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JM Ganvit
Ph.D. Scholar, Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

VK Parmar
Professor and Head Department of Fruit Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

NK Patel
Assistant Professor, Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

MK Gamit
Ph.D. Scholar, Department of Agronomy, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India

Corresponding Author:
JM Ganvit
Ph.D. Scholar, Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

Effect of sowing date and nitrogen on growth and yield of beet leaf (*Beta vulgaris* var. *bengalensis*)

JM Ganvit, VK Parmar, NK Patel and MK Gamit

Abstract
The experiment entitled “Effect of sowing date and nitrogen on growth and yield of beet leaf (*Beta vulgaris* var. *bengalensis*)” was conducted during summer, 2020 at Vegetable Research Farm, RHRS, ASPEE College of Horticulture, 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 kg N ha^{-1} and D_4: 100 N kg ha^{-1}). Plant height (7.40 cm and 37.14 cm, respectively) at 20 DAS and 40 DAS, number of leaves per plant (5.74 and 12.20, respectively) at 20 DAS and 40 DAS, leaf area (122.54 cm^2) and green leaf yield (8.47 kg plot^{-1} and 14.70 t ha^{-1}) in plant from the 2nd cutting were recorded higher in 1st fortnight of January sowing (D_1).
Among the nitrogen doses, plant height at 20 and 40 DAS (8.69 cm and 40.12 cm, respectively), number of leaves per plant at 20 and 40 DAS (6.65 and 13.56), length of leaf (19.76 cm), leaf width (9.32 cm), length of petiole (7.89cm), leaf area (140.23 cm^2), number of cuttings (3.73) and green leaf yield (10.25 kg plot^{-1} and 17.79 t ha^{-1} were obtained higher with application of nitrogen @ 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 yield parameter *i.e.* green leaf yield (10.66 kg plot^{-1} and 18.51 t ha^{-1}). The higher net return of ₹ 1,27,671 ha^{-1} was obtained with D_1N_4 (1st fortnight of January and 100 kg N ha^{-1}).

Keywords: Beet leaf, date of sowing, nitrogen, yield

Introduction

Beet leaf (*Beta vulgaris* var. *bengalensis*) is commonly known as palak. It is one of the most important leafy vegetable crops in the world due to its high nutritive value and better returns in shortest span of life. 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. (Sumati Narayan *et al.* 2018) [41].

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.

It is also known as Indian spinach, Spinach beet, Beet leaf. It belongs to the genus *Beta*, species *vulgaris* and family *Amaranthaceae.* It is believed that beet leaf originated from Indo-Chinaregion. Beet leaf has Chromosome number $2n=2x=18$. In India, major palak producing states are Andhra Pradesh, Kerala, Tamil Nadu, Karnataka, Telangana, 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.

In spite of the importance of this vegetable, attention has been paid to evolve suitable package of practice for remunerative cultivation among the improved agro techniques, use of fertilizers, sowing time, number of leaf cuttings and spacing also affects leaf yield potentiality. Temperature plays a major role in germination, vegetative growth, flowering and fruiting, so the appropriate sowing time is to be ascertained to get higher leaf. Leaf yield can be increased by sowing at proper dates taking adequate number of leaf cutting.

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.

Materials and Methods

A field experiment entitled "Effect of sowing date and nitrogen on growth and yield of beet leaf (*Beta vulgaris* var. *bengalensis*)" was conducted at Vegetable Research Farm, Regional Horticultural Research Station, ASPEE College of Horticulture, Navsari Agricultural University, Navsari. India during Summer, 2020 on var. Pusa Harit to assess the effect of sowing date, nitrogen and their interaction on growth, yield and 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 (D1: 1st Fortnight 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}).

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 while, some were recorded after harvesting the crop.

Results and Discussion

Growth parameters

Plant height

The higher plant height (7.40 cm) and (37.14 cm) at 20 DAS and 40 DAS, respectively (Table 1) ware noted in 1st Fortnight of January (D_1). This might be due to favorable climatic conditions and short day available from germination to full vegetative growth. Similar results were also reported by Bhore (2000) [9f], Ibrahim *et al.* (2010) [18] and Abed and Shebl (2016) [1] in beet leaf.

Table 1: Effect of sowing date and nitrogen on growth of beet leaf

Treatment	Plant height (cm)		Number of leaves per plant		Length of leaf (cm)	Width of leaf (cm)	Length of petiole (cm)	Leaf area (cm^2)
Sowing date	**20 DAS**	**40 DAS**	**20 DAS**	**40 DAS**				
1st Fortnight of January (D_1)	7.40	37.14	5.74	12.20	18.74	8.47	7.23	122.54
2nd Fortnight of January (D_2)	7.00	35.60	5.50	11.88	18.53	8.28	7.03	117.38
1st Fortnight of February (D_3)	6.62	33.82	5.21	11.46	18.24	7.99	6.90	112.20
S.Em.±	0.15	0.65	0.12	0.16	0.41	0.24	0.14	2.27
C.D. at 5%	0.49	2.12	0.41	0.52	NS	NS	NS	7.40
Dose of nitrogen (kg ha^{-1})								
0 kg ha^{-1} (N_1)	5.40	31.15	4.39	10.23	17.33	7.20	6.29	95.35
50 kg ha^{-1} (N_2)	6.44	34.14	5.09	11.36	18.12	7.92	6.75	110.68
75 kg ha^{-1} (N_3)	7.49	36.66	5.80	12.24	18.81	8.55	7.28	123.24
100 kg ha^{-1} (N_4)	8.69	40.12	6.65	13.56	19.76	9.32	7.89	140.23
S.Em.±	0.16	0.98	0.13	0.30	0.37	0.19	0.15	2.01
C.D. at 5%	0.46	2.80	0.37	0.80	1.06	0.55	0.44	5.78
Mean of D x N								
D_1N_1	5.72	32.42	4.52	10.52	17.60	7.40	6.40	99.20
D_1N_2	6.80	35.72	5.36	11.72	18.28	8.08	6.92	115.20
D_1N_3	7.84	38.11	6.04	12.52	19.04	8.80	7.44	128.16
D_1N_4	9.24	42.30	7.04	14.04	20.04	9.60	8.16	147.60
D_2N_1	5.48	31.45	4.48	10.36	17.36	7.24	6.32	97.00
D_2N_2	6.44	34.21	5.08	11.32	18.12	7.96	6.72	110.44
D_2N_3	7.44	36.85	5.80	12.24	18.80	8.56	7.24	122.48
D_2N_4	8.64	39.88	6.64	13.60	19.84	9.36	7.84	139.60
D_3N_1	5.00	29.57	4.16	9.80	17.04	6.96	6.16	89.84
D_3N_2	6.08	32.48	4.84	11.04	17.92	7.72	6.60	106.40
D_3N_3	7.20	35.02	5.56	11.96	18.60	8.28	7.16	119.08
D_3N_4	8.20	38.20	6.28	13.04	19.40	9.00	7.68	133.48
S.Em.± (D x N)	0.28	1.69	0.22	0.51	0.64	0.33	0.27	3.49
C.D. at 5% (D x N)	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of sowing date and nitrogen on yield of beet leaf

Treatment	Number of Cuttings	Green Leaf Yield (kg plot^{-1})	Green Leaf Yield (t ha^{-1})
Sowing date			
1st Fortnight of January (D_1)	3.65	8.47	14.70
2nd Fortnight of January (D_2)	3.65	7.87	13.66
1st Fortnight of February (D_3)	3.35	7.19	12.47
S.Em.±	0.13	0.18	0.31
C.D. at 5%	NS	0.58	1.01
Dose of nitrogen (kg ha^{-1})			
0 kg ha^{-1} (N_1)	3.27	5.56	9.64
50 kg ha^{-1} (N_2)	3.53	7.28	12.63

75 kg ha^{-1} (N_3)	3.67	8.28	14.37
100 kg ha^{-1} (N_4)	3.73	10.25	17.79
S.Em.±	0.12	0.15	0.26
C.D. at 5%	0.34	0.43	0.75
D x N			
S.Em.±	0.20	0.26	0.45
C.D. at 5%	NS	0.75	1.30
Mean of D x N			
D_1N_1	3.40	5.70	9.89
D_1N_2	3.60	8.53	14.82
D_1N_3	4.00	8.96	15.56
D_1N_4	3.60	10.66	18.51
D_2N_1	3.20	5.86	10.18
D_2N_2	3.60	6.72	11.67
D_2N_3	3.80	8.57	14.88
D_2N_4	4.00	10.31	17.91
D_3N_1	3.20	5.10	8.86
D_3N_2	3.40	6.57	11.41
D_3N_3	3.20	7.30	12.68
D_3N_4	3.60	9.76	16.95
S.Em.± (D x N)	0.20	0.26	0.45
C.D. at 5% (D x N)	NS	0.75	1.30
C.V.%	-	7.45	7.45

In respect of dose of nitrogen the significantly maximum plant height at 20 DAS (8.69 cm) and 40 DAS (40.12 cm) was noted (Table 1) with 100 nitrogen kg ha^{-1} (N_4). This might be due to good response of crop to nitrogen applied, help in stimulating the cell division and cell elongation. Nitrogen is a constituent of chlorophyll, nucleic acids, proteins, amino acids, enzymes and alkaloids which increased the metabolic activities and ultimately increased the plant height. Varying responses in respect of plant height with nitrogen fertilizer have also been reported by Singh *et al.* (2015) [38], Wahocho *et al.* (2015) [4], Ali *et al.* (2016) [3] and Pallavi *et al.* (2019) [30] in palak.

Number of leaves per plant

The maximum number of leaves per plant (5.74 and 12.20) at 20 DAS and 40 DAS, respectively (Table 1) ware recorded in 1st Fortnight of January (D_1). These results may be due to the favorable climatic condition from germination to full vegetative growth which enhanced stem elongation of plants that is characterized with higher number of leaves per plant. Similar results were stated by Mirdad (2009) [26], Singh *et al.* (2015) [38], Ali *et al.* (2016) [3] and Pallavi *et al.* (2019) [30].

Nitrogen applied @ 100 kg ha^{-1} had noted more number of leaves (6.65 and 13.56) at 20 DAS and 40 DAS, respectively. This might be due to good response of crop to nitrogen applied. Nitrogen is a constituent of chlorophyll, nucleic acids, proteins, amino acids, enzymes and alkaloids which increased the metabolic activities and ultimately increased the number of leaves. This findings are closely related with the results of Mirdad (2009) [26], Singh *et al.* (2015) [38], Wahocho *et al.* (2015) [4], Ali *et al.* (2016) [3] and Pallavi *et al.* (2019) [30] in beet leaf.

Width of leaf at 2nd cutting

The significant results of nitrogen levels was found on width of leaves at 2nd cutting (Table 1). Maximum width of leaves (9.32 cm) was noted in the treatment N_4 (N at 100 kg ha^{-1}). This might be due to nitrogen induce leaf production and expansion in plant which is directly correlated with leaf width. These results are in close conformity with the findings by Bhore (2000) [9] and Pallavi *et al.* (2019) [30] in beet leaf.

Length of petiole at 2nd cutting

The length of petiole at 2nd cutting was significantly influenced by nitrogen (Table 1). More length of petiole (7.89 cm) was noted with the application nitrogen at 100 kg ha^{-1} (N_4). This might be due to low soil content of nitrogen which was mainly constituent of chlorophyll and protoplasm, affected on photosynthesis for developing low food material and thus less supply of food material to petiole, ultimately results on length of petiole. The results were supported by the findings of Bhore (2000) [9] in beet leaf.

Leaf area at 2nd cutting

The maximum leaf area (122.54 cm^2) was recorded (Table 1) in 1st Fortnight of January (D_1). Promoting effect of early planting may be attributed to the favorable air temperature, day length and light intensity prevailing during growth season, which favours for beet leaf to increased metabolic activity, developing succulence in leaves, increase in length and width of leaves and number of leaves which ultimately increased the leaf area. These findings were reinforced with Abed and Shebl (2016) [1] in beet leaf, Goswami (2018) [16] in vegetable amaranthus and Anitha *et al.* (2016) [4] in fenugreek.

In respect of dose of nitrogen the significantly maximumleaf area (140.23 cm^2) was noted (Table 1) in treatment which received nitrogen @ 100 kg ha^{-1}. As nitrogen increased, cation exchange capacity of the roots was also increased and made plant more efficient in absorbing other nutrients, which were helpful for increase in length and width of leaves by different metabolic activity and resulted in increase in leaf area. Similar results were obtained by Singh *et al.* (2015) [38] in beet leaf.

Yield parameters

Number of cuttings

Maximum number of cuttings (3.73) was observed in (Table 2) the treatment N_4 (100 kg ha^{-1}). The nitrogen play a role of stimulant in metabolic activity which probably increased the length of leaves, width of leaves, leaf area, number of leaves and length of petiole with tenderness of leaves which finally lead to increased yield and number of cuttings. These results are in close confirmative with the findings of Goswami (2019) [15] in vegetable amaranthus.

Green leaf yield (kg plot^{-1})

The results showed that maximum green leaf yield (8.47 kg plot^{-1}) was recorded (Table 2) in 1st Fortnight of January (D_1). This is because of appropriate temperature and short day length which helped for vigorous plant growth. Similar results were obtained by Bhore (2000) [9], Waseem *et al.* (2000) [48] in beet leaf and Goswami (2018) [16] in vegetable amaranthus.

As the nitrogen increased, yield of green leaves of beet leaves also significantly increased. Maximum green leaf yield (10.25 kg plot^{-1}) was obtained (Table 2) in the treatment N_4 (100 kg N ha^{-1}). The nitrogen being the major constituent of cell, helps in progressive initiation of tissue and expansion of cells, which was resulted ultimately reflected into better development in terms of yield. It could also be concluded element of protein, nucleic acids, chlorophyll and growth hormones.

The interaction effect of sowing date and nitrogen was significant on green leaf yield (kg plot^{-1}). The maximum green leaf yield (10.66 kg plot^{-1}) was recorded (Table 2) in the treatment D_1N_4 (1st Fortnight of January and nitrogen @ 100 kg ha^{-1}).

Green leaf yield (t ha^{-1})

The green leaf yield (14.70 t ha^{-1}) was recorded (Table 2) higher in 1st Fortnight of January (D_1). This is because of appropriate temperature and short day length which helped for vigorous plant growth, such condition were available to the crop sown at 1st fortnight of January which resulted in more vegetative growth expressed in terms length of leaves, width of leaves, number of leaves, length of petiole and leaf area which have ultimately increased the green leaf yield. Similar results obtained by Bhore (2000) [9], Waseem *et al.* (2000) [48], Naik *et al*. (2009) [29], Ibrahim *et al.* (2010) [18], Singh *et al.* (2013) [39] and Darani *et al.* (2013) [11] in beet leaf and Goswami (2018) in vegetable amaranthus.

In regarding to dose of nitrogen maximum green leaf yield (17.79 t ha^{-1}) was obtained (Table 2) with nitrogen @ 100 kg ha^{-1} (N_4). This might be due to the nitrogen being the major constituent of cell, helps in progressive initiation of tissue and expansion of cells, which was resulted ultimately reflected into better development in terms of yield. It could also be concluded element of protein, nucleic acids, chlorophyll and growth hormones and is essential in periods of rapid growth. Adequate supply of nitrogen (N) can promote plant growth and increase crop production. These results are in conformity with the finding of Sajirani *et al.* (2012) [34], Singh *et al*. (2015) [38], Wahocho *et al.* (2015) [4] and Ali *et al*. (2016) [3] in beet leaf and Goswami (2019) [15] in vegetable amaranthus.

The interaction effect of sowing date and nitrogen was significant on green leaf yield (t ha^{-1}). Higher green leaf yield (18.51 t ha^{-1}) was noted (Table 2) in the treatment D_1N_4 (1st Fortnight of January and nitrogen @ 100 kg ha^{-1}).

Economics

The data related to economics of crop as influenced by sowing date and nitrogen are furnished in Table 3. Table indicate that the higher net return of ₹ 1,27,671 ha^{-1} with BCR value of 2.22:1 was obtained in treatment D_1N_4 (1st fortnight of January and 100 kg N ha^{-1}).

Table 3: Economics of different treatments (₹ ha^{-1})

Treatment	Green leaf yield (t ha^{-1})	Fixed cost (₹)	Variable cost (₹)	Total cost (₹)	Gross realization (₹)	Net Realization (₹)	BCR
D_1N_1	9.89	54,501	0	54,501	98900	44,399	0.81
D_1N_2	14.82	54,501	2268	56,769	148200	91,431	1.61
D_1N_3	15.56	54,501	2598	57,099	155600	98,501	1.73
D_1N_4	18.51	54,501	2928	57,429	185100	1,27,671	2.22
D_2N_1	10.18	54,501	0	54,501	101800	47,299	0.87
D_2N_2	11.67	54,501	2268	56,769	116700	59,931	1.06
D_2N_3	14.88	54,501	2598	57,099	148800	91,701	1.61
D_2N_4	17.91	54,501	2928	57,429	179100	1,21,671	2.12
D_3N_1	8.86	54,501	0	54,501	88600	34,099	0.63
D_3N_2	11.41	54,501	2268	56,769	114100	57,331	1.01
D_3N_3	12.67	54,501	2598	57,099	126700	69,601	1.22
D_3N_4	16.95	54,501	2928	57,429	169500	1,12,071	1.95

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