Zagazig J. Agric. Res., Vol. 50 No. (4) 2023 437-450

Plant Production Science

Available online at http://zjar.journals.ekb.eg
http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

EFFECT OF TRANSPLANTING DATE ON VEGETATIVE CHARACTERS, LEAF PIGMENTS AND YIELD OF SOME CAULIFLOWER HYBRIDS UNDER SANDY SOIL CONDITIONS

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Received: 04/06/2023 ; Accepted: 25/06/2023

ABSTRACT: This work was carried at a private vegetable farm (Sand Valley Experimental Station) Ismailia Governorate, Egypt during the two successive fall seasons of 2020 and 2021 to study the effect of transplanting date on vegetative growth, leaf pigments and productivity of five cauliflower hybrids under sandy soil conditions. This experiment was include 10 treatments, which were the combinations between two transplanting dates (transplanting in 1st August and transplanting in 1st September) and five cauliflower hybrids (Barkha, Solid Snow, Mexico, Fargo and Raoul). These treatments were arranged in a split plot design with three replications. Transplanting dates were randomly distributed in the main plots, while the cauliflower hybrids were randomly arranged in the sub-plots. The most important results were summarized as follows: The interaction between transplanting date in 1st Sept. and Fargo hybrid recorded the maximum values of plant height, number of leaves lant, leaf length, leaf width and leaf area, whereas the interaction between transplanting in 1stAugust and Barkha hybrid gave the highest concentrations of chlorophyll a, b, (a+b) and carotenoides in leaf tissues of cauliflower in both seasons. The interaction between transplanting date in 1st Sept and Mexico hybrid gave he highest values of total yield/faddan with no significant differences with the interaction between transplanting in 1st Sept. and Fargo hybrid in the 1st season. However, the interaction between transplanting in 1st Sept, and Raoul hybrid significantly increased N, P and K contents in curd in both seasons.

Key wards: Cauliflower, transplanting date, hybrids, leaf pigments, yield.

INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L) is an important cole crop and nutritionally the curd is rich in protein, vitamin C and minerals. Cauliflower is often considered one of the healthiest foods on Earth, because supply of health-promoting phytochemicals, high level of anti-inflammatory compounds, and ability to ward off cancer, heart diseases and brain diseases (**USDA, 2018**).

Cauliflower crop is highly thermo sensitive and variation in temperature significantly influences both vegetative and generative phases of the crop. Planting time plays crucial role for curd initiation and development. Improper planting time and faulty selection of variety may drastically affects the crop growth and curd yield (**Islam *et al*., 2016**).

Cauliflower is very sensitive to temperature depending on varieties so, selection of varieties depends on time of planting. So, selection of suitable varieties for sowing at proper time is the key factor for successful cauliflower production (**Rahman *et al*., 2013** and **Refai and Hassan, 2019**) and the transplanting time should be adjusted in such a manner that plants put up maximum vegetative growth before the temperature goes very low and cauliflower growth is best at a temperature of about 15 to 25^0C (**Kumari *et al*., 2019**).

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Generally, the varieties of any crop can express their potentiality only when grown under optimum conditions. Generally the time of planting depends on the climate of a region and the variety to be grown **(Firoz *et al.*, 2000)** and the purposes of growing crops.

In addition, plant varieties differ in their potential growth and productivity mainly due to the physiological processes controlled by the interaction of both genetic and environmental variability. This diversity can be attributed to the adaptability of genes, morphological characteristics and physiological factors exposed during the crop growth period (**Olaniyi, *et al*. 2010**).

This study was conducted with an objective to find out optimum planting time and to select suitable hybrid of cauliflower for successful cultivation under sandy soil conditions.

MATERIALS AND METHODS

This study was carried out during the two successive fall seasons of 2020 and 2021 at a Private Vegetable Farm (Sand Valley Experimental Station) Ismailia Governorate, Egypt, to study the effect of two transplanting date (Transplanting on 1st August and 1st September) on growth and yield of five cauliflower hybrids (Barkha, Solid Snow, Mexico, Fargo and Raoul) under sandy soil conditions.

These treatments were arranged in a split plot design with three replications. Transplanting dates were randomly distributed in the main plots, while the cauliflower hybrids were randomly arranged in the sub-plots.

Cauliflower seedlings (about 20 cm length) were transplanted at 40 cm apart. The experimental unit area was 14 m^2. It contains four ridges with 5m length each and 70 cm distance between each two bridges. One line was used for taking the samples to measure the morphological and chemical traits and the other lines were used for yield determinations.

All treatments received equal amounts of ammonium sulphate (20.5 % N), ammonium nitrate 33.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate at a rate of 200, 200, 250 and 200 kg/fad, respectively. 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. The rest of N and all K added three portions as soil application at 15 days intervals beginning 30 days after transplanting. The other conventional practices were applied according to cauliflower cultivations in Egypt.

Data Recorded

A random sample of four plants from every experimental unit were randomly taken at 60: 120 days after transplanting (at curd mature stage) in the two growing seasons to measure vegetative growth parameters, and photosynthetic pigments in leaves as follows:

Vegetative growth parameters

Plant height (cm), stem height (cm), number of leaves/plant, leaf length (cm) and width as well as leaf area (cm^2)

Photosynthetic pigments

Chlorophyll a, b and total (a+b) as well as carotenoides were determined in the fourth leaf according to the method described by **Wettestein (1957)**.

Curds yield

The harvest started at 67, 88, 116, 123 and 132 days after transplanting (average two seasons) for Barkha, Solid snow, Mexico, Fargo and Raoul respectively. Plants of the two inner ridges were used for curds yield determination (ton/fad.).

Chemical constituents in curd

The dry weight of curd finely ground and digesting with sulfuric acid and perchloric acid (3:1) nitrogen, phosphorus and potassium content were determined as dry weight basis according to the methods described by **Bremner and Mulvaney (1982**), **Olsen and Sommers (1982)** and **Jackson (1970),** respectively.

Statistical Analysis

Recorded data in both experiments were subjected to the analysis of variance to **Snedecor and Cachran (1980).** Mean separation was done by **Duncan (1958).**

Table 1. Meteorological data at Ismailia during the two growing seasons 2020 and 2021season

Month	Temperature (°C)			RH%
	Max	Min	Mean	
		2020 season		
August	38.16	22.06	30.86	54.60
September	33.84	22.39	27.55	61.16
October	31.73	20.05	25.19	66.26
November	24.48	14.36	20.21	64.20
December	22.15	10.88	16.15	64.45
		2021 season		
August	38.35	23.56	30.96	49.76
September	34.56	21.26	27.91	56.64
October	30.10	18.65	24.38	61.29
November	27.38	15.93	21.66	62.30
December	19.91	10.14	15.03	64.80

These data were obtained from the Central Laboratory for Agricultural Climate (CLAC).

RESULTS AND DISCUSSION

Vegetative Characters

Effect f transplanting dates

Data in Tables 2 to 7 indicate that transplanting of cauliflower in 1st Sept gave higher plant height, number of leaves/plant, leaf length, leaf width and leaf area, whereas transplanting in 1st August gave higher stem height in both seasons.

In this connection higher vegetative growth of the 1st Sept planting date might be due to the prevailing suitable temperature (Table 1) and better meteorological conditions, i.e., sunshine and day length of the medium planting date compared with early and late planting dates. These moderate conditions allow more photosynthesis and more metabolites reflecting better vegetative growth in addition the suitable temperature for absorption and translocation of soil solution by the root system.

These results are harmony with those reported with **Rahman *et al.* (2016)** and **Refai and Hassan (2019)** on cauliflower.

Effect of hybrids

There were significant differences among cauliflower hybrids in plant height, stem height, number of leaves/plant, leaf length, leaf width and leaf area in both seasons (Tables 2 to 7). Fargo hybrid gave the highest values of plant height, stem length, number of leaves/plant, leaf length,, leaf width and leaf area followed by Mexico and Raoul hybrids, whereas Barkha hybrid gave the lowest values from these parameters in both seasons.

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

The previous data are in a line with those obtained by **Islam *et al.* (2016)** and **Naik *et al.* (2016).** They showed that there were significant differences among cauliflower cultivars or varieties in vegetative growth parameters.

Table 2. Effect of transplanting date (D), hybrids (H) and their interaction on plant height (cm) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	74.06 cd	71.78 de	69.67 e	80.33 b	75.11 c	**74.19 B**
1st September	65.33 f	79.11 b	85.22 a	85.11 a	79.83 b	**78.92 A**
Mean (H)	**69.69 D**	**75.44 C**	**77.44 B**	**82.72 A**	**77.47 B**	
			2021 season			
1st August	68.06 g	79.00 e	82.56 d	86.67 c	82.78 d	**79.81 B**
1st September	63.67 h	75.00 f	89.00 b	89.67 a	89.22 ab	**81.31 A**
Mean (H)	**65.86 D**	**77.00 C**	**85.78 B**	**88.17 A**	**86.00 B**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 3. Effect of transplanting date (D), hybrids (H) and their interaction on stem height (cm) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	18.56 e	18.56 e	28.22 c	31.00 b	33.00 a	**25.86 A**
1st September	15.00 f	15.56 f	26.22 d	32.67 a	25.89 d	**23.06 B**
Mean (H)	**16.78 D**	**17.06 D**	**27.22 C**	**31.83 A**	**29.44 B**	
			2021 season			
1st August	25.89 d	23.00 e	30.11 b	34.89 a	27.33 c	**28.24 A**
1st September	15.56 f	16.56 f	22.67 e	28.67 bc	21.56 e	**21.00 B**
Mean (H)	**20.72 D**	**19.78 E**	**26.39 B**	**31.78 A**	**24.44 C**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 4. Effect of transplanting date (D), hybrids (H) and their interaction on number of leaves/ plant of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	32.00 fg	31.33 g	35.44 e	36.33 de	33.33 f	**33.68 B**
1st September	32.56 fg	39.56 c	48.78 a	46.67 b	37.67 d	**41.04 A**
Mean (H)	**32.28 C**	**35.44 B**	**42.11 A**	**41.50 A**	**35.50 B**	
			2021 season			
1st August	44.44 g	47.44 f	49.44 d	53.11 c	48.44 e	**48.57 B**
1st September	39.33 h	54.33 b	54.22 b	61.67 a	37.67 i	**49.44 A**
Mean (H)	**41.88 E**	**50.88 C**	**51.83 B**	**57.39 A**	**43.05 D**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 5. Effect of transplanting date (D), hybrids (H) and their interaction on leaf length (cm) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	57.78 d	53.56 f	58.33 d	56.56 e	51.33 g	55.51 B
1st September	53.11 f	55.89 e	60.67 c	66.67 a	61.67 b	59.60 A
Mean (H)	55.44 D	54.72 E	59.50 B	61.61 A	56.50 C	
			2021 season			
1st August	58.56 e	55.78 f	60.44 d	60.44 d	58.78 e	58.80 B
1st September	54.33 f	63.67 c	65.78 b	67.44 a	60.89 d	62.42 A
Mean (H)	56.44 C	59.72 B	63.11 A	63.94 A	59.83 B	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 6. Effect of transplanting date (D), hybrids (H) and their interaction on leaf width (cm) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	24.11 e	21.11 g	26.33 c	25.89 c	26.22 c	24.73 B
1st September	21.89 f	24.56 de	27.44 b	30.33 a	25.00 d	25.84 A
Mean (H)	23.00 D	22.83 D	26.88 B	28.11 A	25.61 C	
			2021 season			
1st August	24.22 e	22.78 f	24.78 de	25.06 d	24.67 de	24.30 B
1st September	22.11 f	24.78 de	29.56 b	31.33 a	26.11 c	26.77 A
Mean (H)	23.16 E	23.78 D	27.17 B	28.19 A	25.39 C	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 7. Effect of transplanting date (D), hybrids (H) and their interaction on leaf area (cm^2) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	1393.1 f	1270.7 g	1497.7 d	1514.6 d	1450.1 e	**1425.2 B**
1st September	1162.6 h	1577.7 c	1944.5 b	2112.9 a	1589.8 c	**1677.5 A**
Mean (H)	**1277.8 E**	**1424.2 D**	**1721.1 B**	**1813.8 A**	**1520.0 C**	
			2021 season			
1st August	1130.7 h	1535.8 e	1464.3 f	1345.9 g	1450.1 f	**1385.4 B**
1st September	1372.7 g	1664.8 c	2022.1 b	2112.9 a	1589.8 d	**1752.5 A**
Mean (H)	**1251.7 D**	**1600.3 B**	**1743.2 A**	**1729.4 A**	**1520.0 C**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Effect of the interaction

The interaction between transplanting dates and hybrids had significant effect of all plant growth parameters in both seasons. The interaction between transplanting date in 1st Sept. and Fargo hybrid recorded the maximum values of plant height, number of leaves/plant, leaf length,, leaf width and leaf area, whereas the interaction between transplanting in 1st Sept. and Barkha hybrid recorded the minimum values of all plant growth characters in both seasons (Tables 2 to 7).

Cauliflower is very sensitive to temperature depending on varieties so, selection of varieties depends on time of planting. Selection of suitable varieties for sowing at proper time is the key factor for successful cauliflower production (**Rahman *et al*., 2013** and **Refai and Hassan, 2019**). Some investigators reported that the combined effect of planting date and cultivars affected cauliflower growth **(Nooprom and Santipracha, 2013; Debnath *et al*., 2015)**.

Photosynthetic Pigments

Effect of transplanting dates

Data listed in Tables 8 to 11 show the effect of transplanting dates on chlorophyll a, b, chlorophyll (a+b) and carotenoides in leaves of cauliflower in both growing season. The maximum concentrations of chlorophyll a, b and total (a+b) and carotenoides in leaves were recorded when transplanting cauliflower in 1st Sept. as compared to transplanting in 1st August in both seasons.

These findings are in agreement with those obtained by **Kanase *et al.* (2018)** on Broccoli who reported that chlorophyll a, b, chlorophyll (a+b) and carotenoides in leaves measurements were significantly affected by planting date.

Effect of hybrids

There were significant differences among five hybrids in chlorophyll a, b, a + b and carotenoides in leaf tissues and Barkha and Mexico hybrids gave the highest concentrations of chlorophyll a, b , a+b and carotenoides in leaf tissues, while Raoul hybrid gave the lowest concentrations of all leaf pigments in both seasons (Tables 8, 9, 10 and 11).

These results are in agreement with those obtained by **Dhakal *et al*. (2019), Mijwel and Ridha (2021)** and **Tawfeeq and Abdulrhman (2021).** They found that there were significant differences among cultivars regarding total chlorophyll in leaves of cauliflower.

Effect of the interaction

Different concentrations of chlorophyll a, b, (a + b) and carotenoides in leaf tissues of cauliflower had significant affected by the interaction between transplanting dates and hybrids in both seasons (Tables 8, 9, 10 and 11). The interaction between transplanting date in 1st Sept. and Barkha hybrid gave the highest concentrations of chlorophyll a, b, (a+b) and carotenoides in leaf tissues of cauliflower, while Raoul hybrid gave the lowest concentrations of all leaf pigments when transplanted in 1st August in both seasons.

Total Yield/fad.

Effect of transplanting date

Data in Table 12 show the effect of transplanting dates on total yield of curds in both seasons. Data also, that there were significant differences between two transplanting dates regarding total yield of curds in 2020 and 2021 seasons. Transplanting cauliflower in 1st Sept. recorded higher total yield of curds (39.18 and 40.53 ton / fad.) than transplanting in 1st August (36.66 and 37.17 ton/fad.) in the 1st and 2nd seasons, respectively. The increases in total yield of curds due to transplanting in 1st Sept were about 2.52 and 3.36 tons than transplanting in 1st August in the 1st and 2nd seasons, respectively.

The longer crop duration in late planting might be due to higher temperature in early growth stage resulting in more vegetative growth period than in later planting and was in accordance of the explanations of (**Islam *et al*., 2016**). According to **Ara *et al.* (2009**), quick curd initiation on late planting was due to the exposure of plant to favourable climate for shorter period for vegetative growth and the subsequent higher temperature hastened the curd initiation and hence reached the harvesting stage faster than early planted cauliflower.

Table 8. Effect of transplanting date (D), hybrids (H) and their interaction on chlorophyll a (mg/g DW) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	3.23 a	2.85 e	3.04 c	2.65 f	2.54 g	**2.86 B**
1st September	2.84 e	2.83 e	3.03 c	3.17 b	2.96 d	**2.97 A**
Mean (H)	**3.04 A**	**2.84 C**	**3.03 A**	**2.91 B**	**2.75 D**	
			2021 season			
1st August	3.55 a	3.13 d	3.34 bc	2.92 e	2.71 f	**3.13 B**
1st September	3.12 d	3.12 d	3.35 bc	3.38 b	3.25 c	**3.25 A**
Mean (H)	**3.33 A**	**3.13 B**	**3.34 A**	**3.15 B**	**2.98 C**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 9. Effect of transplanting date (D), hybrids (H) and their interaction on chlorophyll b (mg/g DW) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	2.11 a	1.84 e	1.96 c	1.69 g	1.65 h	**1.85 B**
1st September	1.83 e	1.80 f	1.96 c	2.09 b	1.92 d	**1.92 A**
Mean (H)	**1.97 A**	**1.82 D**	**1.96 B**	**1.89 C**	**1.78 E**	
			2021 season			
1st August	2.19 a	1.93 d	2.07 b	1.75 f	1.71 g	**1.93 B**
1st September	1.90 de	1.87 e	2.08 b	2.18 a	2.00 c	**2.01 A**
Mean (H)	**2.05 B**	**1.90 D**	**2.08 A**	**1.96 C**	**1.86 E**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 10. Effect of transplanting date (D), hybrids (H) and their interaction on total chlorophyll a+b (mg/g DW) in leaf of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	5.35 a	4.70 e	5.00 c	4.34 f	4.19 g	**4.72 B**
1st September	4.68 e	4.64 e	4.99 c	5.26 b	4.88 d	**4.89 A**
Mean (H)	**5.01 A**	**4.67 C**	**5.00 A**	**4.80 B**	**4.53 D**	
			2021 season			
1st August	5.74 a	5.07 e	5.41 c	4.68 f	4.43 g	**5.07 B**
1st September	5.03 e	5.00 e	5.44 c	5.56 b	5.26 d	**5.26 A**
Mean (H)	**5.39 A**	**5.03 C**	**5.42 A**	**5.12 B**	**4.84 D**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 11. Effect of transplanting date (D), hybrids (H) and their interaction on carotenoides (mg /g DW) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	2.76 a	2.46 e	2.62 c	2.25 g	2.16 h	**2.45 B**
1st September	2.44 e	2.42 f	2.62 c	2.73 b	2.56 d	**2.55 A**
Mean (H)	**2.60 B**	**2.44 D**	**2.62 A**	**2.49 C**	**2.36 E**	
			2021 season			
1st August	2.90 a	2.61 bcde	2.78 abcd	2.42 ef	2.31 f	**2.61 A**
1st September	2.59 cde	2.56 def	2.78 abc	2.86 ab	2.72 abcd	**2.71 A**
Mean (H)	**2.75 A**	**2.59 B**	**2.78 A**	**2.64 AB**	**2.52 B**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 12. Effect of transplanting date (D), hybrids (H) and their interaction on curd yield (ton/ fad.) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	28.80f	33.15e	37.20d	42.30bc	41.85c	**36.66B**
1st September	22.95g	36.15d	46.05a	46.80a	43.95b	**39.18A**
Mean (H)	**25.88E**	**34.65D**	**41.63C**	**44.55A**	**42.90B**	
			2021 season			
1st August	31.20e	31.05ef	42.30c	46.35b	34.95d	**37.17B**
1st September	27.90f	37.35d	53.55a	46.50b	37.35d	**40.53A**
Mean (H)	**29.55D**	**34.20C**	**47.93A**	**46.43A**	**36.15B**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Adequate vegetative growth and carbohydrate accumulation contributes a lot in the development of economic part in cauliflower. Hence, vigorous plants ultimately led to larger curd size. In contrast, those sowing dates having inadequate vegetative growth resulted into small curds. Significant differences among sowing dates and curd yield were earlier reported by **Naik *et al*. (2016), Rahman *et al*. (2016) and Baral *et al.* (2020)** on cauliflower.

Effect of hybrids

Data in Table 12 show that there were significant differences among different hybrids two in yield and its components in 2020 and 2021 seasons. Fargo hybrid gave the highest yield of curds /faddan with no significant differences with Mexico hybrid in the 2nd season. This means that Fargo and Mexico hybrids gave the highest total yield of curd in both seasons.

Plant varieties differ in their potential growth and productivity mainly due to the physiological processes controlled by the interaction of both genetic and environmental variability. This diversity can be attributed to the adaptability of genes, morphological characteristics and physiological factors exposed during the crop growth period (**Olaniyi *et al*. 2010**). And it is necessary to divide the phenotypic variance into various components such as environmental and genetic depending on genetic, environmental parameters with phenotypic and genotypic coefficients of variations and differences with degree of inheritance (**Hadi *et al*., 2017**).

Varietals variation for yield of cauliflower was reported by **Hossaina *et al.* (2020), Mijwel and Ridha (2021)** and **Pandey *et al*. (2021)** on cauliflower.

Effect of the interaction

The interaction between transplanting dates and cauliflower hybrids had significant effect on total yield of curds /fad. in both grown seasons under sandy soil conditions (Table 12). The interaction between transplanting date in 1st Sept. and Mexico hybrid gave he highest values of total yield of curd /fad. with no significant differences with the interaction between transplanting in 1st Sept. and Fargo hybrid in the 1st season.

The interaction between transplanting dates and varieties for total yield was earlier reported by **Ara *et al*. (2009)** on cauliflower, they showed that the weight of marketable curd per plant highest in CL0134 when coupled in late planning.

Chemical Constituents in Curd

Effect of transplanting dates

Data in Tables 13, 14 and 15 show the effect of transplanting dates on nitrogen, phosphorus and, potassium contents in curd of cauliflower in both seasons. Transplanting of cauliflower in 1st Sept. significantly increased N, P and K contents in curd as compared to transplanting in 1st August.

These results are in agreement with the literature of **Salman and Abdul Razzaq (2022)** showed that, the first cultivation date planting in September gave the most significant values in the content of nitrogen, phosphorous and potassium in broccoli compared to the second cultivation date (planting in October).

Effect of hybrids

There were significant differences among cauliflower hybrids in N, P and K contents and Raoul hybrid gave the highest N, P and K contents in both seasons (Tables 13, 14 and 15). The differences among varieties, or cultivars respond differently for their genotypic characters, input requirement, growth process and the prevailing environment during the growing season.

In this regard**, Mijwel and Ridha (2021)** evaluated five Cauliflower varieties namely Fujiyama, Cezar, Barq, Lamar and Alnahar, they found that Cezar variety gave the maximum concentration of total nitrogen and total carbohydrates in curd as compared other varieties.

Effect of the interaction

Data in Tables 13, 14 and 15 indicated that the interaction between transplanting dates and cauliflower hybrid reflected a significant effect on N, P and K contents in curd of cauliflower in both seasons. The interaction between transplanting in 1st Sept. and Raoul hybrid significantly increased N, P and K contents in curd in both seasons.

Table 13. Effect of transplanting date (D), hybrids (H) and their interaction on nitrogen contents in curd (%) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
2020 season						
1st August	2.39 de	2.07 f	1.82 g	2.11 f	2.27 ef	**2.13 B**
1st September	1.64 g	2.79 bc	2.62 cd	2.85 b	3.09 a	**2.59 A**
Mean (H)	**2.01 D**	**2.43 B**	**2.22 C**	**2.48 B**	**2.68 A**	
2021 season						
1st August	2.03 e	2.11 de	1.82 f	1.78 f	2.23 d	**1.99 B**
1st September	2.75 b	2.87 b	2.62 c	2.58 c	3.11 a	**2.78 A**
Mean (H)	**2.39 C**	**2.49 B**	**2.22 D**	**2.18 D**	**2.67 A**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 14. Effect of transplanting date (D), hybrids (H) and their interaction on phosphorus contents in curd (%) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	0.536 e	0.417 g	0.483 f	0.496 f	0.584 d	**0.503 B**
1st September	0.651 c	0.766 b	0.558 e	0.543 e	0.881 a	**0.679 A**
Mean (H)	**0.593 B**	**0.591 B**	**0.520 C**	**0.519 C**	**0.732 A**	
			2021 season			
1st August	0.539 e	0.587 d	0.487 f	0.491 f	0.761 b	0.573 B
1st September	0.421 g	0.655 c	0.561 e	0.548 e	0.879 a	0.612 A
Mean (H)	**0.480 D**	**0.621 B**	**0.524 C**	**0.519 C**	**0.820 A**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

Table 15. Effect of transplanting date (D), hybrids (H) and their interaction on potassium contents in curd (%) of cauliflower plants grown in sandy soil conditions during 2020 and 2021 seasons

Transplanting dates (D)	Hybrids (H)					Mean (D)
	Barkha	Solid Snow	Mexico	Fargo	Raoul	
			2020 season			
1st August	2.45 e	2.11 h	1.85 i	2.24 g	2.36 f	**2.20 B**
1st September	2.04 h	2.94 c	2.64 d	3.08 b	3.37 a	**2.81 A**
Mean (H)	**2.24 D**	**2.52 C**	**2.24 D**	**2.66 B**	**2.86 A**	
			2021 season			
1st August	2.41 e	2.17 g	1.81 h	2.29 f	2.43 e	**2.22 B**
1st September	2.06 g	2.96 c	2.68 d	3.11 b	3.39 a	**2.84 A**
Mean (H)	**2.23 D**	**2.56 C**	**2.24 D**	**2.70 B**	**2.91 A**	

Values having the same alphabetical letter(s) did not significantly difference at the 0.05 level of significance, according to Duncan's multiple range test.

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تأثير ميعاد الشتل على الصفات الخضرية، صبغات الورقة والمحصول لبعض هجن القنبيط تحت ظروف الأرض الرملية

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أجريت هذه الدراسة خلال الموسمين المتتاليين لخريف 2020 و 2021 في مزرعة خضر خاصة بمحطة ساند فالى التجريبية) بمحافظة الإسماعيلية ، مصر ، لدراسة تأثير مواعيد الشتل المختلفة (الشتل فى الأول من أغسطس، الشتل فى الاول من سبتمبر على نمو وصبغات التمثيل الضوئى وإنتاجية خمس هجن من القنبيط (بارخا، سولد سنو، مكسيكو، فارجو وراؤول) تحت ظروف الارض الرملية. اشتملت هذه التجربة على عشر معاملات، وهى عبارة عن توليفات بين ميعادين للشتل (الشتل في الأول من أغسطس والشتل في الأول من سبتمبر) وخمسة هجن من القرنبيط (البارخا ، الصولد سنو، المكسيكى، وفارجو ، وراؤول). تم توزيع المعاملات عشوائيا في نظام القطع المنشقة في ثلاثة مكررات. تم توزيع مواعيد الشتل عشوائيا في القطع الرئيسية ، بينما تم توزيع هجن القنبيط عشوائيا في القطع الفرعية. وتم تلخيص أهم النتائج على النحو التالي: سجل التفاعل بين ميعاد الشتل في الاول من سبتمبر وهجين فارجو القيم القصوى لارتفاع النبات ، وعدد الأوراق/ النبات، وطول وعرض الورقة ، ومساحة الورقة ، بينما سجل التفاعل بين الشتل في الأول من أغسطس وهجين البرخا أعلى تركيزات من كلوروفيل أ ، ب ، (أ + ب) والكاروتينات في أنسجة أوراق القنبيط في كلا الموسمين. أعطى التفاعل بين ميعاد الشتل في الأول من سبتمبر وهجين مكسيكو أعلى قيم للمحصول الكلى للفدان مع عدم وجود فروق معنوية مع التفاعل بين الشتل في الأول من سبتمبر وهجين فارجو في الموسم الاول. أدى التفاعل بين شتل هجين راؤول في الأول من سبتمبر إلى زيادة معنوية في محتوى القرص الزهرى من النتروجين والفوسفور والبوتاسيوم في كلا الموسمين.

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