Na-oes verrotting van aartappels
Post-harvest decay of potatoes

2015

potatoes
aartappels SA

CHIPS

Na-oesverrotting lei tot nat sakkies en is 'n probleem wat gereeld in warm somermaande voorkom. Vir die boer is dit 'n frustrasie omdat aartappels die plaas in 'n goeie toestand verlaat, net om 'n paar dae later te verneem dat sy besending hersorteer, afgegradeer, of weggegooi moes word. Al hierdie faktore het natuurlik 'n negatiewe impak op die boer se rendement. Verbruikers spreek ook gereeld hul ontevredenheid oor slegte aartappels uit.

Dit is vir die bedryf belangrik om na-oesverrotting tot die minimum te beperk, nie net om goeie pryse op die mark te handhaaf nie, maar ook om die verbruiker se behoefte aan kos wat waarde vir geld bied, aan te spreek.

Beheer van na-oesverrotting begin nie in die pakstoor nie. Dit begin reeds in die groeiseisoen op die land en gevolglik tydens elke stap van na-oeshantering.

'n Reeks artikels aangaande die oorsake en bestuur van na-oesverrotting is in verskillende uitgawes van CHIPS in 2014 gepubliseer. Hierdie bundel is saamgestel uit al sodanige artikels om die inligting bymekaar te hou en gebruik te vergemaklik.

Dr. Fienie Niederwieser
Bestuurder: Navorsing en Ontwikkeling, Aartappels Suid-Afrika

Post-harvest decay leads to wet bags and is a problem that occurs regularly during hot summer months. It is frustrating for the farmer when potatoes leave the farm in good condition, just to receive feedback a few days later about degrading, resorting and destroying of his consignment. All these factors naturally has a negative impact on the farmer's return. Consumers also regularly express their dissatisfaction with rotting potatoes.

It is imperative for the industry to limit post-harvest decay to the minimum, not only to realise good prices on the market, but also to provide the consumer with food that offers value for money.

Management of post-harvest decay does not start in the pack house. It already starts during the growing season on the field and subsequently during every step of the post-harvest process.

A series of articles regarding the causes and management of post-harvest decay has been published in CHIPS in 2014. This publication has been compiled from these articles to keep information together and easier to store and use.

Dr Fienie Niederwieser
Manager: Research and Development, Potatoes South Africa

INHOUD • CONTENT

Reeks oor na-oes verrotting van aartappels I: Hoe vrot aartappels?

Dr. Fienie Niederwieser (Bestuurder: Navorsing en Ontwikkeling, Aartappels Suid-Afrika)

Na-oesverrotting van aartappels word hoofsaaklik veroorsaak deur die patogene wat sagtevrot veroorsaak, naamlik *Pectobacterium* en *Dickeya* species. *Pectobacterium* en *Dickeya* was vroeër bekend as *Erwinia* spp).

Bakterieselle beland saam met besmette grond en knolle in waswater. Soos wat grond en organiese materiaal, ook stukkies aartappelweefsel in opbou, raak die waswater letterlik 'n verrykte medium waarin sagtevrot patogene kan oorleef, vermeerder en ander knolle besmet. Knolle word deur sagtevrot bakterieselle besmet waar tydens die oes en vervoerproses ontstaan het, en hulle oorleef in die vogtige wondweefsel totdat toestande gunstig is om verrotting te veroorsaak.

Toestande wat gunstig is vir verrotting is en . Onder sulke omstandighede, skei bakterieselle pektinolitiese ensieme af om selwande te verteer. Wanneer die selwande deurgedring is, word die selinhoud verteer, waarna die selinhoud dan as voedingmedium vir die bakterieselle dien. Hoe meer bakterieselle teenwoordig is, hoe vinniger verrot die aartappels.

Wanneer wat met sagtevrot-bakterieë besmet is in papiersakkies gepak word, kan verrotting plaasvind omdat en beperk word. Dit skep dus toestande waaronder sagtevrot-bakterieë gedy, veral in . Waar plastieksakkies gebruik word vir herverpakking laat dit 'n mate van ventilasie toe deur die gaatjies in die plastiek, maar as 'n nat besmette knol styf teen die plastiek gepak is, skep dit ook ideale toestande vir na-oesverrotting. Een vrot aartappel vorm dan inokulum wat ander knolle kan besmet, veral as hulle of is.

Na aanleiding van bogenoemde kan gesien word dat aspekte en praktyke waaraan aandag gegee moet word om na-oesverotting te bestuur, die volgende insluit:

- Deur praktyke toe te pas om knolweefsel meer weerstandig teen verrotting te maak.
- Die opbou van organiese materiaal en sagtevrot-bakterieë in waswater moet beperk word.
- Deur meganiese beskadiging te beperk, word besmetting van knolle deur sagtevrot bakterieë verminder.
- Effektiewe sanitasie van knolle kan verrotting van knolle wat wel besmet is, hokslaan.
- Deur toestande wat verrotting bevorder te beperk, kan verrotting verder beperk word.

Reeks oor na-oes verrotting van aartappels II: Die rol van kalsium

Estelle Kempen, Stellenbosch Universiteit

Pectobacterium wat na-oesverotting veroosaak, infiltreer plant selle deur pektinolitiese ensieme af te skei. Dié ensieme hidroliseer (verteer) pektien van die midellamella (wat selwande van aangrensende selle aan mekaar bind). Dit veroorsaak dat die selle van mekaar skei en selstruktuur verlore gaan. Om die infiltrasie van weefsel deur bakterieselle te beperk, is die eerste punt van beheer dus die middellamella en die selwande. Hoe sterker die wande van selle net onder die periderm (skil) en aan die buitekant van die medulla, hoe stadiger vind verrotting plaas.

'n Groot persentasie kalsium in selle kom in die midellamella van selwande voor om die selwande te versterk. Kalsium speel ook 'n belangrike rol in die deurlaatbaarheid van selmembrane, wat die selle verder versterk. Dus: 'n hoë kalsiumkonsentrasie in die selle van die skil en die selle net onder die skil verhoog 'n knol se weerstand teen die aksie van pektinolitiese ensieme wat *Pectobacterium*-selle afskei om die weefsel binne te dring.

Navorsing elders het getoon dat die kalsiuminhoud van beide die skil en die medulla verhoog kan word deur verhoogde in-seisoen toediening van kalsium. By die Universiteit van Stellenbosch het ons bevind dat die beste resultate verkry word wanneer genoeg

Dit is veral in die periderm waar die kalsiuminhoud verhoog het, waarskynlik as gevolg van die feit dat kalsium in die grondoplossing direk deur die onverkurkte peridermselle van jong knolle opgeneem word.

Hoewel die kalsiuminhoud van die medulla belangrik is om fisiologiese afwykings soos interne bruinvlek te verhoed, is dit die kalsiuminhoud van die selle net onder die skil en in die skil wat aartappels meer weerstandig maak teen die indringing van *Pectobacterium* sagtevrotselle.

Dit is dus belangrik dat genoeg opneembare kalsium in die grond teenwoordig is tydens, en net na knolinisiasie. Kalsium word hoofsaaklik deur die transpirasiestroom in die xileemvate vanaf die wortels na die loof vervoer. Die kalsium in knolle word direk deur onverkurkte peridermselle opgeneem of deur die stolonwortels na aan die ontwikkelende knolle. Kalsium wat as blaarbespuiting toegedien word, bereik dus nie die knolle nie.

Reeks oor na-oesverotting van aartappels

III: Goeie praktyke in die pakstoor om na-oesverrotting te bekamp

Dr. Mieke Daneel (LNR Instituut vir Tropiese en Subtropiese Vrugte)

Goeie praktyke in pakstore speel 'n belangrike rol in die bekamping van na-oesverrotting. In Suid-Afrika is pakstore en paklyne nie uniform nie, daarom word basiese riglyne vir goeie praktyke hieronder gegee. Deur beginsels te verstaan, kan pakstore, paklyne en hantering aangepas word om verrotting te beperk.

Na oes word ongewaste aartappels in waens na die pakstoor vervoer en in die aartappelwassers oorgedra. Waens is dikwels vol grond en organiese materiaal wat saam met die aartappels in die aartappelwassers beland. Waens moet derhalwe gereeld skoongemaak word. Een of ander proses om die vrag af te spoel voordat dit in die aartappelwassers beland kan die hoeveelheid grond, organiese materiaal en mikro-organismes verminder.

Verrotte- of siek knolle word op die verpakkingslyn geïdentifiseer en beland moontlik nie in sakkies nie, maar is 'n bron van mikro-organismes wat ander knolle kan besmet. Hulle besmet ook die verpakkingslyn, rollers en borsels. Aartappels moet gesorteer word vir vrot voordat dit op die

verpakkingslyn beland. Maak dus seker dat daar genoeg sorteerders aan die begin van die proses is om verrotte knolle te verwyder om die bron van besmetting te beperk.

Waar knolle net geborsel word voordat dit in sakkies gepak word, is dit net so belangrik dat die verpakkingslyn nie besmet word nie. Dit is ewe belangrik om verrotte knolle aan die begin van die proses te verwyder.

Water dien as reservoir vir bakterieë en ander kontaminante indien dit nie met 'n saniteerder behandel word nie. Hierdie bakterieë soos *Pectobacterium (Erwinia)* en ander mikro-organismes kan potensieel elke aartappelknol wat oor die verpakkingslyn gaan, besmet. Die saniteerders is kontakmiddels wat teen die aanbevole dosering en metode aangewend moet word elke keer wanneer water in die aartappelwasser vervang word. Saniteerders word op grond en organiese materiaal ge-adsorbeer wat hul werking verlaag. Omdat groot hoeveelhede grond en organiese materiaal in die aartappelwasser beland, moet die water gereeld vervang word wanneer groot hoeveelhede aartappels gesorteer word.

Onbehandelde water word dikwels in pakhuise gebruik om aartappels te was. Bakterieë kan in sulke water aanwesig kan wees nog voordat dit gebruik word om aartappels te was. Dit benadruk die belang van die gebruik van 'n goeie saniteermiddel.

Verrottingsorganismes gedy onder nat toestande. Sorg dus dat water van knolle verwyder word voordat dit in sakkies beland.

Oorweeg dit om in 'n benewelingsisteem te belê vir aanwending van die saniteerder nadat knolle gewas is. Beneweling het tot gevolg dat die saniteerder aangewend word teen die regte konsentrasie in 'n klein volume skoon water. Omdat die water nie hergebruik word nie, word die saniteerder nie op grond en organiese materiaal geadsorbeer nie. Beneweling word in verskeie ander bedrywe met sukses toegepas omdat sanitasie effektief en koste-effektief is.

As hipochloriet in byvoorbeeld HTH™ of Jik™ gebruik word as saniteerder, is dit belangrik dat die pH van die waswater tussen 6 en 7 gehou moet word. Hipochloriet

se effektiwiteit verlaag drasties indien die water se pH nie reg is nie. Onthou ook dat sanitasie deur hipochloriet negatief beïnvloed word deur grond en organiese materiaal in waswater. Sien ook die verslag van Tlangelani Nghondzweni in hierdie uitgawe van CHIPS.

Beskadiging van die skil en kneusing van weefsel is 'n belangrike faktor wat bydra tot verlaging in houvermoë van aartappels omdat wonde verrottingsbakterie (en ander patogene) toegang bied tot die knol. Installeer absorberende oppervlakke in byvoorbeeld hoë impak areas en vermy skerp hoeke op die verpakkingslyn. Hanteer knolle baie versigtig tydens sortering, verpakking en opberging. Moet nie toelaat dat sakke rondgegooi word en dat werkers daarop loop nie.

Voldoende lugbeweging tydens verpakking en vervoer van aartappels is belangrik om te verseker dat toestande vir verrotting nie ontstaan nie en verminder verspreiding van verrotting van een knol na ander in die sakkie.

Berg en vervoer aartappels by lae temperature omdat hoë temperature bevorderlik is vir verrotting. Onthou egter dat wanneer knoltemperatuur laer is as 9°C, knolle makliker kraak as by hoër temperatuur en daardeur wonde veroorsaak wat verrotting bevorder. Indien moontlik, moet aartappels nie verpak word as knoltemperatuur so laag is nie.

Toerusting moet daagliks gewas en ontsmet word, veral wanneer hoë volumes aartappels gesorteer word, en wanneer toestande op die land voor en tydens oes 'n risiko vir besmetting inhou. Was met hoëdrukspuite is effektief om grond en organiese materiaal van die verpakkingslyn en aartappelwasser te verwyder ten einde besmetting

van skoon knolle te verminder. Wanneer verrotte aartappels wel op die verpakkingslyn beland het, word 'n skoonmaakbesmettingsmiddel (detergent-disinfectant) aanbeveel.

Pas altyd goeie veld en oestegnieke toe. Besmette aartappels kan nie in die pakstoor gesond gemaak word nie. Goeie praktyke in die pakstoor kan egter voorkom dat verrotting van besmette knolle na onbesmette knolle versprei en verrotting kan vir 'n tyd lank vertraag word, maar uiteindelik sal verrotting intree en die rakleeftyd verlaag as die produk wat in die stoor beland het, besmet was.

Sagtevrot, wat normaalweg deur *Pectobacterium* species veroorsaak word, veroorsaak ernstige probleme in die aartapplebedryf. Daarbenewens versprei *Pectobacterium* baie vining *via* waswater. Ongelukkig is daar 'n beperkte aantal saniteermiddels wat vir gebruik teen dié organisme in waswater en tydens verpakking geregistreer is. Daarom is dit belangrik om seker te maak dat die saniteermiddel effektief is en optimaal aangewend word.

- Aartappels moet altyd versigtig hanteer word om beskadiging te voorkom ten einde die toegang van verrottingsbakterieë in knolle te verminder
- Die verpakkingslyn en waswater moet korrek en gereeld ontsmet word om dat besmettingsdruk te verlaag.
- Knolle wat gepak word, moet droog wees.
- Laastens moet die temperatuur tydens hantering, opberging en vervoer koel wees en goeie ventilasie moet gehandhaaf word om te sorg dat toestande nie gunstig is vir verrotting nie.

- Reduce organic debris and micro-organisms dumped in the wash basins as chlorine is adsorbed by organic material and soil particles.
- Rotten produce should never enter the pack line as the whole pack line can become infested by soft rot pathogens.
- Water should be changed several times a day when packing large amounts of potatoes to avoid infection of tubers by pathogens originating from a few rotten tubers.
- Potatoes should be dry before packing to reduce the chances of disease development after packing.
- By using a misting system, it is possible to dry tubers in a relatively short time.
- If chlorine is used as a sanitizer, care must be taken to maintain the pH at 6-7.
- Reduce mechanical damage to limit the risk of infection by bacteria in wash water and on pack lines.
- Prevent conditions favourable for disease development by thorough drying of tubers, low temperature and proper ventilation during transport.
- Good practices start in the field.

Series: Post-harvest decay of potatoes

IV: Chlorine is not effective when used in a tank with recycled water

Tlangelani Nghondzweni, dr. Reinette Gouws, prof. Retha Slabbert (Tshwane University of Technology)

Soft rot, sometimes referred to as 'post-harvest decay', is a wet, mushy rot that progresses rapidly, especially under warm temperatures and moist conditions. Infected tissues decay and macerate to a creamy consistence which turns black in the presence of air (Figure 1), developing a foul odour when invaded by secondary organisms. The macerated lesion can spread to the whole tuber and hence to neighbouring tubers in storage. Soft rot infected potato tubers are not marketable and therefore reduces yield and consumer satisfaction.

Post-harvest wash of potato tubers is a priority in the potato industry to enhance marketability of potatoes. However it is also known that post-harvest wash of potato tubers triggers the activities of soft rot causing bacteria. Post-harvest decay of potato tubers in storage or in transit is generally considered to be caused by the bacteria *Pectobacterium* spp, and *Dickeya* spp. (all formerly belonged to the genus Erwinia). The bacteria can grow both under aerobic and anaerobic conditions, causing a greater total loss of produce than any other bacterial disease.

Bacterial numbers on tuber cells can fluctuate depending on tuber storage conditions, increasing under moist and decreasing under dry conditions. High temperatures and the presence of a water film on the tuber surface together with oxygen depletion due to poorly ventilated conditions, favours the development of bacterial soft rot in freshly harvested potato tubers and in potato storage. At the beginning of tissue maceration the tuber skin may remain

Figure 1: Soft rot infected potato tuber tissues becoming brown-black in colour after exposure to air.

Figure 2: Soft rot infected potato tuber with undamaged skin, which bends inward due to pressure from other tubers in a potato bag.

- Na-oesverrotting word hoofsaaklik veroorsaak die Pectobacterium en Dickeya spp.
- Toestande wat die ontwikkeling van die siekte bevorder is hoë temperatuur, swak ventilasie en warm weer.
- Die gebruik van hipochloriet as ontsmettingsmiddel in wastenks waar water hergebruik word, word redelik algemeen gebruik vir die bestuur van na-oesverrotting.
- Waarnemings is in 'n tipiese kommersiële pakstoor gedoen om te bepaal hoe effektief hipochloriet as ontsmettingsmiddel is
- Resultate het duidelik getoon dat die effektiwiteit van hipochloriet wissel, waarskynlik as gevolg van organiese materiaal en grond in die wastenk. Die praktyk kan nie aanbeveel word nie.

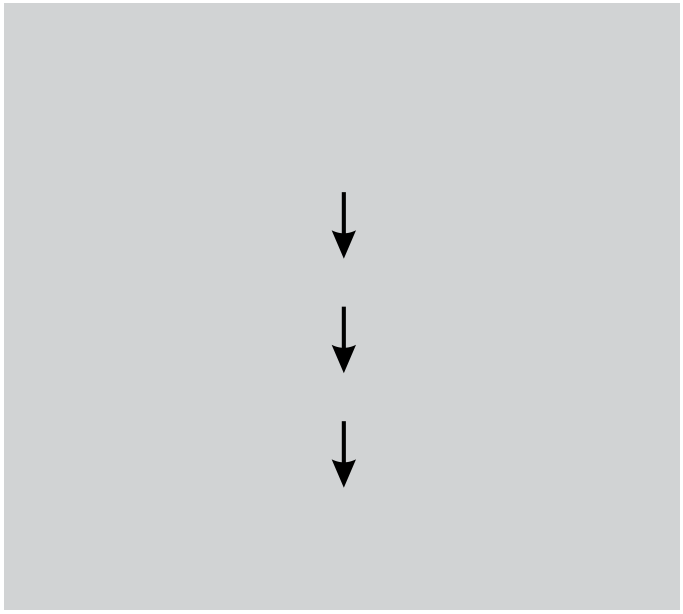
undamaged, making it difficult to identify soft rot infected tubers in storage. However, the skin becomes taught or breaks when applying pressure onto the tuber.

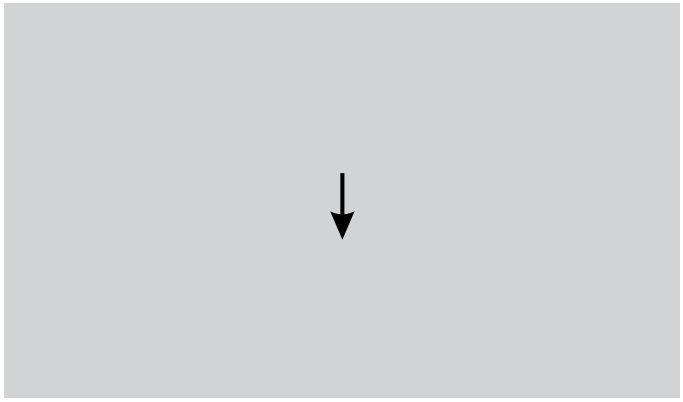
Several disease control measures have been studied to control blackleg and tuber soft rot caused by *Dickeya* and *Pectobacterium* pathogens. However, of these methods only postharvest chemical treatments have found widespread application. Chlorine based chemicals are widely used in the sanitation of fresh produce. Many potato growers are currently using chlorine in the postharvest treatment of potato tubers since it is a very economical alternative.

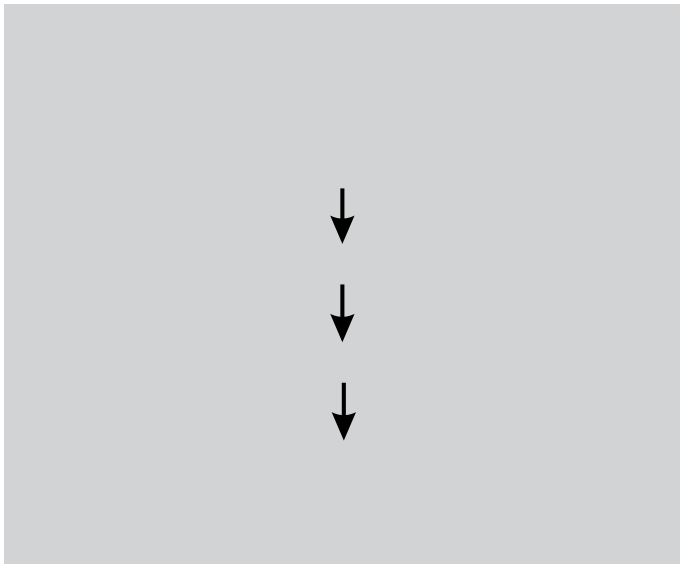
The efficacy of chlorine in reducing post-harvest decay of potato tubers was tested on a farm where freshly harvested potato tubers were washed using a commercial potato washing machine in a closed water recycling system that has a reservoir with a water holding capacity of 36 750L. The same wash water was used for a period of 2 weeks. For the purposes of the trial, the existing potato washing system of the farmer was utilized to make sure of the practical applicability of the end results. Four dosages of HTH chlorine were tested over 8 weeks in 4 different experiments. The chlorine dosages included: 10 parts per million (ppm), 50ppm, 100ppm and 300ppm. The first three dosages (10, 50 and 100 ppm) were each tested on the first day of the cycle after the system was cleaned and filled with clean water. The 300ppm dosage was added on the third day in the same water that was treated with 100ppm at the beginning of the wash recycling system. A sample of potato tubers was collected at the commencement of each trial before adding chlorine into the wash water. After adding the chlorine the granules were allowed to dissolve and circulate to mix well in the wash water for 2 hours before collecting a sample of tubers. Another tuber sample was collected on the third day of washing the tubers with the same water. Each sample comprised of three replicates per treatment and ten tubers per replicate. Samples were incubated at room temperature and evaluated over time for soft rot symptoms.

The results indicated that the sample collected from the tubers which were washed with the water on its second week of recycling [experiment 1], showed a very high incidence of soft rot [56.7%] (Table 1). After the system

Table 1: An illustration of how experimental treatments were employed and the soft rot incidence that was detected from each treatment







was thoroughly cleaned and filled with clean water, the tubers that were washed with untreated clean water as well as the tubers that were washed under 10ppm chlorine treatment showed no disease incidence throughout the evaluation period. However, from the sample that was collected on the third day of using the same wash water that was treated with 10ppm, a disease incidence of 6.7% was detected.

In the second experiment a disease incidence of 10% was detected from the tubers that were washed with untreated water. However, adding 50ppm of HTH chlorine into that highly contaminated water did not reduce the bacterial populations as a soft rot incidence of 16.7% was detected from the collected samples. In the third experiment no soft rot incidence was detected from the sample that was washed with untreated water. Adding 100ppm in that water suppressed the disease for 2 days as no soft rot incidence was detected from both the sample that was collected 2 hours after treating the water with 100ppm and the sample collected on the third. As the washing process continued on the third day with the same wash water that was treated with 100ppm, an additional 300ppm of chlorine was added to the wash water and left to circulate and dissolve for 2 hours. However, the 100ppm and additional 300ppm dosage did not suppress soft rot incidence that was already building up as the tubers samples showed 13.3% disease incidence.

The results of this study shows that regardless of adding various dosages of chlorine in the same recycled potato wash water, the chlorine is not effective once the inoculum builds up and the water retains an increasing load of organic matter. This finding is supported by literature that states that chlorine and CLO_2 have a greatly reduced bactericidal effect in the presence of soils and organic matter in wash flumes and dip tanks, consequently limiting their application as fresh produce sanitizers. We can conclude that by adding various dosages of chlorine into wash water that already contains organic matter and then recirculating the same water there is a build-up of soft rot inoculum and subsequently no effect on soft rot incidence on the washed tubers.

Chlorine can be effective in the control of post-harvest soft rot, given that the treated wash water stays clean or that the water is replaced frequently before inoculum build-up can take place.

Chlorine is not registered for use on potatoes for the fresh market. We subsequently advise against the use of chlorine to sanitise potato tubers.

Series: Post-harvest decay of potatoes

V:The law and usage of disinfectants on table potatoes

Kobus Serfontein (ICA International Chemicals)

Potatoes, as most fresh fruits and vegetables, are plagued by post-harvest spoilage diseases. Bacterial soft rot is, perhaps, the most prominent menace on potatoes and can cause substantial losses. Although the bacterium normally enter the packing facility via a few diseased or rotten potatoes, the potato washing facility often becomes the main source of post-harvest contamination on a larger scale. For this reason, disinfectants are used by producers to sanitize the washing water as well as the surfaces in the packing facility and the tuber surfaces. On other fresh produce, disinfection is used to eliminate potential human pathogens as well.

The potato farmer/packer should, first of all, only use a product that complies with the law. The choice of product that complies depends on the purpose of use and efficacy for the specific purpose. If claims are made on the label regarding the efficacy of the product for specific uses, the supplier should be able to back up the claims with trial data and regulatory approvals.

If anyone talks about the use of a chemical on a crop, pre- and post-harvest, one immediately thinks about Act 36 of 1947 or the "FERTILIZERS, FARM FEEDS, AGRICULTURAL REMEDIES AND STOCK REMEDIES ACT". Agricultural remedies fall under this act. An "agricultural remedy" is defined as "any chemical substance or biological remedy, or any mixture or combination of any substance or remedy intended or offered to be used for the destruction, control, repelling, attraction or prevention of any undesired microbe, alga, nematode, fungus, insect, plant, vertebrate, invertebrate, or any product thereof, but excluding any chemical substance, biological remedy or other remedy in so far as it is controlled under the Medicines and Related Substances Control Act, 1965 (Act 101 of 1965), or the Hazardous Substances Act, 1973 (Act 15 of 1973)." The claim of such product is, in other words, that its application will have a direct impact on the incidence or impact of a disease or pest.

The use of products to sanitize surfaces, which under the current regulation will include fruit and vegetables, falls under the COMPULSORY SPECIFICATION FOR DISINFECTANTS AND DERERGENT-DISINFECTANTS. (National Regulator for Compulsory Specifications or NRCS) Government Notice R529 (Government Gazette 19999) of 14 May 1999 under Section 22 of the Standards Act (Act 29 of 1993). In this Specification, a disinfectant is defined as: "A chemical agent that kills most vegetative forms of pathogenic and other micro-organisms (but not necessarily all bacterial and fungal spores, mycobacteria, rickettsiae or viruses) on inanimate surfaces." An inanimate surface is defined as: "Any surface other than live human or live animal tissue." Under these specifications, disinfectants are tested according to prescribed procedures and concentrations and must fulfill the claims made on the label and registered as such.

The National Regulator for Compulsory Specifications (NRCS) supplies a registration number (example: Act29GNR529/27555/070/210) for disinfectants that is compliant to the regulations.

The farmer/packer must be aware that a sanitizer (disinfectant) can rarely be 100 % effective. It is thus of utmost importance to keep the pressure on the sanitizers as low as possible, by pre-sorting and "helping" the sanitizers by regular replacement of solutions, as most sanitizers are inactivated by organic matter. Regular cleaning of the packing facility, washing and sanitation of surfaces are important to prevent infection of produce. The correct handling of the potatoes before the pack house is vital, as a pack house can never be a "hospital" for "ill" produce.

Some chemicals used as disinfectants may be harmful, toxic or carcinogenic and therefore must comply with the minimum requirements specified in the standard.

Disinfectants coming into contact with food should further comply with the South African National Standard SANS 1853 (DISINFECTANTS AND DETERGENT-DISINFECTANTS FOR USE IN THE FOOD INDUSTRY). Compliance is currently a standard, and not enforced by law. However, responsible suppliers of disinfectants that are used to sanitize fresh produce are making efforts to comply with this standard to ensure that their products are safe for use. Products are tested for chemicals/ingredients potentially harmful to humans and the SABS supplies a certificate to suppliers of disinfectants that comply with the Standard.

If you require specifications on the toxicology and safeness of a disinfectant, request a copy of the MSDS certificate from the supplier.

An example of toxicological information for a popular disinfectant registered in South Africa is given below:

11. TOXICOLOGICAL INFORMATION

ANIMAL ACUTE TOXICITY DATA (PRODUCT)

ORAL:	LD_{50} (rat)	>4000mg/kg
DERMAL:	LD_{50} (rabbit)	>2000mg/kg
INHALATION:	LC_{50} rat	0.161 mg/L air – can cause irritation and damage to mucosal surface.
DERMAL IRRITATION:	(OECD 404)	Irritating to skin
EYE IRRITATION:	(OECD 405)	Risk of serious damage to eyes
SENSITISATION:	Guinea pig	Not a skin sensitizer
CHRONIC TOXICITY:	Oral dog	1 year – no target organs effects
PHARMACOKINETICS:	Dog	This material does not accumulate in body tissues.
MUTAGENICITY:		Non-teratogenic, non-carcinogenic, non mutagenic

- Aangesien besmetting van gesonde knole dikwels tydens die was- en sorteerproses plaasvind, word saniteringsmiddels (ontsmettingsmiddels) algemeen gebruik om aartappels te ontsmet om na-oesverrotting te beperk.
- Wat sê die Wet oor die gebruik van ontsmettingsmiddels op aartappels wat bestem is vir die varsmark?
  -Middels wat registrasie onder Wet 36 van 1947 geniet, is nie vir gebruik as ontsmettingsmiddel geregistreer nie.
  -Ontsmettingsmiddels word deur Wet 29 van 1993 gereguleer. Sien die Staatskoerant 19999 van 14 Mei 1999.
- Aangesien sommige onsmettingsmiddels nadele kan inhou vir die mens se gesondheid, behoort sulke middels te voldoen aan die Suid-Afrikaanse Nasionale Standaard 1853. Tans is dit nie verpligtend dat 'n ontsmettingsmiddel aan die srtandaard voldoen nie, maar verantwoordelike voorsieners gaan die moeite en koste aan om te verseker dat hul middels veilig is vir menslike gebruik.
- Om seker te maak dat 'n middel veilig is vir vars aartappels, vra die voorsienner vir 'n "MSDS"-sertifikaat. Sien voorbeeld elders in die artikel.

Reeks oor na-oesverrotting van aartappels

VI: Beheer van na-oesverrotting begin op die land

Dr. Fienie Niederwieser (Bestuurder: Navorsing & Ontwikkeling, Aartappels Suid-Afrika)

'n Knol waarvan die skil nie geset het nie, is baie dun en beskadig uiters maklik

In die eerste artikels in hierdie reeks, is die oorsaak van na-oesverrotting en die belangrikheid van genoegsame Ca in die knol- en skilweefsel beklemtoon. In artikels in die vorige Chips-uitgawe is die belangrikheid van goeie praktyke in die pakhuis en die gebruik van ontsmettingsmiddels om besmetting deur sagtevrotbakterieë te beperk, bespreek. In hierdie artikel, word die effek van klimaatstoestande voor en tydens oes en oespraktyke as risiko ten opsigte van na-oesverrotting vir 'n bepaalde aanplanting bespreek.

Na-oesverrotting word deur sagtevrot-patogene veroorsaak. In Suid-Afrika is bevind dat hoofsaaklik *Pectobacterium* species voorkom. *Pectobacterium* vermeeder baie vinnig wanneer daar 'n bron van die bakterieë voorkom, die temperatuur hoog is en baie reën voorkom voor oes. Grond wat met verrottingsbakterieë besmet is, sit aan knolle vas tydens oes. Wanneer die skil beskadig word, vestig die bakterieselle hulself in weefsel. Die bakterieselle kan dan verrotting veroorsaak, of hulle kan latent in die wonde oorleef totdat toestande vir sagtevrot gunstig is. Besmette knolle dien as besmettingsbron vir onbesmette knolle tydens die was- en sorteerproses. Na-oesverrotting is veral 'n probleem onder warm weer toestande omdat Pectobacterium selle baie vinnig by hoë temperatuur vermeerder. Verrotting versprei

vinnig in waswater wat nie gereeld vervang word nie of wanneer die ontsmettingsmiddel nie effektief is nie *(Sien Chips Sept/Okt 2014, pp. 46-48)*.

Besmetting van beskadigde knolle vind baie maklik plaas deur die wonde of lentiselle waar verrottingsbakterieë wat in die nat grond teenwoordig is. Deur meganiese beskadiging te beperk, word die risiko vir verrotting beperk omdat die besmettingsbron tydens hantering verlaag word. Beperking van meganiese beskadiging moet egter gepaard gaan met ander maatreëls.

Knolle is meer geneig om te kraak en meganies te beskadig as hulle 'n hoë waterinhoud het (hoë turgordruk) en hul temperatuur laag is, <10°C.

Optimale grondwatervlak is 60-65% van beskikbare grondwater. Indien toestande dit toelaat, staak besproeiing betyds. Dit sal nie net lei tot 'n meer gunstige vogstatus van knolle nie, maar ook toelaat dat die skil behoorlik set.

Grond wat te nat is (veral kleigronde), is geneig om aan knolle vas te sit wat die wasproses bemoeilik en die grondlading in die waswater verhoog.

Grond wat te droog is, kan klonte vorm wat die oesproses bemoeilik en lei tot meganiese beskadiging van knolle. 'n Ligte besproeiing 2 tot 3 dae voor oes, kan hierdie probleem aanspreek.

In die winter wanneer temperatuur <10°C is, is dit wys om nie vroeg in die oggend te oes nie, maar eers wanneer die temperatuur gestyg het. Moet nie geoeste knolle buite laat nie en vermy ook gradering en vervoer van aartappels wanneer die temperatuur baie laag is.

Kultivars verskil in hul geneigdheid om te kraak. Waar produksie hoofsaaklik in die winter plaasvind, word aanbeveel dat hierdie eienskap van nuwe kultivars getoets word. Kultivars met 'n hoë droëmassa, is meer geneig om te kraak as kultivars met 'n laer droëmassa.

Knolle met volwasse, ferm skille, beskadig baie minder as knolle waarvan die skil dun en onverkurk is wanneer hulle geoes word. In warm weer neem dit ongeveer tien dae vir die skil om behoorlik te set. By lae temperatuur moet meer tyd toegelaat word voordat die knolle geoes word.

- Wet conditions coupled with warm weather increase the risk of post-harvest decay, as soft rot bacteria multiplies very fast under such conditions.
- To reduce the spread of *Pectobacterium,* reduce mechanical damage by allowing skin to set before harvest and when the soil water content is 60-65%.
- As tubers tend to crack at temperature <10°C, postpone harvest and sorting of tubers to later in the day when it is warmer.
- If harvesting is during winter, use cultivars less prone to crack.
- Make sure the potato lifter is set correctly.
- Do not allow workers to walk or sit on harvested tubers.
- If black dot/silver scurf occurs in a field, harvest as soon as skin has set to reduce mechanical damage.

Sorg dat die uithaler reg gestel is. Die lem moet diep genoeg gestel wees om die wortels onder die knolle af te sny. Die grondspoed van die uithaler moet in pas wees met die spoed van die kettings sodat knolle op 'n kussing van grond oor die kettingstawe beweeg. Aan die ander kant, moet daar nie te veel grond saam met knolle op die stawe beweeg nie aangesien klippe en gruis knolle beskadig.

Waar knolle met die hand opgetel word, is die risiko van meganiese beskadiging laer as wanneer knolle met outomatiese uithalers geoes word. Werkers moet nie op die vrag aartappels loop of sit op pad na die pakhuis nie aangesien die knolle interne skade kan opdoen wat nie ooglopend is nie en dus word sulke knolle nie verwyder tydens die sorteerproses nie. Die interne kneusing maak sulke knolle egter vatbaar vir verrottingsorganismes.

Die afstand wat aartappels val en die oppervlak waarop hulle val moet by elke stap van die oesproses aandag geniet. Vervang hout- en metaaloppervlakke met absorberende materiaal en beperk die valhoogte tot 'n maksimum van 50 cm. Sorg dat vervoerbande teen maksimum kapasiteit werk sodat knolle so min as moontlik rol.

Om vas te stel waar in die proses van oes tot verpakking meganiese beskadiging plaasvind op 'n spesifieke plaas, kontak Aartappels Suid-Afrika se streekbestuurder in u gebied om met behulp van die "Impact Recording Device" (IRD) vas te stel waar die risiko lê (sien artikel op p. 34 in hierdie uitgawe van CHIPS)

Indien swartspikkel/silwerskurf in 'n land voorkom en die oes uitgestel word, is daar 'n groot moontlikheid dat knolle meganies beskadig word met oes. Die rede is dat die patogeen tussen die skil en die onderliggende weefsel voorkom sodat die skil baie maklik los raak. Beide die aantal besmette knolle en die persentasie oppervlak wat besmet word, neem toe hoe langer knolle in die grond bly. In sulke gevalle is dit wys om te oes sodra die skil geset het en om te verseker dat ontsmetting van knolle voor sortering optimaal geskied.

'n Knol wat met swartspikkel/silwerskurf besmet is, raak baie maklik beskadig

THE POTATO SKIN AND SKIN SET

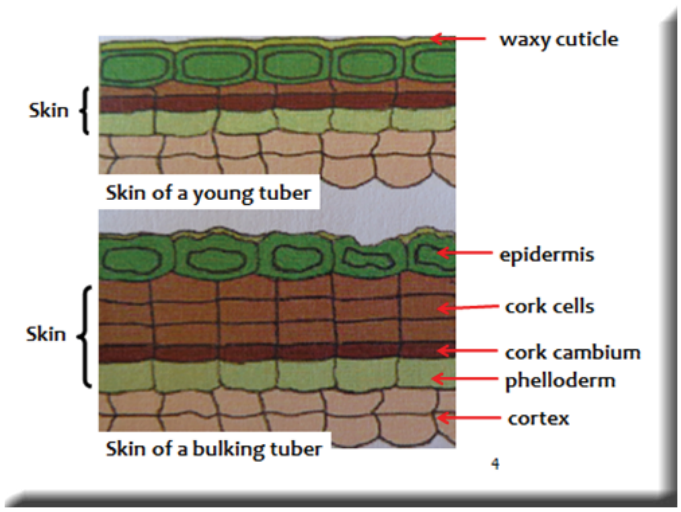
Article and photos: Dr Fienie Niederwieser, Potatoes South Africa

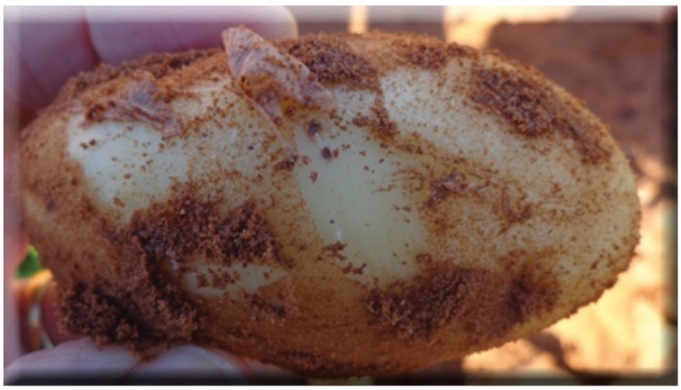
The role of the potato skin, also known as the periderm, is often overlooked. However, just as the human skin, the potato periderm has a very important role to protect the tuber against excessive moisture loss and infection by pathogens.

The universal requirement for a tuber pathogen to infect tuber tissue is the presence of moisture. If the skin is damaged, the tuber's natural defence mechanism is removed. In addition, moisture and nutrients are made available to the pathogen. Fusarium dry rot pathogens enter the tuber through wounds. Without the protection of the intact skin, infection by soft rot pathogens occurs so much easier.

Just after initiation, small tubers are protected by the epidermis which is coated by the waxy cuticle (just like leaves and young stems). Under the epidermis is the cork cambium cell layer which divides to form cork cells and the phelloderm that provide the energy and metabolites required for cell division in the phelloderm.

On tubers that are bulking, the epidermal cells are sloughed off and the phelloderm and cork cambium cells divide actively to keep up with the increasing tuber surface and, at the same time, to increase the layers of cork cells. At this stage the cell walls of the cork cambium are very thin.
After foliage die-off, tuber bulking ceases, the cork cambium cells become inactive, the walls become thick and are not easily broken and all the cells of the skin become suberized and die. Thus the skin "sets".





When tubers are harvested and handled before the skin has set, the skin slips off extremely easily because the cork cambium cells have very thin walls and gives way under mechanical pressure.

Tubers should not be handled before the cork cambium becomes inactive and the cell walls became thick. In other words, leave tubers in the soil until the skin has set: The following factors have an effect on skin set:

- Crop maturity. The skin of bulking tubers does not set as fast as that of mature tubers.
- Soil moisture. A general recommendation is soil moisture levels of 60 – 65%. A light irrigation, two to three days before harvesting, may be applied when the soil is very dry.
- Cultivars. Under similar harvesting practices, tubers with high dry matter content tend to bruise more readily than tubers with low dry matter content.
- Temperature. It is not possible to control soil temperature, but keep in mind that skin set in cold soil is slower than in warm soil.

Tubers respond to wounding by forming a new layer of phelloderm and cork cambium so that a new skin, complete with a protective layer of cork cells, is formed within 10 to 14 days.

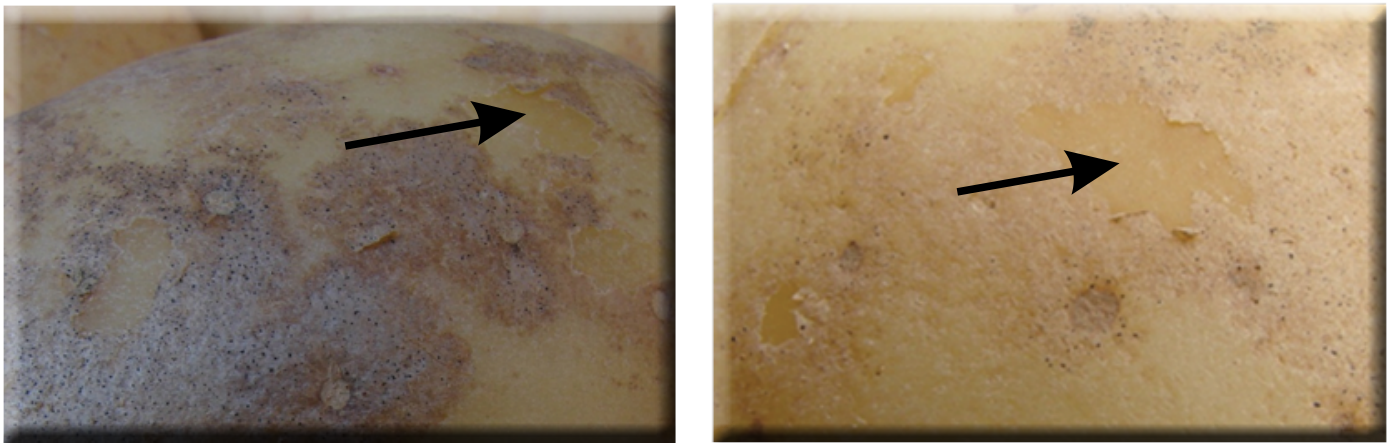
Stimulate wound healing by maintaining favourable conditions:

- Make sure that ventilation is adequate so that oxygen remains available, and CO_2 is removed.
- Wound healing is slow if temperature is low.
- If tubers remain covered by a layer of moisture during wound healing, it may create conditions favourable for infection by soft rot organisms before the protective cork cell layer can be formed.

It is particularly important to promote wound healing on seed tubers as they will normally be stored for months before being sold.

If silver scurf/black dot occurs in a field, tubers should be lifted as soon as possible after skin set. The silver scurf/black dot pathogens grow in the potato skin and cause silvering and separation of the cell layers, thus causing the skin to slip-off very easily, even after the tubers were allowed to set skin. If tubers are left in the field for prolonged periods, the pathogens will continue to grow on the skin and cause large blemishes that may result in down grading on the market. In addition, if tubers were not dried properly after grading soft rot pathogens can enter the wounds and cause rotting.

Where silver scurf/black dot may occur on seed tubers, effective seed treatment is available. It is important to apply the seed treatments as soon as possible after lifting to limit growth of the pathogen in the skin during storage. Ware potatoes should be marketed as soon as possible.



Silver scurf/black dot pathogens occur in the skin of the potato and cause the skin to slip very easily, even after the tubers were allowed to set skin before harvest.

Vergrote lentiselle kan na-oesverrotting vererger

Dr. Fienie Niederwieser (Bestuurder: Navorsing en Ontwikkeling, Aartappels Suid-Afrika)

Verhewe, wit weefsel op die oppervlak van knolle. Die grootte kan wissel van onopvallend tot groot. Wanneer knolle uit nat grond gehaal word, is die verhewe weefsel wit, maar verkleur wanneer dit droog word. In warm weer begin sagtevrot dikwels in vergrote lentiselle en kan verrotting waargeneem word as donker weefsel rondom lentiselle.

Onder normale omstandigheide is lentiselle klein, verkurkte openinkies wat gaswisseling toelaat. Vergrote lentiselle word gevorm onder toestande van 'n tekort aan suurstof en oormatige vog in die grond rondom die kolle, of in opberging omdat die selle onder die lentiselle swel en die massa-selle deur die verkurkte lagie breek. Omdat knolweefsel nie meer deur 'n kurklagie beskerm word nie, is vergrote lentiselle dikwels die plek waardeur sagtevrot die knol besmet.

Vermy lande wat geneig is tot versuiptoestande. Vermy oorbesproeiing twee weke voor oes deur te besproei wanneer 40 – 50% van die plantbeskikbare water gebruik is. Indien knolle met vergrote lentiselle wel geoes word, moet hulle so gou moontlik gedroog word. Oes knolle in versuipkolle apart van ander dele waar moontlik, maak seker dat sanitasie tydens die wasproses optimaal is en dat knolle so vinnig moontlik en goed gedroog word voor verpakking. Wanneer chloor gebruik word as saniteerder in die wastenk, moet waswater gereeld vervang word en moet die pH by 6-7 gehou word.

Vergrote lentiselle op die knol

Vergrote lentiselle op die knol

Duimnaelkrake van nader bekyk

Dr. Fienie Niederwieser (Bestuurder: Navorsing en Ontwikkeling, Aartappels Suid-Afrika)

Meganiese impak manifesteer dikwels as duimnaelkrake op aartappelknolle. Die kraak in die skil lyk asof dit met 'n duimnael gemaak is en vandaar die naam 'duimnaelkrake'. Die krake kan ontstaan na 'n ligte impak of besering en kom aanvanklik net in die periderm (skil) van die knol voor, sonder kneusing van die onderliggende weefsel. Aartappelknolle is veral geneig om te kraak as die temperatuur van die weefsel <10°C is. Wanneer knolle daarna aan lae humiditeitstoestande blootgestel word, droog die weefsel onder die krake uit en raak die duimnaelkrake maklik waarneembaar wat tot kwaliteitsverlaging kan lei. Duimnaelkrake verleen ook aan sagtevrotbakterie 'n toegangsroete na die knolweefsel.

'n Span navorsers in Duitsland het onlangs die oorsake van hierdie duimnaelkrake bestudeer en hul resultate tydens die 19de Konferensie van die European Association for Potato Research (EAPR) gerapporteer. Die span het knolle van agt kulitvars wat koelopgeberg was, aan beheerde beskadiging blootgestel en gevind dat kultivars verskil in hul geneigdheid tot duimnaelkrake. Hierna het hulle die verskille in die eienskappe van die skil en onderliggende weefsel van die agt kultivars ondersoek.

Duimnaelkrake op aartappelknol

Die inhoud van selwandmateriaal in die periderm van sensitiewe kultivars was hoër as by tolerante kultivars. Verder is ook bevind dat die Mg- en Ca-inhoud van selwande van die periderm en onderliggende weefsel van tolerante kultivars hoër is as by sensitiewe kultivars. Die verklaring daarvoor is dat beide Ca en Mg belangrike komponente van pektien is. Ca en Mg dra dus by tot die elastisiteit en jellie-agtigheid van pektien - die verbinding wat selle aanmekaar hou.

Om die voorkoms van duimnaelkrake te voorkom, moet aartappels nie geoes of hanteer word as dit koud is nie. Die temperatuur van aartappelweefsel moet >10°C wees. Verder moet die gewas optimale bemesting ontvang om sorg te dra dat genoeg Ca en Mg in die selwande teenwoordig is.

Meyer, KP.; Hofferbert, H-R; Peters, R & Pawelzik, E 2014. Book of Abstracts – Proceedings of the 19th Conference of the European Association for Potato Research (EAPR) 283.

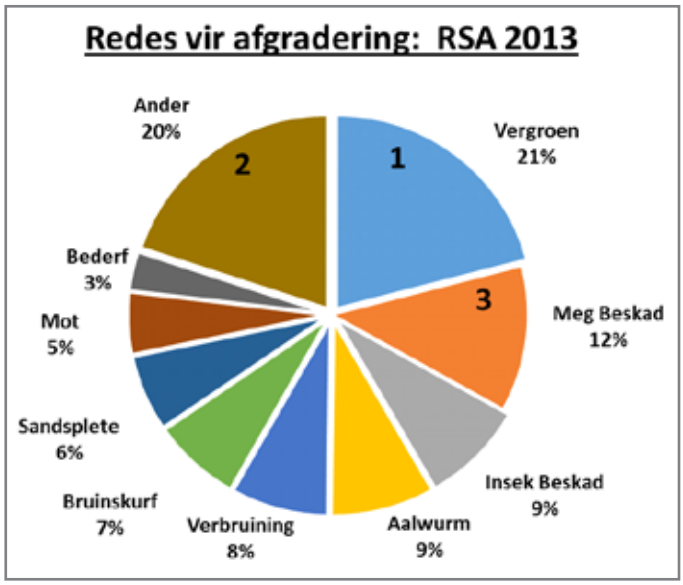
Thumb nail cracks often form when cold tubers (internal temperature < 10°C) are handled. A German team used eight cultivars in a study and found that:

- Cultivars differ in their tolerance to crack.
- The cell walls of sensitive cultivars contained less Mg and Ca than the cell walls of tolerant ones.
- Mg and Ca are important constituents of pectin. Pectin makes cell walls more elastic and less prone to crack.
- To reduce the incidence of thumb nail cracks, do not handle tubers when it is cold, grow tolerant cultivars and make sure that the fertilizer programme is balanced.

"Impact Recording Device" word ingespan om meganiese beskadiging te beperk

Artikel en foto's: Albert Boneschans

Afgradering weens meganiese skade maak 12% uit van alle afgraderings op varsproduktemarkte en produsente verloor ongeveer 839 000 sakkies as gevolg van afgradering. Dit is gelykstaande aan 'n verlies is van R1.5 tot R2.00 per sakkie, 'n verlies van R1 678 000 per jaar vir die produsente.



In die afgelope vyf jaar het Aartappels Suid-Afrika se streekbestuurders die "Impact Recording Device" (IRD) gebruik om aartappelprodusente te help om vas te stel waar in hul verpakkingsproses meganiese beskadiging plaasvind. Die IRD's is by 173 pakstore en 67 uithalers in al die produksiestreke vir hierdie doel ingespan.

Gedurende die toetse is daarin geslaag om die impakte waaraan aartappels tydens die verpakkingsproses blootgestel word, te identifiseer en die nodige aanbevelings te maak. Deur klein praktiese veranderinge aan die toerusting aan te bring wat die impak op aartappels kan verminder of beperk, het talle boere daarin geslaag om meganiese beskadiging te beperk.

Die vernaamste plekke waar skade voorkom:

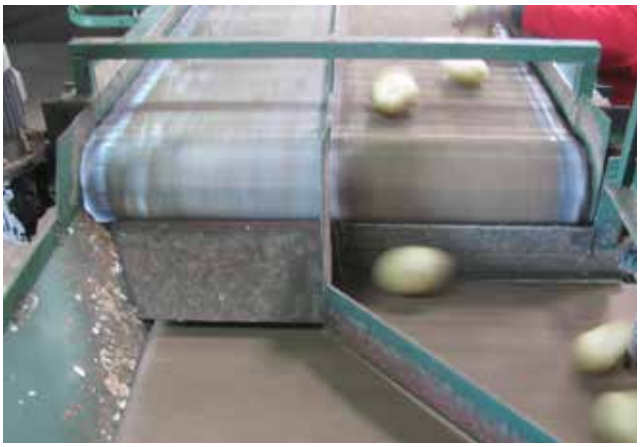
- Valsorteerder "Drop sizer" (Op en deur val).
- Waar knolle op yster val (Rollers).
- Waar die val van een tafel na 'n ander te hoog is.
- As die sorteerder se spoed te vinnig is.

Baie min skade het op uithalers voorgekom, omdat meeste uithalers, veral die massa-uithalers, met 'n IRD toegerus word. Verdere toetse is ook gedoen op 'n sleepwa van die land af na die pakstoor en die IRD het hier ook min skade aangetoon. Let daarop dat bogenoemde egter van plaas tot plaas kan verskil.

Die foto is geneem waar aartappels vanuit die voerbak op die vervoerband op pad is na die wasmasjien.

Gewaste aartappels op pad na die valsorteerder (drop sizer).

Vervoer van aartappels van die valsorteerder (drop sizer) na die Groot-groottegroepsorteertafel. Dit dui die valle op die “groot” sorteertafel aan waar daar moontlike meganiese beskadiging kan plaasvind.



Valle soos hierdie en hoër, kan meganiese skade op aartappels veroorsaak.

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Met die saamstel van die inligting wat in hierdie publikasie vervat word, het Aartappels Suid-Afrika ten beste gepoog om te verseker dat die inligting ten tyde van publikasie korrek en relevant is. Daar word egter geen vertoë gerig of waarborge verskaf oor die volledigheid of akkuraatheid van sodanige inligting nie. U moet veral bedag wees op die feit dat onvolledige inligting weergee kan word, dat die inligting foutief kan wees of dat dit verouderd kan wees.

Die doel met inligting wat verskaf word is nie om die gebruiker te oortuig of te beïnvloed om tot 'n bepaalde gevolgtrekking te kom nie en besluite wat op grond van sodanige inligting geneem word, word geneem op die uitsluitlike verantwoordelikheid van die gebruiker van sodanige inligting. Dit is dus gerade om alle inligting te verifieer voordat u daarvolgens handel en Aartappels Suid-Afrika en sy werknemers, agente en konsultante aanvaar geen wetlike aanspreeklikheid vir besluite wat deur u geneem word en die gevolge wat daaruit voortspruit nie. Indien u sodanige inligting gebruik of daarop reken, vrywaar u Aartappels Suid-Afrika en sy werknemers, konsultante en agente van enige verlies of skade (insluitend indirekte, spesiale of gevolglike verlies of skade) wat voortspruit uit die gebruik van sodanige inligting of deur daarop te reken, ongeag of dit deur enige nalatige handeling of versuim veroorsaak is.

Menings wat uitgespreek word of aansprake en verklarings van veronderstelde feite in die publikasie, weergee nie noodwendig die standpunte van die personeel of bestuur van Aartappels Suid-Afrika nie. Die publikasie, tesame met die inhoud daarvan, is onderhewig aan wetgewing op kopiereg in Suid-Afrika en ingevolge internasionale verdrae, ook aan dié van ander lande. Kopiereg word voorbehou deur Aartappels Suid-Afrika, of in gevalle waar materiaal aan derde partye behoort, besit hulle die kopiereg daarop.

U mag die inligting vervat in hierdie publikasie slegs gebruik vir eie inligtingsdoeleindes, navorsing of studie. U mag die kopiereg van hierdie publikasie (geheel of gedeeltelik) nie reproduseer, oordra, wysig of dit gebruik vir enige kommersiële of ander doel sonder die uitdruklike skriftelike toestemming van Aartappels Suid-Afrika nie en dit mag slegs gedoen word onderhewig aan die voorwaardes waarop sodanige toestemming verleen is.

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