# Effect of sowing time on growth, yield and nutritional properties of cabbage Microgreens grown in soilless culture

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## ABSTRACT

*An experiment was conducted to assess the impact of sowing time (January, March, May, July, September and October) on different parameters of cabbage microgreens grown under artificial light and soilless media. The cabbage seeds were sown in HDPE tray consist of a combination of cocopeat, perlite and vermiculite in 3:1:1 ratio. Significant variation was noted for growth (seedling height, hypocotyl length, root length, cotyledon area, fresh weight and dry weight), yield and biochemical (moisture, chlorophyll a, chlorophyll b, total chlorophyll, total phenol, ascorbic acid, beta carotene, flavonoid, antioxidant capacity, acidity, total sugar and reducing sugar) parameters. Peak growth was noted during May and March. However, the highest yield (1325.899 g/m$^2$) was observed during January. Seed sown during November, September and January observed the maximum total chlorophyll content i.e. 0.955, 0.884 and 0.851 mg/g microgreen FW respectively. Biochemical parameters such as total phenol, ascorbic acid, DPPH Assay were recorded highest in May followed by March. Total sugar content was seen in greater amount during September, March and May than the rest months. The results revealed that growing of cabbage microgreens during summer months (March and May) performed better with respect to nutrition. But to achieve good production January is the best time for sowing.*

***Key words:*** Ascorbic acid, cabbage, DPPH, Microgreens, phenol, soilless, yield,

## INTRODUCTION

Microgreens are celebrated for their brilliant colour, delicate texture and high nutrient density. These are considered an essential component of health-conscious diets worldwide. These young greens are collected at cotyledon stage with the presence or absence of true leaves which have been considered to possess the higher amount of nutrients (vitamins, minerals and antioxidants) than their mature ones. They are considered as superfood due to the presence of several bioactive compounds, secondary metabolites and nutrients (Pratap *et al*., 2023). The unique combination of vibrant flavours, appealing aesthetics and high nutritional content has significantly increased consumer interest in microgreens.

Planting time is one of the considerable factors which influence the growth, yield and nutrient composition. Several climatic factors such as temperature, humidity, light availability etc. affect the growth and productivity of the microgreens (Samuoliene *et al*., 2019; Dubey *et al*., 2024; Abaajeh *et al*., 2023). The

growing of microgreens has been practiced in indoors as well as in controlled environment as they have short growing cycle (Budavari *et al*., 2024).The practice of growing indoors offers control of the environment. The peak nutritional development of microgreens is achieved at specific stage which is influenced by planting time as well as harvesting time (Ortiz *et al.*, 2024, Yanez Medelo *et al*., 2025).

Brassicaceae microgreens have been considered as an excellent source of various pigments, anthocyanin, flavonoid, vitamins, phenolic acid, isothiocyanates and glucosinolates (Marchioni *et al.,* 2021; Dereje *et al*., 2023). The presence of these phytochemicals has different biological activities which help to fight against severe human diseases. They act as anti-inflammatory, anti-diabetics, anti-cancer and antioxidant (Dereje *et al*., 2023). Presence of more complex polyphenols is observed in microgreens than their counter part in *Brassica* crops (Sun *et al*., 2013). This provides a gateway to explore cabbage, a *Brassica* crop, as microgreen.

The rapid increase of urbanization and shortage of agricultural land demands a challenge to feed the population. Microgreens being compact growth and short growing period are suitable for urban farming. This offers a sustainable way to provide high value crop with low minimal input. Given the increasing demand for microgreens and their potential to address urban farming challenges, it is crucial to understand the influence of sowing time on their growth, yield and nutritional quality. Therefore, the present study aims to evaluate the effect of sowing time on these parameters in cabbage microgreens.

## MATERIALS AND METHODS

The study was carried out in Horticulture Farm, Sriniketan. The room consists of several rakes which contains shelves with a dimension of 97 cm x 34 cm. To provide light, LEDs were used with a light intensity of 1900 lux ± in each shelf. To grow microgreens, HDPE trays of 1.5 ft x 2 ft having 5cm depth with drainage facilities were used. These trays were filled with soilless media which is a combination of three media *i.e.,* cocopeat: perlite: vermiculite in 3:1:1 ratio. To access the performance of microgreens, the seeds of cabbage were sown manually in six different months (first week) i.e. January, March, May, July, September and November. Complete randomized design was used with three replications. After sowing, the seeds were watered and covered with another tray for etiolation which enhances germination. After germination, the covered trays were removed and the germinated seeds were watered by the feel method depending upon the requirement. Microgreens were harvested when the two cotyledon leaves have fully emerged with a true leaf. Some morphological parameters (seedling height, hypocotyl length and cotyledon area) were collected before harvesting and some were noted after harvesting (root length, fresh weight of 10 seedlings and yield). After harvesting the microgreens were assessed for biochemical parameters. For proximate analysis moisture content (%) and dry weight (g/10 microgreens) were taken into consideration. Pigments such as Chlorophyll a, Chlorophyll b and total chlorophyll were assessed by adopting the method described by Hiscox and Israelstam (1979) using Dimethyl sulfoxide with the following formula.

Chlorophyll a = $[12.7(D_{663}) - 2.69(D_{645})] \text{ X } \frac{V}{1000\ x\ W}$

Chlorophyll b = $[22.9(D_{645}) - 4.68(D_{663})] \text{ X } \frac{V}{1000\ x\ W}$

Total chlorophyll= Chlorophyll a + Chlorophyll b

Method described by Deb *et al.* (2024) was used to work out the total phenol content using

Folin-Ciocalteau reagent and measuring absorbance at 760 nm using UV-VIS Spectrophotometer. Standard curve was plotted and value was expressed as mg GAE/ g FW (GAE represent Gallic acid Equivalent & FW represent Fresh weight). Ascorbic acid was determined by the method described by AOAC (1990) using titration by metaphosphoric acid. Beta-carotene was worked out as per the method of Davis (1976). The absorbance was noted at 452 nm using UV-VIS spectrophotometer and calibration curve was prepared to calculate the concentration. Total flavonoid was estimated using the method described by Zhishen *et al*. (1999). Aluminium chloride and potassium acetate was used to extract sample. The absorbance was noted using UV-VIS spectrophotometer at 415 nm and expressed as mg QE/g FW (QE represent Quercetin). DPPH Assay was determined to calculate the antioxidant capacity of the microgreens using the method described by Brand-Williams *et al.* (1995). For this 2,2-diphenyl 1-picrylhydrazyl was used and absorbance was noted at 517 nm using UV-VIS Spectrophotometer. Titratable acidity was calculated using the method described by Sadasivam and Manickam (1996). It was expressed as %.

Total Sugar was estimated spectrophotometrically using Phenol-Sulphuric Method (Thimmaiah; 2021). Here, the extract was treated with 5% Phenol and 98% Sulfuric acid and kept in dark. The absorbance was noted at 485 nm and result was expressed as mg glucose/g FW .Reducing sugar was estimated using Dinitrosalicylic (DNS) Acid Method (Thimmaiah; 2021). Aliquot of the sample was allowed to mix with 3 ml DNS reagent. Then was allowed to stand for some time and absorbance was noted at 575 nm in UV-VIS spectrophotometer. Graph was plotted to estimate the amount of reducing sugar and expressed as mg glucose/g FW.

Statistical analysis was carried out using IBM SPSS Software v.25. The mean value have been presented in the table and graph. The difference in mean value for different traits among the treatments has been assessed through the Duncan Multiple Range Test.

## RESULTS AND DISCUSSION

The result of different morphological parameters (seedling height, hypocotyl length, root length, cotyledon area, fresh weight of 10 seedlings & yield) has been displayed in Table 1 which shows significant variation. Microgreens grown during March, May and September exhibited significantly higher seedling height. Mean hypocotyl length of 4.68 cm was noted. Root length ranged from 3.310 to 3.594 cm. The maximum cotyledon area (1.474 $cm^2$) was noted in May sowing and was statistically comparable to that of March, July and September sowing. Significant differences were noted for the biomass accumulation. Peak fresh weight of cabbage microgreens was recorded for May sowing. Mean yield of 1297.324 $g/m^2$ was obtained. The maximum yield obtained was 1328.651 $g/m^2$ for September sowing, which was statistically at par (*p* value>0.05) with January, March, November and May. Variation in biometric parameters of microgreens were influenced by several environmental factors such as temperature, humidity etc. (Dubey *et al.,* 2024).

Figure 1 & Figure 2 illustrates the proximate analysis (moisture content and dry weight respectively) across sowing months. Statistically significant differences were noted among the treatments. Mean moisture content of 94.0 % was recorded. May sowing result the highest moisture content i.e. 95.480 %. Mean dry weight of 0.05 g was observed.

Pigment content of cabbage microgreens have been illustrated in Figure 3. The results showed significant differences in chlorophyll content (chlorophyll a, chlorophyll b and total

chlorophyll). A good amount of total chlorophyll was noted for sowing during September, November and January as compared to the other sowing time.

Statistically significant differences were noted for the different biochemical parameters under this study which has been shown in Table 2. Sowing of cabbage microgreens during May showed the maximum presence of total phenol (305.507 mg GAE/100 g FW) and ascorbic acid (87.825 mg/100 g FW) as compared to the other planting time; whereas the least were observed during January sowing. Beta carotene content was observed maximum in March followed by May sowing. Sowing of cabbage microgreens during May and March observed the presence of higher amount of flavonoid as compared to other sowing time. Similar range of flavonoid content was found in cabbage microgreens under soilless media (Gunjal *et al*., 2024). Flavonoid content has been related to various therapeutic treatments, like the anticancer action, antioxidant activity, helps in stroke prevention, antiviral activities, antibacterial action, etc. (Ullah *et al*., 2020). The highest antioxidant capacity was observed in May sowing i.e. 4.052 µmol TE/g FW. Antioxidant property has been associated with the presence of vitamin C, phenolic compound, chlorophyll and carotenoid in plants (Podsedek *et al.*, 2006 and Singh *et al.*, 2006). Titratable acidity ranged from 0.291-0.365%. Maximum total sugar content was found in September sowing (11.985 mg glucose/g FW), which was at par with March, May and July sowing (at 95% CI).

## CONCLUSION

The findings from this present study revealed that proper sowing time coordinates with the favourable environmental conditions not only contribute to growth but also economic viability of microgreen production. From the present research, it was found that the cabbage microgreens sown in March and May resulted in good growth and presence of nutritional composition; whereas pigment content was found maximum during November and January. The maximum yield was achieved during September. Microgreens being delicate in nature have to be grown in specific time to harness the maximum benefit. The findings of this study will help producers to grow according to their requirement based on yield and nutritional importance and feed the fresh, nutrient dense cabbage microgreens to consumer.

## CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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**Table 1: Vegetative parameters of cabbage microgreens across different sowing time**

| Treatment | Seedling height (cm) | Hypocotyl length (cm) | Root length (cm) | Cotyledon area ($cm^2$) | Fresh weight of 10 seedlings (g) | Yield ($g/m^2$) |
|---|---|---|---|---|---|---|
| January | $5.322^{b}$ | $4.488^{c}$ | $3.310^{c}$ | $1.274^{bc}$ | $0.824^{b}$ | $1325.899^{a}$ |
| March | $5.634^{a}$ | $4.909^{a}$ | $3.586^{a}$ | $1.435^{ab}$ | $0.937^{b}$ | $1297.324^{a}$ |
| May | $5.676^{a}$ | $4.974^{a}$ | $3.594^{a}$ | $1.474^{a}$ | $1.123^{a}$ | $1237.580^{a}$ |
| July | $5.405^{b}$ | $4.704^{b}$ | $3.492^{ab}$ | $1.399^{abc}$ | $0.879^{b}$ | $1114.121^{b}$ |
| September | $5.630^{a}$ | $4.590^{bc}$ | $3.585^{a}$ | $1.396^{abc}$ | $0.896^{b}$ | $1328.651^{a}$ |
| November | $5.323^{b}$ | $4.438^{c}$ | $3.377^{bc}$ | $1.227^{c}$ | $0.863^{b}$ | $1260.568^{a}$ |
| Grand mean | 5.50 | 4.68 | 3.49 | 1.37 | 0.92 | 1260.69 |
| SE(m)± | 0.05 | 0.06 | 0.05 | 0.05 | 0.05 | 39.73 |
| CD(0.05) | 0.14 | 0.18 | 0.16 | 0.16 | 0.15 | 122.41 |
| CV(%) | 1.43 | 2.12 | 2.58 | 6.75 | 9.13 | 5.46 |

Note: letters within the treatment indicates the difference derived through Duncan Multiple Range Test.

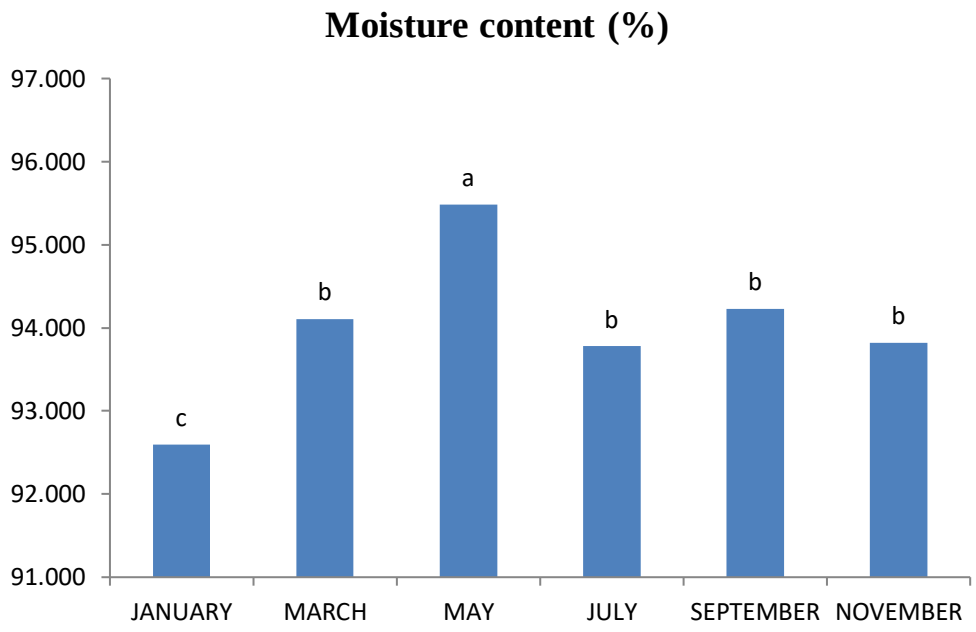


**Figure 1: Moisture content (%) of cabbage microgreens across different sowing time times**

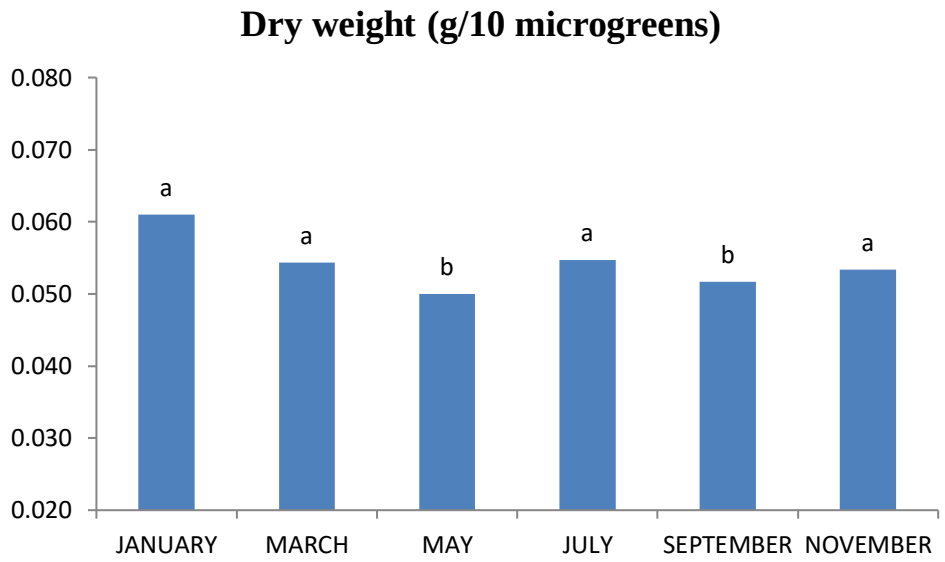


**Figure 2: Dry weight (g/10 microgreens) of cabbage microgreens across different sowing time**

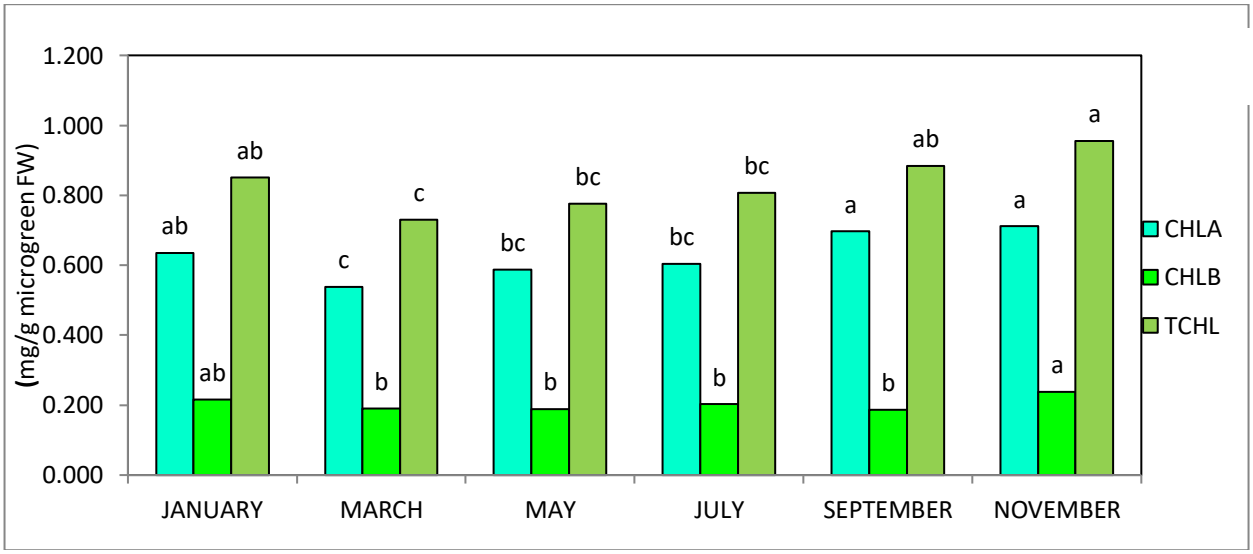


**Figure 3: Pigment content of cabbage microgreens across different sowing time**

Note: CHL A- Chlorophyll a, CHL B-Chlorophyll b, TCHL-Total Chlorophyll, Letters indicate the difference among the treatments

**Table 2. Biochemical parameters of cabbage microgreens across different sowing time**

| Treatment | Total Phenol (mg GAE/100 g FW) | Ascorbic acid (mg/100 g FW) | Beta carotene (mg/100 g FW) | Flavonoid (mg QE/g FW) | DPPH (µmol TE/g FW) | Acidity (%) | Total sugar (mg glucose/g FW) | Reducing sugar ( mg glucose/g FW) |
|---|---|---|---|---|---|---|---|---|
| January | 228.531$^{c}$ | 72.360$^{c}$ | 3.945$^{c}$ | 0.512$^{c}$ | 3.229$^{c}$ | 0.308$^{bc}$ | 9.213$^{c}$ | 3.505$^{c}$ |
| March | 283.407$^{b}$ | 79.977$^{b}$ | 4.437$^{a}$ | 0.765$^{a}$ | 3.779$^{b}$ | 0.352$^{ab}$ | 11.620$^{a}$ | 4.866$^{a}$ |
| May | 305.507$^{a}$ | 87.825$^{a}$ | 4.210$^{b}$ | 0.807$^{a}$ | 4.052$^{a}$ | 0.365$^{a}$ | 11.133$^{a}$ | 4.991$^{a}$ |
| July | 268.284$^{b}$ | 81.513$^{b}$ | 3.968$^{c}$ | 0.639$^{b}$ | 3.715$^{b}$ | 0.345$^{ab}$ | 10.896$^{ab}$ | 4.377$^{b}$ |
| September | 278.247$^{b}$ | 81.560$^{b}$ | 3.837$^{c}$ | 0.754$^{a}$ | 3.396$^{c}$ | 0.341$^{ab}$ | 11.985$^{a}$ | 4.759$^{ab}$ |
| November | 240.447$^{c}$ | 73.641$^{c}$ | 3.830$^{c}$ | 0.461$^{c}$ | 3.251$^{c}$ | 0.291$^{c}$ | 9.900$^{bc}$ | 3.735$^{c}$ |
| Grand mean | 267.40 | 79.48 | 4.04 | 0.66 | 3.57 | 0.33 | 10.79 | 4.37 |
| SE(m)± | 4.94 | 1.16 | 0.07 | 0.02 | 0.05 | 0.02 | 0.38 | 0.14 |
| CD(0.05) | 15.23 | 3.57 | 0.22 | 0.07 | 0.16 | 0.05 | 1.18 | 0.42 |
| CV(%) | 3.20 | 2.52 | 3.02 | 5.79 | 2.57 | 7.85 | 6.14 | 5.36 |

Note: Letters within the treatment indicates the difference derived through Duncan Multiple Range Test, FW-Fresh weight, GAE-gallic acid equivalent, QE-Quercetin, TE-Toluene