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EFFECT OF NITROGEN SOURCES ON GROWTH AND CHEMICAL CONSTITUENTS OF *Cupressus sempervirens* SEEDLINGS GROWN UNDER DIFFERENT LEVELS OF FIELD CAPACITY

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By

S. H. El-Hanafy, H. M. Swefy, A. R. Rabie* and E. H. M. Soliman*

Ornamental Horticulture Department, Faculty of Agriculture, Cairo University,
** Forestry Department, Horticulture Research Institute, Giza, Egypt*

ABSTRACT

This investigation was conducted at the Nursery of the Forestry Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt and the Faculty of Agriculture, Cairo University, during two successive seasons of 2008/2009 and 2009/2010.

The objective of this investigation was to study the influence of three nitrogen fertilizer sources with different levels of field capacity on the growth and chemical constituents of *Cupressus sempervirens* seedlings. grown under different levels of field capacity. The chemical fertilizers used were ammonium sulfate $(NH4)_2\ SO_4$ (20.5% N), calcium nitrate $Ca\ (NO_3)_2$ (15.5% N) and ammonium nitrate $(NH_4)\ (NO_3)_2$ (33.5% N) at the rates of 0.5, 1.0, 1.5 and 2.0 g. N/ seedling with field capacity at levels of 60, 80 and 100 % .

The results showed that, using calcium nitrate gave the highest values of stem length, stem diameter, fresh and dry weight of stem and leaves, in comparison with other nitrogen sources. In general, the application of three nitrogen sources in different rates resulted in increasing of N, P and K leaf content as compared with the control. The highest content of proline in the leaves was obtained from of 2.0g. N/seedling with 60% field capacity level. Whereas, calcium nitrate decreased proline content in comparison with the other nitrogen sources under different field capacity levels.

Key words: *ammonium nitrate, ammonium sulfate, calcium nitrate, Cupressus sempervirens, nitrogen fertilizer and water deficit*.

1. INTRODUCTION

Cupressus sempervirens belongs to family Cupressaceae which has been distributed throughout the Mediterranean region since classical times. In its native soil, grows in a tapering columnar arrived to a height of 90 ft. Its branches are thickly covered with small, imbricate, shiny green leaves. The timer is hard, dose-grained, and of a fine reddish hue and very durable. *Cupressus sempervirens* has a gloomy and forbidding but wonderfully stately aspect (Aromatherapy Global Online Research Archive,2000).

Nitrogen is one of the essential elements in plant nutrition. Lack of adequate nitrogen subsequently produces plants that are lighter green in color due to a smaller amount of chlorophyll (Follett, 1981). Several works have been done on the effect of nitrogen, Sannappa *et al.* (2000) observed that leaf yield of Mulberry had maximum values under the application of calcium ammonium nitrate in comparison with ammonium chloride and ammonium sulfate. Warren and Adams (2002) on *Pinus pinaster*, found that, dry mass was unaffected by N form at 0.125 or 0.5 mM N. In contrast, dry mass of seedlings supplied with ammonium or ammonium nitrate at 2.0 and 8.0 mM N, was approximately threefold greater than seedlings supplied with nitrate alone. Rance *et al.* (2009) used N fertilizer labelled with ^{15}N to follow the accumulation and distribution of N applied at different times after planting *Eucalyptus grandis* seedlings. Results revealed that, after 1 year above-ground biomass of the controls was only 30% of the fertilized trees. At later applications, controls were not significantly different from fertilized trees up to

1 year later. Zhao and Liu (2009) identified the short-term influences of experimental warming, nitrogen fertilization, and their combination on growth and physiological performances of *Picea asperata* seedlings. Results illustrated that nitrogen fertilization significantly improved plant growth in unwarmed plots, by stimulating total biomass, maximum net photosynthetic rate (A_{max}), antioxidant compounds. However, in warmed plots, nitrogen addition clearly decreased A_{max}, antioxidant compounds. Andivia *et al*. (2012) found in holm oak *Quercus ilex*, a very small increment in N doses during the autumn (1.5 vs. 0.0 mg N) improved some morphological parameters, such as stem diameter (D) and shoot dry weight, and physiological parameters, such as total antioxidant activity. Siemens and Zwiazek (2013) studied the effects of high concentrations (4, 8, or 16 mM) of nitrate (NO_3) and ammonium (NH_4) on water relations and growth of trembling aspen seedlings in solution culture. Results demonstrated that, aspen seedlings are tolerant of high nitrate concentrations, but intolerant of high ammonium concentrations. Ammonium was not toxic to aspen seedlings at moderate concentrations and that the seedlings were capable of assimilating and utilizing both ammonium and nitrate as a nitrogen source.

Water is the most limiting ecological resource for most tree and forest sites. As soil-water content declines, trees become more stressed and begin to react to resource availability changes (Coder, 1999). The growing concerns about water scarcity have focused more attention on water management in agriculture and promotion of water conservation through improved water use efficiency (WUE) (Bacelar *et al*., 2012). In this respect, Xiao *et al*. (2009) subjected *Populus cathayana* plantlets to continuous drought stress by withholding soil water content at 25% of field capacity (FC) for 45 days, while the control treatments were kept at 100% FC. Results revealed that, drought stress significantly inhibited plant growth, decreased net photosynthetic rate and stomatal conductance of leaves. Zheng *et al*. (2010) found that, as water stress increased, stomatal conductance (g_s), net photosynthetic rate (P_N), transpiration rate (E), and leaf RWC decreased while LMA increased in all provenances. Results illustrated that dry mass was reduced in droughted plants and the percentage increased in dry mass allocated to roots. Yang *et al*. (2011) exposed *Acer mono* seedlings to two watering regimes (well watered (100% of field capacity) and drought (30% of field capacity)).Results illustrated that drought significantly reduced growth and gas exchange characteristics of *A. mono*, including net photosynthetic rate (P_N), stomatal conductance (g_s). Eldhuset *et al*. (2013) reported how an 11-week drought affected tracheid structure and above- and belowground growth in 5-year-old Norway spruce trees (*Picea abies*) under controlled conditions. Results demonstrated that the canopy of trees subjected to severe drought had significantly less current-year needle biomass, and fewer tracheids and tracheid rows in current-year shoots compared to fully watered control trees. Li *et al*. (2013) exposed *Tamarix ramosissima* and *Populus euphratica* to different groundwater treatments: inundation, drought, and relatively shallow, moderate and deep groundwater. Results showed that, under inundation, *T. ramosissima* showed little growth whereas *P. euphratica* died after 45 days. Droughted seedlings of both species suffered from considerable water stress evidenced by slow growth, decreased total leaf area and specific leaf area, and decreased xylem water potential (ψ), maximum photosynthetic rate and carboxylation efficiency.

The translocation of chemical signals within plants is important for plant adaptation to stress, especially abiotic stresses such as drought (Goodger and Schachtman, 2010).

This study aimed to investigate how nitrogen decreases the harmful effects of water deficit using three sources of nitrogen (ammonium sulphate, calcium nitrate and ammonium nitrate) with three levels of field capacity (60- 80 - 100%).

2. MATERIALS AND METHODS

The present investigation was conducted at the Nursery of the Forestry Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt and the Faculty of Agriculture, Cairo University, Giza, Egypt, during two successive seasons of 2008-2009 and 2009-2010.

One-year-old seedlings of *Cupressus sempervirens* obtained from the nursery of the Forestry Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt, were planted on the second week of April in both seasons in 25 cm diameter plastic pots, filled with 7.5 Kg of sandy soil and remained in pots to the second week of April of 2009 and 2010, respectively.

Seedlings were 30-35 cm in height and 0.3- 0.4 cm in stem diameter. Each pot contained only one healthy seedling. Experiment consisted of 39 treatments, 3 fertilizer sources, 4 fertilizer concentrations for every source and 3 levels of field capacity in addition to three control treatments (60-80-100% of water field capacity without fertilizer).

The chemical fertilizers and levels of soil moisture used in this study were:

Ammonium sulfate $(NH_4)_2SO_4$ (20.5% N)

N1 = 0.5 g. nitrogen = 2.4 g. fertilizer
N2 = 1.0 g. nitrogen = 4.8 g. fertilizer
N3 = 1.5 g. nitrogen = 7.2 g. fertilizer
N4 = 2.0g. nitrogen = 9.6 g. fertilizer

Calcium nitrate $Ca(NO_3)_2$ (15.5% N)

N1 = 0.5 g. nitrogen = 3.2 g. fertilizer
N2 = 1.0 g. nitrogen = 6.4 g. fertilizer
N3 = 1.5 g. nitrogen = 9.6 g. fertilizer
N4 = 2.0g. nitrogen = 12.8 g. fertilizer

Ammonium nitrate $(NH_4)(NO_3)_2$ (33.5% N)

N1 = 0.5 g. nitrogen = 1.5 g. fertilizer
N2 = 1.0 g. nitrogen = 3.0 g. fertilizer
N3 = 1.5 g. nitrogen = 4.5 g. fertilizer
N4 = 2.0 g. nitrogen = 6.0 g. fertilizer

Levels of soil moisture treatments:

60% of field capacity = 0.50 L of water
80% of field capacity = 0.70 L of water
100% of field capacity = 0.85 L of water

After two months from transplanting, the fertilizers were applied separately every 3 months until the end of the experiment in April of 2009 and 2010, respectively. Fertilized and non fertilized plants were irrigated at 60, 80 and 100% water field capacity. Irrigation was applied once weekly in winter and twice weekly in summer.

The following data were recorded Vegetative growth

The vegetative growth parameter: Stem length, stem fresh and dry weight, leaf fresh and dry weight, root fresh and dry weight were detemined. The dry weight of the samples was determined after drying the samples in an oven at 70°C till a constant weight.

Chemical constituents

The chemical analysis was carried out on leaf samples obtained from all treatments. Determination of N %, P %, K % and proline (mg/gm) in leaves was acheived.

Mineral determination

Dry samples of leaves (0.2 gm. each) were used to determine total soluble nitrogen (N), phosphorus (P), Potassium (K) and proline according to Pregl, (1945), Piper, (1947), Brown and Lililand (1946), and Bates *et al*. (1973), respectively.

Statistical analyses

The layout of the experiment was a completely randomized block design in factorial arrangement. The differences between the means of the treatments for the experiment were compared by using LSD at 5% probability, according to Snedecor and Cochran (1972).

Soil physical analysis

The physical analysis of the used soil was done according to the pipette method as described by Black (1965) (Table, A).

Soil and water analysis

For soil, a (1:5 extract) was used for determination of elements. The soil was shaken with

Table (A): Soil physical analysis

Sample	Coarse sand (%)	Fine sand (%)	Clay (%)	Silt (%)	CaCo 3	Texture class
	38.88	42.50	5.20	7.10	5.02	Sandy

Table (B): Soil chemical analysis

Sample	pH	E.C. (mm hos|cm)	Soluble anions and cations (meq/l)					Mineral elements (ppm)	
			Cl	SO4	Ca	Na	K	N	P
	7.5	1.00	0.95	0.70	0.75	1.30	0.21	7.00	1.3

Table (C): Water chemical analysis

Sample	E.C. (mm hos|cm)	Soluble anions and cations (meq/l)					Mineral Elements (mg/L)	
		Cl	SO4	Ca	Na	K	N	P
	1.05	1.08	2.44	3.00	6.02	0.20	1.50	0.14

100 ml deionised water per 20 g soil. The chemical analysis of the used soil was performed before the experiment according to the methods using in plant (Table, B). For water, 100 ml were taken for determing the elements. (Table, C).

3. RESULTS AND DISCUSSION

3.1. Vegetative growth

3.1.1. Stem length

Data presented in Table (1) show that, using calcium nitrate at the rates of 1.5 (N3) and 2.0g N (N4) resulted in the highest values of stem length (80.98 and 83.36 cm) and (83.50 and 86.06 cm) in the first and the second seasons, respectively regardless of field capacity level.

The lowest values of stem length were obtained with 60% of field capacity levels regardless of fertilizer source or its rate in comparison with 80 or 100% of field capacity in both seasons.

The highest value of stem length resulted from using calcium nitrate at the rate of 2.0g. N/seedling with 100% of field capacity level in comparison with other treatments in both seasons.

3.1.2. Stem diameter

Data presented in Table (2) illustrate that, the application of calcium nitrate or ammonium sulfate at the rate of 2.0g N (N4), regardless of field capacity level, gave the thickest value of stem diameter in the first season. In the second one, the rate of 0.5, 1, 1.5 and 2.0g N/seedling gave the highest values of stem diameter regardless of field capacity level, with application of calcium nitrate.

The highest values of stem diameter were obtained with 100% of field capacity level in comparison with 60 or 80% of field capacity in the first and the second seasons, respectively, regardless of fertilizer source or its rate.

The highest value of stem diameter resulted from using calcium nitrate at the rate of 2.0g N/seedling with 100% of water field capacity level in comparison with the other treatments in the first season. In the second one, the highest values of stem diameter were obtained from 1, 2.0g N/seedling with 100% field capacity level.

3.1.3. Stem fresh weight

Data presented in Table (3) indicated that, using of 2.0g N/seedling of calcium nitrate gave the heaviest stem fresh weight (40.78 and 43.32g. /seedling) in the first and second seasons, respectively, regardless of field capacity level.

Using 60% of water field capacity level resulted in the lowest values of stem fresh weight in comparison with 80 or 100% of field capacity, respectively in both seasons, regardless of fertilizer source or its rate.

The highest values of stem fresh weight resulted from using calcium nitrate at the rate of 1.5g N with 100% field capacity level and 2.0g N/seedling with 80 and 100% of field capacity levels in both seasons.

3.1.4. Stem dry weight

Data presented in Table (4) illustrate that, adding nitrogen at the rate of 2.0g N/seedling from calcium nitrate gave the heaviest values of stem dry weight (19.50 and 20.73g. /seedling) in the first and the second seasons, respectively regardless of field capacity level.

The heaviest stem dry weights resulted from calcium nitrate at the rate of 2.0g N/seedling with 80% and 100% of field capacity levels in both seasons.

3.1.5. Leaves fresh weight

Data in Table (5) showed that, using nitrogen at the rate of 2.0g N/seedling from calcium nitrate gave the heaviest values of leaves fresh weight (70.26 and 69.96g. /seedling) in the first and the second seasons, respectively regardless of field capacity level.

Using 100% field capacity level gave the highest values of stem fresh weight in comparison with 60 or 80% field capacity levels in the first and the second seasons, respectively, regardless of fertilizer source or its rate.

In the first season, application of ammonium sulfate and calcium nitrate at the rate of 1.5g N under 100% of water field capacity level and the same fertilizers at the rate of 2.0g N under 80 and 100% of field capacity levels resulted in the highest values of leaves fresh weight. In the second season, the highest values were obtained by using calcium nitrate at the rate of 2.0g N under 100% of water field capacity level.

3.1.6. Leaves dry weight

Data presented in Table (6) show that, using both calcium nitrate and ammonium sulfate at the rate of 2.0g N/seedling gave the highest values of leaves dry weight in the first and the second seasons, respectively regardless of field capacity levels.

The highest values of leaf dry weight were obtained by using calcium nitrate at the rate of 2.0g

Table (1): Effect of nitrogen sources and rates under different levels of water field capacity on stem length (cm.) of *Cupressus sempervirens* seedlings during the seasons of 2008-2009 and 2009-2010.

First season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	50.53 O	52.90 NO	54.40 NO	52.61 G	50.53 O	52.90 NO	54.40 NO	52.61 G	50.53 O	52.90 NO	54.40 NO	52.61 G
N1(0.5g.)	57.67 L-O	57.77 L-O	68.73 F-I	61.39 D-F	53.73 NO	59.90 J-N	66.20 G-K	59.94 EF	50.83 O	60.30 I-N	66.80 G-K	59.31 F
N2(1g.)	62.90 H-M	67.57 G-J	98.60 B	76.36 B	57.42 M-O	65.97 G-L	71.17 E-H	64.84 CD	53.73 NO	61.33 I-N	76.60 D-F	63.89 C-E
N3(1.5g.)	59.03 K-O	81.63 CD	102.3 B	80.98 A	70.80 E-H	71.53 E-G	85.20 C	75.84 B	64.10 G-M	66.17 G-K	68.10 G-J	66.12 C
N4(2g.)	58.43 K-O	79.83 CD	111.8 A	83.36 A	56.73 M-O	70.47 E-H	77.20 DE	68.13 C	27.48 P	61.20 I-N	67.43 G-J	52.03 G
Mean	57.71 E	67.94 BC	87.16 A		57.70 E	64.15 D	70.83 B		49.42 F	60.38 E	66.67 CD	
Second season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	51.83 Q	51.87 Q	59.27 M-Q	54.32 G	51.83 Q	51.87 Q	59.27 M-Q	54.32 G	51.83 Q	51.87 Q	59.27 M-Q	54.32 G
N1(0.5g.)	59.50 M-Q	58.10 N-Q	72.23 F-H	63.28 EF	54.70 O-Q	61.97 I-O	68.63 H-K	61.77 F	52.17 PQ	60.43 K-Q	68.17 H-L	60.26 F
N2(1g.)	61.03 J-O	69.93 G-I	101.6 B	77.53 B	58.97 M-Q	66.73 H-N	74.03 E-H	66.58 DE	54.23 O-Q	62.23 I-O	77.70 D-G	64.72 EF
N3(1.5g.)	65.63 K-P	83.77 CD	106.1 B	85.10 A	72.63 F-H	72.60 F-H	86.70 C	77.31 B	65.50 H-N	67.03 H-M	78.60 D-F	64.72 EF
N4(2g.)	59.73 L-Q	83.27 CD	115.2 A	86.06 A	59.43 M-Q	72.97 F-H	81.57 C-E	71.32 C	30.57 R	69.40 H-J	78.40 D-F	59.45 F
Mean	59.55 F	69.39 C	90.88 A		59.51 EF	65.23 D	74.04 B		50.86 G	62.19 DE	72.43 BC	

Means followed by a letter in common in the same column are not significantly different at 0.05 level of probability

Table (2): Effect of nitrogen sources and rates under different levels of water field capacity on stem diameter (cm.) of *Cupressus sempervirens* seedlings during the seasons of 2008-2009 and 2009-2010.

First season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	0.40 L	0.46 L	0.60 K	0.48 F	0.40 L	0.46 L	0.60 K	0.48 F	0.40 L	0.46 L	0.60 K	0.48 F
N1(0.5g.)	0.76 F-J	0.83 E-H	0.80 E-I	0.80 CD	0.60 K	0.63 JK	0.70 H-K	0.64 E	0.66 I-K	0.76 F-J	0.83 E-H	0.75 D
N2(1g.)	0.76 F-J	0.96 A-D	0.96 A-D	0.90 AB	0.76 F-J	0.86 D-G	0.90 C-F	0.84BC	0.70 H-K	0.73 G-K	0.80 E-I	0.74 D
N3(1.5g.)	0.76 F-J	0.83 E-H	0.80 E-I	0.80 CD	0.70 H-K	0.83 E-H	0.90 C-F	0.81CD	0.60 K	0.70 H-K	0.73 G-K	0.67 E
N4(2g.)	0.83 E-H	0.93 B-E	1.03 A	0.93 A	0.80 E-I	1.0 A-C	1.0 A -C	0.95 A	0.33 L-M	0.63 JK	0.66 I-K	0.53 F
Mean	0.70 CD	0.80 AB	0.84 A		0.65 D	0.76 BC	0.83 A		0.54 E	0.66 D	0.72 C	
Second season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	0.43 J	0.50 IJ	0.56 H-J	0.50 E	0.43 J	0.50 IJ	0.56 H-J	0.50 E	0.43 J	0.50 IJ	0.56 HIJ	0.50 E
N1(0.5g.)	0.76 C-F	0.86 A-C	0.76 C-F	0.80 AB	0.63 F-I	0.70 D-H	0.73 C-G	0.68 CD	0.70 D-H	0.70 D-H	0.73 C-G	0.71 CD
N2(1g.)	0.83 A-D	0.76 C-F	0.96 A	0.85 A	0.60 G-I	0.76 C-F	0.76 C-F	0.71 CD	0.66 E-H	0.73 C-G	0.70 D-H	0.70 CD
N3(1.5g.)	0.80 B-E	0.93 AB	0.86 A-C	0.86 A	0.73 C-G	0.80 B-E	0.76 C-F	0.76 BC	0.60 G-I	0.63 F-I	0.66 E-H	0.63 D
N4(2g.)	0.76 C-F	0.83 A-D	0.96 A	0.85 A	0.76 C-F	0.86 A-C	0.93 AB	0.85 A	0.33 J	0.63 F-I	0.70 D-H	0.55 E
Mean	0.72 BC	0.78 AB	0.82 A		0.63 D	0.72 BC	0.75 B		0.54 E	0.64 D	0.67 CD	

Means followed by a letter in common in the same column are not significantly different at 0.05 level of probability

Table (3): Effect of nitrogen sources and rates under different levels of water field capacity on stem fresh weight (g./seedling) of *Cupressus sempervirens* ***seedlings*** **during the seasons of 2008-2009 and 2009-2010.**

First season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	14.17 O	21.80 K-N	20.03 M-O	18.67FG	14.17 O	21.80 K-N	20.03 M-O	18.67FG	14.17 O	21.80 K-N	20.03 M-O	18.67FG
N1(0.5g.)	18.47 N-O	25.63 G-M	29.10 E-J	24.40 E	20.13 L-O	20.40 L-N	23.43 J-N	21.32 F	29.67 D-I	30.93 C-H	33.60 B-F	31.40 C
N2(1g.)	21.80 K-N	26.33 G-L	34.97 B-E	27.70 D	20.73 L-N	25.03 H-M	28.17 F-J	24.64DE	29.87 D-I	33.13 B-F	34.50 B-E	32.50 C
N3(1.5g.)	31.23 C-G	37.67 B	43.83 A	37.58 B	25.50 G-M	34.70 B-E	35.80 B-D	32.00 C	23.87 I-N	27.47 F-K	30.27 D-H	27.20DE
N4(2g.)	33.03 B-F	44.13 A	45.17 A	40.78 A	33.50 B-F	36.93 BC	38.17 B	36.20 B	15.50 O	23.43 J-N	25.03 H-M	21.32 F
Mean	23.74 D	31.11 B	34.62 A		22.81 DE	27.11 C	29.12 BC		22.61 DE	26.69 C	28.69 C	
Second season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	15.07 P	21.07 O	21.67 O	19.27 K	15.07 P	21.07 O	21.67 O	19.27 K	15.07 P	21.07 O	21.67 O	19.27 K
N1(0.5g.)	21.50 O	24.70 K-O	26.80 I-M	24.33 IJ	21.60 O	22.27 NO	25.07 K-O	22.98 J	31.77 E-H	32.10 E-H	34.50 C-F	32.79 DE
N2(1g.)	23.47 M-O	27.83 H-L	29.53 G-J	26.94GH	23.27 M-O	26.07 J-N	29.43 G-J	26.26 HI	31.50 E-H	32.13 E-H	35.67 C-E	33.10 D
N3(1.5g.)	34.27 C-F	42.23 B	44.07 AB	40.19 B	28.17 H-K	30.80 F-I	33.57 D-G	30.84 EF	25.37 J-O	29.37 G-J	31.67 E-H	28.80 FG
N4(2g.)	37.30 CD	45.37 AB	47.30 A	43.32 A	34.63 C-F	36.90 CD	38.20 C	36.58 C	16.06 P	23.93 K-O	23.83 L-O	21.27 J
Mean	26.32 D	32.24 B	33.87 A		24.55 E	27.42 D	29.59 C		23.95 EF	27.72 D	29.47 C	

Means followed by a letter in common in the same column are not significantly different at 0.05 level of probability

Table (4): Effect of nitrogen sources and rates under different levels of water field capacity on stem dry weight (g./seedling) of *Cupressus sempervirens* seedlings during the seasons of 2008-2009 and 2009-2010.

First season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	7.86 L	8.76 KL	11.03 I-K	9.22 H	7.86 L	8.76 KL	11.03 I-K	9.22 H	7.86 L	8.76 K-L	11.03 I-K	9.22 H
N1(0.5g.)	9.36 KL	12.80 E-J	14.40 C-H	12.19 F	10.37 J-L	10.73 I-K	11.10 I-K	10.73 G	15.47 B-E	14.70 C-H	14.87 C-H	15.01CD
N2(1g.)	10.83 I-K	12.37 G-J	16.80 BC	13.33 EF	10.43 J-L	12.57 F-J	13.43 E-I	12.14 F	13.97 D-H	15.50 B-E	15.13 B-F	14.87CD
N3(1.5g.)	15.00 C-G	17.67 B	21.87 A	18.18 B	12.60 F-J	14.73 C-H	15.47 B-E	14.27C-E	12.20 H-J	14.03 D-H	14.57 C-H	13.60DE
N4(2g.)	14.83 C-H	21.10 A	22.57 A	19.50 A	14.17 C-H	16.37 B-D	16.37 B-D	15.63 C	7.73 K-M	10.27 J-L	11.23 I-K	9.73 H
Mean	11.58 D	14.51 B	17.33 A		11.09 DE	12.63 C	13.48 C		11.45 DE	12.65 C	13.37 C	
Second season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	7.96 P	11.40 L-O	11.00 M-O	10.12GH	7.96 P	11.40 L-O	11.00 M-O	10.12GH	7.96 P	11.40 L-O	11.00 M-O	10.12GH
N1(0.5g.)	10.50 NO	12.13 I-O	13.13 E-N	11.92 EF	10.83 M-O	10.97 M-O	11.57 L-O	11.12FG	15.33 D-F	15.63 D-F	18.40 BC	16.46 C
N2(1g.)	10.20 OP	13.53 E-M	15.07 D-H	12.93 E	11.87 J-O	12.50 G-O	14.37 D-K	12.91 E	14.70 D-I	15.27 D-G	14.90 D-H	14.96 D
N3(1.5g.)	14.83 D-I	19.67 B	22.27 A	18.92 B	12.87 F-O	14.93 D-H	15.87 DE	14.55 D	12.37 H-O	12.90 F-O	14.53 D-J	13.27 E
N4(2g.)	15.47 D-F	22.37 A	24.37 A	20.73 A	15.20 D-G	16.93 CD	19.50 B	17.21 C	8.06 P	11.67 K-O	11.77 K-O	10.49 GH
Mean	11.79 E	15.82 B	17.17 A		11.74 E	13.35 D	14.46 C		11.69 E	13.37 D	14.12 CD	

Means followed by a letter in common in the same column are not significantly different at 0.05 level of probability

Table (5): Effect of nitrogen sources and rates under different levels of water field capacity on leaf fresh weight (g./seedling) of *Cupressus sempervirens* seedlings during the seasons of 2008-2009 and 2009-2010.

First season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	17.67 P	19.93 OP	21.67 N-P	19.76 H	17.67 P	19.93 OP	21.67 N-P	19.76H	17.67 P	19.93 OP	21.67 N-P	19.76 H
N1(0.5g.)	27.23 L-P	46.77 E-I	49.90 C-G	41.30 EF	23.23 N-P	42.50 G-J	47.27 E-I	37.67 F	30.87 K-N	48.33 D-H	56.73 B-D	45.31DE
N2(1g.)	38.50 I-K	55.30 B-E	61.23 B	51.68 C	34.83 J-M	52.27 B-F	59.57 B	48.89CD	27.70 L-O	39.17 H-K	46.30 E-I	37.72 F
N3(1.5g.)	49.57 C-G	61.47 B	75.27 A	62.10 B	44.47 F-I	57.60 B-D	74.57 A	58.88 B	22.03 N-P	25.87 M-P	35.30 J-L	27.73 G
N4(2g.)	58.87 BC	72.60 A	79.30 A	70.26 A	55.73 B-E	71.23 A	78.37 A	58.88 B	15.26 PQ	22.00 N-P	28.23 L-O	21.83 H
Mean	38.37 C	51.21 B	57.47 A		35.19 C	48.71 B	56.33 A		22.71 E	31.06 D	37.69 C	
Second season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	18.43 O	24.47 L-O	26.23 K-O	23.04 I	18.43 O	24.47 L-O	26.23 K-O	23.04 I	18.43 O	24.47 L-O	26.23 K-O	23.04 I
N1(0.5g.)	31.83 I-M	51.90 E-G	55.93 C-G	46.56 EF	27.57 K-O	48.27 GH	53.70 D-G	43.18 FG	34.03 I-L	49.20 F-H	58.50 B-G	47.24 EF
N2(1g.)	35.57 I-K	60.50 B-E	63.73 B-D	53.27 D	29.50 J-N	57.37 B-G	61.53 B-E	49.47 DE	29.13 J-N	41.07 HI	51.67 E-G	40.62 G
N3(1.5g.)	57.93 B-G	64.27 BCD	67.40 B-D	63.20 BC	53.77 D-G	61.40 B-E	65.20 BC	60.12 C	20.43 NO	30.53 J-N	38.00 IJ	29.66 H
N4(2g.)	59.73 B-F	65.57 BC	84.57 A	69.96 A	55.47 C-G	62.37 B-E	80.33 A	66.06 AB	16.23 O	22.73 M-O	28.00 J-O	21.83 I
Mean	40.70 C	53.34 B	59.57 A		36.95 CD	50.74 B	57.40 A		23.67 E	33.60 D	40.48 C	

Means followed by a letter in common in the same column are not significantly different at 0.05 level of probability

Table (6): Effect of nitrogen sources and rates under different levels of water field capacity on leaf dry weight (g./seedling) of *Cupressus sempervirens* seedlings during the seasons of 2008-2009 and 2009-2010.

First season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	8.93 L	11.40 KL	11.50 KL	10.61 G	8.93 L	11.40 KL	11.50 KL	10.61G	8.93 L	11.40 KL	11.50 KL	10.61 G
N1(0.5g.)	11.87 J-L	22.20 E-H	24.00 D-G	19.36 E	12.20 J-L	22.23 E-H	23.17 E-H	19.20E	14.27 JK	24.00 D-G	26.00 C-E	21.42DE
N2(1g.)	21.67 E-H	24.33 D-F	30.20 C	25.33CD	18.87 HI	25.63 C-E	28.43 CD	24.31C	13.70 J-L	19.93 F-I	24.13 D-G	19.26E
N3(1.5g.)	22.97 E-H	29.53 C	35.53 AB	29.34B	23.80 D-G	28.73 CD	37.73 AB	30.09B	10.83 KL	12.63 J-L	19.13 G-I	14.20 F
N4(2g.)	28.47 CD	34.53 B	40.20 A	34.40A	26.63 C-E	36.53 AB	38.93 AB	34.03A	6.96 M	11.10 KL	12.57 J-L	10.20 G
Mean	18.78 C	24.40 B	28.29 A		18.09 C	24.91 B	27.95 A		10.94 E	15.81 D	18.67 C	
Second season												
Fertilizer	**Calcium nitrate**				**Ammonium sulfate**				**Ammonium nitrate**			
	60% F.C.	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**Mean**
control (zero)	11.13 H	12.53 GH	12.77 GH	12.14 EF	11.13 H	12.53 GH	12.77 GH	12.14 EF	11.13 H	12.53 GH	12.77 GH	12.14 EF
N1(0.5g.)	15.17 F-H	23.80 DE	26.70 B-E	21.89CD	11.23 GH	23.47 E	25.43 C-E	20.04 D	17.07 FG	26.70 B-E	29.37 B-D	24.38 C
N2(1g.)	15.20 F-H	28.07 B-E	28.27 B-E	23.84 C	14.80 F-H	27.30 B-E	27.97 B-E	23.36 C	15.37 F-H	18.63 F	25.63 C-E	19.88 D
N3(1.5g.)	26.73 B-E	29.10 B-E	27.50 B-E	27.78 B	27.57 B-E	31.83 B	30.07 BC	29.82AB	10.47 H	14.83 F-H	17.00 FG	14.10 E
N4(2g.)	25.03 C-E	25.63 C-E	39.30 A	29.99AB	27.23 B-E	30.77 BC	39.47 A	32.49 A	7.46 I	11.30 GH	13.87 F-H	10.87 F
Mean	18.65 CD	23.83 B	26.91 A		18.39 CD	25.18 AB	27.14 A		12.30 E	16.80 D	19.73 C	

Means followed by a letter in common in the same column are not significantly different at 0.05 level of probability

Table (7): Effect of nitrogen sources under different levels of field capaciety on nitrogen , phosphorus, potassium content (%) and porline (mg./g. D.W.) In the leaves of *Cupressus sempervirens* seedlings during the seasons of 2008-2009 and 2009-2010.

First season

Treatments		**Nitrogen %**			**Phosphorus%**			**Potassium %**			**Proline (mg./g. D.W.)**		
		60% F.C.	**80% F.C.**	**100% F.C.**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**60% F.C.**	**80% F.C.**	**100% F.C.**
Control (zero)		0.69	0.70	0.70	0.20	0.20	0.21	0.32	0.32	0.33	0.26	0.23	0.22
Calcium nitrate	**N1(0.5g.)**	1.09	1.09	1.12	0.21	0.21	0.22	0.30	0.34	0.34	0.20	0.14	0.10
	N2(1g.)	1.30	1.33	1.33	0.23	0.26	0.26	0.33	0.32	0.37	0.21	0.15	0.10
	N3(1.5g.)	1.40	1.42	1.42	0.30	0.30	0.36	0.37	0.44	0.45	0.23	0.15	0.13
	N4(2g.)	1.97	1.97	2.01	0.34	0.35	0.35	0.31	0.32	0.36	0.23	0.15	0.15
Ammonium sulfate	**N1(0.5g.)**	0.99	0.99	0.99	0.20	0.20	0.20	0.57	0.59	0.59	0.27	0.24	0.25
	N2(1g.)	1.05	1.09	1.10	0.21	0.24	0.27	0.45	0.47	0.50	0.26	0.26	0.25
	N3(1.5g.)	1.09	1.12	1.14	0.22	0.24	0.28	0.40	0.42	0.48	0.33	0.27	0.26
	N4(2g.)	1.42	1.43	1.60	0.22	0.28	0.28	0.36	0.40	0.46	0.36	0.29	0.29
Ammonium nitrate	**N1(0.5g.)**	0.98	0.98	1.01	0.20	0.20	0.20	0.50	0.50	0.50	0.24	0.24	0.25
	N2(1g.)	1.04	1.10	1.10	0.20	0.26	0.26	0.43	0.42	0.52	0.29	0.24	0.25
	N3(1.5g.)	1.01	1.01	1.01	0.20	0.21	0.21	0.37	0.39	0.39	0.39	0.28	0.26
	N4(2g.)	0.88	0.88	0.99	0.20	0.20	0.20	0.31	0.32	0.33	0.40	0.30	0.28

Second season

Treatments		**Nitrogen %**			**Phosphorus%**			**Potassium %**			**Proline (mg./g. D.W.)**		
		60% F.C.	**80% F.C.**	**100% F.C.**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**60% F.C.**	**80% F.C.**	**100% F.C.**	**60% F.C.**	**80% F.C.**	**100% F.C.**
Control (zero)		0.59	0.61	0.60	0.20	0.20	0.20	0.30	0.30	0.30	0.26	0.20	0.20
Calcium nitrate	**N1(0.5g.)**	1.09	1.16	1.50	0.21	0.23	0.23	0.30	0.30	0.34	0.20	0.14	0.12
	N2(1g.)	1.13	1.49	1.99	0.23	0.25	0.28	0.32	0.32	0.34	0.20	0.14	0.12
	N3(1.5g.)	1.39	1.63	2.07	0.31	0.32	0.34	0.46	0.38	0.39	0.20	0.16	0.12
	N4(2g.)	1.69	2.00	2.71	0.31	0.33	0.34	0.37	0.45	0.49	0.20	0.16	0.13
Ammonium sulfate	**N1(0.5g.)**	1.01	1.01	1.02	0.20	0.21	0.21	0.51	0.55	0.65	0.26	0.23	0.24
	N2(1g.)	1.05	1.14	1.14	0.21	0.22	0.26	0.48	0.59	0.59	0.26	024	0.24
	N3(1.5g.)	1.17	1.20	1.18	0.21	0.22	0.26	0.37	0.48	0.49	0.27	0.27	0.27
	N4(2g.)	1.66	1.97	1.52	0.21	0.23	0.26	0.32	0.48	0.49	0.29	0.24	0.27
Ammonium nitrate	**N1(0.5g.)**	0.98	1.00	1.00	0.20	0.20	0.20	0.36	0.57	0.69	0.26	0.25	0.20
	N2(1g.)	1.02	1.10	0.99	0.20	0.23	0.23	0.30	0.40	0.60	0.29	0.25	0.22
	N3(1.5g.)	1.01	1.01	0.98	0.20	0.20	0.21	0.30	0.40	0.40	0.40	0.28	0.27
	N4(2g.)	0.78	0.83	0.90	0.20	0.20	0.20	0.31	0.32	0.41	0.42	0.30	0.29

N/seedling with 100% field capacity level in the first and the second seasons, respectively.

The aforementioned results agreed with many investigations which indicated that low level of water field capacity decreased vegetative growth. Wang *et al.* (2004) measured photosynthesis on five pine species. Their results showed that the net photosynthetic rate was significantly reduced 34.43% under water stress. In this respect, De Diego *et al*. (2012) studied the changes of leaf water potential, hydraulic conductance (K_{leaf}), stomatal conductance and phytohormones under drought in *Pinus radiate*. They found that drought decreased cytokinin levels in the needles parallel to K_{leaf} and gas exchange. Also, Yang *et al*. (2012) investigated the ecophysiological responses of *Abies fabri* seedlings to drought, nitrogen addition alone, and the combination of these treatments, and their results showed that the applied nitrogen improved plant water use efficiency and N accumulation in plant organs under drought conditions. Especially under drought conditions, more N was concentrated into needles by applied nitrogen as compared with other organs.

Calcium ammonium nitrate was the best nitrogen resource to improve plant growth, Sannappa *et al.* (2000) determined the efficiency of different sources of nitrogen fertilizers on the yield and quality of mulberry, such as calcium ammonium nitrate (CAN), ammonium chloride and ammonium sulfate. They observed that leaf yield had maximum values under the application of CAN. Krause *et al*. (2012) investigated *Picea abies* responses to N addition, and found that foliar analyses showed an increase in dry mass tree height and leaf area index.

3.2. Chemical composition

3.2.1. Nitrogen content

Data presented in Table (7) showed that, an increase in leaf N content with the increase of calcium nitrate and ammonium sulfate fertilizer rate, but in the case of ammonium nitrate, the increase remained to the rate of 1.5 and the decrease to the rate of 2.0g N/seedling in the first and the second seasons, respectively.

3.2.2. Phosphorus content

Data in Table (7) illustrated that, calcium nitrate treatment slightly increased leaf P content in comparison with the two other nitrogen sources under different levels of field capacity in both seasons .

3.2. 3. Potassium content

According to the data presented in Table (7), all fertilizer treatments increased potassium content in leaves as compared to the control which gave the lowest values under different levels of water field capacity in the two seasons.

3.2. 4. Proline content

Data presented in Table (7), showed that, treatment with ammonium nitrate and ammonium sulfate increased proline content in the leaves in all fertilizer rates under all field capacity levels as compared to the control, whereas, calcium nitrate decreased it.

For the interaction between N fertilizer rates and water field capacity levels, the highest value of proline was found at the rate of 2.0g N/seedling of ammonium nitrate under 60% of field capacity level (0.40 and 0.42mg/gm dw.) in the first and the second seasons, respectively. On the other side, the lowest value was obtained at the rate of 0.5g N/seedling of calcium nitrate under 100% field capacity level.

In general, proline content in the leaves showed the highest values under 60% field capacity in comparison with the two other levels in all fertilizer rates in different nitrogen sources.

In accordance with these results Shvaleva *et al.* (2005) observed that, there were increases in concentrations of proline in two *Eucalyptus globulus* leaves. Sannappa *et al.* (2000) determined the efficiency of different sources of nitrogen fertilizers on the mulberry. The foliar constituents of mulberry leaf (total carbohydrates, proline, N, P, K, Ca, Mg and S), maximum concentrations were recorded with calcium ammonium nitrate application.

As a recommendation, in abundant water or water deficit conditions, application of calcium nitrate is favorable for *Cupressus sempervirens* seedlings growth as compared with application of ammonium sulfate and ammonium nitrate.

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تأثير مصادر النتروجين على النمو والمحتوى الكيميائى لشتلات السرو النامية تحت مستويات مختلفة من السعة الحقلية

صفية حمدى الحنفى- هند مصطفى سويفي - *عمرو رافت ربيع- *إيناس حسن محمد سليمان

قسم بساتين الزينة – كلية الزراعة – جامعة القاهرة–
* قسم الأشجار الخشبية والغابات – معهد بحوث البساتين – الجيزة

ملخص

اجرى هذا البحث بمشتل قسم الاشجار الخشبية بمعهد بحوث البساتين - مركز البحوث الزراعية- الجيزة- وقسم بساتين الزينة - كلية الزراعة- جامعة القاهرة خلال موسمين متتالين (2008-2009)،(2009-2010).

استهدف هذا البحث دراسة تأثير ثلاثة مصادر للنتروجين على شتلات السرو مع مستويات مختلفة من السعة الحقلية .كانت الأسمدة المستخدمة هى سلفات النشادر(20,5 جم ن) و نترات الكالسيوم (15,5 جم ن) ونترات النشادر (33,5 جم ن) . وذلك بمعدلات 1,0,0,5، 1,5، 2,0 جم ن/ نبات تحت مستويات 60 و 80 و100% من السعة الحقلية. أوضحت النتائج أن استخدام نترات الكالسيوم أعطى أعلى القيم من طول وقطر الساق والوزن الطازج والجاف لكل من الساق والاوراق بالمقارنة مع سلفات النشادر ونترات النشادر. أدى استخدام اى نوع من الاسمدة سواء نترات الكالسيوم أو سلفات النشادر أو نترات النشادر بأى معدل الى زيادة محتوى الأوراق من النيتروجين والفوسفور والبوتاسيوم مقارنة بالكنترول. كانت أعلى قيمة تم الحصول عليها لمحتوى البرولين فى الأوراق باستخدام معدل 2 جم نيتروجين من نترات النشادر تحت مستوى 60% من السعة الحقلية. بينما كانت اقل معدلات للبرولين باستخدام نترات الكالسيوم مقارنة بنترات الامونيوم او سلفات الامونيوم تحت اى مستوى من مستويات السعة الحقلية.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (64) العدد الثاني (إبريل 2013): 172-185.