



Enhancing the Natural Disease Resistance of Potatoes

By Anowarul Bokshi and Jenny Jobling

In order to reduce pollution and strive for a cleaner environment, significant efforts are being made to develop alternatives to synthetic pesticides for the control of plant diseases. A promising alternative is to stimulate the natural resistance of plants. Recent advances in our understanding of the mechanisms of the expression of plant defense mechanisms when attacked by disease causing pathogens means that it is possible to artificially stimulate the natural defense mechanism. This strategy may provide a commercially viable and environmentally friendly alternative to existing disease control methods.

Over the last 30 years a number of compounds have been shown to increase the disease resistance or at least decrease symptoms in plants. Plants have several natural mechanism for defending themselves against disease. Nature has give plants these defense mechanisms so that they can mature and set seed for the next generation. A premature death from disease would mean that no seeds would be sown. This natural mechanism can be exploited with the application of chemicals such salicylic acid. Salicylic acid is naturally produced by plants in response to disease and although is has no direct anti fungal or anti bacterial activity it can induce the natural resistance if it is sprayed on plants in the field. Salicylic acid is not the ideal compound as it is toxic to plants in high

doses but there are similar compounds that will be discussed in this article that are not toxic and can induce disease resistance in potatoes and other plants.

In a classic model of systemic disease resistance, a leaf in response to disease attack produces a signal. This signal may be the production of salicylic acid but other signals have also been identified. The signal moves through the vascular system of the plant to uninfected leaves, where it induces the formation of defensive chemicals and associated resistance against further disease attack.

The natural defense mechanism in plants includes such things as the formation of physical and chemical barriers to the disease pathogens. Environmental stress can also stimulate plants to produce these defense mechanisms. In response to pathogens and stress, the plant produces lignin, which is a compound that strengthens cell walls and chemicals called phytoalexins that inhibit the growth of the pathogen. As plant resistance is built up certain plant enzymes like β -1, 3-glucanase, also increase in activity. These enzymes are needed for the production of the new compounds.

The signals are generated or released during disease infection and are transmitted throughout the plant. This is called a hypersensitive response and has been reported to stimulate a systemic

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expression of resistance within 24 hrs in cucumber plants (Smith *et al.*, 1991). They reported that the signal for systemic resistance developed within 24 hours after inoculation and occurred before any signs of disease damage became visible. They found that immediately after the perception of the signal there were corresponding changes in metabolic activity. These changes included increased production of lignin and phytoalexins and these defend the plants against further development of the disease.

Recent work done by Anowrul Bokshi at the Sydney Postharvest Laboratory have done experimental trials with the chemicals ASA (acetylsalicylic acid), INA (2,6-dichloroisonicotinic acid) and BTH (benzothiadiazole) for inducing disease resistance in potato leaves and tubers.

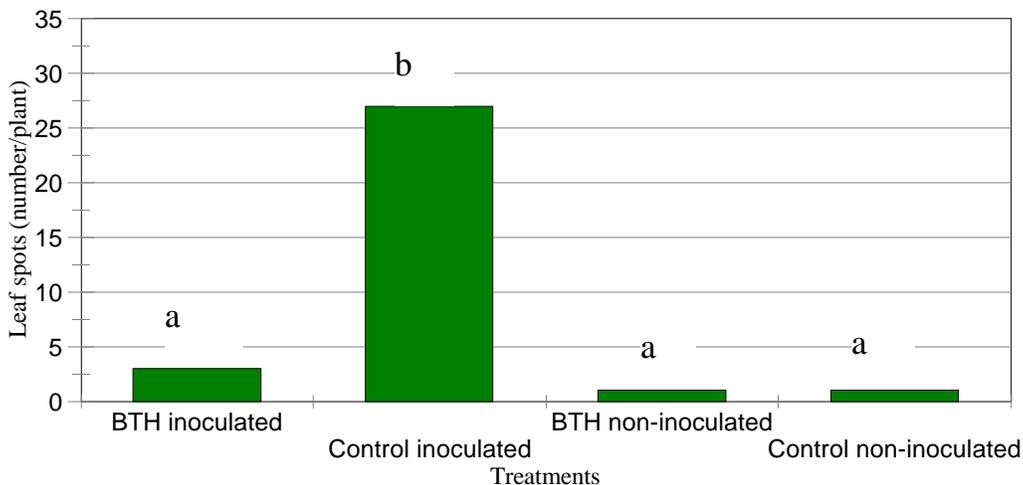
Postharvest storage diseases caused by *Fusarium* and *Erwinia* sp. are the major storage diseases of potatoes and are a major constraint on potato exports. Leaf diseases caused by *Alternaria solani* is another important disease of potatoes in the field and postharvest tuber rots may

develop from plants with high levels of field disease. Several strategies for controlling leaf and tuber diseases have been introduced over the years but serious losses still occur. The use of chemicals that induce disease resistance were trialed as an alternative.

Different plant parts such as leaves, roots and tubers have different capacities to develop disease resistance. The age of the tissue is another important consideration. For this work whole tubers and tuber discs were dipped in ASA, INA and BTH at different concentrations for varying lengths of time and plants in the field were treated with BTH (25, 50, 100 ppm) and ASA (400 ppm) 60 days after sprouting. A glasshouse experiment was also carried out with plants treated at 30 and 60 days with 50 ppm BTH.

The treated potato tubers and discs were then inoculated with *Fusarium sp.* via wounds and plants in the glasshouse were inoculated with *Alternaria sp.* and in another glasshouse powdery mildew diseases were allowed to develop naturally. Tubers harvested from the

Leaf spot on potato plants treated with BTH



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field and glasshouse trials were also challenged with *Fusarium sp.* (dry rot) via wounds. The plants and tubers were assessed after several days for the development of disease symptoms and samples were also analysed for enzyme activity in order to see if the chemicals also induced metabolic changes.

The assessment of the field and glasshouse trials showed that leaf diseases were greatly reduced in the field and the activities of glucanase enzymes in leaves increased several fold. Spraying of BTH on glasshouse potato plants increased resistance against both artificially inoculated *Alternaria sp.* (leaf spot) and the naturally occurring powdery mildew. Application of BTH in the field 60 days after sprouting did not induce disease resistance in harvested tubers.

An early treatment of potato plants at 30 days after sprouting compared to a 60 day treatment did induce resistance in tubers against postharvest fusarium dry rot fungus. There was also an increase in enzyme activity that seemed to persist throughout the whole of the plant's life. Leaves and stems showed the best retention of enzyme activity compared to tubers and roots. This result suggests that timing of the application is critical with earlier applications being more successful. Plant age may also be the limiting factor for the induction of systemic resistance in harvested tubers.

Trials with whole potatoes were not as successful. None of the chemicals used induced resistance in whole tubers. Some increase in resistance of tubers occurred for dipping tuber discs and tubers harvested from plants sprayed with BTH. ASA at 400 ppm and BTH at

25 ppm did increase resistance in tuber discs against fusarium dry rot fungus. This suggests that the chemical does not move through the tuber as easily as it does through the plant and so is less effective. This preliminary work suggests that it may not be possible to increase disease resistance by dipping potato tubers in solutions of these chemicals.

The best results were seen in the excellent control of the two leaf diseases tested. In all cases there was a corresponding increase in enzyme activity suggesting an induction of classic systemic resistance. Induction of systemic resistance in potato plants could be a useful method for controlling foliar as well as postharvest diseases of potatoes. This induced resistance is likely to be effective in other crops, such as cucumbers and melons as well. More work is needed to confirm this. This method of disease control has been shown to be effective and it also has the added benefit of being environmentally safe. This research was funded by HRDC.

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