EFFECT OF DIFFERENT SPACING AND NITROGEN LEVELS ON OF BEETROOT cv. DETROIT DARK RED QUALITY PARAMETERS UNDER TELANGANA STATE CONDITIONS

Abstract

The aim of this paper was to establish the effect of different spacing and nitrogen levels on quality parameters of beetroot cv. Detroit Dark Red under Telangana state conditions. It was carried out during *rabi* season of 2020-21 at SKLTSHU, College of Horticulture, Rajendranagar, Hyderabad, India. The experiment was laid out in Factorial Randomized Block Design with sixteen treatments replicated thrice. Treatment consisted of four levels of spacing S_1 (45cm ×15cm), S_2 (30cm×15cm), S_3 (30cm×10cm) and S_4 (15cm ×15cm) and four levels of nitrogen N_1 (70 Kg ha^{-1}), N_2 (87.5 Kg ha^{-1}), N_3 (105 Kg ha^{-1}) and N_4 (122.5 Kg ha^{-1}). The effects of the spacing and nitrogen levels was observed for quality characters. Highest total soluble solids (TSS) (9.93 ^{o}Brix), reducing sugars (1.64 %), total sugars (7.31 %) and chlorophyll content 45.50 (SPAD value) were recorded in wider spacing S_1- 45 cm x 15 cm and highest ascorbic acid content (10.09 mg $100g^{-1}$) was recorded in closer spacing S_4-15 cm x 15 cm, whereas pH and titrable acidity were found to be non-significant. Highest pH (6.20), reducing sugars (1.52 %), total sugars (7.29 %), ascorbic acid content (10.06 mg $100g^{-1}$) were recorded in nitrogen level N_1-70 Kg N ha^{-1}, whereas highest TSS (9.79 ^{o}Brix), chlorophyll content 45.70 (SPAD value) were observed in nitrogen level N_4-122.5 Kg N ha^{-1}. The interaction effect on quality parameters was found to be non-significant.

Keywords: Beetroot, Spacing, Nitrogen, Detroit Dark Red

Introduction:

Beetroot (*Beta vulgaris* L.) commonly known as Chukandar is one of the important root vegetable crops, belonging to the family Amaranthaceae along with spinach, palak, swiss chard, parsley and celery, having chromosome number 2n=18. It is known by various common names, including beet, chard, and spinach beet, and is well-known for its juice value and medicinal benefits. (Yashwanth, 2015). Root of beetroot is a rich source of proteins (1.7 g), carbohydrates (8.8 g), calcium (18 mg), phosphorous (55 mg) and vitamin-C (10 mg) and has 87.7 percent of water per 100 g of fresh weight (Aykroyd, 1963).

Beetroot gets its intense red color from a high concentration of betalains. Betalains are natural colorants used in food, but they have also gotten a lot of attention because of their health advantages in humans, particularly their antioxidant and anti-inflammatory characteristics. (Georgiev *et al*., 2010, Zielinska *et al.*, 2009). The betalains that are mainly found in beetroot are betacyanin's and betaxanthins (Gandia *et al*., 2010). Beetroot is farmed in many places across the world and is regularly consumed as part of a normal diet. It is also used to make the food coloring agent E 162. (Clifford *et al*., 2015).

Optimum spacing avoids shading effect on plants and intraspace competition. Proper plant geometry minimizes competition for nutrition, light, radiation, water etc. Optimum use of spacing among plants or plant population avoids strong competition between plants for growth factors.

Nitrogen is an important component of many organic molecules in plants, including proteins, nucleic acids, and alkaloids, and its presence is linked to the amount of chlorophyll in the leaves, which impacts photosynthesis. Nitrogen is the plant nutrient that has the greatest impact on crop production efficiency and profitability. Plants with insufficient nitrogen input frequently experience delayed growth, low protein levels, poor yield, low quality production, and inefficient water use. Keeping in view the above information, this research aims to provide results to the programme entitled "Effect of different spacing and nitrogen levels on beetroot cv. Detroit Dark Red quality parameters under Telangana state conditions".

Materials and Methods

The experiment was carried out at College of Horticulture, Rajendranagar, Hyderabad, Telangana State in southern India, during spring-summer season of 2020-21. The experiment was laid out in factorial randomized block design (FRBD) with three replications and sixteen treatments.

pH

The pH of the beetroot liquid fraction was determined using a pH meter (Model Hanna pH 210)

Total soluble solids (^{o}B)

Total soluble solids (TSS) in terms of percentage were obtained by using digital refractometer. Two to three drops of juice were placed on the prism of refractometer and reading was observed on scale and averages were expressed in º Brix.

Titrable acidity (%)

Ten ml of beetroot sample was pipette out in 250 ml beaker and to that 90 ml distilled water is added and it was agitated with magnetic stirrer and electrode pH was immersed in solution and titrated with NaOH from burette to pH value 8.1. At this pH phenolphthalein turns colourless to pink.

$$\text{Percentage acidity} = \frac{\text{Titre x Normality of alkali (0.5) x Vol. made x Eq. wt. of acid}}{\text{Wt. of sample x Vol. of aliquot x 1000}} \text{ X } 100$$

Reducing sugars (%)

The reducing sugars were estimated by the volumetric method as reported by Ranganna (1986).

Total sugars (%)

Total sugars were estimated by the volumetric method as reported by Ranganna (1986).

Ascorbic acid content (mg $100g^{-1}$)

Standard curve

Pipette out 0.0, 0.50, 0.75. 1.0, 1.5, and 2.0 ml of the standard ascorbic acid solution into 50 ml stoppered flasks. Make up the total volume in each flask to 2 ml with 3% HPO_3 solution. Add 1 ml water, 2 ml acetate buffer, 3 ml dye solution and 15 ml xylene in rapid succession. Stopper the conical flasks and shake vigorously for 10 sec to extract the excess dye into the xylene. Allow the layers to separate. With a pipette completely draw out the water layer below the xylene layer and discard. Add a small quantity (0.5-1.0 g) of anhydrous Na_2SO_4 to the xylene layer to remove traces of moisture. Transfer the xylene extracts to the colorimeter tubes and measure the absorbance at 520 nm. Set the instrument to 100% transmittance using xylene as a blank. Plot the absorbance values (A) against ascorbic acid (mg) on a graph paper to get the standard curve. We observe that as the concentration of ascorbic acid in the reaction mixture increases, the absorbance value decreases.

Take 2 ml of sample extract in a stoppered conical flask, add 2 ml of buffer (mix 500 ml of 50% sodium acetate with 500 ml of glacial acetic acid), 1 ml of 40% formaldehyde and mix. Allow to

stand for 10 min. then add 3 ml dye solution (2,6 dichlorophenol indophenol), stopper and shake for 10-15 seconds. Follow the remaining steps as done in the case of standard curve preparation. From the standard curve note the ascorbic acid content (mg) in the 2 ml sample extract taken for the estimation.

Spacing levels	pH	TSS (°Brix)	Titrable acidity (mg 100 g fresh weight^{-1})

Chlorophyll content (SPAD VALUE)

It was measured by Spad meter.

Results and Discussion

pH

The results in the table 1 revealed that there was no significant effect of spacing on pH of beetroot. Nitrogen shows significant effect on pH of beetroot. The maximum pH (6.20) was observed at nitrogen level N_1 (70 Kg N ha^{-1}) which is on par with nitrogen level N_2 (87.5 Kg ha^{-1}) (6.13) and minimum pH (6.06) was recorded at nitrogen at level of N_4 (122.5 Kg N ha^{-1}). Similar results are reported by Abhiram and Kefale (2020) in tomato.

Total Soluble Solids (^{o}B)

The maximum TSS (9.93 ^{o}B) was observed in the spacing S_1 level (45 cm x 15 cm) followed by spacing level S_2 (30 cm x 15 cm) (9.62 ^{o}B). The minimum TSS (9.25 ^{o} B) noticed in spacing level S_4 (15 cm X 15 cm). The maximum TSS (9.79 ^{o}B) was observed with nitrogen level, N_4 (122.5 Kg N ha^{-1}) which is followed by nitrogen level N_3 (105 Kg N ha^{-1}) (9.61^{o}B). The minimum TSS (9.33 ^{o}B) was recorded in the nitrogen level N_1 (70 Kg N ha^{-1}). The interaction effect of different spacing and nitrogen levels was found to be non-significant for TSS. It may be due to the fact that, when there is less competition for light, moisture and nutrients, the plant accumulates large amount of carbohydrates in their root. Higher dose of nitrogen enhanced the growth of leaves which in turn results in increase of photosynthesis and ultimately an increase in storage of carbohydrates and is reflected by increased TSS. These findings are in agreement with the results of earlier workers like, Skrbic (1987) in carrot, Joshi and Patil (1988), Kadam *et al.* (2018) in beetroot. The results were depicted in table 1.

Titrable acidity (%)

Spacing Nitrogen levels did not exert any significant effect on titrable acidity of beetroot. The interaction effect of different spacing and nitrogen levels was found to be non-significant for titrable acidity. Similar results are reported by Abhiram and Kefale (2020), Ronga *et al*. (2020) in tomato and Alves *et al*. (2010) in carrot. The results were placed in the table 1.

Table 1. Effect of different spacing and nitrogen levels on pH, TSS (°Brix) and titrable acidity (mg 100 g fresh weight^{-1}) of beetroot cv. Detroit Dark Red.

	Nitrogen levels (N)														
	N_1	N_2	N_3	N_4	**Mean**	N_1	N_2	N_3	N_4	**Mean**	N_1	N_2	N_3	N_4	**Mean**
S_1	6.31	6.14	6.11	6.08	**6.16**	9.62	9.78	10.00	10.30	**9.93**	0.19	0.21	0.21	0.15	**0.19**
S_2	6.20	6.17	6.13	6.05	**6.14**	9.42	9.55	9.80	9.80	**9.62**	0.28	0.15	0.22	0.21	**0.21**
S_3	6.14	6.12	6.11	6.08	**6.11**	9.20	9.27	9.41	9.66	**9.39**	0.24	0.21	0.21	0.17	**0.21**
S_4	6.17	6.10	6.08	6.05	**6.10**	9.10	9.20	9.32	9.40	**9.25**	0.23	0.24	0.18	0.23	**0.22**
Mean	**6.20**	**6.13**	**6.11**	**6.06**		**9.33**	**9.45**	**9.61**	**9.79**		**0.24**	**0.20**	**0.20**	**0.19**	
Factors	**S.E.m±**		**CD at 5%**			**S.E.m±**		**CD at 5%**			**S.E.m±**		**CD at 5%**		
S	0.02		NS			0.04		0.10			0.01		NS		
N	0.02		0.08			0.04		0.10			0.01		NS		
S X N	0.04		NS			0.08		NS			0.02		NS		
S_1 = 45 cm X 15 cm, S_2 = 30 cm X 15 cm, S_3 = 30 cm X 10 cm, S_4 = 15 cm X 15 cm						N_1 = 70 Kg ha^{-1}, N_2 = 87.5 Kg ha^{-1}, N_3 = 105 Kg ha^{-1}, N_4 = 122.5 Kg ha^{-1}									

Reducing sugars (%) Total sugars (%)

Spacing levels (S) Nitrogen levels (N)

N_1 N_2 N_3 N_4 Mean N_1 N_2 N_3 N_4 Mean

Reducing sugars (%)

The maximum reducing sugars (1.64 %) were observed in spacing S_1 level (45 cm x 15 cm) which is followed by spacing level S_2 (30 cm x 15 cm) (1.42 %). The minimum reducing sugars (1.24 %) were noticed in spacing level S_4 (15 cm x 15 cm). The maximum reducing sugar (1.52 %) was observed in the nitrogen level N_1 (70 Kg N ha^{-1}) which is on par with nitrogen level N_2 (87.5 Kg N ha^{-1}) and N_3 (105 Kg N ha^{-1}) (1.44 % and 1.37 %). The minimum reducing sugar (1.27 %) was observed in the nitrogen level N_4 (122.5 Kg N ha^{-1}). The interaction effect of different spacing and nitrogen levels was found to be non-significant for reducing sugars. Similar results were reported by Sirkar *et al.* (1998) in radish, Kadam *et al.* (2018) in beetroot. The values were presented in table 2.

Total sugars (%)

Spacing showed significant effect among different treatments. The maximum total sugars (7.31 %) were observed in spacing S_1 level (45 cm x 15 c m) which is on par with spacing level S_2 (30 cm x 15 cm) and S_3 (30 cm x 10 cm) (7.15 % and 6.81 %). The minimum total sugars (6.12%) were noticed in spacing level S_4 (15 cm x 15 cm). The maximum total sugar (7.29 %) was observed in the nitrogen level N_1 (70 Kg N ha^{-1}) which is on par with nitrogen level N_2 (87.5 Kg N ha^{-1}) (7.05 %). The minimum total sugar (6.45 %) was observed in the nitrogen level N_4 (122.5 Kg N ha^{-1}). The interaction effect of different spacing and nitrogen levels was found to be non-significant for total sugars. Similar results were reported by Kadam *et al*. (2018) in beetroot. The values were presented in table 2.

Table 2. Effect of different spacing and nitrogen levels on reducing sugars (%) and total sugars (%) of beetroot cv. Detroit Dark Red

S_1	1.72	1.66	1.60	1.57	**1.64**	7.68	7.45	7.20	6.90	**7.31**
S_2	1.61	1.50	1.33	1.22	**1.42**	7.59	7.43	6.85	6.75	**7.15**
S_3	1.46	1.33	1.30	1.13	**1.31**[c]	7.30	6.88	6.59	6.47	**6.81**
S_4	1.30	1.27	1.23	1.16	**1.24**	6.59	6.42	5.81	5.66	**6.12**
Mean	**1.52**	**1.44**	**1.37**	**1.27**		**7.29**	**7.05**	**6.61**	**6.45**	

Factors	**S.E.m±**	**CD at 5%**	**S.E.m±**	**CD at 5%**
S	0.07	0.16	0.23	0.50
N	0.07	0.16	0.23	0.50
S X N	0.12	NS	0.40	NS

S_1 = 45 cm X 15 cm, S_2 = 30 cm X 15 cm, S_3 = 30 cm X 10 cm, S_4 = 15 cm X 15 cm

N_1 = 70 Kg ha^{-1}, N_2 = 87.5 Kg ha^{-1}, N_3 = 105 Kg ha^{-1}, N_4 = 122.5 Kg ha^{-1}

Ascorbic acid content (mg $100g^{-1}$)

Spacing showed significant effect among different treatments. The maximum ascorbic acid content (10.09 mg $100g^{-1}$) was observed in spacing S_4 level (15 cm x 15 cm) which is on par with spacing level S_3 (30 cm x 10 cm) (9.87 mg $100g^{-1}$). The minimum ascorbic acid content (9.63 mg $100g^{-1}$) was noticed in spacing level S_1 (45 cm x 15 cm). The maximum ascorbic acid content (10.06 mg $100g^{-1}$) was observed in the nitrogen level $N_1$70 Kg N ha^{-1}) which is on par with nitrogen level N_2 (87.5 Kg N ha^{-1}) (9.96 mg $100g^{-1}$). The minimum ascorbic acid content (9.64 mg $100g^{-1}$) was observed in the nitrogen level N_4 (122.5 Kg N ha^{-1}). The interaction effect of different spacing and nitrogen levels was found to be non-significant for ascorbic acid content. Similar results were noticed by Rakocevic *et al*. (2012) in carrot. The results were depicted in table 3.

Chlorophyll content (SPAD value)

Spacing showed significant effect among different treatments. The maximum chlorophyll content (45.50 SPAD value) was observed in spacing S_1 level (45 cm x 1 5cm) which is on par with spacing level S_2 (30 cm x 15 cm) (45.11 SPAD value). The minimum chlorophyll content (44.02 SPAD value) was noticed in spacing level S_4 (15 cm x 15 cm). Nitrogen shows significant effect on chlorophyll content. Maximum chlorophyll content (45.70 SPAD value) was recorded with nitrogen at level of N_4 (122.5 Kg N ha^{-1}) which is on par with nitrogen level N_3 (105 Kg N ha^{-1}) (45.17 SPAD value). The minimum chlorophyll content (43.61 SPAD value) was recorded in the nitrogen level N_1 (70 Kg N ha^{-1}). The interaction effect of different spacing and nitrogen levels was found to be non-significant for chlorophyll content. Similar results were reported by Singh *et al*. (2004) in onion. The results were presented in table 3.

Table 3. Effect of different spacing and nitrogen levels on Ascorbic acid content (mg $100g^{-1}$) and Chlorophyll content (SPAD value) of beetroot cv. Detroit Dark Red

Spacing levels (S)	**Ascorbic acid content (mg $100g^{-1}$)**	**Chlorophyll content (SPAD value)**
	Nitrogen levels (N)	

	N_1	N_2	N_3	N_4	**Mean**	N_1	N_2	N_3	N_4	**Mean**
S_1	9.80	9.72	9.51	9.50	**9.63**	44.63	45.55	45.80	46.01	**45.50**
S_2	10.00	9.85	9.70	9.63	**9.80**	44.81	45.42	45.53	44.69	**45.11**
S_3	10.17	10.10	9.70	9.50	**9.87**	43.17	43.65	44.40	46.31	**44.38**
S_4	10.28	10.17	10.00	9.93	**10.09**	41.83	43.53	44.93	45.80	**44.02**
Mean	**10.06**	**9.96**	**9.73**	**9.64**		**43.61**	**44.54**	**45.17**	**45.70**	

Factors	**S.E.m±**	**CD at 5%**	**S.E.m±**	**CD at 5%**
S	0.11	0.24	0.42	0.92
N	0.11	0.24	0.42	0.92
S X N	0.19	NS	0.73	NS

S_1 = 45 cm X 15 cm, S_2 = 30 cm X 15 cm, S_3 = 30 cm X 10 cm, S_4 = 15 cm X 15 cm

N_1 = 70 Kg ha^{-1}, N_2 = 87.5 Kg ha^{-1}, N_3 = 105 Kg ha^{-1}, N_4 = 122.5 Kg ha^{-1}

Conclusion

Highest TSS (9.93^{0}Brix), reducing sugars (1.64 %), total sugars (7.31 %) and chlorophyll content (45.50 SPAD value) were recorded in wider spacing S_1- 45 cm x 15 cm and highest ascorbic acid content (10.09 mg $100g^{-1}$) were recorded in closer spacing S_4-15 cm x 15 cm, whereas pH and titrable acidity were found to be non-significant. Highest pH (6.20), reducing sugars (1.52 %), total sugars (7.29 %), ascorbic acid content 10.06 mg $100g^{-1}$ were recorded in nitrogen level N_1-70 Kg N ha^{-1}, whereas highest TSS (9.79 ^{0}Brix), chlorophyll content 45.70 (SPAD value) were observed in nitrogen level N_4-122.5 Kg N ha^{-1}. The interaction effect on quality parameters was found to be non-significant.

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