may affect sugar beet production or quality were reported by [2-14]. Recently, under Egyptian conditions a great attention is being devoted to search for untraditional natural and safe stimulating growth substances (chemical and biological technologies in agriculture) which have marked influence on plant growth parameters that is reflected to increase plant productivity [15]. Nicotinamide is a stress-associated compound that induces and regulates secondary metabolic accumulation and/or the manifestation of defense metabolism [16].

Therefore the aim of this work is to investigate the synergetic effect of Nicotinamide application to sugar beet varieties under sandy soil conditions.

MATERIALS AND METHODS

A pot experiment was conducted in the greenhouse of the National Research Centre to determine the response of seven sugar beet varieties to foliar treatments with three Nicotinamide concentrations. The experiment included 21 treatments which were the combinations of 7 sugar beet varieties and three levels of Nicotinamide (0, 50 and 100 ppm). The experimental design was RCBD in three replicates. Sugar beet seeds of the selected varieties were sown in earthenware pots No 50 on November 23th. Each pot contained 30 kg of sandy soil obtained from the Agricultural Research Station of the National Research Centre in Nubaria. The mechanical and chemical analyses of the soil are presented in Table 1. A basal dressing of 4.8 g urea 46.5 % which represent 75 kg N feddan, 10.5 and 9 gm pot^{-1} of potassium dihydrogen phosphate and calcium supper phosphate (15.5 %) representing 48 kg K_2o and 48 kg P_2O_5 fed^{-1} respectively were added varieties: Samba, Heba, Sau Cona, Oscar Poly, Farida, Sirona and Peti. Nicotinamide treatment was applied at 0, 50 and 100 ppm on 19th of March 2017.

Samples: Plant samples were taken from 3 replicates. Plants were taken from each treatment to estimate root length, root diameter, mean root weight and mean top weight per plant.

Chemical Constituents of Leaves: The determination of photosynthetic pigments were determined according to the method described by [17], proline content according to the method described by [18], amino acids content according to the method described by [19], total sugars content according to the method described by [20] and total phenols content according to the method described by [21].

Chemical Composition of the Roots: Composite sample of each treatment was taken from the roots for analysis by the sugar factory in El Fayoum to determine:

1. Gross sugar %:
Juice sugar content, which was determined by means of an Automatic Sugar Polarimetric according to [22].

2. Extractable white sugar %:
- Corrected sugar content (white sugar) of beets was calculated by linking the beet non-sugar K, Na and α-amino (expressed as a meq/100 g of beet) according to [23], as follows:

$$ZB = pol - [0.343 (K + NA) + 0.094 AmN + 0.29]$$

where:
ZB = Corrected sugar content (% per beet) or extractable white sugar
Pol = Gross sugar %
AmN = α –amino - N determined by the "blue number method".

3. Loss sugar % = Gross sugar % - white sugar %
4. Juice purity percentage

$$\text{Juice purity \% (Qz)} = ZB/ Pol \times 100$$

5. Soluble non-sugar content:

The soluble non-sugars (potassium, sodium and α - amino nitrogen in meq/100 g of beet) in roots were determined by means of an Automatic Sugar Polari metric system.

Table 1: Mechanical and chemical analysis of experimental soil.

Sand %	Silt %	Clay %	pH	Organic matter, %	$CaCO_3$ %	E.C. dS/m	Soluble N, ppm	Available P, ppm	Exchangeable K, ppm
91.2	3.7	5.1	7.3	0.3	1.4	0.3	8.1	3.2	20

Statistical Analyses: The data were subjected to the proper statistical analyses by [24]. Means were compared by using least significant difference (LSD) at 5%.

RESULTS AND DISCUSSION

Data presented in Table (2) and Fig. (1) show the varietal differences among sugar beet varieties regardless Nicotinamide application in the studied characters under sandy soil conditions. The data show significant differences among varieties in root length and diameter as well as root weight and shoot weight per plant. The most superior variety was Sirona, which possessed greatest values in root length, diameter as well as root and shoot weights. Root fresh weight for the tested varieties was in the following order Sirona > Farida > Oscar Poly > Peti > Sau Cona > Heba > Samba. Enan *et al*. [10] in Egypt, showed that sugar beet varieties differed significantly in root length, diameter and fresh weight plant^{-1}. Similar results were obtained by [2-14] and recently by [1].

Data in Table (3) and Fig. (2) show the effect of foliar applied Nicotinamide on some traits of sugar beet varieties under sandy soil conditions. Insignificant variance in root length was recorded as affected by Nicotinamide levels, while foliar application with Nicotinamide at 100 ppm significantly increased root diameter, root and shoot fresh weight per plant. The obtained results are in accordance with El-Gamal *et al.* [25] who tested biological substances as humic acid (HA), mono potassium phosphate (MKP) and vigamax (amino acids) for maximizing sugar beet and found that all tested treatments significantly improved root length, diameter, root and leaves fresh weight.

The interaction between variety and Nicotineamide application under sandy soil conditions was insignificant for root length/plant, while it was significant for root diameter ($P < 0.05$***), root and shoot yield/plant, which was ($P < 0.001$***).

Chemical Composition of Sugar Beet Leaves: Data in Tables (4 and 5) and Figs. (3-6) shows the effect of Nicotinamide application on photosynthetic pigments, total sugars and total phenols in the tested sugar beet varieties. The data show the variability in photosynthetic pigments content in sugar beet varieties. Some varieties contained the greatest Chl. a content when it was sprayed by 100 ppm Nicotinamide like Peti variety while others like Oscar Poly and Sau Cona contained the greatest Chl. a when the plants were sprayed with 50 ppm. Also, Sirona possessed the greatest concentration of Chl. b and carotenoids. When the plants were sprayed with 50 ppm. The data in the same table and Figs. show that the leaves of Heba variety contained the greatest concentration of total sugars without Nicotinamide followed by the variety Oscar poly when it was sprayed with 50 ppm. Similarly, Sirona variety contained the greatest total phenol concentration without spraying with Nicotinamide, while Heba variety possessed the greatest total phenol concentration when it was sprayed with 50 ppm Nicotinamide. It is will know that Nicotinamide is a stress-associated compound that induces and regulates secondary metabolic accumulation and/or the manifestation of defense metabolism in plants [16]. Youssef *et al*. [26] reported that Nicotinamide is an important derivative of nicotinic acid which is a precursor of two active biological compounds (NAD+ and NADP+). Also, Youssef *et al*. [26] found that Nicotinamide causes an increase in chlorophyll a than that found in control plants of 2-month-old, then with the progress of age a decrease was observed, not only in chlorophyll a, but also in chlorophyll b and carotenoids. El-Bassiouny *et al.* [27] showed that plant treated with Nicotinamide increased significantly all morphological criteria (plant height, leaves number, fresh and dry weights of shoots), metabolism (photosynthetic pigment, total soluble sugar, total carbohydrates, total amino acids and proline), mineral contents (N, P, K, Ca and Mg) and yield (grain, straw and biology) of both cultivars amended with either recommended or half recommended doses of NPK.

Table 2: Effect of sugar beet varieties on sugar beet characters under sandy soil *conditions*.

Variety	Root length (cm)	Root diameter (cm)	Root weight plant^{-1} (g)	Shoot weight plant^{-1} (g)
SAMBA	24.33	3.08	50.66	16.50
HEBA	25.50	3.54	63.08	22.66
SAU CONA	30.08	3.50	77.41	26.16
OSCAR POLY	31.83	3.08	117.91	40.50
FARIDA	28.58	3.50	132.08	45.75
SIRONA	32.16	3.95	194.58	66.33
PETI	31.08	3.95	110.01	37.33
LSD at 0.05	4.26	0.64	7.34	2.48

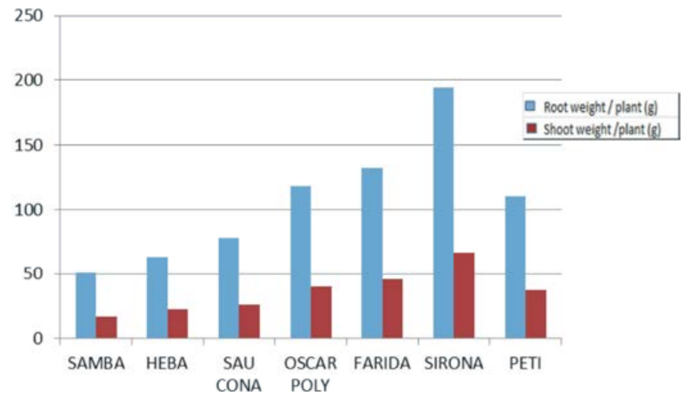

Fig. 1: Effect of varietal differences on root and shoot yields per plant.

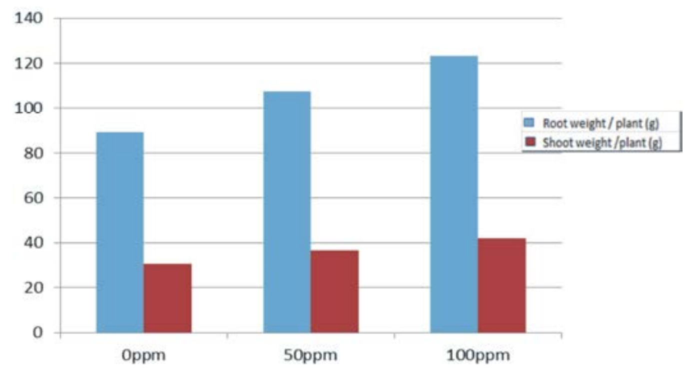

Fig. 2: Effect of foliar spray with nicotinamide on root and shoot yield per plant.

Table 3: Effect of foliar applied Nicotinamide on sugar beet varieties under sandy soil conditions.

Treatment		Root length (cm)	Root diameter (cm)	Root weight plant^{-1} (g)	Shoot weight plant^{-1} (g)
Foliar application	0 ppm	27.67	3.11	89.03	30.75
with Nicotinamide	50 ppm	29.39	3.58	107.32	36.71
	100 ppm	27.67	3.85	123.25	41.92
LSD at 0.05		ns	0.53	4.27	1.32

Table 4: Varietal differences among sugar beet varieties in photosynthetic pigments and total sugars of sugar beet leaves.

Nicotinamide	Chl. a	Chl. b	Carotenoids	Total sugars	Total phenols
0	0.250	0.205	0.150	6.711	1.097
50 ppm	0.282	0.240	0.172	7.383	1.037
100 pm	0.301	0.198	0.155	7.384	1.123

Table 5: Effect of foliar applied Nicotinamide on sugar beet photosynthetic pigments.

Variety	Chl. a (mg/g) FW.	Chl. b (mg/g) FW.	Carotenoids (mg/g) FW.	Total sugars (mg/g) FW.	Total phenols
Peti	0.221	0.196	0.135	3.720	0.907
Farida	0.123	0.115	0.084	5.800	0.907
Sirona	0.348	0.320	0.212	11.830	1.097
Oscar Poly	0.264	0.173	0.147	7.230	1.110
Sau Cona	0.243	0.235	0.167	7.120	1.007
Heba	0.266	0.187	0.155	6.130	1.313
Samba	0.283	0.207	0.153	5.150	0.907

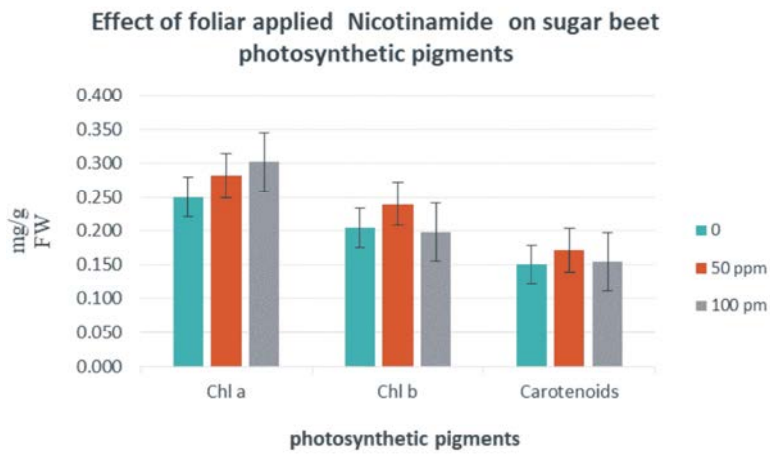

Fig. 3: Effect of foliar applied Nicotinamide on sugar beet photosynthetic pigments

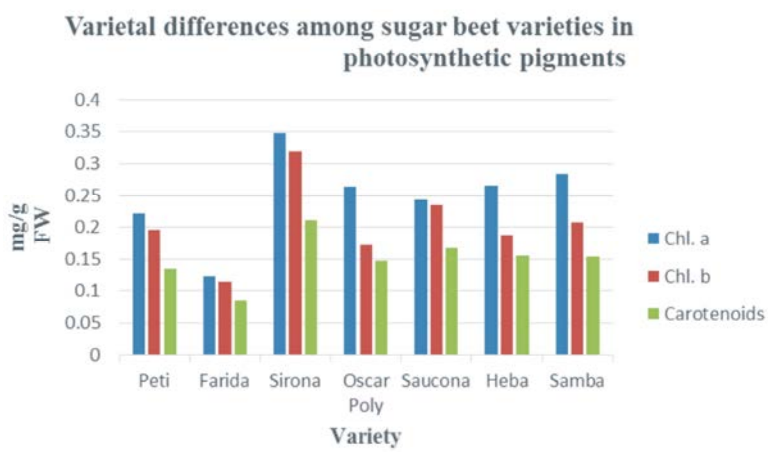

Fig. 4: Varietal differences among sugar beet varieties in photosynthetic pigments

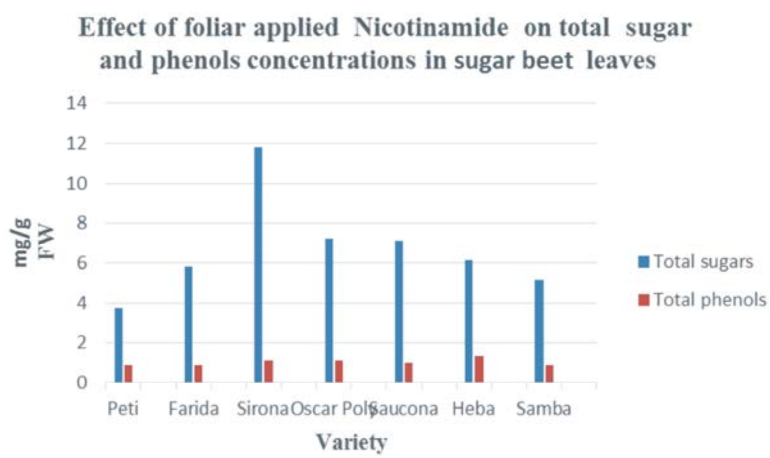

Fig. 5: Effect of foliar applied Nicotinamide on total sugar and phenols concentrations in sugar beet leaves.

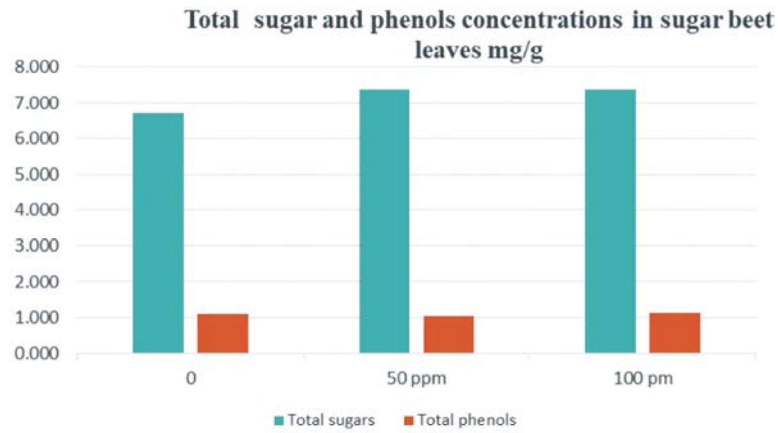

Fig. 6: Effect of foliar applied Nicotinamide on total sugars and phenols concentration in sugar beet leave.

Table 6: Effect of sugar beet variety and Nicotineamide application on photosynthetic pigments total sugars and total phenols

Variety	Nicotinamide	Chl. a (mg/g) FW.	Chl. b (mg/g) FW.	Carotenoids (mg/g) FW.	Total sugars (mg/g) FW.	Total phenols (mg/g) FW.
Peti	0	0.221	0.196	0.135	3.72	0.95
	50 ppm	0.223	0.206	0.149	3.50	0.82
	100 ppm	0.256	0.204	0.152	4.71	0.95
Sirona	0	0.348	0.320	0.212	11.83	1.28
	50 ppm	0.284	0.235	0.168	8.76	1.46
	100 ppm	0.319	0.173	0.122	7.23	1.20
Farida	0	0.123	0.115	0.084	5.80	0.65
	50 ppm	0.388	0.228	0.195	8.87	1.31
	100 ppm	0.323	0.164	0.136	9.53	1.06
Oscar Poly	0	0.264	0.173	0.147	7.23	1.28
	50 ppm	0.397	0.223	0.198	9.96	1.21
	100 ppm	0.150	0.131	0.118	5.58	0.84
Sau Cona	0	0.243	0.235	0.167	7.12	1.07
	50 ppm	0.214	0.179	0.147	6.79	0.73
	100 pm	0.151	0.152	0.109	6.35	0.92
Heba	0	0.266	0.187	0.155	6.13	1.52
	50 ppm	0.255	0.458	0.230	8.43	0.84
	100 ppm	0.175	0.141	0.115	3.72	0.93
Samba	0	0.283	0.207	0.153	5.15	0.93
	50 ppm	0.212	0.150	0.115	5.37	0.89
	100 ppm	0.413	0.258	0.195	5.04	0.90

Sugar Yield: Data in Table (7) and Fig. (7) show that sugar beet varieties exhibited clear differences in quality parameters, which affected sugar extraction parameters due to variety or Nicotinamide application. The lowest sugar beet varieties in yield were Farida, Peti and Samba, which contained the lowest sugar yield per plant, whereas the variety Farida could not compensate its low root production ability by the higher sugar % and sugar yield plant^{-1}. It seems that Alpha amino-N component is related to sugar detracting, where it lowers the Qz parameter. Farida variety possessed the highest purity parameters high Qz and low contents of soluble non-sugars potassium, sodium and α-amino nitrogen beet. The tested varieties could be arranged according to sugar yield plant^{-1} in the following order: Heba > Saucona > Oscar Poly > Samba > Sirona > Farida > Peti (Fig. 8). The obtained results are in accordance with those obtained by Khan *et al.* [28], who reported that varieties differed significantly in root yield, sugar contents and sugar recovery.

Table 7: Sugar beet varietal differences in chemical composition of roots.

Sugar beet variety	Gross sugar %	Juice purity % (Qz)	K%	Na%	α-amino%	Sugar yield $plant^{-1}$ (g)
Peti	15.14	77.56	4.41	2.76	6.89	8.15
Farida	17.72	84.27	4.25	1.70	4.85	10.15
Sirona	16.98	79.55	5.32	2.66	4.74	12.46
Oscar Poly	13.26	70.72	4.48	4.12	6.84	18.97
Sau cona	18.48	82.86	4.66	2.39	4.88	21.25
Heba	16.02	75.00	5.81	3.39	5.95	31.31
Samba	15.06	78.53	4.64	3.00	3.43	17.70
LSD at 0.05						1.18

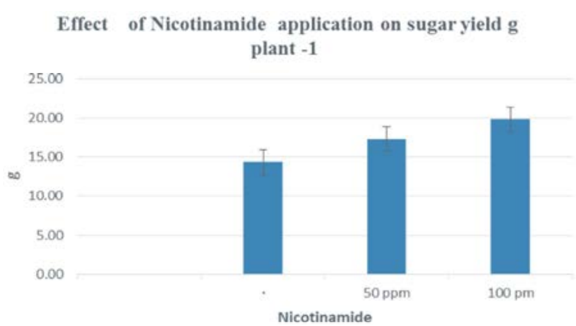

Fig. 7: Effect of foliar spray with Nicotinamide on sugar yield $plant^{-1}$ (g).

CONCLUSION

It could be concluded from this study the variability of sugar beet varieties in their yields under sandy soil conditions. Application of bio stimulant growth substances like Nicotinamide could effectively improve sugar beet biochemical characters which reflect on root and sugar yields.

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