Seed potato improvement in Canada

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Techniques and procedures required for an effective certification program to provide disease-free seed potatoes are described. Canada's Elite Seed Potato Program, originally developed to control bacterial ring rot, now includes to some degree tuber indexing, tuber uniting, and testing for viruses and the spindle tuber viroid. Clone selection procedures and virus-tested stem cuttings are also used in Prince Edward Island and New Brunswick. Contributions made by some of the provinces to the national program include the operation of Elite Seed Potato Farms in Prince Edward Island, New Brunswick, Quebec, and Manitoba. It is also shown that there is a need for full development of the national program to make Canadian Certified seed potatoes acceptable to all countries.

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L'etude decrit les techniques et les methodes nécessaires a la conduite d'un bon programme de contrôle sanitaire de la production des pommes de terre de semence. Le plan de production de semences d'Elite qui, a l'origine ne visait que la fletrissure bacterienne, s'est depuis etendu a l'indexage, a la plantation en tubercules individualisés et au contrôle pour les virus et pour le viroïde de la filosité. L'Île-du-Prince-Edouard et le Nouveau-Brunswick utilisent la selection clonale et le bouturage de tiges indemnes de virus et, en outre, le programme national est bien epaule par les fermes de production de semence d'Elite exploitees par quelques-unes des provinces, Île-du-Prince-Édouard, Nouveau-Brunswick, Quebec et Manitoba. L'etude fait ressortir le besoin d'un programme national complet qui puisse ouvrir a nos semences l'acces de tous les pays.

The potato plant is characterized by an extreme sensitivity to disease, and in the various countries where it is grown it may be affected by any one of more than 300 pests and diseases. As commercial potato crops are produced by vegetative reproduction, many of the diseases transmitted by the seed tubers cause qualitative and quantitative depreciation in yield. That is why the potato, more than any other crop plant, depends upon quality of seed for a high production potential. The practise of seed potato improvement is that of changing and adapting to new techniques and procedures as they are developed to improve both certified seed potato crops and certification methods. Experience in countries most advanced in seed potato improvement has shown that high production levels can be maintained only by continued use of the technical procedures practised in countries where the potato is of prime economic importance.

Seed potato improvement

Of the countries that grow high acreages of seed potatoes the United States and Canada alone do not have clone-selecting, virus-testing, and disease-freeing procedures as part of a total official program throughout the respective countries. But we in Canada do have tuber indexing and tuber uniting; several provinces have a developing virus-testing program and have shown interest in clone selecting; three provinces carry out southern tests for their seed potato growers. Greater control of bacterial ring rot is also being obtained in an Elite Seed Potato Certification Program that is based upon tested freedom of all nuclear stocks of seed potatoes from the causal pathogen, ***Corynebacterium sepedonicum*** (Spieck. & Kotth.) Skapt. & Burkh.

European countries have been changing and adjusting their inspection methods over the past 30 years to obtain more reliance on routine laboratory and greenhouse tests, and much more concentration on seed plots to produce a steady flow from virus-free clone selections down to commercial classes. This has been made possible because the traditional method of planting whole seed has prevented the cutting knife from becoming a major cause of virus spread in basic seed stocks.

Virus-testing and virus-free programs are not new; they have been growing and developing continuously, though at times slowly, over the past 45 years. In fact virus-free seed potato programs had their origin in 1925 immediately after Johnson announced (2) that all healthy looking plants of North America's established potato varieties were infected with a virus, which was later to be called potato virus X. After that report by Johnson several countries, including Great Britain, the Netherlands, and Germany, began a search through their respective stocks of commercial varieties for virus-X-free tubers. Some were found in most of the popular varieties in Europe, including the variety Up-to-date, formerly grown in Canada and known to have been in

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commercial production since 1894. By 1933 virus-X-free stocks of 25 of the most popular varieties in the United Kingdom alone had already been found. Today most countries in Europe that grow seed potatoes, either to be self-sufficient or for export, produce their commercial seed from nuclear stocks of virus-free material. Seed potato growers in most of these countries have been encouraged to accept and participate in this kind of seed potato improvement with the help of price controls and supporting legislation. But the growers pay for this stability with substantial acreage, testing, and other fees.

North America has been rather slow to adopt some of the methods used in Europe because a serious disease problem peculiar to this part of the world transcends those solved by the refined procedures practised in Europe. By cutting whole tubers to use as seed pieces we in North America have spread bacterial ring rot across the continent to make it the most important problem in seed potato certification. Although this disease is present in Europe and is known to have been there for many years before it was reported in North America, it is of little consequence in Europe because it is controlled by planting whole seed. When potato seedlings are selected to become varieties in Europe, breeders make their selections with this planting practise in view.

Methods of certification with laboratory and greenhouse facilities have of course been introduced into certain North American seed potato certification programs, and in Canada valuable stocks of virus-free material of all common varieties are available from the Agriculture Canada Research Station, Vancouver, B.C. and from the Plant Quarantine Division, Agriculture Canada, La Pocatiere, Quebec. So, unofficially, a very active virus-free program has been developing in Canada for some years. But as our prime concern at the moment is to maintain sufficient amounts of bacterial ring rot tested Elite seed to produce Foundation Class seed for our markets, and to find more effective ways to control this disease, preoccupation with bacterial ring rot will remain with us until we have much stronger legislation to control this disease, and potato breeders find immunity to the pathogen.

In the development of a complete seed potato certification program we are preparing to go even further. The potato plant is subject to many diseases which spread readily and in some cases become latent in or on the tubers. Thus it is common for the foliage from planted virus-free tubers to be free from causal organisms of fungal and bacterial diseases even though the seed tuber itself is carrying a latent infection of blackleg or some other non-virus pathogenic disease. Therefore it is possible to propagate disease-free stocks from stem cuttings taken from healthy potato foliage (1). Some of Canada's basic virus-free stocks have been propagated this way in the Maritimes.

Elite seed potato program

Canada's Elite Seed Potato Program has been officially in effect since 1970 and was brought about initially as a planned attempt to obtain more effective control of the bacterial ring rot disease. This disease was first reported in Germany in 1906, but not in Canada until 1931. Although bacterial ring rot is readily controlled in Europe by planting whole seed, this custom has not progressed to any extent in North America. Because the pathogen which causes this disease spreads readily from infected to healthy tubers when they are cut into seed pieces, no tolerance is permitted for the disease in Canadian certified seed. But despite this strong control measure the disease is still prevalent, and the Elite Seed Program was introduced as a further and more effective way to control the disease.

In this Elite Seed Program single plants or tubers are tested in the laboratory for the presence of the bacterial ring rot pathogen and those found to be free are multiplied in bulk to produce Elite I class seed. From this class of seed, Elite II and Elite III classes respectively are produced in successive years, followed by the commercial classes known as Foundation and Certified. The movement down in class from Elite I to Certified is automatic and is known as a "flushing out" procedure.

The stability of the Elite Seed Potato Program is partially dependent upon the continuous selecting and multiplying of bacterial ring rot tested seed stocks by Elite Seed Growers in each province and the provincial Elite Seed Farms. Testing is carried out by staff of the Agriculture Canada Plant Quarantine Division, and clone selecting jointly by staff of that Division and the growers. Substantial support to the program is also given by most provinces to help their growers. The provincial governments of New Brunswick, Quebec, and Manitoba each provides an Elite Seed Farm with all of the staff and facilities required to produce Elite seed stocks. A similar farm has been established on Prince Edward Island by the Prince Edward Island Potato Marketing Board. Three other provinces select and multiply tested seed stocks for the Elite classes in carefully chosen areas.

The current regulations under which seed potato certification is carried out in Canada are therefore based upon a program of continuous selecting, reselecting, testing, and retesting of single plants or tubers to and from the Elite I classes. The future development will be one of concentration on freedom from bacterial ring rot jointly with a complementing and rapidly developing virus-free program.

Virus freeing

It is now possible to have virus-free seed potato certification programs throughout North America because of the ease with which all potato varieties may be freed from virus infections. Procedures to free potatoes from viruses by the use of heat and biological therapies began in the U.S.A. with potato witches

broom in 1943 (5) and in England with leaf roll in 1950 (3). Similar procedures were developed later in France for the potato mosaic viruses X, S, M, Y, and A in 1955 (7) and in England in 1957 (4). These practices have been adopted rapidly in other countries in successive years.

Virus-freeing work for commercial development in Canada was first reported as being done at the Agriculture Canada Research Station at Vancouver in 1967 (6), and since that time has had a good deal of publicity. Material from that source has been distributed across the country, largely to the Provincial Elite Seed farms and to locations selected by the other provinces. Basic stocks on two of these provincial seed farms are virus-free, and since 1973 all plantings on the Prince Edward Island and New Brunswick Elite Seed farms have been with tubers derived from virus-free material.

Virus-free program

New regulations are being written to modify the present Canadian Elite Seed Potato Program and permit that bacterial ring rot testing procedures complement virus-testing requirements. It will take some time to replace the existing Elite stock so carefully nurtured by the many outstanding Elite Seed growers with virus-free or their own virus-freed material, but at the appropriate time the virus-free Elite program will be made complete by an amendment to the regulations.

Each province is contributing to the development of this complete Elite Seed Potato Program largely through assistance in producing the respective provincial basic seed requirements. The most valuable help that a province can give to this end is in providing an Elite Seed Farm with all of the staff and facilities required for such a venture. It is expected that this help will eventually extend to include a provincial seed farm or its equivalent, bacterial ring rot testing, clone selecting, maintenance of nuclear stocks, testing for viruses and spindle tuber viroid, trial plots for virus spread assessments, legislation for bacterial ring rot control, and intensive extension work with seed growers.

Virus-tested stem cuttings

Seed potatoes free from virus infections have been produced commercially in Europe for many years, but it is only now that seed stocks are becoming available substantially free from certain fungal and bacterial diseases. This has been made possible by a new technique whereby virus-free seed stocks are raised from tested stem cuttings instead of tubers (1). At least one country, the United Kingdom, has introduced a Virus-Tested-Stem-Cuttings Class as the highest class of certified seed, which is produced in Scotland. Regulations in that country now require that all basic stocks of certified seed potatoes be derived from stem cuttings, and this procedure is spreading to other countries.

The technique to produce rooted cuttings is similar to that used by horticulturists. Virus-free tubers are planted in pots in a greenhouse, using tubers obtained from stem cuttings in the previous year. When plants are about 15 cm high they are tested for virus freedom, allowed to grow about another 15 cm, and then topped to encourage the rapid growth of side shoots. When the shoots are about 8 cm long they are cut from positions on the stems at least 15 cm above the soil level. From the lowest cutting on each stem a small portion is removed and tested in the laboratory for the blackleg bacterium. If the test is negative the other rooted cuttings from the same stem are transplanted into 8-cm pots, then eventually to the field for normal growth and tuber development. This work is done entirely by the certification agency, and the harvested tubers are given to selected growers to multiply as basic stocks. As elimination of disease in this way does not give immunity from further infection, it is recommended that growers take care to prevent reinfections in a way somewhat similar to bacterial ring rot control methods.

Conclusion

Seed potato certification in Canada is carried out as a national program to produce seed that will be accepted by any country. The demands and requirements in certain valuable markets art? growing to an insistence that all imported seed potatoes be derived from virus-free stocks. Exporters and importers in other countries have found that the strong measures required for seed potato improvement have been well justified. The demand for good seed remains, or is greater than ever, but in all prominent seed potato growing countries, the seed acreage is going down because the harvested tonnage per acre is going up. Some states in the U.S.A. have already introduced propagation of virus-X-free potato stocks as part of their certification programs.

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