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# Effect of Sowing Date and Nitrogen on Quality of Beet Leaf (*Beta vulgaris* var. *bengalensis*)

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The experiment entitled "Effect of sowing date and nitrogen on quality of beet leaf (*Beta vulgaris* var. *bengalensis*)" was conducted during summer, 2020 at Vegetable Research Farm, RHRS, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India. The experiment was laid out in Split plot design with five replications. The experiment was arranged with three levels of sowing date ($D_1$:1st Fortnight of January $D_2$:2nd Fortnight of January and $D_3$:1st Fortnight of February) and four doses of nitrogen ($N_1$:0 kg N ha$^{-1}$, $N_2$:50 kg N ha$^{-1}$, $N_3$: 75

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kg N $ha^{-1}$ and $D_4$: 100 N kg $ha^{-1}$). Total chlorophyll content (1.91 mg $g^{-1}$), moisture content (88.51 %), ash content (7.37 %) and iron content (4.56 ppm) in plant from the 2nd cutting were recorded higher in 1st fortnight of January sowing ($D_1$).
Among the nitrogen doses, ascorbic acid (71.07 mg 100 $g^{-1}$), total chlorophyll content (2.18 mg $g^{-1}$), moisture content (89.22 %) and ash content (8.65 %) were obtained higher with application of nitrogen @ 100 kg $ha^{-1}$ ($N_4$). The iron, nitrogen and potassium content (4.71 ppm, 1.83% and 2.67 %, respectively) in plant and nitrogen (231.18 kg $ha^{-1}$) in soil were higher under nitrogen at 100 kg $ha^{-1}$ ($N_4$).
Beet leaf sown at 1st fortnight of January with 100 kg N $ha^{-1}$ ($D_1N_4$) had given the best performance in the quality parameter *i.e*. total chlorophyll content (2.30 mg $g^{-1}$).

*Keywords: Sowing date; nitrogen; beet leaf; total chlorophyll; fortnight.*

## 1. INTRODUCTION

"Beet leaf (*Beta vulgaris* var. *bengalensis*) is one of the most important leafy vegetable crops, which are consumed all over the world. It is commonly known as palak. It belongs to the genus *Beta*, species *vulgaris* and family *Amaranthaceae* It is believed that beet leaf originated from Indo-China region. Beet leaf has Chromosome number 2*n*=2*x*=18. In India, major palak producing states are Andhra Pradesh, Telangana, Tamil Nadu, Kerala, Karnataka, U.P., West Bengal, Maharashtra and Gujarat. The edible part of beet leaf consists of leaves and stalk. It is cultivated for its fresh green leaves, which becomes ready for harvest (cutting) in about 30 to 35 days from sowing" [1].

It is very popular due to its high nutritive value. It is rich in minerals and hence called as "Mines of Minerals" and cheap source of fat 0.8 g, fibre 0.7 g, protein 3.4 g, minerals 2.2 g, carbohydrates 6.6 g, phosphorus 30 mg, riboflavin 0.56 mg, calcium 380 mg, thiamine 0.26 mg, vitamin 'A' (5862 I.U.), vitamin "C' 70 mg, vitamin "K' 167 mg, magnesium 24 mg. "Which are important components of cell and body fluids to control heart and blood pressure, antioxidant enzyme, superoxide dismutase, for production of red blood cell, sperm generation, digestion and nucleic acid synthesis", [2]. It is also known as Indian spinach, Spinach beet, Beet leaf.

Beet leaf is more valued among all leafy vegetables due to better returns in shortest span of life. Also grow throughout the year so; many cultivators are attracted towards palak cultivation. Now a day's requirement of quality of leaf is rising. The growth, yield and quality of palak leaf in a particular area depend upon genetic constitution of cultivar.

"Nitrogen supply of such a leafy vegetable crop, takes the superiority as a result of the relatively higher demand from this element; since, it plays an essential role in overall metabolism of plant enzymes activity, building up protoplasm, amino acids and proteins, which induce cell division and initiate meristematic activity. Therefore, to meet the nitrogen demand of beet leaf plants using large quantities of nitrogen fertilizer in mineral form still being practiced by growers" [1].

## 2. MATERIALS AND METHODS

A field experiment entitled "Effect of sowing date and nitrogen on quality of beet leaf (*Beta vulgaris* var. *bengalensis*)" was conducted at Vegetable Research Farm, Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. India during *kharif*, 2020 on var. "Pusa Harit to assess the effect of sowing date, nitrogen and their interaction on quality. The experiment was conducted in Split Plot Design (SPD) with five replications. The experiment was arranged with twelve treatment combinations comprising of 3 levels of sowing date ($D_1$: 1st Fort night of January, $D_2$: 2nd Fortnight of January, and $D_3$: 1st Fortnight of February) and four nitrogen doses ($N_1$:0 kg N $ha^{-1}$, $N_2$: 50 kg N $ha^{-1}$, $N_3$: 75 kg N $ha^{-1}$ and $D_4$: 100 N kg $ha^{-1}$)" [1].

"Five plants of beet leaf from each net plot area were selected randomly in the beginning and tagged with the labels for recording different field observations. Some of the observations for various traits were recorded during the growth period of crop and some were recorded after harvesting the crop". [1].

## 3. RESULTS AND DISCUSSION

### 3.1 Quality Parameters from Second Cuttings

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

Higher ascorbic acid (71.07 mg 100 $g^{-1}$) was recorded (Table 1) in the treatment $N_4$ (100 kg N $ha^{-1}$). This might be due to high nitrogen and nitrogen is constituent of fat, proteins, amino acid, enzymes and chlorophyll II and main stimulative agent for enzymatic activity. It increased enzymatic activity which resulted might have increased ascorbic acid. Similar findings were also reported by Bhore [3] and Singh et al. [4] in beet leaf.

#### 3.1.2 Total chlorophyll content (mg $g^{-1}$)

Total chlorophyll content (1.91 mg $g^{-1}$) was recorded (Table 1) significantly higher in 1st Fortnight of January ($D_1$) sowing than the other sowing dates. The data obtained might be ascribed to the seasonal atmosphere conditions during growing season. These results are in conformity with Abed and Shebl [5] in beet leaf.

**Table 1. Effect of sowing date and nitrogen on quality of beet leaf**

| Treatment | Ascorbic Acid (mg 100 $g^{-1}$) | Total Chlorophyll Content (mg $g^{-1}$) | Moisture Content (%) | Ash Content (%) |
|---|---|---|---|---|
| **Sowing date** | | | | |
| 1st Fortnight of January ($D_1$) | 69.89 | 1.91 | 88.51 | 7.37 |
| 2nd Fortnight of January ($D_2$) | 69.59 | 1.83 | 87.58 | 6.99 |
| 1st Fortnight of February ($D_3$) | 69.20 | 1.76 | 86.47 | 6.63 |
| S.Em.± | 0.78 | 0.02 | 0.48 | 0.06 |
| C.D. at 5 % | NS | 0.06 | 1.57 | 0.20 |
| **Dose of nitrogen (kg $ha^{-1}$)** | | | | |
| 0 kg $ha^{-1}$ ($N_1$) | 68.09 | 1.50 | 85.89 | 5.42 |
| 50 kg $ha^{-1}$ ($N_2$) | 69.13 | 1.73 | 87.01 | 6.52 |
| 75 kg $ha^{-1}$ ($N_3$) | 69.94 | 1.92 | 87.95 | 7.40 |
| 100 kg $ha^{-1}$ ($N_4$) | 71.07 | 2.18 | 89.22 | 8.65 |
| S.Em.± | 0.68 | 0.01 | 0.67 | 0.06 |
| C.D. at 5 % | 1.96 | 0.04 | 1.94 | 0.18 |
| D x N | | | | |
| S.Em.± | 1.18 | 0.03 | 1.17 | 0.11 |
| C.D. at 5 % | NS | 0.07 | NS | NS |
| **Mean of D x N** | | | | |
| $D_1N_1$ | 68.33 | 1.56 | 86.76 | 5.70 |
| $D_1N_2$ | 69.47 | 1.80 | 87.95 | 6.85 |
| $D_1N_3$ | 70.15 | 1.97 | 88.92 | 7.74 |
| $D_1N_4$ | 71.60 | 2.30 | 90.39 | 9.20 |
| $D_2N_1$ | 68.22 | 1.53 | 86.05 | 5.54 |
| $D_2N_2$ | 69.13 | 1.72 | 87.08 | 6.50 |
| $D_2N_3$ | 69.95 | 1.90 | 88.06 | 7.36 |
| $D_2N_4$ | 71.06 | 2.18 | 89.14 | 8.56 |
| $D_3N_1$ | 67.72 | 1.41 | 84.86 | 5.00 |
| $D_3N_2$ | 68.78 | 1.67 | 85.10 | 6.21 |
| $D_3N_3$ | 69.73 | 1.88 | 86.90 | 7.10 |
| $D_3N_4$ | 70.55 | 2.05 | 88.13 | 8.19 |
| S.Em.± (D x N) | 1.18 | 0.03 | 1.17 | 0.11 |
| C.D. at 5 % (D x N) | NS | 0.07 | NS | NS |
| C.V. % | - | 3.13 | - | - |

**Table 2. Effect of sowing date and nitrogen on quality of beet leaf**

| Treatment | Iron Content (ppm) | Nitrogen Content (%) | Phosphorus Content (%) | Potassium Content (%) | Soil analysis (After experiment) |
|---|---|---|---|---|---|
| **Sowing date** | | | | | **Nitrogen (kg ha$^{-1}$)** |
| 1st Fortnight of January ($D_1$) | 4.56 | 1.72 | 0.32 | 2.37 | 220.33 |
| 2nd Fortnight of January ($D_2$) | 4.48 | 1.73 | 0.29 | 2.32 | 217.90 |
| 1st Fortnight of February ($D_3$) | 4.40 | 1.61 | 0.31 | 2.31 | 214.45 |
| S.Em.± | 0.04 | 0.03 | 0.01 | 0.04 | 5.69 |
| C.D. at 5 % | 0.13 | NS | NS | NS | NS |
| **Dose of nitrogen (kg ha$^{-1}$)** | | | | | |
| 0 kg ha$^{-1}$ ($N_1$) | 4.27 | 1.46 | 0.26 | 1.90 | 204.65 |
| 50 kg ha$^{-1}$ ($N_2$) | 4.41 | 1.69 | 0.28 | 2.19 | 213.39 |
| 75 kg ha$^{-1}$ ($N_3$) | 4.54 | 1.77 | 0.35 | 2.57 | 221.03 |
| 100 kg ha$^{-1}$ ($N_4$) | 4.71 | 1.83 | 0.34 | 2.67 | 231.18 |
| S.Em.± | 0.04 | 0.03 | 0.02 | 0.04 | 4.55 |
| C.D. at 5 % | 0.12 | 0.09 | 0.04 | 0.11 | 13.07 |
| D x N | | | | | |
| S.Em.± | 0.07 | 0.06 | 0.03 | 0.07 | 7.89 |
| C.D. at 5 % | NS | NS | NS | NS | NS |
| **Mean of D x N** | | | | | |
| $D_1N_1$ | 4.33 | 1.45 | 0.25 | 1.92 | 207.09 |
| $D_1N_2$ | 4.49 | 1.74 | 0.30 | 2.21 | 216.12 |
| $D_1N_3$ | 4.61 | 1.74 | 0.37 | 2.58 | 222.73 |
| $D_1N_4$ | 4.82 | 1.95 | 0.34 | 2.74 | 235.40 |
| $D_2N_1$ | 4.28 | 1.50 | 0.24 | 1.87 | 205.47 |
| $D_2N_2$ | 4.41 | 1.70 | 0.26 | 2.23 | 213.50 |
| $D_2N_3$ | 4.54 | 1.81 | 0.36 | 2.64 | 221.90 |
| $D_2N_4$ | 4.71 | 1.90 | 0.30 | 2.52 | 230.75 |
| $D_3N_1$ | 4.18 | 1.43 | 0.28 | 1.89 | 201.40 |
| $D_3N_2$ | 4.33 | 1.63 | 0.26 | 2.13 | 210.55 |
| $D_3N_3$ | 4.46 | 1.75 | 0.32 | 2.50 | 218.46 |
| $D_3N_4$ | 4.61 | 1.63 | 0.38 | 2.73 | 227.39 |
| S.Em.± (D x N) | 0.07 | 0.06 | 0.03 | 0.07 | 7.89 |
| C.D. at 5 % (D x N) | NS | NS | NS | NS | NS |

Maximum total chlorophyll content (2.18 mg g$^{-1}$) was recorded (Table 1) significantly with application of nitrogen @ 100 kg ha$^{-1}$ ($N_4$) as compare to other nitrogen doses. This might be due to increased nitrogen supply which would retard leaf senescence and improve photosynthesis. Similar results were noticed by Anupama et al. [6] in Fenugreek.

The interaction effect of sowing date and nitrogen was significant on total chlorophyll content (%). Higher total chlorophyll content (2.30 mg g$^{-1}$) was recorded (Table 1) in the treatment $D_1N_4$ (1st Fortnight of January and 100 kg N ha$^{-1}$). This might be due suitable climatic condition, short day length and less light intensity during shoot growth and due to increased nitrogen supply which would retard leaf senescence and improve photosynthesis.

### 3.1.3 Moisture content (%)

Higher moisture content (88.51 %) was noted (Table 1) with treatment $D_1$ (1st Fortnight of January). Maximum moisture content in early dates may be probable due to suitable climatic condition, short day length, low intensity of light which favored for developing succulence and tenderness in earlier sowing dates. Similar result was also found by Bhore [3] in beet leaf and Goswami [7] in vegetable amaranthus.

**Table 3. Mean weekly meteorological parameters recorded during the period of experimentation**

| Months | Standard weeks | Temperature (°C) | | Relative humidity (%) | | Wind velocity (km $hr^{-1}$) | Sunshine hours | Rainfall (mm) | No. of rainy days |
|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Morn. | Even. | | | | |
| January | 1 | 28.0 | 11.6 | 88.1 | 61.4 | 1.6 | 6.8 | 0.0 | 0.0 |
| | 2 | 29.8 | 14.2 | 80.2 | 52.5 | 2.2 | 7.1 | 0.0 | 0.0 |
| | 3 | 27.5 | 8.4 | 86.7 | 53.8 | 1.6 | 8.0 | 0.0 | 0.0 |
| | 4 | 31.5 | 13.4 | 89.0 | 53.2 | 1.0 | 7.5 | 0.0 | 0.0 |
| February | 5 | 28.8 | 11.8 | 89.8 | 47.4 | 1.6 | 8.3 | 0.0 | 0.0 |
| | 6 | 30.1 | 13.4 | 82.2 | 39.9 | 2.2 | 9.2 | 0.0 | 0.0 |
| | 7 | 32.9 | 18.6 | 79.6 | 39.4 | 0.8 | 7.5 | 0.0 | 0.0 |
| | 8 | 34.4 | 15.0 | 90.2 | 41.1 | 0.6 | 8.7 | 0.0 | 0.0 |
| | 9 | 34.0 | 16.2 | 79.1 | 41.8 | 0.7 | 9.6 | 0.0 | 0.0 |
| March | 10 | 30.7 | 17.0 | 91.0 | 51.4 | 3.1 | 8.4 | 0.0 | 0.0 |
| | 11 | 31.6 | 16.1 | 85.4 | 43.2 | 4.0 | 8.8 | 0.0 | 0.0 |
| | 12 | 34.9 | 19.5 | 88.9 | 52.2 | 2.6 | 8.9 | 0.0 | 0.0 |
| April | 13 | 36.7 | 20.5 | 89.8 | 46.6 | 2.7 | 7.8 | 0.0 | 0.0 |
| | 14 | 36.5 | 20.9 | 95.6 | 53.8 | 2.6 | 9.2 | 0.0 | 0.0 |
| | 15 | 36.7 | 22.3 | 91.9 | 50.9 | 3.4 | 9.3 | 0.0 | 0.0 |
| | 16 | 38.0 | 24.1 | 89.7 | 53.7 | 3.0 | 9.5 | 0.0 | 0.0 |

Regarding the dose of nitrogen, more moisture content (89.22 %) was recorded (Table 1) with treatment $N_4$ (100 kg N $ha^{-1}$) as compare to other nitrogen doses. Moisture percentage was increased probably due active participation in nitrogen in protoplasmic activity which has developed succulence and tenderness in leaves of beet leaf. Similar result was found by Singh et al. [4] in beet leaf.

### 3.1.4 Ash content (%)

Ash content (7.37 %) was recorded (Table 1) higher in 1st Fortnight of January ($D_1$) sowing.

Higher ash content (8.65 %) was observed (Table 1) in the treatment $N_4$ (100 kg N $ha^{-1}$). This might be due to increased nitrogen supply which would retard leaf senescence and improve photosynthesis.

## 3.2 Nutrient Content in Plant

### 3.2.1 Iron content (ppm)

Iron content (4.56 ppm) was noted (Table 2) with 1st Fortnight of January ($D_1$) sowing. The data of quality might be ascribed that seasonal environmental conditions during growing period such as temperature, relative humidity, day length and light intensity are favorable conditions available during the growing period when sown earlier than the later sowing. Similar result was also found by Goswami [7] in vegetable amaranthus.

An application of N at 100 kg $ha^{-1}$ had noted (Table 2) higher iron content (4.71 ppm) than other nitrogen levels. The obtained data of quality might be ascribed that higher dose of nitrogen increased availability of nitrogen further nitrogen being an essential constituent of protein. These results corroborated the findings of Goswami [8] in vegetable amaranthus.

### 3.2.2 Nitrogen content (%)

Nitrogen content (1.83 %) in plant was noted (Table 2) higher with application of nitrogen @ 100 kg $ha^{-1}$. This might be due to the application of nitrogen fertilizer increase in nitrogen uptake by plant which resulted in higher nitrogen content in plant and also better development of crop. The present findings are on the lines of the findings of Sajirani et al. [9] in spinach, Sakr and Husein [10] and Goswami [8] in vegetable Amaranthus [11-13].

### 3.2.3 Phosphorus content (%)

More phosphorus content (0.35 %) in plant was noted (Table 2) with treatment $N_3$ (75 kg N $ha^{-1}$). whereas, the less phosphorus content (0.26 %) in plant was recorded with treatment $N_1$ (0 kg N $ha^{-1}$).

### 3.2.4 Potassium content (%)

Higher potassium content (2.67%) in plant was noted (Table 2) with treatment $N_4$ (100 kg N $ha^{-1}$). whereas, lower potassium content (1.90 %) was recorded with no nitrogen application.

## 3.3 Soil Analysis (After Experiment)

### 3.3.1 Nitrogen (kg $ha^{-1}$)

Higher nitrogen (231.18 kg $ha^{-1}$) was noted (Table 2) with treatment $N_4$ (100 kg N $ha^{-1}$) which was statistically at par with $N_3$ (75 kg N $ha^{-1}$). whereas, lower nitrogen (204.65 kg $ha^{-1}$) was recorded with no nitrogen application.

## 4. CONCLUSION

From the result of investigation, it could be concluded that sowing of beet leaf at 1st fortnight of January was superior on quality over rest of sowing date. Application of nitrogen at 100 kg $ha^{-1}$ was superior in terms of quality and nutrient content in plant. Sowing of beet leaf at 1st fortnight of January with application of nitrogen at 100 kg $ha^{-1}$ had given best results on quality parameter like total chlorophyll content.

## CONFERENCE DISCLAIMER

Some part of this manuscript was previously presented in the conference: 6th International Conference on Strategies and Challenges in Agricultural and Life Science for Food Security and Sustainable Environment (SCALFE-2023) on April 28-30, 2023 in Himachal Pradesh University, Summer Hill, Shimla, HP, India. Web Link of the proceeding: https://www.shobhituniversity.ac.in/pdf/Souvenir-Abstract%20Book-Shimla-HPU-SCALFE-2023.pdf

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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