F E R T S E M - SOFTWARE FOR THE OPTIMIZATION OF THE FARMYARD MANURE AND MINERAL FERTILIZATION OF THE VEGETABLE SEED CROPS

GLĂMAN GH.[1]*, LĂCĂTUŞ V.*[2]
[1]SC UNISEM SA, [2]RIVFG Vidra, Ilfov

The present economic and market framework in which one of the most important vegetable growing activities evolves, namely **seed production**, acutely suggests a rational calculus of the requirements and therefore fertilizer consumption. We endorse this assessment through the fertilizers costs, the difficulties still existing in the timing supplying and in the specific sort of some real situations and also through their importance in the **achieving of competitive and high quality seeds**. To this effect within a **RELANSIN** project there has been developed a computing software both for the required organic and mineral fertilizers and their allotment per implement moments.

The software considers the following **inputs**:

- **soil reaction (pH);**
- **texture (or clay content in %);**
- **nitrogen index (NI, %);**
- **mobile phosphorus (P_{AL}, ppm);**
- **exchangeable potassium (K_{AL}, ppm);**
- **farmyard manure fertilization practiced for the last 3 years (t/ha);**
- **cultivated plant (mother or seed plant crops);**
- **surface (ha).**

The calculus for the fertilizer requirements is made on the basis of certain correlations between yield and agrochemical parameters of the soil (NI, P_{AL} and K_{AL}) on the one hand and fertilizer dosage on the other hand. Such correlations are in terms of cubic equations. For the first series of correlations 135 equations were calculated for the dependence of the mother and seed plant crops onto the agrochemical parameters of the soil. Thus establishing the optimum values of the NI, P_{AL} and K_{AL} to which the plants can give a maximum response (table 1). Figures 1-4 shows the dependence experimentally observed and calculated of the farmyard manure, nitrogen, phosphorus and potassium rates onto the IN, P_{AL} and K_{AL} values in the soil. The differences between the two curves, observed and calculated are practically insignificant. Considering the status of the soil fertilization, the quantity of mineral elements extracted from the soil for a certain harvest, and other requirements specific to vegetable cultures whether mother plants or seed plant crops, for the second series of correlations, 245 cubic equations were calculated whereby the organic fertilizer and mineral active substances requirements are estimated. To this effect we illustrate an example for root celery:

1. For the crop of root celery mother plants:

$$N,kg/ha = 297.593 - 103.738*IN + 14.789*IN^2 - 0.841*IN^3$$

$$P_2O_5,kg/ha = 338.778 - 5.106*P_{AL} + 0.044*P_{AL}^2 - 1.48*10^{-4} P_{AL}^3$$

$$K_2O,kg/ha(1) = 489.362 - 2.340*K_{AL} + 47.01*10^{-4}*K_{AL}^2 - 3.398*10^{-6}*K_{AL}^3$$

$$K_2O,kg/ha(2) = 562.468 - 2.688*K_{AL} + 54.02*10^{-4}*K_{AL}^2 - 3.904*10^{-6}*K_{AL}^3$$

$$K_2O,kg/ha(3) = 646.930 - 3.094*K_{AL} + 62.18*10^{-4}*K_{AL}^2 - 4.493*10^{-6}*K_{AL}^3$$

Table 1

Optimum values of the agrochemical parameters of the soil for "maximum" yields

Crop	NI, %	P_{AL}, ppm	K_{AL}, ppm	Yield	Crop	NI, %	P_{AL}, ppm	K_{AL}, ppm	Yield
Tomatoes, s.p.	2.0	70	300	100 kg/ha	Carrot, m.p.	2.5	100	400	50 t/ha
Red pepper, s.p.	4.0	120	400	100 kg/ha	Carrot, m.p.	3.0	100	500	600 kg/ha
Sweet pepper, s.p.	3.0	140	400	80 kg/ha	Parsley, m.p.	2.5	100	400	30 t/ha
Pimiento, s.p.	2.5	60	300	100 kg/ha	Parsley, s.p.	3.0	100	500	600 kg/ha
Egg-plants, s.p.	4.0	80	400	100 kg/ha	Parsnip, m.p.	2.5	100	400	37,5 t/ha
Early cauliflower, s.p.	3.5	80	300	200 kg/ha	Parsnip, s.p.	3.0	100	500	600 kg/ha
Early cabbage, s.p.	2.5	70	310	400 kg/ha	Moon radishes, m.p.	2.0	100	300	10 t/ha
Autumn cabbage, m.p.	4.0	70	250	90 t/ha	Moon radishes, s.p.	3.0	120	400	500 kg/ha
Autumn cabbage, s.p.	3.0	100	400	600 kg/ha	Summer radishes, m.p.	3.0	70	250	35 t/ha
Onion for chive	2.0	140	500	6 t/ha	Summer radishes, s.p.	3.0	100	300	600 kg/ha
Chive onion, m.p.	3.0	120	275	25 t/ha	Winter radishes, m.p.	3.0	70	250	35 t/ha
Direct seeded onion, m.p.	4.0	140	400	20 t/ha	Winter radishes, s.p.	3.0	100	300	600 kg/ha
Onion, s.p.	2.5	120	350	400 kg/ha	Red beet, m.p.	4.0	60	450	40 t/ha
Leek, m.p.	2.5	100	350	30 t/ha	Red beet, s.p.	4.0	100	400	800 kg/ha
Leek, s.p.	2.0	80	300	250 kg/ha	Celery, m.p.	3.0	70	350	30 t/ha
Garlic, planting material	3.0	120	450	5 t/ha	Celery, s.p.	4.5	80	450	500 kg/ha
Lettuce, s.p.	4.0	140	450	350 kg/ha	Chicory, m.p.	5.0	60	600	25 t/ha
Spinach, s.p.	4.0	140	450	700 kg/ha	Chicory, s.p.	2.0	80	300	500 kg/ha
Thyme, s.p.	3.0	80	400	200 kg/ha	Cucumbers, s.p.	4.0	120	450	150 kg/ha
Dock, s.p.	3.0	100	300	300 kg/ha	Marrows, s.p.	3.0	80	450	200 kg/ha
Orach, s.p.	2.0	70	250	150 kg/ha	Cantaloupes, s.p.	2.0	70	300	100 kg/ha
Dill, s.p.	2.0	70	250	500 kg/ha	Water melons, s.p.	5.0	120	450	200 kg/ha
Garden bean., s.p.	2.0	100	500	700 kg/ha	Pumpkin, s.p.	5.0	120	450	200 kg/ha
Garden pea, s.p.	2.5	120	600	1500 kg/ha	s.p.= *seed plants;* *m.p. = mother plants;*				

2. for the seed root celery crop:

$GG,t/ha = 57.144 - 26.870*IN + 5.157*IN^2 - 0.358*IN^3$

$N,kg/ha = 366.661 - 202.265*IN + 43.749*IN^2 - 3.200*IN^3$

$P_2O_5,kg/ha = 561.306 - 11.817*P_{AL} + 0.122*P_{AL}^2 - 4.500*10^{-4} P_{AL}^3$

$K_2O,kg/ha(1) = 360.223 - 1.889*K_{AL} + 41.45*10^{-4}*K_{AL}^2 - 3.022*10^{-6}*K_{AL}^3$

$K_2O,kg/ha(2) = 414.690 - 2.175*K_{AL} + 47.74*10^{-4}*K_{AL}^2 - 3.479*10^{-6}*K_{AL}^3$

$K_2O,kg/ha(3) = 476.525 - 2.499*K_{AL} + 54.83*10^{-4}*K_{AL}^2 - 3.994*10^{-6}*K_{AL}^3$

This requirement is corrected according to the history of the organic fertilization of the relative parcel (table 2).

Table 2

Corrective factors for the NPK dosage according to the year of the organic fertilization.

Fertilization year	f_{cN}(FM)	$f_{c\ P2O5}$(FM)	$f_{c\ K2O}$(FM)
I	1.3	0.8	2.5
II	0.8	0.6	1.3
III	0.6	0.2	0.8

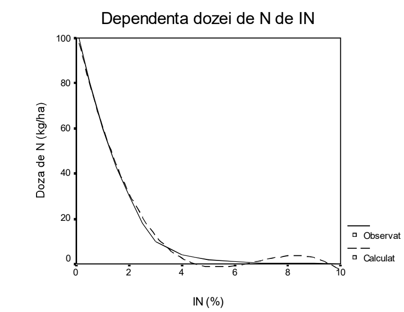


Fig. 1-The relationshep between the rates of N and NI

$N, kg/ha = 102.746 - 49.602*NI + 7.628*NI^2 - 0.372*NI^3$

$R^2 = 0.995$

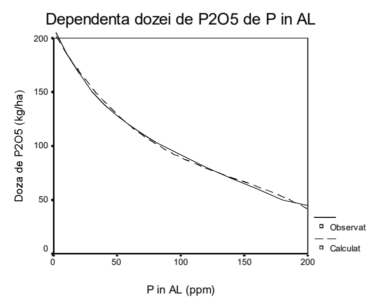


Fig. 2-The relationshep between the rates of P_2O_5 and P_{AL}

$P_2O_5, kg/ha = 205.228 - 2.011*P_{AL} + 0.011*P_{AL}^2 - 2.565*10^{-5}*P_{AL}^3$

$R^2 = 0.997$

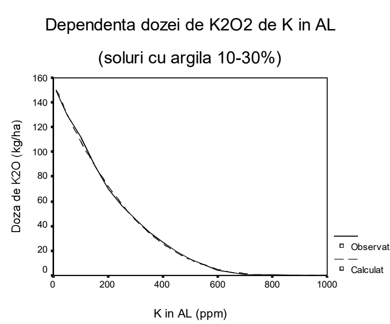


Fig. 3-The relationshep between the rates of K_2O and K_{AL} (soils with 10-30% clay)

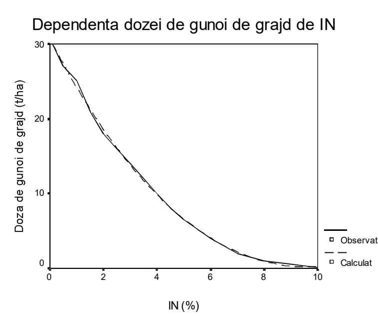


Fig. 4-The relationshep between the rates of farmyard manure and NI

$FM, t/ha = 30.668 - 6.933*NI + 0.457*NI^2 - 0.00681*NI^3$

$R^2 = 0.999$

The phosphorus dosage is also corrected according to soil reaction:

$$f_{c\ P2O5}(pH) = 0.81 + 3.22*10^{-4}*e^{pH}$$

The soil reaction was determined in seven classes, from highly acid to strongly alkaline (table 3):

Table 3

The appreciation of the soil reaction (pH)

Soil reaction	pH value
Highly acid	Less than 5.00
Moderate acid	5.00 – 5.80
Slightly acid	5,81 – 6,80
Neutral	6.81 – 7.20
Slightly alkaline	7.21 – 8.40
Moderate alkaline	8.41 – 9.00
Strongly alkaline	Over 9.01

Regarding the soil agrochemical indicators of the NI, P_{AL} and K_{AL}, the domains in table 4 were used.

Table 4

The appreciation of the soil fertility

Soil fertility	IN, %	P_{AL}, ppm	K_{AL}, ppm
Very low	Less than 1.0	Less than 35	Less than 65
Low	1.1 – 2.0	36 - 72	66 – 132
Medium	2.1 – 3.0	73 - 102	133 – 200
Good	3.1 – 4.0	103 - 144	201 – 300
Very good	4.1 – 6.0	144 - 180	301 – 400
High	6.1 – 8.0	181 - 220	401 - 600

For the potassium dosage a correction according to the clay content of the soil was inserted:

$$\mathbf{f_{c\ K2O}}(\text{clay}) = \mathbf{9.46*10^{-2}*clay - 0.215*10^{-2}*clay^{2} + 1.55*10^{-5}*clay^{3}}$$

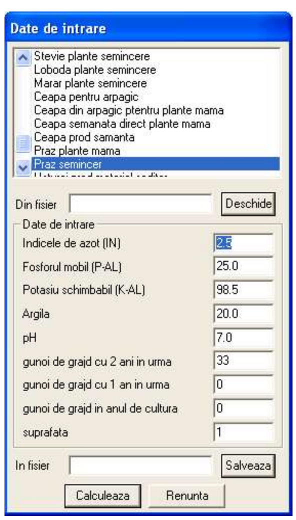
The appreciation of the soil texture is shown in table 5.

Table 5

The appreciation of the soil texture (% clay)

Soil texture	Clay content, (%)
Light	**less than 10**
Medium	**10 – 30**
Heavy	**over 30**

To this effect a software for 45 vegetable, mother plants and seed plant crops has been established.



The software works in two versions:

Version A: when the user knows the agrochemical parameters of the area:

- We enter into program and we access the plant mother or seed plants, as in case.

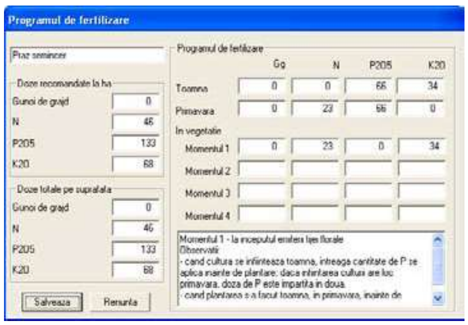
- Crop selection and insertion of the agrochemical parameter values:

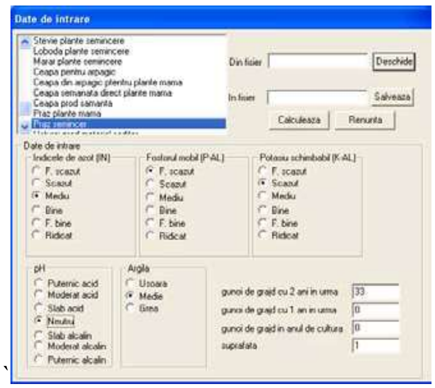
The program shows 45 crops.

The user marks the crop in wich he is interested. Let's say leek seed crop. After this, the program will ask to introduce the agrochemical parameters. For example: 2.5 NI, 25 ppm P_{AL}, 98.5 ppm K_{AL}, 20 % clay, pH 7.0, 33 t/ha farmyard manure applied two years ago and 1 ha area.

- The calculation of the amounts of fertilizers:

By selecting “Calculează” the software will calculate the fertilizers dosage (kg/ha) and display the fertilization program in kg/parcel and the moments of application along with some observations:





The fertiliser rates are:

- Farmyard manure: 0; N: 46 kg/ha; P_2O_5: 133 kg/ha;K_2O: 68 kg/ha;

These amounts of fertilisers will be applied as follows:

- Nitrogen: 1/2 in the spring (as NP fertiliser) and ½ in the vegetation period;
- Phosphorus: 1/2 in the automn and 1/2 in the spring time;
- Potassium: 1/2 in the automn and 1/2 in the vegetation period;

Version B: when the user doesn’t know the necessary agrochemical indicators. In this case a personal estimation of the soil reaction, texture and fertility will be introduced by marking one of the displayed classes:

In our exemple, where we selected leek seed crop, are marked:

- for NI: medium; for P_{AL}: very low; for K_{AL}: low; for pH: neutral;
- for texture: medium; for farmyard manure: 33 t/ha, two years ago;
- for area: 1 ha.

Thenceforth the program will run same as in version A.

Note that the fertilizers dosage calculated with FERTSEM considers the following:

- a balanced fertilization;
- “maximum” harvests both on mother plant cultures and seed plant crops;
- maintaining the soil fertility on an adequate level;

We also recommend that the small fertilizer dosage arising from the calculus should be applied in the periods preceding the maximum consumption from the plants and as complex fertilizers of NP, NK, PK, NPK type, as the case stands.

The program has also a series of restrictions which make the organic and mineral fertilizer dosage not exceeding certain maximum values irrespectively of how low are the values of agrochemical indicators.

FERTSEM takes also into account the “active” participation of the seed producer to the appraisal of the dosage and final fertilization schedule. Based upon his experience, the anticipated harvest and the evolution of the climatic factors, the fertilizer quantities can be modified, mostly lesser, in order to achieve the maximum efficiency.

REFERENCES

1. **Addiscott T. M. and Witmore A. P., 1987** – *Computer simulation of changes in soil nitrogen and crop nitrogen during autumn, winter and spring*. J. Agric. Sci. Camb. 109, 141-157.
2. **Ceapoiu N., 1968** – *Metode statistice aplicate în experienţe agricole şi biologice*. Ed. Agro-Silvică Bucureşti.
3. **Davidescu D. şi Velicica Davidescu, 1981** – *Agrochimia modernă*. Ed. Acad. RSR, 461-486.
4. **Davidescu D. şi Velicica Davidescu, 1992** – *Agrochimie horticolă*. Ed. Acad. RSR, 393-397.
5. **Dobre Elisabeta, Marica Adriana, Tănăsescu M., Lăcătuş V., Mirghiş R., Voican V., Ciupală Aurora, 1993** – *Model matematic de simulare a producţiei potenţiale la tomatele cultivate în câmp şi posibilităţile de perfecţionare a acestuia*. An. ICDLF-Vidra, XII, 217-229.
6. **Dumitrescu M and all., 1975** – *Tehnologia producerii seminţelor şi materialului săditor la plantele legumicole.* Ed. CERES, Bucureşti.
7. **Horie T., 1978** – *A simulation model for cucumber growth to form basis for managing the plant environment system*. Acta Hort., 87, 215-223.
8. **Jidav L. and all., 1983** – *Tehnologia culturilor de legume pentru producerea de seminţe.* Vol. II, MAIA, ICLF Vidra.
9. **Lăcătuş V., 1998** – *Contribuţii la studiul metodicii de dozare a azotului în vederea controlului nutriţiei azotate la cucurbitaceae în spaţii protejate.* Teza de doctorat, 127-139.
10. **Lăcătuş V. and all., 1985** – *Posibilităţi de sporire a eficienţei fertilizării în legumicultură*. Bul. Inf.ASAS.
11. **Lăcătuş V., Florica Gheorghe, Voican V., Tănăsescu M., 1996** – *Program pe calculator de optimizare a compoziţiei agrochimice a substraturilor nutritive pentru producerea răsadurilor.* Ses. An. Ref. Şt. ICDLF.Vidra, 22.
12. **Lăcătuş V., Glăman Ghe., Tănăsescu M., 2002 –** *Program de optimizare a fertilizării organice şi minerale a culturilor semincere de varză şi conopidă. Ses*. An. Ref. Şt. ICDLF Vidra.
13. **Lăcătuş V., Glăman Ghe., Tănăsescu M., Rodica Badea, 2004** – *Software de optimizare a fertilizării organice şi minerale a culturilor semincere de legume*. Ses. An. Ref. Şt. ICDLF Vidra, HORTINFORM, 12/148, 14-17.
14. **Lăcătuş V., Voican V., Tănăsescu M., 1996 –** *FERBAZ- program expert de calcul a dozelor de îngrăşăminte pentru fertilizarea de bază a solurilor de seră cultivate cu tomate*. An. ICDLF-Vidra, XIV, 425-428.
15. **Liebig H. P., 1981** – *A growth model to predict yield and economical figures of the* cucumber crop. Acta Hort. 118, 165-174.
16. **Loncaric Z., Loncaric R., 2006** – *Computer sistem for fertilizer recommendation and economic analyses of field vegetable ecological production in Croatia*. ISHS, Acta Hort. 700.
17. **Voican V., Lăcătuş V. and all., 1993** – Cercetări privind validarea modelului SIMTOM de simulare dinamică a producţiei la tomatele cultivate în câmp. An. AIDLF-Vidra, XIV, 405-415.
18. **Voican v., Lăcătuş V., Ana-Viorica Voican, Gapşa F., Elena Delian, 1998** – Cercetări privind influenţa fertilizării culturilor semincere de tomate cu NPK, asupra unor indici fiziologici ai seminţelor. HORTINFORM, 10/74, 13-20.