DIRECT APPLICATION OF NEW VIRUS TESTING PROCEDURES TO POTATO PRODUCTION

by
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SUMMARY

New advances in our ability to rapidly, reliably, and economically detect the presence of viruses in potatoes have the potential to: 1) usher in a new era of virus-free seed potato availability, 2) avoid much of the loss resulting from net necrosis in leafroll-infected potatoes, 3) aid and expedite development of new superior varieties, and 4) hasten our search for immunities to virus diseases of potato. We expect that the new diagnostic procedures will soon be available directly to growers who wish to verify freedom from virus contamination in the seed they intend to plant. They should also be available to those who wish to determine the percentage of leafroll infection in fields prior to harvest. Fields with high levels of leafroll infection could be used immediately after harvest to avoid the net necrosis symptoms which often develop later during storage.

Washington Potatoes are Heavily Virus Diseased:

We discovered and reported earlier (Thomas and Smith, 1977) that potato virus diseases occur at alarmingly high rates in Washington potato fields. In our study of 70 potato fields only a few fields were essentially free of infection. Overall, more than 80% of the tubers harvested in Washington were infected with one or more viruses. Thirty-seven percent contained the extremely costly potato leafroll virus.

Viruses are Costly to Growers:

These virus diseases are costing millions of dollars in decreased production (Wright, 1977; Manzer, et al. 1979) and in the decreased tuber quality caused by leafroll virus-induced net necrosis (Thomas et al. 1978). Furthermore, these losses in production and quality occur in spite of the fact that growers in Washington spend $50 to $100 per acre on chemicals and their application to control virus vectors. Growers also pay premium prices for certified seed potatoes in an effort to avoid virus diseases.

The most costly loss from virus diseases is a hidden one. It results because potato breeding programs and variety trials are crippled by virus contamination in the clones under evaluation. Growers are thus deprived of new, superior varieties that could be recognized and increased more readily if they did not become contaminated with viruses.

Six Methods to Control Virus Disease - The Components of Integrated Pest Management for Virus Disease Control:

There are six basic methods by which viruses of plants can be controlled. These methods are:

1. Keep viruses out of the potato field - use virus free seed.
2. Eliminate hosts in which viruses are carried overwinter - control volunteers.
3. Stop viruses from spreading in the field - stop transmission by insects and contaminated machinery.
4. Prevent losses from disease - use the leafroll-infected tubers before they develop net necrosis in storage.
5. Develop and use disease resistant varieties - the most certain, most effective, and most economical method in the long run.
6. Cure plants of the disease - an individual clone can now be cured of virus disease in the laboratory and then maintained free of virus.

These six control methods are the component parts of our integrated pest management approach to controlling virus disease. Each of these methods is limited in its capacity to achieve total disease control by technological considerations. Our ability to cure plants in the field, for example, is limited by the fact that we do not have an effective viricide.

Virus Diagnosis - A Key to Better Control:

Perhaps more than any other single technology, the ability to rapidly, reliability, and economically detect (diagnose) the presence of viruses in potatoes would expand the capacities of all six methods to control viruses. Diagnosis ability is especially important in 1) eliminating virus contamination from seed potatoes, 2) in keeping breeding and variety testing programs free of the crippling influence of viruses and 3) in evaluating germplasm for resistance to virus diseases.

ELISA - A New Superior Diagnostic Procedure:

A new type of serological diagnostic procedure called ELISA (enzyme-linked immunosorbent assay) was developed for use with fruit tree viruses in Scotland in 1977 (Clark and Adams, 1977). We became convinced during 1978 that the technique had great potential for use with potato viruses. This past year (1979) we began extensive studies to adapt the method for use with potato viruses, to compare its reliability with that of other standard methods to diagnose potato viruses, and to develop systems to process the very large numbers of samples that would be required for practical potato application.

Exclusion of Virus From Growers' Fields:

During this past year, we emphasized the use of ELISA in control method No. 1, the elimination of viruses from seed potatoes, i.e., the exclusion of virus from the field. Reductions of virus disease can be most rapidly effected in this manner. We also used this method extensively to eliminate virus contamination from breeding and virus testing programs in Washington, and we intend to use it to select for resistances to virus diseases.

As a test of our systems, we diagnosed 45 tubers of each entry in the Washington State Seed Lot Trials for each of the five viruses and found they worked very well.

We concluded that the new potato virus testing systems will vastly improve the capacity of certified seed producers to detect and eliminate viruses from their seed. But more important, the procedures are so rapid and economical that virus testing could be available routinely to individual growers in Washington who wish to insure against virus contamination in the seed they intend to plant. Samples of such seed would be winter-sprouted and assayed for virus contamination prior to planting. We hope to make this type of testing available to growers through a laboratory at IAREC at Prosser, Washington.

Removing the Loss From Leafroll Infection:

The new ELISA method can also have a direct application in reducing the processing losses from net necrosis (control method No. 4). Leafroll infected tubers are frequently sound at harvest time and can be utilized without loss. However, they often develop net necrosis when placed in storage. Not only are affected tubers lost, but losses also result from the costs of storage, of sorting out the affected product, and reduction in product quality.

In our survey of virus infection in Washington fields referred to earlier, we found that the percentage of tubers infected with leafroll varied from 0 to 90% in individual fields. If those fields with high rates of leafroll infection could be identified prior to harvest and the tubers used immediately, much of the loss to net necrosis could be avoided.

We have found that the ELISA assay reliably identifies infected plants, and because of its speed and economy, it can be used to estimate the percentage of leafroll infection in

fields prior to harvest. However, the test requires specialized technique and precision in its application. A previously developed method we developed to achieve the same purpose involving staining leaflets with iodine is somewhat less accurate but can be performed readily under less exacting conditions.

We believe that application of the new virus diagnosis systems and techniques discussed will rapidly and dramatically reduce the rate of virus infection in Washington fields, will aid and expedite development of new, superior varieties, and will lead to discovery of highly effective resistances to potato viruses.

LITERATURE

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