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International Year of the POTATO 2008

HIDDEN TREASURE

POTATO COUNCIL

Potato Workshop

SASA, Edinburgh

2 July 2008

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The 6 P's - Proper prior preparation produces perfect potatoes

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To meet market requirements, whether for ware or seed, potatoes in the UK have to be of a high quality. There are many factors that can affect quality during potato production and if profit is to be maximised, it is important to minimise potential threats. These threats include a plethora of potato diseases. Fundamental to risk management is planning. Before any potato crop is planted, a grower or an agronomist will evaluate risks that might impact on the potato crop. Thus prior preparation can reduce the risk of diseases.

The length of the rotation between potato crops together with an absence of groundkeepers indicates the risk of some diseases (e.g. *Rhizoctonia solani*) will be reduced, although never completely. However, the risk from other pathogens with persistence in soil such as *Spongospora subterranea* or *Colletotrichum coccodes* cannot be ascertained by considering the length of rotations. For all these soil-borne pathogens, it would be far better to measure the level of contamination with which to judge risk.

In two recently completed Potato Council (formerly BPC) projects diagnostic tests have been developed for detection of *C. coccodes* and other soil-borne pathogens. For *C. coccodes*, a study of the epidemiology of the pathogen alongside development of the diagnostic test has enabled the relationship between level of soil contamination and risk of disease development to be determined. The test is now available commercially and provides for the first time a tool which will enhance the planning process to minimise risks that affect potato quality.

Pectobacterium atrosepticum in the environment: What does it do and where does it live?

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The plant pathogen *Pectobacterium atrosepticum* **(***Pba* - formerly *Erwinia carotovora* subsp. *atroseptica)* causes blackleg disease of potato plants and soft rot of tubers in temperate regions. The pathogen contaminates high grade seed after only 1-2 years in the field but little is known about how this occurs or about the life of *Pba* when not on potato. The genome of strain *Pba* SCRI1043 was recently sequenced, revealing many new plant-associated determinants that appear to be unrelated to disease. These include a number of putative agglutinins and genes involved in nitrogen fixation. We examined the ability of *Pba* SCRI1043 to bind to plant roots, including weeds and other crop species. The results revealed that a mutation in a gene encoding a putative agglutinin led to a decrease in this binding ability. *Pba* was also shown to fix nitrogen; a phenomenon often associated with bacteria that live on and around plant roots. Together, these results indicate a possible niche for *Pba* living in the rhizosphere of non-potato plants, which may provide a source of seed tuber contamination in the field.

Potato ring rot: Now you see it, now you don't.

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Potato ring rot, caused by the bacterium *Clavibacter michiganensis* subsp. *sepedonicus* (*Cms*) is a quarantine organism in the EU. Control and surveillance by EU Member States is compulsory, expensive and problematic. This disease has not been found in Scotland but should it be introduced and allowed to spread it would be difficult to eradicate. The success of *Cms* lies in its ability to survive undetected for a number of years, in latently infected seed tubers and on surfaces, leading to subsequent infection of healthy seed. These aspects, among others, have been tackled during a multi-disciplined project carried out by SASA, CSL and SCRI encompassing epidemiology, control and detection of the disease in an aim to identify and reduce risks from *Cms* to the Scottish potato industry.

Seed multiplication favours *Cms* survival as it can become widespread over a number of generations before symptoms manifest themselves *via* latent infection of tubers. Identifying cultivar-specific symptoms in the field would be a valuable tool in aiding early detection and control of the disease, however, symptoms can be hard to detect. Limited information on cultivars (cvs.) commonly grown in the UK necessitated a two-year glasshouse susceptibility study of the top ten cultivars grown for seed in Scotland to *Cms*, at SASA. The cvs studied were: Cara, Charlotte, Desiree, Estima, Hermes, Marfona, Maris Peer, Maris Piper, Pentland Dell and Saxon (http://www.sasa.gov.uk/seed_potatoes/index.cfm; SPCS, 2005).

In 2006, 30-day old potato plants were stem-inoculated with a *Cms* suspension (1.0E+01, 1.0E+04, 1.0E+06 or 1.0E+08 cfu/ml) and observed during a 21-week period. Although cvs. Desiree and M. Peer emerged as resistant compared to susceptible cvs. Estima, Hermes and M. Piper, there was a lack of correlation between cultivar and disease expression. Analysis by real-time PCR confirmed all cvs. could become infected, even at the lowest inoculation concentration with the exception of cv. Desiree. Remaining daughter tubers were stored at 4°C and grown on in 2007. Only tubers with no visual symptoms were selected and all tubers were individually tested for the presence of *Cms* and assigned a disease category as follows: 1= negative (from control plant); 2= negative (from *Cms*-inoculated plant); 3= weak positive (Ct>36: $<4\times10^3$ cfu/ml); 4= strong positive (Ct 18–31; 10^5–10^{10} cfu/ml). Foliar symptoms were more evident in plants grown from tubers known to be latently infected than stem-inoculated plants. Foliar symptoms were not consistent or reliable as an indicator of infection. Not all tubers known to be infected at planting went on to produce infected progeny, however a threshold level of infection at which the disease may persist or be eliminated was indicated. Desiree is already known to be a *Cms*-tolerant variety and this was confirmed in this study. Marfona was identified as a higher risk cv. as progeny tubers were found to contain high levels of bacteria (10^6–10^8 cells/ml) without symptoms or a noticeable decrease in yield. Across all cvs., yield was reduced by over 80% in some individual plants.

Rhizoctonia potato disease in the UK

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Rhizoctonia solani is an important pathogen of potatoes in the UK and can cause both quantitative and qualitative losses. Quantitative losses occur due to the infection of stems, stolons and roots, which can affect both tuber size and number. Direct yield losses of up to 30% have been observed. Qualitative losses occur due to the development of sclerotia on the tuber surface, resulting in the tuber blemish disease, black scurf. However, Rhizoctonia potato disease is often associated with misshapen tubers and other tuber deformities.

The fungus *Rhizoctonia solani* exists as a species complex of 13 known anastomosis groups (AGs) and numerous subgroups. Several AGs are known to be associated with potato disease. In order to determine which AGs are present in UK potato crops, isolates of *R. solani* were collected from potatoes and assigned to AG using a combination of PCR based techniques and by the observation of hyphal fusion. The predominant group was AG3PT but isolates of AG2-1 and AG5 were also present. AG5 was also isolated from a couch grass plant present in one potato sample. Pairings between isolates and the variability in rDNA IGS1 length indicated that there is considerable diversity amongst UK AG2-1 isolates.

Field and glasshouse experiments were conducted to compare the disease caused by the three AGs found in UK potatoes, along with AG8, which was previously shown to cause disease on potato roots although only under controlled conditions. These experiments showed that these AGs caused very different symptoms. AG3PT caused typical Rhizoctonia disease symptoms of stem canker and black scurf but root lesions were also observed. AG2-1 isolates with a shorter rDNA IGS1 region, appeared to be unable to cause large stem lesions whilst severe stem lesions were frequently caused by AG2-1 isolates that had a longer IGS1 region. In AG5 inoculated plants, severe stem lesions were observed, but in field experiments, little or no black scurf was present. AG8 appeared to cause little or no stem canker or black scurf but severe root lesions were observed. In the field experiments direct yield losses were greatest in AG3PT and AG8 inoculated plants, highlighting the importance of root infection in determining quantitative yield losses. AGs therefore differ in disease development and symptom expression. They can also differ in host range and in some instances the choice of disease management strategy may be dependent upon the particular AG present. Therefore, AG is an important factor when considering Rhizoctonia potato disease.

Interactions between population densities of the nematode *Globodera pallida* and *Rhizoctonia solani* diseases of potatoes under controlled environment conditions

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The potato cyst nematode *Globodera pallida* and the soil borne fungus *Rhizoctonia solani* AG3 are problematic and widespread on potatoes in the UK, limiting the efficient potato production. Previously the combined presence of *G. pallida* and *R. solani* has been shown to cause a damaging disease complex of potato but until now no study has investigated the effect of nematode densities on *R. solani* disease of potato. This study explores interactions between *G. pallida* and *R. solani* by comparing disease development in potato plants inoculated with a range of *G. pallida* juvenile densities with *R. solani*. The treatments included inoculating a range of *G. pallida* juvenile densities with *R. solani*, and organism alone at 2, 4 and 6 weeks after planting in the controlled environment conditions.

A sequence of potato plants samples were taken to assess any effects of nematode infestation on the incident of *R. solani* disease severity. The results showed that the severity of stolon infection and stolon pruning caused by *R. solani* significantly increased with a high density of *G. pallida* juveniles. A regression analysis revealed a positive relationship between the number of nematodes juveniles present in the roots and incidence of stolon infection, stolon pruning and stem canker by *R. solani*. The various *R. solani* disease severities were more likely to be greater when potato plants are infested by *G. pallida* at an early stage of their development. For the first time an interaction between *G. pallida* and *R. solani* disease has been demonstrated.

Shuvash Bhattarai is in receipt of a Research Studentship funded by Bayer CropScience Ltd.

The transmission of Potato Viruses Y and A under Scottish field conditions

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PVY and PVA are the two most common viruses causing mosaic symptoms in the Scottish Seed Potato Classification Scheme. Both viruses are reported as aphid transmitted and several studies have estimated values for relative efficiency factors - a measure of the ability of an aphid species to vector PVY. However, these have generally been based on laboratory studies and have rarely been tested in a field situation. No comparable data are available for PVA transmission. Since 2000, various field trials at SASA have investigated the timing of transmission of PVY^{O}, PVY^{N} and PVA. These findings have been correlated against aphid activity as monitored by aphid suction traps and yellow water traps. The current implications from these trials will be discussed, including the identity of the aphid species believed to be driving transmission of mosaic viruses in Scotland.

Temperature in relation to potato mop top virus (PMTV) infection from soil inoculum

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Potato mop top virus (PMTV) causes necrotic arcs and circles (spraing symptoms) in tubers of sensitive potato cultivars. The production of these symptoms can lead to the rejection of ware stocks by processors and packers. Further, seed potatoes showing spraing symptoms can also be rejected by importing countries who apply a strict tolerance to this disease or where PMTV has been assigned quarantine status. Initial transmission of PMTV to potato is mediated by the soil-borne powdery scab pathogen *Spongospora subterranea* f. sp. *subterranea*; a plasmodiophorid which is found world-wide. Powdery scab and PMTV infection are generally associated with cool, wet soils but may also occur in warmer, drier soils that are irrigated

An experiment was conducted in a glasshouse to assess the effect of temperature on infection in plants and tubers of five cultivars produced in soil known to be infested with PMTV. The temperatures were 12, 19 or 26°C and the cultivars were Cara, Nicola, Rooster, Saturna and Slaney. PMTV was not detected in any tubers produced at 26°C. The incidence of infection in tubers produced at 12°C and 19°C did not differ significantly. Spraing symptoms did not develop in tubers produced at 19 or 26°C; however external and internal symptoms were commonly observed together on tubers produced at 12°C. A high incidence of tubers produced at 12°C were affected by powdery scab, with a significantly lower incidence affected at 19°. Powdery scab was not observed on tubers produced at 26°C. The significance of these findings will be discussed.

SASA's work in support of the potato industry

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Scotland is responsible for *c.* 80% of the seed potatoes produced in the UK. These are marketed within the EU and also exported to over 40 countries around the globe. The success of Scotland's seed potato industry is based, to a large extent, on its high health status, particularly for virus diseases, and its historical freedom from a number of important quarantine diseases e.g. ring rot and brown rot. Successful control of viruses is partly due to the Scottish climate, which does not normally favour the multiplication of potato aphids. However, this natural advantage is underpinned by the arrangements for the Scottish Seed Potato Classification Scheme (SPCS).

SASA is the government body which acts as the Certifying Authority for the SPCS and also carries out a range of scientific activities, including nuclear stock production and maintenance, in support of seed potato classification in Scotland. Strict inspection tolerances for disease and trueness to type are applied to Pre-basic and Basic classes of seed potatoes. Certified seed potatoes, which have less rigorous disease tolerances, cannot be produced or marketed in Scotland.

SASA also conducts a number of other important work streams in support of the potato industry. This includes surveillance for quarantine diseases. Testing of new varieties for both National Listing and industry sponsored independent variety trials (IVT). Our laboratory staff also develop new techniques for diagnostic testing in order that the Scottish industry has the tools it needs to maintain the integrity of potato production through out the supply chain.

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