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Growth, Yield and Mineral Contents of Lettuce Cultivars Grown in Nutrient Film Technique (NFT) at Different Transplanting Dates.

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ABSTRACT

An experiment was conducted at the Arid Land Agricultural Research and Services Center (ALARC), Faculty of Agriculture, Ain Shams University, Shoubra El-Kheima, Cairo, Egypt during winter and spring seasons of 2007/2008 and 2008/2009 to investigate the influence of different transplanting dates (mid-September, mid-November, mid-January and mid-March) on vegetative growth, head yield leaf and root tissue mineral contents of two lettuce (*Lactuca sativa* L.) cultivars DP-400 and New Red Fire grown in nutrient film technique (NFT). DP-400 cultivar was superior than New Red Fire cultivar since it gave significantly higher values for head fresh and dry weights as well as head yield (kg/m^2). However, No significant differences were detected between studied cultivars concerning their contents of mineral contents in both leaves and roots.The most suitable transplanting date was the second transplanting date (15th Nov.) for lettuce production under nutrient film technique (NFT) while the worst transplanting date was the fourth transplanting date (15th Mar.) under the conditions of the experiment.Concerning the interaction between two lettuce cultivars and four transplanting dates a significant effect was detected on all measured parameters in both seasons of study except for Mg and Ca contents in leaves tissue. The best results were obtained by planting DP-400 lettuce cultivar in the second transplanting date (15th Nov.) followed by the third transplanting date (15th Jan.) in both seasons of study.

Keywords: NFT, Transplanting dates, Lettuce cultivars, Growth, Yield, Mineral contents.

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INTRODUCTION

Lettuce (*Lactuca sativa* L.) is the fourth most important vegetable crop grown hydroponically in greenhouses proceeded by tomatoes, cucumbers and peppers. It belongs to the family *Asteraceae (Compositae)*, is considered as one of the most important fresh leafy vegetable crops grown in Egypt as a cool-season crop. It is considered as an aphrodisiac food in Ancient Egypt. Later, Ancient Greek physicians believed that lettuce could be acted as a sleep-inducing as well as relaxation agent.

Scarcity of water resources in the arid and semi-arid regions, and rapid growth rate of population as well as global warming were the major factors that drew the attention towards the use of intensive cropping system in Egypt and paved the way for new technologies such as soilless culture. Using soilless culture techniques lead to not only maximize crop yield per square meter of land but also per cubic meter of water in another mean increasing water use efficiency.

Growth rate, total yield, earlier yield and yield quality components of crops grown in nutrient film technique was higher than those grown in other soilless or soil culture as reported by Abou-Hadid *et al.* (1989) and Rumple *et al.* (1996) on tomato; Kim *et al.* (1995) and El-Shinawy and Gawish (2006) on lettuce; Al-Harbi *et al.* (1996) on cucumber, El-Behairy *et al.* (2001) and Singer *et al*. (2009) on cantaloupe; In addition soil grown lettuce has statistically higher content of zinc and iron whereas, hydroponics grown lettuce has a higher contents of N, P, K, Ca, Cu, Mg and Mn (Santos *et al.,* 2003).

Growing lettuce crop in hydroponics NFT system was efficient and could be successfully used to grow up more than 8 crops of heavy head lettuce on a year-around. Lettuce cultivars grown hydroponically demonstrated different behaviours according to the used nutrient solution (Vital *et al.,* 2002).

Abak *et al.* (1994) reported that the most suitable transplanting date was in the beginning of October and in the second half of October for lettuce production under open field conditions and high tunnels, respectively. Harvesting date was earlier by 13-15 days for head lettuces produced under high tunnels than head lettuces produced under open field conditions. Also Abak *et al.* (2000) found that seed yield from the spring sowings were approximately the half of the yield of autumn sowings. They also added that the most suitable sowing date for lettuce seed production was found to be 20 September followed by 10 October.

Transplanting date markedly influenced cultivar yield, quality and nitrate content of lettuce heads (Miccolis *et al.,* 2000; Kobryn, 2001 and Khalf *et al.,* 2003). Also, Al-Harbi (2001) demonstrated that the greatest vegetative growth and yield were obtained in the first (23rd, Sept.) and second (14th, Oct.) planting dates. Delaying the planting date after mid-Oct. resulted in less growth and earlier flowering. In the same regard, Sharma *et al.* (2001) reported that the early (1st Aug.) and late (16th Oct.) transplanting dates resulted in decreasing yield and other horticultural traits of lettuce cultivar. The maximum yield was obtained by the third (1st Sept.) and fourth (16th Sept.) transplanting dates.

There were significant differences in the interaction between cultivars and environmental conditions accompanied in transplanting date on growth, yield and head sensory quality of lettuce as well as cabbage (Radovich *et al.,* 2005). In the same regard, Kunicki *et al.* (2010) declared that spinach yield and nitrate content were dependent on the time of production and cultivar, both studied cultivars yielded better in autumn cultivation than spring cultivation.

The objective of this research was to examine the impact of four transplanting dates (mid-September, mid-November, mid-January and mid-March) on growth, head yield and leaves and root tissue mineral contents of two lettuce cultivars DP-400 and New Red Fire grown in A-shape system of nutrient film technique (NFT).

MATERIAL AND METHODS

Seeds of head lettuce cultivars DP-400 (green lettuce) and New Red Fire (red lettuce) were sown in foam trays (84 cells) filled with a mixture of peat moss and vermiculite (1:1 v/v) media 4 weeks before transplanting dates on 15th August, 15th October, 15th December, 15th February for transplanting dates of mid-September, mid-November, mid-January and mid-March, respectively, in both seasons of 2007/2008 and

2008/2009. Trays were then kept in unheated greenhouse at Arid Land Agricultural Research and Services Center (ALARC), Faculty of Agriculture, Ain Shams University, Shoubra El-Kheima, Qaluobia governorate, Egypt, for three weeks. During this time, all agricultural practices required for lettuce seedlings production in greenhouse were carried out. Afterward, uniform lettuce seedlings at 3 - 4 true leaf stage were transferred to perforated black plastic bags (8 cm diameter X 10 cm length) filled with a mixture of peat moss and vermiculite (1:1 v/v) media, then plastic bags were kept in open field and cared by regular irrigation for another one week before transplanting into NFT gullies.

Nutrient film technique as A-shape system was used as described by Cooper (1979). A-shape system was constructed using Iron metal triangle frame supports like character A with 60 degree angle, 100 cm height and bottom width. In addition, 3 gullies holders were fixed on each side of A-shape triangle frame. A six-inch, grey poly-vinyl chloride (PVC) pipes were used to form the gullies with a slope of 1% towards the solution tank after cut the PVC pipe on a length axis into two half circles, with 15 cm width, 7.5 cm depth and 6 m length. Styro foam straps with 14 cm width were fixed in the gullies. Circular holes with 10 cm diameter were made in the foam straps at 20 cm apart to place a black plastic bag in.

A submersible pump (0.4 HP and 40 Watts) was used in order to pump the nutrient solution through the polyethylene tube (18 mm) to the upper end of the six gullies in each A-shape system. The nutrient solution returns back to the solution tank (reservoir) by gravity and re-pumped again to the gullies. The nutrient solution circulated within the A-shape system for 10 min every hour. The running time was increased gradually over days until harvest according to plant growth stage to reach to 20 min every hour.

The nutrient solution was prepared as described by El-Behairy (1994). The electrical conductivity (EC) of nutrient solution was maintained at 2 - 2.5 dS/m and pH was adjusted to be maintained at 5.5 - 6.5 during the whole period of experimental. The nutrient solution volume was adjusted once a week by adding tap water up to recognized mark in the tank (80 liter). The nutrient solution was completely renewed every month.

Monthly averages of climatic data for experimental site during the experiment period were obtained from a meteorological station located inside the experimental site through Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center (ARC) as shown in Table (1).

Table 1: Monthly averages of maximum, minimum and mean air temperature, relative humidity and average sunlight hours/day during the experiment period at the experiment site.

Month	Average maximum temperature (ºC)	Average minimum temperature (ºC)	Mean (ºC)	Relative humidity (%)	Average sunlight (hours/day)
First season (2007/2008)					
15 Spet. - 15 Oct.	31.81	19.53	25.67	61.23	12.00
15 Oct. - 15 Nov,	25.46	16.74	21.13	61.74	11.00
15 Nov. - 15 Dec.	22.17	13.43	17.79	64.26	10.38
15 Dec. - 15 Jan.	18.51	10.44	14.48	62.71	10.00
15 Jan. - 15 Feb.	20.69	10.81	15.75	59.98	10.88
15 Feb. - 15 Mar.	23.64	11.86	17.75	58.22	11.75
15 Mar. - 15 April	25.16	11.97	18.57	57.70	12.50
15 April - 15 May	30.03	13.87	21.95	56.22	13.25
15 May - 15 June	32.14	15.22	23.68	56.83	14.00
Second season (2008/2009)					
15 Spet. - 15 Oct.	30.02	18.56	24.29	64.01	12.00
15 Oct. - 15 Nov,	28.14	17.26	22.70	60.66	11.00
15 Nov. - 15 Dec.	22.85	14.02	18.44	60.37	10.38
15 Dec. - 15 Jan.	19.13	10.86	14.99	64.84	10.00
15 Jan. - 15 Feb.	19.16	9.41	14.28	60.58	10.88
15 Feb. - 15 Mar.	22.62	10.98	16.80	60.27	11.75
15 Mar. - 15 April	28.55	12.48	20.52	55.51	12.50
15 April - 15 May	29.89	13.73	21.81	55.46	13.25
15 May - 15 June	31.54	13.68	22.61	58.85	14.00

The experiment was arranged in a complete randomized block design with three replicates for each cultivar (DP-400 and New Red Fire) in each transplanting date (mid-September, mid-November, mid-January and mid-March). Three A-shape systems were used for each transplanting date. Lettuce cultivars were randomly distributed on the sides of A-shape system. Each side consisted of three gullies was considered as a replicate with the capacity of 90 lettuce plants per replicate (30 lettuce plants per gully 5 lettuce plants par meter and 30 lettuce plants per square meter).

Lettuce heads produced from each cultivar were hand-harvested by cutting the head from the top of the surface of black plastic bag using a sharp stainless steel knife after 65 - 67, 75 - 77, 72 - 73 and 66 - 67 days from transplanting date for the first, second, third and fourth transplanting dates in the first and second seasons, respectively.

Twenty five heads were randomly selected from each replicate. Afterward, heads were transferred to the laboratory and used to record the following parameters:

1. Total leaves number/head; 2. Head fresh weight (g);
3. Head dry weight (g); 4. Percentage of dry matter accumulation (%);
5. Total yield of head lettuce (Kg/m^2);
6. Mineral nutrient contents in leaf and root tissues.

Mineral nutrient contents (N, P, K, Ca and Mg) were determined in dried tissues of leaf and root of lettuce plant. Dried samples were ground to a fine powder using a stainless steel blender and then used to determine nutrient contents on a dry weight basis. A weight of 0.2 g of dried samples was digested using wet digestion. Afterwards the digested samples were used to determine nutrient contents.

Total nitrogen and phosphorus contents in leaves and roots of lettuce plant were determined using the modified micro Kjeldahl method and colorimetrically by ammonium metavanidate method using spectrophotometer (SPECTRONIC 20D, Milton Roy Co. Ltd., USA), respectively, according to the procedure described by Cottenie *et al.* (1982). Total potassium content was measured using flame photometer method (JENWAY, PFP-7, ELE Instrument Co. Ltd., UK) as described by Chapman and Pratt (1982). While, calcium and magnesium contents were determined using Atomic Absorption spectrophotometer (Analyst 200, Perkin Elmer, Inc., MA, USA), according to Chapman and Pratt (1982).

All data generated were tabulated and subjected to statistical analysis using the analysis of variance method ANOVA with M-Stat package software. Least significant differences test (LSD) was used to compare the significant differences among mean of the treatments at 0.05 level of probability according to the method described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Vegetative growth

Different transplanting dates and cultivars as well as their interaction effects on number of leaves/head, head fresh and dry weights in seasons of 2007/2008 and 2008/2009 were presented in Table (2). Obtained data clearly showed that highly significant differences were detected among different transplanting dates. The highest value for the average number of leaves/head was recorded with the third transplanting date (15^{th} Jan.) followed significantly by the second transplanting date (15^{th} Nov.). Whereas, the lowest values were obtained by the fourth transplanting date (15^{th} Mar.) in the first season. While in the second season the highest values were recorded by the second transplanting date (15^{th} Nov.) followed by the fourth transplanting date (15^{th} Mar.) and the lowest value were obtained by the first transplanting date (15^{th} Sept.). In addition the highest values of head fresh weight were obtained by the second transplanting date (15^{th} Nov.) in both seasons. While the lowest value were obtained by the fourth transplanting date (15^{th} Mar.) in the first season and by the first transplanting date (15^{th} Sept.) in the second season. However, the highest values of head dry weight were obtained by the first transplanting date (15^{th} Sept.) and the lowest values were obtained by the fourth transplanting date (15^{th} Mar.) in both seasons of study.

The obtained results were in harmony with Abak *et al.* (1994); Miccolis *et al.* (2000); Al-Harbi (2001); Kobryn (2001); Khalf *et al.* (2003) and Padilla *et al.* (2007). They reported that transplanting date markedly influenced cultivar growth, yield, quality and nitrate content of lettuce heads.

Abou-Hadid *et al.* (1996) stated that ecological temperatures as well as day length are the most important factors in controlling growth, yield and quality of lettuce. In the same regards, head weight of lettuce cultivars was clearly enhanced by extending day length to 14.5 h especially during winter and early spring plantings (Benoit and Ceustermans, 1993). Moreover, light intensity and duration usually promotes growth and development of lettuce plant (Kim *et al.,* 2004 and Li and Kubota, 2009).

Regarding the effect of cultivar data presented in Table (2) revealed that New Red Fire lettuce cultivar significantly gave higher number of leaves per head and lower head fresh and dry weights than DP-400 cultivar in both seasons. The obtained results were in agreement with Miccolis *et al.* (2000) Sharma *et al.* (2001) and Kleinhenz and Wszelaki (2003).

The interaction effect recorded significant differences on number of leaves/head, head fresh and dry weights in seasons of 2007/2008 and 2008/2009. Generally, it could be stated that the highest number of leaves per head were recorded by New Red Fire cultivar in the second transplanting date (15^{th} Nov.) followed by the third transplanting date (15^{th} Jan.) in both seasons. While the lowest values were recorded by DP-400 cultivar in the first transplanting date (15^{th} Sept.) during the first season, while, in the second season, by the third planting date (15^{th} Jan.). Concerning the fresh and dry weight of lettuce head, the obtained results demonstrated that, the heaviest weight were correlated to DP-400 cultivar when transplanted in the second transplanting date (15^{th} Nov.) in both seasons.

Radovich *et al.* (2003) reported that planting date and cultivar may play an important role in head of cabbage plant growth, yield and sensory quality. Also spinach yield was dependent on the time of production and cultivar (Kunicki *et al.,* 2010).

Dry matter accumulation percentage and lettuce head yield

Data presented in Table (3) showed the effect of different transplanting dates, lettuce cultivars and their interaction on dry matter accumulation and lettuce yield (kg/m^2) during the first and second seasons. Data strongly revealed that there were significant differences among different transplanting dates. The second transplanting date (15^{th} Nov.) recorded the lowest dry matter accumulation percentage and the highest yield as kg/m^2. Whereas, the first transplanting date (15^{th} Sept.) gave the highest value of dry matter accumulation percentage. However, the lowest value of head lettuce yield was obtained by the fourth transplanting date (15^{th} Mar.). The obtained results were completely similar in both seasons of study.

The obtained results were in good accordance with Miccolis *et al.* (2000) and khalf *et al.* (2003) they suggested that higher yield obtained with the winter transplanting was due to an increase in the lettuce head mean weight as a consequence of the better climate conditions during the stage of head formation. Whereas, spring transplanting indeed, was characterized by increasing temperatures.

Concerning the effect of lettuce cultivar, a significant difference was detected between studied cultivars as shown in Table (3). From data presented it could be noticed that during both seasons of study New Red Fire lettuce cultivar significantly gave higher dry matter accumulation percentage than DP-400 cultivar whereas, DP-400 lettuce cultivar gave higher lettuce yield than New Red Fire cultivar.

The obtained results may be due to the difference of genetic characteristics of DP-400 lettuce cultivar in comparison with other New Red Fire lettuce cultivar.

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Table 2: Effect of different transplanting dates, lettuce cultivars and their interaction effect on number of leaves/head, head fresh and dry weight during both seasons of 2007/2008 and 2008/2009.

Treatments		No. of leaves/head	Head fresh weight	Head dry weight	No. of leaves/head	Head fresh weight	Head dry weight
		First season (2007/2008)			Second season (2008/2009)		
Transplanting dates	15th Sept.	27.06	299.99	16.87	27.76	256.01	17.46
	15th Nov.	30.43	394.20	16.79	30.26	356.77	16.26
	15th Jan.	31..6	233.66	11.18	28.98	306.01	13.94
	15th Mar.	26.45	211.93	10.96	29.28	293.41	13.53
Cultivars	DP-400	27.66	359.57	15.37	27.02	354.13	15.69
	New Red Fire	29.84	210.30	12.53	31.13	256.47	14.90
15th Sept.	DP-400	25.73	346.48	16.99	27.26	256.45	17.98
	New Red Fire	28.38	253.51	16.79	28.27	255.57	16.93
15th Nov.	DP-400	27`.95	505.56	18.45	27.51	419.51	18.53
	New Red Fire	32.91	282.85	15.12	33.02	312.03	13.99
15th Jan.	DP-400	30.04	319.34	14.01	26.07	387.03	14.74
	New Red Fire	32.08	147.98	8.35	31.89	225.00	13.13
15th Mar.	DP-400	26.91	266.89	12.02	27.23	353.53	12.87
	New Red Fire	25.98	156.88	9.90	31.33	233.28	14.18
LSD at 5% level	TD	**0.45**	**2.74**	**2.15**	**1.62**	**31.76**	**2.95**
	CVs	**2.17**	**30.23**	**0.83**	**2.17**	**17.9**	**17.08**
	TD x CVs	**0.63**	**38.76**	**3.04**	**2.28**	**44.92**	**4.17**

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Table 3: Effect of different transplanting dates, lettuce cultivars and their interaction effect on dry matter accumulation and lettuce yield (kg/m^2) during both seasons of 2007/2008 and 2008/2009.

Treatments		Dry matter accumulation%	Yield (Kg/m^2)	Dry matter accumulation%	Yield (Kg/m^2)
		First season (2007/2008)		Second season (2008/2009)	
Transplanting dates	15th Sept.	5.74	9.45	5.83	9.18
	15th Nov.	4.50	11.83	4.38	10.97
	15th Jan.	5.00	7.01	4.80	9.18
	15th Mar.	5.40	6.19	4.88	8.86
Cultivars	DP-400	4.45	11.01	3.94	11.40
	New Red Fire	5.87	6.23	6.23	7.69
15th Sept.	DP-400	4.88	11.29	5.03	10.69
	New Red Fire	6.61	7.61	6.63	7.66
15th Nov.	DP-400	3.64	15.17	3.34	12.58
	New Red Fire	5.36	4.49	6.32	9.35
15th Jan.	DP-400	4.78	9.58	3.34	11.61
	New Red Fire	5.22	4.44	5.85	6.75
15th Mar.	DP-400	4.50	8.01	3.36	10.72
	New Red Fire	6.30	4.37	6.12	7.00
LSD at 5% level	TD	**0.53**	**0.88**	**0.35**	**0.98**
	CVs	**0.312**	**1.21**	**0.25**	**0.58**
	TD x CVs	**0.74**	**1.25**	**0.49**	**1.39**

The interaction effects between four transplanting dates and the two lettuce cultivars recorded significant differences on dry matter accumulation percentage and lettuce yield (kg/m^2) in seasons of 2007/2008 and 2008/2009. It is of interest to shade the light on that, in both seasons of study the highest values of dry matter accumulation percentage were obtained by New Red Fire lettuce cultivar in the first transplanting date (15th Sept.) and followed by the fourth transplanting date (15th Mar.) in the first season and by the second transplanting date (15th Nov.) in the second season with the same cultivar. On the other hand, the lowest values of dry matter accumulation percentage were obtained by DP-400 lettuce cultivar in the second transplanting date (15th Nov.) in both seasons. While for lettuce yield, the highest values of yield were recorded by DP-400 lettuce cultivar in the second transplanting date (15th Nov.), 15.17 and 12.58 kg/m^2 in the first and second seasons, respectively. The lowest values were recorded by New Red Fire lettuce cultivar in the fourth transplanting date (15th Mar.) and in the third planting date (15th Jan.) in the first and second seasons, respectively.

There were significant differences in the interaction between cultivars and prevailing environmental conditions during transplanting date on growth yield and head sensory quality of lettuce as well as cabbage (Radovich *et al.,* 2005). Kunicki *et al.* (2010) stated that the yield of spinach plant was dependent on both the time of cultivation and cultivar.

Mineral contents in leaves and roots tissue

Data presented in Tables (4 and 5) showed the effect of four transplanting dates, lettuce cultivars and their interaction on the percentage of nitrogen, phosphorus, potassium, magnesium and calcium in leaf and root tissues during the first and second seasons. There were significant differences detected among different transplanting dates on nutrient contents of leaf and root tissues in both seasons. The highest values for N and P percentage in leaves tissue were determined with second transplanting date (15th Nov.) in both seasons except for P in the second season only where it determined with the third planting date (15th Jan.). While in roots tissue the highest values were recorded by the fourth transplanting date (15th Mar.) for N percentage in both seasons and by the first transplanting date (15th Sept.) and the second transplanting date (15th Nov.) for P percentage in the first and second seasons, respectively. Whereas, the highest values of K percentage in leaves tissue were recorded in the first transplanting date (15th Sept.) in both seasons. While in roots tissue, the highest values of K percentage were recorded by the first transplanting date (15th Sept.) in the first season and by the second transplanting date (15th Nov.) in the second season. No significant differences were detected among transplanting dates concerning their effect on roots tissue content of K and Ca in the first season and P in the second season, and on leaves tissue contents of Mg and Ca in both seasons except for Ca percentage in the second season only where the first transplanting date (15th Sept.) significantly gave the highest value. The highest values of roots tissue contents of Mg and Ca were detected by the second transplanting date (15th Nov.) and by the third transplanting date (15th Jan.) for percentage of Mg and Ca in the first and second seasons, respectively.

The nutrients absorption is usually proportional to the concentration of nutrients in the solution near of roots, being very influenced by the environmental factors, such as: salinity, oxygen, temperature, pH of the nutrient solution, light intensity, photoperiod and humidity of the air as indicated by Vital *et al.* (2002). Also, they demonstrated that under non limiting conditions as in the NFT, nutrient uptake depends only on plant demand determined by the environmental conditions. Hence mineral uptake by the roots is driven by plant growth requirements. In addition Kim *et al.* (2004) and Li and Kubota (2009) stated that light intensity and duration affects nutritional quality of lettuce plant.

Concerning the effect of lettuce cultivar, there were no significant differences were detected among studied cultivars concerning their concentration of nutrients N, P, K, Mg and Ca in leaves and roots tissue in both seasons except for N percentage in both seasons and P percentage in the second season only for leaves tissue. New Red Fire cultivar recorded higher values of N and P percentage than DP-400 cultivar in the second season while in the first season DP-400 cultivar gave higher N percentage than New Red Fire cultivar. While for K percentage in roots tissue in both seasons DP-400 cultivar recorded significantly higher value of K content than New Red Fire cultivar in both seasons.

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Table 4: Effect of different transplanting dates, lettuce cultivars and their interaction effect on the percentage of nutrient contents in leaves tissue during both seasons of 2007/2008 and 2008/2009.

Treatments		N	P	K	Mg	Ca	N	P	K	Mg	Ca
		First season (2007/2008)					Second season (2008/2009)				
Transplanting dates	15th Sept.	3.16	0.45	5.08	0.68	2.00	4.23	0.49	4.73	0.73	1.85
	15th Nov.	5.03	0.47	4.64	0.66	1.85	5.40	0.36	4.20	0.71	1.53
	15th Jan.	4.67	0.43	4.87	0.68	2.10	5.24	0.52	4.43	0.68	1.48
	15th Mar.	4.14	0.46	4.83	0.58	1.77	4.17	0.48	3.84	0.68	1.37
Cultivars	DP-400	4.65	0.43	4.61	0.67	1.97	4.37	0.38	3.82	0.73	1.45
	New Red Fire	4.35	0.49	5.09	0.62	1.89	4.96	0.55	4.78	0.67	1.67
15th Sept.	DP-400	4.41	0.44	4.82	0.70	2.00	5.59	0.44	4.50	0.77	1.93
	New Red Fire	3.92	0.45	4.33	0.66	2.00	4.48	0.54	4.95	0.68	1.77
15th Nov.	DP-400	5.13	0.47	4.03	0.66	1.80	3.84	0.16	4.13	0.72	1.43
	New Red Fire	4.94	0.47	5.25	0.65	1.90	4.59	0.56	4.27	0.70	1.63
15th Jan.	DP-400	4.73	0.35	4.87	0.72	2.33	4.09	0.49	3.45	0.71	1.27
	New Red Fire	4.60	0.50	4.87	0.63	1.87	6.39	0.56	5.42	0.65	1.70
15th Mar.	DP-400	4.35	0.47	4.73	0.62	1.73	3.69	0.42	3.18	0.71	1.17
	New Red Fire	3.94	0.52	4.92	0.54	1.80	4.38	0.53	4.50	0.65	1.57
LSD at 5% level	TD	**0.57**	**0.06**	**0.25**	**NS**	**NS**	**1.07**	**0.15**	**0.46**	**NS**	**0.21**
	CVs	**0.23**	**NS**	**NS**	**NS**	**NS**	**0.51**	**0.31**	**NS**	**NS**	**NS**
	TD x CVs	**0.80**	**0.08**	**0.35**	**NS**	**NS**	**1.51**	**0.21**	**0.66**	**NS**	**0.30**

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Table 5: Effect of different transplanting dates, lettuce cultivars and their interaction effect on the percentage of nutrient contents in roots tissue during both seasons of 2007/2008 and 2008/2009.

Treatments		N	P	K	Mg	Ca	N	P	K	Mg	Ca
		First season (2007/2008)					Second season (2008/2009)				
Transplanting dates	15th Sept.	4.23	0.45	6.18	0.45	1.25	4.59	0.37	6.12	0.61	1.07
	15th Nov.	4.53	0.44	5.98	0.51	0.40	4.01	0.44	6.38	0.67	0.98
	15th Jan.	4.29	0.41	5.98	0.48	1.30	4.20	0.37	5.80	0.67	1.07
	15th Mar.	5.12	0.38	6.17	0.50	1.20	5.29	0.40	6.18	0.64	0.92
Cultivars	DP-400	4.80	0.43	6.19	0.48	1.41	4.87	0.39	6.31	0.63	1.02
	New Red Fire	4.28	0.41	5.96	0.48	1.17	4.18	0.40	5.93	0.66	1.00
15th Sept.	DP-400	4.27	0.48	5.92	0.47	1.27	5.28	0.38	6.37	0.60	1.07
	New Red Fire	4.18	0.42	6.43	0.43	1.23	3.90	0.36	5.87	0.61	1.07
15th Nov.	DP-400	4.73	0.40	6.23	0.48	1.43	4.45	0.43	6.60	0.64	1.10
	New Red Fire	4.34	0.48	5.73	0.54	1.37	3.57	0.45	6.17	0.69	0.87
15th Jan.	DP-400	4.95	0.44	6.25	0.50	1.60	4.46	0.37	5.90	0.62	1.07
	New Red Fire	3.63	0.37	5.70	0.46	1.00	3.94	0.37	5.70	0.72	1.07
15th Mar.	DP-400	5.27	0.39	6.73	0.48	1.33	5.27	0.38	6.37	0.65	0.83
	New Red Fire	4.97	0.36	5.97	0.51	1.07	5.30	0.41	6.00	0.62	1.00
LSD at 5% level	TD	**0.83**	**0.07**	**NS**	**0.01**	**NS**	**0.41**	**NS**	**0.37**	**0.06**	**0.12**
	CVs	**NS**	**NS**	**0.08**	**NS**	**NS**	**NS**	**NS**	**0.03**	**NS**	**NS**
	TD x CVs	**1.18**	**0.10**	**0.48**	**0.02**	**0.47**	**0.58**	**NS**	**0.53**	**0.08**	**0.17**

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The obtained results were in harmony with Abou-Hadid *et al.* (1996); Lopes *et al.* (2003) and Conversa *et al.* (2004). In the same regards, Gonnella *et al.* (2003) indicated that inorganic cation contents in lettuce leaves showed no significant difference. In contrast, Abou-Hadid *et al.* (1996) reported that higher level of elements was accumulated as a result of selective absorption by some varieties of lettuce.

The interaction effects between four transplanting dates and the two lettuce cultivars recorded significant differences on the percentage of N, P, K, Mg and Ca in leaves and roots tissue during the first and second seasons except in the first season for Mg and Ca in leaves tissue and in the second season for Mg and P in leaves and roots tissue, respectively. Generally it could be stated that the highest values of NPK in leaves tissue were obtained by DP-400 cultivar in the second transplanting date (15th Nov.), New Red Fire in the third transplanting date (15th Jan.), New Red Fire in the second transplanting date (15th Nov.) in the first season and by New Red Fire in the third transplanting date (15th Jan.) in the second season. In roots tissue, DP-400 cultivar gave the highest values of N, K in the fourth transplanting date (15th Mar.) and Ca in the third transplanting date (15th Jan.) while New Red Fire cultivar gave the highest values of P and Mg in the second transplanting date (15th Nov.), during the first season. While in the second season, DP-400 cultivar gave the highest value of K, Ca in the second transplanting date (15th Nov.) whereas the highest value of N and Mg percentages were obtained by New Red Fire cultivar in the fourth transplanting date (15th Mar.) and the third transplanting date (15th Jan.).

From the above mentioned results it could be concluded that DP-400 lettuce cultivar was superior than New Red Fire lettuce cultivar in head fresh and dry weights as well as head yield but no significant difference were detected between both cultivars concerning nutrient contents. The most suitable transplanting date was the second transplanting date (15th Nov.) for lettuce production in A-shape system of nutrient film technique (NFT). The best results were obtained by DP-400 cultivar when transplanted in the second transplanting date (15th Nov.) in both seasons of study.

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