SYNTHETIC STUDY CONCERNING THE REQUIREMENTS OF VEGETABLES TO SOIL AND AGROCHEMICAL CONDITIONS FROM ROMANIA
II. AGROCHEMICAL REQUIREMENTS

STUDIU SINTETIC PRIVIND CERINȚELE PLANTELOR LEGUMICOLE FAȚĂ DE CONDIȚIILE PEDOLOGICE ŞI AGROCHIMICE DIN ROMÂNIA
II. CERINȚE AGROCHIMICE

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Abstract. *This scientific paper shows the main vegetable requirements to different specific features of soils. There are also shown the evaluation criteria of soil fertility according to capacity and intensity factors for different vegetable growing systems: in field, solar or warm greenhouse (solar greenhouse).*
Key words: vegetables, soil requirements, vegetable growing regions

Rezumat. *Lucrarea se referă la cerințele principalelor culturi legumicole față de diferite particularități ale solurilor. De asemenea, sunt prezentate criteriile de apreciere a fertilității solurilor pe baza factorilor de capacitate şi de intensvizare pentru diferite sisteme de cultivare a legumelor: în câmp, solar sau seră caldă (seră solar).*
Cuvinte cheie: plante legumicole, cerințe față de sol, zone legumicole.

INTRODUCTION

The vegetable growing in Romania has a well-known tradition, but the highest areas and yields were achieved in the ninth decade of the last century. One of the essential conditions for vegetable growing is soil quality, determined by the great number of its characteristics.

Knowing the importance of soil for vegetable growing, this scientific paper is a synthesis of the experiments carried out at the Research and Development Institute for Vegetable Growing and Horticulture of Vidra and at research and development stations of Romania.

MATERIALS AND METHODS

Data shown in this scientific paper were obtained in long-term trials, in stationary agrochemistry fields, set up in split-split plots or in the confounding system with 4 factors (N, P, K and manure) and 3 graduations in 4 replicates at ICDLF Vidra and SCDL Bacău, Buzău and Işalnița. As biological material, we have used the most favoured Romanian varieties, cultivated according to the technologies elaborated by ICDLF and vegetable growing stations.

Soil sampling, conditioning and analysis were done according to the methodology elaborated by ICPA Bucureşti, at which the watery extract method was added, which was introduced by the Agrochemistry Laboratory of ICDLF Vidra.

RESULTS AND DISCUSSIONS

1. Main agrochemical indicators of field soils cultivated with vegetables

Soil fertility is a multidimensional system. Its analysis should emphasize the *potential* reserve of different elements and the *present* reserve (Davidescu and Velicica Davidescu, 1992). The main agrochemical indicators of soils cultivated with vegetables are humus, nitrogen index, phosphorus and mobile potassium (tab. 1, 2 and 3). At these are added the hydrosoluble forms of NPKMg, both for field crops and especially for protected crops.

Table 1

Estimate of humus content from field soils cultivated with vegetables

Humus content according to texture			Estimate (a)	Fertilizer need
Thin	Mean	Rough		
Below 3.0	Below 2.5	Below 1.5	Low	Very high
3.1 – 5.0	2.6 – 3.5	1.6 – 2.5	Mean	High
5.1 – 7.0	3.6 – 5.0	2.6 – 3.5	Good	Mean
Over 7.0	Over 5.0	Over 3.5	Very good	*

a) Generally, the humus content should be almost 15 % of the clay content for field vegetables and twice higher for greenhouse crop

*) it depends on cultivated plant requirements;

Table 2

Estimate of the nitrogen index (NI)* for field soils cultivated with vegetables

Nitrogen index according to texture			Estimate	Organic fertilizer necessary
Thin	Mean	Rough		
Below 2.5	Below 2.0	Below 1.0	Low	Very high
2.6 – 4.0	2.1 – 3.0	1.1 – 2.0	Mean	High
4.1 – 6.0	3.1 – 4.0	2.1 – 3.0	Good	Mean
Over 6.0	Over 4.0	Over 3.0	Very good	**

*) NI = h*V*0.01 = h*S_B/(S_B + Ah)*100;

**) it depends on cultivated plant requirements;

Table 3

Estimate of mobile potassium and phosphorus supply of garden soils cultivated with vegetables

Content of P_{AL}, ppm	Content of K_{AL}, ppm	Estimate
Below 36	Below 66	Very poor supply
37 - 72	67 - 132	Poor supply
73 – 108	133 - 200	Mean supply
109 – 144	201 – 400	Good supply
Over 144	Over 400	Very good supply

2. Phase fertilization of vegetables in field according to present fertility soil classes

Based on long-term trials placed in a stationary agrochemistry field and giving a greater importance to the intensity factors as concerns soil fertility, we have introduced the notion of present fertility determined in watery extract (WE) and comprising six classes (tab. 4).

Table 4

Present fertility classes *

Class	$N\text{-}NO_3$	P_{H2O}	K_{H2O}	Estimate
0	Below 2	Below 0.2	Below 7.5	Very low
1	2 – 5.5	0.2 – 0.45	7.6 – 12.5	Low
2	5.6 – 11.5	0.46 – 1.55	12.6 – 18.0	Mean
3	11.6 – 20.5	1.56 – 4. 65	18.1 – 25.0	Good
4	20.6 - 30	4.56 – 8.0	25.1 – 35.0	Very good
5	Over 30	Over 8	Over 35	High

*) ppm in EA 1: 2.5 (g/g)

The present fertility is a very useful test for over intensively exploited soils by vegetable growing. According to the plant response, we have defined the present fertility classes corresponding to the main vegetable crops (tab. 5).

Table 5

Present fertility classes recommended for some vegetables

Crop	$N\text{-}NO_3$	P_{H2O}	K_{H2O}
Sweet pepper and bell pepper	4	3	4
Mild heirloom	4	3 – 4	4 – 5
Onion	3 - 4	2	2
Cauliflower	3 - 4	4	2 - 3
Courgette	4	3 - 4	3
Green beans	1	3	3
Green peas	1	2	2
Carrot	2	4	3
Eggplant	4 – 5	3 – 4	4 – 5
Radish	2	2-3	2
Lettuce	2	3-4	3
Extra early tomato	3	4	2-3
Early tomato	3	4	3-4
Summer-autumn tomato	4	4	2-3
Industry tomato	3	4	4-5
Celery	3	4	3
Garlic	4	4	2
Autumn cabbage	3-4	3	2

3. Main agrochemical indicators of soils from greenhouses and solariums cultivated with vegetables

For protected crops, heated or cold, we used the watery extract analysis, with the soil: water ratio of 1:2.5 for the soils from solariums with an organic

matter content below 6.5 % and of 1:5 for the soils with greater values from greenhouses or older solariums. The analytical values are estimated according to the organic matter content (tab. 6, 7, 8, 9, 10).

Table 6

Estimate of the organic matter content * of soils from greenhouses and solariums cultivated with vegetables

Organic matter content according to texture (%)			Estimate	Organic fertilizer necessary
Thin AL-A	Mean L-LA	Rough N-NL		
Below 6.0	Below 4.0	Below 2.0	Bad	Very high
6.1 – 8.0	4.1 – 6.0	2.1 – 4.0	Mean	High
8.1 - 10.0	6.1 – 8.0	4.1 – 6.0	Good	Moderate
Over 10	Over 8	Over 6	Very good	**

*) determined as calcination loss; **) it depends on cultivated plant requirements;

Table 7

Estimate of the mineral nitrogen supply of soils from solariums

Mineral nitrogen content		Estimate
ppm in EA 1:2.5 (g/g)	ppm in K_2SO_4 0,1 %	
‹(2.22*MO + 16.6)	Below 50	Low
≥(2.22*MO +16.6)≤(4.44*MO+33.3)	51 – 105	Mean
≥(4.44*MO +33.3)≤(6.66*MO+50.0)	106 – 155	Normal
≥(6.66*MO+50.0)≤(8.88*MO+66.6)	156 – 200	High
›(8.88*MO+66.6)	Over 200	Very high

*) soils with OM until 6.5 %

Table 8

Estimate of the mineral nitrogen supply of soils from greenhouses *

Mineral nitrogen content, ppm in EA 1:5 g/g	Estimate
‹(3*MO + 12)	Low
≥(3*MO + 12)≤(6*MO+24)	Mean
≥(6*MO+24)≤(9*MO+35)	Normal
≥(9*MO+35)≤(12*MO+47)	High
›(8.88*MO+66.6)	Very high

*) soils with over 6.5 % OM, determined as calcination loss;

Table 9

Estimate of the phosphatation degree of soils from greenhouses and solariums cultivated with vegetables

Greenhouse soils, ppm in EA 1:5			Solarium soils, ppm		Estimate
Soft texture, N-NL	Mean texture, LN-LA	Heavy texture, A-AL	În EA 1:2,5	În AL, (corrected)	
Below 17.5	Below 10.9	Below 8.7	Below 4.4	Below 100	Low
17.6 – 26.2	11.0 – 17.5	8.8 – 13.1	4.5 – 8.7	100 - 177	Mean
26.3 – 39.9	17.6 – 26.2	13.2 – 17.5	8.8 – 17.5	178 - 252	Normal
Over 39.9	Over 26.2	Over 17.5	Over 17.5	Over 252	High

Table 10

Estimate of the hydrosoluble potassium supply of soils from greenhouses and solariums cultivated with vegetables

Greenhouse soils, ppm in EA 1:5*	Solarium soils, ppm in EA 1:2,5**	Estimate
Below (5 MO+20)	Below (3.36 MO+27.4)	Low
›(5 MO+20) ‹ (8.25 MO+39.6)	‹(3.36 MO+27.4) › (7.3 MO+55.0)	Mean
‹(8.25 MO+39.6) › (15 MO+57.7)	‹(7.3 MO+55.0) › (11.0 MO+82.5)	Normal
‹(15 MO+57.7) › (19.8 MO+77.5)	‹(11.0 MO+82.5) › (14.6 MO+110)	High
Over (19.8 MO+77.5)	Over (14.6 MO+110)	Very high

*) soils with over 6.5 % OM, determined by calcination; **) soils with OM until 6.5 %.

4. Total exportation of major elements by main vegetable crops

Vegetables are high consumers of mineral elements. The total quantity of elements extracted from soil together with the crop depends both on the specific consumption, necessary for making one tone of useful product and on the harvest size. If the production factors are close to optimum, both the harvest and the coefficients of utilization will be greater. Table 11 shows the total NPKMg consumption for 36 vegetable crops (Geissler *et al.* 1976; Ghidia and Lăcătuş, 1980; Zuang, 1981; Davidescu and Velicica Davidescu, 1992; Lăcătuş and Stoian, 2001, 2002; Lăcătuş *et al.* 2002; Rusu *et al.* 2005).

Table 11

Total NPKMg consumption by main vegetable crops

No	Crop	Yield t/ha	Exportation, kg/ha			
			N	P_2O_5	K_2O	MgO
0	1	2	3	4	5	6
1	**Bell pepper -c**	20-30	183	28	190	23
2	**Sweet pepper -c**	25-30	240	40	218	37
3	**Sweet pepper -s**	60-80	266	73	545	69
4	**Sweet pepper -p**	40-50	197	60	326	33
5	**Mild heirloom -c**	20-25	106	21	145	16
6	**Cucumber-c**	15-20	43	16	78	10
7	**Cucumber -s (long)**	140-160	330	171	577	124
8	**Cucumber -s (short)**	30-50	70	59	135	29
9	**Cucumber -p (short)**	50-80	110	56	242	29
10	**Seed onion**	35-63	122	51	254	54
11	**Autumn cauliflower -c**	20-25	232	106	342	31
12	**Early cauliflower -c**	12-14	107	60	179	15
13	**Green beans -c**	6-9	165*	46	188	10
14	**Green peas-c**	5-10	108*	34	86	7
15	**Carrot -c**	30-50	138	58	286	22
16	**Parsley-c**	20-30	56	17	112	6
17	**Winter radish -c**	30-40	227	105	175	10
18	**Early radish -p**	15-20	72	35	92	4
19	**Lettuce -c**	30-40	80	34	150	8
20	**Lettuce -s**	25-35	67	27	130	9
21	**Lettuce -p**	15-20	47	16	84	6
22	**Beet -c**	40-50	247	101	445	45

0	1	2	3	4	5	6
23	**Spinach-c**	25-40	118	55	226	28
24	**Ind. tomato -c**	40-60	125	54	147	32
25	**Tomato-s/cycle I**	80-100	278	132	364	94
26	**Tomato-s/cycle II**	50-70	240	53	378	48
27	**Tomato-p**	50-70	300	65	414	62
28	**Early tomato-c**	30-40	81	28	118	24
29	**Summer-autumn tomato -c**	70-90	148	78	148	40
30	**Celery -c**	30-40	222	116	338	39
31	**Autumn cabbage -c**	80-100	246	98	431	48
32	**Early cabbage -c**	40-50	145	62	209	18
33	**Summer cabbage -c**	60-80	206	105	365	42
34	**Eggplant -c**	30-40	140	36	192	36
35	**Eggplant -s**	60-80	418	91	445	50
36	**Eggplant -p**	40-50	319	70	341	37

c-field, p-solarium, s-greenhouse;
*) for these species, the highest amount of N comes from atmosphere

We found that under conditions of normal productions, consumptions vary very much from one crop to another. For nitrogen, the total consumption varies from 43 kg/ha for field cucumber to 418 kg/ha eggplant from greenhouse, without mentioning peas and green beans, where the highest amount of nitrogen comes from atmosphere. For phosphorus, the variation field is between 16 and 171 kg/ha, corresponding to plastic protected lettuce and, respectively, to greenhouse long cucumber. As for potassium, total consumption varies between 78 kg/ha for field cucumber and 577 kg/ha for greenhouse long cucumber. The manganese variation is much higher, from 4 kg/ha for early radish to 124 for greenhouse long cucumber.

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