

EVALUATION OF POTATO VARIETIES FOR ORGANIC FARMING

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Abstract

The suitability of potato varieties for organic farming was evaluated in certificated organic fields. Two medium early varieties ('Sante', 'Lenora') and four medium late varieties ('Brasla', 'Bete', 'Zile', 'Magdalena') were estimated during two years. The tests were carried out in three trial places: Priekuli, Vecauce, Skrīveri. The influence of growing conditions and variety were significant on potato tuber yield. The yields of medium early varieties mostly did not differ significantly in each place both years. The highest average yield between medium late varieties was observed for variety 'Bete'. Leaf resistance of medium early variety 'Lenora' to late blight (*Phytophthora infestans* (Mont.) de Bary) exceeded resistance of the variety 'Sante'. Medium late varieties 'Bete' and 'Zile' had comparatively high resistance to late blight. The starch content of variety 'Brasla' was more than 15% (acceptable for starch production) in each place both years. The comparatively less common scab (*Streptomyces scabies* (Thaxter) Waksman and Henrici) damages were observed on tubers of variety 'Lenora', and black scurf (*Rhizoctonia solani* Kuhn) blemishes – on variety 'Sante' tubers. The most suitable for organic farming were varieties 'Lenora' and 'Zile', but for specific utilisation purposes (starch production or cookery) 'Sante', 'Brasla' and 'Bete' were acceptable.

Key words: potato, organic farming, variety

Introduction

The organic agriculture in Latvia as in other European countries is developing quite fast in the last years. The area of certified land for organic farming was 48 000 ha in 2004. Farmers – producers of organic products – look for productive crop varieties, suited to their local climatic and soil conditions and that are not susceptible to disease and pest attack. Actually, organic agriculture standards recommend the cultivation of site-adapted crop varieties (El Hage Scialabba and Hattam, 2002). Before producing commercial potato seed for organic farmers, the most suitable varieties have to be chosen (Bonnell, 2004; Koppel, 2001). The organic farming growing conditions requires adaptability and stability of potato varieties (Haase *et al.*, 2002). The most important traits for suitable variety in organic farming are: stronger rooting system, quicker haulm development, stability of yielding, stable and high starch content, durable resistance to main diseases (Haase *et al.*, 2002; Koppel, 2001). Mostly the acceptable characteristics are found in the older native cultivars (El Hage Scialabba and Hattam, 2002). Several experiments suggest that modern varieties are well-adapted to harsh environment and present a good level of disease resistance, frequently higher than the one of old varieties and landraces (Le Buanec, 2004). The recent varieties are more acceptable to consumer's demands than the old ones.

The aim of the research was to evaluate suitability of potato varieties to organic farming.

Materials and Methods

The suitability of potato varieties for organic farming was evaluated in certificated organic fields during 2003 and 2004. The growing methods were used according to regulations of organic agriculture settled by the Latvian Council of Ministers.

Tested varieties are described in Table 1. All tested varieties are resistant to nematodes (*Globodera rostochiensis*). All varieties are suitable for market, variety 'Brasla' is used for starch production, too. The used seed material corresponded to basic seed potato quality requirements.

The traits were estimated according to the State Plant Protection Service methodology for evaluation of economical characteristics. The main stress was put on yield, starch content, and resistance to main diseases.

Table 1. The characteristics of tested potato varieties

| No. | Variety | Maturity | Country of origin | Year of realization |
|-----|-----------|--------------|-------------------|---------------------|
| 1. | Sante | Medium early | The Netherlands | 1981 |
| 2. | Lenora | Medium early | Latvia | 1995 |
| 3. | Brasla | Medium late | Latvia | 1990 |
| 4. | Bete | Medium late | Latvia | 1994 |
| 5. | Zile | Medium late | Latvia | 1984 |
| 6. | Magdalena | Medium late | Latvia | 2001 |

The tests were carried out in three trial places: Priekuli, Vecauce and Skrīveri. Mostly the soil characteristics were acceptable for potato growing in every trial place (Table 2). Available for plants potassium and phosphorus in the soil in Vecauce was lower than in other places. The soil texture in Priekuli was lighter than in other places. Oil rape as green manure was used in two sites thus improving growing conditions for plants. The difference between trial sites influenced the results and made possible to access varieties in varied growing conditions.

Table 2. The characteristics of soil in trial places in 2003 and 2004

| Place | Priekuli | | Vecauce | | Skrīveri | |
|--------------------------|-------------------------------|------------|---------|-------------------------------|------------|------|
| Year | 2003 | 2004 | 2003 | 2004 | 2003 | 2004 |
| Soil characteristics: | | | | | | |
| pH _{KCl} | 6.4 | 6.1 | 6.8 | 7.1 | 6.7 | 6.4 |
| humus g kg ⁻¹ | 21 | 30 | 32 | 19 | 33 | 36 |
| P, mg kg ⁻¹ | 64 | 78 | 40 | 34 | 71 | 65 |
| K, mg kg ⁻¹ | 149 | 107 | 66 | 71 | 106 | 124 |
| texture | sandy loam | sandy loam | loam | loam | loam | loam |
| Pre-crop | oil rape – green manure | winter rye | oat | oil rape – green manure | winter rye | oat |

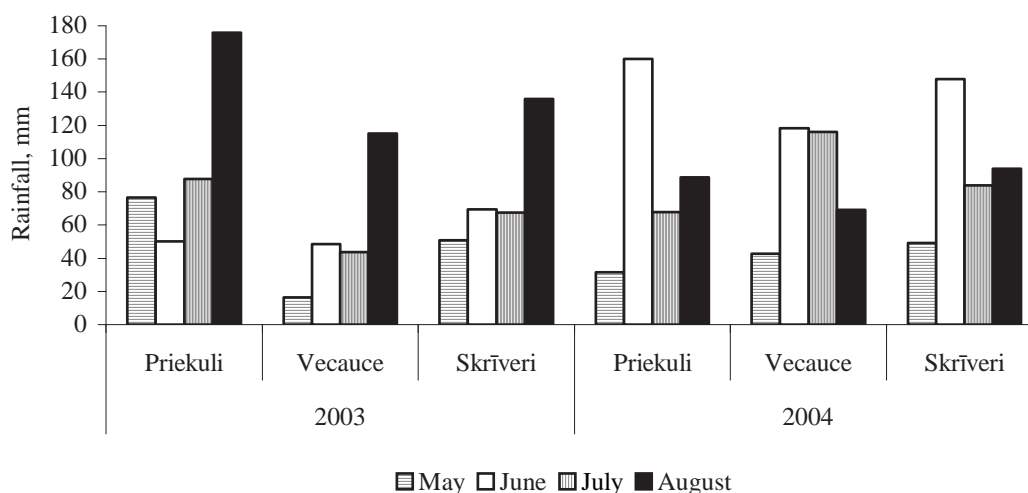


Figure 1. The rainfall in trial places during the 2003 and 2004 growing periods

The weather conditions were different from place to place every year. The average day temperatures did not differ essentially between trial places each year, but temperature in 2004 during the growing period was lower than in 2003, except for August. The average daily temperature in May, June, and July during 2003 was 12.2 °C, 14.1 °C and 19.7 °C, respectively. During the same months in 2004, the average daily temperature was from 0.6 °C to 3.3 °C lower – 10.3 °C, 13.4 °C, and 16.4 °C, respectively, which influenced potato growing. The development of plants in 2004 was slower than in 2003. Only August in 2004 was

wormer than the same month in the previous year; the average daily temperature in August was 15.8 °C in 2003 and 17.5 °C in 2004.

The rainfall was different in every trial place each year (Fig. 1). The least rainfall was observed in Vecauce in 2003, comparatively, the rainfall in Priekuli was twice as in Vecauce in July 2003. The quite high rainfall in August made harvesting difficult during 2003. The high rainfall and low temperature during May in Priekuli made favourable conditions for disease development at the beginning of the growing period in 2004. The quite high rainfall during June and the heavy soil texture in Skrīveri resulted in an extremely high soil humidity that dwarfed plant development in 2004.

Results

The influence of variety and growing conditions on potato yield was significant in both years ($p < 0.01$, except for variety influence in 2004 – $p = 0.03$). It proves the necessity for a proper choice of the variety and the growing place, but does not deny the significance of weather conditions.

The growing conditions in 2004, mainly weather conditions, were not so favourable as in the previous year. The average potato yield was 19.6 t ha⁻¹ in 2004 (comparatively in 2003 – 26.1 t ha⁻¹). Comparing the trial places in 2003, the highest potato yield was obtained in Priekuli, but the lowest in Skrīveri (Table 3). The difference of potato yields between growing places in 2004 was significant and high, the average yield in Skrīveri was about two times less than in other places. The comparatively forceful rainstorm during June made loam soil very wet and heavy that was unfavourable for potato plant development in Skrīveri.

Table 3. The yield of potato varieties, t ha⁻¹, in trial places during 2003 and 2004

| Variety | 2003 | | | 2004 | | |
|-----------|-------------------------------------|---------|----------|-------------------------------------|---------|----------|
| | Priekuli | Vecauce | Skrīveri | Priekuli | Vecauce | Skrīveri |
| Bete | 31.7 | 34.3 | 30.1 | 20.8 | 23.8 | 11.6 |
| Brasla | 30.7 | 27.8 | 24.2 | 21.4 | 29.8 | 10.1 |
| Lenora | 29.0 | 24.2 | 20.3 | 23.5 | 29.9 | 10.2 |
| Sante | 23.5 | 27.3 | 19.9 | 23.5 | 34.8 | 7.8 |
| Zile | 31.7 | 22.8 | 22.4 | 21.4 | 22.7 | 12.0 |
| Magdalena | 25.3 | 23.1 | 20.8 | 18.9 | 25.9 | 11.4 |
| Mean | 28.6 | 26.6 | 22.9 | 21.6 | 27.8 | 10.5 |
| | $\gamma_B = 1.6, \gamma_{AB} = 3.8$ | | | $\gamma_B = 1.7, \gamma_{AB} = 4.1$ | | |

A – varieties, B – trial places, $p < 0.05$.

The average potato yields between varieties differed significantly; the amplitude was from 19.9 to 34.3 t ha⁻¹ in 2003 and from 7.8 to 34.8 t ha⁻¹ in 2004 (Table 3). The ML variety ‘Bete’ had the highest yield in each trial place in 2003. The yield of two other ML varieties – ‘Brasla’ and ‘Zile’ – exceeded 30 t ha⁻¹ in Priekuli. The yield of the same varieties was higher than the yield of ML variety ‘Magdalena’ and of both ME varieties in Skrīveri, too. But in Vecauce, the yield of ME variety ‘Sante’ was similar to that of the ML variety ‘Brasla’; together with ‘Bete’ they exceeded other varieties in Vecauce. In 2004, the situation was different. The highest yield was reported for ME varieties in Vecauce, and variety’s ‘Sante’ yield exceeded that of ‘Lenora’. The yields of both varieties were similar in Priekuli and exceeded the yield of other varieties. The yield of potato varieties in Skrīveri was extremely low due to unfavourable growing conditions. In general, the highest average yield in both years was observed to ML variety ‘Bete’ (Fig. 2). There was no significant difference between the average yields of ME varieties ‘Lenora’ and ‘Sante’ in each year separately. The yields of varieties ‘Brasla’ and ‘Zile’ were not significantly different in each year separately. The lowest average yield in both years was obtained for variety ‘Magdalena’.

The influence of potato variety on starch content was significant ($p < 0.01$) during the trial. The trial years influenced the potato starch content with 82% maximal probability. The influence of trial site in 2003 was significant with more than 99% probability, but in 2004 – 66% maximal probability. The results proved the importance of variety choice for obtaining an advisable starch yield. The starch content of varieties in Priekuli varied from 10.0 to 16.1% in 2003 and from 9.9 to 17.6% in 2004, the lowest starch content was for variety ‘Bete’, but the highest for variety ‘Brasla’ in both years. The variety’s ‘Zile’ starch content was slightly lower than that of the variety ‘Brasla’ and exceeded 15%, i.e., 15.6 in both years. The starch content of both ME varieties and ML variety ‘Magdalena’ was medium and varied from 12.2% to 14.2% in Priekuli.

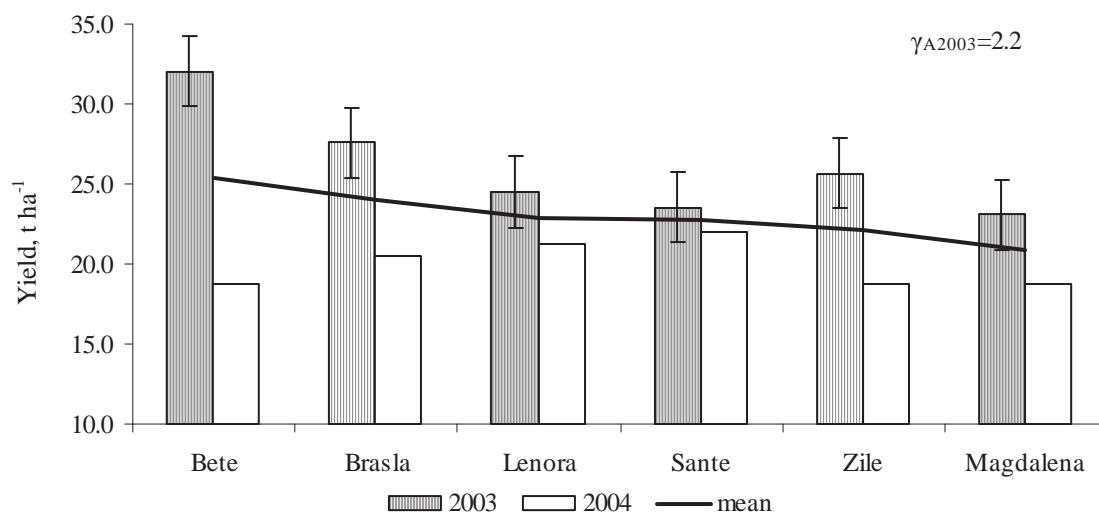


Figure 2. The average yield of potato varieties in 2003 and 2004

The starch content in Skrīveri varied from 11.8 to 16.2% in 2003 and from 10.6 to 16.6% in 2004. The lowest starch content in both years was for variety 'Bete', but highest for varieties 'Lenora' and 'Brasla', respectively. The starch content of ML varieties 'Brasla' and 'Zile' and ME variety 'Lenora' in both years and of ML variety 'Magdalena' in 2003 exceeded 15%. The variance was between 15.1% and 16.2%. The varieties' starch content in Vecauce was in general higher than in other places – from 11.0 to 18.7% in 2003 and from 10.6 to 18.8% in 2004. As in other places, the lowest starch content was observed for variety 'Bete'. The varieties 'Brasla' and 'Zile', respectively, had the highest starch content in Vecauce, and in both years the starch content of both mentioned varieties exceeded 18%. The starch content of both ME varieties and ML variety 'Magdalena' in 2003 was higher than 15% (15.7–17.8%), but in 2004 it varied between 12.4 and 14.4%. The average starch content of ME varieties in all places did not differ significantly in each trial year (Table 4). The highest starch content from ML varieties was detected for variety 'Brasla' in both years; variety's 'Zile' starch content was lower in both years, but difference was not significant. The variety 'Bete' starch content was the lowest in both years; the difference with other varieties was significant.

Table 4. The average starch content of potato varieties

| Variety, maturity (ME –medium early, ML – medium late) | Starch content, % | | |
|--|-------------------|------|------|
| | 2003 | 2004 | Mean |
| Brasla (ML) | 16.9 | 17.4 | 17.2 |
| Zile (ML) | 16.4 | 16.7 | 16.6 |
| Lenora (ME) | 15.9 | 14.2 | 15.1 |
| Magdalena (ML) | 15.3 | 13.7 | 14.5 |
| Sante (ME) | 14.3 | 12.9 | 13.6 |
| Bete (ML) | 10.9 | 10.4 | 10.7 |
| $\gamma_{0.05}$ | 3.6 | 2.0 | 3.9 |

The late blight (*Phytophthora infestans* (Mont.) de Bary) infection on potato leaves was not observed in Vecauce in 2003. Hot and comparatively dry weather during July was unfavourable for late blight development. The observations were not collected in Skrīveri this year. The beginning of late blight infection on potato leaves in Priekuli was observed on July 21, 2003. The first infection spots on leaves were observed on July 2 in Skrīveri and in the second decade of July in Priekuli and Vecauce in 2004. The assessment of varieties resistance in all places was similar (Table 5). Comparing ME varieties, less damage was observed for variety 'Lenora'. Varieties 'Bete' and 'Zile' had less late blight damages on leaves than other ML varieties.

Table 5. The average main disease damages of potato varieties

| Disease damage | Year | Varieties | | | | | | Mean |
|---|------|-----------|--------|--------|------|------|-----------|------|
| | | Sante | Lenora | Brasla | Zile | Bete | Magdalena | |
| Late blight, % of damaged leaf area in the middle of epidemiology | 2003 | 93* | 65* | 85* | 52* | 32* | 87* | – |
| | 2004 | 97 | 57 | 65 | 22 | 22 | 80 | – |
| Black scurf, % of damaged tubers | 2003 | 15 | 21 | 13 | 10 | 9 | 38 | 18 |
| | 2004 | 14 | 25 | 25 | 48 | 27 | 41 | 30 |
| Common scab, % of damaged tubers | 2003 | 25 | 4 | 7 | 15 | 13 | 11 | 13 |
| | 2004 | 21 | 9 | 24 | 20 | 17 | 15 | 18 |
| Late blight, % of damaged tubers | 2003 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2004 | 0.5 | 0.15 | 0 | 0.2 | 0.4 | 0 | 0.2 |
| Healthy tubers, % of totally tested | 2003 | 25 | 43 | 43 | 41 | 35 | 22 | 35 |
| | 2004 | 46 | 52 | 37 | 29 | 43 | 23 | 38 |

* assessment in Priekuli.

Approximately 0–3% of plants of each potato variety were damaged by virus diseases in every trial place both years, except for variety ‘Zile’ in Vecauce – 23% damaged plants in 2003 and 36% in 2004.

On average, disease damage on tubers in 2003 was observed less than in 2004. Actually, in Vecauce, comparatively less damage of common scab (*Streptomyces scabies* Thaxter Waksman and Henrici) was observed in 2004. More durable to black scurf (*Rhizoctonia solani* Kuhn) were both ME varieties and ML variety ‘Brasla’. The variety ‘Lenora’ had less common scab damages than other varieties. Very few damages of late blight on tubers were observed during the investigation. The average amount of healthy tubers was similar in both years; between varieties it varied from 22 to 52%.

Discussion

In organic farming it is important to choose an acceptable variety. It is impossible to avoid the influence of changeable weather conditions on tuber yield. The same variety, ME ‘Bete’, gave the highest yield in each place in 2003. However, also the yield of ML variety ‘Brasla’ was close behind, and variety ‘Zile’ was successful in two trial places. The reason of the quite low variety’s ‘Zile’ yield in Vecauce could be the comparatively high virus diseases spread on the plants. The ME varieties were more successful in Priekuli and Vecauce during 2004.

The choice of the variety with acceptable starch content for potato production is very important. The varieties ‘Brasla’ and ‘Zile’ had a high and stable starch content and the variety ‘Bete’ had the lowest starch content each place in both the years. The growing conditions did not influence the range of the varieties’ starch content as much as the variety. But the results in Vecauce proved that favourable weather conditions (less rainfall than in other places and, subsequently, more sunny days in 2003) could provide a comparatively higher starch accumulation. The choice of variety depends on potato utilization after harvest: varieties with a high starch content could be used for starch production, catering, market, but varieties with a medium and low starch content – for market and for catering, cooking certain dishes.

The late blight damages on potato leaves depended on variety resistance. The choice of a more resistant variety is acceptable. But the yield of both ME varieties (‘Lenora’ and ‘Sante’) and medium late variety ‘Brasla’ was quite acceptable in spite of the high late blight damage on leaves, interrupting plant vegetation. It means that varieties are able to produce tuber yield comparatively fast. ME varieties and varieties producing tubers could be successfully grown in organic fields quite early in spite of susceptibility to late blight. The leave damage substantially influenced plant development, but late blight damage on tubers during the trial years was very small.

The quite large spread of virus diseases in Vecauce on variety’s ‘Zile’ plants could be explained by distribution of virus infection during transporting, planting and ridging. There is not enough data for evaluating resistance of varieties to virus diseases in the current trials, but the spread of virus diseases made us pay attention to the fact. This should be taken into account before choosing ‘Zile’ for growing.

The disease damage on tubers spoils the tuber quality. The choice of more resistant varieties for organic farming is acceptable. The black scurf and common scab development depended on growing conditions. The quite dry soil in Vecauce could be the reason for a comparatively higher spread of common scab infection in 2003. The use of some agronomical practices could be desirable to avoid damage. The variety ‘Lenora’ had less disease damage and could be more suitable to obtain good quality tubers in organic farming. The largest

average amount of healthy tubers was observed to varieties 'Lenora' and 'Brasla' in 2003, and to 'Lenora' in 2004. The amount of healthy tubers depended on growing conditions; the range of varieties was different in some cases. The amount of variety's 'Sante' healthy tubers in Vecauce in 2004 exceeded other varieties twice ('Sante' – 73%, other varieties – from 15 to 49%).

Conclusions

The most suitable for organic farming (acceptable yield, starch content, resistance to late blight) were ME variety 'Lenora' and ML variety 'Zile', but for specific utilisation purposes (starch production or cookery) 'Brasla' and 'Bete' were acceptable. However, noted distribution of virus diseases on variety 'Zile' and black scurf on variety 'Bete' in Vecauce demands very careful attention to seed quality. The yield level of two varieties – medium early variety 'Sante' and medium late 'Brasla' – was acceptable in spite of sensitivity to late blight; these varieties could be used in organic farming if plant protection activities are done. The least amount of disease damaged tubers was for variety 'Lenora'.

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