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Productivity and Head Quality as Affected by Cultivars and Transplanting Dates of Lettuce Grown in Sandy Soil Conditions

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Abstract

A field experiment was carried out during the two winter seasons of 2024/2025 and 2025/2026 at a private vegetable farm (Sand Valley Experimental Station) in Ismailia Governorate, Egypt, to study the effect of lettuce cultivars (Beg Bell and Lida F1) and transplanting dates (1st October, 1st November, and 1st December) on yield and head quality under sandy soil conditions. These treatments were distributed in a split plot design system with three replications. Lettuce cultivars were arranged in the main plots, while the transplanting dates were randomly distributed in the subplots. Transplanting Big Bell cultivar on 1st November gave the highest values of plant height, stem height, stem diameter, outer leaf number, inner leaf number, total number of leaves/plant, leaf length, width, leaf area, dry weight of leaves, total dry weight/plant, N, P, and K contents in leaves and stem, chlorophyll , b, total a+b, carotenoids, edible head weight, edible head diameter, edible head width, edible head length, average head weight, and total yield as well as head quality (vitamin C and TSS), whereas Lida F1, transplanting on 1st October, and the interaction between them gave the lowest values of these traits in both seasons.

Keywords: head lettuce, cultivars, transplanting date, growth, and yield.

1. Introduction

Head lettuce *(Lactuca sativa var. capitata* L.) is among the most widely consumed salad crops worldwide. It is an important leafy vegetable typically eaten fresh and is extensively cultivated as a cool-season crop, being well adapted to temperate climatic conditions **(Shahein *et al.*, 2014).** Butterhead lettuces (*Lactuca sativa var. capitata*), usually forming rounded heads of crisp green or sometimes red-tinted leaves, are useful for salads. Head lettuce (variety capitata), with the leaves folded into a compact head. The cultivated area of lettuce in Egypt is about 7401 feddan (0.42 ha), which produced about 68644 tons (Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, 2012). Also, lettuce is a shallow-rooted crop, but it requires an extensive amount of fertilizers to produce high yield **(Sukor, 2013).**

There were significant differences between lettuce cultivars regarding growth, productivity, and head quality. In this concern, **Miccolis *et al*. (2000) Sharma *et al*. (2001), Kleinhenz and Wszelaki (2003), Robert *et al.* (2006)** , **AL-Dabbagh *et al*. (2014), Shahein *et al*. (2014), Silva *et al*. (2017)** , **Attallah, and Abdalla (2021)**, **Ismail and Obeid (2023)**, **Rakočević *et al*. (2023)**, **Madina *et al.* (2024)** and **Akter *et al*. (2026)**.

Date of transplanting potentially affects plant growth and establishment as it dictates the specific physiological status of plant (*e.g.*, dormancy, leaf drop, bud set, shoot expanding) as well as specific weather conditions (*e.g.*, temperature and moisture, wind, light intensity and quality) that influence root regeneration capacity **(Richardson-Calfee and Harris 2005)**. Autumn and spring are commonly considered the best times for transplanting most plants in climates characterized by wet springs and autumns due to the favorable soils and air temperature conditions and the absence of active shoot growth, all of which minimize the potential for desiccation. However, transplanting in the dormant season is not recommended in climates with severe winters **(Harris and Fanelli 1999; Richardson-Calfee and Harris, 2005)**. Transplanting in dormant season, if the winter soil temperature remains high, provides opportunities for a plant to regenerate its root system prior to shoot growth in springtime **(Buckstrup and Bassuk, 2000)**.

Transplanting dates had a significant effect on plant growth, yield, and quality (**Abou EL-Yazied *et al*., 2007, Sharma *et al*., 2009, Singh *et al.,* 2015, Kaleri *et al.*, 2016 and Hammood, 2020).**

Therefore, the aim of this study was to find out the most suitable cultivar of head lettuce by choosing the appropriate transplanting date, with the aim of obtaining the best yield and good quality of lettuce for this region under sandy soil conditions.

2. Materials and methods

A field experiment was carried out during the two winter seasons of 2024/2025 and 2025/2026 at a private vegetable farm (Sand Valley Experimental Station) in Ismailia Governorate, Egypt, to study the effect of lettuce cultivars (Beg Bell and Lida F_1) and transplanting date (1st October ,1st November and 1st December) on yield and head quality under sandy soil conditions. These treatments were distributed in a split plot design system with three replications. Lettuce cultivars were arranged in the main plots, while the transplanting dates were randomly distributed in the sub-plots.

The physical and chemical properties of the experimental soil are presented in Table 1

Table 1. The physical and chemical properties of the experimental soil in 2024/2025 and 2025/2026 seasons

Soil property	**1st season**	**2nd season**
Physical properties		
Clay (%)	1.41	1.72
Silt (%)	3.19	3.91
Sand (%)	95.4	94.37
Texture	Sandy	Sandy
Chemical properties		
E.C. (mmhos/cm)*	1.54	1.53
pH**	8.02	8.03
Organic matter (%)	0.28	0.27
Available N (mg /kg soil)	22.91	22.59
Available P_2O_5 (mg /kg soil)	13.41	13.12
Available K_2O (mg /kg soil)	0.72	0.68

Samples of the soil were obtained from 25 cm soil surface.

Table 2. Meteorological data during 2024/2025 and 2025/2026 seasons

Month	**2024/2025**		**2025/2026**	
	Maximum ºC	**Minimum ºC**	**Maximum ºC**	**Minimum ºC**
October	26.45	16.24	30.45	19.21
November	24.51	14.35	27.32	15.95
December	22.12	10.89	19.96	10.14
January	20.74	8.94	16.81	6.51
February	21.21	8.93	19.34	7.37
March	23.18	10.37	20.28	7.87

Lettuce is of Big Bell, China origin and imported by Mecca Trade Co., while , Lida F1 American origin and imported by Agrolimited . Egypt

The experimental unit area was 12.6 m^2, every plot consisted of six rows 3.5m in length and 60 cm in width. The transplants were transplanted on both sides of dripper lines at 20 cm between plants. Two rows (4.2 m^2) were used to measure vegetative growth traits and chemical traits, and the other four rows (8.4 m^2) were used for estimating yield and its components and head quality of plants.

All treatments in both experiments received recommended amounts of ammonium sulfate (20.5 % N), ammonium nitrate 33.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulfide. A quarter of N amount and all amount of P_2O_5 were added during soil preparation with FYM which was added at the rate of 20 m^3/fed.

Data recorded:

Vegetative Growth:

A random sample of three plants from every experimental unit was taken after 75 days from transplanting to investigate the following growth parameters: plant height (cm), stem height (cm), stem diameter (cm), number of outer and inner leaves/plant, leaf length and leaf width (cm), leaf area/plant, fresh weight of stem, fresh weight of leaves, and total fresh weight/plant (leaves plus stem).

Dry Weight: Different plant parts will be oven-dried at 70$^{\circ C}$ till constant weight, and the following data were recorded: dry weight of stem, leaves, and total dry weight/plant (stem plus leaves).

2-Leaf pigments

A disc sample from the fourth outer leaf of the lettuce plant was randomly taken from every experimental unit at 75 days after transplanting in both growing seasons to determine chlorophyll a, b, and chlorophyll (a+b) as well as carotenoids according to the method described by **Wettestein (1957)**.

3. Chemical constituents

At 75 days after transplanting, N, P, and K in leaves and stem were determined according to the methods advocated by **Bremner and Mulvaney (1982), Olsen and Sommers (1982)** and **Jackson (1970),** respectively. N, P, and K uptake in leaf and stem were calculated.

4. Yield and its Components: At harvesting time (about 90 days after transplanting), all plants from each plot were harvested to measure edible head weight (g), edible head diameter (cm), edible head width (cm), edible head height (cm), and shape index (width/height); also, average head fresh weight and total yield/fed.

5. Edible head quality at harvesting time

Total soluble solids (TSS%): was measured by using a Galli 110 refractometer in lettuce leaves.

Vitamin C (mg/100g FW) was determined in lettuce leaves according to the method described by **Desai and Desai (2019**).

Total carbohydrate *(%):*It was determined colorimetrically in dry leaves following the methods described by **Michel *et al.* (1956).**

Statistical analysis

Collected data will be subjected to proper statistical analysis of variance according to **Snedecor and Cochran (1980)** and the differences among treatments were compared using **Duncan's multiple** range test (**Duncan, 1958**), where means that have different letters were statistically significant, while those means followed by the same letter were statistically insignificant.

3. Results and discussion

Plant Growth

Effect of cultivars

Plant height, stem height, and stem diameter

Data in Table 3 indicate that there were significant differences between head lettuce cultivars (Big Bell and Lida F_1) with respect to plant height, stem height, and stem diameter, except stem diameter in the 2nd season, and the Big Bell cultivar gave higher plant height (26.41 and 29.40 cm), stem height (4.71 and 4.79 cm), and stem diameter (3.17 and 2.94 cm) in both seasons at 75 days after planting.

The obtained results were in agreement with **Moniruzzaman *et al.* (2007)** showed that plant height was the maximum when planted on 1st November, closely followed by 15 October planting, while 1st December planting produced the lowest values of plant height and number of leaves/plants.

Effect of transplanting date

The obtained results in Table 3 illustrate that transplanting head lettuce on 1st November gave the highest values of plant height (26.06 and 28.93 cm), stem height (4.80 and 4.91 cm) and stem diameter (3.23 and 2.90 cm), followed by transplanting on 1st December in both seasons at 75 days after planting.

Table (3). Effect of lettuce cultivars and transplanting date on plant height , stem height and stem diameter at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments	Plant height (cm)		Stem height (cm)		Stem diameter (cm)	
	2024/2025 season	2025/2026 season	2024/2025 season	2025/2026 season	2024/2025 season	2025/2026 season
	Effect of cultivars					
Big Bell	26.41 a	29.40 a	4.71 a	4.79 a	3.17 a	2.94 a
Lida F_1	22.23 b	26.79 b	4.45 b	4.26 b	3.03 b	2.77 a
LSD at 0.05 level	2.67	0.84	0.14	0.14	0.10	NS
	Effect of transplanting date					
1st October	22.98 b	27.23 c	4.29 c	4.25 c	3.00 b	2.83 a
1st November	26.06 a	28.93 a	4.80 a	4.91 a	3.23 a	2.90 a
1st December	23.92 b	28.12 b	4.66 b	4.41 b	3.07 b	2.85 a
LSD at 0.05 level	1.75	0.55	0.09	0.09	0.07	NS

Effect of the interaction

The interaction between the Big Bell cultivar and transplanting on 1st November recorded maximum plant height (28.83 and 30.14 cm), stem height (5.07 and 5.17 cm) and stem diameter (3.33 and 2.99 cm), followed by the interaction between the Big Bell cultivar and transplanting on 1st December in both seasons at 75 days after transplanting (Table 4). The obtained results were in harmony with **Sharma et al. (2001) and Kleinhenz, and Wszelaki (2003)**

Table (4). Effect of the interaction between lettuce cultivars and transplanting date on plant height , stem height and stem diameter at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments		Plant height (cm)	Stem height (cm)	Stem diameter (cm)
Cvs	**Transplanting date**	**2024/2025 season**		
Big Bell	**1st October**	24.53 bc	4.17 d	3.03 cd
	1st November |	28.83 a	5.07 a	3.33 a
	1st December	25.88 b	4.90 b	3.16 b
Lida F_1	**1st October**	21.44 c	4.41 c	2.98 d
	1st November	23.29 bc	4.53 c	3.13 bc
	1st December	21.96 c	4.43 c	2.99 d
LSD at 0.05 level		2.48	0.13	0.09
		2025/2026 season		
Big Bell	**1st October**	28.44 b	4.46 c	2.86 a
	1st November	30.14 a	5.17 a	2.99 a
	1st December	29.62 a	4.74 b	2.99 a
Lida F_1	**1st October**	26.02 c	4.04 d	2.71 a
	1st November	27.72 b	4.65 b	2.82 a
	1st December	26.63 c	4.09 d	2.80 a
LSD at 0.05 level		0.78	0.13	NS

Leaf traits
Effect of cultivars

The Beg Bill cultivar gave a higher outer leaf number (6.71 and 7.26), inner leaf number (14.37 and 13.61), total number of leaves/plant (21.08 and 20.20), leaf length (22.40 and 22.72 cm), leaf width (18.30 and 18.19 cm), and leaf area (205.27 and 206.75 cm^2) than Lida F_1 at 75 days after transplanting in both seasons (Table 5).

Results are in harmony with **Refai and Ahmed (2009)** showed that the Balady cultivar produced the highest values of number of leaves/plant compared to the Latoga cv. Furthermore, **Attallah and Abdalla (2021)** indicated that Romaine's cv. recorded the highest values of leaf number per plant compared to the 'Green waves' cultivar.

Effect of transplanting date

Transplanting head lettuce on 1st November was the best transplanting date for increasing outer leaf number (6.83 and 7.27), inner leaf number (14.10 and 13.36), total number of leaves/plant (20.92 and 20.04), leaf length (22.36 and 22.18 cm), leaf width (18.05 and 18.32 cm), and leaf area (202.39 and 203.23 cm^2), followed by transplanting on 1st December in both seasons at 75 days after transplanting in both seasons (Table 5).

The previously mentioned results indicated, in general, that the plants grown during the middle transplanting date (1st November) were the most vigorous (expressed as plant height, stem height, and stem diameter) compared to the other investigated transplanting dates. Whereas, the early transplanting date (1st October) resulted in the lowest values of plant growth. This may be attributed to the favorable effect of prevalent temperature (Table 2) during the two growth seasons.

These results are in agreement with **Abou EL-Yazied *et al.* (2007)** tested three transplanting dates (the first of October) on the growth of lettuce. They indicated that transplanting in October gave the highest number of leaves/plant compared to that of transplanting in November and December. In addition**, Kaleri *et al.* (2016)** evaluated six transplanting dates (15th Sept, 1st Oct, 15th Oct, 1st Nov, 15th Nov, and 1st December). On the growth of lettuce. They showed that the maximum plant height was observed at the 15th November and 1st December transplanting date, while the maximum number of leaves per plant was observed at the 1st November transplanting date.

Table (5). Effect of lettuce cultivars and transplanting date on leaf traits of lettuce at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments	Outer leaf	Inner leaf	Total number of	Leaf length	Leaf width	Leaf area

	number / plant	number / plant	leaves/plant	(cm)	(cm)	(cm^2)
	2024/2025 season					
Big Bell	6.71 a	14.37 a	21.08 a	22.40 a	18.30 a	205.27 a
Lida F_1	6.03 b	10.71 b	16.75 b	20.25 b	17.01 b	172.34 b
LSD at 0.05 level	0.32	1.12	1.03	1.23	0.92	19.04
	2025/2026 season					
Big Bell	7.26 a	13.61 a	20.20 a	22.72 a	18.19 a	206.75 a
Lida F_1	5.50 b	10.77 b	16.27 b	20.40 b	17.23 b	176.13 b
LSD at 0.05 level	0.95	1.21	1.06	0.86	0.91	14.90
	Effect of transplanting date					
	2024/2025 season					
1st October	6.05 b	11.37 c	17.42 c	20.43 b	17.14 b	175.32 c
1st November	6.83 a	14.10 a	20.92 a	22.36 a	18.05 a	202.39 a
1st December	6.24 b	12.16 b	18.40 b	21.18 b	17.78 a	188.71 b
LSD at 0.05 level	0.21	0.73	0.67	0.80	0.60	12.50
	2025/2026 season					
1st October	5.77 b	10.92 c	16.19 c	20.89 b	17.23 b	180.64 c
1st November	7.27 a	13.36 a	20.14a	22.18 a	18.32 a	203.23 a
1st December	6.10 b	12.28 b	18.39 b	21.62 a	17.59 b	190.45 b
LSD at 0.05 level	0.62	0.79	0.70	0.56	0.59	9.78

Effect of the interaction

The highest values of outer leaf number (7.51 and 8.37), inner leaf number (16.84 and 15.67), total number of leaves/plant (24.34 and 23.04), leaf length (23.65 and 23.04 cm), leaf width (18.89 and 18.45 cm), and leaf area (223.33 and 212.53 cm^2) were obtained from the interaction between the Beg Bill cultivar and transplanting on 1st November in both seasons at 75 days after planting, followed by the interaction between the Beg Bill cultivar and transplanting on 1st December (Table 6). On the other hand, the lowest values of all leaf traits were recorded with the interaction between Lida F_1 and transplanting on 1st October in both seasons.

Table (6). Effect of the interaction between lettuce cultivars and transplanting date on leaf traits of lettuce at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments		**Outer leaf number / plant**	**Inner leaf number / plant**	**Total number of leaves/plant**	**Leaf length (cm)**	**Leaf width (cm)**	**Leaf area (cm^2)**
Cvs	**Transplanting date**	**2024/2025 season**					
Big Bell	**1st October**	6.25 b	12.11 c	18.36 c	21.37 bc	17.58 b	187.89 bc
	1st November	7.51 a	16.84a	24.34a	23.65 a	18.89 a	223.33 a
	1st December	6.39 b	14.17 b	20.56 b	22.18 b	18.45 a	204.60 b
Lida F_1	**1st October**	5.85 c	10.64 de	16.49 d	19.49 d	16.70 b	162.75 d
	1st November	6.15 b	11.36 cd	17.51 c	21.08 bc	17.21 b	181.44 c
	1st December	6.10 bc	10.15 e	16.25 d	20.19 cd	17.12 b	172.82 cd
LSD at 0.05 level		0.29	1.04	0.96	1.14	0.86	17.67

		2025/2026 season					
Big Bell	**1st October**	6.39 b	11.69 c	17.09 c	22.45 a	18.05 ab	202.61 ab
	1st November	8.37 a	15.67 a	23.04 a	23.04 a	18.45 a	212.53 a
	1st December	7.02 b	13.47 b	20.49 b	22.69 a	18.08 ab	205.10 ab
Lida F_1	**1st October**	5.15 c	10.15 d	15.30 d	19.33 c	16.42 c	158.66 d
	1st November	6.18 b	11.06 cd	17.24 c	21.32 b	18.19 a	193.93 b
	1st December	5.18 c	11.10 cd	16.29 cd	20.56 b	17.10 bc	175.79 c
LSD at 0.05 level		0.88	1.12	0.99	0.79	0.84	13.83

Fresh and dry weight
Effect of cultivars

Data in Tables 7 and 8 indicate that the highest values of fresh weight of leaves (282.27 and 285.53 g), fresh weight of stem (59.84 and 59.08 g) and total fresh weight (343.13 and 344.62 g), dry weight of leaves (20.40 and 20.29 g), dry weight of stem (5.27 and 5.12 g), and total dry weight (25.68 and 25.41 g) were obtained from the Big Bell cultivar at 75 days after transplanting than Lida F1 in both seasons.

The differences between two cultivars in vegetative growth might be due to their genetic ,differentiation which allows some to use the natural resources with high potentiality. The genetic potentiality of both cultivars enables their plants to absorb more nutrients from the soil and have more photosynthetic ,surfaces which allow better photosynthetic capacity.

Results are in harmony with those obtained with **Shahein *et al*. (2014)** indicated that Dark Green cv. gave the taller plants and had the highest dry weight, while Big-Bell gave the highest fresh weight/plant. In addition , **Attallah and Abdalla (2021)** showed that the highest values of fresh and dry weight of leaves/plant were recorded with Romaine's CV recorded than the 'Green waves' cultivar.

Effect of transplanting date

Middle transplanting of head lettuce (1st Nov.) recorded maximum values of fresh weight of leaves (276.63 and 275.03 g), fresh weight of stem (57.72 and 58.57 g) and total fresh weight (334.35 and 333.63 g), dry weight of leaves (19.69 and 20.02 g), dry weight of stem (5.17 and 5.08 g) and total dry weight/plant (24.81 and 25.10 g) in both seasons at 75 days after planting, followed by transplanting on 1st Dec. (Tables 7 and 8). Early transplanting (1st Oct.) recorded minimum fresh weight of leaves, stem and total fresh weight/plant.

Such increments in fresh and dry weight of lettuce during middle transplanting date (1st Nov.) may be due to the suitable and prevalent meteorological factors, especially temperature (Table 2), which affect positively and increase the vegetative growth phase of plants.

In this regard**, Baral *et al.* (2020)** indicated that the above-ground dry matter significantly increased by early transplanting (1st December) compared to late transplanting (16th December). Also, **Hammood (2020)** evaluated four transplanting dates, i.e., (22/10, 22/11, 22/12 and 22/1 on the growth of lettuce. They showed that the second date (22/11) gave the highest fresh and dry weights for leaves.

Table (7). Effect of lettuce cultivars and transplanting date on fresh weight of leaves, stem and total at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments	**Fresh weight of leaves (g)**		**Fresh weight of stem (g)**		**Total fresh weight (g)**	
	2024/2025 season	**2025/2026 season**	**2024/2025 season**	**2025/2026 season**	**2024/2025 season**	**2025/2026 season**
	Effect of cultivars					
Big Bell	283.27 a	285.53 a	59.85 a	59.08 a	343.13 a	344.62 a
Lida F_1	226.52 b	227.12 b	49.70 b	52.74 b	276.22 b	279.20 b
LSD at 0.05 level	9.93	15.73	2.50	1.83	20.70	17.38
	Effect of transplanting date					
1st October	235.29 c	239.16 c	51.86 c	53.47 c	287.15 c	291.63 c
1st November	276.63 a	275.03 a	57.72a	58.57 a	334.35 a	333.61 a
1st December	252.77 b	254.80 b	54.75 b	55.70 b	307.52 b	310.50 b

LSD at 0.05 level	6.52	10.32	1.64	1.20	13.58	11.41

Table (8). Effect of lettuce cultivars and transplanting date on dry weight of leaves, stem and total at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments	Dry weight of leaves (g)		Dry weight of stem (g)		Total dry weight (g)	
	2024/2025 season	2025/2026 season	2024/2025 season	2025/2026 season	2024/2025 season	2025/2026 season
	Effect of cultivars					
Big Bell	20.40 a	20.29 a	5.27 a	5.12 a	25.68 a	25.41 a
Lida F_1	18.20 b	18.47 b	4.76 b	4.69 b	22.96 b	23.17 b
LSD at 0.05 level	1.51	0.94	0.23	0.15	1.10	0.85
	Effect of transplanting date					
1st October	18.87 b	18.64 b	4.87 b	4.74 c	23.74 b	23.38 c
1st November	19.64 a	20.02 a	5.17 a	5.08 a	24.81 a	25.10 a
1st December	19.40 ab	19.49 a	5.02 ab	4.90 b	24.42 ab	24.39 b
LSD at 0.05 level	0.69	0.61	0.15	0.10	0.72	0.55

Effect of the interaction

The obtained results in Tables 9 and 10 indicate that the interaction between the Beg Bill cultivar and transplanting on 1st November was the best treatment for enhancing fresh weight of leaves (312.16 and 309.67 g), fresh weight of stem (62.43 and 61.94 g) and total fresh weight (374.56 and 371.61 g) as well as dry weight of leaves (20.67 and 21.37 g), dry weight of stem (5.42 and 5.29 g) and total dry weight (26.04 and 26.66 g) in both seasons, followed by the interaction between the Beg Bill cultivar and transplanting on 1st Dec., while the interaction between Lida F1 and transplanting on 1st Oct. gave the lowest values of fresh weight/ plant.

Under all plant dates (1st Oct., 1st Nov. and 1st Dec.), the Big Bill cultivar had better growth than the Lida F1 cultivar; the middle transplanting date (1st Nov.) was the most suitable transplanting date for growing plants, followed by transplanting on 1st December.

Table (9). Effect of the interaction between lettuce cultivars and transplanting date on fresh weight of leaves, stem and total at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments		Fresh weight of leaves (g)	Fresh weight of stem (g)	Total fresh weight (g)
Cvs	**Transplanting date**	**2024/2025 season**		
Big Bell	**1st October**	251.92 c	57.59 b	309.51 c
	1st November	312.16 a	62.43a	374.59 a
	1st December	285.73 b	59.55 b	345.28 b
Lida F_1	**1st October**	218.66 d	46.13 e	264.79 d
	1st November	241.09 c	53.02 c	294.11 c
	1st December	219.80 d	49.96 d	269.76 d
LSD at 0.05 level		9.22	2.32	19.21
		2025/2026 season		
Big Bell	**1st October**	258.95 c	56.52 c	315.47 c
	1st November	309.67 a	61.94a	371.61 a
	1st December	287.97 b	58.80 b	346.77 b
Lida F_1	**1st October**	219.36 d	50.42 e	267.78 d
	1st November	240.39 c	55.21 c	295.60 c
	1st December	221.62 d	52.61 d	274.23 d
LSD at 0.05 level		14.60	1.69	16.14

Table (10). Effect of the interaction between lettuce cultivars and transplanting date on dry weight of leaves, stem and total at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments		Dry weight of leaves (g)	Dry weight of stem (g)	Total dry weight (g)
Cvs	Transplanting date	2024/2025 season		
Big Bell	1st October	20.02 a	5.13 bc	25.15 a
	1st November	20.67 a	5.42 a	26.09 a
	1st December	20.53 a	5.28 ab	25.81 a
Lida F1	1st October	17.73 b	4.61 e	22.34 c
	1st November	18.61 b	4.92 cd	23.53 b
	1st December	18.27 b	4.76 de	23.03 bc
LSD at 0.05 level		0.97	0.21	1.03
		2025/2026 season		
Big Bell	1st October	19.14 c	4.89 b	24.03 c
	1st November	21.37 a	5.29 a	26.66 a
	1st December	20.36 b	5.19 a	25.55 b
Lida F1	1st October	18.14 c	4.59 c	22.73 d
	1st November	18.67 c	4.88 b	23.55 c
	1st December	18.62 c	4.62 c	23.24 cd
LSD at 0.05 level		0.87	0.14	0.79

Photosynthetic pigments

Effect of cultivars

The Beg Bill cultivar has higher concentrations of chlorophyll a, b, total a+b and carotenoids in leaf tissues of head lettuce plants than Lida F_1 at 75 days after transplanting in both seasons (Table 11).

Results are in harmony with those obtained with **AL-Dabbagh *et al*. (2014),** who showed that the highest concentration of leaf chlorophyll content was obtained with Great Lakes 118 variety rather than Regina dei ghiacci variety. In addition**, Shahein *et al*. (2014)** indicated that Big-Bell gave the highest total chlorophyll content in leaves compared to Dark Green cv. Also, **Silva et al. (2017)** showed that 'Itapuã 401 gave the highest concentration of leaf chlorophyll of lettuce as compared to other cultivars ('Delícia', 'Babá de Verão'). Furthermore, **Attallah and Abdalla (2021)**, which showed that Romaine's CV recorded a higher concentration of total chlorophyll in lettuce leaf tissues than the 'Green waves' cultivar.

Effect of transplanting date

The highest concentrations of chlorophyll a, b, total a+b and carotenoids in leaf tissues of head lettuce plants were obtained from middle transplanting date (1st Nov.) in both seasons, followed by transplanting on 1st Dec., whereas the early transplanting (1st Oct.) gave the lowest concentrations of leaf pigments (Table 11).

Results are in harmony with those obtained with **Hammood (2020)** showed that the second date (22/11) gave the highest concentration of chlorophyll in the leaves as compared to other transplanting date (22/10, 22/12 and 22/1.

Table (11). Effect of lettuce cultivars and transplanting date on leaf pigments (mg /g FW) at 75 days after transplanting in 2024/2025 and 2025/2026

Treatments	Chlorophyll a		Chlorophyll b		Total chlorophyll a+b		Carotenoides	
	2024/2025 season	20254/2026 season	2024/2025 season	20254/2026 season	2024/2025 season	20254/2026 season	2024/2025 season	20254/2026 season
	Effect of cultivars							
Big Bell	1.87 a	1.76 a	1.16 a	1.12 a	3.04 a	2.89 a	1.06 a	1.11 a
Lida F1	1.63 b	1.49 b	1.07 b	1.04 b	2.71 b	2.53 b	1.14 a	1.18 a
LSD at 0.05 level	0.13	0.09	0.07	0.06	0.15	0.16	NS	NS
	Effect of transplanting date							
1st Octobe	1.63 c	1.58 b	1.08 b	1.07 a	2.71 c	2.65 b	1.16 a	1.20 a

r								
1st November	1.87 a	1.73 a	1.15 a	1.10 a	3.02 a	2.83 a	1.01 b	1.10 b
1st December	1.76 b	1.58 b	1.13 a	1.07 a	2.89 b	2.66 b	1.13 a	1.13 b
LSD at 0.05 level	0.08	0.06	0.04	NS	0.10	0.10	0.06	0.04

Effect of the interaction

The obtained results in Table 12 indicate that the interaction between the Beg Bill cultivar and middle transplanting on 1st November reflects a significant effect on the concentrations of chlorophyll a, b, total a+b and carotenoids in leaf tissues of head lettuce in both seasons at 75 days after planting.

Table (12). Effect of the interaction between lettuce cultivars and transplanting date on leaf pigments (mg /g FW) at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments		Chlorophyll a	Chlorophyll b	Total chlorophyll a+b	Carotenoides
Cvs	**Transplanting date**	**2024/2025 season**			
Big Bell	**1st October**	1.78 bc	1.12 bc	2.90 bc	1.12 abc
	1st November	1.99 a	1.20 a	3.19 a	0.98 d
	1st December	1.86 b	1.18 ab	3.04 b	1.09 bc
Lida F_1	**1st October**	1.48 d	1.04 c	2.52 d	1.21 a
	1st November	1.76 bc	1.10 bc	2.86 bc	1.04 cd
	1st December	1.66 c	1.09 c	2.75 c	1.18 ab
LSD at 0.05 level		0.12	0.06	0.14	0.09
		2025/2026 season			
Big Bell	**1st October**	1.64 b	1.12 a	2.76 bc	1.14 b
	1st November	1.96 a	1.12 a	3.08 a	1.09 b
	1st December	1.70 b	1.14 a	2.84 b	1.10 b
Lida F_1	**1st October**	1.52 c	1.03 bc	2.55 d	1.27 a
	1st November	1.50 c	1.08 ab	2.58 cd	1.11 b
	1st December	1.47 c	1.01 c	2.48 d	1.16 b
LSD at 0.05 level		0.09	0.06	0.15	0.06

Plant chemical composition
Effect of cultivars

Contents of N, P, and K in leaves and stems of the Beg Bill cultivar were higher than N, P and K contents in leaves and stem of Lida F_1 in both seasons at 75 days after transplanting (Table 13).

Results are in agreement with **Shahein *et al.* (2014)** indicated that Big-Bell produced the maximum contents of N, P, and K in leaves compared to Dark Green cv. In addition, **Ismail and Obeid (2023)** showed that local variety was responsible for a rise in leaf phosphorus compared to iceberg crisphead lettuce's.

Effect of transplanting date

The middle transplanting date of head lettuce (1st Nov.) recorded the highest contents of N, P, and K in leaves and stems in both seasons at 75 days after transplanting (Table 13) .

The response of the plant's vegetative growth to the transplanting date was linked to this influence of the transplanting date on microelement contents. The predominant temperature during the various transplanting dates Table (2), which influences nutrient absorption and migration to various morphological sections, may be the cause of the variations in the content of NPK in various plant organs among the studied transplanting dates.

Results are in harmony with **Abou EL-Yazied *et al.* (2007)**, who indicated that transplanting in October gave the highest calcium contents in leaves as compared to other transplanting dates, i.e., November and December. Also, **Hammood (2020)** showed that the first date (22/10) gave the highest contents of N, P, and K in the leaves compared to other dates 22/12, and 22/1 of lettuce.

Table (13). Effect of lettuce cultivars and transplanting date on N, P and K percentages in leaves and stem at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments	Leaves			Stem		
	N	P	K	N	P	K
	Effect of cultivars					
	2024/2025 season					
Big Bell	1.42 a	0.297 a	1.51 a	1.31 a	0.323 a	1.34 a
Lida F_1	1.17 b	0.268 b	1.32 b	1.08 b	0.294 b	1.17 b
LSD at 0.05 level	0.10	0.016	0.11	0.06	0.010	0.08
	2025/2026 season					
Big Bell	1.44 a	0.317 a	1.53 a	1.51 a	0.322 a	1.40 a
Lida F_1	1.31 b	0.290 b	1.43 a	1.26 b	0.293 b	1.20 b
LSD at 0.05 level	0.06	0.011	0.10	0.09	0.015	0.15
	Effect of transplanting date					
	2024/2025 season					
1st October	1.23 b	0.269 c	1.35 b	1.11 c	0.300 b	1.17 b
1st November	1.37 a	0.295 a	1.51 a	1.30 a	0.319 a	1.32 a
1st December	1.29 b	0.284 b	1.39 b	1.19 b	0.307 b	1.28 a
LSD at 0.05 level	0.07	0.010	0.07	0.04	0.007	0.05
	2025/2026 season					
1st October	1.31 c	0.297 b	1.40 b	1.29 c	0.300 b	1.20 b
1st November	1.44 a	0.309 a	1.55 a	1.46 a	0.317 a	1.38 a
1st December	1.38 b	0.306 a	1.50 a	1.39 b	0.306 b	1.33 a
LSD at 0.05 level	0.04	0.007	0.07	0.05	0.010	0.10

Effect of the interaction

The interaction between the Beg Bill cultivar and middle transplanting on 1st Nov., followed by the interaction between the Beg Bill cultivar and late transplanting on 1st Dec., are the best treatments for enhancing the contents of N, P, and K in leaves and stems at 75 days after transplanting in both seasons (Table 14).

Table (14). Effect of the interaction between lettuce cultivars and transplanting date on N, P and K percentage in leaves and stem at 75 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments		Leaves			Stem		
		N	P	K	N	P	K
Cvs	**Transplanting date**	**2024/2025 season**					
Big Bell	**1st October**	1.33 b	0.280 b	1.47 b	1.17 c	0.321 a	1.30 bc
	1st November	1.51 a	0.311 a	1.58 a	1.48 a	0.325 a	1.39 a
	1st December	1.43 a	0.300 a	1.48 ab	1.30 b	0.323 a	1.34 ab
Lida F_1	**1st October**	1.13 d	0.259 c	1.24 c	1.06 d	0.280 c	1.05 d
	1st November	1.24 bc	0.279 b	1.44 b	1.12 cd	0.313 a	1.26 bc
	1st December	1.16 cd	0.268 bc	1.30 c	1.08 d	0.291 b	1.22 c
LSD at 0.05 level		0.09	0.015	0.10	0.06	0.009	0.07
		2025/2026 season					
Big Bell	**1st October**	1.38 b	0.314 a	1.47 b	1.41 c	0.317 b	1.38 a
	1st November	1.54 a	0.321 a	1.60 a	1.61 a	0.332 a	1.43 a
	1st December	1.41 b	0.318 a	1.53 ab	1.51 b	0.319 ab	1.41 a
Lida	**1st October**	1.25	0.280 c	1.34	1.18	0.284	1.02 b

F_1		c		c	e	d	
	1st November	1.35 b	0.298 b	1.50 ab	1.32 cd	0.303 bc	1.34 a
	1st December	1.35 b	0.294 b	1.47 b	1.28 d	0.294 cd	1.25 a
LSD at 0.05 level		0.06	0.010	0.09	0.08	0.014	0.14

Head yield

Effect of cultivars

The obtained results in Table 15 indicate that the Beg bill cultivar gave higher edible head weight (332.37 and 340.82 g), edible head diameter (23.09 and 23.06 cm), edible head width (10.97 and 10.88 cm), and edible head height (16.33 and 16.19 cm), and average head weight (424.02 and 447.95 g) and total yield (20.162 and 21.268 ton/fed.) than the Lida F_1 cultivar in both seasons. The increases in total yield (ton/fed.) were about 2.169 and 2.728 ton /fed. for the Beg Bill cultivar over Lida F_1 cultivar in the 1st and 2nd seasons.

It was clear from these results that head yield results followed the same trend as the dry weight to a greater extent. Since Beg Bill is a variety superior in its dry weight of leaves, stem, and head, which allows plants to receive more light energy and, consequently, more photosynthesis and photosynthetic metabolites, which are translocated and stored in the main yield. In addition, the potentiality of the cultivar for absorbing and translating soil nutrients might also be one of the high-yield components.

The results are in harmony with **Robert *et al.* (2006)** tested some lettuce cultivars, i.e., Green Forest, Apache, Darkland, Tower, Ideal Cos, and Tall Guzmaine. They showed that Green Forest gave the highest head length and head weight, followed by Ideal Cos, while the Apache cultivar produced the highest marketable head. Also, **Shahein *et al.* (2014)** indicated that Big-Bell gave the highest total yield compared to Dark Green cv. However,**Silva *et al.* (2017)** showed that 'Itapuã 401 gave the highest values of head yield of lettuce as compared to other cultivars. In addition , **Rudolph *et al.* (2024)** showed that Vulcan lettuce cultivar produced a higher marketable yield than the other lettuce cultivars, i.e., Pirat, Harmon and Galactic cultivars. Also, **Madina *et al.* (2024)** and **Akter *et al.* (2026)** came to similar results; they showed that there were significant differences between lettuce cultivars for head yield.

Effect of transplanting date

Transplanting on 1st Nov. significantly increased edible head weight (341.58 and 337.67 g), edible head diameter (22.91 and 23.15 cm), edible head width (11.15 and 10.89 cm), edible head height (16.28 and 16.43 cm) and average head weight (425.50 and 432.53 g) and total yield (20.264 and 20.549 ton/fed.) followed by transplanting on 1st Dec., whereas early transplanting date on 1st Oct. gave the lowest values of this traits in both seasons (Table 15) .

The increases in total yield (ton/fed.) for transplanting date on 1st Nov. were about 1.365 and 0.701 ton /fed. and 2.195 and 1.233 over transplanting on 1st Dec. and 1st Oct. , respectively in both seasons.

Since environmental elements like temperature and light length change with different transplanting dates, it is one of the key factors that influences productivity by increasing the timing and duration of the vegetative and reproductive stages. Physiological functions like respiration and photosynthesis are directly impacted by certain components like temperature and light. In order to get the maximum productivity, it is crucial to determine the ideal date for transplanting lettuce that achieves the optimal limits for these characteristics (**Mahmoud, 2008**).

Table (15). Effect of lettuce cultivars on leaf traits of lettuce at 90 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments	**Edible head weight (g)**	**Edible head diameter (cm)**	**Edible head width (cm)**	**Edible head height (cm)**	**Average head weight (g)**	**Total yield (ton/fed.)**
	Effect of cultivars					
	2024/2025 season					
Big Bell	332.37 a	23.09 a	10.97 a	16.33 a	424.02 a	20.162 a
Lida F_1	301.82 b	19.87 b	9.92 b	15.29 b	378.63 b	17.993 b
LSD at 0.05 level	**24.01**	**1.09**	**0.20**	**0.09**	**33.12**	**0.843**
	2025/2026 season					
Big Bell	340.82 a	23.06 a	10.88 a	16.19 a	447.95 a	21.268 a
Lida F_1	303.98 b	21.41 b	10.27 b	15.16 b	390.97 b	18.540 b
LSD at 0.05 level	**26.49**	**0.82**	**0.39**	**0.24**	**24.84**	**1.00**
	Effect of transplanting date					
	2024/2025 season					
1st October	299.65 b	20.08 c	9.75 c	15.41 c	379.99 b	18.069

						c
1st November	341.58 a	22.91 a	11.15 a	16.28 a	425.50 a	20.264 a
1st December	310.05 b	21.46 b	10.44 b	15.75 b	398.49 b	18.899 b
LSD at 0.05 level	**15.76**	**0.71**	**0.13**	**0.06**	**21.74**	**0.553**
	2025/2026 season					
1st October	309.08 b	21.29 c	10.23 c	15.20 c	407.37 b	19.316 b
1st November	337.67 a	23.15 a	10.89 a	16.43 a	432.53 a	20.549 a
1st December	320.45 ab	22.26 b	10.62 b	15.40 b	418.47 ab	19.848 b
LSD at 0.05 level	**17.93**	**0.54**	**0.26**	**0.16**	**16.30**	**0.661**

The appropriate prevalent meteorological conditions, particularly temperature (Table 2), which positively affect and boost the vegetative growth phase of the plant, may be the cause of the increases in head production during the middle transplanting date. Additionally, these appropriate metrological parameters raised the concentration of photosynthetic pigments (Table 12) and macronutrient contents (Table 13), which raised average head weight and total yield per feeding. The highest temperature during the vegetative growth period may have increased the use of assimilated materials in respiration, which in turn decreased the anabolic rate of new plant parts and, ultimately, reduced plant growth. However, the early transplanting date of 1st Oct. resulted in the reduction of all tested morphological characters.

Results are in harmony with **Sharma *et al.* (2009)** showed that transplanting on 16 Jan. gave maximum total yield as compared to other transplanting dates (8 Oct., 2 Nov., 27 Nov., 22 Dec., 10 Feb., and 5 March). In addition, **Kaleri *et al.* (2016)** found that the maximum marketable leaves per plant were determined on 1st November, while the highest yield (kg ha^{-1}) was obtained on 15th November as compared to other transplanting dates (15th Sept., 1st Oct., 15th Oct., and 1st December). Also, **Hammood (2020)** showed the second transplanting date (22/11) and first transplanting date (22/10), exceeding the number of wrapped leaves, fresh weight, dry weight of the leaves, weight of the marketing head, or total marketing production as compared to other transplanting dates (22/12 and 22/1).

Effect of the interaction

The highest edible head weight (349.70 and 361.40 g), edible head diameter (24.50 and 24.17 cm), edible head width (11.57 and 11.48 cm), and edible head height (16.55 and 16.88 cm) and average head weight (440.30 and 467.68 g) and total yield (21.000 and 22.218 ton/fed.) were obtained from the interaction between Beg Bill cultivar and transplanting date on 1st Nov. in both seasons. The interaction between Lida F_1 cultivar and early transplanting on 1st Oct. gave the lowest values of head yield (Table 16).

Under all transplanting dates (1st Oct. 1st Nov. and 1st Dec.) Beg Bill cultivar gave highest edible head weight , head diameter, head width, head height , average head weight and total yield than Lida F_1 in both seasons.

The stimulative effect on the interaction between the Beg Bill cultivar and transplanting on 1st Nov. on total yield may be due to that this treatment increased edible head weight, head diameter, head width, head length and average head weight.

Table (16). Effect of the interaction between lettuce cultivars and transplanting date on head yield of lettuce at 90 days after transplanting in 2024/2025 and 2025/2026 seasons

Treatments		**Edible head weight (g)**	**Edible head diameter (cm)**	**Edible head width (cm)**	**Edible head height (cm)**	**Average head weight (g)**	**Total yield (ton/fed.)**
Cvs	**Transplanting date**	**2024/2025 season**					
Big Bell	**1st October**	317.85 bc	22.16 bc	10.25 d	16.07 c	403.30 bc	19.118 c
	1st November	349.70 a	24.50 a	11.57 a	16.55 a	440.30 a	21.001 a
	1st December	329.55 ab	22.63 b	11.09 b	16.38 b	428.46 ab	20.366 ab
Lida F1	**1st October**	281.45 d	18.01 e	9.25 f	14.75 e	356.68 d	17.019 d
	1st November	333.45 ab	21.32 c	10.73 c	16.01 c	410.70 ab	19.528 bc
	1st December	290.55 cd	20.30 d	9.80 e	15.12 d	368.52 cd	17.432 d
LSD at 0.05 level		**22.29**	**1.01**	**0.19**	**0.09**	**30.74**	**0.783**
		2025/2026 season					
Big	**1st October**	328.90	22.01 c	10.33	15.68	430.68	20.414 b

Bell		b		c	c	b	
	1st November	361.40 a	24.17 a	11.48 a	16.88 a	467.68 a	22.218 a
	1st December	332.15 b	23.00 b	10.85 b	16.02 b	445.48 ab	21.172 b
Lida F1	**1st October**	289.25 c	20.57 d	10.13 c	14.72 d	384.06 c	18.217 c
	1st November	313.95 b	22.13 bc	10.30 c	15.98 b	397.38 c	18.879 c
	1st December	308.75 bc	21.53 c	10.40 bc	14.78 d	391.46 c	18.524 c
LSD at 0.05 level		**24.59**	**0.76**	**0.36**	**0.23**	**23.06**	**0.935**

Head quality
Effect of cultivars

Data in Table 17 indicate that the Big Bell cultivar contains 25.50 and 24.69 mg/100 g Vit C, 23.656 and 23.04% total carbohydrate, and 3.95 and 3.85% TSS in leaves against 24.93 and 23.48 Vit C, 22.66 and 22.94 total carbohydrates, and 3.56 and 3.63 TSS for Lida F_1 in both seasons.

The varieties of any crop can express their potentiality only when grown under optimum conditions, and generally the time of transplanting depends on the climate of a region and the variety to be grown and the purposes of growing crops. So, transplanting time is crucial for the yield and quality, which is an excellent source of vitamin C and folic acid (**Moniruzzaman *et al***., 2007).

Results are in harmony with those obtained with **AL-Dabbagh *et al*. (2014),** who showed that Regina dei ghiacci variety has been significantly superior in the percentage of protein to the Great Lakes 118 variety. Also, **Shahein *et al*. (2014)** indicated that the Big-Bell cv. recorded the highest values of TSS in leaves compared to the Dark Green cv. in addition, **Attallah, and Abdalla (2021)** showed that the 'Romaine' cv. showed higher TSS than the Green waves cv., while there was no significant difference between the two tested cultivars regarding vitamin C content. However, **Abbawi and Al-Zubaidi (2022)** indicated that the Matsuri cultivar produced the highest vitamin C, TSS, and protein percentage compared to the Jassmine and Domo cultivars of broccoli plants. Also, **Rakočević *et al*. (2023)** showed that Kibou variety produced the highest vitamin C in leaves, followed by Levistro, while Carmol variety gave the lowest values. In addition, **Zou *et al.* (2025)** showed that the butterhead variety recorded a higher dry matter content than lettuce Spanish green.

Effect of transplanting date

Middle transplanting on 1st Nov. recorded maximum values of Vit C (26.44 and 24.98 mg/100 g FW), total carbohydrates (24.70 and 24.40%), and TSS (3.79 and 3.74 brix) in both seasons, followed by transplanting on 1st Dec., whereas early transplanting on 1st Oct. recorded minimum values of these traits (Table 17).

Results are in harmony with **Hammood (2020),** who showed that the second (22/11) and first (22/10) dates gave the highest total carbohydrate concentration in lettuce as compared to the third and fourth plant dates, i.e., 22/12 and 22/1.

Table (17). Effect of lettuce cultivars and transplanting date on vitamin C, total carbohydrates and total soluble solids in leaves of lettuce of lettuce at 90 days after transplanting during 2024/2025 and 2025/2026 seasons

Treatments	**Vit C (mg /100 g FW)**		**Total carbohydrates (%)**		**TSS (brix º)**	
	2024/2025 season	**2025/2026 season**	**2024/2025 season**	**2025/2026 season**	**2024/2025 season**	**2025/2026 season**
	Effect of cultivars					
Big Bell	25.50 a	24.69 a	23.65 a	23.04 a	3.95 a	3.83 a
Lida F_1	24.93 b	23.48 b	22.66 b	22.94 a	3.56 b	3.63 b
LSD at 0.05 level	0.30	0.20	0.09	NS	0.08	0.09
	Effect of transplanting date					
1st October	24.23 c	23.18 c	21.95 c	22.11 c	3.73 b	3.70 a
1st November	26.44 a	24.98 a	24.70 a	24.40 a	3.79 a	3.74 a
1st December	24.98 b	24.09 b	22.82 b	22.46 b	3.74 b	3.75 a
LSD at 0.05 level	0.20	0.13	0.05	0.07	0.05	NS

Effect of the interaction

The best Vit C in head of lettuce (26.87 and 25.18 mg/100 g FW), total carbohydrates (25.12 and 24.44%), and TSS (3.97 and 3.88 brix in leaves) were obtained from the interaction between the Beg Bill cultivar and transplanting on 1st Nov. compared to other treatments (Table 18).

For all treatments, Vit. C (mg/100 g FW) in leaves of head lettuce ranged from 26.87 to 25.37 mg/100 g FW) in the 1st season and ranged from 25.18 to 22.25 mg/100 g FW in the 2nd season, and TSS in leaves ranged from 3.97 to 3.51 brix in the 1st season and ranged from 3.88 to 3.67 brix in the 2nd season. There was a positive correlation between vitamin C and TSS in leaves.

Conclusion

From the foregoing results, it could be concluded that Big Bell cultivar transplanting on 1st Nov. gave the highest values of plant height, stem height, stem diameter, outer leaf number, inner leaf number, total number of leaves / plant, leaf length, width, leaf area, dry weight of leaves and total dry weight / plant, N, P, and K contents in leaves and stem, chlorophyll , b, total a+b, carotenoids, edible head weight, edible head diameter, edible head width, and edible head length; average head weight; and total yield as well as head quality (Vit C and TSS), whereas Lida F_1, transplanting on 1st Oct. and the interaction between them gave the lowest values of these traits in both seasons.

Table (18). Effect of the interaction between lettuce cultivars and transplanting date on vitamin C, total carbohydrates and total soluble solids in leaves of lettuce of lettuce at 90 days after transplanting during 2024/2025 and 2025/2026 seasons

Treatments		Vit C (mg /100 g FW)	Total carbohydrates (%)	TSS (brix º)
Cvs	**Transplanting date**	**2024/2025 season**		
Big Bell	**1st October**	25.10 c	22.30 d	3.95 a
	1st November	26.87 a	25.12 a	3.97 a
	1st December	24.55 d	23.54 c	3.93 a
Lida F1	**1st October**	23.37 e	21.61 f	3.51 c
	1st November	26.02 b	24.28 b	3.62 b
	1st December	25.41 c	22.11 e	3.55 bc
LSD at 0.05 level		0.28	0.08	0.07
		2025/2026 season		
Big Bell	**1st October**	24.12 c	22.14 d	3.74 b
	1st November	25.18 a	24.44 a	3.88 a
	1st December	24.77 b	22.54 b	3.89 a
Lida F1	**1st October**	22.25 e	22.08 d	3.67 bc
	1st November	24.78 b	24.36 a	3.61 c
	1st December	23.41 d	22.38 c	3.62 c
LSD at 0.05 level		0.19	0.10	0.09

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