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EVALUATION OF SOME EXOTIC SUGARBEET VARIETIES UNDER DIFFERENT LOCATION OF DISTRICTS THATTA AND HYDERABAD SINDH, PAKISTAN

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Abstract

Sugarbeet is a temperate crop successfully grown in tropical and sub-tropical regions. It has also capability to grow well under different moderate climate regimes. The 10 exotic sugarbeet varieties were tasted on 3 locations of districts Thatta and Hyderabad. Experiments were in a Randomized Complete Block Design (RCBD) with three replications in separate plots. Three seeds were sown per hole. The germination was recorded after 30 days of sowing, while beet yield, sugar recovery and sugar yield obtained at the time of harvesting. The highest mean germination (76.40%) was noted at CBA-SAU Tandojam. The highest mean beet yield obtained at NSTHRI Thatta (54.69 t ha^{-1}) and CBA-SAU Tandojam (55.87 t ha^{-1}) was statistically at par. Similarly, highest mean sugar recovery noted at NSTHRI Thatta (14.58 %) and AAF Mirpur-Sakro (14.62 %) were also statistically likewise. The Highest mean sugar yield (7.44 t ha^{-1}) was noted NSTHRI Thatta. The variety SDPAK-09-07 showed best performance at all three locations. The remaining best performing varieties were California, Magnolia and SDPAK-07-07.

KEYWORDS: Sugarbeet varieties, beet yield, sugar recovery, climate, Sindh

Introduction

Sugarbeet is basically a crop of temperate origin but is successfully grown in a wide range of climatic conditions. Unlike temperate sugarbeet grown in summer, the tropical sugarbeet varieties are grown in winter. Some varieties have performed best in climatic conditions of subtropics in winters, where, there is no frost and have mild temperatures. It is a short duration crop requires 6-8 irrigations for its complete growth period (Oad *et al*., 2007). It has also competency to grow well under low class, saline and saline-sodic soils (Abu *et al*., 2010). The sugarbeet has been tested by various agencies and researchers in Sindh. SMEDA (2007) in collaboration with Strube-Dieckmann (Germany) tested exotic sugarbeet varieties and found suitable to cultivate in selected areas of Punjab and Sindh. Similarly, Oad *et al*., (2001), Memon *et al.* (2004), Tunio *et al*. (2004),Usmanikhail *et al*. (2005), and Kaloi *et al.* (2014) tested some exotic sugarbeet varieties under agro-climatic conditions of Sindh. They reported that crop could be grown in successfully in Sindh and suggested it could be good alternate crop in drought condition. On other hand, sugarcane is a high delta crop requires 80-90 acre inches in Sindh (Khan and Jamil, 2004). Pakistan particularly Sindh is facing acute shortage of irrigation water, could not afford the high delta crops. The recent situation of irrigation water also reduced sugarcane yield. Besides irrigation issues, another main issue is unjustified price and timely payment to growers. Hence, the growers are avoiding cultivating sugarcane. This may

create a big issue of sugar requirement in Pakistan. To overcome such problem, the suagrbeet could be good alternate crop to fulfill the requirement of sugar at some extent. Pakistan Agricultural Research Council (PARC) Thatta under an ALP project (Agricultural Linkage Program) tested 10 exotic sugarbeet varieties on agro-climatic conditions of Sindh. The objective was to grow sugarbeet as a sugar crop in lower Sindh.

Materials and Methods

The experiments were conducted at three different locations of Sindh viz**.** Experimental Farm of National Sugar and Tropical Horticulture Research Institute (NSTHRI), PARC (Pakistan Agricultural Research Council), Thatta (24.70^{o} N and 67.91^{o} E), Aalamgir Agricultural Farm (AAF) near village Nabi Bux Molepoto Mirpur-Sakro, District, Thatta (24.54^{o} N and 67.58^{o} E) and Centre for Bio-Saline Agriculture, Sindh Agriculture University (CBA-SAU). Tandojam, district Hyderabad (25.42^{o} N and 68.53^{o} E) during 2010-2011. Ten exotic sugarbeet varieties (California, Ernestina, Magnolia, Mirabella, Sandrina, SD-12970, SD PAK-03-06, SD PAK-01-07, SD PAK-07-07 and SD PAK-09-07) were tested. Experiments were conducted in a Randomized Complete Block Design (RCBD) with three replications in separate plots. Each treatment plot had eight meters long three rows at one-meter space with 20 cm plant space. Three seeds were sown in each hole and finally plant population was maintained by thinning. The fertilizer has been applied was applied @ 120, 100 kg NP ha^{-1} in the form of Urea and DAP. Thinning and gap filling was done at 3-4 leaf stage. The number of irrigations was 6, 5, and 8 applied to NSTHRI Thatta; AAF Mirpur-Sakro and CBA-SAU Tandojam, respectively.

Germination was recorded after 30 days of sowing, while beet yield, sugar recovery and sugar yield on harvesting during mid of April 2011. The yield was obtained by weighing total beets of the whole treatment plot. The sugar recovery was acquired through randomly collected five beets per treatment plot. The beets were washed with distilled water, cut into small slices and crushed with Fiberator machine (Model: NOSCF-L4). The collected juice was used for Pol (sucrose) by using digital Polarimeter. The sugar recovery was obtained by using formula: Sugar recovery = Pol % **-** 2.75 as given by Asdi (2007) and sugar yield by: Sugar yield = Beet yield × sugar recovery/100 as given by Gobarah and Mekki (2005).

The statistical values/results were analyzed was done by using software program Statistix 8.1 (Analytical Software 2005). The means were separated by Takey's Honestly Significant Difference (HSD) (Steel *et al*., 1997).

Result

The physico-chemical properties of experimental soil are presented in (Table 1). The analysis of variance (ANOVA) presented in (Table 2). The means of varieties presented in Figures (1-4). The means of locations and interaction (Variety × Location) presented in Tables (3-6). The data indicated that varieties, location and interaction were highly significant ($P < 0.05$). The data of germination indicated that the variety SD PAK-07-07 and SD PAK-09-07 gave statistically at par maximum germination of 82.44 and 82.78 %, respectively. Variety Mirabella was lowest by giving 59.33 % germination (Figure 1). The means of locations indicated that CBA-SAU Tandojam was on top with 76.40% germination. While, NSTHRI Thatta and AAF Mirpur-Sakro were statistically at par with 71.30 and 70.70 % germination, respectively (Table 3). As for interaction, variety SD PAK-07-07 was on top by giving 91.67 % germination at CBA-SAU Tandojam, followed by SD PAK-09-09 with 85.67 % at same location of CBA-SAU Tandojam. The lowest germination was found in Mirabella (55.67 %) at AAF Mirpur-Sakro location (Table 3).

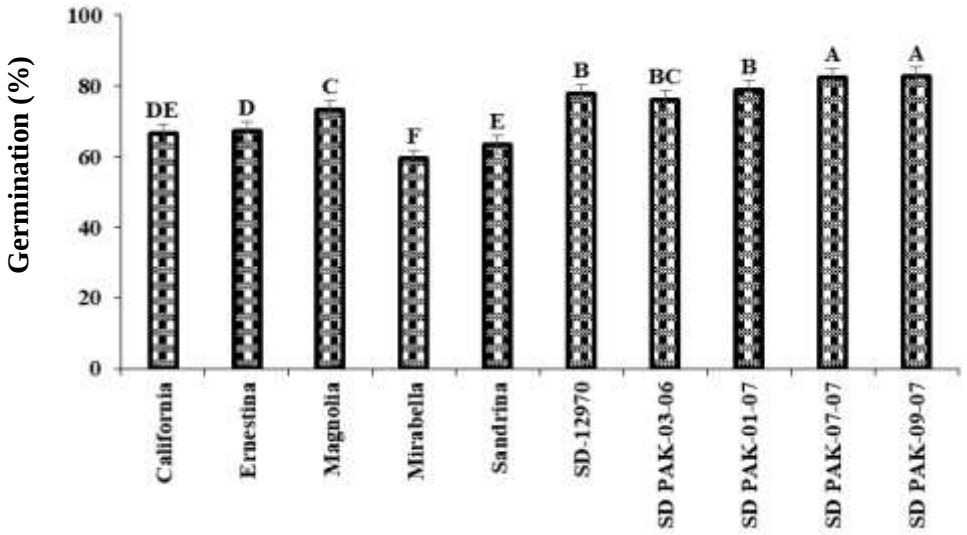
Table-1. Physico-chemical properties of experimental soils at different locations

Location	Soil texture	pH	EC (dS m^{-1})	Available P (mg kg^{1})	Available K (mg kg^{1})	Soluble Na (meq L^{-1})	Organic matter (%)
NSTHRI Thatta	Clayey	8.34	2.14	2.90	256	18.23	0.57
AAF Mirpur-Sakro	Clay loam	7.52	1.56	2.61	245	8.45	0.52
CBA-SAU Tandojam	Clay loam	7.90	1.23	3.12	125	3.78	0.82
Categorization: *pH (Normal: 7.0-7.5, Ref: Ankerman & Richard, 1989); EC (<2 non-saline & 6-8 dS m^{-1} strongly saline, Ref: Bohan et al., 1985); Available P (0-3 low & 8-11 mg kg^{-1}high, Ref: Havlin & Sultanpour, 1981); Available K (0-60 low & >120 mg kg^{-1}high, Ref: Havlin & Sultanpour, 1981) and organic matter (<0.86 low & > 1.29 % adequate, Ref: Jones et al., 1991).*							

Table 2. ANNOVA Table

Source	DF	Germination	Beet yield	Sugar recovery	Sugar yield
Replication	2	3.233	0.149	0.263	0.0761
Variety	9	604.440**	330.951**	2.475**	4.0860**
Location	2	294.300**	459.681**	133.176**	15.3591**
Variety × Location	18	55.028**	165.291**	1.740**	1.8609**
Error	58	4.877	0.931	0.228	0.1035

Figure 1. Mean germination (%) of different sugarbeet varieties



Tables 3. Germination of sugarbeet varieties at various locations

	Location		
Variety	**NSTHRI Thatta**	**AAF Mirpur-Sakro**	**CBA-SAU Tandojam**
	Germination (%)		
California	66.67 il	65.67 jm	67.33 il
Ernestina	64.33 ln	64.33 ln	73.33 fi
Magnolia	70.67 hl	71.67 gk	77.33 ch
Mirabella	57.33 no	55.67 o	65.00 km
Sandrina	57.67 no	59.33 mo	73.33 fi
SD-12970	79.67 bf	80.67 be	73.33 fi
SD PAK-03-06	79.33 bf	76.33 dh	72.67 fj
SD PAK-01-07	75.67 eh	76.67 dh	84.33 bc
SD PAK-07-07	78.33 cg	77.33 ch	91.67 a
SD PAK-09-07	83.33 bd	79.33 bf	85.67 ab
Mean	**71.30 B**	**70.70 B**	**76.40 A**
HSD Table	**Standard Error**	**F value**	**HSD 0.05**
Variety (A)	1.0410	123.94	3.4239
Location (B)	0.5702	60.34	1.3718
A × B	1.8031	11.28	7.0968
CV %	3.03	-	-

The means of beet yield indicated that SD PAK-09-07 gave maximum beet yield of 62.45 t ha^{-1}, followed by California (57.99 t ha^{-1}), Sandrina (55.29 t ha^{-1}) and Ernestina (54.95 t ha^{-1}). While, the minimum yield (41.70 t ha^{-1}) was noted in Mirabella (Figure 2). The means of locations for beet yield showed that NSTHRI Thatta and CBA-SAU Tandojam were statistically at par with maximum yield of 54.69 and 55.87 t ha^{-1}, respectively. Location of AAF Mirpur-Sakro gave 47.50 t ha^{-1} (Table 4). As for interaction, SD PAK-09-07 variety gave maximum beet yield of 74.32 t ha^{-1} at NSTHRI Thatta. The next higher yielding varieties were California and SD-12970 by giving likewise yield of 65.32 and 65.74 t ha^{-1}, respectively at NSTHRI Thatta and SD PAK-09 -07 (67.55 t ha^{-}) and SD PAK-07-07 (65 t ha^{-}) at CBA-SAU Tandojam. While, minimum yield (37.53 t ha^{-1}) was noted in Mirabella at AAF Mirpur-Sakro location. Moreover, variety Mirabella was the lowest beet yielding variety at all locations (Table 4). The result for sugar recovery depicted that all of the varieties gave statistically at par sugar recovery ranged between 13.04 to 13.68 %, except the SD PAK-09-07 gave sugar recovery of 14.76 % (Figure 3). The mean data of locations showed that NSTHRI Thatta and AAF Mirpur-Sakro gave sugar recovery of 14.58 and 14.62 %, respectively, which were statistically at par. The location of CBA-SAU Tandojam was the lowest with sugar recovery of 10.95 % (Table 5). As for interaction, variety SD PAK-09-07 has given gave highest sugar recovery of 16.41 % at location of AAF Mirpur-Sakro. SD PAK-09-07, Ernestina and California were next with statistically at par sugar recovery of 15.51, 15.29 and 15.08 %, respectively at NSTHRI Thatta. Moreover, varieties Ernestina, California and SD PAK-03-06 gave minimum statistically at par sugar recovery of 9.51, 10.06 and 10.51 % at location of CBA-SAU Tandojam, respectively (Table 5).

Figure 2. Mean beet yield of different sugarbeet varieties

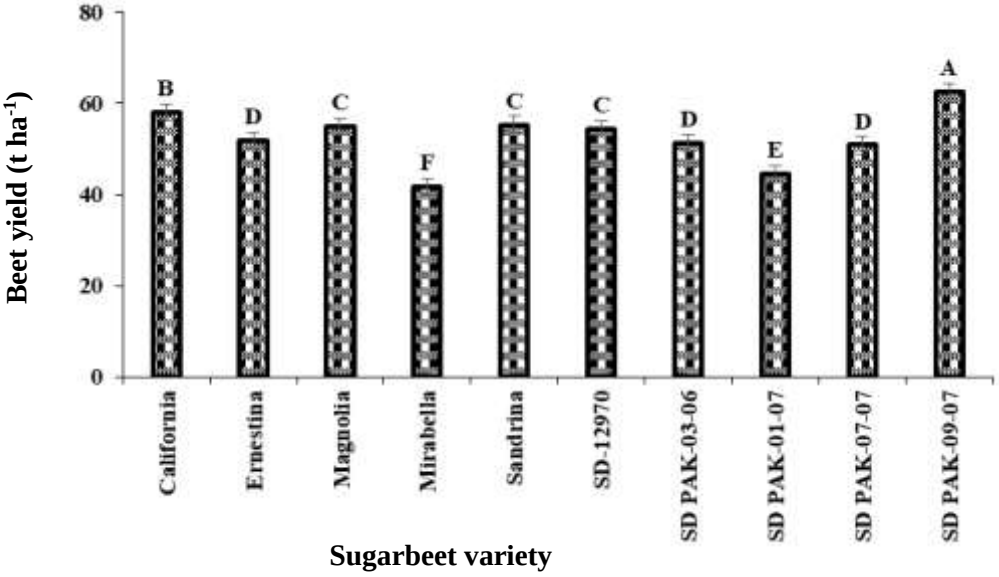
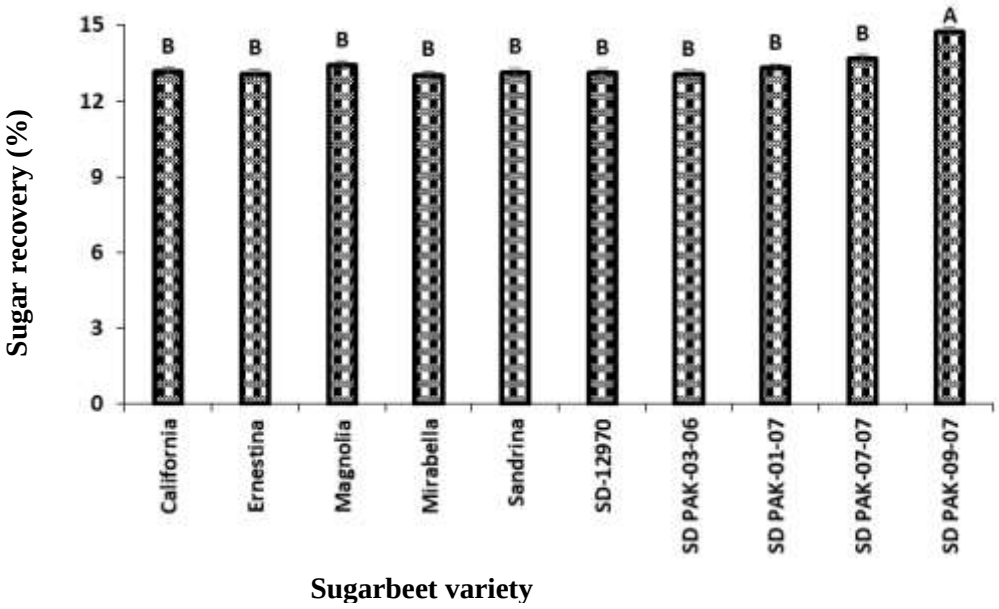


Figure 3. Mean sugar recovery of different sugarbeet varieties



Tables 4. Beet yield of sugarbeet varieties at various locations

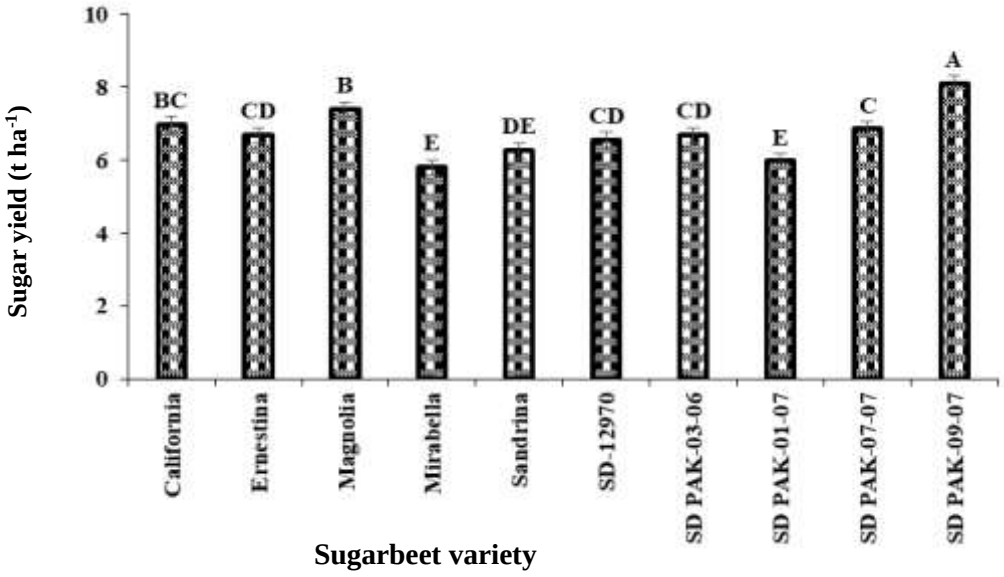
	Location		
Variety	**NSTHRI Thatta**	**AAF Mirpur-Sakro**	**CBA-SAU Tandojam**
	Beet yield (t ha^{-1})		
California	65.32 b	54.22 ef	54.45 ef
Ernestina	51.61 fh	48.60 hj	55.41 de
Magnolia	58.33 cd	46.52 ik	60.01 c
Mirabella	40.83 mn	37.53 o	46.75 ik
Sandrina	50.41gh	60.11 c	55.35 de
SD-12970	65.74 b	51.56 fh	45.74 jk
SD PAK-03-06	49.37hi	50.95 gh	53.34 eg
SD PAK-01-07	48.51 hj	39.35 no	45.79 jk
SD PAK-07-07	42.48 lm	45.40 kl	64.69 b
SD PAK-09-07	**74.32 a**	45.81 jk	67.21 b
Mean	**54.69 A**	**48.009 B**	**54.87 A**
Tukeys HSD Table	**Standard Error**	**F value**	**HSD 0.05**
Variety (A)	0.4548	355.50	1.4959
Location (B)	0.2491	493.78	0.5993
Genotype× Location	0.7878	177.55	3.1006
CV %	1.84	-	-

Tables 5. Sugar recovery of sugarbeet varieties at various locations

	Location		
Variety	**NSTHRI Thatta**	**AAF Mirpur-Sakro**	**CBA-SAU Tandojam**
	Sugar recovery (%)		
California	15.08 ac	14.41 bd	10.06 i
Ernestina	15.29 ac	14.46 bd	9.51 i
Magnolia	14.35 bd	13.84 ce	12.05 fh
Mirabella	13.50 df	13.38 df	12.24 fg
Sandrina	14.41 bd	14.38 bd	10.65 hi
SD-12970	14.22 bd	14.52 bd	10.63 hi
SD PAK-03-06	14.36 bd	14.35 bd	10.51 i
SD PAK-01-07	14.40 bd	14.89 ad	10.61 hi
SD PAK-07-07	14.66 bd	15.54 ab	10.86 gi
SD PAK-09-07	15.51 ab	16.41 a	12.37 eg
Mean	**14.58 A**	**14.62 A**	**10.95 B**
Tukeys HSD Table	**Standard Error**	**F value**	**HSD 0.05**
Genotype	0.2251	10.85	0.7404
Location	0.1233	583.99	0.2966
Genotype×Location	0.3899	7.63	1.5346
CV %	3.57	-	-

The perusal of data of varieties for sugar yield showed that SD PAK-09-07 remained on top by producing sugar yield of 8.11 t ha^{-1}, followed by Magnolia with 7.38 t ha^{-1}. While, Mirabella was the lowest with 5.80 t ha^{-1} (Figure 4). As for locations, NSTHRI Thatta, AAF Mirpur-Sakro and CBA-SAU Tandojam gave sugar yield of 7.44, 6.73 and 6.01 t ha^{-1}, respectively (Table 6). The means of interaction indicated that maximum sugar yield was found in California (7.70 t ha^{-1}), Ernestina (7.94 t ha^{-1}), Magnolia (8.42 t ha^{-1}) and SD PAK-09-07 (8.54 t ha^{-1}) at NSTHRI Thatta, California (7.76 t ha^{-1}), SD-12970 (7.31 t ha^{-1}) and SD PAK-09-07 at AAF Mirpur-Sakro and SD PAK-09-07 (8.27 t ha^{-1}) at CBA-SAU Tandojam, although the yield was statistically at par. (Table 6

Figure 4. Mean sugar yield of different sugarbeet varieties



Tables 6. Sugar yield of sugarbeet varieties at various locations

	Location		
Variety	**NSTHRI Thatta**	**AAF Mirpur-Sakro**	**CBA-SAU Tandojam**
	Sugar yield (t ha^{-1})		
California	7.70 ac	7.76 ac	5.44 ef
Ernestina	7.94 ac	6.96 cd	5.15 f
Magnolia	8.42 a	6.45 de	7.27 bd
Mirabella	6.44 de	5.27 f	5.70 ef
Sandrina	7.27 bd	5.67 ef	5.85 ef
SD-12970	7.31 bd	7.52 ac	4.83 f
SD PAK-03-06	7.15 cd	7.32 bd	5.57 ef
SD PAK-01-07	7.19 cd	5.81 ef	4.93 f
SD PAK-07-07	6.44 de	7.04 cd	7.07 cd
SD PAK-09-07	8.54 a	7.53 ac	8.27 ab
Mean	**7.44 A**	**6.73 B**	**6.01 C**

HSD Table	Standard Error	F value	HSD 0.05
Genotype	0.1517	39.48	0.4988
Location	0.0831	148.41	0.1998
Genotype×Location	0.2627	17.98	1.0338
CV %	4.78	-	-

Discussion

The purpose of study was the assessment of some exotic sugarbeet varieties on some selected at locations in districts of Thatta and Hyderabad. The climatic conditions and related factors like soil physico-chemical properties, agronomic practices and irrigation have significant effect effects upon on sugarbeet (Vandergeten, 1998 and Pacuta 2000). Marlander *et al*. (20l3) and Hoffmann *et al*. (2009) reported that the yield and quality of sugarbeet was affected around 26-80%. Similar results were also reported by Usmanikhail *et al*. (2005) and Kaloi *et al*. (2014). The performance of the varieties was significant with regard to locations. Germination was higher in SDPAK-09-07 and SDPAK-07-07, followed by SDPAK-01-07, SD-12970 and SDPAK-03-06, while Magnolia gave lowest in germination. The beet yield was higher in SDPAK-09-07, followed by California and Sandrina. The sugar recovery was significantly higher in SDPAK-09-07, while the remaining varieties were statistically at par with each other. Similarly, the variety SDPAK-09-07 gave highest sugar yield, followed by Magnolia and California, while Mirabella was lowest. Tunio *et al*. (2004) and Kaloi *et al*. (2014) reported that some exotic sugarbeet varieties like Sandrina. SD-12970, SDPAK-01-07, SDPAK-07-07 and SDPAK-09-07 showed best performance with regard to germination, beet yield and sugar recovery.

The experiments conducted at various locations shown significant difference. Ebrahimian *et al.* (2009) reported likewise differences among sugarbeet varieties tested at different locations. As for comparison of means of the locations, the germination and beet yield was higher at CBA-SAU Tandojam over both the NSTHRI-Thatta and AAF Mirpur-Sakro locations. Though the beet yield obtained at CBA-SAU Tandojam was statistical at par with location of NSTHRI-Thatta. The higher germination might be due to low EC (salinity) at CBA-SAU Tandojam. Sugarbeet is sensitive to salinity at the time of germination and early stage of growth. Our results are in agreement with Ayaz *et al*. (2000) and Mostafavi (2011), who reported that seed germination reduced under saline conditions. The salinity caused stress within root zone that caused some metabolic disorders and inhibited water absorption into the seeds. Hakim *et al*. (2010) reported that salinity triggered nutritional imbalance and leads to reduce photosynthetic efficiency and other physiological disorders. The increase in beet yield at CBA-SAU Tandojam might be due to more available phosphorus, organic matter and sufficient irrigations (Table 1). The results are supported by Cakmakci *et al.* (1999), Usmanikhaili *et al*. (2005) and Javaheri *et al*. (2006) who reported that phosphorus, organic matter and sufficient irrigation water increased beet yield. Similarly, Goodman (1968) and Hosseinpour *et al*. (2006) reported that vegetative growth and beet formation strongly influenced by soil-moisture and soil-fertility.

The statistically at par higher sugar recovery and sugar yield was noted at NSTHRI-Thatta and AAF Mirpur-Sakro locations as compared with CBA-SAU Tandojam location. The higher sugar recovery and sugar yield at two locations might be due to more available potassium (Table 1). The potassium has vital role in quality of sugarbeet and improved the quality of sugarbeet (Etemadi 2000). Potassium enhanced the transfer of sugar and its storage in beet roots

(Winzer *et al*. 1996). While low potassium reduced the translocation of photosynthates from leaves to roots resulting less accumulation of sugar (Hermans *et al*. 2006). Our results are in agreement with El-Maghraby *et al*., 1998, Khalil *et al*. 2001 and Karam *et al*. 2009, who reported that available potassium increased sugar recovery significantly.

Conclusion

The best performing sugarbeet varieties SDPAK 09/07, SDPAK 09/07, California and Magnolia are recommended for commercial cultivation in Thatta and Hyderabad districts of Sindh.

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References

Abo-Shady, K. A., Samia, M. M. Hilal, E. El. M. ElSheref and M. F. M. Ibrahim. (2010). Yield and quality of sugar beet crop as affected by irrigation interval, cultivars and potassium fertilization in north delta. J. Agric. Res. Kafer El-Sheikh Univ. **36**(4): 361-376.

Analytical Software. 2005. Statistix 8.1 User's manual Tallahassee, FL. Asdi (2007).

Ankerman D. and L. Richard. 1989. Soil and plant analysis. Agronomy. Handbook. A & L Agricultural Laboratory. USA. p. 56.

Ayaz, F.A., A. Kadioglu, R.T. Urgut. (2000). Water stess effects on the content of low molecular weight carbohydrates and phenolic acids in cienanthe setosa. Canadian. J. Plant Sci. **80**: 373-378.

Cakmakci, R., F. Kantar and O.F. Algur (1999). Sugarbeet and barley yields in relation to *Bacillus polymyxa* and *Bacillus megaterium* var. *Phosphaticum* inoculation. J. of Plant Nutrition and Soil Sci. **162**(4): 437-442.

Ebrahimian, H. R., S. Y. Sadegheian, M. R. Jahadakbar and Z. Abbasi. (2009). Study of adaptability and stability of sugarbeet monogerm cultivars in different locations of Iran. J. Sugarbeet. **24**(2): 1-13.

Etemadi, A, M.A. (2000). Effect of nitrogen and potassium fertilization on yield and quality of sugar beet in green house. Sugar beet Journal of Agricultural Research. 78: 759-767.

El-Maghraby, S.S., M.M. Shehata and Y.H. Tawfik. (1998). Effect of soil and foliar application of nitrogen and potassium on sugar beet. Egypt. J. Agric. Res. **76**(2): 665- 678.

Gobarah-Mirvat, E. and B.B. Mekki. (2005). Influence of boron application on yield and juice quality of some sugar beet cultivars grown under saline soil conditions. Journal of Applied Sciences Research **1**(5): 373-379.

Goodman, P.J. (1968) Physiological analysis of the effects of different soils on sugarbeet crops in different years. J. Applied. Eco. 5: 339-357.

Hakim, M.A., A.S. Juraimi, M. Begum, M.M. Hanafi, M.R. Ismail, A. Selamat. (2010). Effect of salt stress on germination and early seedling growth of rice (*Oryza sativa* L.). African Journal of Biotechnology, **9**(13): 1911-1918.

Havelin, J.L. and P.N. Soltanpour. 1981. Evaluation of ABDTPA soil test for iron and zinc. *Soil Science Society of America Journal* 45: 70-55.

Hermans, C., J.P. Hammond, P.J. White, N. Verbruggen. (2006). How to plants respond to nutrient shortage by biomass allocation? Trends in Plant Science, **11**: 610-617.

Hoffmann, C.M., T. Huijbregts, N. Van Swaaij and R. Jansen. (2009). Impact of different environments in Europe on yield and quality of sugarbeet varieties. Eur. J. Agron. 30: 7-26.

Hosseinpour, M., A. Sorooshzadeh, M. Aghaalikhani, D.F. Taleghani, M. Khoramian. (2006). The effect of irrigation in spring on water use efficiency and yield of autumn sown sugarbeet. J. Sugarbeet. **22**(2): 35-52.

Javaheri, M.A., H. Najafinezhad, F.A. Shahraki. (2006). Study of autumn sowing of sugarbeet in Orzouiee area (Kerman province) Pajouhesh Sazandegi. 71(2): 85-93.

Jones, Jr., J. B., B. Wolf and H. A. Mills. (1991). Plant analysis handbook. Micro-Macro Publishing, Inc., Athens, GA, USA.

Kaloi G.M., A. H. Mari, M. Zubair, R.N. Panhwar, N. Bughio, S. Junejo, G.S. Unar, M.A. Bhutto. (2014). Performance of exotic sugar beet varieties under agro-climatic conditions of lower sindh. Journal of Animal and Plant Sciences, **24**: 1135-1140.

Karam, F., Y. Rouphael, R. Lahoud, J. Breidi, and G. Colla. (2009). Influence of varieties and potassium application rates on yield and potassium use efficiency of potato. J. Agron. **8**(1): 27-32.

Khalil, S.M., N. Mostafa and Z. R. Mostafa. (2001). Influence of potassium fertilizer and soil salinity on chemical composition of sugar beet. Minufiya J.Agric.Res. **26**(3):583-594.

Khan, I. and M. Jamil. (2004). Ministry of Food, Agriculture and Livestock. Quarterly Science Vision. **9**(1-2): 3-4.

Marlander, B., C. Hoffmann, H.J. Koch, E. Ladewig, R. Merkes, J. Petersen and N. Stockfisch. (2003). Environmental situation and yield performance of the sugarbeet crop in Germany: heading for sustainable development. J. Agron. Crop Sci. **189**: 201-226.

Memon, Y.M., I. Khan and R.N. Panhwar. (2004). Adoptability performance of some exotic sugarbeet varieties under agro-climatic conditions of Thatta. Pakistan Sugar J. **19**(6): 42-46.

Mostafavi, K., H. Sadeghi Geive, M. Dadresan, M. Zarabi. (2011). Effects of drought stress on germination indices of corn hybrids (*Zea mays* L.). International Journal of Agri. Science. **1**(2): 10-18.

Steel, R.G.D., J.H. Torrie and D.A. Dickey. (1997) Principles and Procedures of Statistics: A Biometrical Approach. 3rd Edition, McGraw Hill Co., Inc., New York.

Oad, F.C., A.H. Ansari, B.K. Solangi, M.U. Usmanikhaili, G.N. Sohu and N.L. Oad. (2001). Performance evaluation of exotic sugarbeet under selected agro-climatic conditions of Sindh Province. Int. J. Agri. Biol. **3**(4): 472-474.

Oad, F.C., M.U. Usmanikhaili, U.A. Buriro and M.H. Siddiqui. (2007). Plant population studies of various promising sugarbeet cultivars. Pakistan Sugar J. **19**(6):15-19.

Pacuta, V. (2000). The influence of liquid leaf fertilizers on the quality and quantity of sugarbeet root, Proceedings of the 63 IIRB congress. Pp: 15-17.

Tunio, G.S., H.I. Majeedano, Y.J. Minhas and M.U. Usmanikhail. (2004). Performance of different sugarbeet cultivars under Hyderabad conditions. Pakistan Sugar J. **19**(1): 22-26.

Usmanikhail, M.U., G.S. Tunio, H.I. Majeedano, S. Shahani and L.M. Baloch. (2005). Effect of fertility levels on growth, beetroot and quality of sugarbeet. Pak. Sugr. J. **10**(5):13-16.

Vandergeten, J. P. (1998). Study group on quality and storage, *IIRB info*, No. **2**: 17.

Winzer, T., G. Lohaus, and H.W. Heldt. (1996). Influence of phloem transport, N-fertilization and ion accumulation on sucrose storage in the taproots of fodder beet and sugar beet. Journal of Experimental Botany. **47**: 863-87

Zahoor-ul-Haq, A. Zeb and F. Mehmood. (2006). Yield and quality of two cultivars of sugarbeet as influenced by fertilizer applications. Pakistan J. Sci. Industr. Res. **49:** 211-214.