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THE EFFECT OF DIFFERENT SOWING DATES ON YIELD AND SOME AGRONOMIC CHARACTERISTICS OF CARROT (*DAUCUS CAROTA* L.)

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Abstract

The objective of this study was to determine the effect of different sowing dates on yield and some agronomic characteristics of different carrot varieties ('Romance' F1, 'Nansun' F1, 'Maestro' F1, 'Soprano' F1 and 'Vac-64' F1). The results of the study showed that the effect of sowing dates on the agronomic characteristics was significant. While the highest yield was obtained from 'Soprano' F1 at 4th sowing date, the highest plant height, the highest leaf length, maximum number of leaves, the highest carrot weight, the highest carrot length and the highest carrot diameter was obtained from 'Romance' F1 at 2nd sowing date, 5th sowing date, 4th sowing date, 3rd sowing date, 4th sowing date and 2nd sowing date, respectively.

Key words*: carrot, sowing date, yield.*

INTRODUCTION

Carrot (*Daucus carota* L.), a vegetable species of *Apiaceae* (*Umbelliferae*) family, is widely cultivated in the world (Yamaguchi, 1983; Peirce, 1987; Simon et al., 2008).

In recent years, with the increasing awareness of the nutritional value of carrot, especially in the content of vitamin A (α and β carotene), B1, B2 and C vitamins, has increased its worldwide importance (Leclerc et al., 1991; Warmanand Harvard, 1996; Yawalker, 1985; Arscoot & Tanumihardjo, 2010; Khan, 2011; Carvalho et al., 2014). In addition, carrot contains bioactive compounds such as polyacetylenes and isocumins and fiber that promote human health (Kidmose et al., 2004).

For this reason, carrot is a vegetable that people should consume daily of all ages (Guerra et al., 2001).

Carrot is widely used in canned, juice and cezerye industries as well as in fresh consumption (Chauhan, 1989).

The largest production amount of carrot was China with 20.274.393 tons in 2018, followed by Uzbekistan with 2.249.733 tons and Russia with 1.805.787 tons in the world.

Turkey ranks 10th in world carrot production (Anonymous, 2019a).

Turkey has a satisfactory level of production and consumption of carrot. In 2018, 642.837 tons of carrot were produced in 12347.8 ha area. The proportion of carrot production in total vegetable production is 2.14%, and carrot ranks 9th among all vegetables produced. The provinces have the highest carrot production are Konya, Ankara and Hatay in Turkey. Carrot production in Hatay province is increasing day by day due to climate conditions, export opportunities and contribution to employment. Not only carrots grown in the region are exported to countries such as Syria, Saudi Arabia and Romania, but also are marketed within the different countries of Turkey. Total 58.190 tons of carrots were produced in 2121.9 ha area in Hatay province in 2018 (Anonymous, 2019b). In this region, carrot production starts with the seed sowing from the beginning of August. The harvest starts at December and lasts until the end of April.

The most important climate factor affecting on carrot cultivation is temperature. In addition to plant growth, temperature is also effective in the root shape, root color and growth of the green parts of shoots. Carrot is mainly a temperate crop grown during spring through autumn in temperate countries and during winter in tropical and subtropical countries of

the world especially because it is resistant to frost at germination stage and early period of growing (Bose & Som, 1986).The optimum growth temperature for carrots is between 15.6 and 21.1°C. Higher and lower temperatures adversely affect growth and decrease the quality of roots (Barnes, 1936; Khan, 2011). Sowing date has important effects on the growth, development and yield of carrot due to environmental factors such as temperature and light intensity (Mack, 1979). Therefore, factors affecting the yield of carrot also include sowing date and it may play a critical role to extend availability of carrots in the market in the early and late season (Rashid & Shakur, 1986; Khan, 2011).

In this study, it is aimed to determine the effect of different sowing dates on plant growth, yield and some agronomical characteristics of carrot has great economic importance in Kırıkhan-Hatay, province of Turkey.

MATERIALS AND METHODS

The research was carried out in Kırıkhan district of Hatay province and the laboratories of Kilis 7 Aralik University Advanced Technology Application and Research Center between the years of 2016-2017. 'Nansun' F1, 'Maestro' F1, 'Romance' F1, 'Soprano' F1 and 'Vac-64 ' F1 carrot varieties were used as plant material. In order to determine the effect of different sowing dates, five sowing dates have been tried; 20th July 2016, 10th August 2016, 1st September 2016, 20th September 2016 and 10th October 2016.The experiment was established as randomized blocks design with three replications. Sprinkler irrigation system was used for irrigation of plants. Yield, carrot weight, carrot length, carrot diameter, plant height, number of leaves and leaf length values were determined. Tukey test was used to determine different groups after variance analysis.

RESULTS AND DISCUSSIONS

Yield

The carrot yield varied depending on the sowing dates and the varieties. According to the variance analysis, the effect of different sowing dates on the carrot yield was significant ($p \leq 0.05$). The highest carrot yield was obtained from the 'Soprano' F1 with 469.8 kg ha^{-1}at 4th sowing date (20th September), while the lowest carrot yield was obtained from 'Nansun' F1 with 168.5 kg ha^{-1} at 5th sowing date (Table 1). There have been significant differences in yields between varieties and sowing dates. Similar results were obtained by Sarı and Paksoy (2004). They reported that the yield varied depending on the varieties and sowing dates and the highest total carrot yield. Similarly, Elgin Karabacak (2010) used 24 different sowing dates on a monthly period between 15th March, 2006 and 15th February, 2008 in order to determine the most suitable sowing date for Parmex mini carrot variety. In the study, it was reported that the effect of sowing dates on total yield was significant and the highest yield (251.6 kg ha^{-1}) was obtained from mini carrots sown in February.

Nilsson (1987) determined that delaying of sowing time for 1 or 2 months after the beginning of May resulted in a reduction in the growth of both roots and foliage. Khan (2011) reported that the effect of different sowing date on plant growth of carrot and yield is important.

The highest yield value was reported as 22.63 t ha^{-1}, at 2nd sowing date (15th November). Mason and Tong (1971) used two different sowing dates (October and January) and 12 different carrot varieties.

They reported that the highest yield was obtained from varieties cultivated at the beginning of October. Pashine et al. (1993) investigated effects of sowing date on yield of different carrot cultivars and local carrot genotypes.

They used seven sowing dates at two-week intervals from 5th November to 5th February. The highest yield (155.18 q/ha) was obtained from the sowing on 5th November.

Carrot Weight

The carrot weight varied depending on the sowing dates and the varieties. The highest carrot weight was obtained from 'Romance' F1 (230.22 g/plant) at 3rd sowing date while the lowest carrot weight was obtained from 'Nansun' F1 with 66.58 g/plant at the 2nd sowing date (Table 2).

In a similar study, it was stated that the carrot weight changed depending on the sowing date and variety characteristics and the highest carrot weight (105.60 g/plant) was obtained from Asubeni F1 cultivar (Sarı & Paksoy, 2004).

Carrot Length and Diameter

In the study, the carrot length and carrot diameter varied depending on the sowing dates and the variety.

The highest carrot length was obtained from 'Romance' F1 with 29.33 cm at 4th sowing date (20th September) while the lowest carrot length (11.99 cm) was obtained from 'Maestro' F1 and 'Vac-64 'F1 varieties at 5th sowing date (10th October).

The highest carrot diameter (40.17 mm) was determined at 'Romance' F1 at the 2nd sowing date (10th August) and the lowest carrot diameter was 14.06 at 'Nansun' F1 at 5th sowing date (Table 3).

Different researchers reported that the length and diameter of the carrots obtained from the late sowing dates were higher than the carrots sown in the early period (Hussain et al., 2008). For example, Sarı and Paksoy (2004) reported that the effect of sowing dates and variety on carrot length was significant Similarly, Khan (2011) reported that the effect of sowing dates on plant growth was important, and the maximum root length (22.46 cm) was obtained from the carrots sown on 15th November.

Plant height, Leaf length and Number of leaves

The highest plant height, leaf length and number of leaves were obtained from 'Romance' F1.

These values were measured as 75.66 cm at the 2nd sowing date, 54.33 cm at the 5th sowing date and 8.21 numbers per plant at the 4th sowing date, respectively (Table 4).

The more number of leaves during plant development period of carrot is an important criterion for better growth of the roots.

For this reason, seed sowing date also has an effect on the number of leaves.

Jaiswal et al. (2003) reported that the highest plant height (156.25 cm) and the maximum number of leaves per plant in carrot were obtained from sowing on 20th July.

In another study, it was found that the highest plant height (46.83 cm) was obtained from the plants sowed on November 15 (Khan, 2011; Ali et al., 2014).

In contrast to these findings, Nilsson (1987) reported that delaying of sowing date for one or two months from the beginning of May led to a decrease in both root and leaf growth.

Table 1. Effect of sowing dates on yield of carrot (kg ha^{-1})

Cultivars	Sowing Dates				
	20th July	10th August	1st September	20th September	10th October
'Nansun' F1	318.8 fg	318.3fg	363.0ef	400.3de	168.5k
'Maestro' F1	358.9ef	339.1 f	438.6a-d	448.0a-c	236.3ij
'Romance' F1	194.3 jk	459.6ab	441.6a-d	405.0c-e	230.9ij
'Soprano' F1	421.7 bcd	433.6 a-d	458.6ab	469.8a	214.3ijk
'Vac-64 'F1	284.3 hi	337.0f	253.3hi	320.0fg	181.3k

Levels not connected by same letter are significantly different ($p \leq 0.05$)

Table 2. Effect of sowing dates on carrot weight (g/plant)

Cultivars	Sowing Dates				
	20th July	10th August	1st September	20th September	10th October
'Nansun' F1	76.95 jk	66.58 k	106.05 g-k	106.84 g-j	69.68 jk
'Maestro' F1	119.95 f-i	148.16 d-f	124.16 f-h	182.18 b-d	89.44 h-k
'Romance' F1	81.12 I-k	174.07 c-e	230.22 a	215.41 ab	89.10 h-k
'Soprano' F1	153.72 d-f	95.55 g-k	150.66 d-f	229.22 a	79.43 jk
'Vac-64 'F1	135.16 e-g	175.97 b-d	152.29 d-f	211.59 a-c	73.55 jk

Levels not connected by same letter are significantly different ($p \leq 0.05$)

Table 3. Effect of sowing dates on carrot length (cm) and carrot diameter (mm)

Cultivars	Sowing Dates				
	20th July	10th August	1st September	20th September	10th October
	Carrot length (cm)				
'Nansun' F1	16.25 hi	13.50 ij	15.33 h-j	16.88 g-i	17.33 f-h
'Maestro' F1	17.63 f-h	20.60 d-f	18.38 e-h	23.10 cd	11.99 j
'Romance' F1	15.58 hi	21.48 de	25.44 bc	29.33 a	17.00 g-i
'Soprano' F1	21.61 de	17.33 f-h	20.16 d-g	28.88 ab	16.55 hi
'Vac-64 'F1	16.44 hi	18.66 e-h	15.49 h-j	18.22 e-h	11.99 j
	Carrot diameter (mm)				
'Nansun' F1	29.87 de	18.08 f-i	22.12 f-h	22.28 f-h	14.06 i
'Maestro' F1	36.09 a-d	36.94 a-c	23.67 e-g	24.45 ef	16.33 hi
'Romance' F1	32.53 b-d	40.17 a	40.03 a	35.93 a-d	16.87 hi
'Soprano' F1	35.69 a-d	32.49 b-d	24.26 ef	35.80 a-d	17.41 g-i
'Vac-64 'F1	39.39 a	38.21 ab	29.94 de	31.17 c	18.17 f-i

Levels not connected by same letter are significantly different ($p \leq 0.05$)

Table 4. Effect of sowing dated on plant height (cm), leaf length (cm) and number of leaves (number/plant)

Cultivars	Sowing Dates				
	20th July	10th August	1st September	20th September	10th October
	Plant height (cm)				
'Nansun' F1	44.11 ij	43.49 j	43.77 j	57.88 c-h	64.99 a-f
'Maestro' F1	56.88 d-i	59.65 b-h	53.22 f-j	64.66 a-f	55.77 e-j
'Romance' F1	61.94 b-g	75.66 a	70.55 a-c	75.44 a	71.10 ab
'Soprano' F1	56.33 e-j	50.77 g-j	62.33 b-g	69.55 a-d	48.99 h-j
'Vac-64 'F1	47.99 h-j	65.33 a-f	50.10 g-j	66.99 a-e	53.66 f-j
	Leaf length (cm)				
'Nansun' F1	28.72 g	30.55 fg	27.55 g	43.10 b-d	48.33 a-c
'Maestro' F1	38.99 c-f	40.66 c-e	34.77 d-g	41.44 b-e	26.44 g
'Romance' F1	47.33 a-c	54.10 a	45.44 a-c	46.22 a-c	54.33 a
'Soprano' F1	35.66 d-g	34.77 d-g	40.55 c-e	39.99 c-f	32.66 e-g
'Vac-64 'F1	33.22 efg	45.44 a-c	34.33 d-g	50.55 ab	41.44 b-e
	Number of leaves (number/plant)				
'Nansun' F1	4.61 hi	5.22 f-i	5.11 f-i	6.00 c-h	6.99 a-e
'Maestro' F1	4.88 g-i	6.77 a-f	6.77 a-f	7.55 a-d	5.66 e-h
'Romance' F1	6.38 b-g	6.44 b-g	7.77 ab	8.21 a	7.44 a-d
'Soprano' F1	4.99 g-i	3.55 i	7.21 a-e	7.55 a-d	6.43 b-g
'Vac-64 'F1	7.64 a-c	6.32 b-h	6.77 a-f	6.77 a-f	5.88 d-h

Levels not connected by same letter are significantly different ($p \leq 0.05$)

CONCLUSIONS

In the study, it was determined that the effect of sowing dates on carrot yield and some plant properties was important because of the ecological conditions.

When the varieties and sowing dates interacted, it was determined that the highest yield was obtained from 'Soprano' F1 at 4th sowing date (20th September) with 4698 kg/da. However, the highest carrot length, carrot diameter, plant height, leaf length and number of leaves were obtained from 'Romance' F1. These values were measured as 29.33 cm at 4th sowing date, 40.17 cm at 2nd sowing date, 75.66 cm at the 2nd sowing date, 54.33 cm at the 5th sowing date and 8.21 number/plant at the 4th sowing date, respectively.

The results obtained from the study conducted in Kırıkhan district of Hatay province revealed that 'Soprano' F1 and 'Romance' F1 carrot varieties could be higher yields than the other varieties, provided that seeds sown between 1stSeptember and 20th September.

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