National Potato Conference, February, 2002

Painless Pre-sprouting – A Review of Pre-sprouting Systems
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Systems for Pre-Sprouting Potatoes

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Introduction

Apart from the necessity to pre-sprout early potatoes, pre-sprouting also has many advantages for producers of second early and maincrop producers. In the Irish climate with its short growing season, and wet autumns, earlier harvesting frequently results in reduced damage, bruising, disease, and crops safely in store before the frosts arrive.

The ideal system for successfully pre-sprouting or chitting seed should allow every tuber to have good access to light and air so that only strong short and green sprouts are produced. These will be healthy and be resistant to damage during planting.

Pre-sprouting at Greenmount

Since the mid-eighties 30-50% of Greenmount College's second early and maincrop seed potatoes have been pre-sprouted prior to planting and over most of this period pre-sprouting has been carried out using conventional chitting trays. Chitting trays fully satisfy the requirements of the ideal pre-sprouting system and produce strong healthy sprouts, but successive farm managers have complained of the difficulties of working with the system. These concerns are:

- labour intensive and time consuming to fill trays;
- difficult to transport trays without spillage;
- time consuming and labour intensive to fill the planter.

The Greenmount College farm is a mixed farm and quite often potato planting coincides with first cut silage, therefore availablity of staff a big issue. It was against this background that the Pregerm system was introduced in 2000.

Pregerm system

The Pregerm system was developed in the Netherlands and has been marketed in Britain for a number of years by Burdens Distribution, Boston, Lincolnshire. Seed is placed into a wide and flat net bag rather than a tray. Each Pregerm bag is divided into 6 long pockets that stop the bag bulging at the bottom and maintain its wide flat shape. This ensures that the layer of potatoes in the bag is relatively thin and that light and air can penetrate to all tubers. Each bag typically holds 125kgs of seed.

Storage and transport

Bags are stored and transported on metal racks that hold up to 10 Pregerm bags (1250kgs seed). The racks can be stacked 2 high (3m) and a pair of racks needs an area of approximately 4.6m^2 (1.4m x 3.3m). The racks are designed to be lifted by forklift, and in comparison to trays, the risk of spillage is reduced and no time is wasted trying to secure trays safely to a pallet.

Filling Pregerm bags
Racks are loaded with 10 bags, that are then opened wide at the top so that all bags touch during filling. This provides a large area for filling by elevator, bulk bag or hopper. This usually involves 2 men to ensure that seed is evenly distributed over the sacks without spillage.

To date at Greenmount we have been emptying seed from 50kgs bags into our grader, then filling individual bags from the side conveyor, prior to loading in the rack. This is quite a slow and inefficient method and not recommended where large amounts of seed are being handled.

Pregerm bags offer some potential to save time and labour when setting up seed for pre-sprouting. However, such benefits could be relatively minor as labour demand tends to be low on many farms from February to early March.

Loading the planter
It is during planting that the time and labour saving advantages of the Pregerm system are really noticeable compared to tray pre-sprouting. Firstly, transport to the field is safer and faster as the racks and bags are much more stable than trays. This is especially important if long distances have to be covered. Secondly, loading of the planter takes seconds rather than minutes as the rack is merely suspended over the hopper whilst Velcro flaps at the base of the bags are opened to release the seed. Finally, the empty rack is replaced on the trailer to return to the yard with none of the gathering and stacking associated with trays.

It is the ease of use of the system at planting time that impressed us the most with greatly reduced turnaround time compared to trays. This could be a significant factor if large areas of chitted seed are being planted. The only drawback of the system at planting was the need for a forklift or loader compared to the tray system, but many growers will be using such equipment for loading non-sprouted seed anyway.

Sprout quality
At Greenmount we are only pre-sprouting second early and maincrop potatoes and our aim is to subject the seed to 150 to 200 day degrees after dormancy break. This results in short robust sprouts approximately 1 cm in length capable of withstanding planting by a cup planter. To help ensure that a short sprout is achieved our sprouting area is very well lit with both natural and artificial light, and is cool and well ventilated. Daily day degree accumulation averages approximately 4-6 degrees during February and March, resulting in relatively slow sprout growth.

To date we have been pleased with the quality of sprout produced with the Pregerm system and it compares well with the tray system. Light levels between bags in the centre of a racks is similar to those in the centre of a stack of trays but the tuber layer in the bags is approximately 17cms compared to 12cms for trays. This means that trays still offer an advantage in terms of light penetration and sprouts formed in the middle of the bags may not be as strong as those in the middle of a stack of trays.

There is some damage to sprouts when filling the planter because sprouts that have grown through the netting can become detached, however we have not detected any significant differences in emergence from using Pregerm bags. Where longer sprouts are produced more sprout damage might be expected compared to the tray system.

Cost of the Pregerm system compared to sprouting trays
The following table compares the cost of plastic trays with Pregerm bags. It is assumed that the racks for the Pregerm bags have been constructed by the grower and materials and labour are included in this cost. The exchange rates used are 1 UK pound to 1.62 euro and 1 euro to 0.79 Irish pounds.

	Cost per unit **€ (IR£)**	**Units per tonne**	**Cost per tonne seed** **€ (IR£)**
Plastic trays	5.83 (4.61)	60	**349.80 (276.34)**
Pregerm bags	18.95 (14.98)	8	151.60 (119.76)
Racks (10bags)	162.00 (127.98)	0.8	129.60 (102.38)
			281.20 (222.14)

There is a clear cost advantage to using the Pregerm system provided the grower can manufacturer his own racks or have them made cheaply by a local engineer. Purchasing ready made racks in England and transporting them to Ireland brings the cost up to level of plastic trays. The difference in cost may also be less if second hand trays are purchased.

Conclusions
Following two seasons experience of using the Pregerm bag system the following can be concluded:

- Sprout quality compares well with tray sprouting for sprouts up to 1cm in length;
- Pregerm bags save time and labour at planting;
- Some sprouts catch in netting when discharging bags into planter hopper but there have been no observable effects on crop emergence to date;
- Lower cost system than plastic trays provided racks can be manufactured locally and cheaply.

Acknowledgements
Acknowledgement is given to the following for their assistance in providing information for this paper:

Burdens Distribution Ltd, Sutterton, Boston, Lincolshire
Adrian Saunders, Business Development Adviser, Organic Crops, Greenmount College
Harry Steele-Nicholson, Assistant Farm Manager, Greenmount College

Practical Approaches to the Control of Blackleg

Stuart Wale, SAC Aberdeen

What you need to know about the causal organism

Blackleg in northern Europe is caused by a bacterium called *Erwinia carotovora sub. sp. atroseptica* (Eca). Not only can it cause blackleg in stems of the growing crop, it can cause a soft rot of tubers. Eca can thrive under anaerobic as well as aerobic conditions.

Like most bacteria, Eca can multiply very rapidly under ideal conditions. Given optimum, warm moist, conditions its numbers can double every few hours. Thus, when potato tubers are warm and wet and Eca is present, it can rapidly multiply. To prevent multiplication tubers must be dry or cool. Below 6^{o}C the bacteria do not multiply.

Eca causes tissues to breakdown because it produces enzymes called pectinases which attack the 'glue' that joins cells together. In order for a breakdown to occur, enough enzyme must be produced. This only happens when the bacteria numbers reach a certain level. Thus, if sufficient Eca are present in a lenticel, there will be enough enzyme produced to break through the suberised barrier under the lenticel.

Where a barrier does not exist, for example in a wound or damaged sprout, the number of bacteria needed for creating a rot is less. Thus Eca can invade damaged tissue easily.

The life cycle of blackleg

As Eca does not survive long in soil, under normal rotations the main source of the blackleg bacteria is the seed you use to grow a crop. If sufficient Eca is present in the lenticels of seed tubers, the wound periderm beneath the lenticel is breached and the mother tuber rots. If this happens soon after planting, sprouts may fail to establish and blanking occurs in the field. More normally it occurs after emergence and the growing crop has established. In this situation, the blackleg bacteria move up the vascular tissue of the stems and block water transport to the foliage. The leaves turn yellow, the stem becomes stunted and exhibits wilting and the typical black slimy lesion develops above and below soil level.

Eca bacteria from the rotting stem, but particularly from the mother tuber, spread through the soil to the developing daughter tubers. These become contaminated on the surface and in the lenticels. The spread is greatest when soil conditions are wet. In very wet conditions or prolonged irrigation, the lenticels of the daughter tubers may extrude and facilitate entry of the bacteria. Under dry soil conditions in the period to harvest, there will be little spread to daughter tubers. Thus the weather conditions at and before harvest influence the degree of daughter tuber contamination.

Another important way contamination can occur is during harvest when the contents of rotten mother tubers spread to daughter tubers. Eca can spread to wounds and lenticels.

Once lifted, the survival of Eca on the tubers depends on the storage conditions. Where tubers are dried rapidly and kept dry using positive ventilation, the contamination can decrease over a long period of storage but will probably not be eliminated. If drying is slow or condensation occurs, the contamination can increase. If it increases very rapidly the wound periderm or barrier below wounds or lenticels may be breached and rotting is initiated. Other factors such as dry matter content can affect the extent of rotting after harvest. Cooling tubers immediately after harvest using refrigeration may prevent the development of rots but not reduce contamination much.

Practical control

Under the climate conditions of Great Britain and Ireland, blackleg is an ever-present threat. In susceptible varieties under poor, wet growing conditions it is difficult to avoid some blackleg developing in the field.

Contamination of a seed stock increases with each generation of multiplication. Seed growers have reduced the risk of blackleg by limiting the generations of seed multiplication.

Blackleg is one of the few tuber diseases where a consistent relationship between the level of contamination ('infection') of seed and the subsequent incidence of blackleg has been clearly established. Thus purchasing and planting a seed stock with a low level of contamination is important to minimise the risk of blackleg. Choosing a limited generation seed stock is not a guarantee of freedom from blackleg but should be a lower risk. Otherwise, the level of contamination can be determined by a blackleg risk assessment test.

Blackleg risk assessment tests are available from a number of organisations to measure the degree of Eca contamination on a seed stock. These tests provide approximate estimates of contamination and thus the risk of blackleg, but improved tests with greater accuracy are being developed.

Planting a stock with a low Eca count will reduce the risk of blackleg but may not prevent blackleg developing. There are several possible reasons why this may be case. Firstly, if the growing conditions are particularly adverse (cool and wet), low bacterial numbers on the seed can multiply to a level where the mother tuber rots down and blackleg is initiated. Thus, growing conditions can influence the extent of blackleg development. In wet cool springs blackleg will be greater than with drier springs. But poor soil structure and imperfect drainage as a result of compacted soil will result in rain or irrigation water draining less quickly. This will also encourage Eca multiplication and blackleg development. The results of a blackleg risk assessment come with a

table showing the risk of blackleg for a particular level of contamination under different growing conditions.

Secondly, a blackleg risk assessment test may be carried out some months before planting and if storage is poor or the seed is transported badly or chitted in the wrong environment or chits broken off at planting, the bacterial numbers can rise well above the level indicated at the time of the test. Thus for a blackleg test result to mean anything, it must be combined with correct storage, transport and handling.

Another method of reducing Eca contamination of seed is to lift seed early, before bacteria have spread to daughter tubers. However, under current prices of seed, growers are growing seed on for a dual-purpose crop to make it pay.

At or before harvest, blackleg bacteria may spread from rotting mother tubers and rotting stems to daughter tubers. Some bacteria will land on the tuber surface and some will penetrate the lenticels. On the tuber surface, the bacteria are exposed to the storage environment and when tubers are dried these die quickly. Those contaminating the lenticels, however, are protected from any drying. It is the blackleg bacteria in lenticels that carry the risk of blackleg developing in a subsequent crop. The challenge for the seed grower is two-fold. Firstly, it is crucial to avoid lenticels becoming contaminated by reducing generations, early harvest etc. Secondly, if tuber surface and lenticels are contaminated, drying into store and maintaining correct storage conditions will reduce the level of contamination over time.

Experiments have shown that using positive ventilation to dry tubers and maintaining them in a dry condition can reduce the level of contamination by a factor of log 10^2. Thus, if the average tuber contamination is 10^4 (i.e. 10,000 per tuber) at harvest, after good storage this may be reduced to 10^2 (i.e. 100 per tuber).

Growers have adopted a range of positive ventilation systems according to their situation. Perhaps the most effective have been letterbox ventilation or suction walls. However, the Aspire system, Wedderspoon tents and the Posi-vent have all been used successfully. These systems are used immediately potatoes enter store and ventilation continued for several days until tubers are dry and the heat generated by the tubers at lifting removed. It may take longer than a few days to fully dry a crop. Thereafter, the intermittent use of positive ventilation can ensure that tubers remain dry. If non-positive ventilation is only available, the aim should be to equalise temperature differences across the store and let tubers dry by convection.

Drying using natural air, for example in Dutch Barns, can be used successfully but control of drying is not precise. If a weather front of warm humid air passes, condensation will develop if the tubers are colder than the air.

There remains a lot we do not know about blackleg. For example, we cannot quantify exactly the degree of positive ventilation that is needed to reduce

contamination. The extent of bacterial spread to daughter tubers under different soil conditions is also unclear. We are just beginning to understand the relationship between the extent of blackleg in the field and the likelihood of daughter tuber contamination. For seed growers it is unclear how the roguing of blackleg to achieve certification affects progeny contamination.

Summary of practical control measures:

For seed growers:

- Harvest seed early
- Warm tubers before grading to minimise damage
- Avoid rotting tubers passing over grading lines by picking off rots early
- Clean the grader after dressing a stock containing rots

For all growers

- Use limited generation seed
- Plant seed with a low blackleg bacterial count. If in doubt carry out a blackleg risk assessment test of stocks of susceptible varieties
- Handle seed carefully on arrival by ventilating and keeping cool
- Avoid sprouts developing on seed that can be knocked off at planting
- Don't plant diseased and damaged tubers. Mother tuber breakdown by Eca is most likely in seed tubers that are diseased or damaged
- Plant seed into good seedbeds where drainage is not impeded
- Where possible plant into conditions favourable for rapid growth
- Do not apply more than recommended fertiliser (especially nitrogen)
- Avoid waterlogging when irrigating
- Do not pulverise the haulm when blackleg is present and the crop is wet or rain is imminent
- Lift as early as possible, consistent with a good skin set
- Minimise damage at harvest
- Remove mother tubers, rotting tubers, clods and stones at harvest
- Avoid lifting crops in the wet
- Dry tubers as rapidly as possible after lifting using positive ventilation and maintain dry
- Avoid condensation during storage, especially when storage temperatures are 6^{o}C or above
- Clean stores, boxes, trays and machinery between seasons or more frequently if appropriate

The Bord Glas Quality Programme

Michael Neary, Quality Programme Manager

Bord Glas

The promotion of quality standards within the horticultural industry is one of the key functions of Bord Glas. Since its establishment, Bord Glas has been developing and evolving a quality programme for the fresh produce industry. The consumer requires a quality product in terms of its visual appearance and the system within which it was produced. Produce must be produced, handled, packaged and transported to the highest standards of quality and hygiene in a clean and environmentally friendly manner. There is a requirement for food safety issues to be addressed and a system of traceability to be in place. The Bord Glas Quality Programme has been developed to assist in addressing these issues and to promote quality standards within the industry.

The Bord Glas Quality Programme covers all sectors of the horticultural industry including the potato sector. There are currently 700 horticultural entries participating in the programme. In the potato sector the Bord Glas Quality Programme was initially targeted at the potato packer point of the supply chain. In recent years all the major potato packers have participated in the Quality Programme and achieved the Bord Glas Quality Award following independent adjudication for compliance to the Bord Glas standards. Potato producers are now joining the programme in increasing numbers highlighting the importance this sector puts on the production of a quality safe product. While participation in the programme is voluntary many growers supplying key outlets on the home market are required by these customers to be a participant in the Bord Glas Quality Programme as one of the conditions of supply. In the potato sector the main objective of the Quality Programme is to promote satisfactory standards of quality and hygiene at producer and packer level by assessing the standards they are presently achieving and identifying steps for improvement.

The Quality standards for the Bord Glas Quality Programme are set down in the Bord Glas Specification for Horticultural Producers and supporting documentation including the Bord Glas potato quality manual. These standards are based on legislative, best practice and market requirements. The scope of the standard covers issues in the areas of cropping practice, quality/hygiene matters, pack house, cold chain, crop protection products, keeping records and documentation. The standard is updated regularly to take account of new legislation and changing requirements.

The cropping practice section covers issues which are common practice to growers in their day to day growing of the potato crop such as soil, water and fertiliser management. The Hygiene/Quality section looks at staff facilities. The sections on the packhouse and cold chain (if relevant) covers the provision of these facilities and associated equipment and their condition. The section on crop protection product looks at their proper storage and use and

the safe disposal of waste materials. Record keeping identifies the important records that need to be regularly maintained, such as crop, chemical usage, and bait record. The section on documentation identifies the key documents which should be held on site such as a safety statement, first aid and spray operator training certificate.

The operation of the Quality Programme requires the grower to apply to participate in the Quality Programme. The grower will then be provided with the relevant documentation and the details of the operation of the scheme. The applicant will receive a minimum of two inspections within a twelve month period. Feedback will be provided after each inspection on the quality issues which need to be addressed (if and where there are any outstanding), and these will be followed through on the next inspection. Awards are presented, following independent adjudication for compliance to Bord Glas standards, to growers and pre-packers. Certificates of Merit are presented to those participants who display significant levels of improvement in standards.

The Bord Glas Quality Programme continues to change and evolve to take account of new developments and changing requirements. One of the more important developments in recent times is the expectation by the consumer that the food they eat has been produced with the minimal use of crop protection products and in a manner which does not impact negatively on the environment. The implementation of integrated crop management (ICM) systems addresses this issue. The aim of integrated crop management is to utilise long-term sustainable cultural practice that will economically produce high quality, fresh produce with a minimal impact on the environment, ICM systems comprise many husbandry disciplines, including integrated pest management (IPM). Pesticides are only employed when without their use, significant economic losses would occur, due to a reduction in crop yield or quality. A detailed integrated crop management code of practice has been compiled for each horticultural sector including the potato sector. The key requirements in the ICM codes of practice (many which are already being implemented by growers in their existing growing practices) are incorporated into the Bord Glas Quality Programme. This provides the mechanism to identify, highlight and promote the implementation of ICM systems within the potato sector.

The importance of the implementation of integrated crop management systems can now be seen in a European context. The Euro-Retailer group (EUREP) was established in 1997. This group represents the leading retailers of Europe including Irish and UK retailers. This group has drawn up and agreed to accept and promote throughout Europe a protocol under the title of Good Agricultural Practice (GAP). The groups aim is to achieve a generally accepted minimum standard for the production of fruit and vegetables. The ICM codes of practice for the Irish horticultural industry which are referred to above encompasses the requirements set out in the code of good agricultural practice by the Euro-Retailer group. Accordingly producers participating in the Bord Glas Quality Programme are in effect implementing the Euro wide protocol of good agriculture practice. This will be important going forward as some market outlets are now referring to this standard. In the near future

Bord Glas will be seeking formal recognition by EUREP that the Quality Programme conforms to the standards set out in their code of agricultural practice.

It is now becoming increasingly important that the inspection and certification of participants to a set standard in any quality scheme is carried out independently of the industry and of any interested parties. The accreditation of an independent body to operate the Bord Glas Quality Programme to an appropriate and recognised European standard will enable the programme to satisfy the requirement of being independent. The appropriate European standard is EN45011 for bodies operating product certification systems. In future the inspection and certification components of the Bord Glas Quality Programme will be carried out by an independent body nominated by Bord Glas. Bord Glas has nominated the National Standards Authority of Ireland (NSAI) to carry out independent inspections and certification of the participants in the Quality Programme in line with EN45011 requirements. Last year the NSAI were accredited by the National Accreditation Board of Ireland to the EN45011 standard for the Bord Glas Quality Programme. This successful completion of the accreditation process will enable the Bord Glas Quality Programme to enhance its acceptability within the market place.

The safe and proper use of crop protection products continues to be a very important issue for the horticultural industry including the potato sector, particularly in the light of consumers ongoing concerns regarding any residues in the food they eat. Bord Glas as part of the Quality Programme introduced random residue testing of produce from participants to keep a strong focus on this issue and to ensure that the best practices in relation to the use of chemicals are being implemented. Over each of the last three years a number of samples of potatoes have been taken and tested and all the results have been very satisfactory and compliant with the relevant regulation. This highlights the good standards that are being worked to within the industry.

This year the aim of Bord Glas is to work with the potato sector to streamline the specification and inspection of the Quality Programme to ensure its effective and practical implementation at producer level. In the near future Bord Glas plan to carry out a consumer promotional campaign of the Quality Programme and the Bord Glas quality symbol. The promotional campaign will include informing consumers on what the symbol is, what it means, the details of the Quality Programme and what it means in terms of food safety and quality. It will be important going forward to have the potato sector associated with such a promotion.

To this end maximising grower participation in the Quality Programme will be very important into the future.

RITA AHERN, MANAGING DIRECTOR, GREENACRES FOODS LTD.

The Challenges and Opportunities in the Frozen Potato Products Market

Company Background
Greenacres Foods was set up in 1994 in North Cork by Rita Ahern, Food Scientist to become Ireland's first manufacturer and marketer of a range of frozen potato speciality products. The Company has won several enterprise and new product awards.

Imports into Ireland of products such as French fries, potato wedges, waffles and croquettes amounted to €24.1m (£19m) in 19993 and to over €54.6m (43m) in 1999 (these figures exclude potato crisps). The Irish imported specialty potato products are supplied by Dutch, Belgian & U.K. multinational companies (e.g. McCain). However, as the large French fry processors use only the off cuts of chips to make their potato wedges and hash browns there is always opportunity for a high quality product.

In 1997 the Company was expanded through a Joint Venture with Sam Dennigan & Co. Ltd., Ireland's largest Potato Wholesaler. The Company moved to a new manufacturing facility in the Limerick Food Centre.

The Company now has 18 full retime employees. Rita's brother, Joe and four other Food Scientists make up the technical team. All of the Greenacres Production Operatives have a Certificate in Food Hygiene. The fully automated plant operates a full HACCP system. Greenacres currently produces about thirteen different potato specialties including potato wedges, potato croquettes and potato cakes for both the *Rita Ahern* brand and own label customers in Ireland including Dunnes, Tesco, SuperValue-Centra, Superquinn, Londis, Spar and independent retail outlets. Greenacres also sells its range in Northern Ireland and the U.K. An average of 40 tonnes of potatoes per week are currently processed using such varieties as Rooster, Maris Piper, Estima and Golden Wonder. Where possible in excess of 90% of all potatoes used in the factory are sourced in Ireland.