

## ORIGINAL ARTICLES

### Screening of some exotic sugar beet cultivars grown under newly reclaimed sandy soil for yield and sugar quality traits

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#### ABSTRACT

In order to evaluate some exotic sugar beet cultivars grown under newly reclaimed sandy soil on yield and sugar quality traits basis the present study was undertaken. Therefore, two field trials using twelve exotic sugar beet (*Beta vulgaris* L.) cultivars were conducted at Research and Production Station, National Research Centre, Alemam Malek village, Al Nubaria District, Al Behaira Governorate, Egypt in 2008/09 and 2009/10 winter seasons to examine the adaption ability, yield and quality of twelve exotic sugar beet (*Beta vulgaris* L.) cultivars under newly reclaimed sand soil in northern delta region, Egypt. The results showed significant differences among tested cultivars in all studied character. Multigerm cultivars gave more value of root, yield, and quality compared Monogerm cultivars. Conversely trend was recorded for impurity components. In conclusion, Heliospoly, proved to be the best promising cultivar with the highest root yield, sugar recovery and ultimate maximum sugar yield. Conversely Monte Rosa comes out as a poorest cultivar with minimum root yield and eventually provided lowest sugar yield. Hence, Heliospoly cultivar can be cultivated as commercial crop in the investigated area of Nubaria region. Other cultivars could be employed as other sugar beet genetic resources with reasonable root and sugar yields.

**Key words:** Sugar beet, Exotic cultivars, Yield, Quality, Impurity

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#### Introduction

The Egyptian climatic conditions are unfavorable for floral induction of sugar beet. That led to import its seeds from abroad especially from Europe. So, we need to optimize imported cultivars production by evaluation and adaptation under Egyptian conditions. Many studies confirm the importance of selection suitable cultivars for increasing yield and quality of sugar beet (Oad *et al.* 2001, El-Harriri and Gobarah 2001; Zalal *et al.* 2002; Ramadan *et al.* 2003; Azzazy, 2004).

Sugar beet (*Beta vulgaris* L.) is ranked as the second most important sugar crop after sugar cane in Egypt, as it is cultivated in more than 63 thousand hectares, with an average production of 50 tons/hectare (FAO, 2011). Recently, sugar beet crop has been an important position in Egyptian crop rotation as a winter crop not only in fertile soils, but also in poor, saline, alkaline and calcareous soils. Approximately 66 % of our local needs are produced locally from sugar beet and sugar cane while, the rest (34 %) is imported from foreign countries (FAO, 2011). Moreover, sugar beet is considered one of the most important crops, not only for sugar production but also for fodder and organic matter for the soil. It is also considered as a double benefit crop to the farmers, where the roots are processed for sugar production and the green leaves and tops are used for animal feeding.

In Egypt, sugar beet is grown in the northern Delta and desert parties in the Governorate of Kafr El-Sheikh and in Nubariya region. But in the recent years, it extended southwards to the governorates of Beni Suef and Fayoum as well as proliferation in the provinces of Lower Egypt, especially sub-Rashid neighborhood, Damietta particularly in the Governorates of Kafr El-Sheikh, El-Gharbia and EL- Dakahliya. Most beet production in the above mentioned regions, is under the control of private sector companies, except for about 15,000 MT produced by the Sugar and Integrated Industries Company (SIIC). Government of Egypt has taken steps to introduce sugar beet in the country by accustoming the cultivation of some exotic sugar beet cultivars initially at Agriculture Research Center, Giza, Egypt for testing their adaptability in the country.

Several studies either in Egypt or abroad reported the importance of selected suitable cultivars for increasing sugar productivity as well as showed the differences between sugar beet cultivars in yield and quality. In Egypt, Nasr and Abd El-Razek (2008) evaluated 6 exotic sugar beet cultivars under newly reclaimed soil condition of Sinai, they showed that Oscar poly cultivar recorded the highest root yield but, Monte Bianco

cultivar surpassed all cultivars in sugar yield. Gobarah and Mekki (2005), found that the three sugar beet cultivars (Ras Ploy, Kawemira and Top) under study were significantly different in root length and diameter (cm), root weight (Kg), root, top, sugar and recoverable sugar yields (ton/acre). Top cultivar showed more root, sugar and recoverable sugar yield than other two cultivars, while Ras Ploy cultivar showed more sucrose, recoverable sucrose, as well as, Juice purity percentages than Kawemira and Top cvs. This means that Ras Poly cultivar had the lowest Na, K and  $\alpha$ -amino-N in their root juice. Similar trend was obtained by Shehata *et al.* (2000). While, Ismail (2002) reported that root length and diameter were not significantly different between sugar beet cultivars used, whereas root and sugar yields were significant in El-Fayium Governorate. Recently, Koream *et al.* (2012) found that ten sugar beet cultivars differed in yield and quality regarding susceptibility and biochemical reaction to root-knot nematode.

In abroad, Jamal and Bahadar (1988) in Pakistan, conducted a varietal adaptability trial in district Bannu, Khyber Pakhtoon Khawah (KPK) comprising four sugar beet varieties, viz. Kave poly, Kave mira, Kave terma and Zwan poly. They reported that beet cultivar Kave-poly produced maximum beet root yield while Kave-terma was superior in sugar contents (Pol = 12.41%). Similarly, Khan *et al.* (2004) reported that varieties differed significantly for yield and sugar contents in Bannu, Dera Ismail Khan and Kohat Districts of southern Pakistan. The average beet yield remained 36.0 to 72.8 t ha<sup>-1</sup>. It has been reported from three years of sugar beet varietal trials that in different parts of Punjab sugar beet varieties performed differently with respect to germination, yield and sugar recovery (Ahmad and Awais, 2011).

Although, sugar beet requires less water and matures within 6 - 7 months and can be a good substitute of sugarcane crop, but it cannot be grown substitute for sugar cane because the presence of about 27 complementary industries associated with the cultivation of sugar cane. Keeping the above facts in view, Agriculture scientists take an interest to optimize yield and quality of sugar beet in newly reclaimed sand soil through different methods especially evaluation and adaptation of exotic commercial cultivars. Therefore this study aims to evaluate some exotic sugar beet cultivars grown under newly reclaimed sandy soil on yield and sugar quality traits basis in Nubaria Province, Egypt.

## Materials and Methods

Twelve sugar beet exotic cultivars were evaluated at Research and Production Station, National Research Centre, Alemam Malek Village, Al Nubaria District, Al Behaira Governorate, Egypt during 2008/09 and 2009/10 winter successive seasons. The experimental area is located at the North of Cairo (30.8667N latitude and 31.1667E longitude) at an elevation of 21 m above the sea level. It has an arid climate with cool winter and hot dry summer prevailing in the experimental area. The soil was sand, non-saline, alkaline in reaction and had low organic matter, phosphorus and nitrogen contents. The physicochemical and mechanical properties of experimental site are given in the Table 1, according to Chapman and Pratt (1978).

**Table 1:** Soil and water analysis for site experiments in Nubaria region.

Parameters	Soil depth		Water
	0-15	15-30	
Particle size distribution			
Coarse sand	48.20	54.75	..
Fine sand	49.11	41.46	..
Clay + Silt	2.69	3.82	..
Texture	Sandy	Sandy	..
PH (1:2.5)	8.22	7.94	7.55
EC(dSm <sup>-1</sup> )(1:5)	0.20	0.15	0.50
Organic matter (%)	0.67	0.43	...
Soluble cations (mq/l)			
Ca <sup>++</sup>	0.60	0.50	1.50
Mg <sup>++</sup>	0.50	0.30	0.60
Na <sup>+</sup>	0.90	0.80	2.50
K <sup>+</sup>	0.20	0.10	0.20
Soluble anions (mq/l)			
CO <sup>-3</sup>	-	-	-
HCO <sup>-3</sup>	0.60	0.40	1.20
Cl <sup>-</sup>	0.75	0.70	2.80
SO <sup>-4</sup>	0.85	0.60	0.80

The origin of the studied cultivars was Netherland, Germany, Denmark and France (Table 2). The soil was ploughed triple, settled, ridged and divided into plots. During soil preparation, the recommended dose of phosphorus fertilizer was applied at a level of 200 kg calcium super phosphate fed<sup>-1</sup> (15.5% P<sub>2</sub>O<sub>5</sub>). Then the experimental area ridged and divided into plots (3.5 m width x 7m length). Two-three seeds of each cultivar were sown in hills spaced 20 cm apart on one side of ridge. Each cultivar was replicated three times and

arranged in Randomized Complete Block Design (RCBD). The experiments were planted in the first week of October in both seasons.

**Table 2:** Sugar beet (*Beta vulgaris* L.) cultivars \*used in this study.

No.	Cultivar	Seeds	Origin
1	DS-9007 (Lilly)	Multigerm	Denmark
2	DS-9004 (Mirador)	Multigerm	Denmark
3	Disk 01-99	Monogerm	Germany
4	LP-15 (L-12)	Multigerm	France
5	LP-16 (Percia)	Monogerm	France
6	Monte Rosa	Multigerm	Germany
7	Rosana	Multigerm	Germany
8	Rhist	Monogerm	Germany
9	Swallow	Multigerm	Germany
10	Toro	Multigerm	Germany
11	Chems	Multigerm	Germany
12	Heliospoly	Multigerm	Netherlands

\*Source: Sugar Crops Research Institute, Agriculture Research Centre, Ministry of Agriculture, Giza, Egypt.

The plots were sprinkler irrigated immediately after sowing. After 35 days from sowing, plants were thinned twice and the later one was done to ensure one plant/hill. Nitrogen fertilizer as ammonium sulphate (20.6 %N) at the rate of 150 kg N/fed was added in four equal doses after thinning (35 days from sowing), 15, 30 and 45 days later, respectively. Potassium in the form of potassium sulphate (48 % K<sub>2</sub>O) was added at the rate of 50 kg fed<sup>-1</sup> in two equal doses after thinning and 15 days later, respectively. Other agricultural practices were kept the same as normally practiced in growing sugar beet fields. Sprinkler irrigation was applied as plants needed.

At harvest, ten plants were taken at random from each plot to determine fresh root parameters (length (cm), diameter (cm) and weight (kg)). Plants in the four inner ridge of each plot were collected and cleaned, therefore roots were separated and weighted in kilograms and converted to estimate root yield (ton fed<sup>-1</sup>). Sugar yield (ton fed<sup>-1</sup>) was calculated by multiplying root yield by root sucrose percentage.

A sample of 10 kg of roots were taken at random from each plot and sent to the Beet Laboratory at Nubaria Sugar Factory to determine root quality. Alpha amino nitrogen ( $\alpha$ -amino-N), sodium (Na) and potassium (K) concentrations were estimated according to the procedure of Sugar Company by Auto Analyzer described by Cooke and Scott (1993). TSS and sucrose percentage estimated in fresh samples of sugar beet root by using Saccharometer according to the method described by A.O.A.C. (1995). Sugar loss was calculated using the following formula: Sugar loss % =  $0.29 + 0.343 (K + Na) + 0.094 \alpha\text{-amino-N}$ , Sugar recovery % was calculated using the following equation: Sugar recovery (%) = sucrose (%) - sugar loss (%) (Cooke and Scott, 1993). Recoverable sugar yield (ton fed<sup>-1</sup>) was calculated using the following equation of Mohamed (2002): Recoverable sugar yield = root yield (ton fed<sup>-1</sup>) x sugar recovery. Quality index was calculated as (sugar recovery (%) x 100)/sucrose (%). Gross sugar yield (ton fed<sup>-1</sup>) = root yield (ton fed<sup>-1</sup>) x sucrose (%). Sugar loss yield was computed as: root yield (ton fed<sup>-1</sup>) x sugar loss.

Data were analyzed using an ANOVA of Randomized Complete Block Design (the analytical package M-STATC v. 3.1., 1988). Since the trend was similar in both seasons, Bartlett's test was applied and the combined analysis of the two growing seasons was done. LSD ( $P = 0.05$ ) was used to compare means of varieties. The simple correlation coefficients among the most of studied characters were performed using the analytical package SPSS v. 16.1., 2007 (SPSS, 2007).

## Result and Discussion

### 1. Root parameters:

The combined analysis of the data presented in Table 3 showed significant differences ( $P \leq 0.01$ ) in sugar beet root length and weight; however the differences were insignificant in root diameter at harvest. Tested sugar beet cultivars differed significantly in root length (cm) where it ranged between 30.50 – 41.00 cm with average 34.12 cm. Monte Rosa cultivar came in the first order with 41.0 cm while DS-9007 and Heliospoly came in the last order with 30.50 cm. On the other hand there are high significant differences among cultivars in response to root weight. The heaviest root weight (1.43 and 1.37 kg) was reported by DS-9004 and Heliospoly, respectively, while the lowest value of root weight (0.85 kg) was reported by Monte Rosa cultivar. There were insignificant differences among cultivars regarding root diameter; they ranged between 30.50 cm – 39.17 cm width for Disk 01-99 and Heliospoly cultivars, respectively. It could be noticed from these results that the cultivars with shorter roots possessed heavier and wider roots. The differences among cultivars used in these traits might be attributed to the differences in genetic constituents for each cultivar. These results are in line with those obtained by Shehata *et al* (2000) and Gobarah and Mekki (2005), while Ismail (2002) reported that root

length and diameter were not significantly different between sugar beet cultivars used, whereas root and sugar yields were significant. In abroad, varietal differences in root parameters were also recorded by Khan *et al.*, (2004); Zahoor-ul-Haq *et al.*, (2006); Ebrahimian *et al.* (2009) and Ahmed *et al.* (2012).

**Table 3:** Root parameters of sugar beet cultivars grown in sand soil (combined data over 2008/09 and 2009/10 seasons).

Parameter	Root parameter		
Cultivar	Length (cm)	Diameter (cm)	Weight (kg)
DS – 9007	30.5	38.50	1.20
DS – 9004	33.3	35.33	1.43
Disk 01-99	33.1	30.50	1.08
LP-15	34.6	33.50	0.99
LP-16	33.17	38.17	1.13
Monte Rosa	41.00	35.33	0.85
Rosana	34.67	37.50	1.22
Rhist	36.83	36.33	1.18
Swallow	32.83	32.00	1.03
Toro	35.67	37.00	0.98
Chems	33.17	37.50	1.18
Heliospoly	30.50	39.17	1.37
Grand mean	34.12	35.90	1.14
F sig.	**	ns	**
LSD at 5% level	3.68	ns	0.15
CV (%)	9.31	13.50	11.42

ns= not significant, \*\*, statistically significant difference at  $P = 0.01$ , CV= Coefficient of Variation.

## 2. Sugar beet yield (ton fed<sup>-1</sup>):

The combined analysis in table 4 showed significant differences among sugar beet cultivars in producing fresh root, gross sugar, white sugar and sugar loss to molasses yield (ton fed<sup>-1</sup>). The variation among tested cultivars ranged between (22.57 – 34.23) in fresh root, (3.96 - 6.08) in gross sugar, (2.79 – 5.67) in extractable sugar and (0.82 – 1.50 ton fed<sup>-1</sup>) in sugar loss to molasses. Regarding fresh root yield, Heliospoly and DS-9004 cultivars produced the highest values (32.80 and 34.23 ton fed<sup>-1</sup>), respectively. While the lowest value of fresh root yield was obtained from Monte Rosa (22.57 ton fed<sup>-1</sup>). Data in the same table showed maximum value of gross sugar yield (5.11, 5.98 and 6.08 ton fed<sup>-1</sup>) for the cultivars DS-9007, DS-9004 and Heliospoly respectively, while the cultivars Monte rose and Lp-15 showed minimum values of gross sugar yield (3.82 and 3.96, respectively). The rest of cultivars yielded gross sugar (4.22 - 4.88 ton fed<sup>-1</sup>). Similar tendency was observed for white sugar yield per feddan. Where the same superiority of three cultivars named DS-9007, DS-9004 and Heliospoly in gross sugar yield was evident for white sugar yield compared to the other cultivars. The cultivars Disk 01-99, Monte Rosa, Rhist, Lp-15 and Swallow showed later order for producing extractable sugar yield (2.79, 3.03, 3.15, 3.16 and 3.22 ton fed<sup>-1</sup>, respectively). The white sugar yield of the rest cultivars ranged from 4.09 - 4.79 ton fed<sup>-1</sup>. The lowest sugar loss to molasses was recorded by Toro (0.82 ton fed<sup>-1</sup>), followed by Heliospoly cultivar (0.87 ton fed<sup>-1</sup>), while the highest sugar loss value was recorded by DS-9004 cultivar (1.67 ton fed<sup>-1</sup>). Generally, the cultivars under the current study performed better with regard to beet yield, sugar recovery and other parameters. Several investigators indicated that sugar beet has a fairly wide adaptability and is relatively resistant to cold, withstand drought, and are not overly sensitive to salinity (Ahmed and Rasoul 2011, Ahmed *et al.*, 2012), however, productivity under unfavorable conditions is not high (Katerji *et al.* 1997 and Petkeviciene, 2009). Moreover, other investigators indicated that the beet yield differed with different cultivars but it was comparable to the average yield traits of previous studies conducted at different location in Egypt (El-Geddawy *et al.* 2006, Abo-Elftooh *et al.* 2007, Shalby *et al.*, 2011 and Hussein *et al.*, 2012). Finally, the obtained results of fresh root, gross and white sugar yield (ton fed<sup>-1</sup>) possessed higher reasonable and promising values under Nubaria region in the present study.

## 3-Sugar beet quality parameters:

Sugar beet quality is a complicated process influenced by several factors. The technical quality of sugar beet is essential for economical sugar manufacturing. In particular, it depends on the chemical composition of the beet. The chemical composition of sugar beet is the most important parameter affecting its processing. Sugar factories require beet with high concentrations of sucrose and low concentrations of molassigenic substances to maximize the amount of extractable sugar.

**Table 4:** Yield (ton fed<sup>-1</sup>) of sugar beet cultivars grown in sand soil (combined data over 2008/09 and 2009/10 seasons).

Parameter	Yield (ton fed <sup>-1</sup> )			
	Fresh root	Gross sugar	*White sugar	*Sugar loss to molasses
DS – 9007	28.80	5.11	4.39	1.36
DS – 9004	34.23	5.98	4.79	1.67
Disk 01-99	25.63	4.34	2.79	1.21
LP-15	24.13	3.96	3.16	1.17
LP-16	26.87	4.28	3.38	0.93
Monte Rosa	22.57	3.82	3.03	1.07
Rosana	29.20	4.88	4.13	1.31
Rhist	28.40	4.46	3.15	1.20
Swallow	24.80	4.22	3.22	1.08
Toro	27.60	4.69	4.30	0.82
Chems	28.40	4.56	4.04	1.50
Heliospoly	32.80	6.08	5.67	0.87
Grand mean	27.79	4.70	3.84	1.18
F sig.	**	**	**	**
LSD at 0.05 level	2.43	0.47	0.70	0.17
CV (%)	7.54	8.56	10.81	8.26

\*\*, statistically significant difference at  $P = 0.01$ , CV= Coefficient of Variation.

\* Data of 2009/10 season.

The most important factors which affect the productivity and quality of sugar beet roots are sugar, extractable, sugar loss to molasses and purity percentage and quality index of root juice as shown in Tables (5). Statistical analysis of the data indicates that reliable differences among tested cultivars were obtained for quality percentage (%) i.e. sugar, content, sugar recovery, sugar loss to molasses and quality index. Regarding sugar content, the tested cultivars gave satisfactory values (15.96 - 18.57%) comparable to that of beet producing countries which is in the range of 15-20% (Martin *et al.*, 1967 and Ahmed *et al.*, 2012). Among cultivars, Heliospoly recorded the highest value (18.57%). While the lower values were recorded by Rhist, Chems followed by Lp-16 (15.72, 15.96 and 15.9, respectively). The data of purity percentage revealed significant differences among the tested cultivars ( $P < 0.01$ ). Greater purity was found in juice extracted from three root cultivars i.e., Disk 01-99, Rhist and Heliospoly (86.26, 86.32 and 86.79%, respectively). However, the minimum purity of juice was recorded in roots of Rosana and LP-15 cultivars (74.99 and 78.39%, respectively). The juice purity in the rest cultivars ranged from 80.49 to 83.79%. Similar tendency was observed in the other quality parameters, where Heliospoly recorded the highest sugar recoverable and quality index. Meanwhile, Heliospoly recorded the lowest value of sugar loss to molasses. The superior of Heliospoly cultivar in quality parameters may be probably due to it contains fewer values in the most of impurity parameters (Figs. 1A&1B).

The differences among cultivars used in these traits might be attributed to the differences in genetic constituents for each cultivar and their ability to benefit from the environmental factors which enabled it to adapt and achieve better yield and quality parameters. These results are in line with those obtained by Shehata *et al* (2000), Gobarah and Mekki (2005) and Ismail (2002). The overall chemical composition of sugar beet in Europe may vary considerably due to differences in cultivars and growing conditions (Bohn, 1998 and Burba, *et al.* 2001). Similar conclusion was obtained by Ebrahimian *et al.*, (2009), Necdet, *et al.* (2007) and Ahmed *et al.*, (2012).

**Table 5:** Some quality parameters of sugar beet cultivars grown in sandy soil at 2009/10 seasons.

Parameter	Quality (%)				
	*Sucrose	Purity	White sugar	Molasses sugar	Quality index
DS – 9007	17.65	82.01	14.01	4.37	76.16
DS – 9004	17.48	80.49	12.85	4.49	74.13
Disk 01-99	16.91	86.26	11.45	4.95	69.80
LP-15	16.37	82.02	12.70	4.71	72.93
LP-16	15.97	78.39	12.10	3.34	78.37
Monte Rosa	16.88	82.53	12.55	4.44	73.85
Rosana	16.66	74.99	13.19	4.22	75.74
Rhist	15.72	86.32	11.58	4.42	72.38
Swallow	17.02	83.14	12.59	4.23	74.85
Toro	16.94	83.97	14.93	2.86	83.91
Chems	15.96	83.97	12.06	4.46	73.00
Heliospoly	18.57	86.79	16.15	2.46	86.75
Grand mean	16.84	82.57	13.01	4.08	75.99
F sig.	**	**	**	**	**
LSD at 5%	0.57	1.43	1.09	0.14	1.88
CV%	2.88	1.02	4.94	2.09	1.46

\*\*, statistically significant difference at  $P = 0.01$ , CV= Coefficient of Variation.

\* Combined data of 2008/09 and 2009/10 seasons.

#### 4- Impurity components:

The technical beet quality, i.e. the process ability in the sugar factory, is determined not only by sucrose concentration, but also by the concentrations of other constituents that impair white sugar recovery. These are called root impurities such as potassium, sodium,  $\alpha$ -amino-N and other nitrogenous compounds as well as K/Na, K+Na/ $\alpha$ -amino-N (alkalinity coefficient) ratios and impurities index (Fig. 1a & 1b).

Sugar beet cultivars differed significantly in all tested impurity parameters (Fig. 1a & 1b).

Data presented in fig. 1a shows that three sugar beet cultivars i.e., Swallow, DS-9004 and Disk 01-99 gave more value of K (7.80, 7.85 and 8.50 mmol/100 g paste, respectively) than others, while only two cultivars namely Toro and Heliospoly came in the last order in containing K (4.42 and 5.12, respectively). The rest cultivars contained K values between (6.60 and 7.30). Roots with K content of 3.59 and 5.13 mmol/100 g paste are considered to be commercially acceptable for processing (Milford *et al.*, 2000). In our case, K content in root of Toro and Heliospoly cultivars was under these limits. While the others cultivars contained K value more than the above limit K cited.

Concerning Na, both cultivars (Heliospoly and Toro) gave the lowest values (0.72 and 1.64, respectively) compared with other cultivars. While, Chems, Rosana, Lp-15 and Monta rosa contained the highest concentrations (4.06 – 4.49 mmol/100 g paste). Values of Na ranged between 2.81 and 3.27 for the rest of the cultivars. Generally, semi-arid regions, such as the experimental site where the present study was conducted suffer from high Na concentration in soil (Table 1). K and Na in sugar beet roots are considered as other molassigenic factors which cause enhanced sugar losses (Harvey and Dutton, 1993). Therefore, sugar beet growth could be suppressed by excess Na level in the soil (Marschner, 1995) or high level of root Na content could be a main molassigenic factor during sugar beet processing (Honarvar and Alimoradi, 2003; Tsialtas and Masharis, 2009). Barbanti (1994) defined the acceptable Na limit in sugar beet roots as 1.33 mmol/100 g fresh root for Italy ecological conditions. In the present study, the observed Na content in roots of Heliospoly cultivar is evidently lower than that reported by Barbanti (1994). The overall chemical composition of sugar beet in Europe may vary considerably due to differences in cultivar and growing conditions (Bohn, 1998 and Burba, *et al.* 2001).

$\alpha$ -Amino-N in sugar beet root is also considered as molassigenic factor which cause enhanced sugar losses (Harvey and Dutton, 1993). In our study,  $\alpha$ -amino-N contents of Rosana, Heliospoly and Swallow cultivars gave lower value (1.72, 2.01 and 2.02 respectively) than others, while three cultivars namely LP-15, Disk 01-99 and DS-9007 gave the highest value (7.48, 8.31 and 8.50, respectively). Whereas, the values of  $\alpha$ -amino-N for the rest six cultivars ranged between 3.50 and 5.21 mmol/100 g paste.  $\alpha$ -Amino-N is the organic form of N used by sugar beet plants for re-growth (Pocock *et al.*, 1990) and increased amounts of  $\alpha$ -amino-N has reduced extractability of sugar during factory processing because it binds sugar to molasses on a large scale (Harvey and Dutton, 1993). The acceptable amount of  $\alpha$ -amino-N in sugar beet roots is 2.14 mmol/100 g fresh root for mineral soils and 2.86 mmol/100 g fresh root for organic soils according to Palmer and Casburn (1985). In our study, three cultivars (Rosana, Heliospoly and Swallow) did not exceed the abovementioned limit.

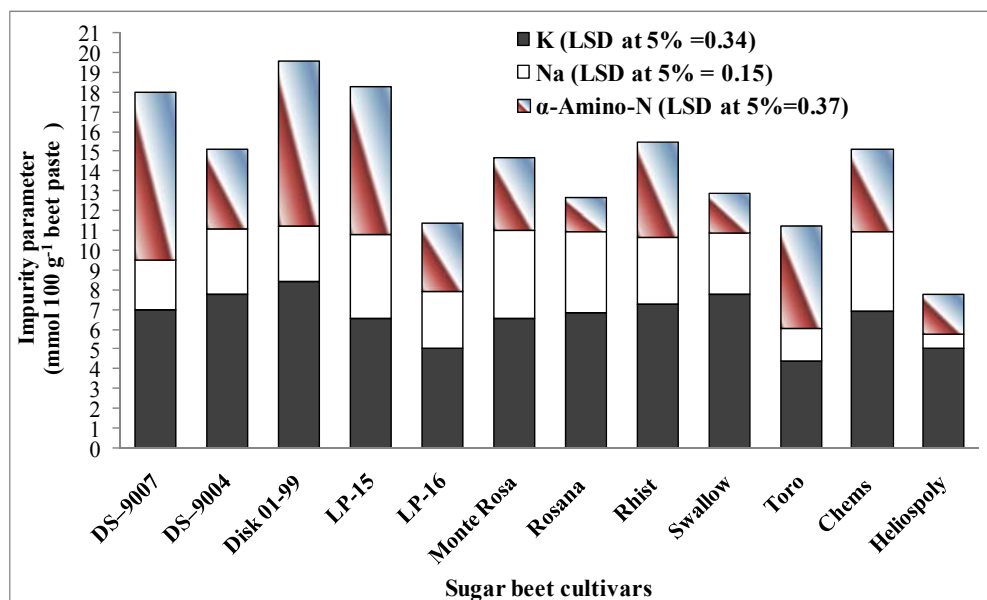
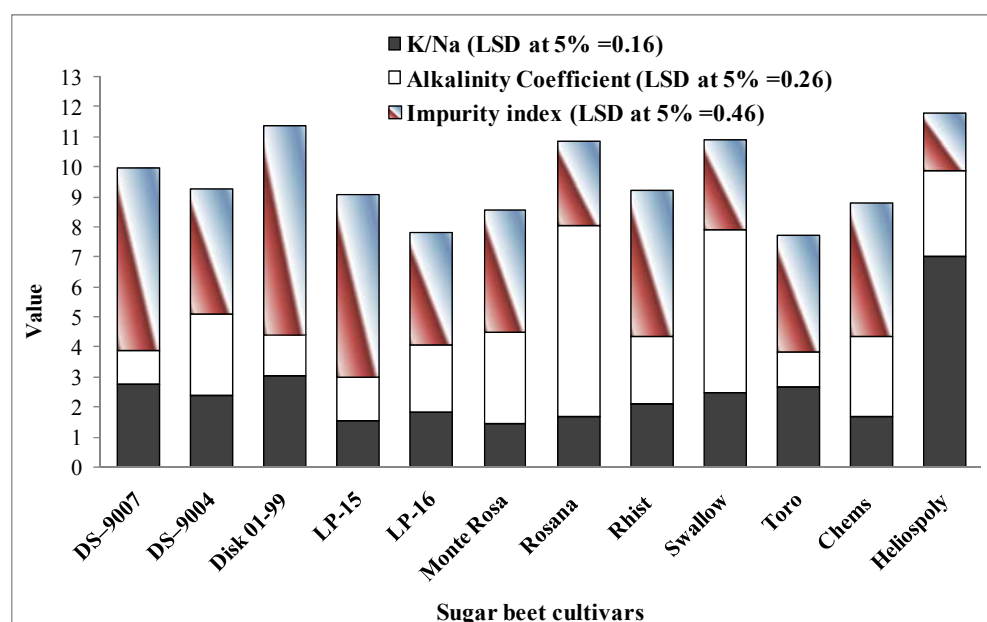


Fig. 1a: Impurity parameters of sugar beet cultivars grown in sandy soil at 2009/10 season.

From the three mentioned laboratory determination parameters (K, Na and Amino-N), the three other calculated impurity parameters (K/Na, K+Na/ $\alpha$ -Amino-N ratios (alkalinity coefficient) and impurity index) are shown in Fig 1b. These parameters are considered also molassigenic factors which cause enhanced sugar losses (Harvey and Dutton, 1993). The tested *Beta vulgaris* cultivars varied widely in the proportion of K/Na, K+Na/ $\alpha$ -amino-N ratios (alkalinity coefficient) and impurity index (Fig. 1b). Differences in the three above mentioned parameters ranged from 1.56 to 7.03, 1.36 – 6.39 and 1.90 to 6.97, respectively. The highest K/Na ratio values (3.05 and 7.03 ) are being found in the roots of Disk 01-99 and Heliospoly cultivars respectively, while the lowest values (1.47, 1.56, 1.70 and 1.71) being found in Monte rosa, LP-15, Rosana and Chems, respectively. The value of K/Na ratio in the rest cultivars ranged from 2.13 to 2.70. Concerning the alkalinity coefficient, the two cultivars Swallow and Rosana had the highest value (5.49 and 6.39, respectively), while four cultivars (DS-9007, Toro, Disk 01-99 and LP-15) came the last order (1.12, 1.16, 1.36 and 1.45, respectively). The value of alkalinity coefficient in the other 6 cultivars ranged from 2.2 to 3.04. The lowest value of impurity index (1.90 and 3.01) was recorded in roots of Heliospoly and Swallow cultivars, respectively. While the highest values (6.09, 6.10 and 6.97) were recorded in the roots of DS-9007, LP-15 and Disk 01-99 cultivars, respectively. The mean value of this trait for the rest cultivars ranged from 3.73 to 4.42. The technical quality of sugar beets, which is oriented towards an economical production of sucrose, is not only dependent on the sugar content of the beets, but also on several other properties of the root such as impurity parameters which affect to different degrees the industrial processing of beets in the sugar factory. Technical quality comprises chiefly the mechanical and chemical properties of the root, properties which can largely be influenced by cultivar and environment as well as by agronomic and cultural practices (Burba, *et al*, 2001 and Ahmed 2012). The overall chemical composition of sugar beet in Europe may vary considerably due to differences in cultivars and growing conditions (Bohn, 1998, Burba, *et al*. 2001 and Huijbregts, 2003).



**Fig. 1b:** Impurity parameters of sugar beet cultivars grown in sandy soil at 2009/10 season.

#### 4- Correlative relationships between the different beet characters studied:

In the improvement of sugar beet cultivars it is important to know the degree of association between those characters being studied. Accordingly, correlation coefficients were calculated using root parameters, yield per feddan, quality and impurity parameters. Values of "r" with significance levels are given in Table 6. Among various parameters under investigation there was a strong and positive correlation among root yield and root weight, gross and recoverable sugar yield while a weak and negative correlation was recorded between root yield and root length, purity and impurity parameters. A weak and positive correlation was recorded between root yield and root diameter, sucrose content and sugar loss to molasses yield. Hence, beet yield in sugar beet could be considered as the function of fresh root weight and root diameter. Similar tendency was observed with gross sugar yield. Concerning sugar recovery, all tested parameters had negative effect except root diameter and weight, purity and sucrose content. Hence the increase in root length, impurity parameters may leads to

reduction in qualitative characteristics of sugar beet. Similar observations have been recorded in a number of studies (Milfor and Watson, 1971; Hecker, 1991; Mahmoodi *et al.*, 2008).

**Table 6:** Correlation coefficient between sugar beet characters.

Characters		Root parameters			Yield (ton fed. <sup>-1</sup> )				Quality (%)		Impurity parameter (mmol 100 g <sup>-1</sup> fresh baste)		
		Length (cm)	Diameter (cm)	Weight (kg)	Fresh root	Gross sugar	White sugar	Molass sugar	Sucrose	Purity	K	Na	$\alpha$ -Amino-N
Root parameters	Length (cm)	1											
	Diameter (cm)	-0.19	1										
	Weight (kg)	-.638(*)	0.416	1									
Yield (ton fed. <sup>-1</sup> )	Fresh root	-0.535	0.516	.949(**)	1								
	Gross sugar	-.580(*)	0.467	.89(**)	.955(**)	1							
	White sugar	-0.529	.665(*)	.72(**)	.85(**)	.91(**)	1						
	Molass sugar	-0.136	-0.099	0.455	0.353	0.25	0.07	1					
Quality (%)	Sucrose	-0.448	0.141	0.387	0.46	.701(*)	.695(*)	-0.106	1				
	Purity	-0.052	-0.231	-0.071	-0.03	0.04	-0.01	-0.239	0.192	1			
Impurity (mmol 100 g <sup>-1</sup> baste)	K	-0.014	-.656(*)	0.099	-0.09	-0.12	-0.41	.706(*)	-0.115	0.048	1		
	Na	0.562	-0.315	-0.361	-0.47	-.590(*)	-.607(*)	0.513	-.634(*)	-0.418	0.503	1	
	$\alpha$ -Amino-N	-0.108	-0.305	-0.22	-0.25	-0.22	-0.305	0.185	-0.072	0.29	0.257	0.033	1

\*, \*\* = Significantly differences at 0.05 and 0.01, respectively.

### Conclusion:

It could be concluded from this study that evaluation of exotic sugar beet cultivars should be undertaken on yield and sugar quality traits basis such as K, Na, alkaline coefficient and impurity index. Heliospoly, proved to be the best promising cultivar with the highest root yield, sugar recovery and ultimate maximum sugar yield can be cultivated as commercial crop in the investigated area of Nubaria region. Conversely Monte Rosa comes out as a poorest cultivar with minimum root yield and eventually provided lowest sugar yield. Other cultivars could be employed as other sugar beet genetic resources with reasonable root and sugar yields in such sandy soil of the Nubaria region.

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