Scientific Papers. Series A. Agronomy, Vol. LXIII, No. 1, 2020
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

THE QUALITY OF THE PLANTING MATERIAL FOR POTATO CROPS - FACTOR IN INSURING PROFITABLE PRODUCTS

Eduard MIKE

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania

Corresponding author email: mikeedy@yahoo.com

Abstract

Planting material quality is a complex notion supported by the phytosanitary, biological and physical quality of potato tubers. Phytosanitary quality refers to health status of tubers of adherent soil to tubers through which can be transmitted a lot number of diseases caused by viruses, bacteria, mycosis and soil pests, quarantine organism phytosanitary quarantine organism transmitted by tubers and soil. Potato diseases and pests may diminish the yield through: reducing or blocking photosynthesis; reducing or blocking transport of assimilated products from leaves to tubers; stain, wriggle, necrosis of leaves and plant death; rot of tubers in the field or storage. The biological quality of the planting material is characterized by the plants' capacity to sprout, emerge, grow and to make tubers, being influenced by physiological degeneration. Physiological degeneration is determined by high temperatures during the vegetation, by increasing the intensity of the aphids' flight transmitting viruses, but also by the condition of storage unventilated warehouses with high temperatures and high humidity. The physical quality of potato tubers is conferred by the external appearance and the size. The tubers which have other shapes and colors nonspecific to the variety are eliminated during sorting for batching together with the tubers that present deformations or infections with different diseases and pests. Depending on the size of the tubers the density and the planting norm are established. Due to the complexity of the factors involved in the making of a planting material with appropriate biological, physical and phytosanitary characteristics and the current state of potato production at national level, specific researches were initiated aimed to increase the areas cultivated with certified potato material and implicitly increase the average productions.

Key words*: potato, planting material multiplying, biological and physical quality.*

INTRODUCTION

The potato is one of the most important cultivated plants, with a high ecological plasticity, being grown on all the continents to be used fresh, as food, or processed as raw material for starch and alcohol, etc. but also as animal feed.

The degeneration of the potato has been, for a long time, a phenomenon manifesting itself as a weakening of the plant's entire vegetative system, leading to yield loss.

Parmentier (1786) was the first scientist to notice the degeneration of the potato cultivars grown. Ever since then, the potato degeneration has remained of interest for scientists, and the relation between climate and the degeneration of the potato is essential; this is why, in Romania and throughout the world, dedicated areas were set out, specialized in the cultivation and reproduction of tubers.

Ensuring the quality of the planting material to obtain the planned yield represents the most important activity in this sector, and is carried out by business operators authorised for the production, processing and marketing of planting material, and checked by the regional inspectorates in charge of the tuber's quality verification.

Tuber zoning represents a priority in potato growing. That is why, in countries with a seed growing tradition, there are areas with specific conditions dedicated to seed crops, areas where only tubers are grown, humid, cool areas, with as few aphids as possible.

The recent climatic changes led to a decrease in the areas tilled for seed, as well as to the change of the cultivar's conveyer in favour of the early and extra-early cultivars, with a shorter vegetation period, requiring less water and reaching maturity after 76-80 days of vegetation.

MATERIALS AND METHODS

Scientific literature and the legislation governing the growth, processing and sale of tubers were studied for this paper.

The areas that are favourable to the growth of potato planting material are cool areas with good air circulation, which don't encourage aphid proliferation, with a long interval from the first flight to the start of the maximum summer flight of aphids.

The depreciation of potato cultivars under the conditions of the favourable and very favourable areas is caused by viral degeneration where, after three years of propagation, the viral infection can increase from 34% to 85%, as a result of planting non-certified material.

In our country, the area necessary for the cultivation of seed potatoes spanned in the beginning over 5 regions (Figure 1): Harman and Rasnov in the Brasov county, Ciuc and Lazarea in the Harghita county, Suceava in the Suceava county, Targu Secuiesc in Covasna and Neamt in the Neamt county, and it subsequently extended with areas in the Botosani, Bacau, Iasi, Sibiu, Hunedoara counties, in humid, cool areas, for a total of 30,000 ha.

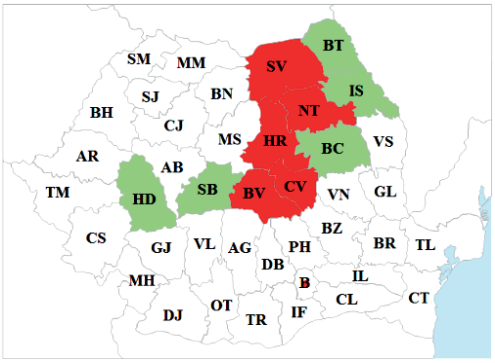

Figure 1. Closed areas for growing tubers

The delimitation of closed areas and the creation of the best conditions for the distribution of the tuber crops within the country proved to be a particularly useful and technically and economically effective measure. The distribution must be further refined by measures ensuring the most effective use of the favourable ecological conditions, where the source of viral infection and the plants' potential of viral infection are minimized.

Table 1. The evolution of cultivated areas (ha) in regions favourable to tuber crops for planting

Year / County	2009 -ha-	2011 -ha-	2013 -ha-	2015 -ha-	2016 -ha-	2017 -ha-	2018 -ha-	2019 -ha-
Bacau	9	-	-	-	-	-	-	-
Botosani	50	-	-	-	-	-	-	-
Brasov	407	265	109	200	126	167	148	150
Covasna	455	159	111	284	311	290	238	286
Harghita	338	114	37	108	134	110	75	103
Hunedoara	14	-	-	-	-	-	-	-
Iasi	69	84	-	23	33	10	8	-
Neamt	56	-	11	32	27	10	7	6
Sibiu	27	15	26	32	28	28	28	34
Suceava	536	117	25	20	26	44	57	81
Total	**1961**	**754**	**319**	**699**	**685**	**659**	**561**	**660**

Table 1 shows an alarming decrease in the potato tubers areas in regions closed for the cultivation of planting material from 1961 ha in 2009 to only 319 ha in 2013; we see a slight increase in the following years, reaching 660 ha in 2019, also as a result of the implementation of join support for this crop as of 2015.

The yield obtained on the 660-ha certified country level is around 16,500 tons of certified planting material. This quantity is enough to plant certified material only on 4700 ha, i.e. 2.7% of the 170,000 ha of potatoes declared by the National Institute of Statistics for 2019, well under the level of the European states, where an average of 2200 kg/ha of certified seed is used on the total area; for us, the certified material used for the crops represents merely 470 kg/ha.

As a result of planting material of non-conforming quality, the national average yield is of only 14500 kg/ha, and the cultivates areas are steadily declining.

RESULTS AND DISCUSSIONS

The depreciation of the biological yield potential is a consequence of two major causes, the viral infection and the decreased growth rate due to the physiological age.

The main diseases affecting the phytosanitary quality of the seed potato are: viruses, bacterioses and mycoses.

The most common viruses for potato crops are:

The potato leafroll virus - PLRV)

Potato leafroll was the first viral disease of the potato to be studied (Figure 2). The first symptoms are seen at the tip of the plant and consist of the leaf margins curling or rolling towards the upper side of the leaf blade, and leaflets chlorosis. Later on, the rolling extends to

the basal leaves, which become thick, leathery, rigid, because of the physiological age of the planting material.
In the field, this virus is persistently spread only by aphids. The *Myzus persicae* aphid is the most effective vector.

Figure 2. Potato leafroll virus - PLRV (http://kb-dev.gramophone.in/tag/leaf-roll-virus/?lang=en)

Potato virus Y/PVY, leads to the formation of mosaic patterns, curling, spotting and ringspot disease (Figure 3). Potato virus Y is easily spread and can lead to major yield loss up to 70%. The most frequent vector is the green peach aphid (*Myzus persicae).*
The symptoms are more often than not the formation of marble and mosaic patterns. Virus Y^O strains usually encourage the curling of the leaves and even to the necrotic spotting of the leaves of some cultivars. Many cultivars infected with virus Y^C have symptoms of necrotic spotting.

Figure 3. Potato virus Y/PVY (https://www.agroscope.admin.ch/agroscope/fr/home/actualite/kurznews/2017/livre-PVY.html)

Virus Y^{NTN} or the superficial necrotic spotting of the tuber (Potato virus Y^{NTN}/PVY^{NTN})
Potatoes cultivated in Europe are increasingly more affected by a virus Y strain with typical symptoms on the tubers, i.e. superficial necrotic ringspots. At first glance, they may be mistaken for the rings caused by the "tuber spotting" or the mop - top virus. This virus, named *Potato virus* (Y^{NTN}/PVY^{NTN}) (Figure 4), can sometimes overcome PVY resistance. During ELISA testing, virus Y^{NTN} is identified as virus Y and is not mentioned as a distinct strain.
Symptoms: upon harvesting, tubers show superficial irregularities shaped as arcs or rings. Sometimes, such semicircular defects have a pink hue. Later on, they sink in, become necrotic and brown. At this stage, it is difficult to differentiate them from the tuber necrosis caused by "tuber spotting" and the thickening of the tip of the potato plant (the mop - top virus). Finally, the entire area inside the ring becomes necrotic, brown and sinks in.

Figure 4. Potato virus Y^{NTN}/PVY^{NTN} (https://www.akkerwijzer.nl/artikel/85725-yntn-virus-volop-in-consumptieaardappelen/)

Potato leaf rolling mosaic - Potato virus M (PVM)
All European cultivars are prone to infection, but the economic significance is not clearly

defined, albeit believed to be insignificant. Potato virus M can lead to yield loss of up to 40%.
Potato virus M is transmitted by contact, but in the field, it is generally spread by aphids, non-persistently (Figure 5). *Myzus persicae* and *Aphis nasturtii* are the most important vectors.

Figure 5. Potato virus M (PVM) (http://ephytia.inra.fr/en/C/21040/Potato-Potato-virus-M-PVM)

Yield losses caused by viral diseases may be prevented by using certified planting material.
The infection of the seed potato is particularly prevented by the early removal of infected plants, chemical treatment for aphid control and the destruction of the diseased plants removed.

Main potato pests affecting the phytosanitary quality of the seed potato

Aphids *(Aphids* spp.*)* are a major threat for tuber crops, because they spread viruses from one plant to the other.
Aphids are found in particular on the lower side of the leaf. The most dangerous species for potatoes are *Myzus persicae, Aphis nasturtii, Aulacorhum solani and Myzus ascalonicus*.

The Colorado potato beetle *(Leptinotarsa decemlineata)*
Beetles coming from outside the crop sit on the young plants feeding on the leaf margins. They lay orange eggs, 1-2 mm in length, in distinctive groups of 15-80 eggs. The larvae are rapacious and can eat the entire leaf, leaving only the leafstalk.
Control is possible only with the help of pesticides destroying the adults as well as the larvae.

Potato cyst nematodes (*Globodera rostochiensis and Globodera palida*)
The first sign of their presence in the field are areas with slow growing plants. The infected plants are darker and flower later. The radicular system is much more extended, because the infected roots branch out more. Swollen cysts can be seen on the roots, like needle point, 6-8 weeks after planting (Figure 6).

Figure 6. *Globodera* spp. (https://www.forestryimages.org/browse/detail.cfm?imgnum=5393019)

Potato stalk and tuber nematode (*Ditylenchus destructor*) is a pest the attacks of which have serious consequences for potato crops (Figure 7). This pest generated serious damage to the potato crop, both on the quantity and on the quality of the crop. The nematode is a worm which attacks only the underground parts of the plant. No signs of the attack are visible on the surface. On the potato tubers, the nematode attack created small discolored areas, where the epidermis is discolored and starts to crack. The tubers attacked by the nematode become brown and have a texture characteristic for the rot attack. The attack of these worms affects the crop quality and the yield.

Figure 7. *Ditylenchus destructor*

The seed potato is cultivated only on soil free of potato cyst nematodes.

The biological quality of the planting material is defined by a high germination, springing, growth and tuberization potential, and is influenced by the physiological aging of tubers (Draica, 1980).

Regarding the physiological aging (Draica, 1980), mentions that the phenomenon is manifested by the tubers' loss of the potential to produce high yield plants, leading to viral degeneration.

Physiological aging is determined by high temperatures during vegetation as well as during storage.

Research showed that the planting material produced in areas or under conditions with lower temperatures has a higher yield potential, the tubers have more sprouts and more main stalks/hole, respectively. In general, it is unanimously accepted that biologically as well as phytosanitary, the tubers grown in humid, cool areas is superior to the ones grown in areas with high temperatures, where the pilosity phenomenon frequently occurs.

In areas with high temperatures, when the conditions are unfavourable during vegetation: spurious precipitation, and in particular high temperatures exceeding the biological limits (over 24°C), certain physiological and biochemical processes take place leading to the tubers' arrested development, deformation, decreased rest period and the sprouting of the parent tubers, the creation of secondary and even tertiary tubers, phenomena which depreciate the biological quality as well as the culinary and industrial processing quality (Draica, 1980).

For tubers obtained and stored under optimal environmental conditions, at the end of the rest period comes the incubation stage.

Therefore, the physiological age of the tubers can be assessed based on the sprouting, i.e. based on the aspect of the sprouts when planted.

The biological conditions used in Europe and in our country, according to Law no. 266/2002 on the production, processing, marketing and quality certification, sale of seeds and seed material, and Order no. 1266/2005 are (Table 2):

- Pre-basic seed;
- Basic seed;
- Certified seed;
- Marketed seed.

Table 2. Requirements for cultivar purity and phytosanitary condition (Order no. 1266/2005)

Biological harvest category	Maximum accepted ratio %							
	of alien plants during field inspection	of atypical plants during field inspection	during a field inspection - total viroses	during the latest field inspection – blackleg and tuber wet rot	*Rhizoctonia solani*	in direct line		
						Virus testing	Purity	
							Atypical	Other cultivars
1	2	3	4	5	6	7	8	9
Pre-basic seed	0.0	0.0	0.1	0.0	3	0.5*	0.01	0.0
CEE 1 Basic seed class SE; CEE 2	0.1	0.25	0.1 0.5*)	0.0 0.5	5	4.0*	0.25	0.1
Basic seed class E; CEE 3	0.1	0.25	1.0*)	1.0	5**)	4.0*	0.25	0.1
Certified seed classs A	0.2	0.5	2.0*)	1.5	10**)	8.0**)	0.5	0.2
Certified seed class B	0.2	0.5	5.0*)	2.0	10**)	10.0**)	0.5	0.2

*) Both serious and simple viroses are taken into account.

**) Serious viroses are taken into account, but not simple mosaic patterns where the symptoms are discoloration without leaf deformation.

The field inspection of seed crops is carried out by the approving inspector, and the minimum number of field inspection during vegetation is 4 for pre-basic and basic seed and 3 for certified seed.

Tuber crops must be free of black scab (*Synchytrium endobioticum*), ring rot (*Clavibacter michiganensis* subsp. *sepedonicus*) and other quarantine organisms.

The removal of atypical, alien plants and of plants infected by pests, is mandatory, beginning with the start of vegetation, until the destruction of the stems.

The removal is carried out by pulling out the diseased plant, including all tubers, removing them from the crop in plastic bags and destroying them.

Physical quality

From this perspective, the exterior aspect and size are highly relevant.

During screening and calibration by size, the physical quality is certified by the approving inspector.

Tubers with a shape or colour atypical for the soil are eliminated during planting.

As regards the tuber size, considering the latest fast reproduction techniques, it is arguable that all the tubers can be used as planting material, regardless of size, provided that they come from certified potato batches, officially approved.

We must note that the planting distance and norm, as well as the cost of the planting material, depend on the size of the tubers.

Seed tubers must comply with the following calibration requirements:

a) Fractional calibration: 25-35 mm; 35-45 mm; 45-55 mm; over 55 mm; without exceeding 75 mm;
b) Simple calibration: 25-45 mm; 35-55 mm; 55-75 mm;

For the Pre-basic yield; Basic and Certified in all classes, harvested and certified in Romania, the following deviations are admitted (Table 3).

Table 3. Deviations admitted for the certified tuber yield

Pos.	Impurities, defects and pests	Maximum % admitted per weight		
		Pre-basic	Basic Class SE and E, CEE 1, 2 and 3	Certified Class A and B
1	Foreign objects	1.0	1.0	2.0
2	External defects	3.0	3.0	3.0
3	Wet and dry rote, unless caused by *Synchytrium endobioticum, Corynebacterium sepedonicum* or *Pseudomonas solanacearum*	0.2	0.5	1.0
4	Common scab	5.0	5.0	5.0
5	Powdery scab	1.0	3.0	3.0
6	Rhizoctoniosis	1.0	5.0	5.0
7	Total deviations from items 2, 3, 4, 5 and 6	5.0	6.0	6.0

For the release of the phytosanitary passport, before the potato delivery by the grower, samples are taken during harvest and conditioning, to determine the presence of quarantine organisms.

CONCLUSIONS

Growing seed potatoes requires a complex approach and can only be carried out by professionals.

Climatic changes and land division led to a decrease in the certified potato areas and to the planting of non-conform material.

The large number of phytosanitary treatments required to prevent and control diseases and pests of the tubers leads to high production costs which oftentimes cannot be reclaimed.

The increase of the average potato yield is conditioned upon the provision of certified planting material.

The extension of the areas requires the reorganisation of the national tubers growing system.

The production of the planting material according to the national, European and international standards cannot be achieved without awareness of the relevant legislation.

Viral diseases lead to yields decreased by up to 80%, therefore seed potato crops are located in areas with low intensity aphid flight.

BIBLIOGRAPHY

Donescu, D. (2001). *Biologia şi ecologia comunităţilor de afide dăunătoare din culturile de cartof pentru sămânţă în contextul protecţiei integrate.* Doctoral dissertation, USAMV Cluj-Napoca.

Draica, C., Mike, L., Dima, E.L, Chiru, N., Rosu, R., Molnar, Z. (2004). *Modernizarea tehnologiei de producere a cartofului pentru sămânţă.* Editura Phoenix Brasov, ISBN 973-8416-5-9.

Draica, C. (1980). *Cercetări privind mărimea coeficientului de înmulţire la cartoful pentru sămânţă.* Doctoral dissertation, USAMV Cluj-Napoca.

Man, S. (1975). *Contribuţii la producerea cartofului pentru sămânţă în zonele închise.* Doctoral dissertation, USAMV Cluj-Napoca.

Parmentier, A.A. (1786). Lecture read before de Royal Society of Agriculture, France.

Iacob, V., Ulea, E., Puiu, I. (1998). *Fitopatologie Agricolă*, Editura Ion Ionescu de la Brad, Iasi.

Law no. 266/2002 *on potato growth and processing, quality certification, seed and planting material marketing and cultivar registration*. Issuer: The Parliament of Romania, published in the Official Journal no. 343 of 23 May 2002, republished in the Official Journal no. 7 of 4 January 2011, republished in the Official Journal no. 239 of 3 April 2014.

Commission Decision 2004/842/EC of 01.12.2004. published in https://eur-lex.europa.eu/eli/dec/2004/842/2017-04-01

Order no. 1266/2005 of the Ministry of Agriculture, Forests and Rural Development, approving the rules and technical standards for the production for sale, quality certification and sale of seed potatoes. Issuer: The Ministry of Agriculture, Forests and Rural Development, Published in the Official Journal no. 14 bis of 6 January 2006.

http://ephytia.inra.fr/en/C/21040/Potato-Potato-virus-M-PVM

http://kb-dev.gramophone.in/tag/leaf-roll-virus/?lang=en

https://www.agroscope.admin.ch/agroscope/fr/home/actualite/kurznews/2017/livre-PVY.html

https://www.akkerwijzer.nl/artikel/85725-yntn-virus-volop-in-consumptieaardappelen/

https://www.forestryimages.org/browse/detail.cfm?imgnum=5393019