ASSESSMENT OF N AND K CONTENT, IN GREENHOUSE SOILS WITH PLANTS IN NORMAL NUTRIENT STATUS

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ABSTRACT

Research conducted on 68 greenhouse crops of Thessalia, plants showed normal nutritional status in N and K, found in the territories in which the range of values of the specific electrical conductivity of the extract 1soil : 5$H_2$0 ranged from 0.12 up to 1,130 mS/cm, while the average was 0,512 mS/cm. The electrical conductivity values of the total sample, were at higher levels.

Exploring the covariance between the changes in conductivity of the extract 1:5 and the corresponding values of water-soluble amounts of N and K in various crop period, it showed a positive correlation coefficient. According to the relevant multiple regression equation, an increase of 100 ppm respectively, of water-soluble forms of both N and K is associated with a possible increase of the specific conductivity of the extract 1:5, by 0,280 mS/cm.

In the same soil samples with normal plants nutritional status in N and K, it was confirmed high available levels to plants of N and K, when the conductivity of that 1:5 extract, was higher than 0,4 mS/cm.

1. INTRODUCTION

The greenhouse crops are characterized by large nutrient requirements of N & K, but it should be combined with securing low degree of salinity of soils. Moreover, the accumulation of large quantities of nutrients to soils of greenhouses has consequences on quality value of the products (Roorda van Eysinga, 1980). So, an effective fertilization technique must respect the above findings . For example, frequent fertilizations with large rates must respect the soil salinity (Monico et Ryer, 1982). The methods for assessing nutrient content of soils based on nutrient content of the aqueous extraction (Ende, 1968, Chouliaras , 1991), enable the measurement on the same time of the electrical conductivity on the same extract . However, since it is usual practice the evaluation in greenhouse soils of forms as total-N, mineral-N, and exchangeable-K, it is interesting to investigate the correlation between these parameters, and the corresponding water soluble amounts of these elements.

2. MATERIALS AND METHODS

Sixty height (68) cultivations of greenhouses were examined in all Thessalia region, in a research program conducted at TEI of Larissa, in the years 1987-88-89-90 and 91. For that study, data were evaluated based on

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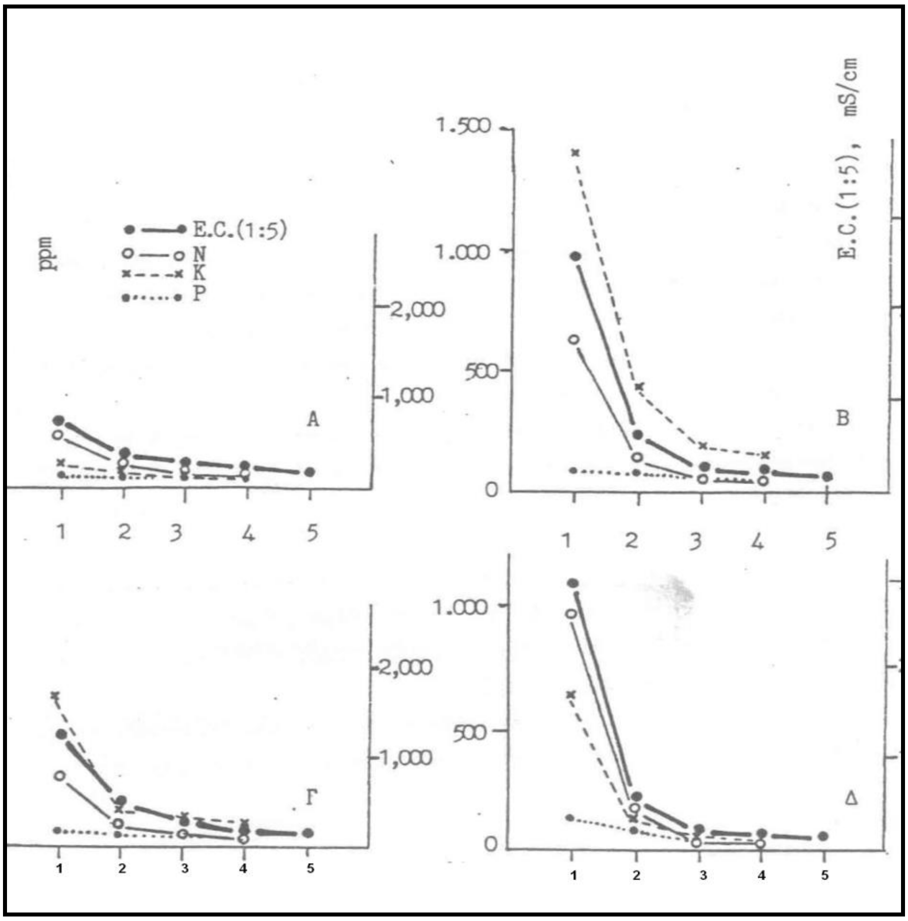
the following measurements:
- The specific electrical conductivity of the extract 1soil : $5H_2O$.
- The content of soil total –N, N -mineral and N- water soluble).
- The content of soils in exchangeable-K and K- soluble in extract in (1:5).
- The foliar content of plant in N, K, P, Ca and Mg in the dry matter.

The soil sampling was conducted in three phases:

- ✓ Do : Before basic dressing.
- ✓ Da: 6-8 weeks after the establishment of the crop.
- ✓ Db:12 -16 weeks after the establishment of the crop.

Foliar analysis was based on young but well developed (active) leaves, at phases Da and Db. Twenty (20) crops of tomatoes were studied, 13 of cucumber, 7 of pepper, 14 of lettuce, 5 of onion, 9 of beans, watermelon, melon, squash and eggplant. Characterization of nutritional status of plant was based on the content of dry matter in leaf nutrients (Walsh and Beaton, 1973), (Winsor and Adams, 1987).

3. RESULTS



.1, 2, 3, 4, 5 extraction order, A,B,Γ,Δ: soil samples

Fig-1: Extractable amounts of N, P, K with successive extractions in 1soil:$5H_2O$ solutions.

The Figure - 1 shows the important amounts of water-soluble forms of N and K, obtained by the first extraction in the ratio 1soil : $5H_2O$. It is also noted the parallel change of the electrical conductivity in water soluble extracts, depending on the extraction order.
The crop plants with normal nutritional status in N and K were found on soils where the electrical conductivity of the extract (1:5) not exceed 1,130 mS / cm, and the sample varies with an average of 0,512 mS/cm. The vast majority of the soil sample with normal nutritional status was found at Da phase of plant growth, (Table-1). The total sample, showed higher salinity, and it is characterized by a corresponding average of 0,705 and 0,736 mS/cm in Da and Db phases of sampling.

Table-1: Electrical conductivity (mS/cm) of the extract 1soil:$5H_2O$

	D	range	average	n
I	Do	0,312 - 1,880	0,893	10
	Da	0,120 - 3,250	0,705	68
	Db	0,200 - 2,900	0,736	30
II	Da	0,120 - 1,130	0,512	28
	Db	0,240 - 0,590		2

I: total sample, **II:** Soils with plant with normal nutrition, **D:** Sampling phase

The changes of the amounts of water-soluble nutrient elements N , K and the corresponding changes of the electrical conductivity of the extract 1:5, between Da and Db sampling phases, can confirme the following multiple regression equation:
Y = 0,050 + 0,0009*X1 + 0,0013*X2, n=25, r=0.802***
Where,
Y = Changes in conductivity (mS / cm) between Da and Db -phase sampling
X1 = Changes in water soluble N (ppm) between Da and Db-phase sampling
X2 = Changes in water - soluble K (ppm) between Da and Db phase sampling
.
The overall distribution of levels of soils in various forms of N (total-N, inorganic - N , water soluble- N) and K (exchangeable –K, water soluble-K) are presented in Tables -2 and -3.
Tables 4 and -5 show the distributions for the sample of greenhouses plants, with normal nutritional status, in N and K. The total- N ranges of 492 - 3465 ppm, the inorganic-N from 144 - 592 ppm, water soluble- N from 70 - 359 ppm in soil. For K, measurements showed for exchangeable-K contents

ranging from 112 -1817 ppm and for water soluble- K from 20-536 ppm. Studying individual cases to the sample with plants in normal nutritional status in N and K, it showed that when the value of the specific conductivity of the extract 1:5 becomes greater than 0,4 mS/cm (12 cases), values of soluble- N and exchangeable-K, were always greater than 96 and 239 ppm respectively. Exploring the relationships between different forms of nutrients N and K in the soil of plants with normal nutritional status, both between the form pairs, and with the values of the electrical conductivity of (1:5) extract, these results are shown in Table -6. In all cases, positive linear correlation were confirmed Also a positive correlation between the water soluble-K and the saturation percentage of CEC by exchangeable-K, was found, establishing the following regression equations:

Y = -85 + 40*X   r = 0.601,   n = 10, Do

Y = -9 + 27*X   r = 0.782***,   n = 69, Da

Y = -87 + 35*X   r = 0.896***,   n = 30, Db

wherein:
Y = K – soluble, ppm in soil
X=% saturation CEC with exchangeable-K, (CEC & K-exchangeable in me/100g soil), Do, Da, Db: Phases of sampling

Finally it should be noted that cultures with plants in normal nutritional status in N and K, were also found in normal nutritional status concerning P and Mg tissue contents.

Table -2: Contents of all soils in total- N, mineral- N, and water soluble-N (ppm)

N-form	D	range	average	n
Total-N	**Do**	802 - 3762	1462	10
	Da	364 - 6027	1495	68
	Db	642 - 6299	2472	30
Mineral-N	**Do**	188 - 767	413	10
	Da	143 -1335	383	68
	Db	140 -1245	439	30
Water soluble-N	**Do**	65 - 630	261	10
	Da	36 -1120	245	68
	Db	36-639	245	30

Table-3: Contents of all soils in K (ppm)

K form	D	range	average	n
Exchangeable-K	Do	232 -1177	709	10
	Da	78 -2707	687	69
	Db	86 -2360	709	30
Water soluble-K	Do	39-735	238	10
	Da	20 -1201	220	69
	Db	20-967	233	30

Table - 4: Content of N in soils (ppm), with plants in normal nutritional status

crop	D	Μορφή - N	range	average	n
tomato	Da	Total-N	550-3185	213	6
		Mineral -N	214- 592	436	6
		Water soluble-N	96- 307	220	6
cucumber	Da	Total-N	995 - 1428	993	3
		Mineral -N	196 - 445	333	3
		Water soluble-N	184 - 329	210	3
lettuce	Da	Total-N	873 - 3465	1757	5
		Mineral -N	146-470	249	5
		Water soluble-N	109-359	192	5
onion	Da	Total-N	808 - 3131	1600	5
		Mineral -N	114 - 367	259	5
		Water soluble-N	93 - 187	163	5
various	*Da*	Total-N	492-3175	1112	8
		Mineral -N	146-373	244	8
		Water soluble-N	70- 261	145	8

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Table 5: Contents of Soils in K (ppm) with plants in normal nutritional status

crop	D	K	range	average	n
tomato	Da	Exchangeable-K	239 - 1314	627	6
		Water soluble-K	59 - 536	251	6
cucumber	Da	Exchangeable-K	241 - 907	541	3
		Water soluble-K	50 - 153	85	3
lettuce	Da	Exchangeable-K	261 - 1817	624	5
		Water soluble-K	48 - 534	202	5
onion	Da	Exchangeable-K	112 - 642	443	5
		Water soluble-K	38 - 271	121	5
various	Da	Exchangeable-K	288- 710	448	8
		Water soluble-K	2O - 312	85	8

D; Sampling phase

Table - 6: Linear correlations between forms of N, K and EC in soils, with plants in normal nutritional status

Regression parameters		relationships		r	n
X	Ψ				
Total-N	EC	$\Psi=0\,,11+2,6\bullet.10^{-4}\bullet X$	α	0,653***	27
Mineral-N	EC	$\Psi=0,20+2,2.10^{-3}\bullet X$	β	0,755***	27
Water soluble -N	EC	$\Psi=0,20+3,9*10^{-3}{'}X$	γ	0,717***	27
Total-N	Mineral-N	Ψ=206+0,O6•X	δ	0,468***	27
total-N	Water soluble -N	Ψ=136+0,03•X	ε	0,431*	27
mineral -N	Water soluble -N	Ψ=62+0,40*X	στ	0,757***	27
Exchangeable-K	EC	$\Psi=0,10+7,4.10^{-4}*X$	ζ	0.706***	27
Water soluble-K	EC	$\Psi=0,301+1,8.10^{-3}\bullet X$	η	0,765***	27
Exchangeable-K	Water soluble-K	Ψ=.-30+ 0,3·X	θ	0,736***	27

N, K: ppm in soil, EC: mS/cm, p*:0,05, p:***:0,001

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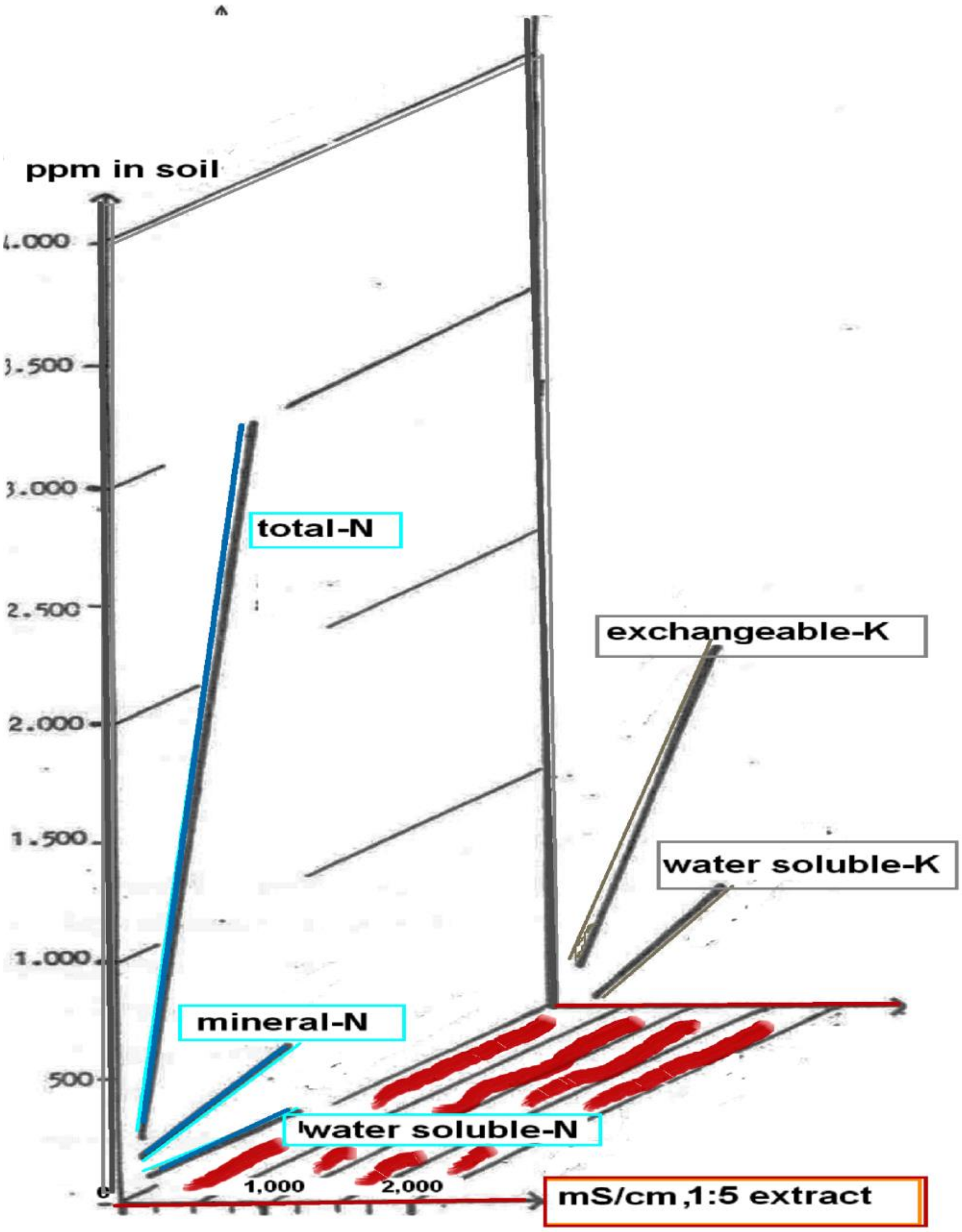
4. CONCLUSIONS

Crops with normal nutritional status in N and K were found in a wide range of soils, at lower average value of soil salinity, in comparison with the total sample of study; also their soil contents in N and K, were also at values lower than the corresponding values of the total sample. The fact that the vast majority of plant in normal nutritional status found essentially only in the first cultivation period (Da: phase of sampling) it shows the difficult task of maintaining general conditions for OPTIMUM nutrition in a greenhouse cultivation. On the other hand, it implies the particular risk by the producer to face the consequences of the injurious effects of salinity, if over- fertilization is done particularly for N & K. According to the multiple regression equation established, a relative increase in soil of water-soluble for both N & K, for example with 100 ppm respectively, leads to a possible increase of the electrical conductivity of the extract 1soil: $5H_2O$ with 0,280 mS/cm. Thus both from the statistical approach, and the study of the individual cases of the sample with plants in normal nutritional status in N and K, it follows that values of the specific conductivity of the extract 1:5 greater than 0,4 mS / cm, represent high levels of soil provision in N and K in available amounts . Already in previous work (Chouliaras, 1991), in generally it was found on soils of greenhouses in Thessalia, that when the specific conductivity of 1:5 extract was greater than 0,4 mS / cm, it revealed the presence of significant reserves for plants of N. According to established equations (a), (b), (c), (g) and (h) of table – 6, on the sample with plants in normal nutritional status, the value of 0,4 mS / cm of the extract 1:5, depends statistically on levels in soil with 1154 ppm total-N, 273 ppm mineral-N, 154 ppm water- soluble -N, 405 ppm exchangeable –K, and 56 ppm water soluble-K (Figure-2).

These conclusions can not be generalized for all cases. Thus, only a part of the amount of exchangeable-K corresponds to water soluble- K, affecting directly the electrical conductivity of the extract (1soil:$5H_2O$), (Chouliaras, 1991). Moreover, according to investigations, the percentage of CEC saturation with exchangeable-K, is indirectly connected with the intensity of diffusion of K^+ ions in the rhizosphere (Quemener, 1979).

From all above noted, it is concluded that frequent determinations of the specific conductivity of the extract 1:5, in greenhouse soils, is very important act. The good nutritional status of plants, is a result both by ensuring the necessary and balanced supply of N and K in plants, and the maintenance of a low degree of soil salinity.

Fig—2: Linear regression between N & K forms with soil electrical conductivity, in 1soil:5H_2O extract.



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