Agriculture: Africa's "Engine for Growth" - Plant science and biotechnology hold the key, Rothamsted Research, Harpenden, 12-14 October 2009

Delegates at Africa Conference at Rothamsted. Reproduced by kind permission of Utopia Audiovisual

The AAB symposium titled "Agriculture: Africa's engine for growth - Plant Science and Biotechnology hold the key" held at Rothamsted Research from 12-14 of October (2009) brought together about 50 scientists from Africa and 50 researchers from the rest of the world. The scientific programme, which also included a Funders Forum and a Schools event, focussed on how new advances in plant science research and developing technologies are being used to the benefit of African agriculture. This forum allowed a full and frank consideration of the roles of novel, dynamic, and relevant technologies and their possible applications in agriculture. The consensus view was that although improvements in farming practices and crop management are essential modern genetics must be utilized too. Intensification of global synergies and alliances are further required in order to apply multi-disciplinary approaches and make prudent and timely recommendations regarding areas of highest priority for translation of modern plant sciences to the field, as well as devising appropriate actions on key activities in crop improvement. The need to enhance education in the new areas of plant research and biotechnology was finally also addressed as was the key question of whether plant science and biotechnology hold the key providing suitable solutions for Africa. The participants agreed that while plant science and biotechnology may not completely "hold the key" these areas must an important part of the solution, as is the need to develop feasible strategies for generic translational pipelines for introducing genes and traits required for improvement of agricultural crops. This symposium was considered to be a great success by all who were involved. The meeting not only provided interesting and thought-provoking insights in new areas of plant science research but also viewed how such advances are being implemented for the benefit of African Agriculture, in order to improve food security.

Christine H. Foyer, Africa College, Centre for Plant Sciences, University of Leeds, UK. October, 2009

Roger Plumb gives delegates a tour of the experimental plots at Rothamsted

http://www.utopia-audiovisual.co.uk/science.html

Biopesticides: Commercial Uptake, The Olde Barn Hotel, Marston, 21 April 2010

Biopesticides are pest management tools based on mass produced biologically-based agents. The term encompasses micro-organisms, plant extracts and semiochemicals, often sold in formulations that are quick to apply through conventional pesticide application equipment. Biopesticides can be valuable components of integrated pest management (IPM) programmes but should not be viewed as like-for-like alternatives to synthetic chemical toxins. Their modes of action are quite different and their performance can be seriously affected by environmental conditions.

In 2006 and 2007, the University of Warwick organised two RELU sponsored conferences which explored the difficulty in bringing biopesticides to the market in the UK with emphasis on the regulatory process. Much progress has been made in the interim and several products based on biopesticides

have now been approved for use on food crops in the UK.

In April 2010, the AAB's Biological Control Group joined forces with the International Biocontrol Manufacturers Association to provide an update on the range of biopesticides that are now available to UK farmers and growers. The programme was designed by Phil Walker (IBMA Chairman) and Rob Jacobson (AAB Biocontrol Group Convenor) to ensure that end-users had realistic expectations about the performance of biopesticides and understood how to use them to best effect. There were success stories about individual products and examples of how biopesticides have been integrated into whole IPM programmes.

This article is based on three of the more general introductory papers [i.e. by Prof. Wyn Grant (University of Warwick), Dr Roma Gwynn (Rationale) and Dr David Chandler (Warwick HRI)] with a few of our own thoughts along the way.

Political considerations:

The recent European Union legislative package is likely to restrict the availability of synthetic products thus providing an opportunity for biopesticides. The emphasis on IPM in the Sustainable Use Directive (SUD) will also provide gaps to be filled by biopesticides. However, as is often the case with EU legislative proposals, there are likely to be difficulties with implementation at member state level. In the UK, we already have many of the mechanisms in place that will be required by the SUD. Nonetheless, the UK government must get up to speed very quickly and gain a much better understanding of what can realistically be achieved by IPM. It was therefore very disappointing that no government policy makers attended this highly relevant event.

There are also some challenges in the broader climate of politics and public opinion. The emphasis on climate change has tended to dominate discussions of environmental politics reducing the time given to other important issues such as this.

Recessions tend to lead to an emphasis on purely economic considerations and to less discussion of the politics of externalities. This problem is magnified by a lack of understanding (and perhaps interest) among the public about biocontrol products and what they can contribute to sustainable solutions to plant protection against pests and diseases. Prof. Grant said that the "generally unsympathetic attitude of environmental groups" was not at all helpful. It is clear that our industry will have to promote a positive message about crop protection in the future. It will be particularly important that the SME's producing and selling the majority of biorational products build coalitions to promote their common cause.

In summary, we live in the 'Regulatory State' and the pressure for greater regulation is not going to go away. There are many societal drivers of that including changing attitudes to risk. There is also a worrying tendency for the 'process' to displace the 'goals' within the regulatory agencies.

Availability of biopesticides:

Globally there is a drive for good quality food production using sustainable crop protection practices. Yet even with current crop protection measures it is estimated that between 30% and 40% of crops are lost due to pests, diseases and weeds before harvest. Crop protection is therefore an important consideration for assuring food security in the coming years.

Biopesticides can help growers and farmers meet this challenge but there have to be products before we can have uptake. There are currently 260 biopesticides approved in the USA, 77 approved in the EU but only 16 approved in the UK. Prof Grant pointed to the "very rigid grounds for intervention in the UK compared with a more fluid national interest approach in the USA".

Dr Gwynn cited the following reasons for the small number of biopesticide products currently available in UK:

- Low product demand
- Historically fragmented and insignificant markets
- Low profit margins
- A relatively costly and complex registration process (originally designed for chemical toxins)

However, demand is likely to increase due to the following drivers:

- Demand for produce with no detectable chemical pesticide residues
- The need for additional tools, actives and approaches to combat resistance
- The loss of synthetic active ingredients and products
- For use in IC/PM in the implementation of the SUD
- Response to the EU Water Framework Directive

The registered biopesticides currently available in the UK include products based on a pheromone, yeast, plant virus, granulosis virus (x2), fungi (x4), fatty acids, bacteria (x3) and plant extracts (x3). There are products aimed at monitoring and controlling insects, fungal pathogens, plant viruses and post harvest pathogens.

There are also products which are exempt from registration but are able to make crop protection

Beauveria bassina *infection on a capsid bug.*

claims on their labels; i.e. macro-organisms such as invertebrate parasites, predators and entomopathogenic nematodes. In addition, products such as plant strengtheners, growth promoters, stimulants and root symbionts are exempt from registration because they are not considered primarily to be crop protection agents. We are all aware of the so-called "grey products" which circumvent registration by making only indirect crop protection claims. The effects of these products are never clearly defined and they rarely live up to expectations. As a consequence, they are potentially very damaging to the overall image of biopesticides.

Changing our perspectives:

Properly developed biopesticides have an important function as components of ICM but it would be foolish to consider them to be stand-alone treatments. Dr Chandler described the very different attributes of biologically-based products and the need for different application strategies.

We expect synthetic pesticides to provide a very high level of control of the target organism but such control is rarely achieved from a one-off treatment with a biopesticide and this can lead to their rejection by growers. For best effect, the products often have to be used as prophylactics which may mean repeated applications to suppress the development of the target organism. However, the best overall results are usually obtained where biopesticides are used in combination with other products.

Dr Chandler described the successful application of the entomopathogenic fungi, *Beauveria bassiana*, as a second line of defence to support predatory mites against spider mites. The predators are used as a season-long control measure while the fungus is used to slow down the pest development if it approaches the economic damage threshold. When used in this way, a 40-50% reduction in pest numbers is enough to prevent economic damage, yet this would be totally inadequate if the product were being used as a stand-alone treatment.

There are opportunities to make biopesticides work better by optimising the formulations. For example, the germination of spores of certain entomopathogenic fungi can be enhanced at less than optimum humidity by formulating in oil rather than wettable powder. We should also make better use of the ability of microbial control agents to reproduce within the pest /disease population and hence provide an element of self sustaining control.

Dr Chandler described exciting new scientific developments that indicate how biopesticides may be developed in the future. If we take insect pathogenic fungi, for example, some strains have been isolated recently which function as plant endophytes, and can help protect plants from insect attack. Other strains are now known that cause induced systemic resistance in plants and so help them to defend against plant pathogens.

However, Dr Chandler considered that the biggest developments in biopesticides in the longer term are likely to result from information about the genomes of pests and their natural enemies. A large number of pests, crops and microbial control agents will have their genomes sequenced in the next 10-20 years and this will allow us to identify new gene targets for pest control and to develop new management tactics. This may provide single interventions but is more likely to lead to new combinations of tactics. For example, maize plants have been engineered to express a natural chemical alarm compound, which recruits naturally occurring insect pathogenic nematodes in the soil and thus helps to protect against the western corn rootworm. Similarly, by using molecular biology information, a simple non-toxic sugar compound has been identified that blocks a pathogen receptor molecule in termites and makes them more susceptible to entomopathogenic fungi.

Caterpillar killed by Bacillus thuringiensis

Where do we go from here:

We have no doubt that we are merely scraping at the surface when it comes to exploiting the full potential of biologically-based crop protection methods. However, their use must be based on a thorough knowledge of the four way interactions between the plant, herbivorous organism, beneficial organism and cropping environment. This will only be achieved by a greater international commitment to both fundamental and applied research on the subject. Over the last 60 years, governments all over the world have invested vast sums of public money into research to develop chemical pesticides to secure food supplies. That has been entirely appropriate but the time has now come to make a similar commitment to more sustainable biologically-based control measures.

The next Biopesticides Conference will be on 29 November 2011, running back-to-back with the Advances in Biological Control conference on 30 November. Book your seats early because we predict that it will be oversubscribed!

Rob Jacobson & Phil Walker, April 2010