

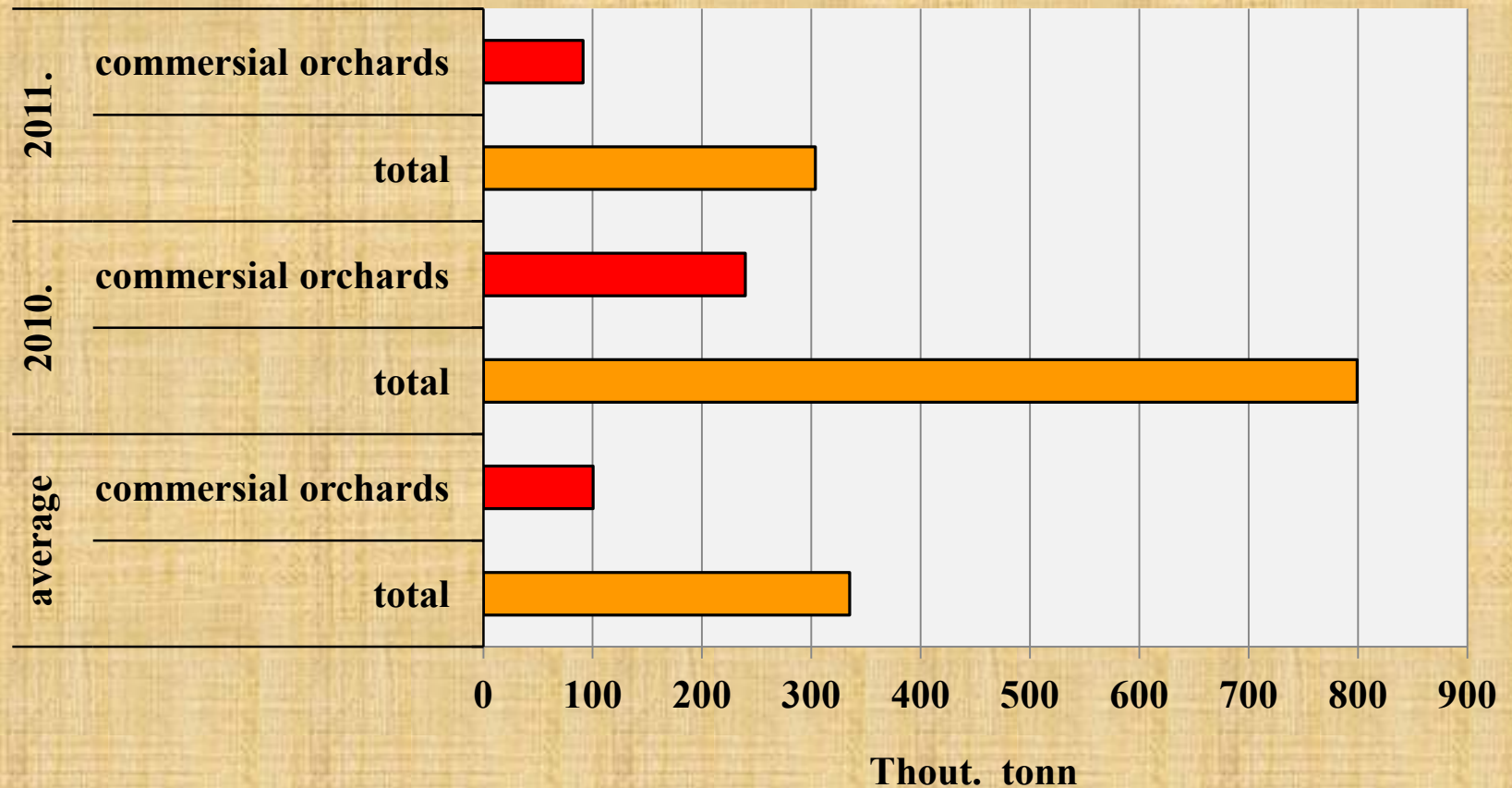
BREEDING of NEW APPLE CULTIVARS in BELARUS



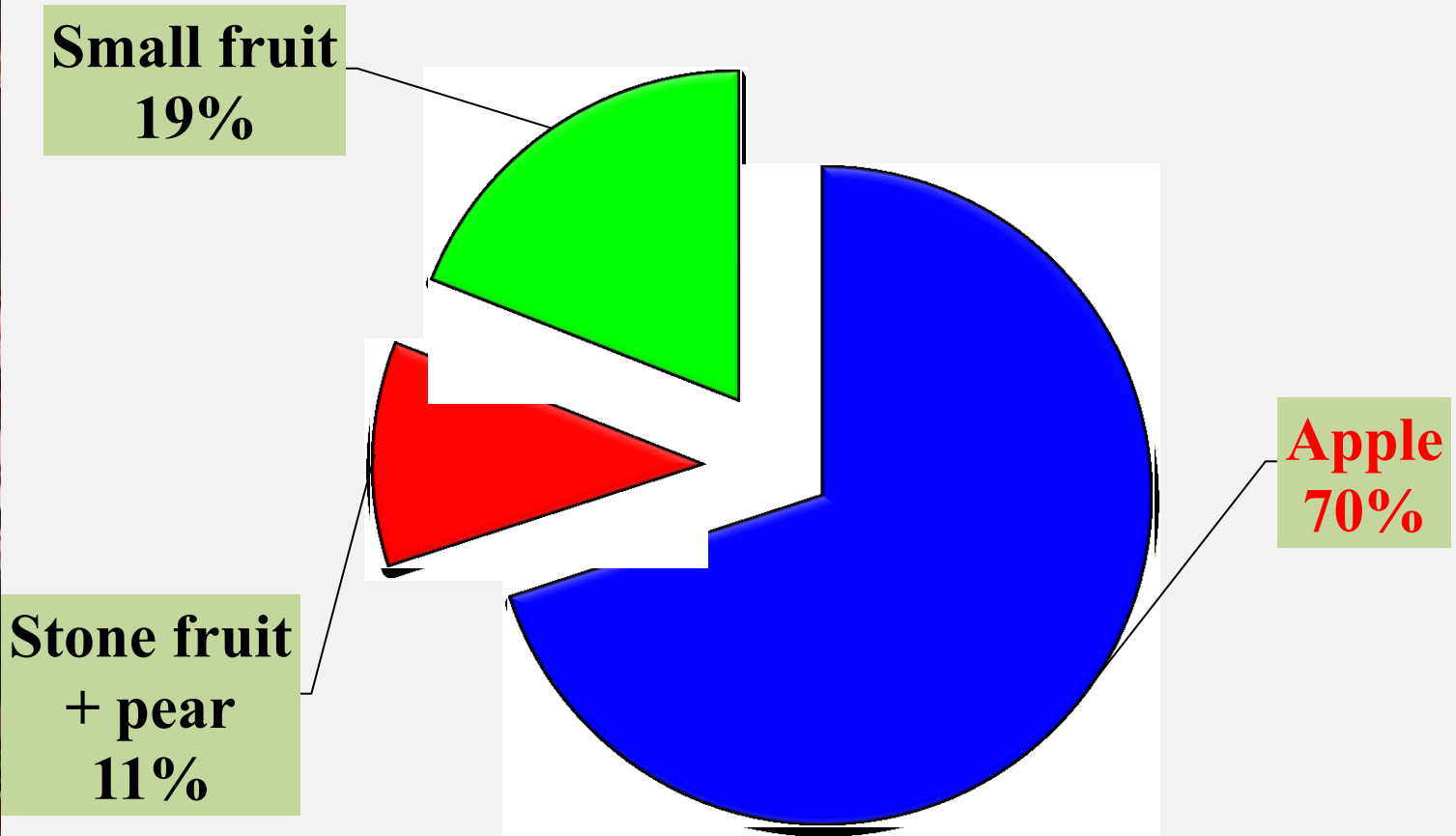
KAZLOUSKAYA ZOYA, *HASHENKA*
T., VASEHA V., YARMOLICH S.

- The best crop was in **2010 – 559 300 ton**
- of fruit, in **2011 – 212500 t** including crop of small private garden.

Gross output of commercial orchards is 30%.



Currently 70% of total fruit production is apple





**The National Register content
48 apple cultivars including 23
cultivars of Belarusian breeding**

СОРТА ЯБЛОНИ БЕЛОРУССКОЙ СЕЛЕКЦИИ



ALESYA.



LUCHEZARNOYE



VESYALINA



DARUNAK



VERBNOYE

СОРТА ЯБЛОНИ БЕЛОРУССКОЙ СЕЛЕКЦИИ ВЫСОКОУСТОЙЧИВЫЕ К ПАРШЕ



BELORUSSKOYE SLADKOYE



POSPEH



IMANT



syabryna

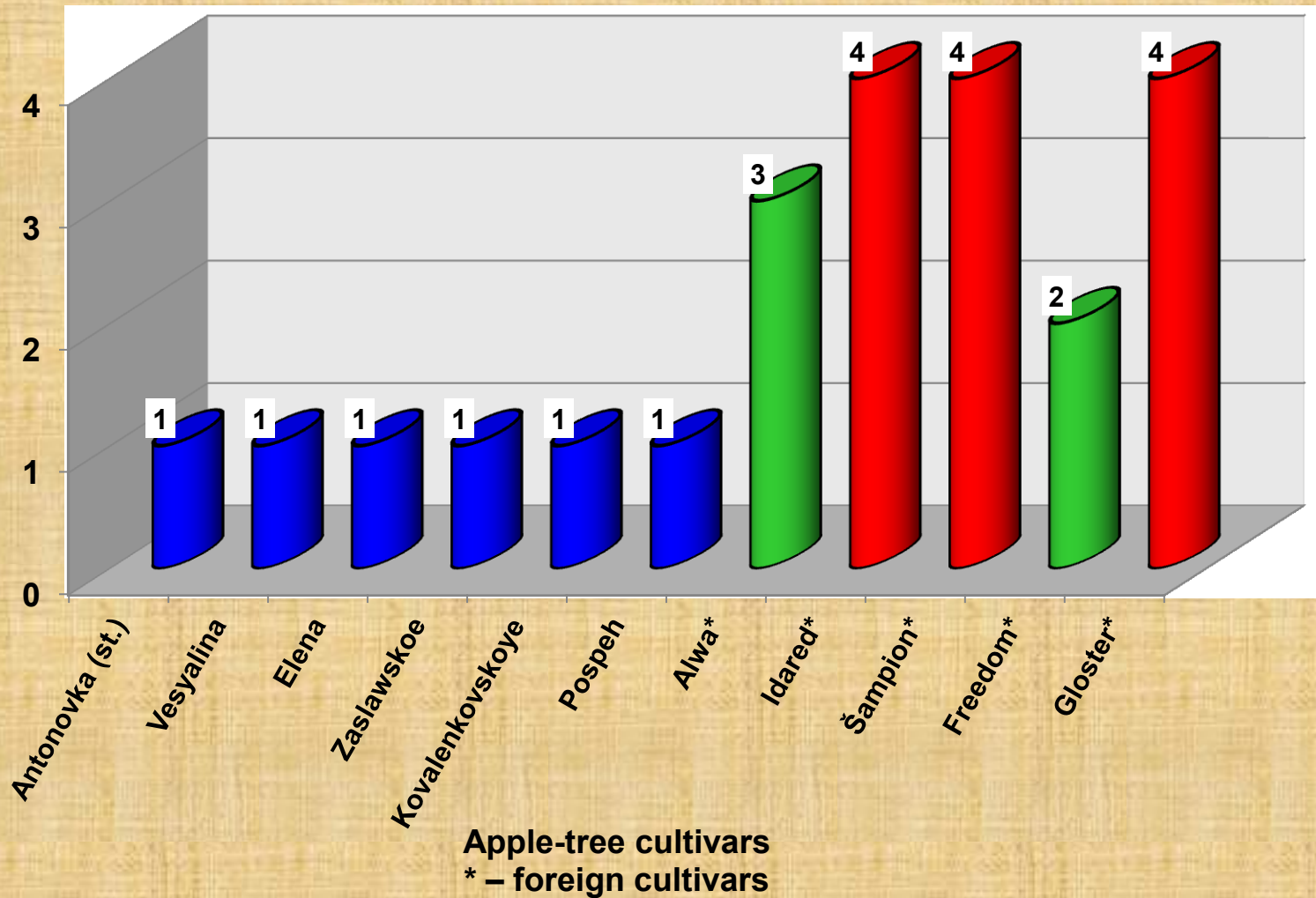


Pamyat Kovalenko

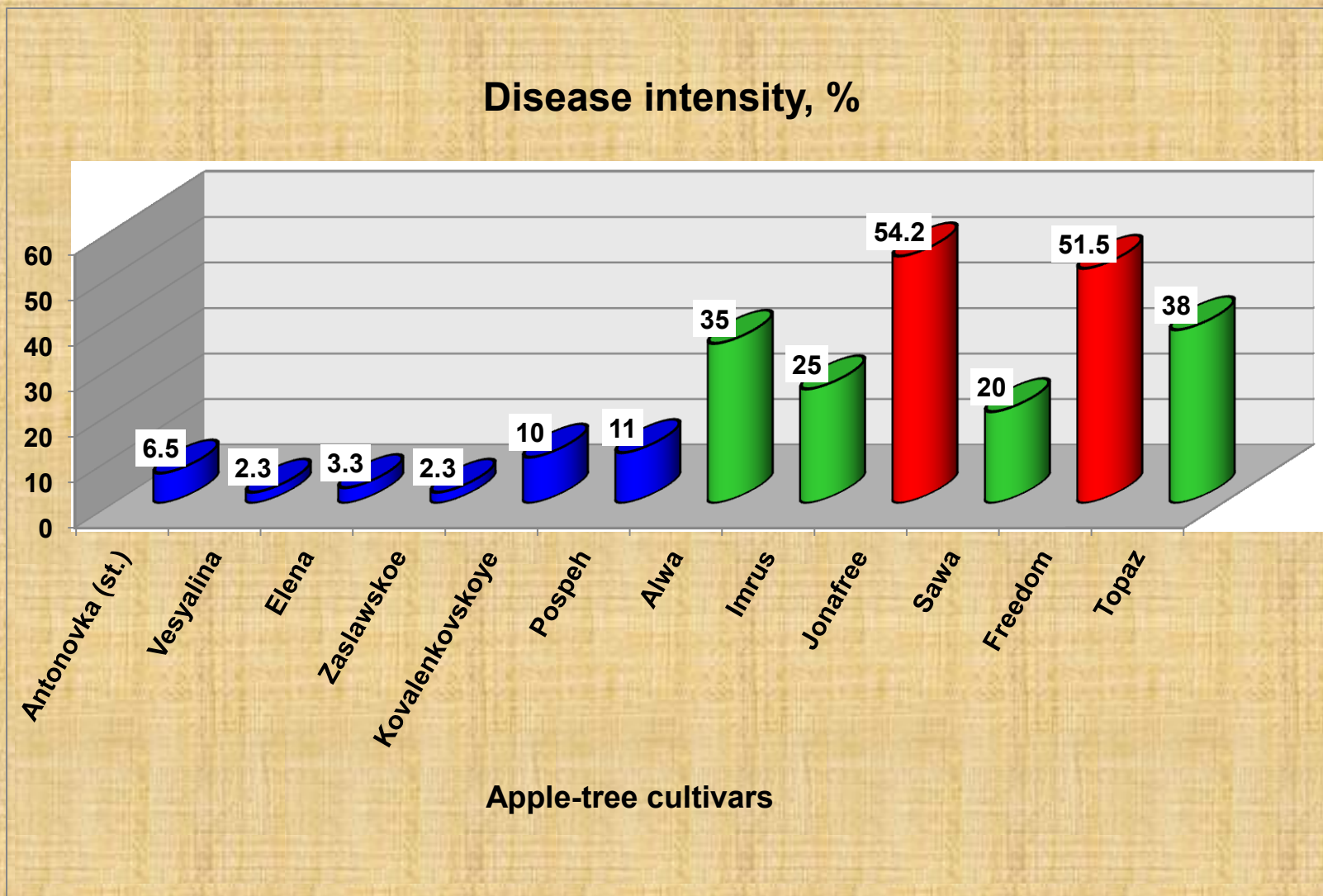


- **Recently there were mass import from Poland such cultivars as 'Idared', 'Sampion', 'Jonagold', 'Ligol'. But after two last hardy winters the interest of growers to the cultivars is sharp lower.**

The level of frost damage



**Winter hardiness of native and foreign
apple cultivars (average rating for 2004-2012)**



Susceptibility to Nectria canker of native and foreign apple cultivars

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- A vertical strip on the left side of the slide shows a close-up of pink cherry blossoms with dark green leaves.
- **The apple breeding has long tradition in Belarus. The first breeding experiments began in 1929 and they have been continued up to the present time. As apple assortment of orchards in the first half of last century was formed early ripening local and non adaptive late varieties from West Europe and USA so made it one's aim - to create late ripening with long storage life and good adapted cultivars to climatic conditions of Belarus.**



There are 3 periods of Belarusian breeding work:

- **1929-1964 – Syubarov’s period** with result including 17 cultivars as ‘Bananovoye’, ‘Belorusskii sinap’, ‘Minskoye’, etc.;
- **1964 (1958) – 1992 – Kovalenko’s period** in which were obtained cvs. ‘Belorusskoye malinovoye’, ‘Antei’, ‘Alesya’, ‘Vesyalina’, ‘Verbnoye’ etc.; and
- **modern period since 1993.**

- 
- **Modern apple breeding aims to produce new hybrid fund for obtain commercial cultivars with high quality of fruits, multiple resistance to various biotic and abiotic stresses.**
 - **There is a strong need for new superior cultivars as competition is for establishing a new orchards.**

Plant material

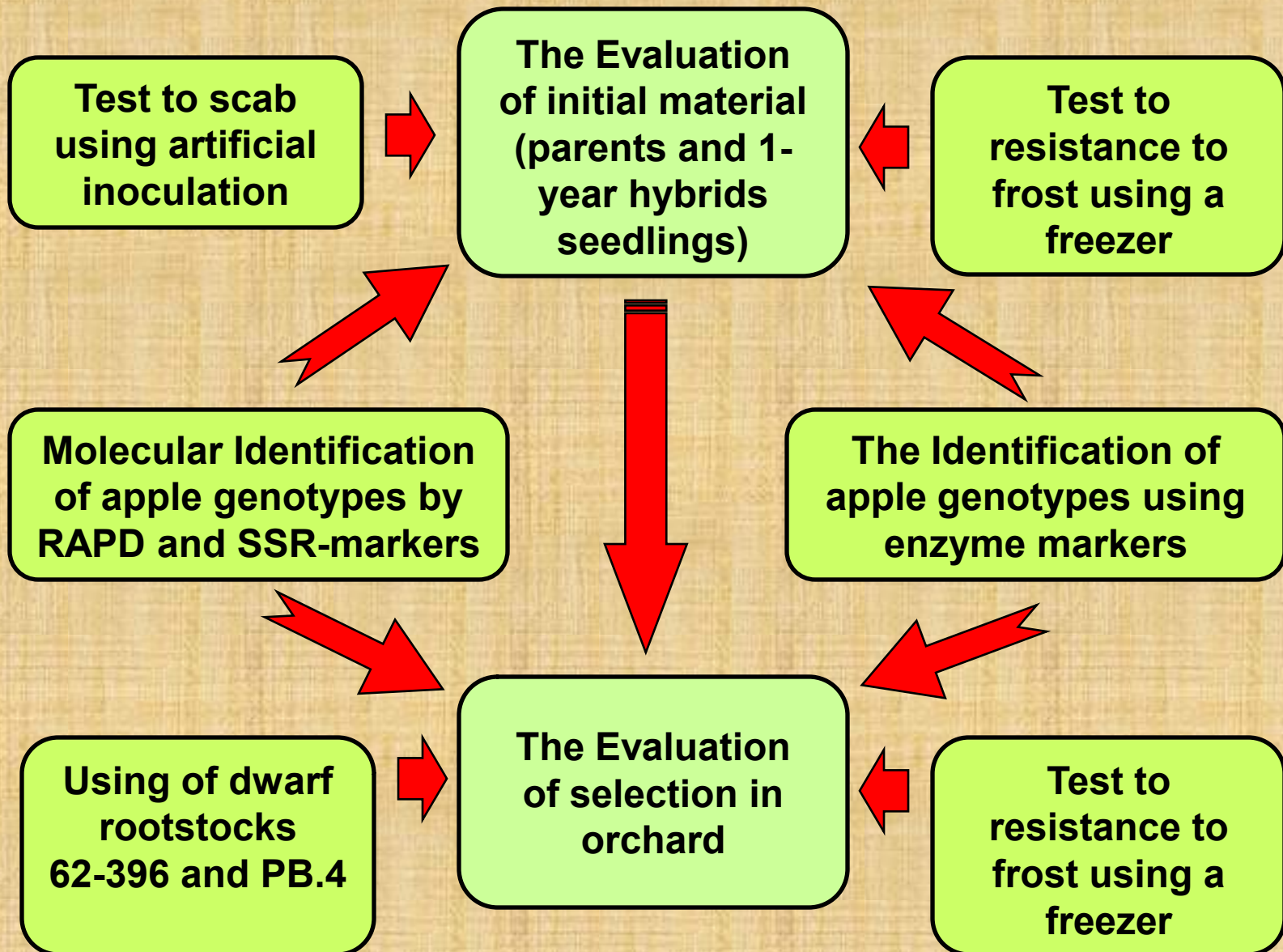
- **Research objects were apple hybrid fund for 1994-2000 including 252 progenies with a total amount more than 29 thousand hybrid seedlings, 4938 hybrid plants on own roots in orchards, also 18 selections on rootstocks 62-396, PB.4 in experimental orchard which was planted in 2006 growing in Samokhvalovitchy, Minsk region. The test plot design was 4 by 1.25 m.**



Methods

- **The study and trial hybrids and selections were carried out during 1994-2011 according to the methods of VNIISPK (Sedov, 1995, 1999).**
- **Crossing is a chief method of breeding.**
- **Evaluation of apple tree winter hardiness with direct freezing by our method (Kazlouskaya et al., 2008).**
- **Molecular investigations were carried out according to Urbanovich et al., 2011.**

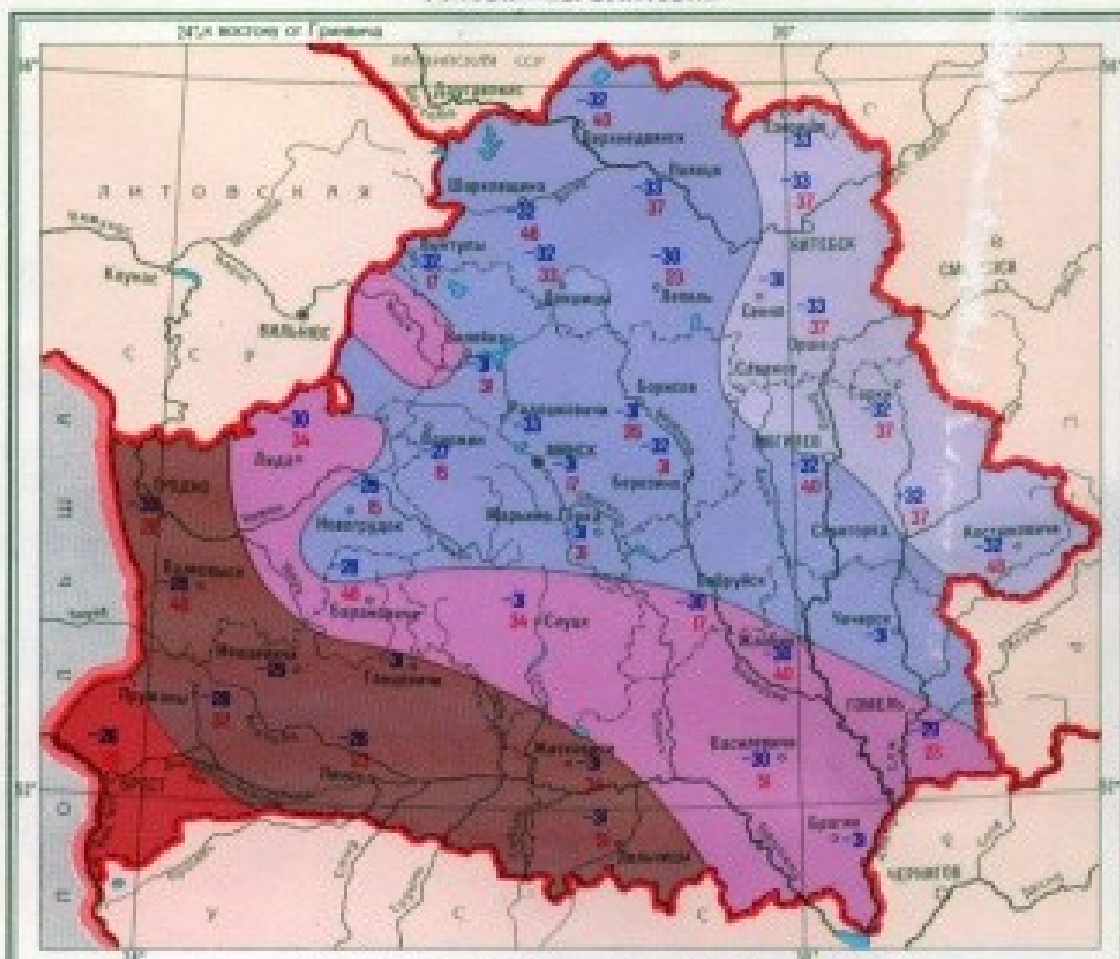
The scheme of apple breeding process in Belarusian RUE “Institute for Fruit Growing”



ДАТЫ ПЕРВЫХ И ПОСЛЕДНИХ ЗАМОРОЗОВ И СУММЫ АКТИВНЫХ ТЕМПЕРАТУР



УСЛОВИЯ ПЕРЕЗИМОВКИ



УСЛОВНЫЕ ОБОЗНАЧЕНИЯ

Число дней с оттепелью

менее 30 30 35 40 45 более

- 30 Минимальная температура воздуха, достигаемая в среднем раз в 5 лет
- 34 Повторяемость (%) зим с минимальной температурой воздуха ($\leq -20^{\circ}\text{C}$) при высоте снежного покрова $\leq 5\text{ см}$



Characteristic of apple hybrid fund

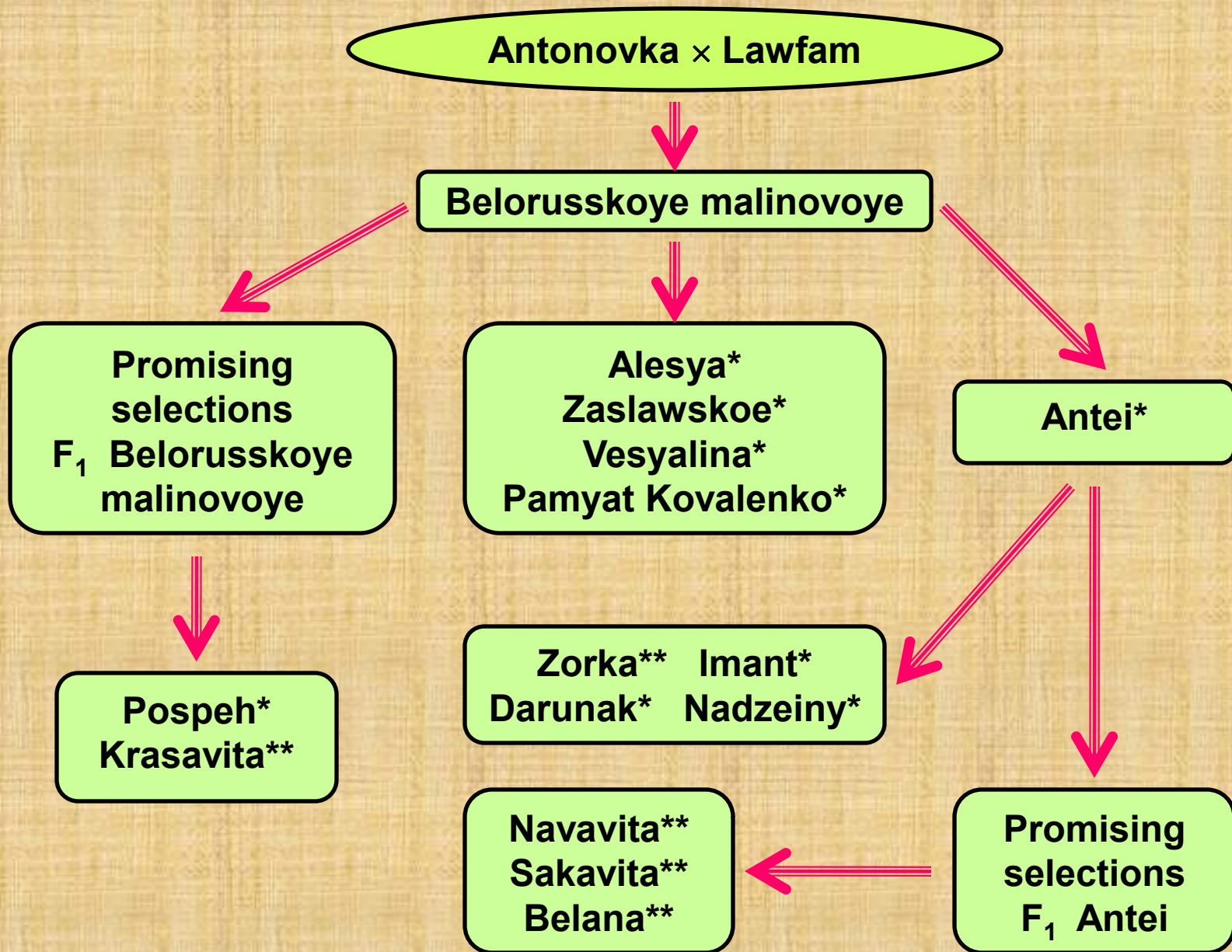
Not every cultivar can realize its potential in the climate of Belarus. Taking into account length of vegetation period, number of solar hours during the vegetation period and frosty winters, in breeding program are including more than 100 varieties by different geographic and genetic derivation including the best our Belarusian cultivars and promising selections also some best foreign cultivars.

A vertical strip on the left side of the slide shows a close-up of pink cherry blossoms with dark green leaves.

• Our breeding program aimed to determine favorable character for breeding high quality cultivars by using a few excellent cultivars and their progenies also introducing special traits such as disease resistance, pest resistance and a labor-saving character to apple cultivars from progenies of species *M.×prunifolia*, *M.sieboldii*, *M.×zumi*, *M.coronaria*, *M.×sargentii*. *M.niedzwetzkyana*.

- According to our analysis a cultivar Belorusskoye malinovoye (Antonovka × Lawfam) and offsprings of one's are mostly efficient sources in apple breeding in our conditions





* The cultivars are in State Register of Belarus; *Alesya*, *Antei*, *Imant*, *Vesyalina* – in Russia;

** The cultivars are in State Testing of Belarus.

Table 1. Total volume and results of apple hybrid fund from crossing 1994-2000

Year	Number of cross	Number of flowers	Number of seeds	Number of 1-year old hybrid plants	Number of selection in orchards	Number of promising selections
1994	42	73660	19664	8755	517	15
1995	10	4370	2179	840	117	4
1996	35	65090	32652	2750	603	6
1997	30	19040	7929	2720	330	8
1998	54	59020	34453	5417	1156	9
1999	47	83800	53814	5244	940	51
2000	48	79720	19744	3790	1275	31
Total	252	384 700	170 435	29 516	4938	120

Evaluation for resistance to scab

In 90-s of last century in hybridization has been included scab resistant sources with major gene Vf. The best efficient male parent in our breeding program is Swedish selection 'BM41497'.

Donor properties of the genotype are reproducing its offsprings very well. In the second stage of apple durable resistant breeding programme for 1993-2000 has been using promising selections from cross combination 'Antei' x 'BM41497' mainly.

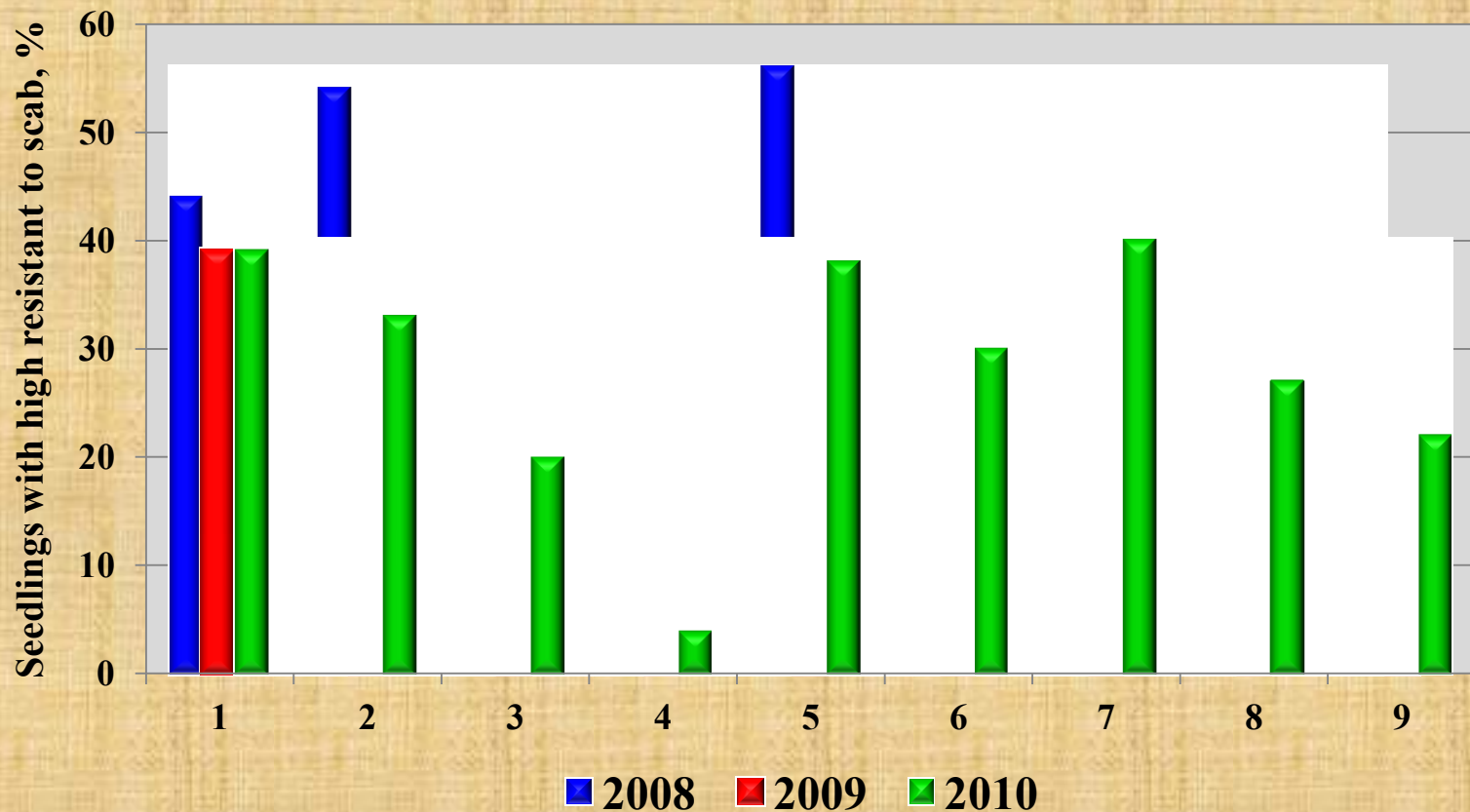
Table 2. Results of apple breeding using scab resistant sources 1994-2000

Genotype	Number of cross	Number of selections in orchard	Number of promising selections	Number of cultivars
F₁BM41497	18	641	40	3
Freedom	1	43	1	0
Jonafree	2	79	2	0
Imrus	1	12	1	0
Liberty	6	260	13	1
Otava	3	26	7	1
Prima	2	83	4	0
Priscilla	1	7	1	0
Relinda	1	4	1	0
Reglindis	1	3	1	0
Remo	1	20	1	0
Redkroft*	3	28	5	0
Sawa*	3	30	5	0
Total	43	1236	82	5

* - promising selections derived from (Antei × BM41497) together



Recently a scab epidemic has been observed annual in our condition. First in 2004 we has been observed the damage by scab some Vf-resistant cultivars in our collection orchard, mainly foreign cultivars as 'Freedom', 'BM41497', 'Prima', 'Witos'. Very heavy scab epidemic in two consecutive seasons 2008 and 2009 provided an opportunity to do field assessments on scab damage of hybrid progenies as well as comparing the field and greenhouse data for the progenies. The level of the infection was increasing and in 2009 there was very strong scab infection. In all progenies there was the lowest share of resistant offsprings in 2009 as climate condition were very favorable for scab developing in this year.



Hybrid population: 1 – *M.×domestica* × *M.×zumi*,
2 – *M.×domestica* × (*M.×prunifolia* × *M.×floribunda*),
3 – *M. sieboldii* × *M.×domestica*, 4 – *M.×domestica* × *M.×domestica*,
5 – *M. coronaria* × *M.×domestica*,
6 – *M.×domestica* × (*M.×floribunda* × *M.×atrosanguinea*),
7 – *M.×zumi* × *M.×domestica*, 8 – *M.×domestica* × *M.×floribunda*,
9 – *M.×atrosanguinea* × *M.×domestica*



It should note that progenies after test by artificial inoculation including strains from scabbed leaves picked on Vf-gene cultivars were the most healthy. Scab strains collection is content strains from leaves 'BM41497', 'Freedom', 'Syabryna' ('Lobo' x 'Prima') also another scab susceptibility genotypes *M.×domestica*, *M.×floribunda*, *M.coronaria*, *M.×atrosanguinea*, *M.×prunifolia*, *M.niedzwetzkyana*.

Our investigations for intraspecific diversity of *Venturia inaequalis* (Coock.) Wint. has been revealed five types of strains according to morphological and cultural features (Hashenka,2009).



Molecular investigation

For identification Vf gene in hybrid populations were applied SSR-markers and there were revealed that not every resistant hybrid (after test on artificial inoculation) on strong natural infection in field has content Vf gene

Table 4. Identification of gene Vf on hybrid progenies after artificial inoculation by *Venturia inaequalis*

Hybrid progeny	Number hybrids for DNA analysis	Hybrids with gene <i>Vf</i>		Hybrids without gene <i>Vf</i>	
		number	%	number	%
86-54/137 × Rubin	199	113	57	85	42,5
25/175 (F ₂ <i>M. sieboldii</i>) × 86-54/133	175	69	39	99	57
86-54/137 × Pamyat' Vavilova	42	26	62	16	38
19/2 (F ₁ <i>M. sieboldii</i>) × 86-41/5	60	36	60	23	38
Imant × Redkroft	49	29	59	20	41
Otava o.p. №11 × Nadzeiny	70	57	83	12	16
21/4 (F ₁ <i>M. xzumi</i>) × 86-41/5	49	16	34	31	62
Pinova × 86-39/105	94	70	75	24	25
Sir Prize × Imant	4	4	100	0	0
86-39/105 × F ₁ Šampion	28	25	89	3	11
Pinova × Imant	32	21	66	11	34



The research of genome of our apple collection was revealed a gene *Va1 (Rvi17)* in series cultivars: old cultivars - 'Antonovka' and its sport, 'Korobovka krupnoplodnaya', Belarusian selection – 'Belorusskii sinap', 'Charawnitsa', 'Kovalenkovskoye', 'Loshizkoye', 'Novinka osyeni', 'Pamyat Pashkevitcha', 'Pepin litowskii uluchshennyi', 'Verbnoye' and American cv. 'Freedom' (Urbanovich¹, et.al., 2011).

But important to note that not every our accesses derived from ancestors 'Antonovka' is content *Va1*, while some of them are field resistant to scab as 'Alesya', 'Shchedroye', 'Pamyat Syubarovoi', 'Rebristoye' etc.



Recently we are provided molecular test of our initial material and hybrid progenies for identification some genes of resistance to scab, mildew, fire blight and aphid (Urbanovich³ *et.al.*, 2011). Cv. 'Charawnitsa' ('Belorusskii sinap'×'Cox's Orange Pippin') has multiple resistant to scab, mildew, fire blight and aphid (Urbanovich¹, *et.al.*, 2011) and old Russian cultivar 'Chulanovka' is important source of resistance to scab and mildew (Hashenka, 2009; Urbanovich⁴ *et.al.*, 2011). Moreover some offsprings of 'Chulanovka' are high resistant in field but not revealed the genes *Pl-1*, *Pl-2*, *Pl-w*, *Pl-d* in the genotypes.

So it should develop molecular investigation for useful apple breeding.

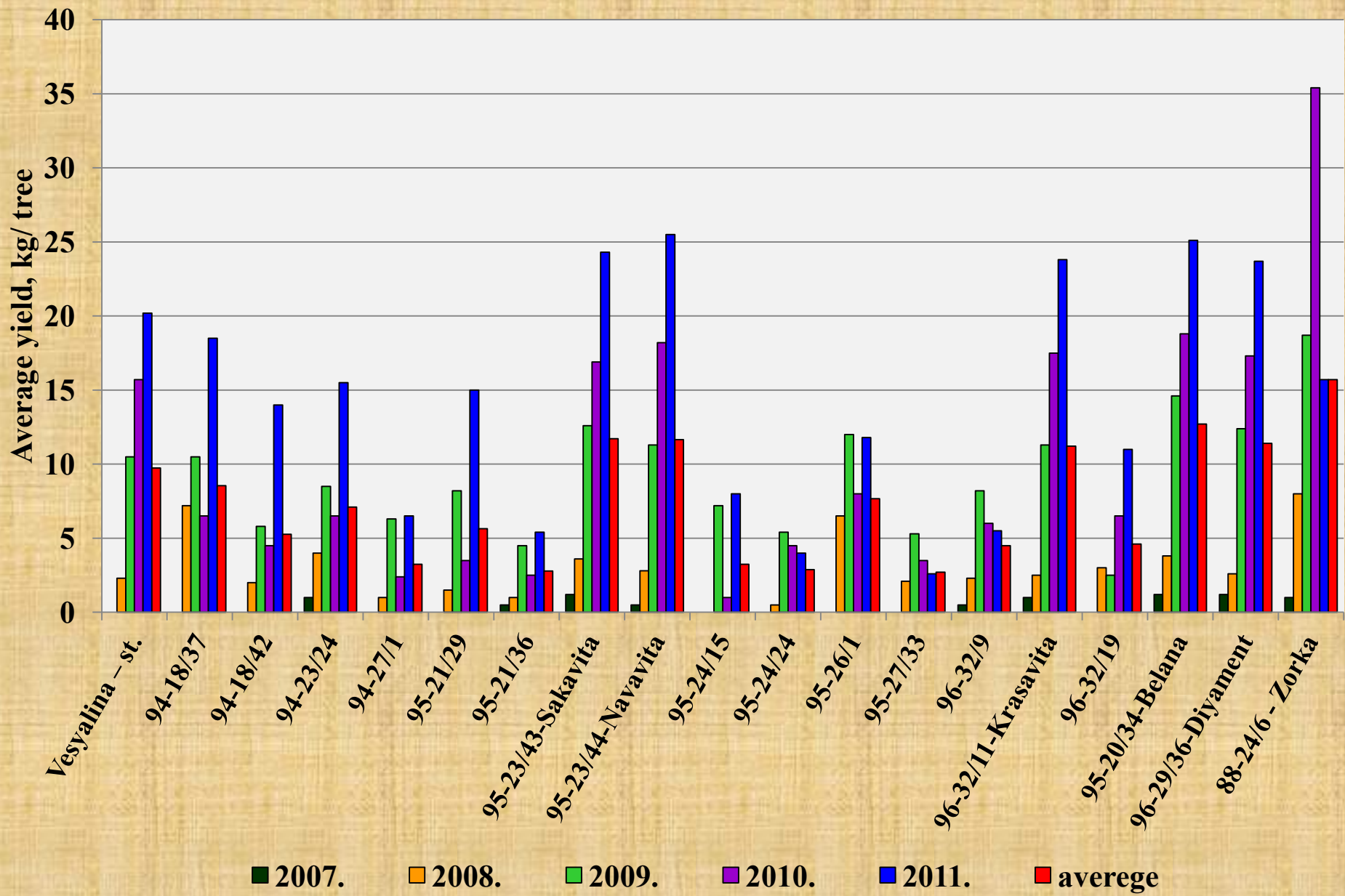
First elaborations for DNA investigation of apple genome in Belarus





Test of promising selections on dwarf rootstocks

- In 2011 is finished complex evaluation of 18 apple selections on rootstocks 62-396 and PB – 4.**
- 16 selections were obtained from crossing in 1994 – 1996,**
- one – in 1987.**



Yield of cultivars and promising apple selection (2007-2011)

Table 5. Characters of apple fruit of promising selections

Selections, cultivars	Appearance, point	Taste, point	Wight, g	Index* of shape	Color ground/over	Storage life, days
94-18/37	4.7	4.2	174	0.84	yellow- green/red	150
94-18/42	4.0	4.2	140	0.86	yellow- green/bright red	170
94-23/24	4.1	4.3	110	0.85	yellow- green/dark red	170
94-27/1	4.0	4.0	105	0.76	green/red-brown	170
95-21/29	4.5	4.2	97	0.81	green/purple	100
95-21/36	4.0	4.2	105	0.84	green/purple	140
95-23/43 - Sakavita	4.2	4.4	186	0.82	yellow- green/brown- red	180
95-23/44 -Navavita	4.2	4.2	150	0.76	whitish green/purple-red	150
95-24/15	4.3	4.1	115	0.89	green/purple	140
95-24/24	4.5	4.0	136	0.94	yellow- green/dark red	140
95-26/1	4.5	4.0	198	0.90	yellow- green/bright red	170
95-27/33	4.0	4.0	112	0.94	yellow- green/red- brown	170
96-32/9	4.3	4.5	120	0.71	red	150
96-32/11 -Krasavita	4.5	4.6	150	0.82	yellow /pink- red	170
96-32/19	4.2	4.5	173	0.73	yellow/red	140
95-20/34 - Belana	4.4	4.5	180	0.77	yellow /red	180
98-29/36 – Diyament	4.5	4.8	158	0.75	yellow/pink-red	130
88-24/6 - Zorka	4.5	4.7	175	0.92	green/purple red	150

* Index of shape : 0,90 => – oblong-conical; 0,80-0,89 – round; 0,80 =< flat, flat-round

- **BELANA**
95-20/34
(72-11/47 x
86-54/125,135)



- **DIYAMENT**
98-29/36
(OTAVA O.P.)



- KRASAVITA
- 96-32/11
- 72-11/47 ×
ŠAMPION



- NAVAVITA
- 95-23/44
- 78-15/242 ×
(ANTEI ×
BM41497)



- SAKAVITA
- 95-23/43
- 78-15/242 ×
(ANTEI ×
BM41497)



- SAKAVITA
- 95-23/43
- 78-15/242 × (ANTEI
× BM41497)



- **ZORKA**

88-24/6 (ANTEI ×
LIBERTY)



Conclusion

- The new resistant apple cultivars 'Belana', 'Diyament', 'Krasavita', 'Navavita', 'Sakavita', 'Zorka' are well suited to be included into the resistant dessert apple assortment for Belarusian orchards. They combine high fruit quality and resistance against scab, bark canker, winter and spring frosts. They possess a regularly high yield.



***THANK YOU
FOR
ATTENTION!***