Future Research in Plant Diseases

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Traditionally, control of plant diseases has depended on four general methods; exclusion, eradication, protection and host resistance. These same general disease control methods are used in the control of animal and human disease. The chief difference between the control of animal and human diseases on the one hand and plant diseases on the other is that controls of plant diseases generally lack methods to make susceptible individuals resistant or to 'cure' sick individuals. Therapeutic fungicides and antibiotics have had only limited curative application in plant diseases.

The most important method for the control of plant disease continues to be the identification of genetically controlled resistance factors and their transfer to acceptable crop cultivars. Genetic factors which impart resistance to specific plant pathogens have been widely used to control plant diseases. In those cases where there are large numbers of major genes governing resistance to a parasitic species, effective disease control has been maintained over years. Major genes governing host resistance have become ineffective in some cases; but when this has happened, the problem has usually been quickly resolved with the introduction of different host genes governing resistance to the new lines of the parasite.

Over time, many major genes governing resistance to specific pathogens in crop plants have been introduced and then become ineffective. This deployment of genes and their subsequent loss of effectiveness has caused serious concern among geneticists dealing with host plant resistance, and other sources of genetic host resistance have been sought.

Two types of genetic resistance other than major gene resistance are host genes which slow pathogen development and non-specific resistance. Both of these forms of resistance are usually governed by several genes (polygenes) instead of single, major genes. Host genes which slow but do not totally stop a pathogen's development are currently being widely sought and included in a number of crop improvement programs. This form of non-specific host resistance is usually effective across a large number of isolates of a pathogenic species, and it is theorized that this form of resistance is less susceptible to mutational changes in the pathogenic species. Another type of non-specific resistance also includes the resistance that a host has toward organisms that are not its pathogens e.g., corn is not attacked by wheat stem rust, etc. Biotechnological techniques are being applied to transfer non-specific resistance factors to crop plants.

Plant pathology laboratory technician Vicki Gustafson transfers small pieces of sunflower plant material into tubes for continued tissue culture to be used for screening for disease resistance.

Research in plant pathology over the next two decades will have several areas of thrust. Ongoing research efforts at North Dakota State University are already using biotechnological research to improve methods of plant disease diagnosis. Research on disease modeling and prediction, determination of economic thresholds, non-specific (polygenic) resistances, resistance to diseases such as scab and root rot of cereals that have been difficult to control, and transfer of resistance genes from alien hosts to crop species in cooperation with an ARS durum geneticist are currently underway.

In addition to these research areas, biotechnological methods are being employed in potatoes, sunflowers, dry edible beans and flax in an effort to detect or develop crop lines resistant to one or more factors. Most of these research areas represent complicated biological problems, and research on them will certainly be continued into the 21st Century.

One of the great unknowns in plant disease control is the degree to which plant pathogens, challenged with previously effective non-specific resistance systems distributed over

large acreages, will perform over time. Plant pathogens challenged with systemic fungicides which were previously not present in their environment have shown great ability to mutate to the point of being unaffected by these systemic fungicides. This same problem has occurred in human and animal diseases as evidence by the loss of effectiveness of some antibiotics.

If the present use of biotechnology is expanded and genes governing resistance to plant pathogens of crop plants are introduced from alien species, basic genetic studies must be conducted on the pathogens to determine if these plant pathogens have the capacity to mutate to a degree to become effective against the introduced genes. Future research on plant disease resistance needs to continue basic research on the genetic system within the parasite and its capacity to change.

Several lines of research being conducted at different research centers in the United States deal with the aspect of converting a susceptible plant into a resistant plant without recourse to conventional plant breeding. Substances from plants attacked by non-pathogens have been isolated and found to impart some degree of resistance. If such systems could be developed, it might be possible to produce a satisfactory level of resistance to specific parasites in a field of susceptible plants for one season at the time the crop was threatened.

Over the next decade or two, continued emphasis will be placed on research to reduce the economic input and the use of pesticides in crop production and to increase control methods. Reduction of economic inputs and pesticide use will require tighter management by operators. This in turn will require finer adjustments of plant disease epidemiology and the development of grower friendly crop production models.

It will be increasingly difficult to defend production of crops requiring input levels that exceed projected monetary returns obtainable from a 'free' market. The economics of crop production may become the most important single consideration of whether traditional crop production is continued or alternative uses for the land are developed. Two programs have been developed in the Plant Pathology Department at North Dakota State University to lessen economic input in crop production.

. Integrated pest management is under the direction of Dr. Marcia McMullen. This program seeks to make use of information from all areas of agricultural research to develop plant disease practices with lessened economic input and better environment management.

Research on barley disease epidemiology was initiated by Dr. V. D. Pederson, retired, over 15 years ago with the idea of improving barley disease detection and more accurately determining crop disease loss. This research has led to the possibility of creating barley foliar disease models to determine crop losses caused by barley diseases and project economically sound disease control practices. Research on the diseases of wheat, dry edible beans, potatoes, sugar beets, and sunflowers has come to a point where modeling can be used. Only current budget restraints prevent us from moving quickly into this valuable and nationally expanding area of research.