Late blight in organic potato growing: managing resistance and early tuber growth

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Abstract

In organic potato production yields are often reduced by potato late blight (Phytophthora infestans). Two aspects are important in late blight management: a sufficiently high (field) resistance to late blight, and early tuber formation. With early tuber formation the period of tuber growth is extended at the beginning, and with a high resistance level at the end.

In 2006 and 2007 experiments were carried out in which the effects of the physiological age of seed tubers on field resistance to late blight and on tuber yield of potatoes (Solanum tuberosum L.) were tested for early and moderately late varieties. The results indicate that with the use of physiologically older seed tubers (by pre-sprouting) the field resistance to late blight is generally lower than with younger seed tubers. With physiologically older seed tubers, however, yields are generally higher at the time the crop has to be defoliated because of late blight.

It is concluded that especially when the growing period of a potato crop is short, for example as a consequence of an early late blight epidemic, or when a late variety is grown, early tuber growth by the use of older (pre-sprouted) seed tubers is highly important to assure an acceptable yield level at the end of the growing season. Even in years with a long growing season, a late variety like Agria may yield up to 12 t/ha more when physiologically older seed tubers are used.

Introduction

In organic potato growing, late blight, caused by the oömycete *Phytophthora infestans*, is one of the most devastating diseases, shortening the available growth period and thus reducing yields of potato crops (*Solanum tuberosum* L.) (Tamm et al., 2004). Because chemical-synthetical pesticides are not allowed under organic regulations farmers have to achieve a sufficient yield before the potato crop becomes infected with late blight.

The period of tuber growth can be extended at both ends: at the beginning, by using an early variety or physiologically older seed tubers, resulting in early onset of tuber formation, or at the end, by growing a variety or a crop with a high level of field resistance, allowing the crop to continue to grow despite late blight pressure.

Variety choice is generally considered the first and most important step in late blight management, but early varieties are generally too susceptible, and more resistant late varieties may, especially in years with an early late blight epidemic, not yet have

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reached an acceptable yield level when late blight strikes.

The use of physiologically older seed tubers, for example by pre-sprouting, results in earlier crop establishment and earlier onset of tuber growth (Struik & Wiersema, 1999). Pre-sprouting is a generally accepted technology in organic potato growing, but many farmers do not adopt it because of technical problems (work load, required planting equipment, etc.). Moreover, pre-sprouting may give a crop with a lower field resistance (Hospers-Brands et al., 2005).

In 2006 and 2007 we carried out experiments to optimize the balance between early crop establishment by using physiologically older seed tubers on the one hand and enhancing field resistance by using younger seed tubers on the other hand, with four contrasting varieties.

Materials and methods

Variety choice. The varieties were selected to cover a range of early to moderately late maturity type, and a range of late blight resistance levels (Table 1).

Tab. 1: Characteristics of the tested varieties

	Earliness[a]	Late blight resistance foliage[b]
Junior	9	4
Ditta	6	6
Nicola	5.5	4.5
Agria	5	5.5

[a] 1 = very late, 9 = very early, [b] 1 = very susceptible, 9 = resistant

In 2007, the quality of the de-sprouted seed tubers of Junior was too low to allow normal crop growth. Emergence was delayed and after a poor crop development, yields were very low. Results for Junior in 2007 are therefore not presented here.

Seed tuber treatments. We tested young tubers with young sprouts (control) (2006 and 2007), old tubers with old sprouts (pre-sprouted) (only in 2006), and old tubers with young sprouts (de-sprouted) (2006 and 2007). The control tubers were kept in cold storage until one week before planting and then mini-chitted at 16 °C. The pre-sprouted and de-sprouted tubers were kept in cold storage until five weeks before planting, and then pre-sprouted at 16 °C. From the de-sprouted tubers the sprouts were removed two weeks before planting; then the tubers were mini-chitted at 16 °C.

Test sites. The experiment in 2006 was carried out on an organic clay location and in 2007 on an organic sand location in the Netherlands. Crop management was according to the management of the commercial potato crops grown on the farms. The test sites were subjected to natural infection by late blight. The crops were defoliated by burning the foliage as soon as 7% or more of the leaf area in a given plot was infected by late blight, according to Dutch legislation.

Assessments. Emergence rate, soil cover, late blight infection (field assessments and laboratory tests on detached leaves) and fresh tuber yields were recorded. Using the statistical program Genstat (version 7.2) for both years least significant differences (LSD) were calculated, for the interaction variety*seed tuber treatment.

Results

Weather conditions differed between the two experimental years. In 2006, after a cold and wet spring, the summer was warm and dry. As a result, the late blight epidemic started late, at a moment when some organic potato crops were already showing natural senescence. In 2007 the early spring was very warm and dry, but the summer was very wet, and the late blight epidemic extremely early and aggressive.

Crop development. In both years older seed tubers (pre-sprouted or de-sprouted) emerged 1 – 5 days earlier than young seed tubers (control) (differences significant at the 5% level), and canopy development was faster during the first half of the growing season. In 2006, however, when, because of the late onset of the blight epidemic, the growing season was rather long, in the second half of the growing season the canopy from the oldest (pre-sprouted) seed tubers of the earliest varieties already started to senesce, when the canopy from the youngest seed tubers was still expanding. The effects of differences in canopy development were reflected in tuber yields (see below).

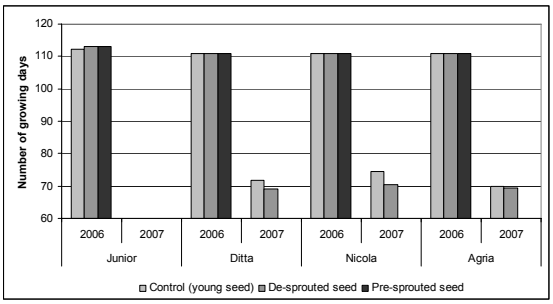

Figure 1: Growing days from planting until defoliation (7% of leaf area infected by late blight). 2006: LSD=0.39; 2007: LSD=4.60 (5% level, variety*seed tuber treatment).

Late blight. Generally, crops from the youngest seed tubers were less infected by late blight than crops from the oldest seed tubers. In 2006, with a late onset of the late blight epidemic, almost no differences in number of growing days were found, but in 2007 crops from the younger seed tubers could grow 1 – 4 days longer than crops from the older seed tubers (Fig. 1) (differences in 2007 not significant). Crops from pre-sprouted seed tubers seemed to be slightly more susceptible to late blight than crops from non-sprouted seed tubers, but crops from the de-sprouted seed tubers were in 2006 as resistant as the non-sprouted crops (results not presented).

Yield. Final yields were dependent on variety, seed tuber treatment and timing of the late blight infection. In 2006, infection by late blight was rather late, and for the earliest variety (Junior), the youngest seed tubers gave a 5.5 t/ha higher yield than the older seed tubers, whereas for the latest variety (Agria) the opposite was true: the older seed tubers gave a 9 – 12 t/ha higher yield than the young seed tubers (differences significant at the 5% level). In 2007, with much lower yield levels in general, yields from the older (de-sprouted) seed tubers were up to 3 t/ha higher than yields from the younger seed tubers (differences not significant) (Fig. 2).

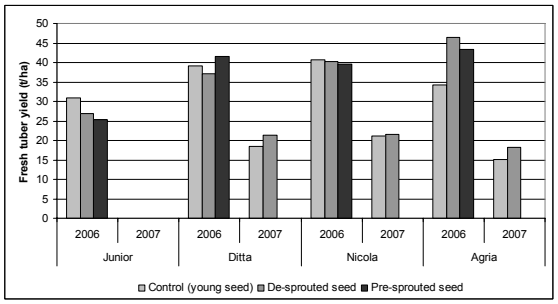

Figure 2: Final fresh tuber yield. 2006: LSD=4.42; 2007: LSD=4.83 (5% level, variety*seed tuber treatment).

Discussion

Especially late varieties seemed to profit from the yield-enhancing effects of physiologically older (pre-sprouted or de-sprouted) seed tubers. The effects, however, depended on the timing of the late blight infection: when the infection was early (2007), all varieties had higher yields with the older seed tubers, but when the infection was late (2006), only the late varieties had higher yields with older seed tubers. In this situation for early varieties the yield was highest for the younger seed tubers, because the canopy of this crop continued to expand when the canopy from the older seed tubers was already senescing. With respect to tuber yields, the yield-enhancing effects of pre-sprouting were more importance than the resistance depressing effects.

Conclusions

Early crop establishment is especially important when a late variety is grown and / or when the crop has only a short growth period because of an early late blight epidemic.

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