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ACTUAL SOIL FERTILITY IN VEGETABLE PLASTIC HOUSES

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Abstract. *The paper refers to a random survey, conducted in 11 Counties, important in vegetables growing in Romania, and around Bucharest, regarding to the actual fertility status of plastic house soils cultivated with vegetables. The study was conducted during the period 2002-2012, and a total of 493 of soil samples on the depth of 0-30 cm, were analysed. It was found a relatively increasing trend of fertility until 2009, after which the concentrations of nitrogen, phosphorus and potassium in water-soluble forms, have fallen. Mean values revealed a normal concentration with nitrogen (94 mg·kg^{-1}) and medium for potassium (104 mg·kg^{-1}), with a good content of organic matter (OM = 8.8 %). Water solubil phosphorus concentration was medium (17 mg·kg^{-1}), on a medium textured soils. Also were calculated some significant correlations between soil pH and hydrosoluble phosphorus and nitrate nitrogen. Significated correlation coeficients were found between salt concentration and water soluble forms of N-NO$_3$, K and Na. On the basis the plastic house soil contents of N, P and K (water-soluble forms), average fertility status of soils in our plastic houses cultivated with vegetables, crop structure in 2 cycles (early spring tomatoes and autumn cucumbers) or in one extended cycle (sweet peppers and aubergines), a total taken up of major elements and the average coefficients of fertilizers use, it was calculated an aproximative necessary of active ingredient for an area of about 7,500 hectares of plastic houses (the year 2014) namely: N 2,145 t, P$_2$O$_5$ 1,425 t and K$_2$O 4,425 t. This means a consumption of N, P$_2$O$_5$ and K$_2$O, of 286, 190 and respectively 595 kg·ha^{-1}·year^{-1}.*

Key words: *plastic houses, actual soil fertility, agrochemical correlations, aproximative necessary of NPK.*

INTRODUCTION

Vegetable cultivation in plastic houses is a real alternative for vegetable growing in Romania. Generally, protected crops are considered to be the best and cheapest insurance against climate damage (BOULARD AND ANTIPOLIS, 2005; LĂCĂTUŞ, 2008; LĂCĂTUŞ AND CÂRSTEA, 2012). Climate change for many years onwards, characterised by a prolonged drought combined with very high temperatures (SANDU AND MATEESCU, 2012), sometimes turned the cultivation of vegetables in the open field, in a real "adventure" (LĂCĂTUŞ and al., 2012). Lately, for example, to ensure the consumption of tomatoes from field crops has become a national problem. Many producers have given up. And not only from this crop! The area cultivated with vegetables has declined gradually from approximately 235,000 hectares to perhaps 80-110,000 hectares (LĂCĂTUŞ, 2013; SCURTU AND LĂCĂTUŞ, 2013; LĂCĂTUŞ AND AL. 2013; GLĂMAN AND AL. 2015). In this context, the plastic house is a safe solution for the development of a sustainable vegetable growing (BOULARD, 2008; SCURTU AND LĂCĂTUŞ, 2013).

Growing vegetables in protected system involves also additional costs (VOICAN AND LĂCĂTUŞ, 2001; CANTLIFE AND VANSICKLE, 2009). It's construction, the plastic film and last but not least cultivated biological material. While hybrids use are high performance: very early and very productive. To put the value these qualities, it is necessary to practice an appropriate technology. It is necessary, inter alia, as to have a soil fertility condition very good. This, of course, translates into a much higher consumption of fertilisers, for both the creation of an optimal level of nutrients in the soil and to cover consumption items, those taken up by plants.

MATERIAL AND METHODS

In the Research and Development Institute for Vegetables and Flowers Growing (RDIVFG), operates a laboratory of Agrochemistry, Biochemistry and Physiology (ABP), which performs analysis of agrochemical soil fertility status in order to establish it. Benefiting from a project in the framework of ADER (ADER, 3.1.2), we performed analyses and interpretation of soil samples, carried out over a period of 11 years (2002-2012). Soil sample was made up of 15-20 polls, and harvesting depth was of 25-30 cm. Normally was collected one soil sample from a solar surface of which has varied between 200 and 1000 m^2. If there have been several plastic houses, number of soil samples depended on uniformity of these.

The method of analysis used as extractant distilled water, and the rate of exctraction soil : water was 1: 2.5 w/w (WE 1: 2.5), when the organic matter content (OM) of soil was under 6.5 %, and 1:5 w/w (WE 1:5), when OM was higher than 6.5 %. The analysis was conducted in fresh soil. By using this method is that it determines the actual fertility of soils. In this way has been given greater importance to intensity factor vs. capacitance. Thus, we believe that the determinations are more suitable for vegetable crops in plastic houses, intensive crops and sometimes even superintensive, as is the case of the heated crops. Determinations were performed:

- humidity = gravimetrically by drying at 105 ° C for 14 hours at an oven ITM 100;
- OM = trough incineration at 560 ºC for two hours, at a Rabertherm oven;
- pH = soil reacton by potentiometric method;
- SC = soluble salt concentration, by conductometry method, Radelkis, type 102/1;
- $N\text{-}NO_3$ = nitrate nitrogen, reaction with fenoldisulfonic acid, then neutralized with a solution of 20 % NaOH, up to the persistent yellow color and mesured to SPECORD 205 spectrophotometer, at 410 nm;
- P = water soluble phosphorus, reaction with molibdenic reagent (after Troug-Meyer) in the presence of a reducing agent such as $SnCl_2$ and mesured to SPECORD 205 spectrophotometer at 620 nm;
- K and Na = water soluble potassium and sodium, flamphotometric directly in the extract at a flampfotometer FLAPHO 41;
- Ca and Mg = water soluble calcium and magnesium, titrimetrically.

The results were expressed in $mg \cdot kg^{-1}$ at the soil dry at 105 ° C.

The data analyzed in this paper come from 11 Counties and from Bucharest. It should be noted that this is not a systematic study but one randomly, but that can give us, through the multitude of soil samples analysed, namely 493 and certain correlations, indicative information regarding fertility status and especially the need for mineral fertilizers of this vegetable sector. Interpretation of soil analysis results was done on the basis of the interpretation of the laboratory of ABP of RDIVFG and which will take account the content of organic matter of the soil (GHIDIA AND AL. 1972, 1973; LĂCĂTUŞ, 2006; LĂCĂTUŞ AND CÂRSTEA, 2015).

RESULT AND DISCUSSION

Soil samples analyzed come from Counties of Buzău, Călăraşi, Dâmboviţa, Galaţi, Giurgiu, Ialomiţa, Ilfov, Olt, Prahova, Teleorman and Tulcea, as well as in Bucharest. It is found that the areas are included in Romania's importance in the cultivation of vegetables, less the areas in the West, Northwest and North of Moldova.

On the basis of the interpretation of the ABP, the mean values founded in the 11 years, show a good-very good content of OM and a medium degree of actual fertility of soils. The variation of the main agrochemicals indicators are shown in table 1. Generally we can see quite big variation, especially in case of soluble salt concentration, organic matter and water soluble phosphorus, but also for the other parameters, variations more or less statistically significant.

Table 1

Dynamic of the average values of the main soil actual fertility indicators from plastic houses, in 2002-2012 period

Year	pH	OM	SC	$N-NO_3$	P	K	Ca	Mg	Na
		%	$mg \cdot kg^{-1}$						
2002	7.17	12.50	0.1838	923	24.6	78	204	107	127
2003	6.93	8.00	0.1333	50	23.0	75	134	67	147
2004	6.88	8.81	0.1502	95	26.1	112	177	69	104
2005	7.01	8.96	0.1682	85	10.9	82	211	68	120
2006	6.63	9.14	0.1267	80	9.4	71	180	68	87
2007	6.74	8.80	0.1851	176	11.1	174	260	107	176
2008	6.81	9.57	0.1993	134	14.1	157	220	115	78
2009	6.96	8.52	0.1886	114	20.7	122	200	110	153
2010	7.18	8.06	0.1021	42	17.9	48	188	46	78
2011	6.91	7.86	0.1763	139	23.8	179	219	150	167
2012	7.04	6.69	0.0570	26	8.5	42	48	44	84
Mean	6.85	8.80	0.1586	105	15	110	202	86	119
Max.	10.00	32.00	1.2300	923	124	1825	1882	537	1137
Min.	4.10	2.40	0.0054	0.5	0.5	1	9	2	1

In figure 1 is represented the evolution of soil reactions. We can notice that until the end of 2006 year, the pH decreased from 7.2 to 6.8 and after this it increased again. The correlation coefficient is significant, but the variations are not significant from agrochemical point of view, these are generally in neutral range (6.8-7.2).

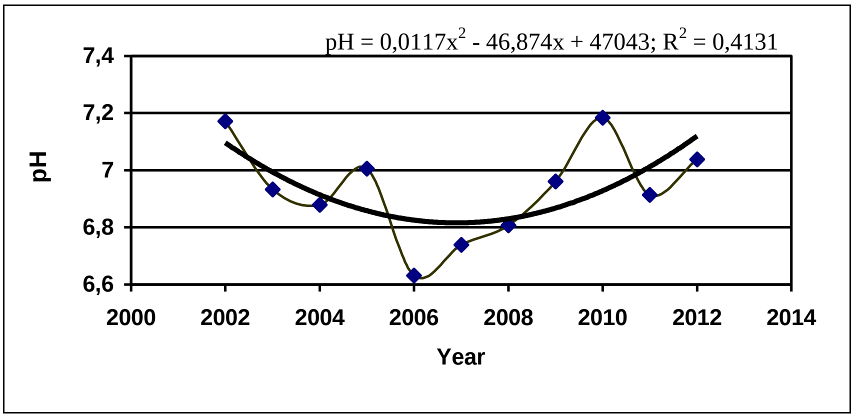

Fig. 1 – The evolution of soil reaction

By analysing soil reaction as compared to main cultivated species requirements, we can see that this is not particularly favorable. Although many of the species grown in our country in plastic houses, supports and a pH greater than 7.0 is preferred, however, a weak acid reaction (pH between 6 and 6.5).

As regards the evolution of insurance with organic matter, figure 2, things are clear enough. There is an alarming decreasing it to below 7 %. Unfortunately this change is explained by the reduction of sources of supply of manure, after the year 2000.

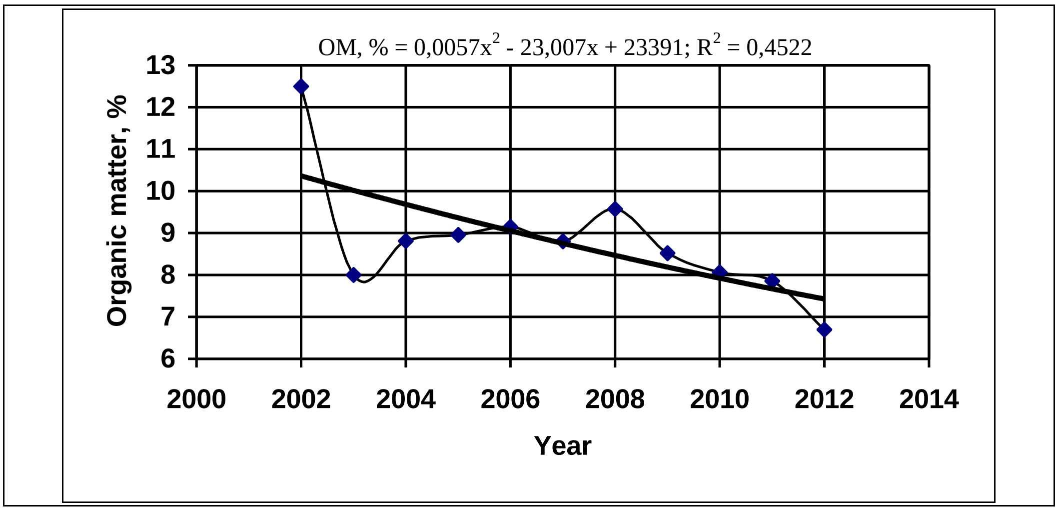

Fig. 2 – The evolution of soil organic matter

Another parameter that is important to us, it is the concentration of water-soluble salts of the soil solution (figure 3).

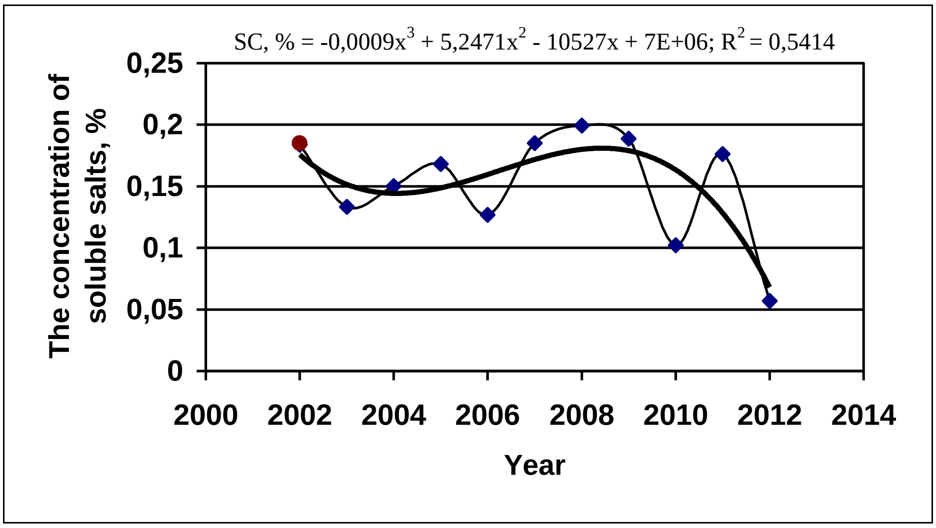

Fig. 3 – The evolution of soluble salts from soil solution

And in this case we can see that, in the period 2003 to 2009 there has been a slight upward trend, but it is still, the trend is to decrease to values below the normal. The downward trend is due to likely price increases to fertilizers on the background of a relative pauperization of vegetable growers in plastic houses in our country.

In figures 4-8 are played dynamic developments in the main elements of nutrition. Almost all the elements, nitrate nitrogen, phosphorus, potassium and magnesium, reflect a downward trend. This drop is below the values required for an optimal nutrition.

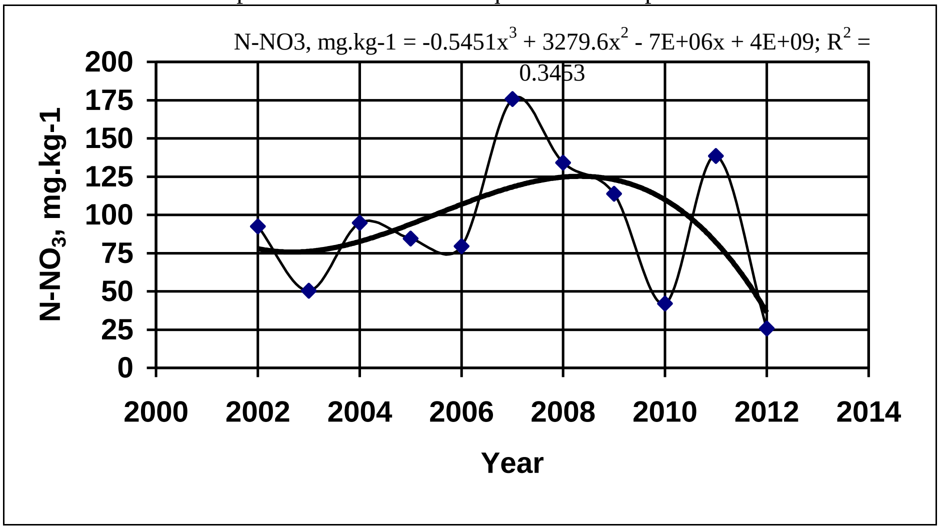

Fig. 4 – The evolution of nitrate nitrogen concentration in the soil solution

In Figure 4 we find that after a period of slow increase of the concentration of nitrate nitrogen, by the year 2009, it begins to decline. Subtraction is pretty sudden, from about 125 mg·kg^{-1} to 26 mg·kg^{-1} N-NO$_3$. Equation of degree 3 that I used it to describe the time evolution of the content of nitrates in the soil, does not have a significant correlation coefficient. The two trends of increasing and then decreasing are fairly clear.

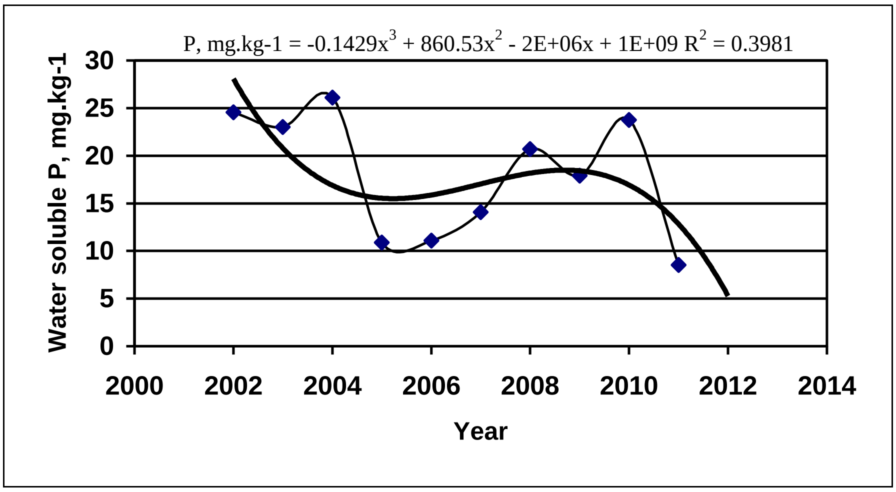

Fig. 5 – The evolution of water soluble phosphorus concentrations

Tthe same trend we see also in case of water solubil phosphorus which decreases after 2009 (fig. 5). Unlike in the case of nitrogen, phosphorus is generally a decrease over time, with a plateau between 2004 and 2009.

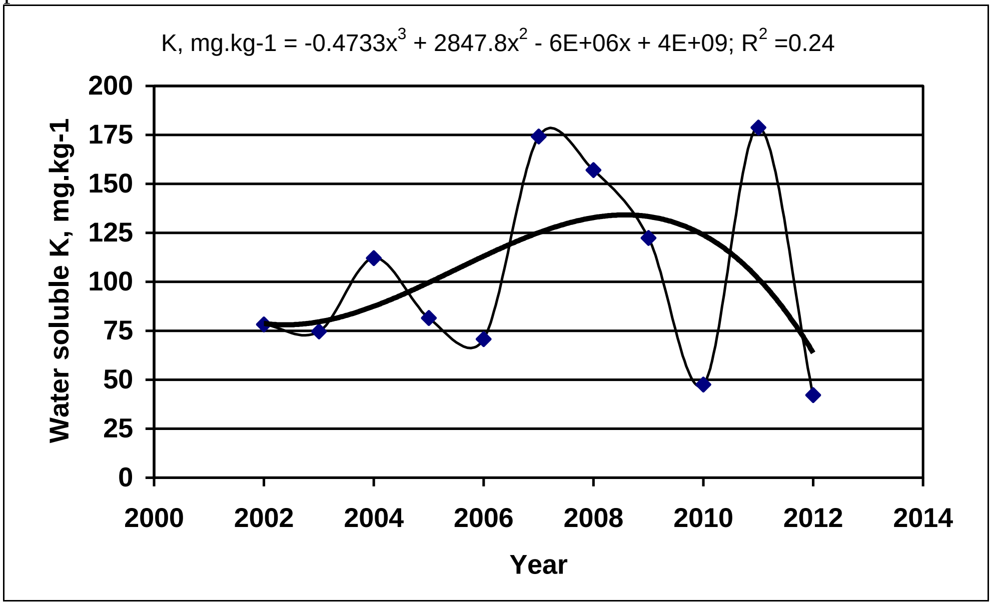

Fig. 6 – The evolution of water soluble potassium concentrations

In terms of potassium water soluble, we observe an increase in its concentration in the soil until 2009, after which it decreases to values below 75 $mg \cdot kg^{-1}$ (fig. 6). The 3 degree of equation is used in this case to describe the correlation between the concentration of potassium and the year of crop, has no signification.

We believe that these decreases contents of N, P and K in soils of plastic houses, after 2009, is due to both the effects of the economic crisis that has affected the purchasing power of farmers and increase areas of plastic houses, which meant taking into operation of new lands. Perhaps because of this, correlation curves have not had significant indices.

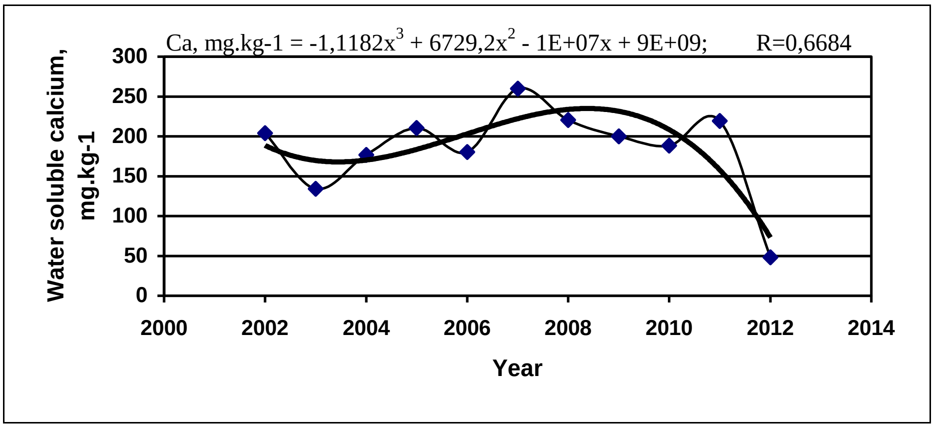

Fig. 7 – The evolution of water soluble calcium

An evolution relatively constant had concentrations of magnesium and sodium in water-soluble forms (figures 8 and 9). In fact, the regression coefficients in these two cases, they are not significants.

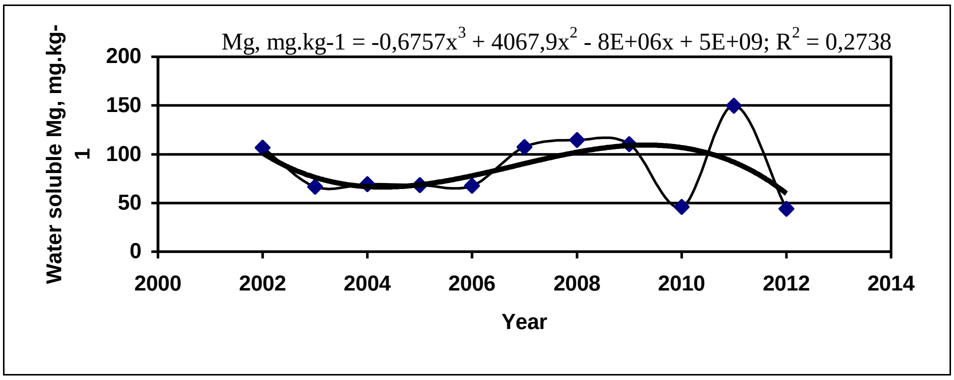

Fig. 8 – The evolution of water soluble magnesium concentration

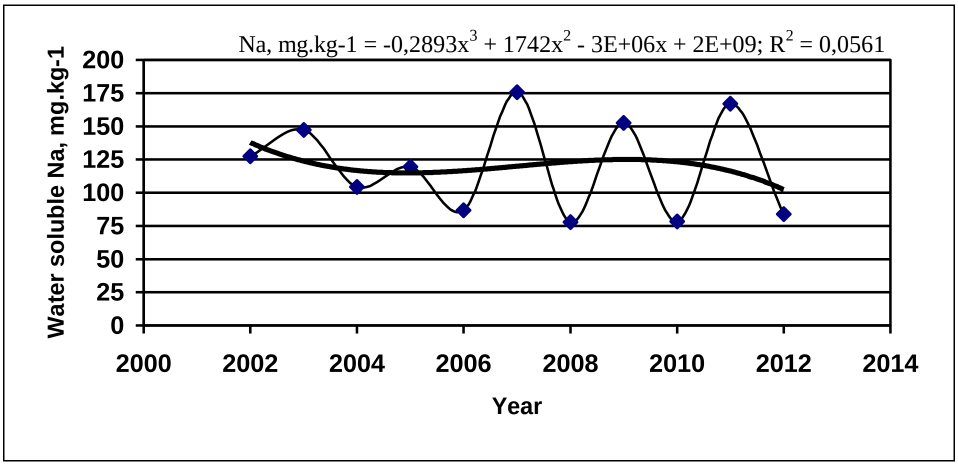

Fig. 9 – The evolution of water soluble sodium concentration

As a check on the veracity determined values, I compared the evolution in soil reaction together with that of the concentration of water soluble phosphorus (Figure 10), and it was that as a general rule, as the pH increases, the concentration of phosphorus decreases (Borlan et al. 1990; Davidescu and Velicica Davidescu, 1992; Lacatusu, 2000). In figure 10 it is found that an evolution in contradictory, sinusoidically, whose equation of degree 3 has a coefficient of correlation significantly.

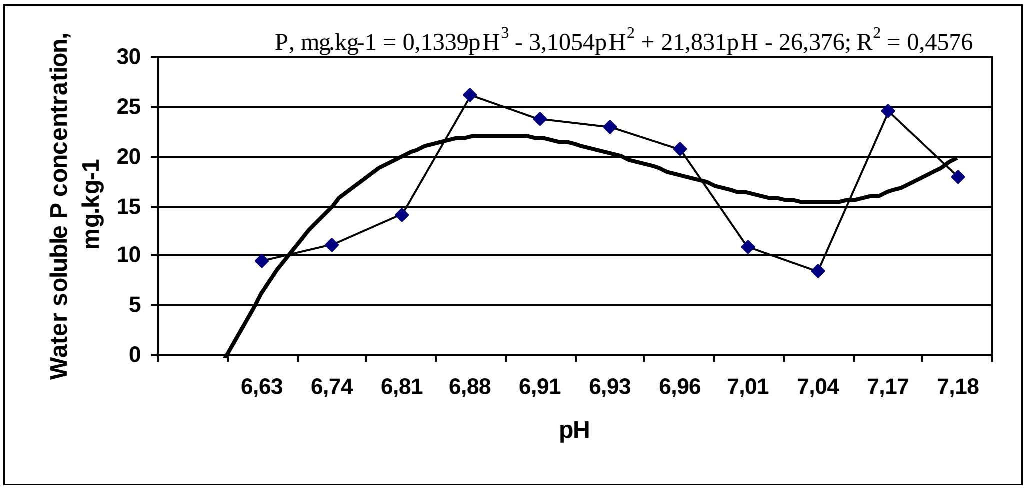

Fig. 10 – The correlation between soil reaction and water soluble phosphorus concentration

The explanation for such a development must be traced to several factors. In the first row variation range of pH is quite restricted, between 6,63 and 7,18. Secondly, it is possible that the system of fertilization, most often in the cases examined by the installation of driping - fertigation - and which requires the use of certain fertilizers with water-soluble phosphorus (MAP, POLYFEED, FERTICARE, KRISTALIN, etc.), such that the concentration of water soluble phosphorus according to the doses of phosphorous applied and less depending on the soil characteristics.

We watched, also, the influence of concentration of nitrate nitrogen on soil reaction (Figure 11). Even in this case it is not possible to say that there is a correlation, although it is noted that a higher concentration of nitrates in soil solution determine some acidification.

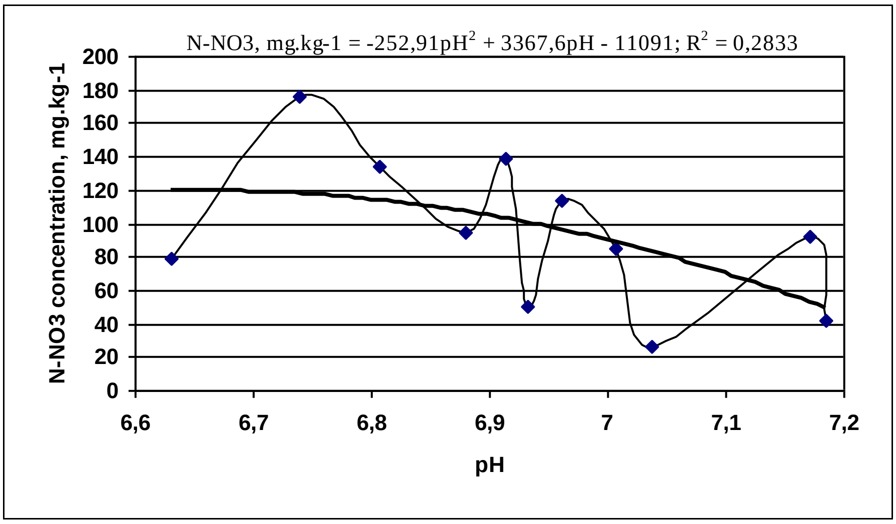

Fig. 11 – The correlation between N-NO_3 and soil reaction

As regards the concentration of soluble salts and its dependence on levels of main nutrients, figures 12-14, it is noted, as it was expected, that the largest influence has nitrate nitrogen, with a coefficient of correlation of a very significant, R^2= 0,7042 , followed by water-soluble sodium with R^2 =0,6371.

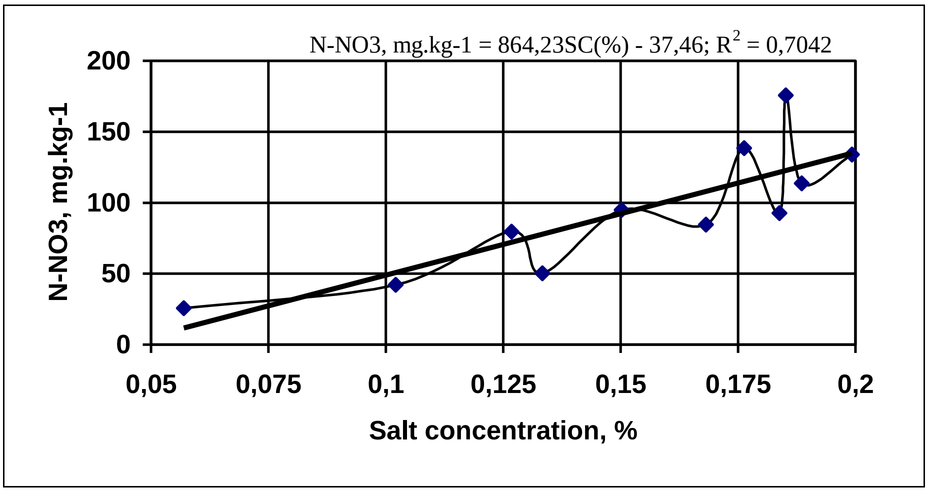

Fig. 12 – The correlation between nitrate nitrogen level from soil solution and salt concentration

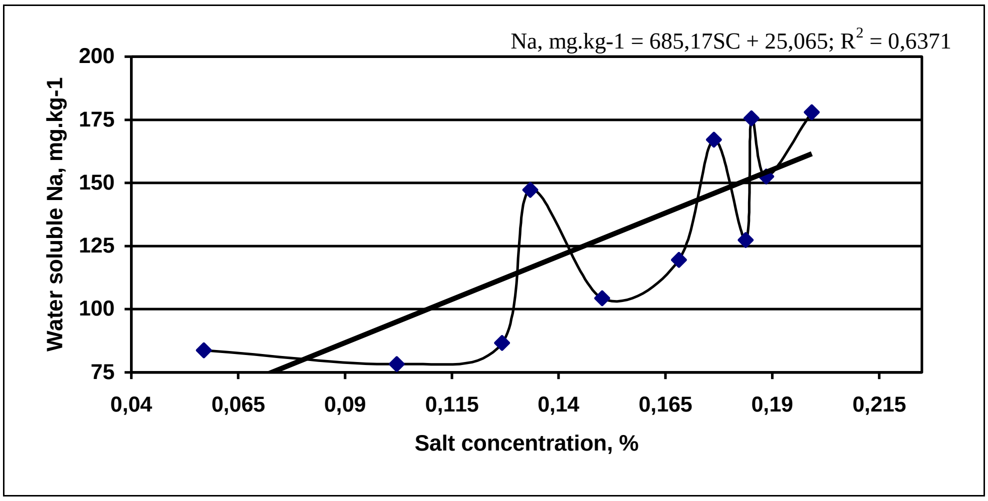

Fig. 13 – Correlation between salt concentration of soil solution and the level of water solube sodium

The water-soluble potassium also influences the level of soluble salts concentration (Fig. 13). The coefficient of correlation is significantly (R^2= 0,578) .

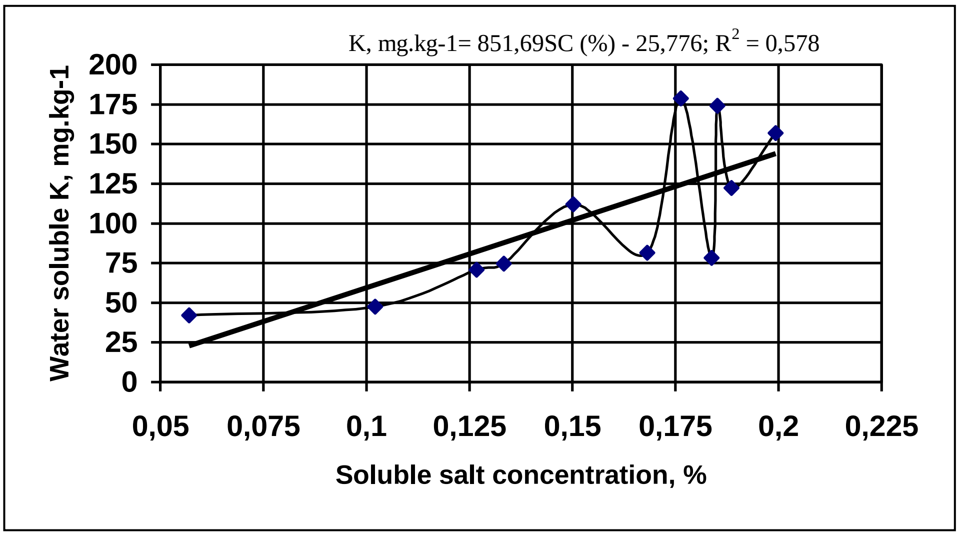

Fig. 14 – Correlation between salt concentration of soil solution and the level of water solube potassium

As it was expected, comparing sum A+ C (anions + cations) with concentration values of water-soluble salts, has led to the best ensured correlation, with a coefficient of correlation equal to 0.77 (Figure 15). Simplifying, we can say that ∑ A+C (mg.kg^{-1}) ≈ 4,000 * SC (%), relationship which can be used in laboratories for an initial check of truthfulness approximate analytical results obtained from soil analysis in water extract. In fact this relationship has been and probably still is used in the analytical laboratories of the soil by the method of aqueous extract 1:2.5 or 1:5 (w/w) in the Netherlands and of the network ADAS in Great Britain. It is one more proof that the values determined in our laboratory are correct.

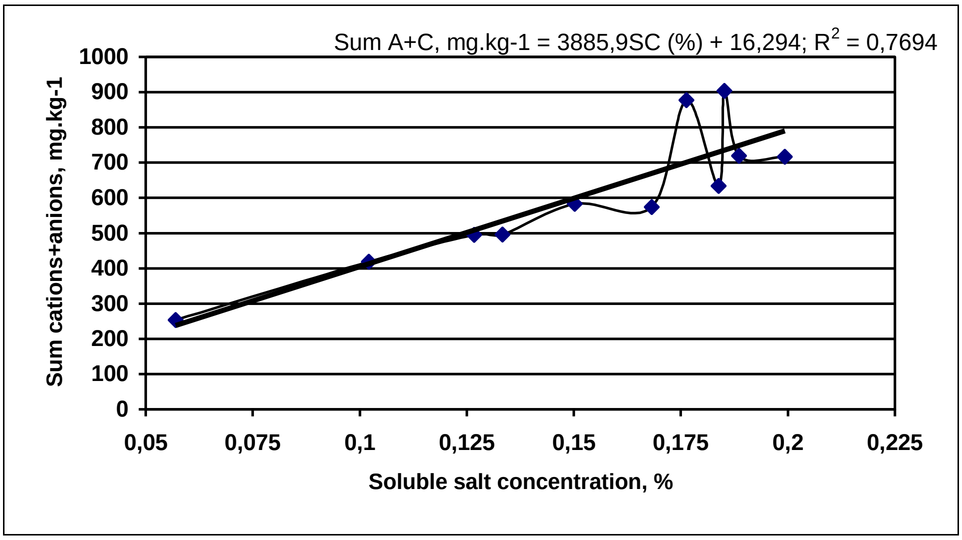

Fig. 15 – Correlation between salt concentration and the sum of soluble anions and cations in aqueous extract

Still, we took a few-most important areals for protected crop of vegetables in Romania and we have analyzed the evolution of actual fertility of the soils of these areas for the period 2002-2012.

The actual soil fertility status of plastic houses from Galati County

We'll start with Galati county, in which there is one of the most important vegetable area, with the center in Matca - Tecuci, the most representative for the crop vegetables under plastic (Table 2) and where they're coming from the majority of the samples. It is found that average values indicate soils with neutral reaction, very well secured with organic matter and with a very good total concentration of soluble salts. Between major elements of mineral nutrition, nitrogen and phosphorus have high mean values and potassium and calcium in the water soluble forms, are normally supplied. The concentration of water soluble magnesium is very high and, what is worse, is in imbalance with the potassium. This is the source of some problems wich have growers, not necessarily only in this area, with regard to uneven ripening of fruit of tomato, due to antagonism K:Mg.

Table 2

The evolution of actual soil fertility of plastic houses from Galati county

Year	pH	OM	SC	$N\text{-}NO_3$	P	K	Ca	Mg	Na	Amount of samples
		%		$mg \cdot kg^{-1}$						
2002	7.17	12.5	0.184	93	24.6	78	204	107	127	7
2003	6.93	8.00	0.133	50	23.0	75	134	67	147	3
2004	6.96	9.83	0.227	116	29.0	168	150	89	170	6
2006	7.15	10.00	0.090	68	28.0	46	69	45	142	2
2007	6.77	8.17	0.248	188	21.1	265	260	130	242	9
2008	6.69	7.40	0.209	166	7.3	171	203	1089	85	10
2009	7.00	7.40	0.252	162	20.1	233	205	147	198	12
2011	7.00	10.00	0.421	316	14.0	250	944	318	494	1
Average ± sd	**6.96 ± 0,17**	**9.16 ± 1.75**	**0.220 ± 0.1**	**145 ± 85**	**20.9 ± 7.2**	**161 ± 86**	**271 ± 278**	**249 ± 350**	**201 ± 128**	**6 ± 4**
Max.	**7.17**	**12.50**	**0.421**	**316**	**29.0**	**265**	**944**	**1089**	**494**	**12**
Min.	**6.69**	**7.40**	**0.09**	**50**	**7.3**	**46**	**69**	**45**	**85**	**1**

Given ensure very good with organic matter, the sodium concentration, although it seems more than usually, it is not high. In fact there were times it was found that large values of organic matter from large doses and continue fertilizing with manure, have led to high concentrations of sodium. Under the circumstances, on the basis of averages, it should be avoided, and it is possible, an increase in the levels of potassium, both at fertilization, before deep ploughing, with granular potassium sulphate, as well as fertilization of preparing land, before to plough soil with the Falck, with potassium sulphate crystallized. This fertilizer is recommended to be used and in the vegetation, as an alternative to potassium nitrate, to decreased, occasionally, soil reaction. Dynamically, during the period 2002-2011, it is found that an upward trend in the concentration of salts of the soil solution on the background of developments in descending order of insurance with organic matter during the period 2002-2009 (Figure 16). After 2009 insurance with organic matter has increased, because of course applications of organic fertilisers. There is an increase in cases in which there have been applied organic fertilizers, other than traditional livestock manure, such as: *humusoil*, *humusil* or *vermicompost*.

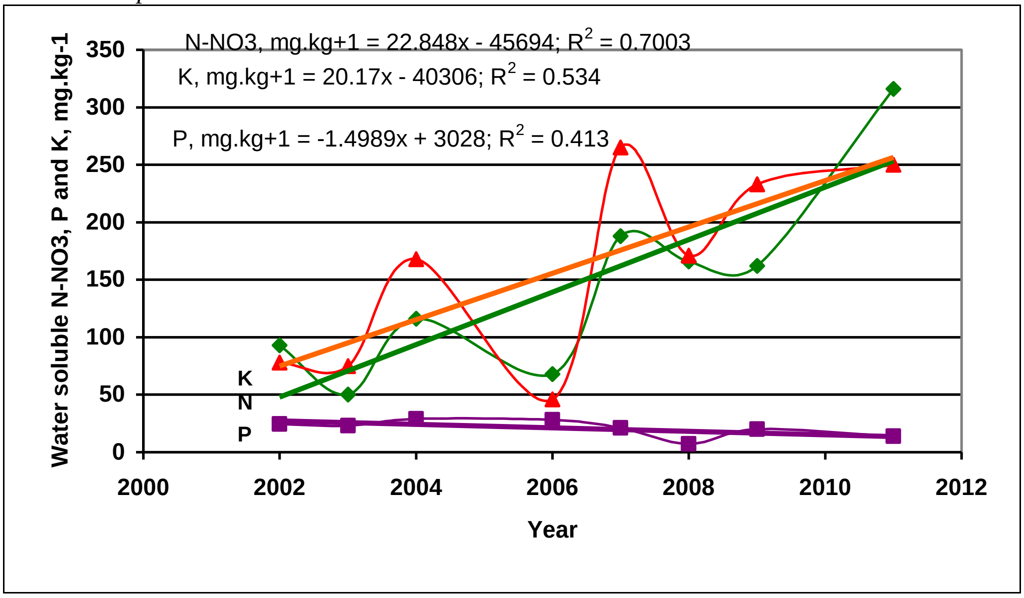

Fig. 16 - The dynamic of water soluble nitrate nitrogen, phosphorus and potassium concentrations in plastic house soils from Galati County

The trend of increasing of both elements, nitrogen and potassium, is statistically assured (0.7 for N-NO_3 and 0.534 for K). During the same period however, water soluble phosphorus, easily accessible to plants, has more of a tendency of decreasing of the concentration (regression coefficient of 0.413).

The actual soil fertility status of plastic houses from Ilfov County

Ilfov County is also known for specialising in vegetable crop ponds in plastic houses. In this County for the period 2004-2012, 150 were analyzed soil samples. In table 3 are presented recorded average values for the contents of different agrochemical parameters, determined in water extract.

Table 3

The evolution of actual soil fertility status of plastic houses in Ilfov County

Year	pH	OM	SC	N-NO_3	P	K	Ca	Mg	Na	Amount of samples
		%		mg·kg^{-1}						
2004	6.63	7.78	0.12	60	19	93	167	51	57	12
2005	7.32	8.76	0.17	78	14	101	224	70	114	27
2006	6.87	9.37	0.16	117	11	98	249	75	93	35
2007	7.13	10.79	0.17	153	12	153	227	106	205	17
2008	6.74	8.86	0.14	81	27	102	216	92	61	14
2009	6.98	9.50	0.17	115	30	73	165	98	146	22
2010	7.19	8.46	0.11	52	20	58	195	45	101	13
2011	7.20	7.33	0.07	30	24	46	114	38	81	6
2012	7.18	6.00	0.04	18	7	28	32	31	74	4
Mean	**7.02**	**8.54**	**0.13**	**78**	**18**	**84**	**177**	**67**	**104**	**17**

±	± 0,23	± 1.38	± 0.05	± 44	± 8	± 37	± 68	± 28	± 47	±10
Max.	7,32	10,79	0.17	153	30	153	249	106	205	35
Min.	6,63	6	0.04	18	7	28	32	31	57	4

Except soil reaction which is, and in this case neutral and insurance with organic matter which is good, the values for the other parameters, are smaller. Thus, nitrate nitrogen which has an average value of 78 mg·kg^{-1}, fall within the class of medium insurance, water soluble phosphorus 18 mg·kg^{-1} is normal, and the potassium water-soluble with 84 mg·kg^{-1} is also medium provided (fig. 17). Calcium and sodium in the water soluble forms are normal. Magnesium is slightly raised.

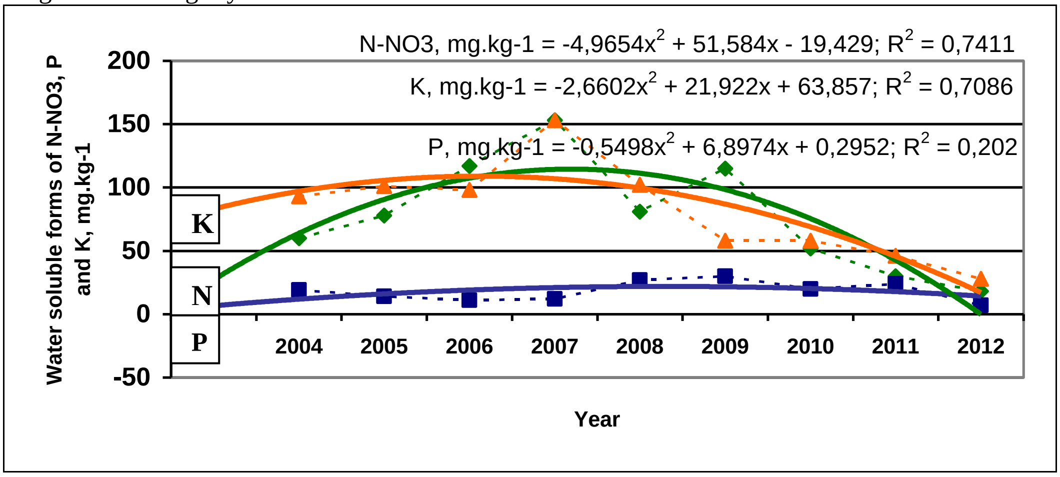

Fig. 17 - The dynamic of water soluble nitrate nitrogen, phosphorus and potassium concentrations in plastic house soils from Ilfov County

In time, for the period 2004-2012, it is found and in this area a downward trend in insurance with organic matter, from an average maximum of approx. 10 % to 6 %. The decrease started after 2007. Also the concentration of soluble salts had a tendency to be reduced to values below 0.1 %. Both these trends, of OM and SC are distinct significant. As regards soil reaction, the slight upward trend is not ensured statistically (fig. 18).

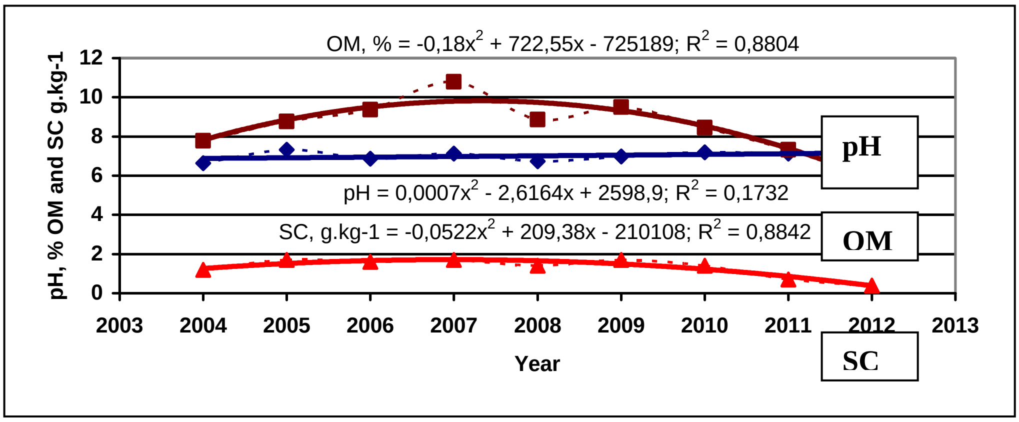

Fig 18. The dynamic of soluble salt concentration, pH and organic matter in plastic house soils from Ilfov County

The actual soil fertility status of plastic houses from Giurgiu County

A third vegetable area taken in the study, is located in Giurgiu County (Table 4). Average values recorded during the period 2004-2012, shows and in this case a neutral pH (6.89), a good supply of organic matter (8.8 %) and a medium concentration of soluble salts. The main elements of nutrition have the following average values:

- nitrate nitrogen, 110 ppm = normal;
- water soluble phosphorus, 16.4 ppm = normal;
- water soluble potassium, 131 ppm = medium;
- water soluble calcium 197 ppm = medium (but balanced with K);
- water soluble magnesium, 109 ppm = high;
- sodium water-soluble, 118 ppm = medium.

Table 4

The evolution of actual soil fertility status of plastic houses
from vegetable area in Giurgiu County

Year	pH	OM	SC	N-NO_3	P	K	Ca	Mg	Na	Amount of samples
		%		mg·kg^{-1}						
2004	6.91	9.5	0.125	78	27.0	94	145	64	50	13
2005	6.90	7.7	0.150	75	11.4	48	172	67	86	26
2006	6.60	9.2	0.109	58	8.0	52	152	63	81	48
2007	6.60	9.1	0.198	189	12.6	220	280	128	191	34
2008	6.90	11.3	0.237	156	8.2	190	233	134	86	19
2009	6.60	8.5	0.250	147	20.2	165	302	170	140	13
2010	7.30	8.1	0.106	38	18.3	50	201	51	75	12
2011	7.00	8.4	0.242	206	28.5	290	224	238	232	10
2012	7.20	7.3	0.089	39	13.2	69	60	67	123	6
Mean ±	**6.89 ± 0.26**	**8.8 ± 1.2**	**0.167 ± 0.065**	**110 ± 65**	**16.4 ± 7.6**	**131 ± 89**	**197 ± 74**	**109 ± 64**	**118 ± 60**	**20 ±14**
Max.	**7,30**	**11.3**	**0.250**	**206**	**28.5**	**290**	**302**	**238**	**232**	**48**
Min.	**6,60**	**7.3**	**0.089**	**38**	**8**	**48**	**60**	**51**	**50**	**6**

The variability of the determined values is very high, corresponding plastic houses particularities in each side. But if we look closely into maximum figures, we can see that for a very good organic matter content (11.3 %), maximum average concentrations of the main elements of nutrition are above the values considered normal, in particular sodium and magnesium.

Following the change in the dynamic of agrochemical indicators determine during the period 2004-2012 (figures 19 and 20) we see a downward trend of the values after the year 2009. Organic matter decreases to values below 8 % and the concentration of water-soluble salts, less than 0.2 %. Soil reaction has variations in smaller and a slight upward trend, but without any statistically significance.

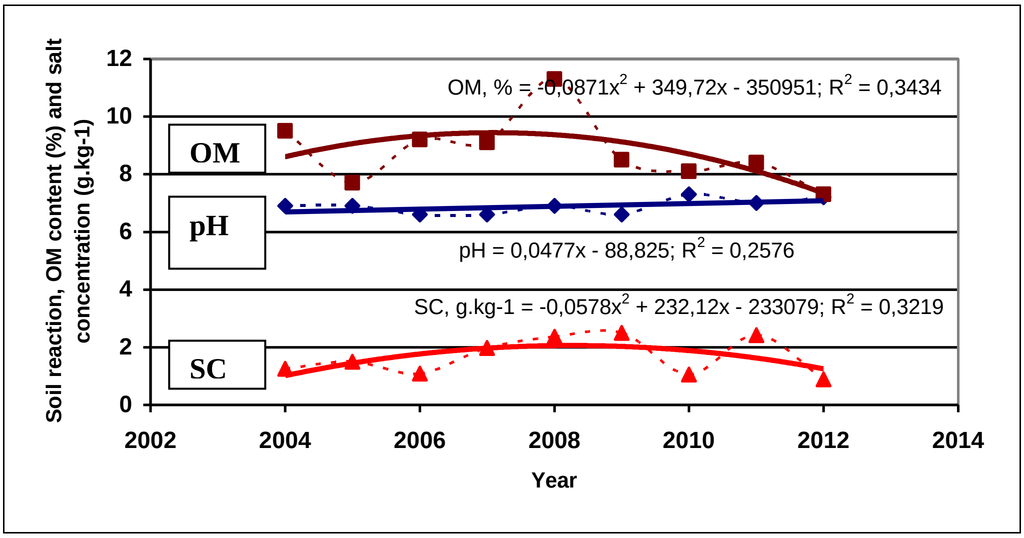

Fig 19. The dynamic of soluble salt concentration, pH and organic matter in plastic house soils from Giurgiu County

After 2007 concentrations of nitrate nitrogen and potassium in soil solution begins to fall until 2010, after which it can be seen from a new upward trend. Lower values, but in 2012, I think they have a tendency to be general decrease (fig. 20).

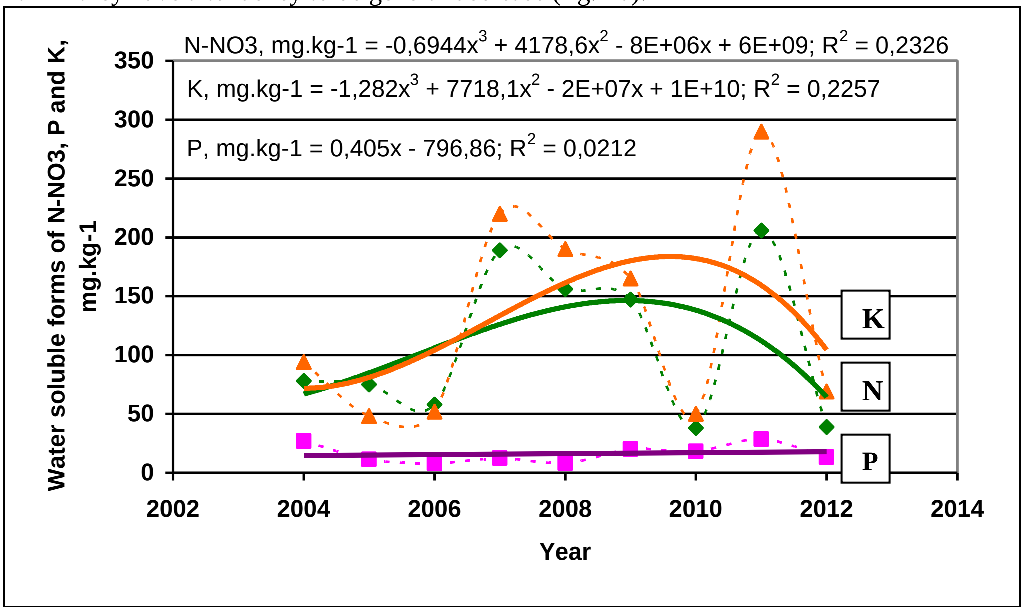

Fig. 20 - The dynamic of water soluble nitrate nitrogen, phosphorus and potassium concentrations in plastic house soils from Giurgiu County

In relation to the number of samples, we have found one alarming thing (Fig. 21). After the year 2006 there is a downward trend in the number of those who were interested in knowledge of the state of fertility of the soil of their own plastic hauses.

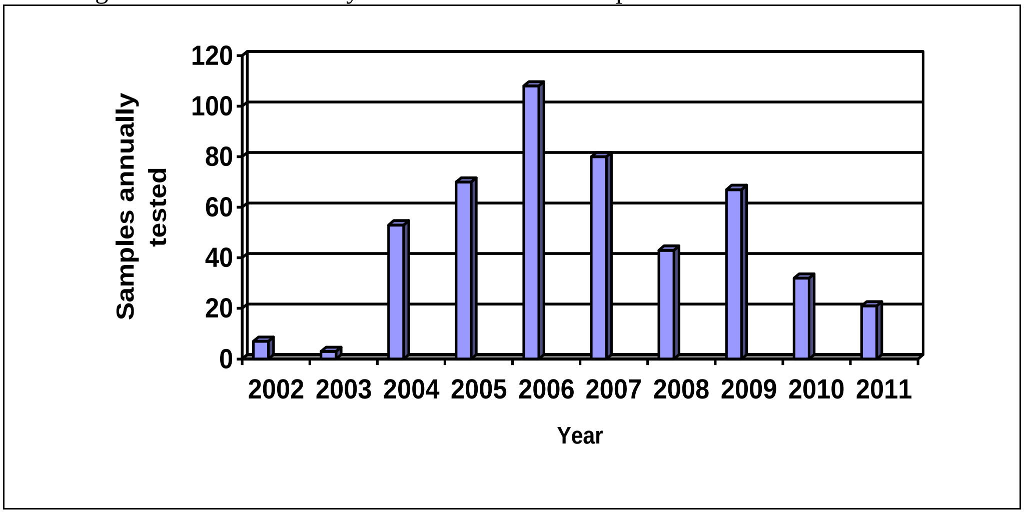

Fig. 21. The evolution of the amount of samples tested in 2002-2011 period

Even if the cost of analysis together with relevant interpretation and a program of fertilization, to which is added appreciation for the co-insurance with water and recommendations on basic fertilization in autumn and to prepare the ground for planting in the spring following, cost only 33.3 €, it seems that the financial situation of producers is more than precarious. To this we add the reduced their level of information and most of all the lack any economic management.

The aproximative appreciation of active substance requirements for vegetable crops from plastic houses

Based on the assessment of soil cover insurance with nitrogen, phosphorus and potassium in water-soluble form (Ghidia and al. 1972, 1973; Lăcătuş, 2006; Lăcătuş and Cârstea, 2015), the average situation of soil fertility of our plastic houses cultivated with vegetables (tab. 1), the structure of crops in 2 cycles per year (tomatoes and cucumbers) or in one extended cycle (bell peppers and aubergines), from the total consumption of major elements (table 5) and from the average coefficients of utilization of fertilizers, we have calculated a necessary indication of active ingredient for an area of about 7,500 hectares plastic houses (the year 2014):

- N: 2,145 t with a mean consumption of 286 $kg\cdot ha^{-1}\cdot year^{-1}$;
- P_2O_5: 1,425 t with a mean consumption of 190 $kg\cdot ha^{-1}\cdot year^{-1}$;
- K_2O: 4,462 t (including and correction to optimum) with a mean consumption of 595 $kg\cdot ha^{-1}\cdot year^{-1}$.

Table 5

Total NPK taken up by mean vegetable crops cultivated in plastic houses

Vegetable crop	Yelds $t\cdot ha^{-1}$	Total NPK taken up, $kg\cdot ha^{-1}$			
		N	P_2O_5	K_2O	MgO
Sweet peppers	40-50	197	60	326	33
Cucumbers	50-80	110	56	242	29

Tomatoes	50-70	300	65	414	62
Eggplants	40-50	319	70	341	37

Drip irrigation extension, including fertigation and thus the use of soluble, complex fertilizers can reduce the quantities of active ingredient from above, with 20-30 % (Lăcătuş and Cârstea, 2006; Sezen et al. 2006).

The values obtained seem to be great at first glance and is in contradiction with the statements of individuals, as well as in vegetable production and especially in plastic houses, would apply excess fertilizers. But the situation is not so. This confirms the yealds that we realize. As a rule, they are less than 3-4 times compared to the Netherlands and 2 times less than that in Spain, at the same crop time (Castilla and Leonardi, 2010; Costa and Heuvelink, 2000; Baudoin, 1999). Mention that in this article we presented the average values obtained. These averages, however, hide the minimum up to 1 $mg \cdot kg^{-1}$ from nitrogen, phosphorus or potassium in aqueous extract.

CONCLUSIONS

Although this study has a random character, may be off a few conclusions:

- in general, after a relatively icreasing trend, after 2009 the concentrations of nitrogen, phosphorus and potassium in the water-soluble forms in soil, have decreased;
- evolution of the status of actual fertility of the soil is relatively different from one area to another;
-average values of the 493 of soil samples analyzed, revealed a normal insurance with nitrogen (94 $mg \cdot kg^{-1}$) and medium with potassium (104 $mg \cdot kg^{-1}$), amid a very good insurance with organic matter (8.8 %);
-ensuring the water soluble phosphorus is medium (17 $mg \cdot kg^{-1}$) on a medium textured soil;
-to target requirements: N, P_2O_5 and K_2O is 286, 190 and respectively 595 $kg \cdot ha^{-1} \cdot year^{-1}$.

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