BLIGHTGAME — A COMPUTER AID FOR TEACHING PLANT DISEASE MANAGEMENT

T.M. STEWART

Department of Plant Health, Massey University, Palmerston North

SUMMARY

Using equations derived from the literature and provided by ADAS (MAFF UK) an interactive potato late blight simulation, BLIGHTGAME, was developed. From 2 weeks after crop emergence and progressing a day at a time, players must decide on appropriate fungicide applications based on weather information and crop growth stage. At the end of the game players receive a return/investment ratio, along with a detailed graph of weather and disease development which they are required to analyse. Although the present model uses artificial weather data and is designed primarily for teaching, it has the potential to be a useful research tool.

INTRODUCTION

Late blight of potatoes (*Phytophthora infestans* (Mont.) DBY), is important in all temperate countries, and thus has received attention from biological modellers. Some models predict the appearance of blight in the crop by measuring favourable weather conditions (Krause *et al* 1975, Hartill and Young 1985). Others are true simulations which chart the progress of the blight throughout the season (Bruhn and Fry 1981).

In 1980, ADAS (The Agricultural Development and Advisory Service of the Ministry of Agriculture, Fisheries and Food, UK) developed a computer simulation which related the progress of potato blight to weather (Hume 1986 pers comm.). This model, developed primarily for forecasting, was used with some success up to 1983 but in that year it proved unreliable, despite analyses of past epidemics being accurate. One major problem was that the ADAS model was constructed to calculate the progress of blight in a standard main crop from an assumed source of infection within the crop. It took no account of the development of blight on cull piles and earlies and the transfer of spores from these sources to maincrops.

Notwithstanding this limitation, the model appeared to have teaching potential, particularly as it charted the progress of an epidemic rather than just predicting when it should occur. By incorporating biological equations for the infection cycle developed for this model, and adding fungicidal effects and a players' interface, a microcomputer based management "game", BLIGHTGAME, similar to MAIZEGAME (Fenemore and Stewart 1986), was developed.

STRUCTURE OF THE GAME

The programme simulates the development of blight in a 10 hectare crop of a susceptible cultivar (such as Iam Hardy) assuming a primary source of infection within the crop. The player takes over the management of the crop 6 weeks after planting. The season runs for a further 120 days or until the foliage is destroyed by blight.

The player can select weather data from 5 different years which include a range of wet, dry and average seasons. The player is expected to run through several simulations, the object being to optimize the return/investment ratio, i.e. obtain the highest yield for the least expenditure. In doing this, an appreciation of disease development and the principles of supervised spraying should be gained.

(i) Disease Development

The stages of the life cycle explicitly modelled by the programme are:

The player is expected to take note of weather data, crop growth stage and disease progress and then decide which fungicide to apply and when, using Beaumont periods (Beaumont 1947), Smith periods (Smith 1956) or other such rules as a timing guide for the applications.

There are four stages of crop growth:

1. Foliage meeting neither in rows nor across them.
2. Foliage meeting in but not across rows.
3. Complete canopy.
4. Complete canopy with prostrate stems and erect side branches.

The crop growth stage affects the humidity within the canopy, and therefore has a direct affect on disease development.

At present, the model uses artificial weather data. While this data appears reasonable, it is intended to collect real data in the coming seasons. The cost of hourly weather data, from the New Zealand Meteorological Service, for the seasons 1980-1985 on two sites was quoted as \$10,321 (+ G.S.T.) which was prohibitive.

(ii) Fungicides

At the end of each day in the programme, players are asked if they wish to apply a fungicide the next day. Two fungicides are available; mancozeb (Dithane M45) and metalaxyl/mancozeb (Ridomil MZ).

Mancozeb reduces spore germination, but has only a low anti-sporulant effect and no eradicator effect. Metalaxyl/mancozeb has a high eradicator and protectant action (Hodgson 1963, Fry *et al* 1979, Bruck *et al* 1980). The fungus can quickly become resistant to metalaxyl so there is a small, but increasing risk of resistance to this component of the metalaxyl/mancozeb mixture, after three applications within a season.

The model does not allow fungicide application if there is significant rainfall on the day.

(iii) Effect of blight on yield

The blight/yield model is simple and takes no account of varietal differences. Because of compensatory growth, blight does not significantly affect tuber development until about 40% of the foliage is infected. Above that level, tuber growth is affected and stops completely at 75% foliage infection (Large 1952).

Reduced quality from tuber infections are not included in the game, although in reality they could be a significant factor. However, if the crop is destroyed more than a month before maturity then it is assumed that tubers are small, and not saleable.

(iv) Return/investment ratio

This ratio is the dollar return for the crop divided by the total cost of the fungicides and their application. In practice, the price growers receive for their potatoes is extremely variable. For the game however, the price is fixed at an "average" figure of \$200/tonne.

ASSESSMENT

As well as aiming for a high return/investment ratio, the player must observe how the disease develops through the season.

This is accomplished by allowing the player each day to observe a graph showing disease development so far. At the end of the game, major spore release periods and

number of active lesions/haulm are also shown, superimposed on the disease development data. Players are asked to note in particular:

1. The periods when high numbers of spores were released.
2. The periods when numbers of active lesions increased or decreased.
3. The effect the fungicides had on these parameters including differences in effect between mancozeb and the metalaxyl/mancozeb mixture, and signs of resistance.
4. The effect of weather on these parameters.

After "growing" the crop for several seasons, players are asked to write a one or two page analysis of disease development during the season(s), explaining the reasons for the changes in slope of the various graphs. They are also asked to evaluate their own fungicide strategy. This should improve with each playing.

CONCLUSIONS

The model has performed well as a teaching aid. It is hoped that it can be verified by growing isolated crops and monitoring the weather, disease development and yield. A complete and accurate blight model would also be useful as a research tool to evaluate different fungicide strategies.

ACKNOWLEDGEMENTS

Chris Hume of ADAS, MAFF UK for providing details of the Sparks model, and P.G. Fenemore and P.G. Long (Dept. Plant Health, Massey Uni.) for their constructive evaluations during development.

REFERENCES

- Beaumont, A., 1947. The dependence on weather of the dates of outbreak of potato blight epidemics. *Trans. Bri. Mycol. Soc* 31: 45-53.
- Bruhn, J.A. and Fry, W.E., 1981. Analysis of potato blight epidemiology by simulation modeling. *Phytopathology* 71: 612-616.
- Bruck, R.I., Fry W.E. and Apple A.E., 1980. Effect of metalaxyl, an acylalanine fungicide, on the developmental stages of *Phytophthora infestans*. *Phytopathology* 70: 597-601.
- Fenemore, P.G. and Stewart, T.M., 1986. A microcomputer-based pest management game. *Proc. 39th N.Z. Weed and Pest Control Conf.*: 241-243.
- Fry, W.E., Bruck, R.I. and Mundt, C.C., 1979. Retardation of potato blight epidemics by fungicides with eradicant and protectant properties. *Plant Disease Reporter* 63: 970-974.
- Hartill, W.F.T. and Young, K., 1985. Chemical control of late blight. In *Potato Growing: A Changing Scene: Agronomy Society of NZ Special Publication No. 3*: 55-60.
- Hodgson, W.A., 1963. The eradicant effect of some fungicides on potato late blight. *American Potato Journal* 40: 143-148.
- Large, E.C., 1952. The interpretation of progress curves for potato blight and other plant diseases. *Plant Pathology* 1: 109-117.
- Krause, R.A., Massie, L.B. and Hyre, R.A., 1975. Blitecast: a computerized forecast of potato late blight. *Plant Disease Reporter* 59: 95-98.
- Smith, L.P., 1956. Potato blight forecasting by 90 per cent humidity criteria. *Plant Pathology* 5: 83-87.