

Fertilization optimization in the case of the *Nemere* variety through the refinement of the romanian chemical fertilizer in the Targu Secuiesc depression

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Abstract Profitable potato cultures cannot be developed without chemical and/or organic fertilization. The fertilization must assure the best possible valorization of the intensive varieties' production potential under the ecological conditions existing in the cultivation region.

The experiments took place at the Potato Research and Development Station Targu Secuiesc in the period 2008-2010.

Our research proposed this approach to the aspects of potato fertilization in the case of the *Nemere* variety, created at the Potato Research and Development Station Targu Secuiesc.

To achieve a higher production level, 4 levels of fertilization and 2 types of fertilizers were studied.

The objectives of this research were:

- ↳ study of indigenous potato varieties for industrial processing
- ↳ the influence of the dose and rate of chemical fertilizers on production, dry matter and starch content.

Potato is one of the most important crop plants, which has a high ecological plasticity, being grown on all continents, in over 140 countries, mainly for consumable purposes rather than for industrial one and for animal feeding [1].

Potato is used for industrial purposes like in the production of alcohol, starch and glucose. 1000 kg of potatoes produce 56-132 l of alcohol, or 140 kg of starch, or 240-260 kg of chips, or 700-750 kg of French fries. More than 700 derivatives can be produced from starch that are used in food processing industry in pharmaceutical industry, in textile industry and in paper-manufacturing etc. [3, 4].

Once cultivated, the potato has been increasingly appreciated and became one of the most important crops for Romania's economy.

Processing potato in various forms of prepared and semi-prepared foods means a true revolution in potato production. These processed products, in addition to being nutritious and tasty, make housewives' life easier [5].

In developed countries, more than 28 types of potato dishes are produced (chips, French fries, flakes for mashed potatoes, dehydrated potatoes, canned foods etc.), that provide a higher recovery of potato production. Potato also serves as raw material in the industry, being produced around 40 products: glucose, dextrin, oxidized starch, which are either raw material or auxiliary material in industrial production processes

Key words

potato, variety, fertilization, nitrogen doses

like in food, paper, cellulose, chemical, pharmaceutical, building materials, heavy industry, mining industry and other industries [2].

In recent decades, potato processing turned to have multitudinous utilization mode, developing new potato flake products, selected products by frying (chips) and semi-frying (French fries), by freezing or by canning.

Material and Research Method

✓ Factor A – planting time

a₁ – Early (at the beginning of April)

a₂ – Late (at the end of April)

✓ Factor B – type of fertilizer (basic fertilization)

b₁ – C15:15:15 (N 90 kg s.a./ha:P 90 kg s.a./ha:K 90 kg s.a./ha)

b₂ – C11:9:20 (N 137 kg s.a./ha:P 112 kg s.a./ha:K 250 kg s.a./ha)

✓ Factor C – nitrogen level

c₁ – N₆₈ = 200 kg/ha ammonium nitrate

c₂ – N₁₀₂ = 300 kg/ha ammonium nitrate

c₃ – N₁₃₆ = 400 kg/ha ammonium nitrate

c₄ – N₁₇₀ = 500 kg/ha ammonium nitrate

The experiment was located after subdivided parcels method in 3 repetitions.

As biological material we used the *Gared*, *Nemere* and *Milenium* varieties, which are in Base Class Super Elite biological category.

The plantation was performed semi-mechanized, the planting distance being 75/25 cm, thus creating a density of 53.300 plants/ha.

Chemical fertilizers were applied at the time of the seedbed preparation.

Observations were carried out during the vegetation period with reference to:

- ✓ the date of the main agrophytotechnical works;
- ✓ the dates of the main phenophases;
- ✓ the number of planting holes in the two middle rows;
- ✓ the harvest was carried out according to variants and repetitions;
 - ⊙ number and weight of tubers < 55 mm
 - ⊙ number and weight of tubers 35-55 mm
 - ⊙ number and weight of tubers > 35 mm

The calculation and interpretation of results was carried out according to the method of variance analysis, and for the appreciation of the significance of

differences it was used the test of multiple comparisons (Duncan).

Biological material used in the study

The biological material used during the experimental years of 2008, 2009, 2010 falls within the Base Class Super Elite biological category.

Potato varieties used in the study are:

NEMERE variety

Nemere potato variety was created at S.C.D.C. Tg. Secuiesc and it was homologated in 2000.

Morphological characters: the sprouts have an oval shape with middle size and red – violet colors on the base of sprouts. The bud of sprout on light is half open and porosity is very dense. The tubers vary in size from medium to large. The leaves have a medium size with a clear green color. The sprouts have large white flowers. Tubers have round –oval shape. Color of skin and pulp is yellow. Stems are erect. Leafs are semi compact with middle size foliols, green clear. Flowers are white and big.



Figure 1. The *Nemere* variety – potato tubers

Vegetation period: *Nemere* variety belongs to the group of semi-late varieties, with a vegetation period of 80-100 days.

Resistance to diseases and pest: *Nemere* variety is resistant to virus Y and is tolerant to blight (*Phytophthora infestans* (Mont de Bary)).

Culinary quality: it belongs to C class. It is recommended to winter consumption and processing. The starch content is 16-17%.

Yielding capacity: it is a high-yielding potato variety with a yield of over 63.5 tonnes/ha.

Zoning: *Nemere* variety is recommended for very

favorable zones of potato production.

GARED variety

Gared potato variety was created at S.C.D.C Tg. Secuiesc, and homologated in 2004 and certified in 2009.

Morphological characters: the plant is vigorous with a large number of stems and belongs to foliage type. The leaves have a medium size with light – green color. The flowers have a medium size, having a violet color with white points. The tubers have a short oval shape with shallow eyes. The color of skin is red and

the color of flesh is cream. The sprouts have a conic shape with middle size and red – violet colors on the base of sprouts. The bud of sprout on light is half open and porosity is dense to very dense.

Vegetation period: *Gared* variety belongs to the group of late varieties, with a vegetation period of over 110 days.

Yielding capacity: it is a high-yielding potato variety with a yield of over 67.0 tones/ha.

Culinary quality: is good and belongs to B class. *Gared* variety is very suitable for pommes frites production. The content of starch is over 21%.

Resistance to diseases and pest: *Gared* variety is resisting to late blight on leaves and tubers, is resisting to leave roll virus (PLRV) and tolerant to virus (PVY). It is resisting to potato cyst nematodes (*Globodera rostochiensis*) and black wart (*Synchytrium endobioticum*).



Figure 2. The *Gared* variety – potato tubers

MILENIUM variety

Milenium potato variety was created at S.C.D.C Tg. Secuiesc, and homologated in 2004 and certified in 2005.

Morphological characters: Tubers have round –oval shape with shallow eyes. Color of skin and pulp is yellow. Stems are tall. Leaves have middle size foliols, green clear. Flowers are white.

Vegetation period: The vegetation period are 100–110 days and this variety belonging to middle late varieties.

Resistance to diseases and pest: it is resistant to PVY and sensitive to late blight (*Phytophthora infestans*). It is resistant to cist nematodes (*Globodera rostochiensis*).

Culinary quality: it has 18.53% starch content and belongs to C group. It is recommended to winter consumption and processing.

Yield capacity; It has a high yield capacity (58.1t/ha).



Figure 3. The *Milenium* variety – potato tubers

Fertilizers applied in the experiment

Ammonium nitrate it has got 33.0-34.5% nitrogen content, most frequently of 33.5%. It appears in the form of a crystallized or granulated salt of white, sometimes pink-yellowish color, it is water-soluble and very hygroscopic. It can be applied on every type of soil, but with restrictions on soils with an acidic reaction.

The Complex Fertilizer 15-15-15 it is a mineral compound that contains three nutritive elements: nitrogen, phosphorus and potassium. The identification code of these fertilizers is conventionally based on the individual size of the components. This type of fertilizer contains 15% nitrogen, 15% phosphorus and 15% potassium.

The Complex Fertilizer 9-11-20 it is a mineral

compound that contains three nutritive elements: nitrogen, phosphorus and potassium.

Results and Discussions

The highest production for the *Nemere* variety has been obtained by the fertilization variant with 400 kg/ha ammonium nitrate at both planting times, 34.4 t/ha (early planting time) and 30.9 t/ha (late planting time) for the total production, and 30.9 t/ha (early planting time) and 24.1 t/ha (late planting time) for the production for processing, at this level of fertilization the average weight of a tuber being the highest 64.2 g at the early planting time and 57.7 g at the late planting time.

Table 1

The average effect of fertilization with ammonium nitrate on the production of the *Nemere* variety planted at different times (average values 2008-2010)

Planting time	Ammonium nitrate kg/ha	<i>Nemere</i>					
		Total production		Processed production		Average tuber mass	
		t/ha	Duncan test	t/ha	Duncan test	g	Duncan test
1	200	30.1	D	27.6	BC	56.7	C
	300	31.6	B	28.7	B	56.7	C
	400	34.4	A	30.9	A	62.4	A
	500	31.3	BC	28.1	BC	59.7	B
2	200	28.7	E	25.5	E	51.8	D
	300	30.4	CD	27.0	CD	52.6	D
	400	30.9	BCD	28.1	BC	57.7	BC
	500	28.7	E	25.9	DE	56.0	C
Average	200	29.4	C	26.6	C	54.2	C
	300	31.0	B	27.9	B	54.6	C
	400	32.7	A	29.5	A	60.0	A
	500	30.0	C	27.0	C	57.8	B

LSD 5% (ammonium nitrate) = 0.6 t/ha
LSD 5% (planting time * ammonium nitrate) = 0.9 t/ha

0.8 t/ha
1.6 t/ha
1.8 g
2.5 g

In the case of fertilization with C 11:9:20 compound fertilizer has been obtained an average increase in the total production, namely 0.9 t/ha (3.0%) which is significantly higher than the C15:15:15 fertilization variant. The highest increase in the production has been recorded in the case of the production for processing at the early planting time, in the case of fertilization with C11:9:20 compound fertilizer the increase was 1.7 t/ha (6.6%), while in the

total production it was 1.3 t/ha (4.5%).

High increases in the production were recorded also in the case of basic fertilization with C11:9:20 compound fertilizer, levels of fertilization with 300 kg/ha and 400 kg/ha ammonium nitrate bringing an increase of 10.2% in the production, 15.2% in the total production, and 10.7% and 15.6% in the production for processing.

Table 2

Average rate of growth in potato production due to fertilization with complex fertilizers at different planting times of the *Nemere* variety (2008 – 2010)

Planting time	Complex fertilizer	<i>Nemere</i>					
		Total production			Processed production		
		t/ha	Dif. t/ha	Rel. %	t/ha	Dif. t/ha	Rel. %
1	C15:15:15 600 kg/ha	31.6	-	100	28.7	-	100
	C11:9:20 1250 kg/ha	32.1	+ 0.5	101.6	29.0	+ 0.3	101.0
2	C15:15:15 600 kg/ha	29.1	-	100	25.8	-	100
	C11:9:20 1250 kg/ha	30.4	+ 1.3*	104.5	27.5	+ 1.7*	106.6
Average	Planting time 1	31.8	-	100	28.8	-	100
	Planting time 2	29.7	- 2.1 ^o	93.4	26.6	- 2.2 ^o	92.4
	C15:15:15 600 kg/ha	30.3	-	100	27.2	-	100
	C11:9:20 1250 kg/ha	31.2	+ 0.9*	103.0	28.2	+ 1.0	103.7

LSD 5% (planting time) =

0.4 t/ha

0.4 t/ha

LSD 5% (complex) =

0.3 t/ha

0.4 t/ha

LSD 5% (planting time * complex) =

0.6 t/ha

0.8 t/ha

Table 3

Interaction effects of the complex fertilizers applied and the doses of ammonium nitrate fertilizer on the production of *Nemere* variety (Average values 2008-2010)

Complex fertilizer	Ammonium nitrate	<i>Nemere</i>					
		Total production			Processed production		
		t/ha	Dif. t/ha	Rel. %	t/ha	Dif. t/ha	Rel. %
C15:15:15 600 kg/ha	200	27.4	-	100	25.2	-	100
	300	29.2	+ 1.8*	106.6	26.5	+ 1.3*	105.2
	400	30.8	+ 3.4*	112.4	28.7	+ 3.5*	113.9
	500	27.4	0	100.0	25.3	+ 0.1	100.4
	Average	30.3	-	100	27.2	-	100
C11:9:20 1200 kg/ha	200	28.3	-	100	26.2	-	100
	300	31.2	+ 2.9*	110.2	29.0	+ 2.8*	110.7
	400	32.6	+ 4.3*	115.2	30.3	+ 4.1*	115.6
	500	26.6	- 1.7 ^o	94.0	24.5	- 1.7 ^o	93.5
	Average	31.2	+ 0.9*	103.0	28.2	+ 1.0	103.7

LSD 5% (complex) =

0.3 t/ha

0.4 t/ha

LSD 5% (complex * ammonium nitrate) =

0.9 t/ha

1.2 t/ha

For high yields of potato the *Nemere* variety needs to be planted early and requires compound fertilizers with favorable ratio for potassium. Under these conditions we can obtain high yields.

Compared to other varieties the *Nemere* variety is more dependent on climate year, there are significant differences in the total production and in the production for processing at basic fertilization with compound fertilizer, in which dominates the potassium, it achieves significant total production increases by using 300 and 400 kg/ha ammonium nitrate at planting.

Economic effects resulting from fertilization optimization in the case of the varieties tested under the conditions in Targu Secuiesc

In the early planting time the best variants from economical point of view compared to the lowest level of nitrogen fertilization (200 kg/ha ammonium nitrate) were the next levels, which by adding 100 kg ammonium nitrate, that is to say additional inputs (marginal cost) of 0.126 thousand lei/ha, has been returned for the first step (between 200 and 300 kg ammonium nitrate) 0,741 thousand lei and between

300 and 400 kg ammonium nitrate 0,680 thousand lei marginal profit. The rate of profitableness shows that

that 0, 126 lei invested additionally were recovered by a five-fold profit.

Table 4

Fertilization variants selected by margin analysis in the case of the *Nemere* variety (Tg. Secuiesc, 2008-2010)

Var.	Planting time	Basis fertilization	Ammonium nitrate kg/ha	Average profitability Thousand / ha	Cost varies Thousand / ha	Marginal profitability Thousand / ha	Marginal cost Thousand / ha	Profitability rate %
1	I	C15:15:15 600 kg/ha	200	12.312	1.248	0	0	0
2			300	13.054	1.374	0.741	0.126	588.7*
3			400	13.743	1.500	0.680	0.126	539.8*

* For these variations has exceeded the required rate of profitability of 10%

One can say that in the case of the *Nemere* variety at early planting time it is justified a basic fertilization with C 15:15:15, a dose of 600 kg/ha, and the doses of nitrate can be increased up to 400 kg/ha.

Conclusions

- ↳ The highest production for the *Nemere* variety has been obtained by the fertilization variant with 400 kg/ha ammonium nitrate at both planting times, 34.4 t/ha (early planting time) and 30.9 t/ha (late planting time) for the total production, and 30.9 t/ha (early planting time) and 24.1 t/ha (late planting time) for the production for processing, at this level of fertilization the average weight of a tuber being the highest 64.2 g at the early planting time and 57.7 g at the late planting time.
- ↳ In the case of fertilization with C 11:9:20 compound fertilizer has been obtained an average increase in the total production, namely 0.9 t/ha (3.0%) which is significantly higher than the C15:15:15 fertilization variant. The highest increase in the production has been recorded in the case of the production for processing at the early planting time, in the case of fertilization with C11:9:20 compound fertilizer the increase was 1.7 t/ha (6.6%), while in the total production it was 1.3 t/ha (4.5%).
- ↳ High increases in the production were recorded also in the case of basic fertilization with C11:9:20 compound fertilizer, levels of fertilization with 300 kg/ha and 400 kg/ha ammonium nitrate bringing an increase of 10.2% in the production, 15.2% in the total production, and 10.7% and 15.6% in the production for processing.
- ↳ For high yields of potato the *Nemere* variety needs to be planted early and requires compound fertilizers with favorable ratio for potassium. Under these conditions we can obtain high yields.
- ↳ Compared to other varieties the *Nemere* variety is more dependent on climate year, there are significant differences in the total production and in the production for processing at basic fertilization with compound fertilizer, in which dominates the

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- ↳ In the early planting time the best variants from economical point of view compared to the lowest level of nitrogen fertilization (200 kg/ha ammonium nitrate) were the next levels, which by adding 100 kg ammonium nitrate, that is to say additional inputs (marginal cost) of 0.126 thousand lei/ha, has been returned for the first step (between 200 and 300 kg ammonium nitrate) 0,741 thousand lei and between 300 and 400 kg ammonium nitrate 0,680 thousand lei marginal profit. The rate of profitableness shows that that 0, 126 lei invested additionally were recovered by a five-fold profit.
- ↳ One can say that in the case of the *Nemere* variety at early planting time it is justified a basic fertilization with C 15:15:15, a dose of 600 kg/ha, and the doses of nitrate can be increased up to 400 kg/ha.

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