THE NEW POTATO VARIETY 'REET'

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Abstract
The characteristics of the new nematode (Ro1) and wart (D 1) the resistant to early and to medium ripening potato variety Reet (Mats x Gitte) developed at the Jõgeva Plant Breeding Institute (Jõgeva PBI) is discussed in this paper. The variety Reet was included in the Estonian and European Variety List in 2007.
The breeding goal was to obtain a variety, of potato which meets the requirements of food markets and processing factories. Reet passed the preliminary and final trials in 2000-2004 at the Jõgeva PBI, where it was compared with the standard varieties Berber (early), Piret (medium) and Ants (medium late). The tuber yield of Reet was equal to Ants and Berber but lower than Piret. The yield of the marketable tubers of Reet was equal to the variety Berber in a dynamics trial performed at different harvest times. Reet exceeded the standard varieties by tuber weight, although the number of tubers per plant was low. There was a low appearance of black scurf, common scab and potato virus infection on the plants of the new variety. It had a relatively good resistance to late foliage blight, exceeding all standard varieties. Therefore the new variety is suitable for organic farming. Reet has good quality characteristics (shallow eyes, regular shape, no darkening).
The peeling test with an abrasive peeler showed that Reet had relatively small peeling remains, approximately 100.0-150.0 g kg^{-1}. The content of reducing sugars was low. This makes refers suitable for making chips and French fries.

Key words: potato variety, yield, disease resistance, cooking quality.

Introduction
Due to different conditions and requirements in various locations, many potato varieties exist all over the world. These varieties correspond with the different purposes for which the crop is grown, with the different tastes and preferences of the people and with the different environments in which the crops are grown. Some varieties can be grown in many places and have a wide range of usability; others are meant for very specific purposes or for specific environmental conditions. Apart from production capacity, an important varietal characteristic is the resistance to pests and diseases. Breeding work is constantly going on to develop new varieties, combining high yield and other favourable characteristics with new or improved resistance to all kinds of pathogens. Every potato producer knows that locally bred varieties are most suitable for local growing conditions. The main goal of potato breeding at the Jõgeva PBI is developing medium and medium late, disease (especially late blight resistant), pest and mechanical damage resistant, high yielding and quality table and industrial potato varieties. The yielding capacity, agronomic characteristics, tuber quality and disease resistance of new varieties should be equal or better than these of foreign varieties. Quality characteristics should correspond to contemporary requirements for table and industrial varieties.

Materials and Methods
The new nematode and wart resistant early to medium potato variety Reet (breed J 649-94) was developed at the Jõgeva PBI, Estonia. Reet was selected from the cross between the Estonian variety Mats and the German nematode resistant variety Gitte. This paper gives information about the economical and biological characteristics of the new variety Reet in 2000-2004, when it was tested in preliminary, final and dynamic trials. The official trials in Estonia and the technical examination (DUS test) in Czech Republic were carried out in 2005-2006.
Reet was compared with the standard varieties Berber (early Dutch variety), Piret (medium Estonian variety) and Ants (medium late Estonian variety).

Conventional breeding methods, crossing with different hybrid varieties or hybrids and repeated selection of hybrid tuber generations were used in breeding. The crossing and growing of seedlings was carried out in the greenhouse and the next generations were tested in the field. Experimental fields of the Jõgeva PBI are located on sandy loam *Calcaric Luvisol* soil by FAO/UNESCO classification. The fields were deeply shredded, cultivated and complete chlorine free mineral fertilizer (containing 80 g kg^{-1} N, 50 g kg^{-1} P and 190 g kg^{-1} K) by 650 kg ha^{-1} was used in the spring. Chemical control of weeds was carried out with mixture of the herbicides *Sencor* (250 g ha^{-1}) and *Titus* (25 g ha^{-1}). To avoid an early late blight infection of foliage and thus suffer a decrease of yield, chemical control was done with *Ridomil Gold MZ 68* (2.5 kg ha^{-1}). During the growth period the plants were hilled up three times and harrowed once. The preliminary, final and dynamic trials were planted in 5 replications, designed and analysed by the NNA (Nearest Neighbour Analysis) method using the AGROBASE 20 computer package. To assess the probability of differences between traits, the least significant differences (LSD_{05}) were calculated. In this paper all experimental data are presented as an average of the years 2000-2004.

The yield was weighed, the analysis of the yield structure was carried out and the starch content was estimated with Reimann scales (on the basic of special weight). The yield structure contains tubers per plant, tuber weight and damaged tubers. The dynamics of the tuber yield was determined three times at intervals of 7 days. Each sample consisted of 10 plants harvested by hand from the test plots. The planting material was pre-sprouted.

Phytophthora infestans DB (late blight) was visually estimated as a percentage of the infected foliage surface. The estimate of late blight was carried out three times and the first estimate was based on the beginning of the infection. Resistance to tuber diseases (tuber rots, black scurf, common scab) was estimated on a 0-5 point scale and potato viruses visually on a 0-9 point scale, where 0 was the most resistant.

Cooking estimats of the cooking and other quality traits tests were carried out by the workers of the potato breeding section of the Jõgeva PBI in autumn and spring (Tsahkna, 2004[b]). The taste was estimated on a 9-point scale where 9 was - excellent and 1 - unsuitable, with strong flavour. Mealiness was estimated on a 5-point scale, where 1 was watery, mellow and moist, 5 dry and very mealy. Disintegration (destruction or disintegration during boiling) was also estimated on a 5-point scale, where 1- stood for tuber that remained whole and 5 for a tuber that had disintrigated into pieces . Enzymatic darkening as well as after cooking darkening was estimated after 1,5 and 24 hours on a 9-point scale, where 1 showed no darkening and 9 a strong darkening of the tuber (Tsahkna, 2000). Two methods for making an estimate for the suitability of potato varieties for chips have been used: the colour test after frying the tuber slices (1-9 points, where 8 and 9 points are preferred) and the determination of the content of reducing sugars by the colorimetric method. Varieties with high (200-220 g kg^{-1}) dry matter and low (2.0-2.5 g kg^{-1} in raw mass) reducing sugars content are preferred for chips. The suitability for chips was estimated both in autumn and spring. In order to estimate chip quality in the spring, the samples were kept for 4 weeks in +10°C temperature (Tsahkna, 1995).

For the peeling test five tubers were peeled with an abrasive peeler. The tubers were weighed before and after the peeling and the peeling remains were calculated (Tsahkna, 2004[a]).

Results and Discussion

The morphological description of the variety Reet is given in accordance with UPOV characteristics. Plant height is medium to tall and growth habit erect. The leaf is small, with a medium intensity of green colour. The thickness of the main stem is medium to thick and with medium extension of antocyanin coloration. The flower corolla is small, blue-violet and the intensity of the antocyanin coloration of the inner side is medium to strong. Lightsprout is medium, spherical and blue-violet. The skin colour of tuber is yellow, the colour of the flesh is yellow and the depth of the eyes is shallow.

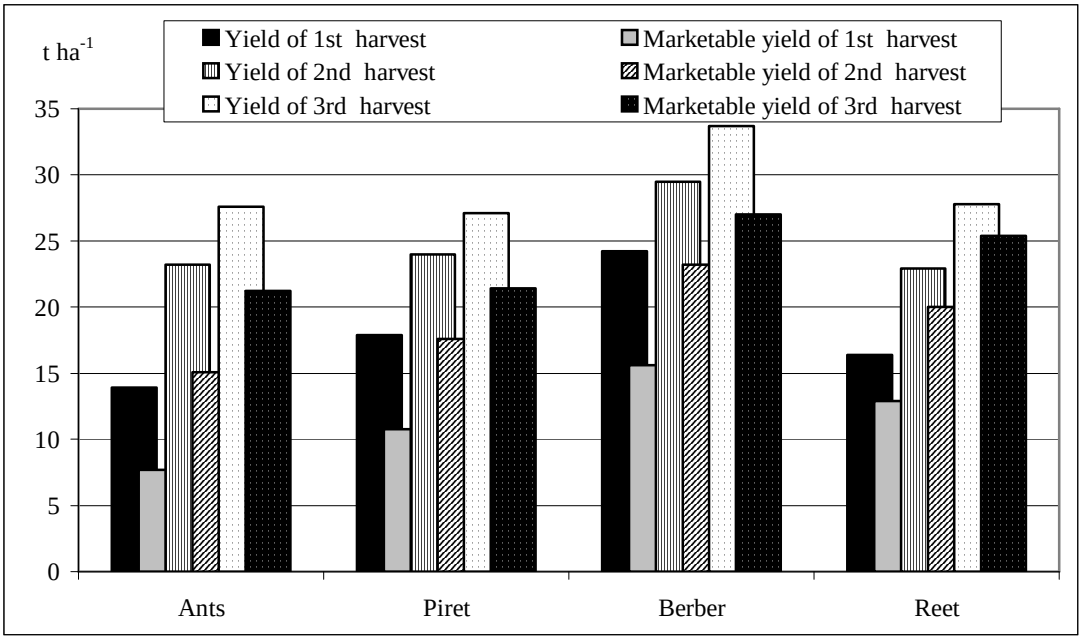
The most important yield characteristics (yield of tubers, number of tubers per plant, weight of tuber, damaged tubers) and starch content of new potato variety Reet are compared with the standard varieties (Berber, Piret and Ants) and presented in Table 1.

Table 1. Yield characteristics of the potato variety Reet at the Jõgeva PBI in 2000–2004

Character	Unit	LSD_{05}[1]	Ants	Piret	Berber	Reet
Tuber yield	t ha^{-1}	3.4	37.8	41.6	34.2	36.6
Tubers per plant	number	1.4	9.0	8.9	8.5	6.9
Tuber weight	G	10.0	75.0	84.0	74.0	100.0
Starch content	g kg^{-1}	7.0	141.0	155.0	118.0	159.0
Damaged tubers	g kg^{-1}	6.0	26.0	25.0	20.0	38.0

[1]LSD_{05} – least significant differences at P = 0.05

The results of the dynamic trials demonstrated the earliness of the variety Reet. The marketable yield of tubers harvested at three different times is shown in Figure 1.
Disease resistance to the most important diseases (late blight, tuber rots, black scurf, common scab, potato viruses X-Y-PRLV-M) of the new variety is given in Table 2. The early variety Berber is very susceptible to foliage late blight (*Phytopthora infestance)*, Ants and Piret are moderately resistant to late blight.



LSD_{05} of tuber yield of 1st harvest –3,4 t ha^{-1}; LSD_{05} of tuber yield of 2nd harvest –2,6 t ha^{-1}; LSD_{05} of tuber yield of 3rd harvest –2,9 t ha^{-1}.
LSD_{05} of marketable tuber yield of 1st harvest –3,1 t ha^{-1}; LSD_{05} of marketable tuber yield of 2nd harvest –2,6 t ha^{-1}; LSD_{05} of marketable tuber yield of 3rd harvest –1,9 t ha^{-1}.

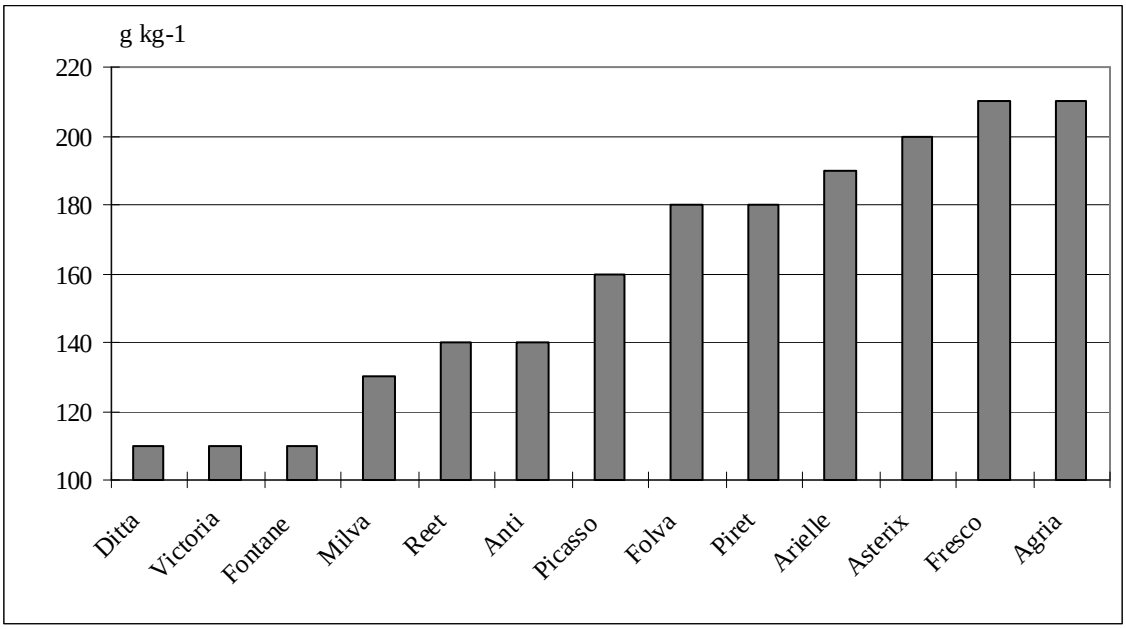
Figure 1. Yield of tubers and the marketable yield of the variety Reet in the dynamic trial at the Jõgeva PBI in 2000–2004

The cooking quality traits and the peeling quantity of Reet are very important because it was bred as a table and industrial variety. Table 3 presents the data of taste, mealiness, disintegration, darkening, chips colour and the content of reducing sugar of Reet compared with standard varieties. The results of peeling quantity of some listed varieties tested in 2005-2006 are compared in Figure 2. The vegetation period of the pre-sprouted variety Reet is 90-100 days. The initial development is medium rapid in Estonian climatic conditions.
Yield characteristic. The tuber yield of Reet (36.6 t ha^{-1}) was equal to Ants and Berber but significantly lower 5.0 t ha^{-1} than that of Piret (LSD_{05} 3.4 t ha^{-1}). The tuber weight and the number of tubers per plant are closely related. All standard varieties exceeded the new variety Reet by number of tubers per plant, but the average tuber weight of Reet was the biggest (100 g) compared with other varieties. The largest tubers of Reet tended to be damaged more during the harvest (Table 1).

Table 2. Disease resistance of the potato variety Reet at the Jõgeva PBI in 2000–2004

Character	Unit	Ants	Piret	Berber	Reet
Late blight: 1st estimation	%[2]	4.5	3.1	54.1	2.0
2nd estimation	%[2]	34.1	23.0	82.8	18.0
3rd estimation	%[2]	60.6	54.7	100.0	45.1
Tuber rots	g kg^{-1}	0.6	0.5	1.0	1.1
Black scurf	0-5 points[3]	0.4	1.0	0.8	0.4
Common scab	0-5 points[3]	0.4	0.4	1.0	0.6
Potato viruses X-Y-PRLV-M	0-9 points[4]	3-1-0-0	3-0-1-1	9-5-7-2	4-0-0-3

[2] – percentage of infected foliage surface
[3] – tuber disease resistance 0–5 points (0–resistant)
[4] – plants infected by potato viruses X-Y-PRLV-M in scale 0–9 (0–not infected)



LSD_{05}–15 g kg^{-1}

Figure 2. Peeling remains of some varieties in the Estonian Variety List tested at the Jõgeva PBI in 2005–2006,

The content of dry matter, including starch content, is influenced by the variety, the physiological age of tuber at harvesting, the intensity of light, the water supply in the soil, soil conditions, etc (van der Zaag, 1992; Tsahkna, Tähtjärv, 2007). As an average for the years 2000-2004 the starch content of the variety Reet was equal to the variety Piret, but higher than that of the varieties Berber and Ants.

The dynamics of potato yield formation is significantly influenced by weather conditions. Therefore the average of 5 experimental years gives an objective view of the yield formation and earliness of the new variety (Figure 1). The early variety Berber exceeded the variety Reet significantly by tuber yield in all three harvests in the dynamic trials but in terms of marketable tuber yield the numbers were not significant. By marketable tuber yield Reet exceeded the variety Ants in all harvests respectively 5.2, 4.9 and 4.2 t ha^{-1} and the variety Piret in the 3rd harvest. From these results we have concluded that because of the higher total tuber yield for the variety Reet we can also get higher marketable tuber yield compared to variety Berber.

Disease resistance. Reet is a nematode (Ro1) and wart (D 1) resistant variety. The importance of resistance breeding has not changed but the importance of external and internal tuber quality is becoming more and more important. External tuber disorders, like coverage with common scab *(Streptomyces scabies* Waksman et Henrici) and black scurf *(Rhizoctonia solani* Kühn) reduces their marketability. According to the trial data presented in Table 2 the appearance of black scurf

and common scab in the variety Reet was low, ass were the amount of plants infected by potato viruses. The X-virus was the most destructive among potato viruses (4 points).

Different strategies have been used at the Jõgeva PBI to breed late blight resistant varieties. Two different resistance forms to late blight exist in potato plants. Major genes give full protection against the different physiological races of *Phytophthora infestans*, but from the emergence of new races resistance is lost. Increases in pathotype complexity and diversity create additional difficulties in potato breeding for late blight resistance. Only varieties with a high level of field resistance are able to resist severe late blight epidemics. New sources of disease resistance were used to create more resistant varieties (Koppel, Tsahkna, 2003). The variety Reet exceeded the standard variety Berber its low first infection rate and the slower speed of foliage late blight infection in all 3 estimates (Table 2). Compared to standard varieties the new variety had a higher resistance to foliage late blight. This is a very important trait of the variety that may increase tuber yield.

Cooking quality. The taste of potato is not a very important trait in the breeding programme at the moment, but since our consumers use the potato as a table potato we will still estimate this feature. In addition to taste disintegration, mealiness after cooking the darkening of cooked potatoes and enzymatic darkening are the most important traits to determine cooking quality. Reet has been bred as an industrial variety but its cooking quality also shows that it is suitable as a table potato (Table 3). The taste of Reet is considered not as good as standard varieties. Disintegration is also low and mealiness is at the same level as the variety Ants. That the new variety can be used for salads and as a table (cooking type AB). The high content of chlorogenic acid is one of the main reasons for the darkening of raw potato tubers and is coused mainly by genotype, but also by weather conditions (drought, water stress). The trails data has shown that a low content of chlorogenic acid in the varieties correlats with low after cooking (non-enzymatic) darkening (Koppel, Tsahkna, 2003). Table 3 shows that enzymatic darkening of Reet is absent or is minimal and after cooking darkening is also less compared with the standard varieties. It is very important in industrial use. The contents of dry matter and reducing sugars are also very important traits for industrial use. The results of the trials show that the variety Reet has a low content of reducing sugars in autumn and a slightly higher content in the spring resulting in light yellow (8 points) even coloured. The results have proved that the suitability of potato genotypes for making chips can be estimated a visual color test after frying.

Table 3. Cooking quality of the potato variety Reet at the Jõgeva PBI in 2000–2004

Character	Unit	Ants	Piret	Berber	Reet
Taste	1-9 points[1]	7.3	7.5	6.9	6.2
Mealiness	1-5 points[2]	2.5	2.8	1.6	2.3
Disintegration	1-5 points[2]	1.1	1.6	1.0	1.0
Darkening: after cooking	1-9 points[1]	1.6	1.2	1.3	1.3
Enzymatic	1-9 points[1]	4.0	1.2	1.7	1.7
Chips colour: in autumn	1-9 points[1]	7.6	8.0	6.5	8.0
in spring	1-9 points[1]	5.5	7.3	5.0	8.0
Content of reducing sugars: in autumn	g kg^{-1}	2.5	2.0	5.0	2.0
in spring	g kg^{-1}	6.0	2.5	10.0	3.2

[1] – 9–the excellent taste or max darkening or preferred chips colour; [2] – 5–max mealiness or crumbliness

As the suitability of the tubers for mechanical processing cannot be estimated solely on the basis of the external quality traits of tuber, peeling tests with an abrasive peeler were carried out. The results of the peeling remains of the tested varieties of the Estonian Variety List are given in Figure 2. The variety Reet had no significant differences in peeling remains compared with the varieties Milva and Anti. The varieties Ditta, Victoria and Fontane had less peeling remains. Had significantly more peeling remains the varieties Picasso, Folva, Piret, Arielle, Asterix, Fresco and Agria.

Conclusions

The nematode (Ro1) and wart (D 1) resistant early to medium ripening potato variety Reet (breed J 649-94) has been developed at the Jõgeva PBI and included in the Estonian and European Variety List in 2007. Reet is a selection from the cross between Mats and GitteN.

The tubers of the new variety have regular shape, shallow depth eyes, yellow skin and flesh colour and a blue-violet flower corolla. Reet has medium tuber size and a high marketable tuber yield. The number of tubers per plant is medium but the average tuber weight is large. The new variety is relatively resistant to potato virus diseases, foliage late blight, black scurf and common scab. Because the foliage late blight infecting starts slower and spreads less the new variety is suitable for use in organic farming.

The new variety is free from darkening after cooking and enzymatic discoloration, it has a low content of reducing sugars and rather small peeling remains. Reet can be used as a table and industrial potato, including making chips and French fries.

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JAUNA KARTUPEĻU ŠĶIRNE 'REET'

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Rakstā izklāstīts jaunas, pret nematodi (Ro1) un vēzi (D 1) izturīgas, agras līdz vidēji agras, Jegevas selekcijas institūtā (Jõgeva PBI) izaudzētas kartupeļu šķirnes 'Reet' ('Mats x 'Gitte') raksturojums. Šķirne 'Reet' 2007. gadā iekļauta Igaunijas un Eiropas Augu Šķirņu Katalogā. Selekcijas mērķis bija izveidot šķirnes, kas atbilst pārtikas tirgus un pārstrādes uzņēmumu prasībām. Šķirnei 'Reet' 2000. – 2004. veikta iepriekšējās un gala pārbaudes Jõgeva PBI, salīdzinot ar standartšķirnēm 'Berber' (agra), Piret (vidēji agra) un Ants (vidēji vēla). Kartupeļu bumbuļu raža šķirnei 'Reet' bija līdzvērtīga šķirņu 'Ants' un 'Berber' ražai, bet zemāka kā šķirnei 'Piret'. Dinamikas izmēģinājumos dažādos ražas vākšanas termiņos bumbuļu preču produkcijas raža šķirnei 'Reet' bija vienāda ar šķirnes 'Berber' ražu. Kartupeļu bumbuļa svara ziņā šķirne 'Reet' pārspēja standartšķirnes, lai gan bumbuļu skaits vienā cerā bija zems. Šķirnes augiem bija ļoti maz melnā kraupja, parastā kraupja un vīrusslimību infekcijas pazīmju. Tai bija relatīvi laba izturība pret lakstu puvi uz lapām, pārsniedzot visu standartšķirņu izturību. Tātad jaunā šķirne ir piemērota bioloģiskajai lauksaimniecībai. Šķirnei 'Reet' ir labas kvalitatīvās īpašības (seklas acis, izlīdzināta forma, netumšojas). Mizošanas testa ar abrazīvo mizotāju laikā konstatēts, ka šķirnes bumbuļiem ir relatīvi maz mizošanas atlieku, apmēram 100.0-150.0 g kg^{-1}. Reducējošo cukuru saturs bija zems. Tas liecina par piemērotību čipsu un frī gatavošanai.