# ~~STUDIES ON~~ EFFECT OF DIFFERENT SPACING AND NITROGEN LEVELS ON ~~QUALITY PARAMETERS OF~~ BEETROOT ~~(*Beta vulgaris* L.)~~ cv. DETROIT DARK RED QUALITY PARAMETERS UNDER TELANGANA STATE CONDITIONS


## Abstract

The present investigation ~~entitled "Studies on effect of different spacing and nitrogen levels on quality parameters of beetroot (*Beta vulgaris* L.) cv. Detroit Dark Red under telangana conditions"~~ 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 ~~(FRBD)~~ 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 ~~significant~~ effects of the spacing and nitrogen levels were observed for quality characters. Highest total soluble solids (TSS) (9.93 °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 °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.), ~~is~~ commonly is known as Chukandar and is one of the important root vegetable crops, belongs to the family Chenopodiaceae along with spinach, palak, Swiss chard, parsley and celery, having chromosome no (2n=18).

Beetroot is famous for its juice value and medicinal properties and known by several common names like beet, chard, spinach beet. (Yashwanth, 2015). Roots of beetroot is a rich source of proteins (1.7 g), carbohydrates (8.8 g), calcium (18 mg), phosphorous (55 mg) and vit-C (10 mg) and 87.7 percent of water per 100 g of fresh weight (Aykroyd, 1963).

The intense red colour of beetroot derives from high concentration of betalains. Betalains are used as natural colorants by the food industry, but have also received increasing attention due to possible health benefits in humans, especially their antioxidant and anti-inflammatory activities (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). Today, beetroot is grown in many countries worldwide is regularly consumed as part of the normal diet, and commonly used in manufacturing as food colouring agent known as 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 ~~has dual advantages. It~~ avoids strong competition between plants for growth factors, ~~such as water, nutrient and light.~~

**Comment [u1]:** I suggest to put something so: 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 Telengana State conditions. It was carried out during .....

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**Comment [u3]:** I suggest to put spinach (*Spinacia oleracea* L., Amaranthaceae),

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Nitrogen has a great importance as a constituent of numerous organic molecules in plants such as proteins, nucleic acids and alkaloids and its content is associated with the leaf relative chlorophyll content which affects photosynthesis. Nitrogen is the plant nutrient that is most limiting to efficient and profitable crop production. Inadequate supply of available nitrogen frequently results in plants that have slow growth, depressed protein levels, poor yield, low quality produce and inefficient water use.

Keeping in view of the above information, thise research aims to provide results to the programme entitled "Sstudies on effect of different spacing and nitrogen levels on growth, yield and quality of beetroot (*Beta vulgaris* l.) cv. Detroit Dark Red under Telangana conditions is planned".

**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 (° 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 (%)**

Ten10 ml of sample was pipette out in 250 ml beaker and added 90 ml distilled water and it was agitated using 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.

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

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**Reducing sugars (%)**

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

**Total sugars (%)**

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

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

Take 2 ml of sample extract in a stoppered conical flask, add 2 ml of buffer, 1 ml of 40% formaldehyde and mix. Allow to stand for 10 min. then add 3 ml dye solution, 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.

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**Chlorophyll content (SPAD VALUE)**

It was measured by Spad meter.

**Results and Discussion**

**pH**

The results 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 (°B)**

The maximum TSS (9.93 °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 °B). The minimum TSS (9.25 °B) noticed in spacing level $S_4$ (15 cm X 15 cm). The maximum TSS (9.79 °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 °B). The minimum TSS (9.33 °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.

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**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.

**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.

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

| Spacing levels (S) | pH | | | | | TSS (°b°Brix) | | | | | Titrable acidity (mg 100 g fresh weight$^{-1}$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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$^{a}$** | 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 | 9.70 | 9.80 | **9.62$^{b}$** | 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 | **9.39c** | 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$^{d}$** | 0.23 | 0.24 | 0.18 | 0.23 | **0.22** |
| **Mean** | **6.20$^{a}$** | **6.13$^{ab}$** | **6.11$^{bc}$** | **6.06$^{bcd}$** | | **9.33$^{d}$** | **9.45$^{c}$** | **9.61$^{b}$** | **9.79$^{a}$** | | **0.24** | **0.20** | **0.20** | **0.19** | |

| Factors | pH | | TSS (°b°Brix) | | Titrable acidity (mg 100 g fresh weight$^{-1}$) | |
|---|---|---|---|---|---|---|
| | 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$^{-1}$

**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.

**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.

**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.

## Conclusion

Highest TSS (9.93 °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 °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.

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

| Spacing levels (S) | Reducing sugars (%) | | | | | Total sugars (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Nitrogen levels (N) | | | | | | | | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_4$ | **Mean** | $N_1$ | $N_2$ | $N_3$ | $N_4$ | **Mean** |
| $S_1$ | 1.72 | 1.66 | 1.60 | 1.57 | **1.64$^{a}$** | 7.68 | 7.45 | 7.20 | 6.90 | **7.31$^{a}$** |
| $S_2$ | 1.61 | 1.50 | 1.33 | 1.22 | **1.42$^{b}$** | 7.59 | 7.43 | 6.85 | 6.75 | **7.15$^{ab}$** |
| $S_3$ | 1.46 | 1.33 | 1.30 | 1.13 | **1.31$^{bc}$** | 7.30 | 6.88 | 6.59 | 6.47 | **6.81$^{abc}$** |
| $S_4$ | 1.30 | 1.27 | 1.23 | 1.16 | **1.24$^{cd}$** | 6.59 | 6.42 | 5.81 | 5.66 | **6.12$^{d}$** |
| **Mean** | **1.52$^{a}$** | **1.44$^{ab}$** | **1.37$^{abc}$** | **1.27$^{cd}$** | | **7.29$^{a}$** | **7.05$^{ab}$** | **6.61$^{bc}$** | **6.45$^{cd}$** | |
| 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 $ha^{-1}$

**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$^{bcd}$** | 44.63 | 45.55 | 45.80 | 46.01 | **45.50$^{a}$** |
| $S_2$ | 10.00 | 9.85 | 9.70 | 9.63 | **9.80$^{bc}$** | 44.81 | 45.42 | 45.53 | 44.69 | **45.11$^{ab}$** |
| $S_3$ | 10.17 | 10.10 | 9.70 | 9.50 | **9.87$^{ab}$** | 43.17 | 43.65 | 44.40 | 46.31 | **44.38$^{bc}$** |
| $S_4$ | 10.28 | 10.17 | 10.00 | 9.93 | **10.09$^{a}$** | 41.83 | 43.53 | 44.93 | 45.80 | **44.02$^{cd}$** |
| **Mean** | **10.06$^{a}$** | **9.96$^{b}$** | **9.73$^{bc}$** | **9.64$^{cd}$** | | **43.61$^{d}$** | **44.54$^{bc}$** | **45.17$^{ab}$** | **45.70$^{a}$** | |

| 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$^{-1}$

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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Kadam, V. D., Shinde, S. J. and Satav, D. C. 2018. Effect of different spacing and fertilizer levels on yield and economics of beetroot *(Beta vulgaris* L.). *Journal of Pharmacognosy and Phytochemistry*. 7(6): 31-35.

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