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The Canon of Potato Science:

33. Haulm Killing

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What is it?

Harvesting can only be done successfully when the tubers have reached a certain level of maturity. Maturation of tubers improves skin set thus improving the resistance to scuffing and skinning, increases resistance to bruising and other types of damage during harvesting and handling, and prolongs storage life by decreasing storage decay and reducing water loss during storage. More mature tubers also have a higher starch content and lower reducing sugar content than less mature tubers.

In many potato growing areas the potato crop does not senesce naturally and tubers do not mature naturally, but growers destroy the crop when it is still partly green and tubers are still growing. So, tuber maturation is artificially induced by killing the haulm. Killing potato vine (haulm) is usually done 10–25 days prior to harvesting the potato tubers, although in some cases it is done only a few days before harvesting. Green-crop harvesting also does occur under very specific conditions or in a two-step approach where vine removal and lifting is followed by a short phase of storage in the field under a thin layer of soil after which the tubers are collected. Crops approaching maturity require less time for skin set than crops which are still in full production. This means that the time between haulm killing and harvesting can be shorter when the haulm killing is done in a more mature crop.

Haulm killing serves different purposes in both seed crops and in ware crops:

1. To allow a timely and easy operation of harvesting by reducing vine quantity, releasing tubers from stolons and stems and inducing tuber maturation and skin set;

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2. To advance tuber maturation, thus reducing damage during harvesting and handling, preventing large storage losses and improving produce quality;
3. To induce proper skin set, thus reducing skinning during harvesting.

In seed crops, important additional objectives are:

1. To stop tuber growth in order to reduce seed size and to obtain a uniform size distribution with a maximum proportion of the tubers in the most profitable size class;
2. To reduce the risk of spread of virus infection by inhibiting plant-to-plant spread through vectors such as aphids;
3. To suppress the development of seed-borne survival structures of fungi (e.g., sclerotia of *Rhizoctonia solani*, i.e. black scurf);
4. To influence the development of dormancy and physiological ageing of the seed tubers during storage. When tubers are allowed to grow longer they will have a shorter dormancy and start to age earlier.

In ware crops, important additional objectives are:

1. To eliminate the haulm as source of inoculum of late blight for neighbouring fields (especially in organic production) or for tubers (both conventional and organic production);
2. To optimize tuber size distribution;
3. To manipulate inoculum build-up of soil-borne diseases such as *Verticillium dahliae* by proper haulm killing techniques;
4. In extreme cases: to prevent or stop second growth.

There are three traditional methods for vine killing:

1. Mechanical/physical vine killing (including cutting, chopping, flail mowing, rolling, pulling, flaming);
2. Chemical vine killing (also called *vine desiccation*, using chemical compounds such as diquat, paraquat, sulfuric acid, glyphosinate, etc.); and
3. A combination of mechanical and chemical methods of vine killing, in which the tuber maturation goes faster and the vine killing is more effective than with only mechanical or only chemical haulm destruction.

The method used has an effect on:

- Possible skin damage;
- Regrowth and associated risk of virus infection in seed potato production;
- Control of soil-borne and seed-borne diseases including black scurf (*Rhizoctonia), Phytophthora, Phoma, Verticillium* and bacteria.

Moreover, methods differ in their environmental footprint, reliability (giving weather conditions) and risk of imposing damage to the produce.

Why is it Important in Potato Science?

Research on haulm killing has tremendously increased our knowledge on the physiology of tuber size distribution, tuber maturation, skin set, and different types of damages. Investigations into different methods of haulm destruction also provided insight into the effects of different events during the final part of the field phase on the dynamics of populations of soil-borne and seed-borne diseases.

The pressure from governments to reduce the use of herbicides and growth regulators, the bans on certain vine desiccants used in the past and damage imposed to produce of seed or ware crops by non-judicial use of vine-killing agents or use under unfavourable weather conditions keep the farmers, the producers of the chemical products, agronomic researchers and processors or users on their toes.

Why is it Important for the Potato Industry?

Vine killing or desiccation can improve tuber maturation and skin set which can add to the value of the crop. Ware potatoes with proper skin set are more resistant to skinning resulting in a more appealing product, maintain better skin colour, lose less weight in storage, and are more resistant to bruising and soft rot. In seed production, proper vine killing techniques improve the quality of the seed tubers by preventing virus infection and accumulation of survival structures of seed-borne diseases or the increase in inoculum density of soil-borne diseases.

Vine killing can also have detrimental side effects. First of all, in both seed and ware, it can be an expensive production practice that results in varying degrees of success.

Moreover, in ware potato production, the internal quality of the tubers can be reduced. Stem-end browning of the vascular ring can occur if the vines are killed quickly under unfavourable environmental conditions. This discolouration may result in a lower fresh market value. To limit the risk of vascular ring discolouration from vine killing, chemical vine killers should not be used in hot, dry weather or should then be applied in lower dosages. Finally, vine killing will reduce specific gravity of the tubers compared to no vine killing.

In seed potato production, certain methods of haulm killing can contribute to the build-up of soil-borne or seed-borne diseases.

To compare the relative performance of the different methods we concentrate on flaming, cutting, pulling, green-crop harvesting, cutting and local chemical destruction, and chemical destruction.

Haulm flaming does not contribute to the control of *Rhizoctonia solani* on the seed tubers, but is effective in controlling other diseases. It is not dependent on weather conditions, but costs for investment and operation are high. It is often used in organic potato production.

Haulm cutting is a good method for crops which are near maturity, for crops which are harvested manually and for crops which are marketed soon after harvest. When crops are still rather vegetative in their growth, the skin hardening process is slow and the risk for re-growth of new shoots is high. These new shoots are very susceptible to viruses. After haulm cutting skin setting is rather slow and tubers may become affected by black scurf.

Haulm pulling induces rapid skin set. It is therefore a very effective method to reduce skin damage at harvest, and the development of black scurf on tubers in the soil is also slower than after chemical haulm killing. After haulm pulling there is no regrowth and the connection between vine and tubers is cut through. Both aspects make the method suitable to minimize the risk of virus infection of seed tubers. However, haulm pulling may cause problems with greening of tubers, attacks by tuber moths and exposure of tubers to high temperatures. Haulm pulling is also labour intensive.

Green-crop harvesting, i.e. vine removal and lifting, followed by a field period during which skin set can take place, can be very useful in controlling *Rhizoctonia solani*.

Cutting and local chemical destruction is a reliable, but relatively expensive method, combining the benefits of mechanical and chemical haulm destruction.

Chemical haulm killing requires little labour and investment but its success depends very much on weather. Moreover, there are negative effects on the development of soil-borne and seed-borne diseases and possible negative effects on tuber quality, with differences between registered products mostly related to the mode of action of the active substance and the extent to which the active substance is systemic in the plant. Moreover, the method is so drastic that more tuber growing days are lost than with other methods. In crop with strong vegetative development one application may not be sufficient.

Scientific Developments

Ongoing research is trying to increase the efficiency of chemical vine killing and reduce the amount of active ingredient required to do a proper job. Within the possibilities offered by precision agriculture attempts are being made to create site-specific adjustments of the amounts of chemicals used for haulm killing based on quantity of biomass measured in the field by practical crop reflection sensors such as the Yara N-sensor and Ntech Greenseekers. Research is also needed on the relationships between environmental conditions and efficiency of the vine killing, especially given the persistent worries about transport of chemical components from the vine into the tubers resulting in damage to the meristematic tissues of the tubers in the case of seed tubers and to possible quality reduction and susceptibility to rot in ware.

More research is needed and under way to optimize the method of haulm killing to suppress the different soil-borne and seed-borne diseases.

Research is carried out to better time the haulm killing based on records of tuber bulking to obtain an optimal physiological status or an optimal start of physiological ageing of seed tubers.

Research on the timing of haulm killing based on the changes in the chemical composition of the tubers during senescence could provide tools to improve tuber maturation thus making the tubers more resistant to damage, water loss and undesirable changes in chemical composition.

Further Reading

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