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Evaluation of beet varieties for forage yield and quality parameters

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Abstract
Eight beet varieties were evaluated for fodder yield and quality parameters. The green and dry fodder yield obtained from beet varieties ranged from 84.23 to 106.04 t/ha and 7.11 to 15.00 t/ha, respectively. Sugar beet variety Mangnolia recorded the highest green fodder yield (106 t/ha) and dry matter yield (15 t/ha). Sugar beet varieties recorded significantly higher dry fodder yields than the fodder beet varieties. High crude protein and low soluble sugar content was observed in roots of fodder beet than sugar beet varieties. Crude protein, crude fat, crude fibre, silica and oxalic acid contents were recorded higher in beet varieties leaves portion compared to roots. Oxalic acid content was found low in beet roots (0.5 to 0.8 %). Higher minerals content (calcium, phosphorus, potassium, magnesium and sodium) was observed in fodder beet variety JK Kuber.

Keywords: Fodder beet, Fodder yield, Proximate analysis, Sugar beet

Introduction
The Beet (*Beta vulgaris*) belonging to family Amaranthaceae, is a biennial crop grown for its fleshy and swollen roots. It is a temperate crop being cultivated in many parts of the world for sugar, fodder and vegetable purpose and popularly called as sugar beet, fodder beet & beet root, respectively. Beet is successfully grown as a fodder crop and used as valuable source of green fodder for cattle in many developed countries (Niazi *et al.,* 2000). The high sugar content in its fodder makes them palatable and a rich source of energy (Draycott and Christenson, 2003). Beets are also a potential crop for silage making with maize and oats. However, its cultivation in India as fodder crop is not common.

The objective of the present study was to evaluate the forage and quality components of different beet varieties available in India. The result was expected to be useful for identifying suitable varieties having genetic potential to provide high biomass yield along with good quality fodder, particularly for the Gujarat.

Materials and Methods
The experiment was laid out in a randomized block design with four replications consisting of eight beet varieties belonging to fodder beet and sugar beet type at fodder demonstration unit (FDU) of National Dairy Development Board, Anand (Gujarat) during 2011-12. The fodder beet varieties used in trial were JK Kuber, Jauna, Jamon, Monro and Splendide whereas; sugar beet varieties were Espernza, Mangnolia and Calixta. The soil of the experimental site was loam in texture with EC - 0.48, pH - 8.0, total nitrogen (1163.5 kg/ha), available P_2O_5 (28.44 kg/ha) and available K_2O (262.64 kg/ha). The soil contained DTPA-extractable Fe (8.97 ppm), Mn (22.17 ppm), Zn (8.63 ppm) and Cu (3.94 ppm). The crop was sown manually in the last week of November, 2011. The total plot size was 5 x 3 meter square with net plot area of 4 x 2 meter square at harvest. Two seed per hill were sown at 3 cm depth with 50x15 cm spacing. The crop was fertilized with 150:60:60 kg NPK/ha. One-third of N and the entire quantity of P & K was given as basal dose and remaining N was applied as top-dressing in two equal doses at 45 and 65 days after sowing. Two hand weeding were done at 25 and 55 days after sowing, gap filling was also done to maintain desired spacing. Total 10 irrigations were applied during the crop growth period. The crop was harvested in first week of June, 2012. After harvest, fresh biomass yield of leaves and roots were determined and, 500 gram chopped fodder samples of leaves and roots portion were dried in ovens separately at 70^{0}C to a constant weight for dry matter content. Dried samples were ground for chemical analysis and the amount of N was found by using micro-Kjehldal method (Jackson, 1973). Crude protein content was calculated multiplying N amount of each sample by 6.25. Proximate analysis of fodder samples for nutritive value was carried out following the standard laboratory procedures recommended by (AOAC, 2005). Minerals content was determined according to Inductively Coupled Plasma-Optical Emission Spectroscopy, Perkin Elmer, OPTIMA-3300 RL (ICP-OES) test method. Oxalic acid content was determined by Titrimetric method. Total soluble sugar content (Brix %) in

roots was taken using Hand-Refractometer. Data were analyzed statistically as per Snedecor and Cochran (1994).

Results and Discussion

Fodder yield

The result showed that sugar beet variety Mangnolia produced the highest total green fodder yield (106.04 t/ha) and dry fodder yield (15.0 t/ha) among all the varieties (Table 1). Higher fodder yields were obtained from roots as compared to leaves portion. Fodder beet and sugar beet varieties recorded green fodder yield from roots ranging from 67.07 t/ha to 75.94 t/ha which were statistically at par. Kapur *et al*., (2005) reported fresh roots yield varying from 47.7 to 91.3 t/ha in different sugar beet varieties. The superiority of sugar beet varieties might be attributed to significantly higher dry matter content in roots as compared to fodder beet roots (Table 2).

Crude protein content and yield

The crude protein content in roots of fodder beet varied from 11.4 to 14.7 % but was found significantly higher than sugar beet varieties roots which varied from 6.7 to 8.0 %. However, the differences in crude protein content in leaves of different beet varieties were found non-significant and ranged from 15.4 to 19.6 %. All the beet varieties recorded higher crude protein content in their leaves than roots portion. Nadaf *et al.,* (1998a) also reported that crude protein content in leaves of fodder beet varieties ranged between 11.4 to 15.8 %, while the roots contained crude protein content between 4.5 to 9.8 %.

Crude protein yields from leaves and roots portion were found statistically different between beet. Among all the varieties, sugar beet Calixta recorded highest total crude protein yield (1.60 t/ha). Among all varieties, Mangnolia at par with Calixta produced significantly highest crude protein yield (0.88 t/ha) from leaves, whereas, Splendide (0.86 t/ha) statistically differed with JK Kuber from roots portion. Turk (2010) reported that crude protein content and crude protein yield in roots of fodder beet variety Ecdogelb varied from 10.68 % to 11.34 % and 1.09 t/ha to 1.20 t/ha, respectively.

Chemical composition

Significantly higher total soluble sugar content was recorded in roots of sugar beet compared to fodder beet (Table 2). This is in accordance with the observations recorded by Singh and Garg (2012), that reported average soluble sugar content in roots of sugar beet varieties and fodder beet varieties ranging between (12.0 to 14.9 %) and (7.0 to 7.9 %), respectively during harvesting period. Sugar beet variety Calixta significantly recorded the highest soluble sugar content (12.4 %) among all the beet varieties.

Dry matter content variation in leaves of beet varieties were not found significant. Sugar beet variety Calixta at par with Espernza recorded significantly higher dry matter content (15.6 %) in roots than other beet varieties. Crude fat, crude fibre, silica and oxalic acid contents were observed higher in leaves portion than roots in all the beet varieties. However, differences among beet varieties for these parameters were found to be non-significant. Nadaf *et al.,* (1998b) reported higher crude fat and crude fibre content in fodder beet leaves as compared to roots. Very low levels of oxalic acid content were observed in beet roots varying between (0.5 to 0.8 %) as compared to beet leaves (5.1 to 5.9 %). Burba and Nitzschke (1974) reported oxalic acid content in sugar beet roots between 3.0 to 6.0 g/kg of the dry matter. Copper and Johnson (1984) suggested that oxalic acid levels in excess of 100 g/kg of the dry matter would be required to make a plant potentially dangerous for animal feeding.

Mineral composition

***Calcium**:* In all the varieties calcium content was observed more in leaves than roots (table 3). However, calcium was found to be significantly different in roots only. Fodder beet variety JK Kuber recorded the highest calcium content (0.17 %) in roots among all the varieties.

***Phosphorus**:* Phosphorus content in leaves of beet varieties was found to be slightly more as compared to roots. However, significant differences among beet varieties were recorded in roots only. Fodder beet variety JK Kuber statistically at par with fodder beet varieties Jauna and Monro recorded more phosphorus content (0.32 %) as compared to remaining beet varieties.

***Potassium**:* Significant differences for potassium content among beet varieties were observed in roots portion. Potassium content (1.66 %) in roots of fodder beet variety JK Kuber was found to be significantly greater than other beet varieties.

***Sodium**:* Differences in sodium content among beet varieties were found to be significant in both leaves and roots. However, in all the beet varieties, higher sodium content was recorded in leaves than roots. In leaves, fodder beet varieties Monro, Splendide and Jauna statistically at par amongst themselves recorded significantly higher sodium content than the sugar beet varieties. Sodium content (4.38 %) in roots of fodder beet vareity JK Kuber was found to be significantly higher than other varieties.

Magnesium*:* Magnesium content was found to be higher in leaves of beet varieties as compared to root. Similar observations were reported by Nadaf ***et al.,*** (1998a) and Khogali ***et al.,*** (2011). However, significant difference in magnesium content among beet varieties was observed in leaves only. Fodder beet variety JK Kuber statistically at par with Jauna recorded higher magnesium content (0.90 %) among beet varieties.

Copper, Zinc, Manganese and Iron: Non-significant differences were observed in leaves and roots of all the beet varieties for minerals *i.e.* copper, zinc, manganese and iron. Only copper content was found to be significantly differing in roots. Roots of fodder beet variety JK Kuber at par with other fodder beet varieties Jamon and Monro recorded significantly more copper content (12.4 ppm) than rest of the varieties.

Thus, it may be concluded from the trial that for obtaining high biomass yield with good quality fodder sugar beet varieties Mangnolia and Espernza, and fodder beet varieties Jauna and Jamon can be cultivated in Gujarat.

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Table 1: Yield potential of different beet varieties

Varieties	Green fodder yield (t/ha)			Dry fodder yield (t/ha)			Crude protein yield (t/ha)		
	Leaves	Roots	Total	Leaves	Roots	Total	Leaves	Roots	Total
Fodder Beet									
JK Kuber	19.37	68.51	87.88	2.67	4.44	7.11	0.41	0.64	1.05
Jauna	24.07	75.94	100.00	3.25	6.38	9.63	0.55	0.74	1.29
Jamon	27.35	70.85	98.20	3.55	6.23	9.78	0.66	0.80	1.46
Monro	15.47	68.76	84.23	2.13	5.59	7.72	0.35	0.82	1.17
Splendide	21.57	72.85	94.42	3.04	7.55	10.59	0.47	0.86	1.34
Sugar Beet									
Espernza	26.25	72.29	98.54	3.75	10.49	14.23	0.70	0.77	1.47
Mangnolia	30.47	75.57	106.04	4.63	10.37	15.00	0.88	0.69	1.57
Calixta	26.88	67.07	93.94	3.93	10.46	14.39	0.77	0.83	1.60
S Em ±	1.87	4.24	4.24	0.25	0.63	0.69	0.05	0.06	0.08
CD at 5 %	5.49	NS	12.48	0.74	1.84	2.03	0.14	0.19	0.24

Table 2: Chemical composition (%) of different beet varieties

Varieties	Total soluble sugar (Roots)	Dry matter		Crude protein		Crude fat		Crude fibre		Silica		Oxalic acid	
		Leaves	Roots	Leaves	Roots	Leaves	Roots	Leaves	Roots	Leaves	Roots	Leaves	Roots
Fodder Beet													
JK Kuber	5.2	13.8	6.5	15.4	14.4	2.8	0.9	13.0	3.9	3.1	1.3	5.3	0.7
Jauna	6.3	13.6	8.4	16.9	11.6	2.5	0.4	11.8	2.5	1.8	0.9	5.6	0.8
Jamon	5.9	13.4	8.8	18.5	12.8	2.3	0.8	10.9	4.7	1.6	1.4	5.9	0.6
Monro	6.7	14.0	8.2	16.2	14.7	3.1	0.5	12.7	3.1	1.3	0.8	5.1	0.6
Splendide													
Sugar Beet	6.3	14.4	10.4	15.6	11.4	3.1	1.0	12.8	3.1	1.4	1.1	5.9	0.6
Espernza	11.2	14.5	14.5	18.7	7.4	3.1	0.5	12.3	2.3	2.4	0.7	5.9	0.6
Mangnolia	11.1	15.3	13.7	19.0	6.7	3.0	0.3	14.1	2.0	1.5	0.6	5.5	0.6
Calixta	12.4	14.9	15.6	19.6	8.0	2.6	0.5	14.3	2.4	1.5	0.6	5.5	0.5
S Em ±	0.3	0.4	0.5	0.9	1.3	0.3	0.3	0.9	1.0	0.4	0.3	0.2	0.1
CD at 5 %	0.7	NS	1.4	NS	4.3	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Mineral composition of different beet varieties

Varieties	Calcium (%)		Phosphorus (%)		Potassium (%)		Sodium (%)		Magnesium (%)	
	Leaves	Roots	Leaves	Roots	Leaves	Roots	Leaves	Roots	Leaves	Roots
Fodder Beet										
JK Kuber	0.59	0.17	0.34	0.32	1.43	1.66	5.38	4.38	0.90	0.21
Jauna	0.54	0.11	0.32	0.26	1.20	1.06	5.61	2.14	0.89	0.24
Jamon	0.46	0.12	0.34	0.24	1.22	0.89	4.93	2.63	0.67	0.21
Monro	0.51	0.10	0.30	0.29	1.07	0.96	5.90	2.44	0.78	0.15
Splendide	0.59	0.11	0.29	0.22	1.07	0.75	5.63	2.34	0.62	0.22
Sugar Beet										
Espernza	0.41	0.10	0.34	0.20	1.62	0.62	4.69	1.52	0.66	0.24
Mangnolia	0.49	0.13	0.31	0.18	1.45	0.51	4.57	1.22	0.63	0.28
Calixta	0.52	0.09	0.35	0.22	1.29	0.66	4.48	0.92	0.68	0.23
S Em $\pm$	0.06	0.01	0.02	0.02	0.21	0.14	0.26	0.44	0.04	0.04
CD at 5 %	NS	0.04	NS	0.07	NS	0.49	0.88	1.48	0.12	NS

Varieties	Copper (ppm)		Zinc (ppm)		Manganese(ppm)		Iron (ppm)	
	Leaves	Roots	Leaves	Roots	Leaves	Roots	Leaves	Roots
Fodder Beet								
JK Kuber	6.94	12.4	27.5	21.7	72.7	31.6	820.4	377.4
Jauna	9.20	7.0	33.2	35.3	70.8	27.6	845.1	324.6
Jamon	8.85	10.6	23.1	30.2	53.8	32.9	652.9	301.4
Monro	7.06	11.5	26.9	33.2	60.2	30.0	796.0	254.3
Splendide	6.57	7.2	25.8	28.3	57.6	22.5	741.5	272.0
Sugar Beet								
Espernza	8.46	5.2	26.7	18.2	47.7	35.0	649.4	249.4
Mangnolia	8.99	4.1	26.7	26.3	52.8	32.1	707.0	232.0
Calixta	9.60	4.5	28.4	19.1	57.1	24.6	696.9	218.2
S Em $\pm$	2.93	1.4	5.1	8.2	4.7	3.4	40.5	35.1
CD at 5 %	NS	4.6	NS	NS	NS	NS	NS	NS

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