INTRODUCTION

The present thesis is meant to be a contribution to ongoing research in the field of seed potato production in virus free conditions, for providing producers planting material of high phytosanitary quality. At the same time, the present thesis, constitutes a contribution to the studies concerning the application of this activity in other areas besides the closed ones.

The seed potato represents a major concern in all potato producing countries, no matter how old their tradition in producing or propagating it is.

In our country farmers show an encreased interest in potato production obtaining relatively constant yields of 20 t/ha and 30-35 t/ha. But at national level the average production is only 8,0-14,9 t/ha (the average yield for the years 1991-2002) an evidence of the fact that many cultivators still use biologically damaged planting material (BENEA, 2003). This leads to the loss of the plants production potential even as far as loosing the variety.

This is the consequence of two important causes: virus infection and decrease of growing strength. Amount and quality of production are mainly influenced by the variety and the quality of the planting material.

Two main causes are known to affect potato crops: the sources of virus infections and the virus vectors. If one of the two causes could be eliminated seed potato production and breeding would be simpler and more profitable.

In the areas in the would where one of these causes is eliminated because of natural conditions or is easily maintained at low rates, we find the most favorable regions for seed potato production and propagation. These areas are few: only Canada, the North of Europe or the *mountain regions at over 1000 m altitude*.

Accounting this and the fact that our activity takes place in a highland-mountain region (south Transilvania) with a chilly climate and rich precipitations create favorable conditions for potato growing, we set forth to investigate the potential of the region for the organization of seed potato production and propagation.

CHAPTER I
Research concerning Potato Planting Material Production and Propagation

1.1. Short History of Potato Growing in the World and in Romania

The potato is one of the most important and profitable field crops being a member of the *Solanaceae* family. According to VAVILOV (1968) AND WILSIE (1972) its origins are in South America along with the *Solanum andigenum* (Juz. Buk) Hawk and *Solanum phureja* (Juz. Buk) varieties. The *Solanum tuberosum* L. comes from Chile. From immemorial times it represented a staple product of Inca agriculture in Peru and Chile, of the population in Guatemala and the Aztecs in Mexico.

1.2. The Importance of the Potato Crop

From a phytotechnical viewpoint the potato is an important plant being a completely mechanized crop the leaves the soil weed free; it economically values manure and mineral fertilizers; it reacts with encreased yield when irrigated; it is cultivated in colder highland regions; in specialized areas it covers as crop the whole agricultural territory; it is a good forerunner for for the fall wheat, barley and other crops (BÎLTEANU, 1993).

High altitudes, the existence of natural barriers create natural conditions for isolating crops and therefore reduce virotic desease propagation (BOZEŞAN, 2003). The potato represents for Romania a staple food for the population.

1.3. Theoretical Background for the Seed Potato Production and Propagation

1.3.1. Potato Degeneration

The cultivation of potatoes all over the world has proved that with all the varieties by growing them year for year a depreciation of the vegetative system of the plant takes place. Implicitly, continuously and progressively the initial production potential degenerates. Degeneration is an irreversible process.

VELICAN (1959) in his attempt to elucidate the causes and prevention methods for the potato degeneration establishes three basic theories: ecological, physiological aging and virotical.

1.3.2. Virotical Degeneration

Nowadays it is universally accepted that this kind of damage is caused by potato specific or unspecific viruses. The virus transmission vehicle from the affected plants to the healthy ones is a species of aphids, the direct contact between plants, the tools, insects or funghi from an organ to an other through the sap, from one year to the next by tubers, aphids or other insects that winter as adults, through funghi spores (COJOCARU, 1987).

CIOCHIA and BOERIU (1996) have published the list of aphids, vectors of viroses for the potato. We mention:

- *Acyrthosiphon pisum* Harris (1776) – the pea's green louse;
- *Aphis fabae* Scopoli (1763) – the beet's black louse;
- *Aphis frangulae* Kaltembach (1845) – the cucumber's louse;
- *Aphis gossypii* Glover (1854) – the cucumber's louse;
- *Aphis nasturtii* Kaltembach (1843) – the verigar's louse;
- *Aulacorthum solani* Kaltembach (1843) – the potato's spotted louse;
- *Aulacorthum circuflexum* Buckton (1876)
- *Macrosiphum euphorbiae* Thomas (1878) – the potato's striped louse;
- *Myzus persicae* Sulzer (1776) – the peach tree green louse;
- *Myzus certus* Walker (1849);
- *Myzus ornatus* Laing (1932) – the parsnip's louse;
- *Phorodum humuli* Schrank (1801) – the hop's green louse;
- *Rhopalosiphum padi* Linne (1758) – the cereals' grey louse;
- *Rhopalosiphum insertum* Walker

These aphid species are transmitters of the following viruses according to the cited study (CIOCHIA and BOERIU, 1996):

- The Potato leafroll virus;
- The Potato virus M;
- The Potato virus S;
- The Potato virus Z;
- The Potato virus A;
- The Potato aucuba mosaic virus

1.3.3. The Potato's Physiological Degeneration

In the latest years a special attention has been given to some factors influencing the aging processes of seed tubers and the effect of the physiological age upon the plants' vigor of growth and upon production. Decrease in production caused by the seed potato's unfit physiological age is called physiological degeneration (LOON, 1985).

1.3.4. Resistance to Viroses

To diminish the percentage of virus infected plants a better management of phytosanitary methods in producing seed potatoes is of necessity. Besides this also a higher proportion of resistant varieties within the admitted assortement is of importance.

1.4. Obtaining Desease Free Potato Planting Material

With the potato, more than with any other species, the planting material, characterized by its phytosanitarical, biological and physical features, is of paramount importance for constant, quality high rate yields (GOREA et all, 1982. MAN et all, 1984, BERINDEI, 1985).

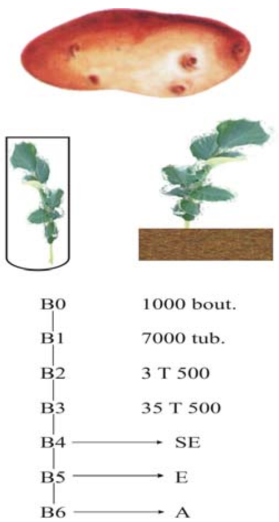
1.4.1. Methods and Systems for Producing and Propagating Seed Potatoes Practiced all over the World

The beginning of the XX^{th} century marked the starting point for the methodology of producing planting material for the potato (CATELLY, 1969).

The diagram for producing and propagating the seed potato is a universal one with slight differences in duration from a country to another.

The territory of Romania due to ecopedoclimatic conditions is not a favorable area with the exception of certain regions of limited dimensions. Therefore the production of seed potatoes is done under a tremendous infection pressure influence constituting a problem for the national system in the production of potato planting material. This problem can be solved by using the method of "in vitro" propagation. At present there are known three major ways of obtaining seed tubers using "in vitro" techniques in meristem crops: using stem cuttings; using microtubers; using minitubers.

1.4.1.1. The Method of Obtaining Seed Tubers through Stem Cuttings

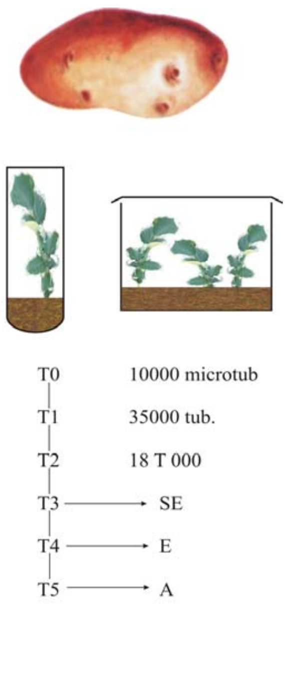


The method is used in hot houses or insect-proof tunnels and consists in collecting the meristems from the top of the offshoot of the virus free tubers, tested with great precision methods.

The multiplying coefficient is about seven a month, and the number in of cuttings grows in geometrical progression (MORAR, 1994).

Fig.1. Obtaining seed tubers through stem cuttings (adapted after MOLET, 1990)

1.4.1.2. The method of Obtaining Seed Tubers through Microtubers

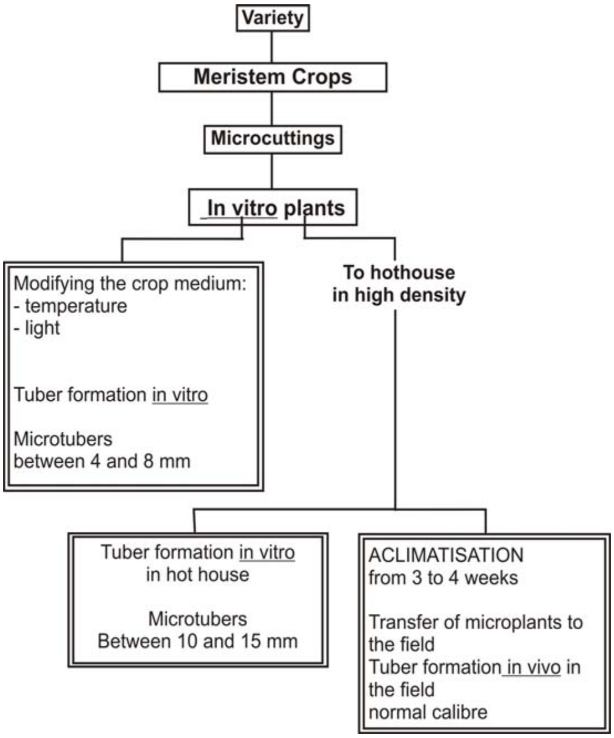


Studying the capacity of "in vitro" cuttings to produce tubers in 1980, Wang realized in Taiwan the procedure of obtaining microtubers.

The method of producing the seed potato through microtubers is derived from the stem cutting methodology. Tuber production takes place with 30 days plants in a liquid medium and total obscurity at a constant temperature of 18^{o} C.

Fig. 2. Obtaining seed tubers through microtubers (diagram)

1.4.1.3. The Method of Obtaining Seed Tubers through Minitubers



The minitubers are tubers of small size / under 28 mm as diametre) and are a result of potato replication through cuttings or microtubers. Theoretically the minitubers have the same phytosanitary quality as the mother cuttings or microtubers .

The diagram presented in fig. 3. is up to a point similar to the diagram of fig. 2 for production of cuttings or microtubers.

Fig. 3. Obtaining minitubers (diagram**)**

1.4.2. Methods and Systems for Seed Potato Production and Propagation in Romanian

1.4.2.1. Empirical Methods in the Seed Potato Production and Propagation in our Country

Between the two World Wars Romania had a relatively limited area where the potato was cultivated. The planting material was either imported or mostly it come from domestic production. The seed materai llacked phytosanitary certification (CATELLY, 1974). This lead to a rapid degeneration of the existent varieties, it lead to mixture of species and low yields (CONSTANTINESCU et all., 1965).

1.4.2.2. Scientific Bases for Seed Potato Production and Propagation in Romania

The beginnings of scientifically based production of potato planting registered in 1961-1962, when a four year technical frame was set to ensure the annual need of seed potatoes of regional varieties according to the renewal duration.

The national system of seed potato production was organized in 1968 into "closed areas" (fig. 4) by the Potato Research and Production Institute, Braşov for 7 countries (MAN et all., 1987).

There were established three areas where potato degeneration occurred intensly (See MAN et all., 1987, MORAR, 1994).

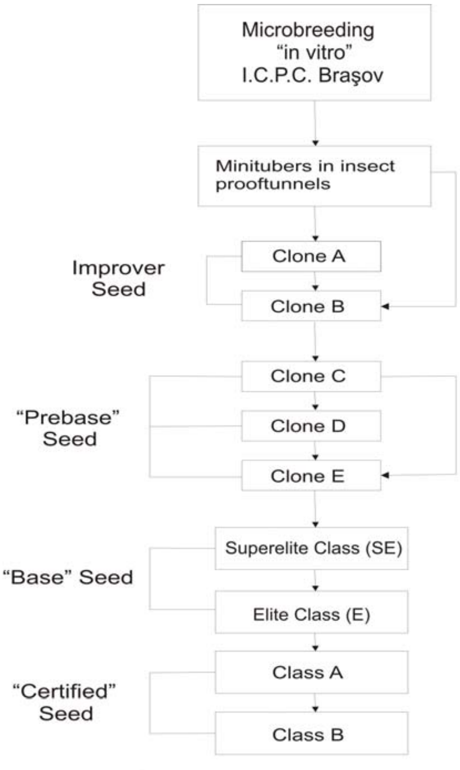


Fig. 4. Production of potato planting material in closed areas (diagram)

1.4.3. Propagation of Potato Planting Material Outside the Closed Areas

Because the pedoclimatically favorable areas are limited and they cannot provide the seed potato needs for the whole country it becomes obvious that a concept of a system to propagate outside the closed areas is needed. Following the diagram of fig. 4 for closed areas for each country there has been established the amount of clasa A and B planting material.

1.4.4. Providing the Needed Seed at National Level Using for Food Crops the Biological Category Class A

The research of MAN et all. (1986), tried to produce in two successive years planting material of equal biological value.

They also notical an improvement of the seed potato quality in closed areas as a result of limiting the virus infection sources by cutting down the areas cultivated with biological category Class B.

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1.4.5. Reducing the Virotic Disease Infection Degree by Generalisation of the ELISA Test and the Rapid Micromultiplication Procedures

The ELISA test allows a quick tracing of potato viruses in leafs, stems or tubers. Introducing this technique in our country since 1989 leads to a large possibility of control in order to eliminate the virus infected clones from replication.

1.4.6. Rising the Potato Propagation Coefficient and Reducing the Planting Rate

Rising the seed potato propagation coefficient and reducing the planting rate is a goal with all seed potato producers in the world (EDDOWS, 1971; GRISON et all., 1975; HAGMAN, 1973).

1.4.7. Using Seeds with Potato growing

An aim that may revolutionise the entire research and practice of potato growing in the world is the use of seeds obtained from the fruit to obtain the tubers.

CHAPTER II
Environment Conditions in which Research Has Been Conducted

2.1. Natural Surrounding in which Research Experiments Have Been Organized

Experiments concerning seed potato production and propagation conditions have been organized during 1999-2003 in several fields of different areas of Sibiu country. The areas cover an altitude difference from 375 m (Avrig) up to Păltiniş.

2.1.1. Geographical Setting and Borders

Sibiu country, the place of research, is situated almost in the centre of the country; it's surface of 5422 km^2 , representing 2,3% of Romania's surface.

2.2. Climate

Due of the position of our country in the South-Est of Europe and duet o the presence and form of the Carpathian chain of mountains, Transilvania experiences the activity of the North Atlantic Ocean Cyclons (the Island Cyclon) blowing towards the Est and the South Est of Europe. Transilvania alspo experiences the influence of Polar Air invasions from the North-West, North and North-Est. As a result the northern slope of the West Carpatians has a climate that is dominated by the influence of the western winds an dis generally colder and damper than the one of the southern slope of the same mountains.

The mountain area of the country is specific of the climate of middle and high mountain.

2.2.1. Sun Radiation

The global sun radiation varies at Sibiu 1284,7 Kwh. m^{-2} year $^{-1}$ in the low area he falls to 1275 Kwh. m^{-2} year $^{-1}$ at Păltiniş (table 8), according to the studies of Buiuc (1984).

2.2.2. Air Temperature

Air temperature varies a lot mostly because of altitude. The annual average temperature varies around 8,5-9,0^{o}C in the low region of the country (8,9^{o}C at Apoldu de Sus, 8,7°C at Sibiu, Boița and Bratei); it falls below 5°C on the slopes and peaks of the middle mountains (4,5°C at Păltiniş – peak, 4°C at Păltiniş – resort) and below 0°C on the peaks of the high mountains (BUIUC et ALL., 1975).

2.2.3. Precipitations

The annual number of days with precipitations (days with quantities >=0,1 mm) in the low areas of the country varies between 109,8 days) / year in Mediaş and 129,7 days / year in Sibiu. In the middle mountain area the frequency of these days rises according to altitude, reaching 141.1 days / year at Păltiniş – resort and 158,8 days / year at Păltiniş – peak. With altitudes over 2200 m the number is over 170,0 days / year (BUIUC et all., 1975).

The average annual frequencies registered in Sibiu show the NV winds (13%) and SE winds (8,2%) to be predominant. In Păltiniş we have winds predominantly from the V (28,4%), SVC (15,9%) and E (12,9%).

2.3. Soils

Sibiu county is fragmented and very diverse (hills, mountains, valleys) it has various climate and vegetation conditions and therefore a large variety of soils exist (fig. 5).

Thus the Târnava region alternates brown soils, black soils and different erosion soils (fig. 11). The Făgăraş region comprises among others brown, black soils and brown acid soils. The mountain area comprises brown acid soils, humus soil, moistly in the area of alpine pastures. The Sibiu region comprises brown, brown acid and also erodet soils.

The Olt and Cibin river meadows are soils at different stages of evolution making up about 59.000 ha.

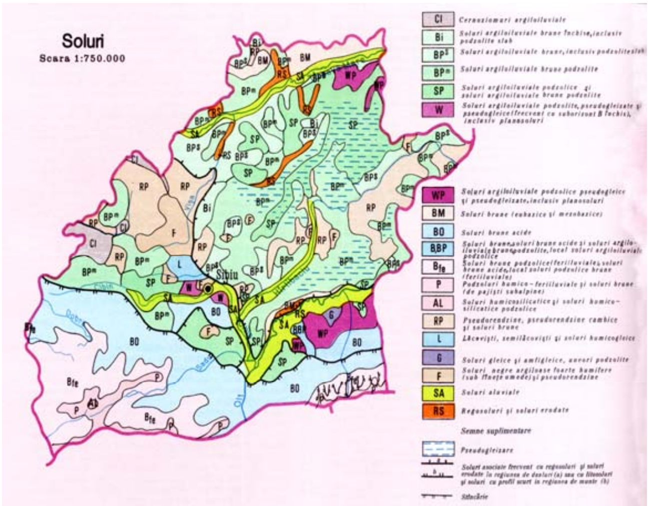

Fig. 5. Specific Soils of Sibiu county (according to the Geographical Encyclopedia of Romania, 1982)

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CHAPTER III
Aim, Object, Material and Method of Research. Observations and Conclusions

3.1. Aim and Object of conducted Research

Considering the importance of the potato crop in the Sibiu area and neighbour regions, as well as the producers tradition we have drawn our attention in research to solve aspects as:

- providing the complete need of seed potatoes from virus free areas;
- promoting for cultivation Romanian varieties;
- improving the zoning of potato varieties according to their resistance to climatic and virotic degeneration.

3.2. Object

Our study concerning the seed potato propagation in virus free areas of Păltiniş at 1420 m. has lead our attention to research the possibilities of constituting a closed microzone for the seed potato production and propagation in this area of the Cindrel mountains.

Considering the need to provide potato producers with virus free planting material we have oriented our research towards the following aspects:

- sorting the territory according to virotic deseases infection pressure;
- elaboration of a crop technology to meet the specific area conditions for the seed potato production and propagation;
- using the ELISA test to make to virus diagnoses of the obtained material;
- reducing the quantity of planting material from closed areas by obtaining the biological category class B outside the closed areas;
- determining the resistence variability to virotic and physiological degeneration of an assortment of varieties in the highland area, the Sibiu region and neighbour areas;
- providing the need of planting material, biological category class B for all producers in the highlands area, the Sibiu region and the neighbour areas;
- encreasing the average yield by generalizing biological category class B for food potato crops;
- encreasing crop profitability and consequently an encrease of benefits and profit for the seed potato and food potato producers of these areas.

3.3. Biological Material used for Research

According to the fact that a profitable crop needs the choice of an appropriate variety (BOZEŞAN, 2000) we chose:

- 9 new Romanian potato varieties: Robusta, Rozana, Runica, Timpuriu de Brasov, Amelia, Nicoleta, Productiv, Tentant, Dacia;
- 3 older potato varieties, imported and due to qualities still maintained in growing: Ostara, Sante, Desiree;
- as witness to comparing results, we decided for the average rate of the experience.

Research Method

The experiments conducted in order to analize the main factors in determining the phytosanitary and biological value for the planting material we applied completely the technology for cultivating the seed potato and we strictly observed the following technological links:

- the base was the biological category of the planting material for each variety;
- planting has been operated as early as possible;
- density of planting was 65000 plants/ha (70X22 cm);
- the size of the tubers used for planting was homogeneous (45-55mm).

The study was conducted over a period of time of three years (2001-2003).

In the field were determined and measured:

- plant sporing;
- homogennity of plants;
- existence of gaps;
- overall shape of plants;
- height of bushes;
- date of budding;
- date of flourishing;
- richness in flowers
- colour of flowers.
- stalks colour;
- number of stems;
- percentage of virus affected plants;
- aphid catching;
- tuber production and the structure of the crop

We also fulfilled the vegetation break off. Harvesting has been done manually and the tuber production of each lot has been calibrated on fractions of size: below 30 mm (below STAS), 30-45 mm (seed) and above 55 mm (food). For each fraction the number and weight of the tubers has been determined as well as the percentage of seed.

Organisation of Research

In order to analize the possibility of obtaining outside the closed areas of potato planting material with correct phytosanitary and biological value, we organized an experiment in three locations as follows: the base biological category material produced at Braşov is propagated in the agricultural are of Avrig and Sibiu for a period of time of two years in order to obtain the biological categories class A and class B that will constitute the planting material for the farmers.

During the experiment we also observed:

1. The evolution of aphids in seed potato crops in the fields: Păltiniş, Avrig, Sibiu;
2. Researching the possibilities of seed potato propagation outside the closed areas.

Experiment Technique

1. The experiments concerning the evolution of aphid populations in seed potato crops in the fields had as aim to establish the favourability rate of the area for propagating the potato planting material. At the same time to establish the best moment to break off vegetation of the aphid affected potato in order to limit the attack of viroses from stalk and leaves to the tuber;

2. The experiments concerning the research of possibilities to propagate the seed potato outside the closed areas had as aim obtaining the biological category Class B in areas or specialized farms from the biological material produce dat Braşov and propagated one year at Păltiniş.

CHAPTER IV
Experiment results and discussions

4.1. Evolution of the Aphid Populations in the Seed Potato Crops of the Experiment Fields, Păltiniş, Sibiu and Avrig

The research conducted in the period 1999-2003, in the specific conditions of Sibiu county, in the potato crops had the following interests:

1. Monitoring aphid flights from seed potato crops in order to determine the aphidfauna specific for the areas of the experiments;
2. The dynamics of the aphid populations with major interest on the main potato virus vector species;
3. Analyses of the relationship between the dynamics and the size of the aphid populations, specific for each year of the experiment cycle, on the one hand, and the seed potato virotic desease frequency, on the other;
4. The study of ecological conditions influences and determining the biological cycle of the main aphid species as potato virus vectors: *Myzus persicae* Sulzer, *Aphis frangulae* Kalt, *Aphis fabae* Scopoli, *Brevycorine brassicae* L., *Phorodon humuli* Schrank and *Schizaphis graminum* Rondani.

4.1.1. The Study of Climatic Elements Specific of the Potato Crop Areas of Sibiu County, that may Influence the Quality of the Seed Potato

Alongside the climatic data presented in chapter 2 (paragraph 2.3.) it necessary to present meteorological data specific for the years of the experiment 1999-2003 that contribute to the explanation of some physiological processes tightly linked to plant evolution and variety differentiation in the experiment of 1999-2003.

4.1.2. Collecting Aphid Populations in the Seed Potato Crops

Entomological material (aphid) collection has been done simultaneously in all three experiment fields (Păltiniş, Sibiu and Avrig). In these areas yellow pots (Möericke) were placed in the seed potato crops (MÖERICKE, 1962). Species determination has been done by comparison with specialty literature: BLACKMAN, EASTOP (1985). The activity of the aphid species has been analysed with the help of the main analytic index linked to the number of the aphids respectively abundance and relative dominance (D), recommended by DONESCU (2003).

4.2. Pedoclimatic Conditions for the Experiments

The behavior of the varieties to the seed potato virotic degeneration as well as the evolution of the populations of potato virus vector aphids require a short presentation of soil and climatic conditions for each of the places where the research has been conducted.

1. Păltiniş (1420 m)

The climate of Păltiniş – resort (1420 m) is of mountain type, being part of warm area slopes due to frequent and long termic inversions (BUIUC et all., 1975).

Table 1

Temperature and Plurimetric Rates in the Experiment Period Păltiniş (1420 m)

Month / *Year*	IV	V	VI	VII	VIII	IX	Average IV-IX
Average Temperature (^{0}C)							
1999	3,9	8,0	13,3	14,9	13,5	10,8	10,7
2000	6,0	10,1	13,0	14,1	15,2	9,0	11,2
2001	3,6	9,0	10,5	14,2	14,9	8,9	10,2
2002	3,2	10,8	13,0	15,4	12,9	8,4	10,6
2003	1,5	13,1	14,4	13,4	15,8	8,7	11,2
Average 1999-2003	**3,6**	**10,2**	**12,8**	**14,4**	**14,5**	**9,2**	**10,8**
Pluriannual average	**3,0**	**7,9**	**11,3**	**13,4**	**13,4**	**10,1**	**9,8**
Month* / *Year	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**Summs IV-IX**
Precipitations (mm)							
1999	86,2	107,3	177,2	136,2	99,2	81,9	698,0
2000	35,6	76,8	48,0	96,9	39,1	137,2	433,6
2001	150,7	83,8	160,2	192,1	134,1	177,2	898,1
2002	74,2	128,6	140,7	176,8	192,9	106,2	819,4
2003	88,7	72,5	31,6	182,4	33,1	139,2	547,5
Average 1999-2003	**87,1**	**93,8**	**111,5**	**156,9**	**99,7**	**128,3**	**677,3**
Pluriannual average	**85,2**	**106,9**	**147,4**	**115,5**	**107,6**	**59,2**	**621,8**

The low temperatures < -2^{0}C determine in spring the destroyal of fundatrix forms on primary hosts and thus minimal collecting in potato crops.

At Păltiniş, in the period of the experiments 1999-2003, the period of low temperature > -2^{0}C, was 51 days shorter than the pluriannual average.

The average abundance of precipitations (mm / day with precipitations) in Păltiniş as presented in table 2, show a high rate of precipitations that contribute to a high rate of air moisture that determines the growth of some parasite funghi (Entomophthorales), that favour the decrease of aphid populations (ROBERT, 1981).

Table 2

Abundance of Precipitations in Păltiniş - mm / day with precipitations

Month / *Year*	IV	V	VI	VII	VIII	IX	Average IV-IX
1999	3,59	5,44	10,42	7,17	7,08	10,24	7,02
2000	2,54	6,40	4,36	8,81	3,91	9,15	5,94
2001	12,56	4,66	7,63	10,11	10,32	8,44	8,64
2002	3,90	9,18	7,04	7,07	10,72	5,59	7,12
2003	4,47	6,59	2,87	7,93	4,73	10,71	6,84
Average 1999-2003	**5,41**	**6,45**	**6,46**	**8,22**	**7,35**	**8,83**	**7,12**
Pluriannual average	**6,66**	**7,27**	**8,67**	**7,91**	**9,44**	**6,96**	**7,82**

MÜLLER and UNGER (1955) consider that rain frequency with quantities higher than 10 mm in 24 hours influence negatively the attack flight..

Table 3

Frequency of days with higher quantities than 10 mm / 24 hours in Păltiniş

Month / *Year*	IV	V	VI	VII	VIII	IX	Total IV-IX
1999	1	5	7	5	3	2	23
2000	1	3	2	1	1	2	10
2001	3	2	5	8	3	9	30
2002	2	4	8	6	6	4	30
2003	2	3	1	7	1	5	19
Average 1999-2003	**1,8**	**3,4**	**4,6**	**5,4**	**2,8**	**4,4**	**22,4**
Pluriannual average	**2,0**	**3,8**	**5,3**	**4,8**	**3,4**	**2,1**	**21,4**

2. Sibiu (425)

The specific climate of the Sibiu region is characterized by frequent termic inversions besides cold currents descending the slopes of the neighbour mountains (nights and winter).

Table 4

Characterization of Temperature Rates in the Period of Experiments in Sibiu (425)

Months / *Year*	IV	V	VI	VII	VIII	IX	Average IV-IX
Average Air Temperature (^{0}C)							
1999	10,0	13,8	18,8	20,7	19,1	15,6	16,3
2000	12,1	16,0	19,2	20,3	20,7	13,6	17,0
2001	9,8	15,5	16,4	20,2	19,8	13,7	15,9
2002	8,9	17,1	19,1	20,9	18,4	13,6	16,3
2003	8,0	19,0	20,8	19,8	21,3	13,6	17,1
Average 1999-2003	**9,8**	**16,3**	**18,9**	**20,4**	**19,9**	**14,0**	**16,6**
Pluriannual average	**9,7**	**14,7**	**17,7**	**19,6**	**18,9**	**14,8**	**15,9**
Precipitations (mm)							
1999	85,6	52,6	99,9	129,9	42,0	66,8	476,0
2000	12,8	32,8	23,9	68,1	25,3	78,7	241,6
2001	88,4	41,6	148,6	112,0	54,5	151,8	596,9
2002	46,6	30,8	54,0	165,0	76,5	77,2	450,1
2003	42,4	49,9	2,5	103,6	22,5	64,8	285,7
Average 1999-2003	**55,2**	**41,5**	**65,8**	**115,7**	**44,2**	**87,9**	**410,3**
Pluriannual average	**54,7**	**80,4**	**113,0**	**87,3**	**75,0**	**54,5**	**464,9**

In the period of the experiments (1999-2003) the average monthly temperature values (^{o}C) are presented in table 4.

The low temperatures < -2^{o}C that determine in spring the destroyal of fundatrix forms or primary hosts are presented in table 5 and have as effect the drastic reduction of aphids in the area.

Table 5

Average period of last low temperature < -2^{o}C in spring and the first autumn frost < -2^{o}C and the length of the low temperature > -2^{o}C period at Sibiu

Anul	Last day t^0_{min} <-2^{0}C, spring	First day t^0_{min} < -2^{0}C, autumn	Duration with t^0_{min} > -2^{0}C
1999	25.03	18.10	207
2000	10.04	21.10	194
2001	5.04	25.10	203
2002	9.04	21.10	195
2003	9.04	20.10	194
Average 1999-2003	**5.04**	**21.10**	**198,6**
Pluriannual average	**14.03**	**24.11**	**255,0**

Table 6

Abundance of precipitations in Sibiu (mm / day)

Month / *Year*	IV	V	VI	VII	VIII	IX	Average IV-IX
1999	4,76	3,76	6,66	8,12	4,67	8,35	6,05
2000	0,85	2,73	2,66	7,57	3,61	8,74	4,36
2001	7,37	3,20	8,26	7,47	7,78	6,90	6,83
2002	3,33	3,85	3,86	9,17	5,10	4,82	5,02
2003	3,53	6,24	0,83	5,45	4,50	7,20	4,62
Average 1999-2003	**3,97**	**3,96**	**4,45**	**7,56**	**5,13**	**7,20**	**5,38**
Pluriannual average	**4,60**	**5,43**	**7,20**	**7,40**	**7,42**	**5,99**	**6,34**

Examining the results of table 6 it can be observed that in the period 1999-2003 precipitations in Sibiu have been less abundant than the pluviannual average values.

Table 7

Frequency of days with higher precipitation quantity than 10 mm / 24 hours in Sibiu

Month / *Year*	IV	V	VI	VII	VIII	IX	Total IV-IX
1999	3	-	3	4	1	2	13
2000	-	-	-	1	1	2	4
2001	3	1	6	2	2	6	20
2002	1	1	1	7	3	3	16
2003	2	1	-	3	1	2	9
Average 1999-2003	1,8	0,6	2,0	3,4	1,6	3,0	12,4
Pluriannual average	2,0	3,8	5,3	4,8	3,4	2,1	21,4

In the potato vegetation period (IV-IX) in the years of the experiment (1999-2003) there were 12,4 days with precipitations higher than 10,0 mm (table 7).

4.3. The growth of Seed Potato Virus Vector Aphids within the Agroecosystem

There is a close correlation between the speed of biochemical processes characteristic of each species and the temperature and this has permitted the formulation of mathematical equations very different from one species to an other. The equation of the **temperature constant** may successfully contribute to the *explication of the growing, developing, propagating processes and the biological spreading of the species.*

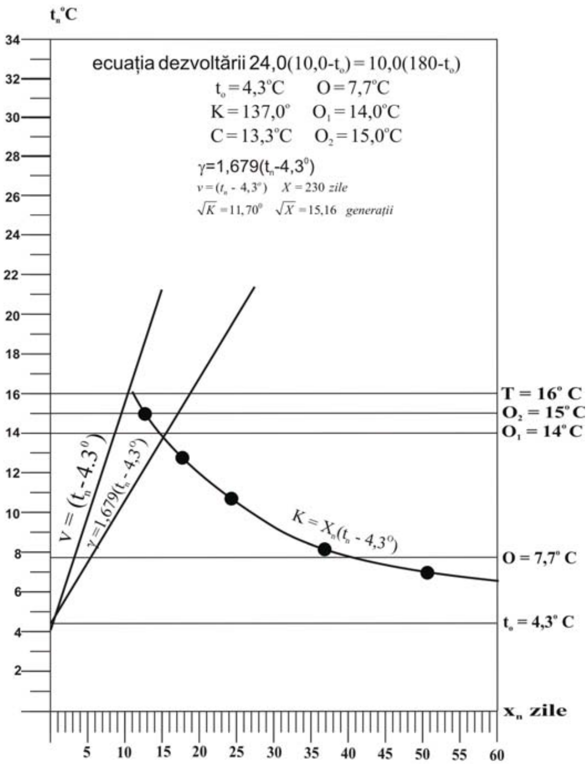
BLUNCK (1914,1923) has elaborated the equation of the **temperature constant** (K), which he defines as the product between development time (x_n) and the actual temperature (t_n-t_o) this being the same no matter the place of the experiment:

$$K = X_n(t_n-t_o) \qquad (A)$$

Starting from experiment accurate determinations, with the help of equation (A) we can mathematically express: the **inferior biological threshold** (t_o) specific for the species as well as the temperature constant (K).

On the basis of the temperature constant for each aphid species we have determined:

- the prolificity threshold (O);
- the best temperature threshold (O_1);
- the superior temperature threshold (T)
- the regression line constant (C);
- the tropic constant (X);
- the propagating equation (γ)



4.3.1. The species biological constant

The paper brings a detailed study and determination of the growth, and propagation constant, the dynamics of species for the following potato planting material viruses vector aphids in the county of Sibiu:

- Myzus persicae Sulzer (4.3.2.);
- The species complex Aphis frangulae Kalt and A. nasturtii Kalt (4.3.3.);
- Aphis fabae Scopoli (4.3.4.);
- Brevicoryne brassicae (4.3.5.);
- Macrosiphum euphorbiae Hott et Fris (4.3.6.).

Fig. 6. The graphic of growth, development and Propagation of the peach-tree green louse Myzus persicae Sulzer

Because of the big amount of personal research that is difficult to be resumed in an abstract we give a overview of the material for the *Myzus persicae* Sulzer species, the strongest potato virus vector.

4.3.2. The Constant of the peach tree green louse (Myzus persicae Sulzer) during the experiment period (1999-2003) in Sibiu

Chapter 1.3. presents the main seed potato viruses vector aphid species in the conditions of Sibiu county.

The main constants of the Myzus persicae Sulzer are presented in fig. 6.

Table 8 presents the evolution of the peach tree green louse in the period 1999-2003 and as pluriannual average values.

Fig. 7 presentsthe dioecic holocycle of the peach tree green louse in the ecoclimatic conditions specific of the average values of the period of experiments 1999-2003.

From the study of MEIER in Switzerland it results that the higher the altitude the appearance of the Myzus persicae Sulzer species on secondary hosts thus on the potato is delayed with 30 days at altitudes of 850-1000 m. That means that the summer flight delays up to the 14-15 th of July. At altitudes between 1000-1500 m the aphids summer flight begins only on the 15th of August, and at altitudes of 1850 m it delays up to the beginning of September.

4.4. Aphid Development in the Păltiniş Area

In mountain conditions aphid development depends on temperature and the existence of primary hosts on which the first part of these aphids holocycle takes place.

According to the research of DRĂGULESCU (2003) in the area of Păltiniş there are no primary hosts to be found for the major part of aphid species.

Our research fully confirm the data presented by MEIER (1958) for Switzerland who showed that the appearance of the Myzus persicae Sulzer species on the secondary hosts and thus on the potato is delayed the higher the altitude.

In the ecoclimatic specific conditions at the altitude of 1420 m in Păltiniş, although there are primary hosts for the *Macrosiphum euphorbiae* Hott et Fris species, the local development is practically impossible.

In this context, from the study of the bioclimatic diagram the propagation of the species Macrosiphum euphorbiae Hott et Fris in the conditions of precipitations and temperature specific for Păltiniş in the year 2003 it results that for this area this species has no proper conditions for growth and development.

Tabelul 8

Annual Dynamics for the Peach Tree Green Louse (Myzus persicae Sulzer)
at Sibiu 1999-2003 and pluriannual values

Last spring frost $t_{min}< -2^0C$		Year (period)	Primary Host					Secundary Host										Primary Host		Duration of first frost $t_{min}<-2^0C$	
			F	Fg I	Fg II	Fg III	Fg IV	V I	V II	V III	V IV	V V	V VI	V VII	V VIII	V IX	VS X	S	Dep. ou iarnă		
-2,1	24,03	1999	17.04	10.05	25.05	4.06	13.06	23.06	3.07	11.07	21.07	30.07	9.08	18.08	29.08	11.09	23.09	5.10	15.10	-4.9^0C	17.10
-4,5	3,04	2000	16.04	29.04	12.05	25.05	5.06	13.06	23.06	3.07	11.07	23.07	1.08	10.08	19.08	28.08	11.09	24.09	4.10	-4.7^0C	20.10
-2,2	4,04	2001	7.04	30.04	14.05	26.05	8.06	18.06	30.06	10.07	18.07	28.07	5.08	14.08	23.08	4.09	20.09	4.10	14.10	-2.0^0C	25.10
-3,4	8,04	2002	20.04	6.05	18.05	28.05	10.06	19.06	27.06	6.07	14.07	23.07	2.08	11.08	22.08	2.09	17.09	4.10	14.10	-3.0^0C	20.10
-3,7	8,04	2003	29.04	9.05	19.05	30.05	8.06	16.06	26.06	4.07	16.07	24.07	2.08	11.08	19.08	28.08	8.09	6.10	16.10	-5.8^0C	19.10
-3,2	4,04	Average 1999-2003	18.04	5.05	18.05	29.05	9.06	18.06	28.06	7.07	16.07	26.07	4.08	13.08	22.08	2.09	16.09	3.10	13.10	-4.0^0C	20.10
-2,4	14,03	Pluriannual average	24.04	10.05	23.05	3.06	14.06	25.06	5.07	14.07	23.07	1.08	10.08	20.08	30.08	10.09	24.09	11.10	21.10	-2.2^0C	15.10

Date of emmigration flight

Date of back-migration flight

Year 2003 virginogenes of IXth generation 22.09

NOTE:

F = Fundatrix
Fg = Fundatrigene
V = Virginogene aptere
Vs = Virginogene sexupare
S = Sexuate ♂ aripați
♀ aptere

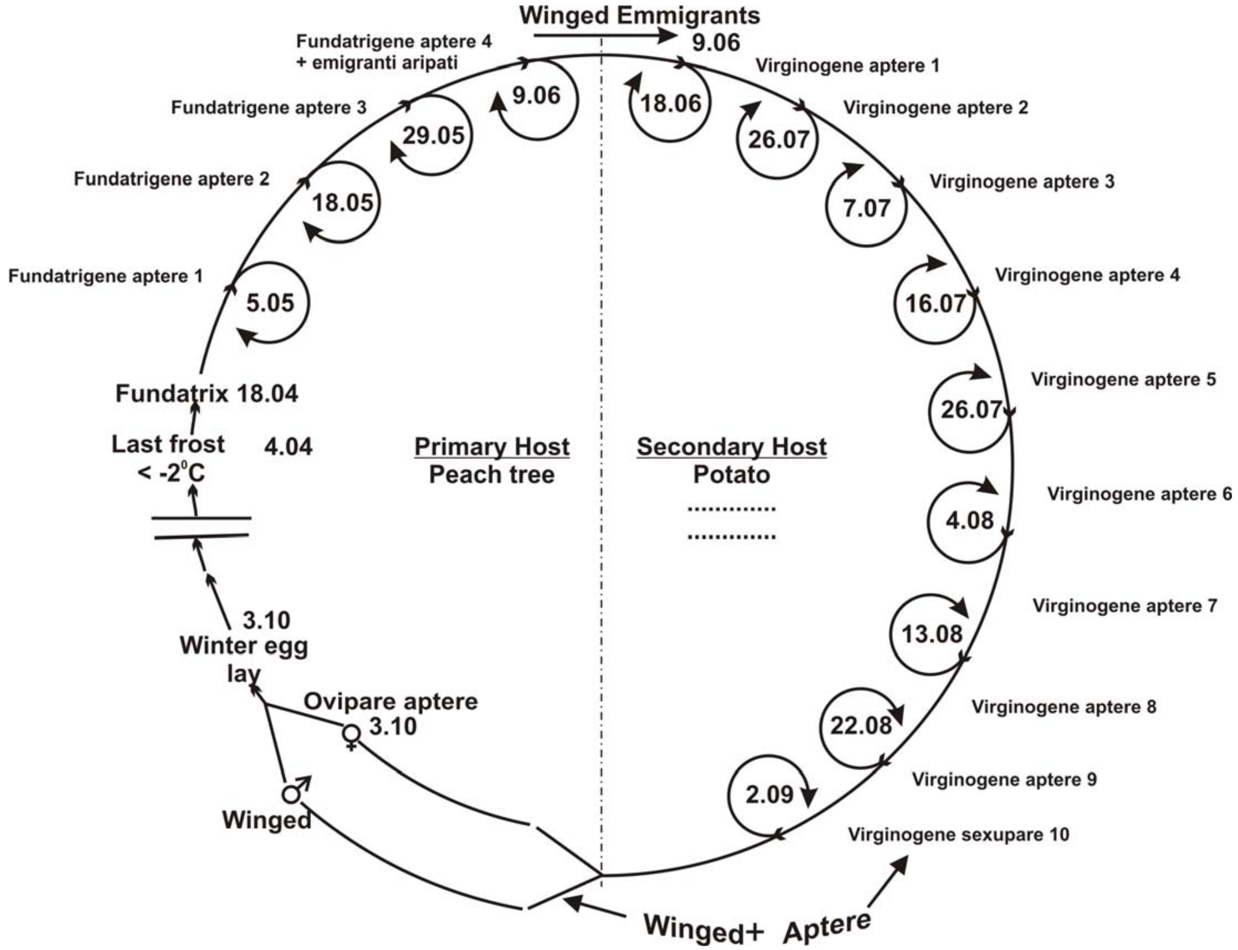
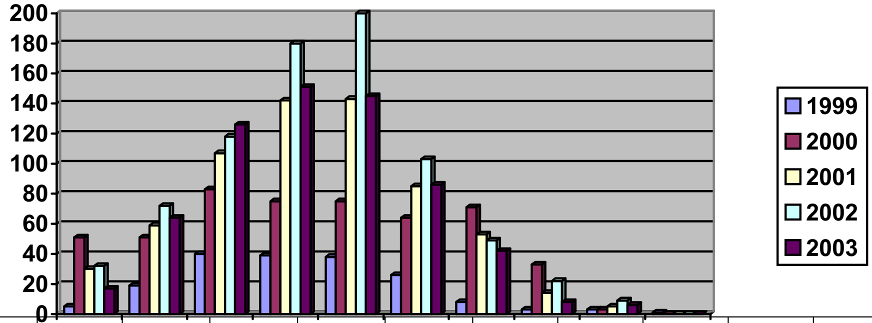


Fig. 7. The peach tree green louse dioecic holoczcle – Myzodes persicae Sulzer, in the ecoclimatic conditions specific of Sibiu 1999-2003

4.5. Structure and Evolution of Seed Potato Crop Aphid Populations in Sibiu County 1999-2003

4.5.1. Evolution of Aphid Populations in Sibiu 1999-2003

The evolution of the aphid populations in Sibiu while the experiment took place (1999-2003) was influenced by the evolution of the agrometeorological factors. That is the excessively dry period of the years 2000 and 2003, the delayed frosts in spring with low temperatures < -2°C as was the case in 2001 when the frost of the 5th of Aprilie (-2,2°C) led to the fundatrix destroyal of many of the Sibiu County's species (fig. 8).



	5/2	5/3	6/1	6/2	6/3	7/1	7/2	7/3	8/1	8/2	Years total catches
1999	5	19	40	39	38	26	8	3	3	1	182
2000	51	51	83	75	75	64	71	33	3	0	506
2001	30	59	107	142	143	85	53	14	5	0	638
2002	32	72	118	180	200	103	49	22	9	0	785
2003	17	64	126	151	145	86	42	8	6	0	645

Fig. 8. The annual, monthly and decade evolution of the seed potato aphid populations in Sibiu 1999-2003

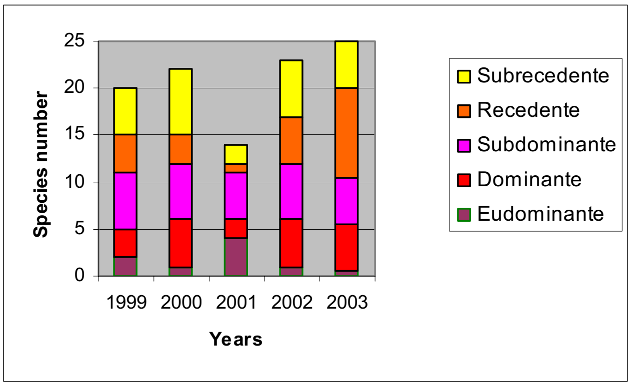
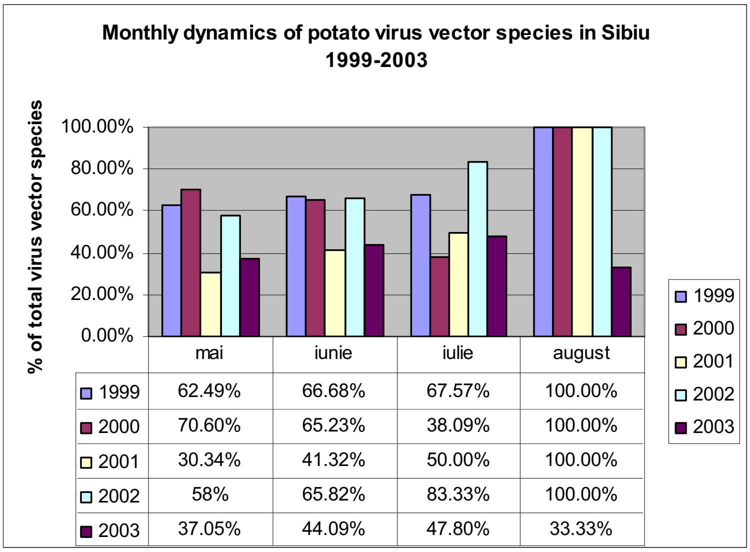


Fig. 9. Classes of dominance determined for aphid species in Sibiu 1999-2003

In all the years of the study 1999-2003 one can observe a severe reduction of aphid abundence end of July and beginning of August.

The tables (32 to 33) show (fig. 9) that according to the class of dominance the most numerous number of aphid species were collected in 2000 and 2003 and the fewest in 2001.

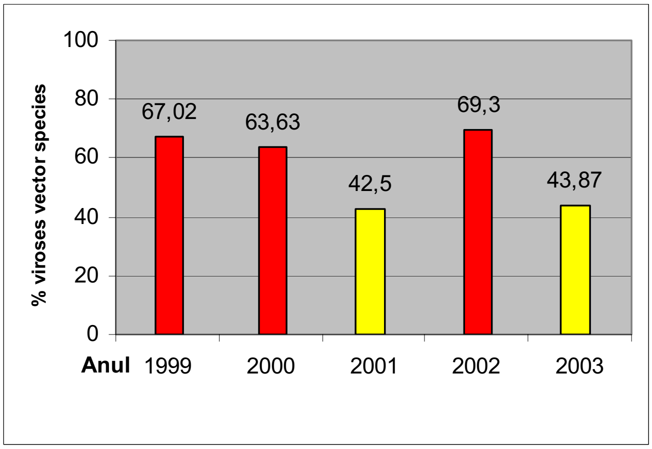


	mai	iunie	iulie	august
1999	62.49%	66.68%	67.57%	100.00%
2000	70.60%	65.23%	38.09%	100.00%
2001	30.34%	41.32%	50.00%	100.00%
2002	58%	65.82%	83.33%	100.00%
2003	37.05%	44.09%	47.80%	33.33%

Fig. 10. Monthly dynamics of potato virus vector species in Sibiu 1999-2003

From the analyses of the monthly dynamics and dominance of the virosesvector aphid species along five years of collecting activity, we can resume as follows:

- the seed potato viroses vector aphids of the specific ecoclimatic conditions of Sibiu represented over 60% in May, June and July in the years 1999, 2000 and 2002, in the years 2001 and 2003 they dropped to 50% and even 30% in May 2001;
- in August when the collected aphids register a low abundance the seed potato viroses vector aphids represent 100% of the collections of 1999, 2000, 2001 and 2002, and they drop to only 33% in 2003 (fig. 10).



The analysis of the annual dynamics of the seed potato viroses vector aphids in the Sibiu area shows that in three years (1999, 2000 and 2002) the viroses vector species captured in Möericke cups in Sibiu represent over 60% of the total, arriving at a maximum proportion in 2002 (i.e. 69,30% of the total) of 8 species of viroses vector aphids (fig. 11).

Fig. 11. Annual dynamics of the seed potato viruses vector aphid species (from the annual total) in Sibiu 1999-2003

Aphid dynamics has also lead to corresponding infections. The most affected variety was the Desirée.

4.5.2. The Evolution of Aphid Populations in Avrig 2002-2003

The ecoclimatic conditions of Avrig are less favorable than in Sibiu because of the Olt valleyscold currentsand the mountain breezes that bring very cold air at nights in the low regions of Avrig. Aphid abundance is 33-36% lower in Avrig than in Sibiu. The form of the distribution in time brings no differences but the values of Avrig are lower than of Sibiu.

Tabelul 9

A parallel Avrig-Sibiu for the abundance of aphid species

Year	Place	May		June			July			August		Total
		2	3	1	2	3	1	2	3	1	2	year
2002	Sibiu	32	72	118	180	200	103	49	22	9	0	785
	Avrig	23	46	81	115	140	71	15	3	0	0	494
2003	Sibiu	17	64	126	151	145	86	42	8	6	0	645
	Avrig	8	37	67	94	110	62	31	3	0	0	412

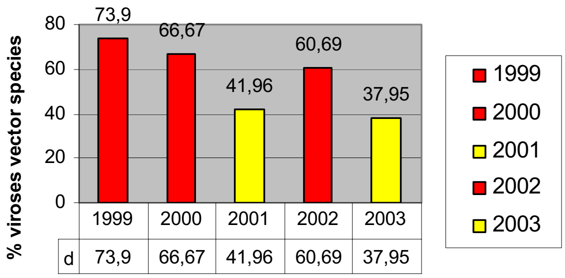
As a result of a lower abundance rate of aphids in Avrig the number of virotic attacks is reduced even with the Desirée variety.

4.5.3. The Evolution of Aphid Populations in Păltiniş 1999-2003

Duet o the specific ecoclimatic conditions of Păltiniş, because of the lack of primary host, aphids get there by long distance flight or passiv flight transported by the wind.

Research conducted by MEIER (1958) in Switzerland and by BUIUC et all., (1988, 1989) in Romania show that altitude leads to a delay in aphid presence. For the altitude of 1420 m at the Păltiniş experimental field the delay represents about 45 days versus the Sibiu area.

Fig 12. The dynamics / year of the seed potato viroses vector aphid species (of total / year) in Păltiniş 1999-2003



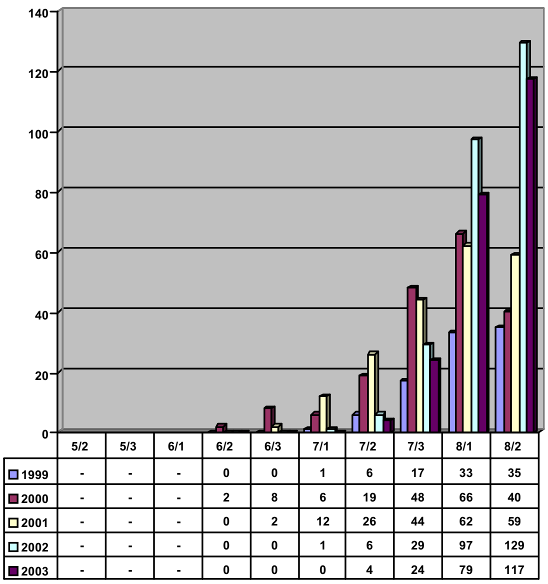


Fig. 13. Annual, monthly and decade evolution of the abundance of the seed potato crop aphid populations in Păltiniş 1999-2003

4.6. Results of Research Concerning the Propagation of Superior Category Potato Planting Material in Virus Free Conditions

4.6.1. Maintaining the phytosanitary standard for the potato planting material propagated at Păltiniş

The phytosanitary quality of the potato planting material is determined by the degree of virotic infection. Therefore a very important aspect in obtaining best planting material is keeping the degree of virotic infections at low level.

4.6.2. Maintaining the phytosanitary standard for the potato planting material propagate dat Sibiu and Avrig

The measures for keeping virotic infections at low level differ according to the manner of virus transmission.

According to the determination of the degree of infection with viruses in the potato planting material propagating lots at Sibiu the certified biological category (class A) confirms to the standard limits concerning the overall percentage of heavy viruses and the percentage of viruses considered light.

4.7. Results Concerning the Analyses of Production Material Elements Propagated in the Conditions of the Sibiu Highland – Mountain Area

Potato production amount is influenced by the phytosanitary and biological anality, that is by the degree of virotic infection of the planting material

4.8. Diagram of the Structure of the Obtained Production in the Experiment Field of Păltiniş

The structure of the obtained production in the experimental field of Păltiniş for the year 2001 shows that all the experiment varieties including all species behaved well in the potato planting material propagating process (fig. 14). Analysing the results (fig. 15) for later species in the three years of experiment it is evident that production is determined by the amount of seed tubers followed by tubers with a diametre bigger than 55 mm and is less determined by the tubers below standard.

4.9. Diagram of the Percentage of Seed Obtained in the Experiment Field of Păltiniş

The percentage of seed obtained in the year 2001 (fig. 16) doesn't show significant differences in the species comprising 57,4% (Ostara) and 64,6% (Timpuriu de Brasov). In 2002 the percentage of obtained seed kept at a favourable level between 56,6% (Runica) and 70% (Dacia). The same is true for 2003 with the exception of Tentant with a percentage of seed less than 50%.

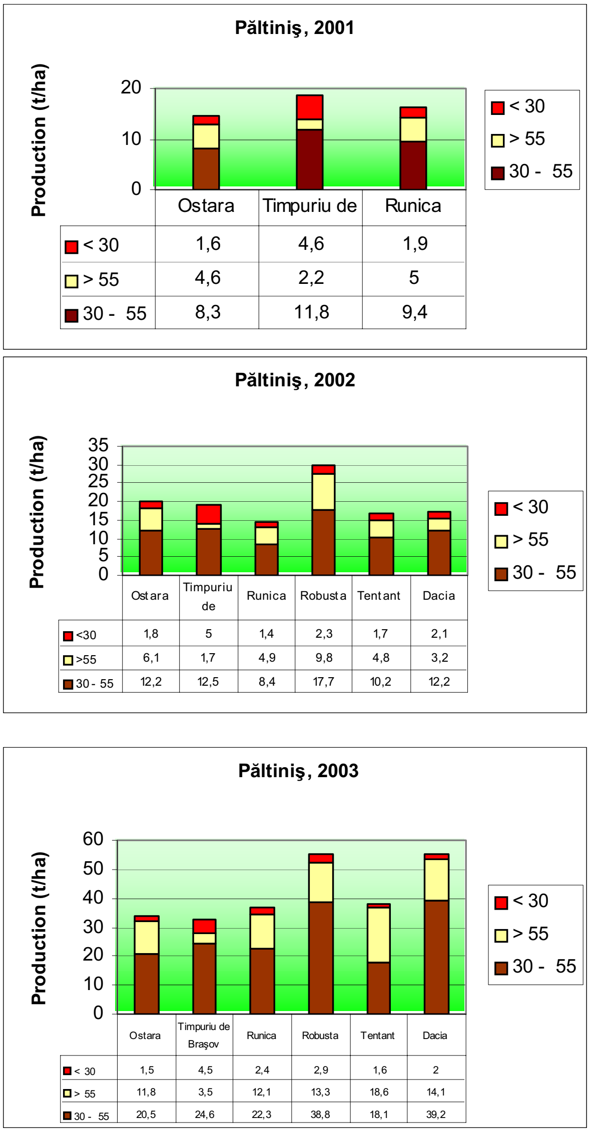


Fig. 14. Structure of production obtained with early species in Păltiniş 2001, 2002, 2003

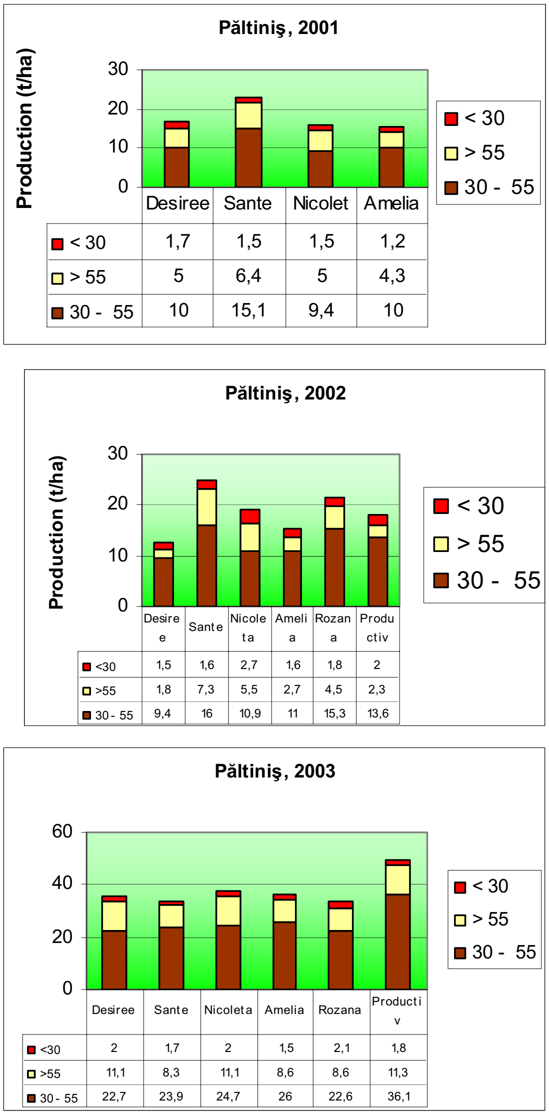


Fig. 15. Structure of production obtained with later species in Păltiniş 2001, 2002, 2003

The obtained results concerning the percentage of seed with later species show the same capacitz in the context of a specific technology to form an important percentage of seed tubers (fig. 17.).

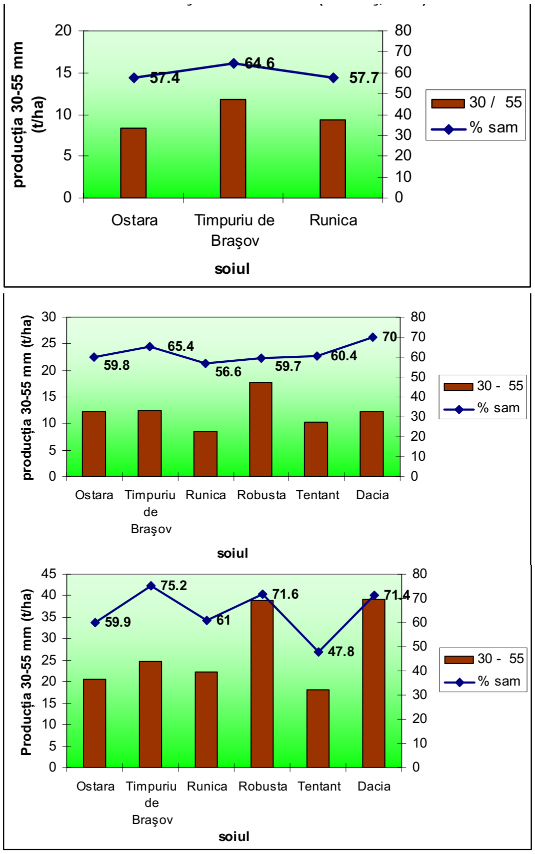


Fig. 16. Percentage of seed obtained with early species in Păltiniş 2001, 2002, 2003

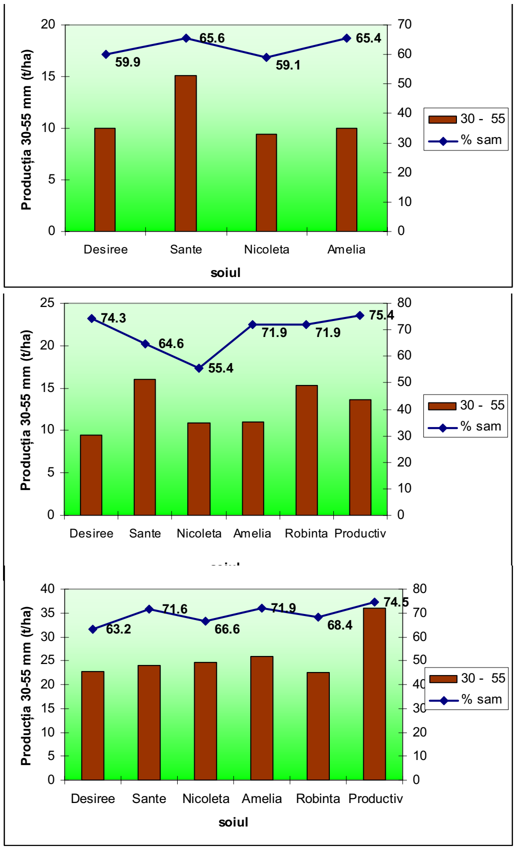


Fig. 17. Percentage of seed obtained with later species in Păltiniş 2001, 2002, 2003

4.10. Results Obtained in Analyzing Productivity Elements of the Păltiniş Material Propagated in Sibiu and Avrig in 2002

The analyses of results of the two places has been done by comparison of the productivity elements, of total yield, of total number of tubers, of fractions and of percentage of seed:

4.11. Diagram of the Yield Structure in the Experiment Field in Sibiu and Avrig

Yield structure in the fields Sibiu and Avrig in 2002 and 2003 shows a similar good behaviour of all the experimented species in the propagation process of the potato planting material (fig. 18).

Results analyses walk the same pass described earlier with special evidence for high productivity rates for the Sante, Nicoleta, Amelia species (fig. 19).

4.12. Diagram of the Percentage of Seed in the Field of Sibiu and Avrig

For the early species in 2002 in Sibiu the percentage of seed is over 55% excepting Ostara (fig. 20).

Significant differences between species have been registered for the later species in 2002 in Sibiu (fig. 21).

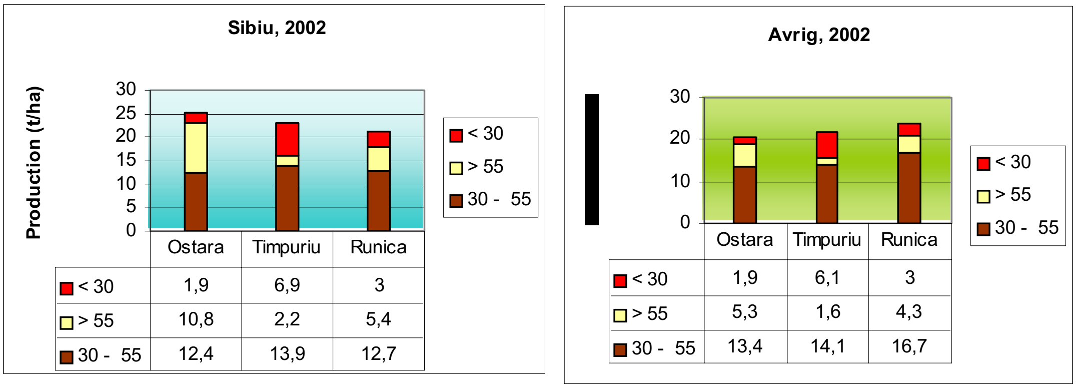


Fig. 18. The yield structure for early in Sibiu and Avrig 2002

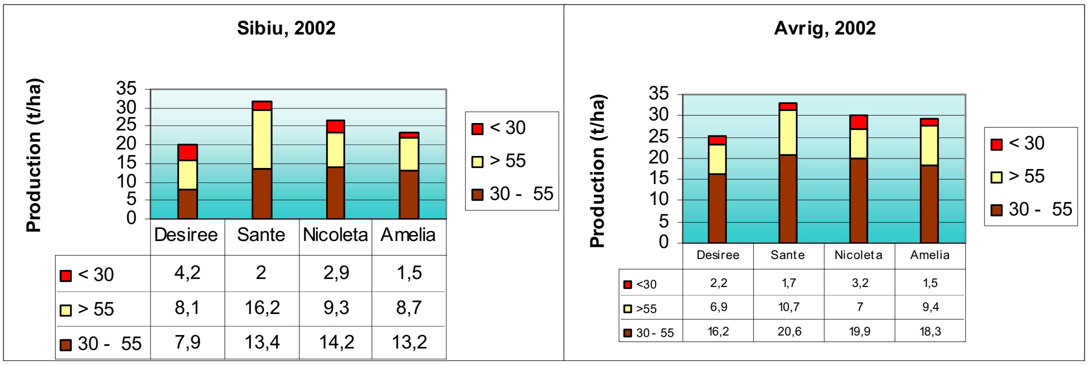


Fig. 19. Yield structure for later species in Sibiu and Avrig 2002

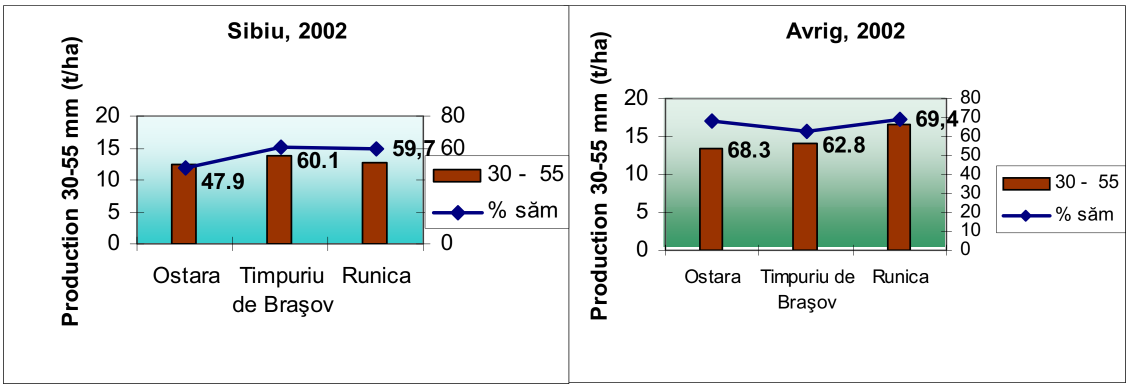


Fig. 20. Percentage of seed for the early species in Sibiu and Avrig in 2002

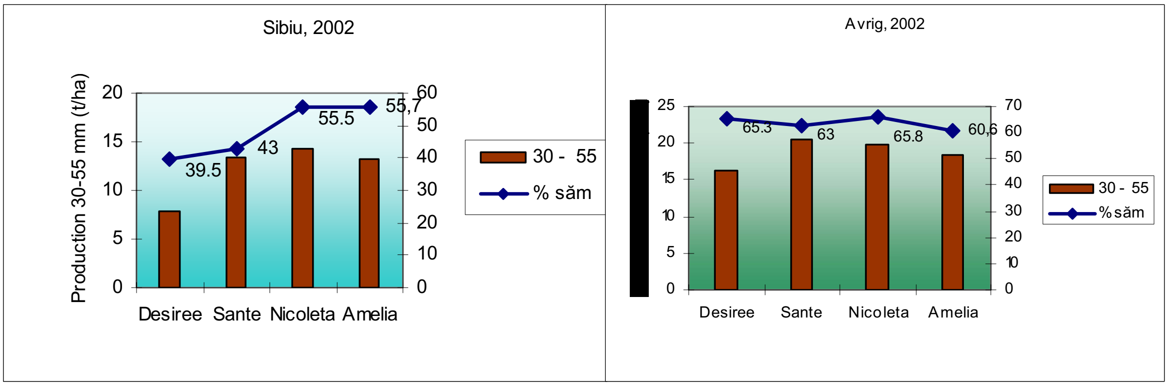


Fig. 21. Percentage of seed for the later species in Sibiu and Avrig in 2002

4.13. Results of Productivity Analyses of the Păltiniş Material Propagated in Sibiu and Avrig in 2003

The analyses of results in the two places in 2003 has been done by comparison of productivity elements of Sibiu and Avrig.

4.14. Diagram of Yield Structure in the Experiment Fields Sibiu and Avrig

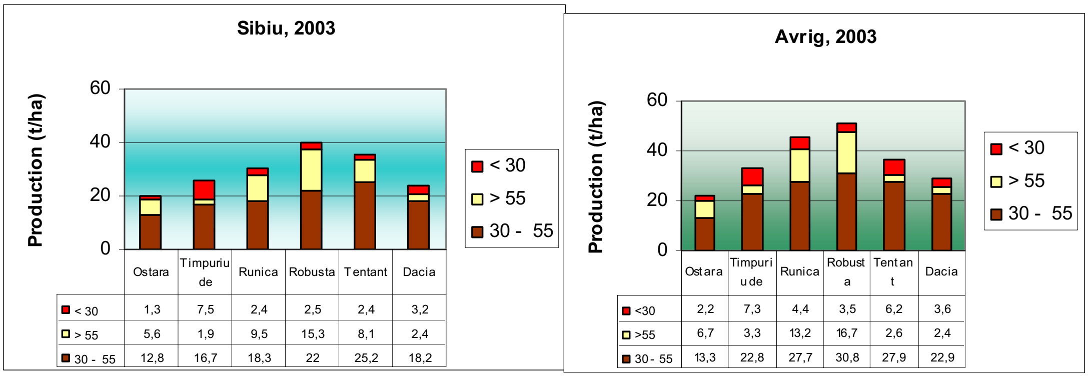
The results of 2003 concerning the Păltiniş material show for Sibiu a yield structure that is mostly determined by the seed tubers with significant differences between the analysed species (fig. 22).

The results for later species follow the earlier presented trend. The Sante, Nicoleta, Robinta, Productiv, Amelia species can be named for their high productivity rates (fig. 23).

4.15. Diagram for Seed Percentage in the Experiment Fields in Sibiu and Avrig

The seed percentage for early species in 2003 in Sibiu show rates over 55% excepting Ostara (fig. 24).

As for later species in 2003 in Sibiu there are significant differences between species (fig. 25).



Sibiu, 2003

	Ostara	Timpuriu de	Runica	Robusta	Tentant	Dacia
< 30	1,3	7,5	2,4	2,5	2,4	3,2
> 55	5,6	1,9	9,5	15,3	8,1	2,4
30 - 55	12,8	16,7	18,3	22	25,2	18,2

Avrig, 2003

	Ostara	Timpuriu de	Runica	Robusta	Tentant	Dacia
<30	2,2	7,3	4,4	3,5	6,2	3,6
>55	6,7	3,3	13,2	16,7	2,6	2,4
30 - 55	13,3	22,8	27,7	30,8	27,9	22,9

Fig. 22. Yield structure for early species in Sibiu and Avrig for 2003

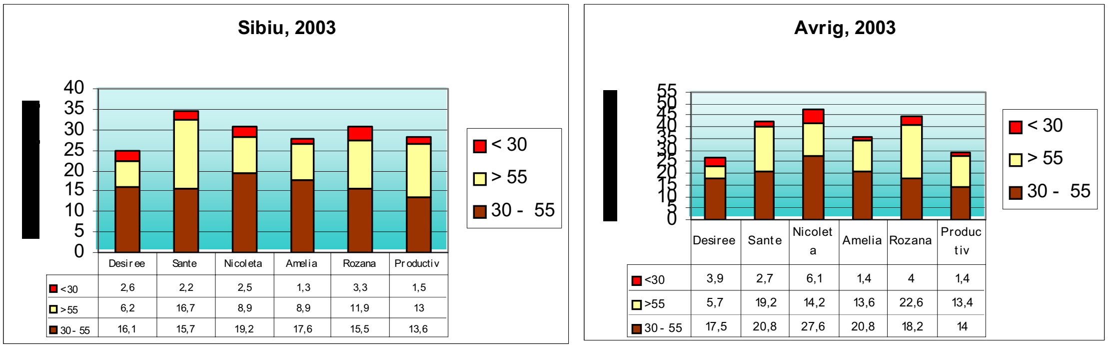


Fig. 23. Yield structure for later species in Sibiu and Avrig for 2003

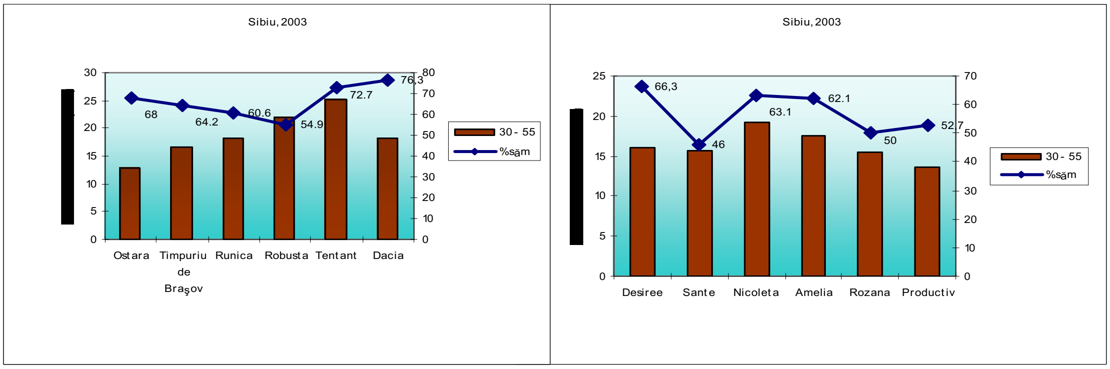


Fig. 25. Seed percentage for later species in Sibiu and Avrig 2003

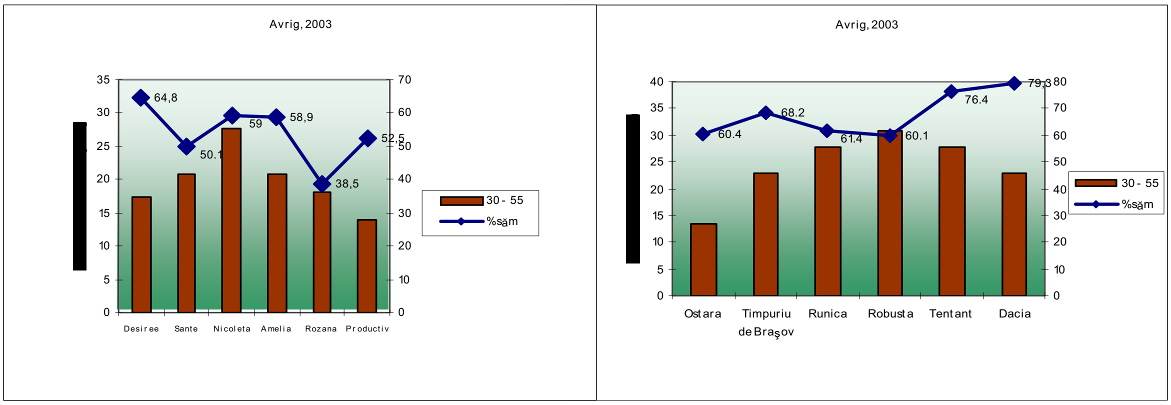
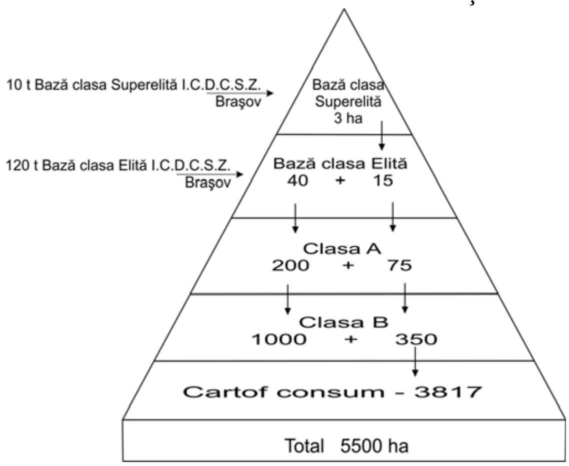


Fig. 24. Seed percentage for early species in Sibiu and Avrig 2003

CHAPTER V
Potato Planting Material Production and Propagation in Sibiu County – its Organisation and Economic Effciency

In the viruses free area of Păltiniş – 1420 m may be organized an area for seed potato production and propagation for biological category Base on a surface of e ha, for 4 years; the surface may be increased.



The biological category Class B may be produced in the low region of Sibiu county (Avrig – 420 m), with favourable climatic conditions, moistered and chilly, on a surface of 55 ha of high favorability for the potato (IAGĂRU şi colab. 2002)

Ensuring on local basis the needs of seed potato for the whole potato cultivated surface in Sibiu county the costs could be reduced and important sums may be saved each year.

CHAPTER VI
Conclusions

1. In the Sibiu area the seed potato viruses vector aphids appear from the first days of potato springing keeping at high rate along June and July decreasing in August;
2. In the Făgăraş region where Avrig is situated the abundance of viruses vector aphids is half compared to Sibiu region because of the colder climate due to cold air from the Făgăraş Mountains slopes;
3. In the area of potato fields in Păltiniş, aphids appear carried at long distances by passive flight (wind transported) with a 40-45 days delay compared to Sibiu;
4. The first and second decade of August is the time of viroses vector aphids in Păltiniş. This means 10-20 days before potato stalk destruction thus the migration of viruses to the tubers is stopped;
5. In these conditions producing potato seed in the high regions of Păltiniş ensures virus free seeding material that is propagated in the cold submountain region thus ensuring the needed seed for Sibiu county avoiding long and expensive transportation from the closed areas of seed potato production;

6. Important is also the variety cultivated due to sensitivity to viruses or due to anatomic characteristics that may favor or stop persistent viros inoculation;
7. Through coordinates of growth, development and propagation a prognoses of the holocycles of different species is possible, the aphides being insects most suitable to mathematical modeling;
8. The virus infection percentage after the first and second propagation year for the potato planting material from Păltiniş is considerably determined by the evolution of the aphid population (the main potato viruses vector – Myzus persicae), by the dimension of the infection source from outside the crop and is less determined by the initial infection of the material;
9. At present the seed potato production of the certified biological category is organized only in counties with closed areas. It is absolutely necessary that the other counties too direct their research towards organizing specialized areas (closed microareas) in order to obtain seed potato of certified biological category Classes A and B in the mountain and highland region;
10. Obtaining biological category Class B outside the closed areas in Sibiu county is a solution to provide the need for seed potato for the whole area and provides also the premises to encrease production by generalizing the use of biological category Class B for planting food potato crops;
11. Lately, the necessity arose for creating specialized species according to use groups. Thus the need to select species with a great number of tubers, Timpuriu de Brasov and Nicoleta; species that are industrialized and require equalshaped tubers, but also species with big size tubers very asked on the market (Amelia, Robusta);
12. According to productivity result analysis for all the varieties experimented at Păltiniş, Sibiu and Avrig the conclusion is positive with special mention of Robusta, Dacia, Ostara and Tentant for early species and Sante, Productiv, Robinta, Amelia, Nicoleta for later species;
13. The Romanian potato varieties have a high biological production capacity given by the existing equilibrium between the number of tubers and their size, characteristics usually in a negative balance (small tubers and many or the reverse);
14. Refering to seed percentage from the three experiment fields we mention positively Timpuriu de Brasov, Dacia, Robusta and Ostara for early species and Sante, Amelia and Productiv for later species;
15. At Păltiniş – 1420 m in the virus free area could be organized the production and propagation of the biological category Class B seed potato on a 3 ha surface that could be encreased;
16. Biological category Class B can be produced in the low area o Sibiu county (Avrig – 420 m) in favorable climatic conditions, moisturized and chilly, on a 55 ha surface on fields with hightly favorable for potato growing;
17. Providing the need for seed potato on local basis for the whole potato cultivated surface in the county of Sibiu expensive would be reduced and important savings would be made each year.

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