ABSTRACTS OF PAPERS

Physiological age of the seed potato

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Introduction

Crop yield in potato is strongly influenced by seed quality. Important seed quality characteristics are: seed tuber size, physical characteristics such as shape and presence of wounds, physiological age and seed tuber health. I focus here on physiological age. Physiological age can be defined as the stage of development of a seed tuber, which changes progressively by increasing chronological age and is modified by growth history and storage conditions (Reust, 1986; Struik & Wiersema, 1999). This means that physiological age includes other aspects than just chronological age.
Physiological age of seed potatoes strongly affects emergence, number of stems per plant, number of tubers per stem, tuber-size distribution and tuber yield of the progeny crop (Van der Zaag & Van Loon, 1987; Van Ittersum, 1992; Struik & Wiersema, 1999). The physiological age needs to be optimized to produce a canopy and a tuber system that allow tuber production for specific outlets (Struik et al., 1990, 1991). In many parts of the world it is difficult to obtain seeds in the optimal stage, especially in areas with double cropping.

Development of physiological age

The development of a seed tuber starts with a dormant phase. Immediately after it is initiated a tuber develops a certain degree of dormancy. Dormancy is the physiological state of the tuber in which autonomous sprout growth will not occur within 2 weeks, even not when the tuber is kept in conditions ideal for sprout growth (Reust, 1986; Van Ittersum, 1992; Struik & Wiersema, 1999). During dormancy biochemical and physiological processes do occur but they do not trigger immediate morphological changes. Yet these processes are relevant for the number of sprouts produced after breaking of the dormancy and for the growth vigour of the seed tuber. Conditions during dormancy and thereafter affect the progress of the physiological ageing and therefore influence the performance of the seed tuber. After breaking of dormancy the seed tuber goes through different phases: apical dominance, normal sprouting, production of branched sprouts, senility and incubation (little tuber formation). Crops grown from seed tubers in different phases will differ in canopy structure, tuber number, yield, tuber size distribution and tuber quality (Ewing & Struik, 1992; Struik & Wiersema, 1999).

Separate effects of the physiological age of the seed tuber and the sprouts

Krijthe (1962) and Van Ittersum (1992) demonstrated that both mother tuber age and sprout age affect the performance of a seed tuber. Until breaking of the dormancy changes in the physiological status of the seed are only reflected by biochemical and physiological changes in the seed tuber itself and not by morphological changes. After dormancy breaking the physiological age is still influenced by the age of the mother tuber, but modified by the additional effects of conditions and treatments on the behaviour of the sprouts (Caldiz et al., 2001). However, the evidence for these separate effects from experimentation is still scarce.

Effects of growth history
Growing conditions during the seed production affect the dormancy and physiological age after harvest, albeit much less than storage conditions after harvest. Photoperiod, temperature, light intensity, and nitrogen fertilizer all have significant effects. However, soil conditions after haulm destruction but before harvest probably have the largest effect.

Effects of storage regimes
Environmental factors during storage affect physiological age. Relevant factors include relative humidity, temperature, photoperiod and diffuse light. Especially the temperature effect is highly complex and cultivar specific. As metabolic processes and physiological events taking place before and after dormancy differ, the sensitivity towards environmental conditions, and especially towards temperature, during the different stages of physiological development of the seed tuber may also differ (Scholte, 1986; Struik & Wiersema, 1999; Struik et al., 2006). Heat shocks, cold shocks, and similar accumulated day-degrees built up in different ways may all have their specific effects, depending on cultivar (Van Ittersum, 1992; Struik & Wiersema, 1999; Struik et al., 2006). Diffuse light may prevent rapid ageing of seed tubers. This positive effect is realized both by effects on the development of the sprouts and on the condition of the mother tuber. The positive effect of prolonged exposure to light is cultivar specific and depends on storage temperature and photoperiod. At 16 ºC growth vigour of seed tubers remains highest under long days, whereas at 28 ºC growth vigour decreases much faster under long days than under short days.

De-sprouting
For the proper expression of the effects of physiological age de-sprouting is essential. However, de-sprouting can be very destructive following high storage temperatures.

Indicators of physiological age
Both for scientific and practical purposes an indicator of dormancy or physiological age would be very useful. Many different characteristics have been proposed as indicators. These include physiological, (bio)chemical, molecular, and biophysical ones (Bachem et al., 2000; Caldiz et al., 2001). Such indicators are needed to quantify and explain differences in rate of ageing between seed lots, caused by differences in origin, storage conditions, cultivar and treatment. They are also needed to quantify and model the effects of seed age on crop growth and yield.
The most direct and simple ways to indicate physiological age are based on accumulated day-degrees from dormancy break (O’Brien & Allen, 1981; O’Brien et al., 1983), storage temperature sum (Scholte, 1986; Struik & Wiersema, 1999) or indices for relative growth vigour (Van der Zaag & Van Loon, 1987; Van Ittersum et al., 1990; Van Ittersum, 1992). However, it has proven to be very difficult to develop a unifying concept that is applicable under all conditions of production and storage and to all cultivars.

Molecular approaches
Studies on the molecular physiology of seed tubers have shown that resources of soluble sugars are sufficient to break dormancy and to feed the sprouts during the first stages of sprouting. Just before or at the onset of the sprouting process there is a dramatic increase in the soluble sugar content in the buds, yet this is not the trigger that initiates sprouting.

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