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Effect of Different Forms and Levels of Nitrogen on Vegetative Growth and Leaf Nutrient Status of Nursery Seedling Rootstocks of Peach

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ABSTRACT

A field experiment was carried out in nursery of Seed and Plant Institute of Karaj (Iran) to determine the effect of various forms and levels of nitrogen application on vegetative growth and leaf nutrient status of two peach seedling rootstocks (Missouri and Yazdi). The study was carried out in two experimental years, 2009 and 2010. Seedlings were planted per plot at the end of January 2009. In addition, Dixiered cultivar as scion was grafted on studied seedlings rootstocks at the end of August 2009, respectively. For each experimental year, soil application of nitrogen fertilizers were added once at the beginning of April and repeated every 14 days. Each treatment was replied 7 times. The results of first experimental year (2009) showed that the application of 600 kg sulfate ammonium ha^{-1} had highest dry weight of shoot and root production and leaf N concentration of Missouri and Yazdi seedling rootstocks. However, the result of second experimental year (2010) showed that the application of 200 kg sulfate ammonium ha^{-1} for Missouri and Yazdi rootstocks with Dixiered as peach scion cultivar showed highest shoot length, shoot diameter and leaf surface. Furthermore, The DOP and to ΣDOP index were estimated for the diagnosis of the leaf mineral status of the trees. According to ΣDOP index (for 2009+2010), application of 400 kg sulfate ammonium ha^{-1} for Missouri rootstock with Dixiered as peach scion cultivar showed better balanced nutritional values, the weakest balanced nutritional values belonged to the Yazdi rootstock (with Dixiered as peach scion cultivar) by application of 600 kg urea ha^{-1}.

Key words: Forms and levels of nitrogen application, peach seedling rootstocks (Missouri and Yazdi), vegetative growth, leaf nutrient status

INTRODUCTION

Statistical data of peach trees in Iran are 456.29 thousand tones for production, 28.86 thousand hectare for area harvested and averaging 158.097.00 kg ha^{-1} for yield (FAO, 2007). A nutrient survey in Iran indicated that soil texture is one of the most important limitation factors in peach orchards (Jafarzadeh and Shahbazi, 2010). There is many literature on the link between horticulture (Al-Shaikh *et al*., 2007; Baninasab *et al*., 2007) and nitrogen efficiency. And also most agricultural crops require large quantities of nitrate-rich fertilizer to realize optimal yields (Uhegbu *et al*., 2011; Ghoneim *et al*., 2008; Bashirov, 2009; Nouri *et al*., 2010; Mustapha, 2011; Oyinlola and Jinadu, 2012). Nitrogen is often the only nutrient that needs to be supplied to peach trees on a regular basis. On less fertile soils, deficiencies of Fe, Zn, B, K, Mg, Mn may develop. On peach growing areas deficiencies of P, Ca, S and Cu are rarely seen (Johnson and Uriu, 1989; Johnson, 1993). Method, dose and time of nitrogen application of fertilizers are vital for securing higher yields (Niederholzer *et al.*, 2001; Huett and Stewart, 1999; Dong *et al.*, 2005; Arora *et al.*, 1999; Crisosto *et al.*, 1997; Chatzitheodorou *et al.*, 2004; Saenz *et al.*, 1997). This interdependence was shown, among others, in walnut (Anderson *et al.*, 2006); almond (Brown *et al.*, 2004) or citrus (Quinones *et al.*, 2005) leaves. Also, peach seedling rootstocks have been reported to influence growth and yield of the scion cultivars (Layne *et al.*, 1976) and the nutritional status of peach trees (Tsipouridis *et al.*, 2002). From this point, a number of methods are available for diagnostic interpretation of foliar data e.g., concentrations and ratios such as Evolutive Nutrient Balance (ENB), Diagnosis and Recommendation Integrated System (DRIS), Deviation from Optimum Percentage (DOP and ΣDOP index) and others (Montanes *et al.*, 1991; Sanz, 1999; Zarrouk *et al.*, 2005). The aim of the present investigations was to study the effect of two forms of nitrogen fertilization (consisted of sulfate ammonium and urea) and four levels of nitrogen application on vegetative growth and leaf nutrient status in peach nursery seedling rootstocks (Missouri and Yazdi).

MATERIALS AND METHODS

A field experiment was carried out in nursery of Seed and Plant Institute of Karaj (Iran) to determine the effect of various forms and levels of nitrogen application on vegetative growth and leaf nutrient status of two peach seedling rootstocks (Missouri and Yazdi). The study was carried out in two experimental years, 2009 and 2010. Five hundred seedlings were planted per plot at the end of January 2009. Seedlings rootstocks were spaced at 10×30 cm. At the end of August of 2009, studied seedlings were transplanted to Dixiered variety. For each experimental year, soil application of nitrogen fertilizers were added once at the beginning of April each year and repeated every 14 days. Each treatment was replied 7 times. The experiment was laid out in a RCBD with split plot arrangement at the seed and plant improvement institute, Karaj/Iran. The main plot treatments included two forms of nitrogen fertilization, i.e., sulfate and urea while the sub plot treatments were; four different levels of nitrogen, i.e., 0 (control), 200, 400 and 600 kg ha^{-1}. Sub plot were two studied peach seedling rootstocks. The other cultural practices were the same for all seedling rootstocks. Chemical properties of soil at the beginning of experiment were determined following of soil analysis (Walkley and Black, 1934; Isaac and Kerber, 1971; Olsen and Sommers, 1982). Surface soil (0-20 cm) variables (Total Neutralizing Value %, pH, total N%, available K use (me L^{-1}), available P (me L^{-1}), silt%, sand%, clay%,Organic matter%, Fe ppm, Zn ppm, Cu ppm, Mn ppm, B ppm) of studied peach seedlings rootstocks before soil application of nitrogen fertilizers are presented in Table 1. During the course of experimentation mineral, leaf chlorophyll content and some growth characters (leaf surface, shoot length, diameter of shoot, dry weight of shoot and root) of 2 studied peach seedlings rootstocks were recorded. Leaf chlorophyll concentration was

Table 1: Surface soil (0-20 cm) characteristics of Missouri and Yazdi seedling rootstocks grown on nursery of SPII before soil application of nitrogen fertilizers

	Soil texture													
Surface soil	Clay (%)	Silt (%)	Sand (%)	EC dS m^{-1}	pH	Organic neutralizing matter (%)	Total value (%)	Total N (%)	Available K (me L^{-1})	Available P (ppm) me L^{-1})	Available Cu (ppm)	Available Fe (ppm)	Available Mn (ppm)	Available Zn (ppm)
0-20 cm	27	14	27	2.38	7.83	0.45	10.07	0.05	188	11	1.93	6.08	22.01	0.5

estimated by a SPAD-502 m (Minolta Co. Oska. Japan) in all leaves sampled. SPAD values were converted to chlorophyll concentration (µmole m^{-2}) by using the calibration equation:

$$Y= 0.15X^2+1.49X+85$$

where, Y is the chlorophyll concentration and X is the SPAD value in leaves (Pestana *et al.*, 2004). Leafs from each treatments were composited, oven dried and ground for chemical analysis. Nitrogen was determined by micro-Kjeldahl method (AOAC, 1980) and potassium, phosphorus, calcium, magnesium, iron, manganese, zinc, copper and Boron were determined by atomic absorption spectophotometry (AOAC, 1980). Standard procedures were adopted for recording the studied data. Fisher's Analysis of Variance technique and L.S.D. were applied for testing the significance of differences among treatment means (Steel and Torrie, 1984). The DOP and ΣDOP index were estimated for the diagnosis of the leaf mineral status of the trees (Montanes *et al.*, 1991). The DOP index was calculated from the leaf analysis in July of 2009 and 2010 by the following mathematical expression:

$$DOP=\frac{C\times 100}{C_{ref}}-100$$

where, C is the nutrient content in the sample to be studied and C_{ref} is the major nutrient content considered as optimum, both values given on a dry matter basis. The C_{ref} was taken from optimum values, for nutrients. The ΣDOP for two studied years is obtained by adding the values of DOP index irrespective of sign. The larger the ΣDOP, the greater is the intensity of imbalances among nutrients.

RESULTS

Surface soil (0-20 cm) variables (Total Neutralizing Value%, pH, total N%, available K use (me L^{-1}), available P (me L^{-1}), silt%, sand%, clay%,organic matter%, Fe ppm., Zn ppm., Cu ppm., Mn ppm., B ppm.) of studied peach seedlings rootstocks before soil application of nitrogen fertilizers are presented in Table 1. The soil has low levels of organic matter and total N, high pH and relative middle levels on nutrients. The following observations were recorded during the course of experimentation.

Dry weight of shoot and root (g) in July 2009: Various levels of nitrogen gave significant differences in producing dry weight of shoot and root. Maximum production of dry weight of shoot and root (13.1) was produced by N_2 treatment (400 kg N ha^{-1}) which was statistically similar to N_3 treatment (600 kg N ha^{-1}) producing 12.51 g dry weights of shoot and root. Dry weight of shoot and root were not significantly affected by rootstocks. Similarly, different methods of nitrogen application were not influenced by dry weight of shoot and root (Table 2).

Shoot length (cm) in July 2009: Various levels of nitrogen gave significant differences in shoot length. Maximum shoot length (45.92) was produced by N_2 treatment (400 kg N ha^{-1} which was statistically similar to N_3 treatment (600 kg N ha^{-1}) producing 45.42 cm shoot length. Shoot length was not significantly affected by rootstocks and different methods of nitrogen application (Table 2).

Shoot length (cm) of studied rootstocks with Dixiered as scion cultivar in July 2010: Various levels of nitrogen also gave significant differences in shoot length of studied rootstocks with

Table 2: Effect of various levels and forms of nitrogen application on vegetative growth, mineral and leaf chlorophyll content of Missouri and Yazdi seedling rootstocks in July 2009 and 2010 (with Dixie red peach cultivar as scion)

Rootstocks	Dry weight of shoot and root (g)	Shoot length (cm)	Shoot diameter (cm)	Leaf Surface (cm^2)	Leaf-N (%)	Leaf-P (%)	Leaf-K (%)	Leaf-Ca (%)	Leaf-Mg (%)	Leaf-Fe ppm	Leaf-Cu (ppm)	Leaf-Zn (ppm)	Leaf B (ppm)	Leaf Mn (ppm)	Leaf-chlorophyll (μMol m^{-2})
Data in 2009															
Missouri	11.66^{a}	46.04^{a}	2.33^{a}	6.58^{a}	4.57^{a}	0.20^{a}	1.63^{a}	0.75^{b}	0.43^{b}	539.64^{a}	6.81^{a}	13.39^{a}	36.25^{a}	65.36^{a}	107.86^{a}
Yazdi	9.42^{a}	38.42^{b}	2.14^{a}	6.18^{a}	4.21^{b}	0.24^{a}	1.14^{b}	0.98^{a}	0.50^{a}	568.64^{a}	6.93^{a}	13.87^{a}	29.69^{b}	64.32^{a}	89.83^{b}
Significance	NS	NS	NS	NS	*	**	**	**	**	NS	NS	NS	**	NS	**
Application forms															
Sulfate ammonium	11.81^{a}	42.92^{a}	2.42^{a}	6.39^{a}	4.74^{a}	0.27^{a}	1.43^{a}	0.90^{a}	0.47^{a}	528.53^{a}	7.91^{a}	14.43^{a}	30.00	67.40^{a}	99.85^{a}
Urea	9.27^{b}	41.54^{a}	2.05^{a}	6.38^{a}	4.05^{b}	0.17^{b}	1.34^{a}	0.83^{a}	0.45^{a}	579.76^{a}	6.13^{b}	12.84^{b}	39.94^{a}	62.29^{b}	97.83^{a}
Significance	NS	NS	NS	NS	**	**	NS	NS	NS	NS	**	**	**	*	NS
Nitrogen levels															
Control (N0)	6.90^{b}	36^{b}	1.67^{b}	5.18^{b}	4.06^{b}	0.21^{b}	1.43^{a}	0.81^{a}	0.44^{b}	546.98^{a}	6.09^{b}	13.29^{a}	37.50^{a}	67.68^{a}	93.96^{b}
200 kg N h^{-1} (N1)	9.76b^{a}	41.58^{ab}	2.08^{b}	6.87^{a}	4.14^{b}	0.30^{a}	1.41^{a}	0.90^{a}	0.50^{a}	531.53^{a}	7.0^{a}	13.33^{a}	25.63^{c}	63.73^{a}	108.15^{a}
400 kg N h^{-1} (N2)	13.1^{a}	45.92^{a}	2.42^{a}	7.07^{a}	4.39^{ab}	0.19^{b}	1.40^{a}	0.88^{a}	0.49^{a}	536.74^{a}	6.91^{ab}	13.91^{a}	33.13^{b}	67.68^{a}	96.02^{b}
600 kg N ha^{-1} (N3)	12.51^{a}	45.42^{a}	2.78^{a}	6.41^{ab}	4.98^{a}	0.18^{b}	1.30^{a}	0.86^{a}	0.43^{b}	601.33^{a}	7.48^{a}	13.99^{a}	35.63^{ab}	65.73^{a}	97.23^{b}
Significance	*	*	* *	*	**	NS	NS	**	NS	*	NS	**	NS	**	
Interaction	NS	NS	NS	NS	*	*	NS	NS	NS	**	NS	*	NS	NS	NS
Data in 2010 (with Dixiered peach cultivar as scion)															
Missouri		144.73^{a}	4.06^{a}	31.05^{a}	4.90^{a}	0.24^{a}	2.72^{a}	1.31^{a}	0.22^{a}	321.62^{a}	9.68^{a}	13.64^{a}	40^{a}	52.44^{a}	88.0^{a}
Yazdi		130.17^{b}	3.52^{b}	17.24^{b}	4.08^{a}	0.17^{b}	2.15^{b}	1.13^{b}	0.31^{b}	298.26	8.1^{b}	12.34^{b}	33.13^{b}	29.57^{b}	86.30^{a}
Significance		**	**	**	**	**	**	**	*	**	**	**	**	**	NS
Sulfate ammonium		133.48^{b}	3.81^{a}	27.20^{a}	4.77^{a}	0.19^{b}	2.46^{b}	1.22^{a}	0.20^{b}	323.92^{a}	9.05^{a}	13.47^{a}	38.13^{a}	45.54^{b}	87.66^{a}
Urea		141.42^{a}	3.77^{a}	21.09	4.21^{b}	0.21^{a}	2.40^{a}	1.217^{a}	0.23^{a}	295.96	8.73^{b}	12.51^{b}	35^{b}	46.48^{a}	86.65^{b}
Significance		**	NS	**	**	**	**	NS	*	**	**	**	**	**	*
Control (N0)		116.29^{d}	2.92^{c}	23.88^{b}	4.11^{d}	0.185^{c}	2.75^{a}	1.57^{a}	0.27^{a}	311.65^{b}	9.95^{a}	11.50^{d}	40^{a}	49.13^{a}	87.65^{a}
200 kg N h^{-1} (N1)		164.33^{a}	4.33^{b}	28.38^{a}	4.37^{c}	0.185^{c}	2.46^{b}	1.23^{b}	0.22^{b}	381.79^{a}	8.38^{c}	13.83^{a}	32.50^{d}	47.73^{b}	87.79^{a}
400 kg N h^{-1} (N2)		141.92^{b}	4.75^{a}	22.16^{b}	4.81^{a}	0.20^{b}	2.62^{c}	1.14^{c}	0.21^{b}	29.17^{c}	8.41^{c}	13.51^{b}	35^{c}	44.40^{c}	86.86^{b}
600 kg N ha^{-1} (N3)		127.25^{c}	3.17^{c}	22.16^{b}	4.66^{b}	0.24^{a}	2.21^{d}	0.94^{d}	0.18^{c}	255.14^{d}	8.82^{b}	13.11^{c}	28.75^{b}	452.78^{d}	86.30^{b}
Significance		**	**	*	**	**	**	**	**	**	**	**	**	**	*
**Interaction		**	**	**	**	**	**	**	**	**	**	**	**	**	**

*Significant; **Highly significant; NS: Non significant. Two means not sharing a single letter in common, differ significantly at $p<0.05$

Table 3: Effect of various levels and forms of nitrogen application on shoot length, shoot diameter and leaf characteristics in Missouri and Yazdi seedling rootstocks in July 2009 and 2010 (with Dixie red peach cultivar as scion)

Treatments			Dry weight (g) of shoot and root	Shoot diameter (cm)		Leaf surface (cm^2)		Shoot length (cm)		Leaf-chlorophyll (μmole m^{-2})	
Rootstocks	Application forms	Nitrogen levels kg h^{-1}	2009	2009	2010	2009	2010	2009	2010	2009	2010
Missouri	Sulfate ammonium	Control (N_0)	7.21	0.83	3.00	4.65	37.87	28.67	136.5	100.05	87.73
Missouri	Sulfate ammonium	200 (N_1)	9.33	2.50	4.00	5.66	39.5	40.33	160	132.20	93.16
Missouri	Sulfate ammonium	400 (N_2)	17.03	1.67	5.67	6.91	38.53	41.00	150	104.45	89.48
Missouri	Sulfate ammonium	600 (N_3)	17.11	1.40	3.00	7.81	21.26	40.67	145	104.28	86.47
Missouri	Urea	Control (N_0)	7.20	0.83	2.67	4.65	38.69	27.67	98.67	100	87.99
Missouri	Urea	200 (N_1)	12.82	1.67	6.00	5.85	24.88	44.67	190	116.28	86.09
Missouri	Urea	400 (N_2)	11.70	1.83	4.50	7.32	21.83	35.00	137.67	98.29	85.96
Missouri	Urea	600 (N_3)	10.94	1.50	3.67	6.81	25.85	39.67	140	106.23	87.13
Yazdi	Sulfate ammonium	Control (N_0)	6.59	1.00	3.00	7.67	9.085	30.33	90	87.87	86.6
Yazdi	Sulfate ammonium	200 (N_1)	6.77	1.00	3.00	6.04	29.15	29.33	152.23	89.47	85.88
Yazdi	Sulfate ammonium	400 (N_2)	12.22	1.00	4.50	6.28	14.32	27.00	144	92.02	85.92
Yazdi	Sulfate ammonium	600 (N_3)	18.27	0.92	4.00	6.22	27.15	28.33	90	87.48	86.02
Yazdi	Urea	Control (N_0)	6.59	1.00	3.00	6.78	9.12	30.33	140	87.87	88.28
Yazdi	Urea	200 (N_1)	10.11	1.00	4.67	6.35	20	27.33	155	93.64	86.05
Yazdi	Urea	400 (N_2)	11.11	1.08	4.00	8.03	13.95	27.00	136	89.35	86.09
Yazdi	Urea	600 (N_3)	3.73	0.67	2.00	6.61	14.37	24.67	134	90.93	85.59
LSD 5%			9.41	0.62	0.53	0.63	8.16	2.51	12.89	12.11	4.20

Dixiered cultivar as scion for 2010. Maximum shoot length (164.33) was produced by N_1 treatment (200 kg N ha^{-1}). Similarly, different methods of nitrogen application influenced shoot length. The treatment Urea produced the highest shoot length (141.42). Rootstocks also influenced shoot length. Dixiered cultivar grafted on Missouri rootstock showed the highest shoot length (144.73) (Table 2). Interaction between nitrogen levels, application methods and rootstocks was also found significant. The highest shoot length (190) was recorded by application of 200 kg urea ha^{-1} for Missouri rootstock with Dixiered as peach scion cultivar (Table 3).

Shoot diameter (cm) in July 2009: Various levels of nitrogen gave significant differences in shoot diameter. Maximum shoot diameter (2.78 cm) was produced by N_3 treatment (600 kg N ha^{-1}) which was statistically similar to N_2 treatment (400 kg N ha^{-1}) producing 2.42 cm shoot diameter. Shoot diameters were not significantly affected by rootstocks and different methods of nitrogen application (Table 2).

Shoot diameter (cm) of studied rootstocks with Dixiered as scion cultivar in July 2010: Various levels of nitrogen gave significant differences in shoot diameter. Maximum shoot diameter (4.75 cm) was produced by N_2 treatment (400 kg N ha^{-1}). Rootstocks also influenced shoot diameter. Dixiered cultivar grafted on Missouri rootstock showed the highest shoot diameter (4.06 cm). Shoot diameters were not significantly affected by different methods of nitrogen application. Interaction between nitrogen levels, application methods and rootstock was also found significant. The highest shoot diameter (6 cm) was recorded by application of 200 kg sulfate ammonium ha^{-1} for Missouri rootstock with Dixiered as peach scion cultivar (Table 3).

Table 4: Effect of various levels and forms of nitrogen application on leaf mineral nutrient concentration in Missouri and Yazdi seedling rootstocks in July 2009 and 2010 (with Red dexy peach cultivar as scion)

Treatments			N (%)		P (%)		K (%)		Ca (%)		Mg (%)		Fe (ppm)		Cu (ppm)		Zn (ppm)		B (ppm)		Mn (ppm)	
Rootstocks	Application forms	Nitrogen levels (kg ha^{-1})	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Missouri	Sulfat ammonium	Control(0)	4.24	4.12	0.21	0.18	1.76	2.99	0.69	1.46	0.46	0.23	634.75	298.40	6.43	9.35	11.80	11.75	40.0	45	62.28	52.40
Missouri	Sulfat ammonium	200 (N1)	3.95	5.26	0.25	0.16	2	2.02	1.01	1.77	0.47	0.22	296.50	596.50	7.68	9.05	13.15	18.60	25.0	25	65.33	58.60
Missouri	Sulfat ammonium	400 (N2)	5.37	5.45	0.22	0.21	1.61	3.05	0.87	1.25	0.47	0.18	456.15	285.43	8.03	10.95	15.55	16.30	40.0	45	75.05	50.70
Missouri	Sulfat ammonium	600 (N3)	7.60	5.45	0.16	0.20	1.51	2.92	0.68	0.90	0.39	0.16	547.18	251.55	6.98	10.30	12.88	12.25	27.50	45	62.80	45.10
Missouri	Urea	Control (0)	4.24	4.12	0.21	0.18	2.3	2.99	0.69	1.46	0.46	0.23	634.75	298.40	5.43	9.35	11.80	11.75	40.0	45	62.28	52.40
Missouri	Urea	200 (N1)	3.75	4.86	0.19	0.28	1.6	2.64	0.78	0.90	0.45	0.21	433.98	259.80	6.08	9.75	14.58	13.55	37.50	45	60.88	57.95
Missouri	Urea	400 (N2)	3.78	5.58	0.17	0.19	1.21	2.44	0.65	1.49	0.39	0.27	68.63	300.80	5.78	9.10	12.95	11.65	37.50	30	67.58	56.95
Missouri	Urea	600 (N3)	3.67	4.31	0.17	0.50	1.35	2.71	0.64	1.27	0.36	0.28	527.68	282.045	9.08	9.60	14.45	13.25	42.50	40	66.70	45.45
Yazdi	Sulfat ammonium	Control (0)	3.88	4.11	0.21	0.19	0.85	2.51	0.93	1.67	0.43	0.31	459.20	324.90	6.75	10.55	14.78	11.25	35.0	35	62.18	45.85
Yazdi	Sulfat ammonium	200 (N1)	4.29	4.16	0.63	0.16	1.3	1.75	1.03	0.93	0.57	0.19	481.18	355.80	9.13	7.15	15.08	12.05	17.50	35	67.33	34.90
Yazdi	Sulfat ammonium	400 (N2)	4.08	4.06	0.24	0.26	1.32	1.61	0.88	0.63	0.56	0.14	441.18	253.15	6.87	6.80	16.13	13.10	25.0	35	66.68	27.90
Yazdi	Sulfat ammonium	600 (N3)	5.00	5.49	0.25	0.16	1.1	2.37	1.12	1.16	0.45	0.20	811.58	225.60	8.25	8.2	16.05	12.45	30.0	40	77.48	48.85
Yazdi	Urea	Control (0)	3.88	4.11	0.21	0.19	0.85	2.51	0.93	1.67	0.43	0.31	459.20	324.90	6.75	10.55	14.78	11.25	30.0	35	62.18	45.85
Yazdi	Urea	200 (N1)	4.57	3.21	0.12	0.14	0.95	2.44	0.80	1.33	0.50	0.24	814.45	315.05	5.13	7.55	10.53	11.10	22.50	25	61.38	39.45
Yazdi	Urea	400 (N2)	4.34	4.11	0.13	0.15	1.49	2.16	1.16	1.19	0.55	0.23	561.50	325.30	5.18	6.80	11.05	13	20.0	30	61.43	42.05
Yazdi	Urea	600 (N3)	4.19	3.38	0.15	0.08	1.26	1.82	1.01	0.43	0.51	0.09	520.88	261.35	5.60	7.14	12.60	14.50	42.50	30	55.93	31.70
LSD 5(%)			1.23	0.17	0.09	0.02	0.41	0.05	0.34	0.15	0.10	0.025	172.39	4.34	2.11	0.56	2.30	0.55	7.20	2.022	13.52	0.60

Leaf characteristics in July 2009: Various levels of nitrogen gave significant differences in leaf chlorophyll concentration (µmol m^{-2}). Highest leaf chlorophyll concentration (108.15) was produced by N_1 treatment (200 kg N ha^{-1}). Rootstocks also influenced leaf chlorophyll concentration. Missouri rootstock showed the highest leaf chlorophyll concentration (107.86). Leaf chlorophyll concentration was not significantly affected by different methods of nitrogen application (Table 2).Various levels of nitrogen gave significant differences in leaf surface (cm^2). Highest leaf surface (7.07) was produced by N_2 treatment (400 kg N ha^{-1}) which was statistically similar to N_1 treatment (200 kg N ha^{-1}) producing 6.87 cm^2 leaf surface. Leaf surface was not significantly affected by rootstocks and different methods of nitrogen application (Table 2).

Leaf characteristics of studied rootstocks with Dixiered as scion cultivar in July 2010: Various levels of nitrogen gave significant differences in leaf chlorophyll concentration (µmole m^{-2}). Highest leaf chlorophyll concentration (87.79) was produced by N_1 treatment (200 kg N ha^{-1}) which was statistically similar to N_0 (control) producing 87.65 µmole m^{-2}. Different methods of nitrogen application also influenced leaf chlorophyll concentration. The treatment sulfate ammonium produced the highest leaf chlorophyll concentration (87.06). Leaf chlorophyll concentration was not significantly affected by rootstocks. Interaction between nitrogen levels, application methods and rootstock was also found significant. The highest leaf chlorophyll concentration (93.16) was recorded by application of 200 kg sulfate ammonium/ha for Missouri rootstock with Dixiered as peach scion cultivar (Table 3).

Leaf mineral nutrients in July 2009: Rootstocks influenced leaf N, P, K, Ca, Mg and leaf B concentration. Missouri rootstock showed the highest leaf-N (4.57%), the highest leaf-P (0.20%), the highest leaf-K (1.63%) and the highest leaf-B (36.25 ppm) concentration (Table 2).

Different methods of nitrogen application influenced leaf N, P, Cu, Zn, B and Mn content. Application of sulfate ammonium showed the highest N (4.74%), P (0.27%), Cu (7.91 ppm.),Zn (14.43 ppm.) and Mn (67.40 ppm.) concentration (Table 2). Various levels of nitrogen influenced N, P, Mg and Cu and B concentration. Highest leaf-N concentration (4.98%) was produced by N_3 treatment (600 kg N ha^{-1}). N_1 treatment (200 kg N ha^{-1}) showed the highest P (0.30%), Mg (0.50%), Cu (7.0 ppm.) and Mn (63.73 ppm.) concentration (Table 2).

Interaction between nitrogen levels, application methods and rootstocks was found significant only for leaf-N, P, Fe and Zn concentration. The highest leaf-N concentration (7.60%) was shown on Missouri rootstock by application of 600 kg sulfate ammonium ha^{-1}. Yazdi root stock showed the highest leaf-p (0.63%) concentration by application of 200 kg sulfate ammonium ha^{-1}, leaf-Fe (814.45 ppm) concentration by application of 200 kg Urea ha^{-1} and leaf-Zn (16.13%) concentration by application of 400 kg sulfate ammonium ha^{-1} (Table 4).

Leaf mineral nutrients of studied rootstocks with Dixiered as scion cultivar in July 2010: Rootstocks influenced all studied leaf mineral nutrient concentration. The highest leaf mineral nutrient concentration was shown on Missouri rootstock with Dixiered as peach scion cultivar (Table 2).

Different methods of nitrogen application also influenced all studied leaf mineral nutrient, except of leaf-Ca content. Application of sulfate ammonium showed the highest leaf-N (4.77%), Fe (332.92 ppm), Cu (9.05 ppm), Zn (13.47 ppm) and B (38.13 ppm) concentration (Table 2).

Table 5: Effect of various levels and forms of nitrogen application on ΣDOP index (determined from leaf nutrient) in Missouri and Yazdi seedling rootstocks at July 2009 and 2010 and ΣDOP index for both years

Treatments			ΣDOP index (2009)	ΣDOP index (2010) (with Dixiered peach cultivar as scion)	ΣDOP index (2009+2010)
Rootstocks	Application forms	Nitrogen levels (kg ha^{-1})			
Missouri	Sulfate ammonium	Control (N_0)	124.930	145.690	270.62[j]
Missouri	Sulfate ammonium	200 (N_1)	158.030	96.560	254.59[k]
Missouri	Sulfate ammonium	400 (N_2)	66.810	72.680	139.49[p]
Missouri	Sulfate ammonium	600 (N_3)	75.940	137.500	213.44[o]
Missouri	Urea	Control (N_0)	110.020	141.690	251.71[l]
Missouri	Urea	200 (N_1)	199.990	113.520	313.51[h]
Missouri	Urea	400 1 (N_2)	190.740	126.550	317.29[g]
Missouri	Urea	600 (N_3)	182.030	45.580	227.61[n]
Yazdi	Sulfate ammonium	Control (N_0)	210.260	151.380	361.64[f]
Yazdi	Sulfate ammonium	200 (N_1)	8.550	296.340	304.89[i]
Yazdi	Sulfate ammonium	400 (N_2)	144.310	326.460	470.77[c]
Yazdi	Sulfate ammonium	600 (N_3)	212.650	185.330	233.85[m]
Yazdi	Urea	Control (N_0)	222.760	151.380	374.14[e]
Yazdi	Urea	200 (N_1)	191.470	310.291	501.761[b]
Yazdi	Urea	400 (N_2)	173.590	270.320	443.91[d]
Yazdi	Urea	600 (N_3)	175.244	427.820	603.064[a]

The different small letters in the last column indicate significant differences between values of ΣDOP(2009+2010) at p = 0.05 by LSD test

Various levels of nitrogen gave significant differences in all studied leaf mineral nutrient concentration. Highest leaf-N concentration (4.81%) was produced by N_2 treatment (400 kg N ha^{-1}) and highest leaf-P concentration (0.24%) by N_3 treatment (600 kg N ha^{-1}). The highest leaf-Fe (381.79 ppm) and Leaf-Zn (13.83 ppm) concentration were produced by N_1 treatment (200 kg N ha^{-1}) (Table 2).

Interaction between nitrogen levels, application methods and rootstocks was found significant for all studied leaf mineral nutrient concentration. The highest leaf Ca (1.77%0), leaf-Fe (596.50 ppm), leaf-Zn (18.60 ppm) and leaf-Mn (58.60%) concentration was shown on Missouri rootstock with Dixiered as peach scion cultivar by application of 200 kg sulfate ammonium ha^{-1}. The highest leaf-K (3.05%) concentration was observed on Missouri rootstock with Dixiered as peach scion cultivar by application of 400 kg sulfate ammonium ha^{-1}, the highest leaf-N concentration (5.58%) on Missouri rootstock with Dixiered as peach scion cultivar by application of 400 kg Urea ha^{-1}), the highest leaf-P concentration (0.50%) on Missouri with Dixiered as peach scion cultivar by application of 600 kg Urea ha^{-1} and the highest leaf-Mg concentration (0.31%) on Yazdi with Dixiered as peach scion cultivar in control treatment (Table 4).

Evaluation of DOP and ΣDOP index: Significant differences were observed among treatments for ΣDOP (2009+2010) index (Table 5). According ΣDOP index (for 2009+2010), application of 400 kg sulfate ammonium ha^{-1} for Missouri rootstock with Dixiered as peach scion cultivar showed better balanced nutritional values, the weakest balanced nutritional values belonged to the Yazdi rootstock (with Dixiered as peach scion cultivar) by application of 600 kg urea ha^{-1}. A significant and negative correlation was found between ΣDOP (2009+2010) index and shoot diameter (r = -0.53; $p<0.05$ (Fig. 1). And also, a significant and negative correlation was found between ΣDOP (2009+2010) index and leaf surface (r = -0.68; $p<0.01$) (Fig. 1 and 2).

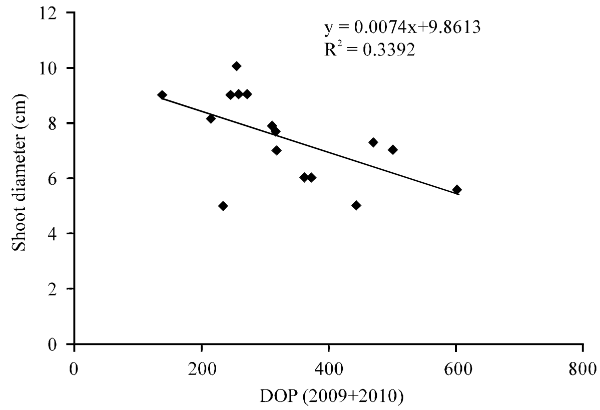

Fig. 1: Correlation between ΣDOP 2009+2010 and shoot diameter (in July 2010) of Missouri and Yazdi rootstocks with Dixiered as scion

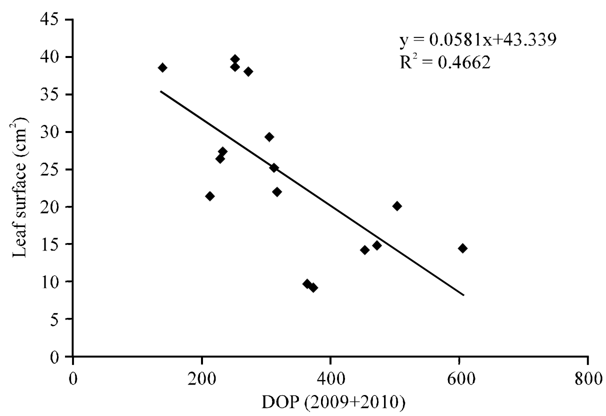

Fig. 2: Correlation between ΣDOP 2009+2010 and leaf surface (in July 2010) of Missouri and Yazdi rootstocks with Dixiered as scion

DISCUSSION

Dry mass of current-year vegetative growth was most affected by N fertilization. As is seem in Fig. 3, dry weight of shoot and root in both studied rootstocks by application of 600 kg sulfate ammonium ha^{-1} was higher than the other treatments in July 2009. This is in agreement with the results reported by Rufat and Dejong (2001). Taylor and Van-den-Ende (1969) and Stassen *et al.* (1981) reported that Fertilization with N is required to maintain vegetative growth. As are seem in Fig. 4 and 5, shoot length and shoot diameter of Yazdi rootstocks with Dixiered as scion cultivar by application of 200 Kg Urea ha^{-1} was higher than the other treatments in July 2010. However, for Missouri root stocks with Dixiered as scion cultivar in July 2010, higher shoot diameter was recorded by application of 400 kg sulfate ammonium ha^{-1} (Fig. 4, 5).

Deviation from Optimum Percentage (DOP and ΣDOP index) was applied to interpret leaf nutrient status of studied peach trees (Montanes *et al.*, 1991). Leaf N (in both studied years) was higher than optimum according to Bergmann (1992) on all treatments (Table 4) but all other studied leaf nutrients on all treatments showed a relative deviation to the optimum concentration according to results of above authors.

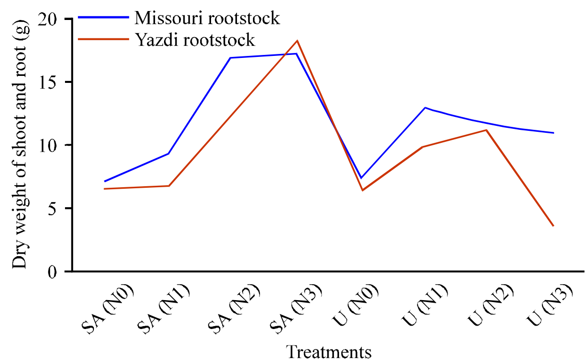

Fig. 3: Effects of various levels and forms of nitrogen application dry weight of shoot and root in Missouri and Yazdi seeding rootstocks in July 2009

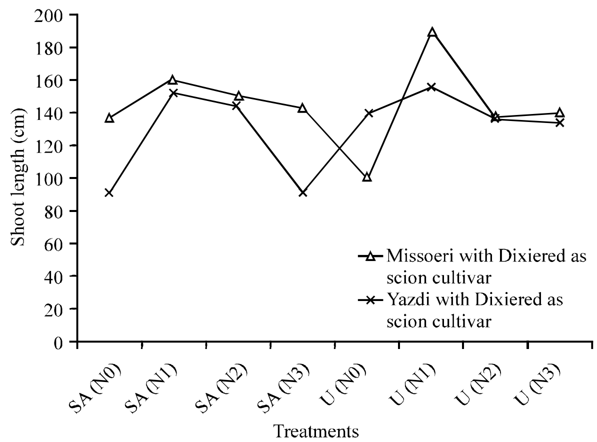

Fig. 4: Effects of various levels and forms of nitrogen application of shoot length of Missouri and Yazdi seeding rootstocks with Dixiered as scion cultivar in July 2010

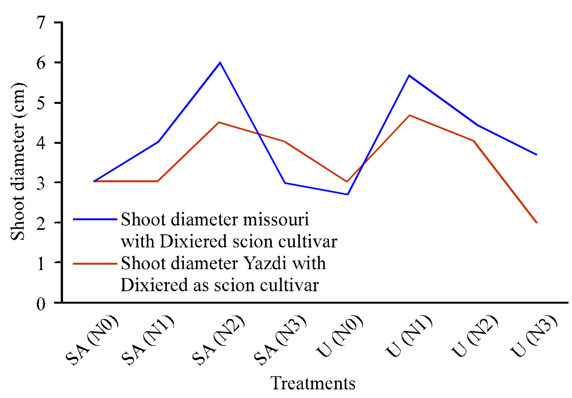

Fig. 5: Effects of various levels and forms of nitrogen application of shoot length of Missouri and Yazdi seeding rootstocks with Dixiered as scion cultivar in July 2010

Regarding ΣDOP index for 2009, the weakest balanced nutritional values belonged to the Yazdi rootstock without any application of nitrogen and highest to the Yazdi by application of 200 kg sulfate ammonium ha^{-1}. In addition, the weakest balanced nutritional values ha in 2010 belonged to the Yazdi rootstock by application of 600 kg urea ha^{-1} and highest to the Missouri by application of 600 kg Urea ha^{-1}. Regarding ΣDOP index for both years, the weakest balanced nutritional values belonged to the Yazdi rootstock with Dixiered as peach scion cultivar by application of 600 kg urea ha^{-1} and highest to the Missouri rootstock with Dixiered as peach scion cultivar by application of 400 kg sulfate ammonium ha^{-1} (Table 5). In our study, the effect of two forms of nitrogen fertilization and four levels of nitrogen application in 2 peach nursery seedling rootstocks during 2009 and 2010(with Dixiered peach cultivar as scion) years were investigated. From this point, application of different form and level of nitrogen in two years had different effect of each studied rootstock. Some authors have indicated that in many cases it may be desirable to use lower soil application of nitrogen fertilizers to ensure good rootstocks growth in nurseries (Knight, 1973; Will, 1971; Tagliavini *et al.*, 1996; Cheng and Fuchigami, 1997; Xie and Cummings, 1995). Comparing with our study on vegetative growth of one year old studied peach seedling rootstocks, some differences can be observed during 2009 and 2010. In the present study, the results of first experiment year 2009 showed that use of higher soil application of nitrogen fertilizers had higher growth characters (such as dry weight of shoot and root, shoot diameter and leaf surface) for both studied seedling rootstocks. On the contrary, application of 200 kg ha^{-1} sulfate ammonium to Missouri and Yazdi rootstocks (with Dixiered as peach scion cultivar) for the second experiment year (2010) resulted in the highest growth characters (leaf surface, shoot and root length and shoot diameter).

CONCLUSION

The results of first experiment year (2009) showed that the application of 600 Kg sulfate ammonium ha^{-1} had highest dry weight of shoot and root production and leaf N concentration of Missouri and Yazdi seedling rootstocks. However, the result of second experiment year (2010) showed that the application of 200 kg sulfate ammonium ha^{-1} for Missouri and Yazdi rootstocks with Dixiered as peach scion cultivar showed highest shoot length, shoot diameter and leaf surface. Furthermore, The DOP and ΣDOP index were estimated for the diagnosis of the leaf mineral status of the trees. According ΣDOP index (for 2009+2010), application of 400 kg sulfate ammonium ha^{-1} for Missouri rootstock with Dixiered as peach scion cultivar showed better balanced nutritional values, the weakest balanced nutritional values belonged to the Yazdi rootstock (with Dixiered as peach scion cultivar) by application of 600 kg urea ha^{-1}.

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