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Influence of sowing time on the performance of Palak (*Beta vulgaris var bengalensis*) under the foot hills of Arunachal Pradesh

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Abstract
The present study was conducted at Vegetable Research Farm, College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh. The experiment was conducted on the palak variety All Green with different date of sowings (1.10 2021, 15.10 2021 and 30.10 2021) with various cuttings (C_0, C_1, C_2 and C_3). The highest plant height of 24.55 cm was observed on D1 while the more number of leaves (14.36) were recorded on D2. The highest leaf length (10.47cm) and the highest green leaf yield per hectare (232.74) were observed on D2. D3 had the highest leaf moisture content (96.99), the highest level of leaf chlorophyll (0.91) the highest total carotenoid content (0.84). The result showed that the plants sown on 15 October 2021 exhibited maximum yield for all most all the growth and yield parameters while plants sown on 30 October 2021 showed highest values for quality parameters. The results of this study revealed that palak crop was infested by *Fusarium* wilt and percent disease incidence is more on D1 and a least PDI was observed on D3.

Keywords: Date of sowing, disease incidence, leaf yield, palak

Introduction
Green leafy vegetables make up around one-third of India's 6000 cultivable plant species. Leafy vegetables are crucial to a healthy diet because of their richness in protein, vitamin C, beta carotene, vitamins from the B group, and minerals. Because they include essential nutrients for maintaining good health, vegetables are an essential part of a person's diet.

One of the leafy vegetable that is most frequently grown in India is spinach beet (*Beta vulgaris var. bengalensis* L.). One of the most significant green vegetables consumed nationwide is spinach beet, also known as palak, which has the chromosomal number 2n = 18 and is a member of the "Chenopodiaceae" family. Tropical and subtropical climates are recommended for growing it. Due to the fact that Bengal was where its leaves were initially employed, the name *Beta vulgaris var. bengalensis* was derived. Since Indian spinach was already popular in China in 647 A.D., it is most likely a native of Indo-Chinese regions (Nath, 1976) [12]. Palak leaves contain a wide range of therapeutic qualities. According to Jabeen *et al*. (2018) [6], palak leaves are a good source of natural antioxidants like flavanoids, polyphenol, vitamins, and folic acid. The leaves are used as a medicine for liver and spleen problems as well as to treat inflammation, paralysis, headaches, and earaches. Additionally, it aids in balancing the acidity created during the digestion of fatty foods and prevents constipation.

Ascorbic acid is present in large quantities in palak leaves. Since ascorbic acid is water soluble and readily absorbed by tissues, it has the ability to combat the harmful free radicals that are produced during metabolic processes. In other words, it is a good source of carotenoids, which function as powerful antioxidants to prevent eye damage and, as a result, keep older people from going blind. 100 g leaves contain 86.6% moisture, 3.4 g protein, 0.8 g fat, 6.6 g carbohydrate, 5862 IU vitamin A, 0.26 mg thiamine, 0.56 mg Riboflavin, 3.3 mg Niacin, 70 mg Ascorbic Acid, 380 mg Calcium, 30 mg phosphorus and 16 mg Iron (Narayan *et al.*, 2018) [6]. Vegetative growth, which includes leaf count, leaf size, and plant height, has an impact on the yield of Indian spinach beet. It quickly yields a large number of leaves throughout the brief rainy and moderate spring season. However, there hasn't been much work done into creating a suitable set of techniques for palak production. Temperature has an impact on germination, vegetative growth, flowering, and fruiting, thus choosing the proper time to plant can increase yields without incurring any additional costs.

Materials and method

The experiment was conducted in a factorial randomised block design with 12 treatment combinations at Vegetable Research Farm, College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh. The land was ploughed properly and the beds of 2m width and 2m length were prepared. The seeds of palak variety All Green were sown in lines. The treatment combinations of the present study were T_1 (D1C0 1st sowing on 1.10 2021 + zero cutting), T_2 (D1C1 1st sowing on 1.10 2021 + One cutting), T_3 (D1C2 1st sowing on 1.10 2021 + Two cutting), T_4 (D1C3 1st sowing on 1.10 2021 + Three cutting), T_5 (D2C0 2nd sowing on 15.10 2021 + Zero cutting),T_6 (D2C1 2nd sowing on 15.10 2021+ One cutting), T_7 (D2C2 2nd sowing on 15.10 2021+ Two cutting), T_8 (D2C3 2nd sowing on 15.10 2021+ Three cutting), T_9 (D3C0 3rd sowing on 30.10 2021+ Zero cutting), T_{10} (D3C1 3rd sowing on 30.10 2021+ One cutting), T_{11} (D3C2 3rd sowing on 30.10 2021+ Two cutting), T_{12} (D3C3 3rd sowing on 30.10 2021+ Three cutting). Thinning of the seedlings was done at 10 days after sowing (DAS). The observations recorded are plant height, number of branches, number of leaves, width of leaves, length of leaves, length of the petiole, leaf area, leaf area index, green leaf yield per plot, green leaf yield per hectare, leaf moisture content (%), ascorbic acid (mg/100g), total phenols (mg/100g), chlorophyll (mg/g), carotenoids (mg/100g) and disease severity. The prevalence of palak wilt was noted during the commencement of the disease. Jat *et al*. (2017) [7] provided the following formulas to calculate the percent disease incidence (PDI).

$$\text{Formula: PDI (\%)} = \frac{\text{No. of infected plants observed}}{\text{Total No. of plants observed}} \text{ x } 100$$

Results and Discussions

Growth and yield parameters

The mean plant height of the palak plant was significantly influenced by the planting dates. It was clear from measurements of plant height taken 90 days after sowing that the various treatments used in the current investigation had a considerable impact. Particularly, the highest plant height of 24.55 cm was recorded on the first day of sowing D1 (1st October 2021), followed by the lowest plant height of 20.41 cm on the third date of sowing D3 (30th October 2021). These findings were consistent with those of Waseem *et al*. (2001) [16], Rafat *et al*. (2017) [13], and Kaur *et al*. (2022) [8].

It was shown that the date of sowing had a substantial impact on the number of branches per plant at 90 DAS. The highest branches (7.19) were produced on the second planting date of D2 (15.10.21), and 5.96 on the first sowing date of D1 (01.10.21). 4.54 branches, formed in D3 on October 30th, were the fewest number ever recorded. This research supported the conclusions of Bhutia and Sharangi (2018) [2].

The sowing date was found to have a substantial impact on the number of leaves per plant. On D2 (15.10.2021), which was the second of the three planting days, the most leaves (14.36) were discovered, followed by 14.11 on D1 (01.10.21), which was the first sowing date. On the third sowing date (30.10.21), the bare minimum number of leaves was recorded (12.47). It was revealed that the planting date had a significant impact on leaf width as the crop grew. Measurements of leaf width varied according to sowing dates. D2 (6.23), which was statistically comparable to DI (6.13), had the widest leaves, whereas D3 (4.37) had the narrowest leaves. The length of the leaves was shown to be significantly influenced by different planting dates. When compared to earlier sowing dates, the highest leaf length at D2 was 10.47, which was followed, in that order, by 9.61 at D1. The shortest leaf length was 7.69 on the third date after sowing, or D3. The petiole length was found to be significantly influenced by different sowing dates. D2 had the petiole that was the longest, measuring 10.1, followed by D1 at 7.98. The shortest petiole measured 7.72 on D3. According to Imani MR (2013) [5], Kaur *et al*. (2022) [8] and Waseem *et al*. (2001) [16], these findings were in agreement.

The leaf area was significantly impacted by the various sowing date. In comparison to the other sowing dates, D2 had the plants with the maximum leaf area (37.33) and D3 had the lowest leaf area (20.61). Among the different sowing dates, the plants sown on D2 (0.81) had the highest leaf area index, which was followed by D1 (0.7). The lowest leaf area index (0.4) was recorded by plants that were planted on D3. These results agreed with those of Kaur *et al*. (2022) [8] and Bharad *et al*. (2013) [1]. According to the findings, sowing dates significantly impacted the quantity of green leaves produced on each plot. In comparison to the other sowing dates, the second sowing, D2, had the largest green leaf yield per plot (9.32), and the third (D3), the lowest (4.44). In terms of sowing dates, the second planting on D2 (232.74) produced the highest green leaf yield per hectare, whereas plants seeded on D3 (110.76) produced the lowest yield. The outcomes of this study were consistent with those of Waseem *et al*. (2001) [16], Dharmik (1996) [3] and Bharad *et al*. (2013) [1]. Optimal environmental conditions from germination to full vegetative growth may result in the maximum plant height. The increased number of leaves per plant, number of branches per plant, length of leaves, width of leaves, length of petioles, leaf area, and leaf area index may have been caused by the ideal temperature, which promoted rapid plant growth.

Quality parameters

D3 had the highest leaf moisture content, measuring 96.99, and D2 came in second with 95.44. The leaf moisture content for the first date sowing D1 was the lowest, coming in at 94.32. This outcome was consistent with that of Singh *et al*. (2015) [14]. The relationship between leaf area and moisture content is direct (Jabeen *et al*., 2018) [6]. It was discovered that there was a considerable effect of different sowing dates on the chlorophyll concentration of leaves. On the third sowing date (D3) (30.10.2021), the highest level of leaf chlorophyll (0.91) was discovered. This was followed by 0.66 on the second sowing date (D2) (15.10.21). The lowest value, 0.46, was noted for the first sowing date (01.10.21). Chlorophyll decreased with increasing temperature, which is what led to this (El-Gendy 2010) [4]. The concentration of ascorbic acid was significantly impacted by each of the distinct effects of the various sowing dates. The ascorbic acid content of the plants growing on D3 was the highest (108.45), whereas the ascorbic acid content of the plants sown on D1 was the lowest (101.24). It was shown that changing sowing dates had significant impacts on the overall phenol content. These findings concur with those of Jabeen *et al*. (2018) [6]. D3 (30.10.2021) contained the most total phenols (12.1), followed by D2 (15.10.2021) with 11.12. On the first sowing day (01.10.21), the lowest reading of 9.3 was recorded. Plants planted on D1 had the lowest total carotenoid content (0.36), whereas those planted on D3 had the highest total carotenoid content (0.84). The results obtained matched those of

Vethamoni and Thampi (2018), Bharad *et al*. (2013) [1], and Singh *et al*. (2015) [14].

Disease parameters

On the incidence of diseases, different sowing dates had a major impact. On plants sown on the first date of sowing (D1) highest percentage of disease incidence was reported (40.38), followed by 33.11 on the second date of sowing, D2. The disease prevalence was lowest, at a percentage of 22.95, on the third date of sowing D3. The findings of Kumawat *et al*. (2017) [9] and Jat *et al*. (2017) [7] were in agreement with these findings.

Crops planted earlier developed diseases more quickly than later-planted crops. It's possible that the warmer soil temperature contributed to the previous season's severe wilt disease. Since 25C was the pathogen's preferred temperature range for hyphal growth, the wilt disease was severe above that point (Naiki *et al*. 1983) [10].

Table 1: Effect of date of sowing on various parameters of palak

Sl. No.	Parameters	Mean of Sowing		
		D1	D2	D3
		Date: (01.10.21)	Date: (15.10.21)	Date: (30.10.21)
1	Plant height	24.55	21.95	20.41
2	Number of branches per plant	5.96	7.19	4.54
3	Number of leaves per plant	14.11	14.36	12.47
4	Width of leaves	6.13	6.23	4.37
5	Length of leaves	9.61	10.47	7.69
6	Length of petiole	7.98	10.1	7.72
7	Leaf area	34.85	37.33	20.61
8	Leaf area index	0.7	0.81	0.4
9	Green leaf yield per plot	7.81	9.32	4.44
10	Green leaf yield per hectare	195.51	232.74	110.76
11	Leaf moisture content	94.32	95.44	96.99
12	Leaf chlorophyll	0.46	0.66	0.91
13	Ascorbic acid	101.24	101.86	108.45
14	Total phenols	9.3	11.12	12.1
15	Total carotenoids	0.36	0.52	0.84
16	Percentage disease incidence	40.38	33.11	22.95

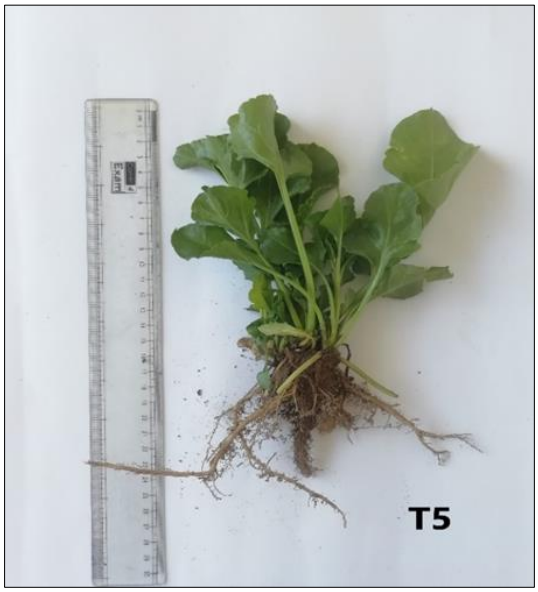

Fig 1: Treatment T_5 (D2C0 2nd sowing on 15.10 2021 + Zero cutting)

Conclusions

The results of the experiment show that the plants sown on October 15, 2021, outperformed other treatments in terms of growth indices, while those sowed on October 30, 2021, produced plants of higher quality and with lower disease incidence in palak variety All Green under the foothills of Arunachal Pradesh.

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