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Root yield and quality of tropical sugar beet (*Beta vulgaris* L.) cultivars under land configurations in *vertisol* and impact on soil health

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ABSTRACT

A field experiment was conducted during the winter (rabi) season of 2015-16 at Navsari Agricultural University, Navsari to assess the effect of land configuration and tropical sugar beet (Beta vulgaris L.) cultivars on yield and quality of root under south Gujarat condition. Nine treatment combinations comprising three land configurations, viz. flat bed, ridge furrow and raised bed allocated to main plots and three varieties, viz. 'SV 887', 'SV 889' and 'SV 892' allocated to sub-plots were evaluated in split-plot design with four replications. Among land configurations, raised bed planting gave fresh root yield of 68.36 t ha^{-1}. Among cultivars, 'SV 887' gave the maximum root yield of 64.63 t ha^{-1}. But Planting of 'SV 887' on raised bed recorded the maximum of 69.57 t ha^{-1} beet root yield. Among cultivars,'SV-892' recorded the maximum TSS of 19.12%, sucrose content of 16.42% and sugar recovery percentage of 14.08% and proved significantly superior to other two cultivars. From sugar yield point of view, bed planting recorded the maximum sugar yield of 9.67 t ha^{-1} among planting methods and 'SV 887' gave the maximum sugar yield of 8.92 t ha^{-1} among cultivars. Planting of 'SV 887' on raised bed recorded the maximum sugar yield of 9.84 t ha^{-1}. Among various land configurations, raised bed method recorded the minimum BD value of 1.37 g cc^{-1} and ridge and furrow method recorded the statistically similar value. Planting of sugar beet cultivar 'SV 887' on raised bed was found promising with respect to yield and quality of beet root in heavy black soil of south Gujarat.

***Keywords*:** Amino nitrogen, Beet root, potassium, sodium, sucrose, sugar recovery and TSS

Sugar beet roots contain high concentration of sucrose. It contributes about 21.8 per cent of world sugar. It is considered to be a temperate crop, but some varieties perform well in climatic conditions of tropics and subtropics. Composition wise, a freshly harvested sugar beet root contains 75-76 per cent water, 15-20 per cent sugars, 2.6 per cent non-sugars and 4-6 per cent the pulp. A successful production of sugar beet under subtropical conditions is possible with the use of suitable varieties (Brar *et al.*, 2015). Variety plays an important role on the performance of tropical sugar beet (Bairagi *et al.*, 2013). In vertisol, land configuration needs alteration for satisfactory drainage, improvement in soil structure, proper growth and development of beet root. Ahmad *et al.* (2010) recommended bed planting for sugar beet production in the Peshawar valley. Keeping these points in view, the present investigation was undertaken to study the effect of various cultivars and land configurations on productivity and quality of beet root and soil health, as no such work was done earlier.

The field experiment was conducted during the winter (*rabi*) season of 2015-16 at the College farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari. The soil of the experimental site was clayey in texture (clay 62.30%, silt 21.85% and sand 15.85%), having pH 8.29 and electrical conductivity 0.38 dS m^{-1} and organic carbon 0.72% in top of 15 cm soil. The soil was low in available nitrogen (172 kg ha^{-1}), high in available phosphorus (49 kg ha^{-1}) and fairly rich in available potassium (458 kg ha^{-1}). The nine treatment combinations comprising three land configurations, *viz.* L_1- flat bed, L_2- ridge furrow and L_3-raised bed in main plots and three varieties, *viz.* V_1- 'SV 887'(160-165 days), V_2- 'SV 889'(165-175 days) and V_3, 'SV 892'(165-175 days) in sub-plots were tried in split pot design with four replications. The three sugar beet varieties were sown as per treatment specifications on 7 November, 2015 at a spacing of 45 x 20 cm using seed rate of 12 kg ha^{-1} and fertilized with 120 - 60 - 60 kg N - P_2O_5 - K_2O ha^{-1}. A total of nine irrigations were given during the crop life period and two hand weeding were carried out at 20 and 40 DAS.

At crop maturity, root yield ha^{-1} was calculated based on the net plot (4.8 × 2.7m) yield and expressed in t ha^{-1}. For quality analysis, after recording the weight of fresh root, these were washed with distilled water and samples were stored in refrigeration below 4°C. Each root was sliced vertically and horizontally to get proportionate quantity of beet from all portion of the root. The samples were mixed thoroughly and representative sample was drawn randomly for analysis. The biochemical parameters analysed for root juice samples included, total soluble solids (TSS), sucrose content and alpha amino N, sodium and potassium content. Treatment wise total soluble solid (TSS) was recorded with the help of pocket hand refractometer, having a scale in the range of 0-32. The sucrose percentage in sugar beet was estimated by Sachr Le-Docta process (Le-Docte, 1927). The α - Amino N content was determined by procedure described

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by Moore and Stein (1954) which uses colorimetric method after reacting with ninhydrin for colour development. Amino acids when react with ninhydrin at desired pH and temperature forms blue coloured compound. Intensity of coloured compound was measured calorimetrically using green filter (570 mµ wavelength). Sodium and potassium from same juice sample was determined by emission spectrophotometry using Flame photometer (Jackson, 1973) and expressed in m mol 100^{-1}g. Sugar recovery percentage computed by deducting sucrose loss from sucrose content. The following formulae were used for computing sugar recovery (%).

Sugar recovery (SR%) = Sucrose % - Sugar loss %

Sucrose loss (%) = 0.29 + 0.343 (K + Na) + 0.094 (α -Amino N)

Sugar yield was calculated by multiplying fresh root yield with sugar recovery percentage and was expressed in t ha^{-1}. Soil samples were drawn by core sampler from each plot and bulk density was determined by core method (Black, 1965). The processed samples were used for determining organic carbon by Walkley and Black's Rapid titration method (Jackson, 1973). The available N, P and K were determined by using alkaline potassium permanganate method (Subbiah and Asija, 1956), Olsen's method (Olsen *et al*., 1954) and flame photometric determination (Jackson, 1967).

Root yield

Both land configurations and cultivars influenced fresh and dry root yield significantly (Table 1). Among land configurations, raised bed planting gave fresh root yield of 68.36 t ha^{-1}. Raised bed provided well aerated, friable and well-drained soil conditions conducive for growth and development of beet root. Raised bed increased the fresh root by 22.3 per cent over flat bed. Ahmad *et al.* (2010), Deshpande *et al.* (2015) and Marey (2015) reported higher yield in raised bed planting as compared to ridge and furrow planting. Saini *et al.* (2018) reported significantly higher fresh herbage and essential oil yield in bed planting than in flat planting among both the harvests of patchouli. Among cultivars, 'SV-887' gave the maximum root yield of 64.63 t ha^{-1} and proved significantly superior to both 'SV 889' and 'SV 892'. Different varieties were in the order of 'SV 887' > 'SV 892' > 'SV 889' for fresh root yield. The magnitude of increase in root yield of 'SV 887' was to the tune of 10.6 per cent over 'SV 889'. Varietal difference for yield of sugar beet was reported earlier by Kaloi *et al*. (2014), Ferdous *et al.* (2015) and Ganapati *et al.* (2016). The land configurations and cultivars exhibited the similar trend for dry root yield. Interaction effects of land configurations and cultivars for fresh and dry root yield were found significant. Planting of 'SV 887' on raised bed recorded the maximum fresh root yield of 69.57 t ha^{-1} and all varieties under raised bed planting and 'SV 887' under ridge and furrow planting remained at par with it. The exactly similar trend was noted for dry root yield.

Quality parameters

Land configurations failed to influence TSS content, sucrose content and sugar recovery percentage significantly (Table 2). But raised bed method recorded the mean maximum values for TSS, sucrose content and sugar recovery percentage. From sugar yield point of view, bed planting recorded the maximum sugar yield of 9.67 t ha^{-1} and proved significantly superior to both ridge furrow and flat bed planting. Different land configurations were in the order of raised bed > ridge furrow > flat bed for sugar yield. Bed planting facilitated proper water distribution and reduced weed infestation which ultimately improved root quality. Ahmad *et al.* (2010) reported lower sucrose percentage and sugar yield under flat bed planting than the ridge furrow and bed planting. Marey (2015) reported higher sugar percentage with bed planting than ridge planting.

Among cultivars, 'SV 892' recorded the maximum TSS of 19.12%, sucrose content of 16.42% and sugar recovery percentage of 14.08% and proved significantly superior to other two cultivars, while 'SV 887' gave the maximum sugar yield of 8.92 t ha^{-1} among cultivars. Interaction effects of land configurations and cultivars were found significant for TSS content, sucrose content and sugar recovery percentage. The cultivar 'SV 892' under raised bed planting recorded the maximum TSS of 19.85%, sucrose content of 16.59% and sugar recovery percentage of 14.20%. Planting of 'SV 887' on raised bed recorded the maximum sugar yield of 9.84 t ha^{-1}. Kaloi *et al*. (2014), Ganapati *et al.* (2016) and Sanghera *et al*. (2016) reported varietal difference in sugar content in sugar beet.

Important impurities in sugar beet include amino nitrogen, sodium and potassium. Land configurations failed to influence α Amino N, Na and K content significantly (Table 3). Among cultivars, 'SV 887' had the maximum impurity percentage.

Soil quality

Among physical and chemical properties, only bulk density values of soil were significantly influenced by land configuration (Table 4). In general, bulk density values decreased from the initial value of 1.55 g cc^{-1}.

Table 1: Effect of land configuration and varieties on fresh and dry root yield of sugar beet

Treatments	L_1-Flat bed	L_2-Ridge furrow	L_3-Raised bed	Mean
		Fresh root yield (t ha^{-1})		
V_1- SV 887	59.00	65.34	69.57	64.63
V_2- SV 889	50.44	57.29	67.62	58.45
V_3- SV 892	58.18	57.82	67.88	61.29
Mean	**55.87**	**60.15**	**68.36**	**61.46**
LSD (0.05)	**L= 4.92**	**V= 2.65**	**VL=4.59**	**LV=6.17**
		Dry root yield (t ha^{-1})		
V_1- SV 887	14.89	16.50	17.76	16.38
V_2- SV 889	12.62	14.09	16.87	14.53
V_3- SV 892	14.72	14.71	16.93	15.46
Mean	**14.08**	**15.10**	**17.19**	**15.45**
LSD (0.05)	**L= 1.15**	**V=0.62**	**VL=1.08**	**LV=1.44**

Note: L-Land configuration, V-Variety, VL-Two V at same L, LV- Two L at same or different V

Table 2: Effect of land configuration and varieties on TSS, sucrose content, sugar recovery percentage and sugar yield

Treatments	L_1-Flat bed	L_2-Ridge furrow	L_3-Raised bed	Mean
		TSS content (%)		
V_1- SV 887	18.86	18.14	19.46	18.82
V_2- SV 889	18.10	18.49	19.07	18.55
V_3- SV 892	18.56	18.94	19.85	19.12
Mean	**18.51**	**18.53**	**19.46**	**18.83**
LSD (0.05)	**L=NS**	**V=0.25**	**VL=0.43**	**LV=1.06**
		Sucrose content (%)		
V_1- SV 887	15.98	16.07	16.58	16.21
V_2- SV 889	15.49	16.08	16.46	16.01
V_3- SV 892	15.94	16.74	16.59	16.42
Mean	**15.80**	**16.30**	**16.54**	**16.21**
LSD (0.05)	**L=NS**	**V=0.18**	**VL=0.32**	**LV=0.73**
		Sugar recovery percentage		
V_1- SV 887	13.56	13.68	14.15	13.80
V_2- SV 889	13.16	13.75	14.09	13.67
V_3- SV 892	13.62	14.42	14.20	14.08
Mean	**13.45**	**13.95**	**14.15**	**13.85**
LSD (0.05)	**L=NS**	**V=0.18**	**VL=0.31**	**LV=0.75**
		Sugar yield (t ha^{-1})		
V_1- SV 887	8.00	8.94	9.85	8.93
V_2- SV 889	6.63	7.88	9.53	8.01
V_3- SV 892	7.92	8.34	9.64	8.63
Mean	**7.51**	**8.39**	**9.67**	**8.52**
LSD (0.05)	**L=0.86**	**V=0.35**	**VL=NS**	**LV=NS**

Table 3: Effect of treatments on α amino N, Na, K content of sugar beet

Treatment	α Amino N (m mol 100 g^{-1})	Na content (m mol 100 g^{-1})	K content (m mol 100 g^{-1})
Land configuration (L)			
L_1 : Flat bed	2.08	1.24	4.20
L_2 : Ridge furrow	2.17	1.16	4.24
L_3 : Raised bed	2.22	1.20	4.33
LSD (0.05)	NS	NS	NS
Varieties (V)			
V_1 : SV 887	2.21	1.25	4.33
V_2 : SV 889	2.11	1.19	4.21
V_3 : SV 892	2.14	1.16	4.23
LSD (0.05)	**0.06**	**0.04**	**0.09**
Interaction	**NS**	**NS**	**NS**

Table 4: Effect of land configuration and varieties on physical and chemical properties of soil

Treatments	Bulk density (g cc^{-1})	Organic carbon (%)	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Initial value	1.57	0.72	172	49	458
Land configuration (L)					
L_1 : Flat bed	1.55	0.80	219	67	455
L_2 : Ridge furrow	1.42	0.73	210	65	440
L_3 : Raised bed	1.37	0.72	195	60	437
LSD(0.05)	0.14	NS	NS	NS	NS
Varieties (V)					
V_1 : SV 887	1.45	0.73	205	62	442
V_2 : SV 889	1.46	0.76	211	66	446
V_3 : SV 892	1.44	0.75	208	64	444
LSD (0.05)	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS

Among various land configurations, raised bed method recorded the minimum BD value of 1.37 g cc^{-1} and ridge and furrow method recorded the statistically similar value. Soil working for bed making and ridge making loosened the soil and decreased bulk density. Both land configuration and cultivar failed to cause difference in available nitrogen, phosphorus and potassium status of soil after crop harvest. Available nitrogen and phosphorus content increased over the initial values, but available potassium decreased over the initial value.

Considering, yield, quality parameters and effect on soil health, planting of sugar beet cultivar 'SV 887' on raised bed was found promising in heavy black soil of south Gujarat.

REFERENCES

Ahmad, Z., Shah, P., Kakar, K.M., Sharkawi, H.E., Gama, P.B.S., Khan, E.A., Honna, T. and Yamamoto, S. 2010. Sugar beet (*Beta vulgaris* L.) response to different planting methods and row geometries II: Effect on plant growth and quality. *J. Food, Agric. and Env*., **8**: 785-91.

Bairagi, A., Paul, S.K., Kader, M.A. and Hossain, M.S. 2013. Yield of tropical sugar beet as influenced by variety and rate of fertilizer application. *Pakistan Sugar J*., **28**: 13-20.

Black, C.A. 1965. *Method of Soil Analysis Part I and II*. American Soc. Agron.Wisconsin, USA.

Brar, N.S., Dhillon, B.S., Saini, K.S. and Sharma, P.K. 2015. Agronomy of sugar beet cultivation-A review. *J. Agril. Rev*., **36**: 184-97.

Deshpande, H.H., Nadagouda, B.T. and Hunshal, C.S. 2015. Sugar beet response to planting methods and dates of sowing in deccan plateau of peninsular India. *Int. Res. J. Agril. Econ. Stat.*, **6**: 83-88.

Ferdous, H.M., Khaliq, Q.A. and Karim, A. 2015. Effect of sowing dates on growth and yield of tropical sugar beet. *Int. J. Agron. Agril. Res.*, **7**: 53-60.

Ganapati, R.K., Rahman, M.M., Kabiraj, R.C., Sen, R. and Islam, M.S. 2016. Screening of water stress tolerant sugar beet (*Beta vulgaris* L.) genotypes. *Int. J. Sust.Crop Prod.*, **11**: 29-35.

Jackson, M.L. 1967. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Jackson, M.L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Kaloi, G.M., Mari, A.H., Zubair, M., Panhwar, R.N., Bughio, N., Junejo, S., Unar, G.S. and Bhutto, M.A. 2014. Performance of exotic sugar beet varieties under agro-climatic conditions of lower Sindh. *J. Anim. Pl. Sci.*, **24**: 1135-40.

Le-Docte, A. 1927. Commercial determination of sugar beet root using the sachr Le-Docta process. *Int. Sugar J.*, **29**: 488-92.

Marey, S.A. 2015. Affecting each of ridger furrow opener parameters and planting methods on water use efficiency and sugar beet yield. *Bulgarian J. Agril. Sci*., **21**: 1304-11.

Moore, S. and Stein, W.H. 1954. A modified ninhydrin reagent for the photometric determination of amino acids and related compounds. *J. Biol. Chem.*, **211**: 907-13.

Olsen, S.R., Col, C.V., Watanabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. *Circ. U.S. Dep. Agric*., pp. 939.

Saini, M.K., Kaur, S. and Arora, J.K. 2018. Influence of date of planting, land configuration and planting geometries in patchouli (*Pogostemon cablin* Benth.) under sub-mountaineous region of Punjab. *J. Crop and Weed*, **14**: 7-13.

Sanghera, G.S., Singh, R.P., Kashyap, L., Tyagi, V. and Sharma, B. 2016. Evaluation of sugarbeet genotypes (*Beta vulgaris* L.) for root yield and quality traits under subtropical conditions. *J. Krishi Vigyan*, **5**: 67-73.

Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for the estimation of available nitrogen in soil. *Curr. Sci*., **25**: 259-60.