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The Canon of Potato Science:

40. Physiological Age of Seed Tubers

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What is it?

The physiological quality of seed tubers is determined by dormancy and – after the dormancy has been broken – by physiological age. Physiological age is the developmental stage of a potato seed tuber but it can also be defined as the physiological state of the seed tuber which influences its production capacity. Physiological age determines the behaviour of each bud of the seed tuber thus affecting the number of sprouts per eye and their vigour. Moreover, it also influences the physiological behaviour of the resulting stem, even well after emergence.

Physiological age advances progressively by increasing chronological age, but also depends on:

a. the size of the individual tuber;
b. the growth history of the seed crop from which the seed tuber has been obtained;
c. possible treatments applied to the seed crop (e.g., hormonal sprays on the canopy);
d. the timing and method of haulm killing;
e. the conditions between haulm killing of the seed crop and the harvesting of the seed tuber;
f. the conditions during storage and from storage until planting;
g. possible treatments during harvesting or storage;
h. possible treatments between storage and planting.

The temperature sum after the end of dormancy during storage of is the most dominant factor affecting physiological ageing, although its effect is moderated by light conditions and by genotypic characteristics.

While the physiological age progresses, the seed tuber goes through different stages, including dormancy (no sprout), apical dominance (only one sprout), normal

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sprouting (only a few sprouts per seed tuber), normal, advanced sprouting (many sprouts per seed tuber which are often branched), senility (excessive sprouting with very weak sprouts), and incubation (little tuber formation). The rate with which the seed tubers go through these stages is very much depending on the cultivar. Cultivars also differ in their sensitivity to the environment during the different stages.

When the seed tuber is exposed to cool temperatures during its dormancy period the number of sprouts per seed tuber after natural dormancy break increases with an increase in the number of weeks of exposure to cool temperatures as the apical dominance of the top sprout becomes less.

De-sprouting advances ageing.

Why is it Important in Potato Science?

During the life cycle of the seed tuber several developmental phases can be distinguished, including organogenesis, tuber bulking, dormancy, sprouting, and resource mobilisation. Although the potato tuber is a relatively simple organ consisting essentially of a modified below-ground stem, its life cycle requires the co-ordinated orchestration of a complex series of physiological processes and metabolic pathways, which are most likely regulated by many different genes. It has been pointed out by several researchers that there is a similarity between dormancy and ageing on the one hand and the process of tuberisation on the other. Moreover, transgenerational information transfer is easy in vegetatively propagated crops.

Physiological age is important for crop physiologists as it affects the balance between above-ground growth and below-ground growth, and between vegetative development and reproductive development. Physiological age is an important factor in the yield formation of the subsequent crop.

For crop physiologists it is also important that there are very many different ways to manipulate physiological age, either during crop growth or after harvest. At the same time there are many different sources of variation, both within a seed lot and between seed lots of the same genotype and seed lots of different genotypes. Especially when genotypes or cultivars are compared the seed potato material must be in comparable physiological stages.

Why is it Important for the Potato Industry?

Crop yield and quality are strongly influenced by the number of stems per unit area and thus by the number of seed tubers planted and the number of stems per seed tuber. The number of stems per seed tuber depends on the number of eyes, the number of sprouts per eye and the number of stems produced per sprout present. The number of eyes per seed tuber is not affected by physiological age, but the other two factors are. Moreover, physiological age affects the growth vigour of stems and their physiological behaviour, including time of tuber onset, tuber number and tuber size distribution, onset of senescence, number of sympodial branches, and flowering behaviour. Within a certain, well-defined range younger seed tubers emerge later, have fewer stems per seed tuber, show later tuberisation but less secondary growth, have more foliar growth, more tubers per stem, a later maturity, and a higher yield when grown until full maturity.

Physiological age can therefore be an agronomic tool to help the crop adjust to the ecological conditions of the growing season and to perform optimally for the purpose it is grown. For example in countries with late blight epidemics, organic potato crops require relatively old seed, in countries with aphid pressure later during the growing season seed potato crops should also be planted with older seed tubers. Crops with specific demands for tuber size distribution also require specific seed ages. For seed exporting countries and for countries with more than one growing season per year it is essential to control physiological age very precisely. The logistics of the seed storage and trade should be adjusted to get the seed in the optimum condition when planted. Given the strong interaction between conditions and cultivar it is expected that the best storage recipe is cultivar specific.

Scientific Developments

The most essential challenge of research on physiological age is to find a reliable and rapid diagnostic tool capable of assessing the physiological age at any stage during the development of the seed tuber and to predict its further ageing process as a function of temperature sum. Many research groups have taken up this challenge in the past but it proved to be very difficult to identify traits that could assess the status of the seed tuber consistently across genotypes and environments and predict its future trend. However, it is expected that with the modern molecular tools, and especially with metabolomics, it will be possible to assess physiological age and predict its behaviour in relation to storage conditions much more accurately and across genotypes. Such a tool will allow the optimization of the seed vigour depending on the crop use and its location and management. Moreover such a tool will advance breeding for slow ageing at a given duration of dormancy.

Further Reading

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