CULTIVATION OF POTATO VARIETIES IN DIFFERENT LOCATIONS IN ESTONIA

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ABSTRACT. *Due to different conditions and requirements in various locations, many potato varieties exist all over the world. Some varieties can be grown in many places and have a wide range of usability, while others are meant for very specific purposes or for specific environmental conditions.*

The aim of this paper was to find out how the same potato variety may be affected by different soil and weather conditions.

Higher plausible yields of tuber were at three locations in Tartu, except the variety 'Maret', affected by more moisture retaining soil. Kuusiku and Jõgeva tests did not have any credible differences between the varieties 'Anti', 'Piret' and the breed 1182-97.

Most of the varieties and breeds tested at Jõgeva, except the breed 649-94, had credibly the highest weight of tuber; the lowest was in Tartu. At the same time the amount of tubers per plant was the lowest at Jõgeva and the highest in Tartu. There was no credible difference in the average weight of tuber or it was minimal at Jõgeva and Kuusiku. The same tendency could be noticed about the amount of tubers per plant.

The variety 'Piret' and the breed 1182-97 did not have any credible differences in marketable tubers. The biggest difference in marketable tubers between different locations had the variety 'Maret', in which case for example in Kuusiku it had 18% less marketable tubers than in Tartu and 16% less than at Jõgeva.

The varieties at Kuusiku had credibly the highest starch content.

The results of tests show that the same variety planted in different locations in Estonia also has differences in yield factors.

Keywords: *potato variety, precipitation, soil, location, yield of tuber, weight of tuber, tubers per plant, marketable tubers, starch content.*

Introduction

Although potato is quite adaptable to planting conditions and it is considered to be cultivatable in almost all climate and soil conditions, it has, as every culture, certain requirements for ecological conditions (Jõudu, 2002). The stability of variety features and preserving quality in different conditions have great importance; both total and graded yield and quality factors are affected by variety and location (Crop Monitor, 2003, Tomasiewicz *et al*., 2003, Haase *et al.*, 2005).

Every potato producer is aware that it is better to cultivate locally bred varieties in similar conditions. But the local conditions may also have different soil or weather conditions. The yield of tuber and its quality may be affected by the length of vegetation period and weather, soil type and soil texture. The weather conditions that affect the yield the most are precipitation and air temperature (http://www.gvc.gu.se/… 2002, http://mars.jrc.it/marsstat/Crop_Yield_Forecasting…)

According to references, sharp transitions of potato tubers from one soil type to another (*e.g.* from clay to sand) may cause stress, also severely curtail root growth, because the potato root is not strong and has difficulty in penetrating caked or heavy soils. This situation may cause decrease in yield or quality (Van der Zaag, 1992). The amount and distribution of rainfall during the vegetation period suitable for certain variety requirements and soil conditions have great impact on the yield and the quality of tuber (Vesik, 1996). The need for water also depends on soil texture. For example, during the potato growth period it is 370–390 mm on sandy loam and 300–320 mm on loamy soil (Tartlan, 2005).

Potato prefers light and airy soil. The most suitable for potatoes are sandy loam and loamy soils full of humus (Vesik, 1966, http://cropandsoil.oregonstate.edu/classes…). Sandy soils have a lower percentage of organic matter and soil moisture, whereas clay soils have a higher percentage of organic matter and soil moisture. Finer textured soils have more moisture, which increases microbial activity (Haluschak *et al*., 2003).

The content of dry substance (including starch content) varies during different years even within the same variety. The content of dry substance depends on the variety, the weather conditions, the location (Van Eijk, Hak, 1995, Brunt *et al.*, 2002)). Mainly cool and misty weather decreases the content of dry substance, while warm and sunny weather increases it (Tsahkna, 1995).

Material and methods

The research observed three varieties of Jõgeva Plant Breeding Institute: 'Anti' (late), 'Maret' (early), 'Piret' (medium) and two breeds: 649-97 (medium), 1182-97 (medium late). The tests were taken at three different locations in Estonia: at Jõgeva Plant Breeding Institute (Jõgeva), at Kuusiku Testing Centre of Agricultural Research Centre (Kuusiku) and at Eerika experimental field of Agricultural and Environmental Institute of Estonian University of Life Sciences (Tartu) in 2005. The seed potato originated from Jõgeva Plant Breeding Institute. All the fields had similar cultivation and fertilization. The fields were deeply shredded, cultivated and complete chlorine free mineral fertilizer Cropcare (N:P:K – 8:12:23) by 600 kg per ha was used. During the growth period the plants were hilled up three times and harrowed one time. The late blight control was done by Ridomil Gold MZ 68-ga (2.5 kg per ha) once. The testing field of Jõgeva Plant Breeding Institute was on brown lessive medium texture loamy soil (ls). The testing field of Kuusiku Testing Centre was on light loamy texture pebble rendzina soil. Eerika experimental field was on light loamy pseudopodzolic soil (Kõlli, Lemetti, 1999).

The quality traits of potatoes are during the vegetation period to a certain degree affected by the weather. According to the expert on agricultural meteorology at Jõgeva Plant Breeding Institute L. Keppart, at the time of planting potato in 2005 (the last ten days in May) the air and soil temperatures were permanently above 10 °C. At first the growth was slow due to the cool weather and little rain in June. It got warmer in July, but there was not enough moisture in the soil. At the beginning of July the productive water supply in the soil was at the minimum of optimal level. Owing to dryness quite few tubers formed, the infection with common scab and growth disorders appeared more often, as because of the dry soil the plants were not able to absorb nutrients. Huge amounts of precipitation at the beginning of August caused floods in some fields in Pärnumaa and North-West Estonia, as a result of which the potatoes started to decay and there was a mass-spread of late blight. The weather of the second part of August and the beginning of September favoured potato's growth until severe night frost on September 17 ended the growth of some late potato varieties at Jõgeva and other places. The weather conditions were suitable for harvesting. The previously mentioned weather pattern shows how different the conditions may be in Estonia and how they affect the yield and quality of potato varieties cultivated in different locations.

The analysis of the yield of all the testing places was carried out at Jõgeva Plant Breeding Institute (Jõgeva PBI). The yield was weighed, the analysis of the structure was carried out, the starch content was measured by Reimann scales. ANOVA randomized complete block design was used for data processing. The date analyse was carried out by programm Agrobase 20.

Results and discussion

As Estonia is part of the European Union (EU), it is allowed to import every potato variety on the list of the varieties of the EU. But practice has shown that the imported varieties do not perform in accordance with their description. To provide scientific explanation to this kind of peculiarity, a test was set up at different locations in Estonia. The results were meant to account for the previously mentioned practice.

In order to bring out the dependence of the test results on the soils of the different locations, it is necessary to describe these soils from an agro-technical point of view.

The testing field of **Jõgeva PBI** was located on medium texture **brown lessive soil**. The natural drainage of these soils is impeded. Thanks to quite good ventilation they warm up normally in spring and there are no delays in becoming ready to cultivate. This is good field soil with high productivity and suitable for intensive use. The suitability of use for potatoes is 9. They have an optimal content of humus and a good structure, favourable water capacity and a pervious soil. The amount of yield depends on fertilization, agro-techniques and the amount and spread of rainfall during the vegetation period. A short drought is not an issue. In South-Estonia the brown lessive soil often involves pseudopodzolic soil. And so was **Eerika** experimental field located on light loamy **pseudopodzolic soil**. This soil has a low content of humus and calcium, a low ability to keep humus and must be as a result properly fertilized. There is a possibility of density formation under the ploughing layer and upper water temporarily in spring and autumn, which limits the use of agro-technical measures at the right time. The suitability of use for potatoes is 9. The testing field at **Kuusiku Testing Centre** was located on light loamy texture pebble rendzina soil. These soils are slightly pebbly, fertile, full of forage and generally rich in nutrients. They are sufficiently moist and pervious, their water capacity is low. Drought might become a problem, but the soil warms up quickly in spring. There is a low humus and calcium content. Medium deep and deep pebble soils are universal in terms of suitability of usage, being appropriate for the cultivation of most cultures. (Kõlli, Lemetti, 1999).

As one factor affecting potato yield and quality is weather conditions during the vegetation period, a table with rainfall amounts at different locations has been drawn up (Table 1). Potato needs 2.5–3 mm of moisture per day in June and 4–6 mm in July. At Jõgeva there was an average rainfall 1.7 mm per day in June and 1.9 mm in July and in Kuusiku 2.6 mm in June and 1.6 mm in July. It became warm in July, but nevertheless, the amount of

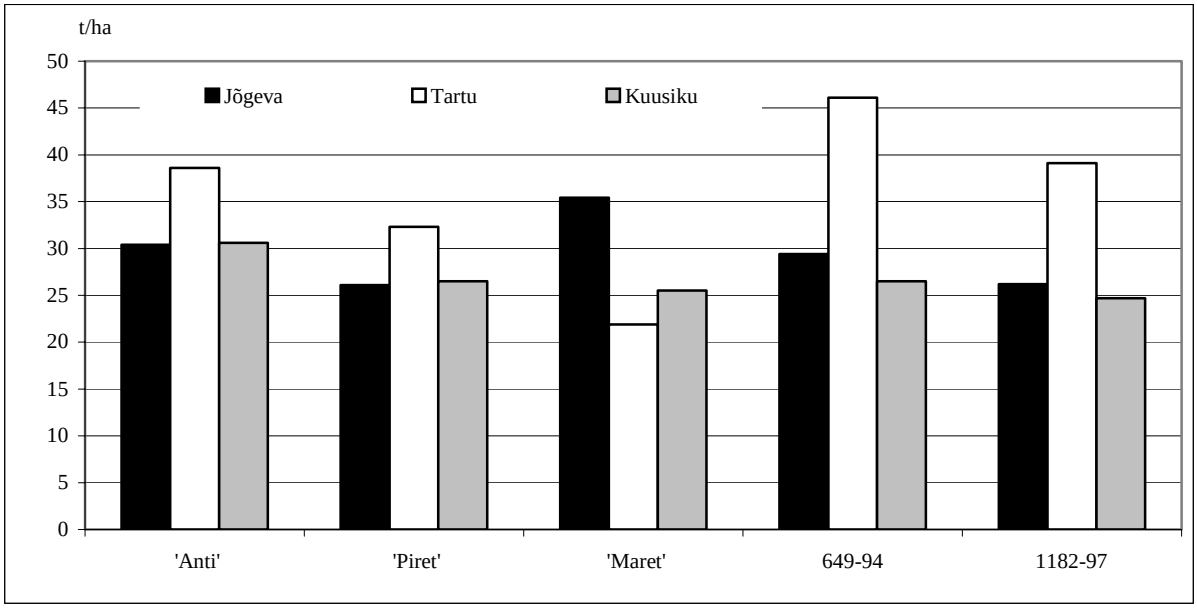
moisture in the soil was not sufficient for potato. The productive water supply at the beginning of July was at a minimal level of the optimal need. If the need for water during the active growth period could be satisfied by 300 mm of rainfall, then according to the references it might be divided as follows: 70 mm in June, 120 mm in July and 90 mm in August (Jõudu, 2002). But at Jõgeva it was 50 mm and at Kuusiku 79 mm in June, in July respectively 60 mm ja 50 mm, in August 116 mm and 171 mm.

Table 1. Rainfall during the vegetation period in 2005 (mm)

Location/Month	June	July	August
Norm ls/sl	70/85	120/150	90/115
Jõgeva	50	60	116
Kuusiku	79	50	171
Tartu	69	25	96

As a result of testing, the yield of tuber, starch content, weight of tuber, tubers per plant and the amount of marketable tubers were evaluated. In the case of all data attempts were made to find connections between the soil of the location and the rainfall during the active vegetation period.

Yield of tuber. Figure 1 shows that the early variety 'Maret' and medium variety 'Piret' had relatively low yield, because there was precipitation below the norm in June and July and due to the drought the plants could not absorb the nutrients. 'Maret' gave the highest yield at Jõgeva, because it formed before the drought period and its size was affected by the rainfall at the end of July. In July the least rainfall was in Tartu and this could probably affect the yield of 'Maret' to such a degree that it appeared to be credibly the lowest of the three locations. The yield of 'Piret' was the highest in Tartu. There was no credible difference between the yields at Jõgeva and Kuusiku. Medium breed 649-94 had the highest yield in Tartu, which was probably caused by suitable soil and rainfall in August. The breed 649-94 had credible difference in yields at Jõgeva and Kuusiku, although the amount of rainfall was almost the same, but the pebbly soil at Kuusiku is more pervious. The late variety 'Anti' could make use of the rainfall in August, which was above the norm in all three locations (a bit less in Tartu). The yields of 'Anti' at Jõgeva and Kuusiku were practically equal, however, the yield was credibly higher (38.6 t/ha) in Tartu, probably caused by the suitable soil and weather conditions. The yield of medium late breed 1182-97 was the highest in Tartu, too. The reasons were the same as in the case of 'Anti'.

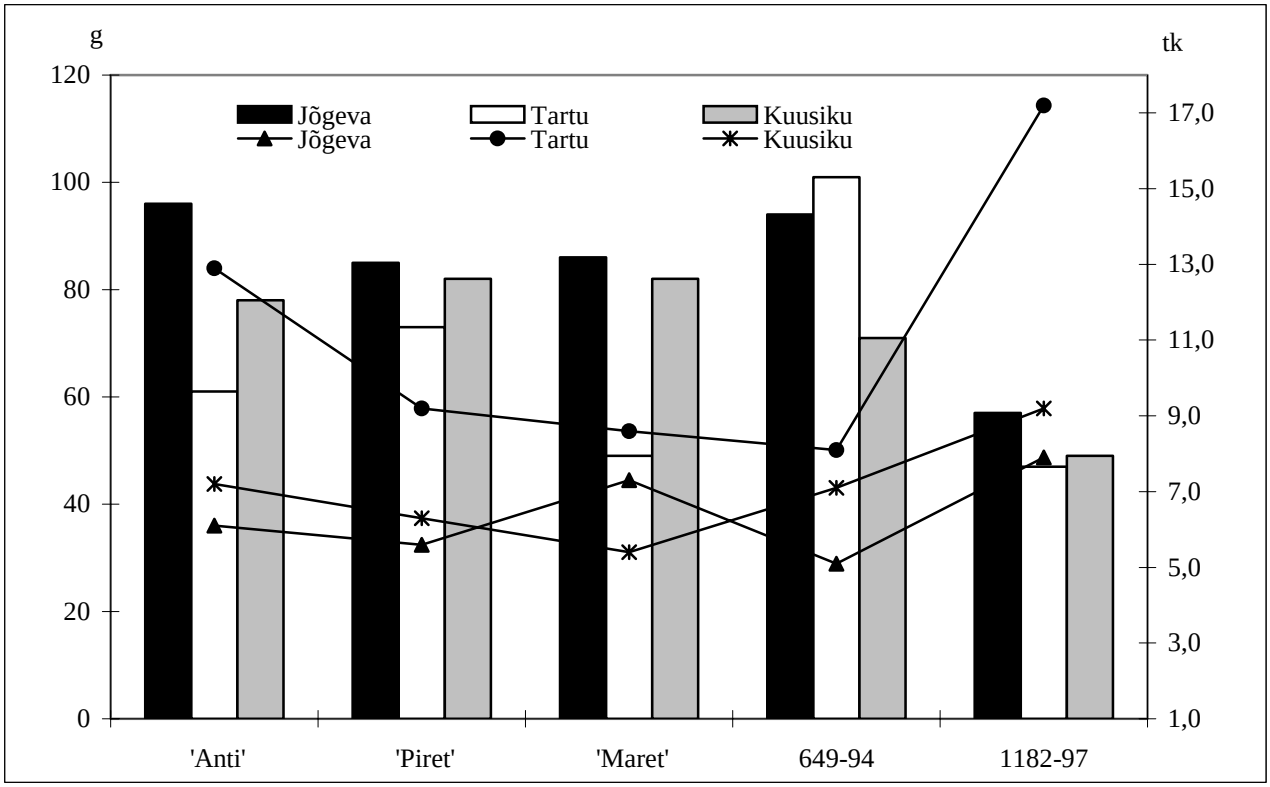


LSD 95% = 1.9

Figure 1. Yield of tuber (t/ha) at different locations in 2005

Weight of tuber and tubers per plant. The weight of tuber and the number of tubers per plant are closely related, which is why they are shown together in Figure 2. Most of the tested varieties and breeds at Jõgeva had the biggest average weight of tuber, except for the breed 649-94. The smallest tuber weight was in Tartu. At the same time Figure 2 shows that at Jõgeva there is also the smallest number of tubers per plant and the biggest is in Tartu. The above fact was caused by the drought in Jõgeva in June, because of which only few tubers formed per plant, but later the rainfall at the end of July and in August made these tubers grow big. But in

Tartu the amount of rainfall was almost normal, so the formation of tubers was possible and the dryness in July caused the small weight of tuber. The smallest average weight of tuber could be noticed in the case of the variety 'Maret' and the breed 1182-97 in Tartu (49 g and 47 g). Being an early variety, 'Maret' could probably form more tubers, but the following drought hindered their growth. The medium late breed 1182-97 grows fast in the beginning and has a long period of growth and consequently formed more tubers in comparison with another late variety 'Anti' (slow primary growth), but it could not grow them big enough due to the drought. Credible difference in weight of tuber did not appear or it was minimal at Jõgeva and Kuusiku, the same tendency appeared in the number of tubers per plant.



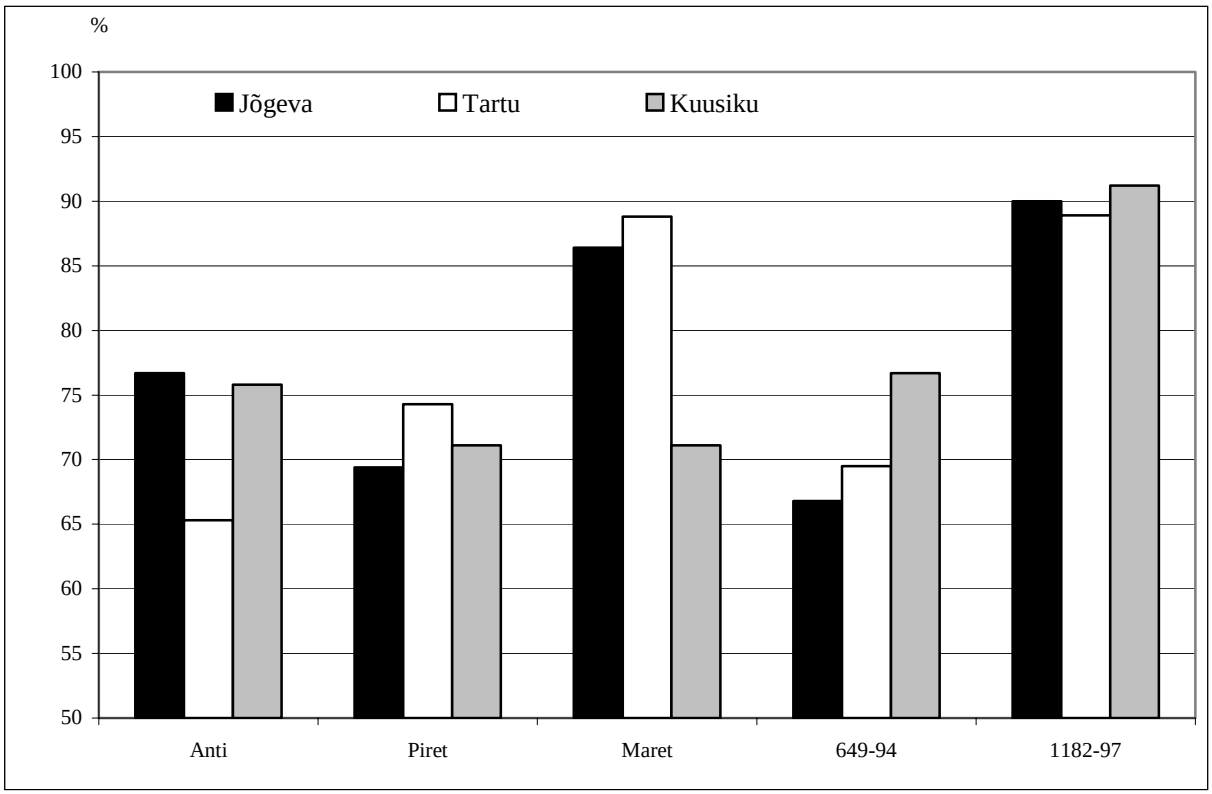
LSD 95%$_{\text{weight of tuber}}$ = 6, LSD 95%$_{\text{tubers per plant}}$ = 0.9

Figure 2. Weight of tuber (g) and tubers per plant (tuber) at different locations in 2005

Percentage of marketable tubers. Marketable tubers include tubers with the diameter of 35–60 mm. Figure 3 shows that the number of marketable tubers depends both on location and variety. There were no credible differences in location between 'Piret' and the breed 1182-97. The latter can be characterized by a relatively small average tuber and the yield of the year 2005 consisted of 90% of marketable tubers. 'Anti', 'Piret' and the breed 649-94 had comparatively fewer marketable tubers. This could be explained by a great number of relatively big tubers with the diameter of more than 60 mm which these varieties have and which are not considered marketable tubers. Having a relatively small number of tubers per plant, 20–30% of tubers grew bigger than 60 mm due to rainfall in August. The early variety 'Maret' at Jõgeva and in Tartu did not have many tubers over 60 mm (11% and 4%, respectively), only at Kuusiku the figure reached 28%. Figure 2 shows as well that its average weight of tuber was more than 80 g, but the number of tubers was the smallest compared to other locations.

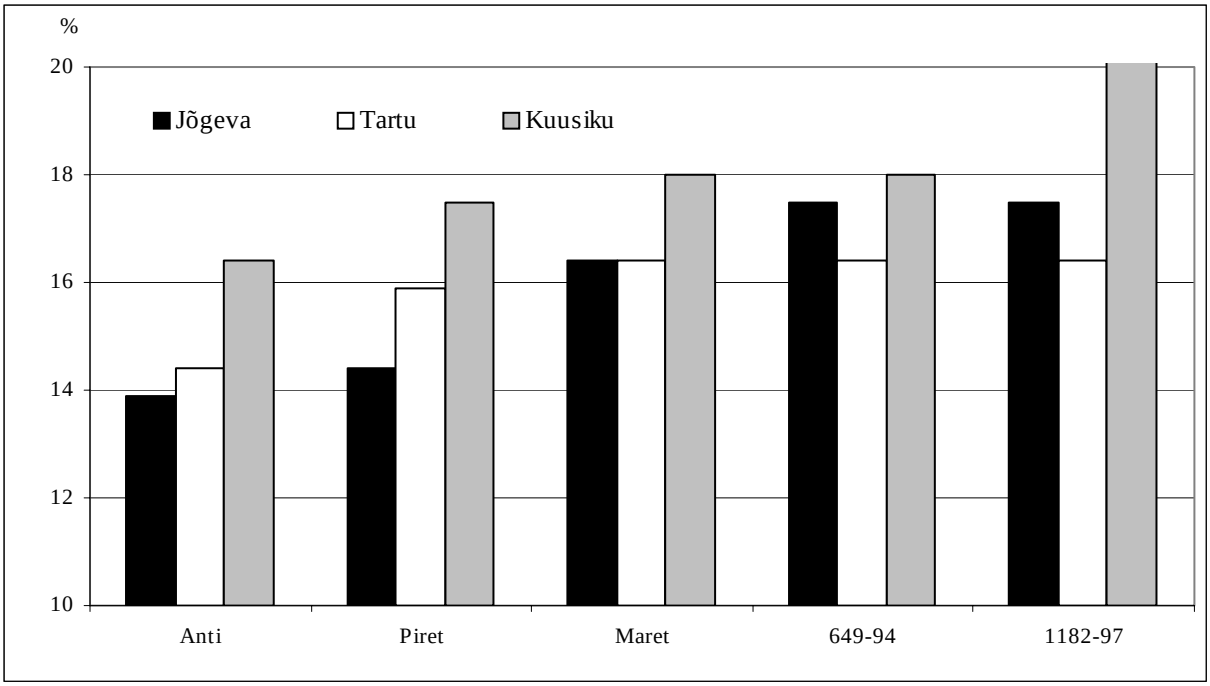
Starch content of tubers. Based on references (van der Zaag, 1992, Tsahkna, 1995, Tsahkna, 2004) and practice it is possible to state that the content of dry substance, starch content included, is influenced by variety, physiological age of tuber at harvesting, temperature, intensity of light, water supply in soil, soil conditions, etc. Figure 4 shows the differences of starch content in tubers depending on variety and location. Credibly the highest starch content was at Kuusiku, although there was more rainfall during the active vegetation period than at Jõgeva and in Tartu. But the pebbly soil at Kuusiku is more pervious and suffered more under the drought. According to Tsahkna, 1995, warm and sunny weather increases the starch content in tubers. The summer of 2005 was especially droughty at the tested locations. The varieties 'Anti' and 'Maret' did not have any credible differences in starch content at Jõgeva and Tartu locations.

The test reveals the answer to the statements of consumers about the different starch content of the same variety of the same year. We can see that the difference of starch content among the same variety can be from 2.5% ('Anti') to 3.7% (breed 1182-97).



LSD 95% = 9.8

Figure 3. Percentage of marketable tubers in yield (%) at different locations in 2005



LSD 95% = 1.1

Figure 4. Starch content at different locations in 2005

Summary

The aim of this paper was to find out how the same potato variety may perform in different soil and weather conditions. The tests were carried out in 2005, using five different varieties of Jõgeva Plant Breeding Institute at three different locations in Estonia (Jõgeva, Tartu, Kuusiku). The yield of tuber, the weight of tuber, the number of tubers per plant, the percentage of marketable tubers per yield and starch content were measured.

1. Yield of tuber. The highest plausible yield of tuber could be observed at three locations in Tartu, except the variety 'Maret'. As in Tartu there was the least of rainfall during the vegetation period (190 mm) and at Kuusiku the most (300 mm), the highest yield in Tartu was caused by the bigger water capacity of the soil. There were no plausible differences in yield between the varieties 'Anti', 'Piret' and the breed 1182-97 in the course of the tests at Kuusiku and Jõgeva.

2. Weight of tuber and number of tubers per plant. Most of the tested varieties and breeds at Jõgeva had the biggest plausible average weight of tuber, except the breed 649-94, being the smallest in Tartu. At the same time, at Jõgeva there was the smallest number of tubers per plant and in Tartu the biggest. It was caused by drought at Jõgeva in June and at the beginning of July. In Tartu the level of precipitation was normal so that more tubers could form, but the drought in July lowered the weight of tubers. At Jõgeva and Kuusiku there was no plausible difference between the average weight of tuber, or it was minimal. The same tendency could be observed in the case of the number of tubers per plant.

3. Percentage of marketable tubers. The variety 'Piret' and the breed 1182-97 did not exhibit any plausible differences in the proportion of marketable tubers between the locations. The breed 1182-97 had the highest percentage of marketable tubers, because the yield consisted of comparatively equal-sized tubers. The lack of differences could be explained by the fact that the diameter of marketable tubers may have a wide range (35–60 mm). The variety 'Piret' exhibited little variation in the percentage of marketable tubers.

4. Starch content of tubers. The highest plausible starch content could be noticed at Kuusiku. The growth period displayed the highest amount of precipitation, but as the soil was more pervious, a deficiency in water appeared, causing high starch content.

As a result of the tests it is possible to state that the factors of yield and quality of the same variety may differ in different locations. If these differences appear even in such a small country as Estonia, it is true that an imported variety from different soil and weather conditions may perform in a completely different manner in our Estonian conditions.

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