NEW TRENDS IN CROP ENHANCEMENT TECHNOLOGY IN BIOAGRICULTURE

The Canadian Food Inspection Agency defines 'biotechnology' as "the application of science and engineering in the direct or indirect use of living organisms, or parts or products of living organisms, in their natural or modified forms."[1] This definition emphasizes the diversity of biotechnology, from traditional plant breeding through to genetic engineering and across agriculture from soils and crops to animals, biofuels and biomaterials.

Experimental field trial of soybean inoculants, shorter, lighter green plot in front right is untreated control. Front left plot was treated with XiteBio SoyRhizo.

Nodules on the roots of legumes contain rhizobia bacteria that fix nitrogen for the plants (pink).

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Green and environmentally friendly technology is of growing importance in all industries including agriculture, in for example microbial products or products based on live microorganisms.

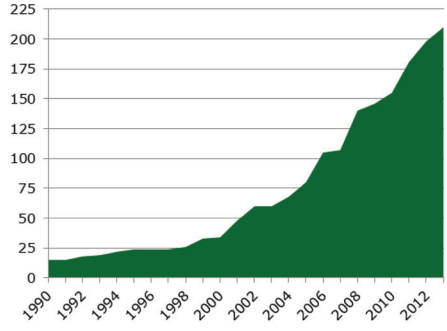
Crop producers have known for millennia that legume crops play an important role in maintaining soil fertility, even before the ancient Romans wrote about incorporating legumes in crop rotations. Eventually this led to the first biological applications, which were really nothing more than soil taken from locations where legumes were observed to better rejuvenate the soil and applied to other areas. Today, microbial products represent a $265 million USD market with a much larger diversity of products for more crops and applications than its humble beginnings would suggest. Three turning points were critical to this transformation:

Discovery

Although growths on the roots of legume plants had been described and documented for hundreds of years, it was not until 1888 that bacteria were first isolated from these growths (or nodules). These first species of Rhizobium were found to convert atmospheric nitrogen into a plant-usable form. Less than 10 years later the first pure culture bacterial inoculant had been developed. Peat-based carrier and rhizobium bacteria-based seed inoculants for legume crops remained the norm for nearly a century.

Renewed Interest

No fundamental changes occurred in the agriculture biologicals market until 1990 when the first liquid crop inoculant was available in Canada. This renewed interest in crop inoculants stimulated a flurry of research diversifying the ways in which inoculants could be more successful and in the ways they could be applied. In 1994 the first



The number of registered biological products available in Canada from 1990 to present has skyrocketed. (data as of June 2013)

legume inoculant combining biological approaches (fungi + bacteria) was available. It had been known since before the 1950s[2] that the pre-existing native bacteria sometimes outcompete those in the inoculant, rendering it ineffective. This combined biological product was the first to work towards improving the success of the crop inoculant by boosting plant growth and the competitive ability of the introduced inoculant bacteria.

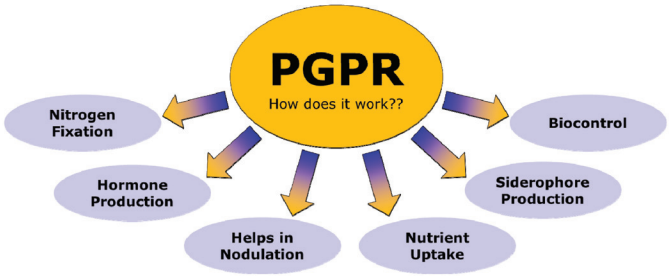
Then in 1995 the first granular inoculant was introduced to the Canadian market offering more options for the convenient application of inoculants. This emphasised the value that producers were beginning to place on this aspect of the microbial products. There were over 30 biological products available in Canada in 1999, more than twice as many as a decade earlier.

"Up until now inoculants have been a commodity just like seed used to be a commodity. Then it was differentiated by variety and sold on a brand name basis. That is where we are headed with inoculants," said Sanford Gleddie, then head of marketing at former Philom Bios company. He predicted the trend of increasing products from more companies quite correctly, as currently there are 210 biological products available in Canada from 21 companies as compared to 15 products from two companies in 1990. Gleddie further predicted that "companies will eventually have strains of rhizobia bacteria they will market as superior to the competition's bacteria".[3] He was correct in this regard as well, as many products promote unique blends of nitrogen fixing rhizobia as well as combinations of rhizobia and other microbes.

The reason for the increase in the number of types of inoculant products goes back to the concept of competition between the introduced and native soil microbes. Dr. Manas Banerjee, president and CEO of XiteBio Technologies, a Winnipeg-based bioresearch company explains: "With billions of bacteria in every spoonful of soil and limited food and space on roots for bacterial colonisation, inoculants are not always able to successfully compete their way to nodule formation in legumes."

Changing Trends

The past few years have seen an explosion in the number of biological products registered for the Canadian market. This is due to an emerging shift in the industry towards biological products that promote positive interactions with the native soil microflora and products that are applicable to a wider range of crops. "Throughout most of the first century of the inoculant industry, fundamental assumptions were made about the role of bacteria in promoting plant growth. Two of the best examples were that there are only soil bacteria that can boost legume growth and that the inoculant bacteria must compete against the pre-existing soil microbes for an inoculant to be successful. But now those assumptions are being questioned and there are new alternatives emerging," says Dr. Banerjee.



Products based on microbial biotechnology are generally plant growth promoting rhizobacteria (PGPR - bacteria that inhabit in the rhizosphere or root adhering soils). "The first PGPR based product for a non-legume crop was registered in Canada in 2005, and in just eight years there has been nearly a three-fold increase in the number of PGPR and biological products coming to the Canadian market," says Dr. Banerjee. There are now biological products available for many crops, including corn, wheat, and canola. He continues "just as the discovery and commercialization of PGPR for many crops is changing the inoculant, well really it is the biologicals industry these days, so too did the recent commercialization of AGPT™ (Advanced Growth Promoting Technology) could present a fundamental change to the inoculant industry."

AGPT™ is the technology that challenges the assumption that inoculant bacteria must compete against those already present. The philosophy behind AGPT™ is really one of co-operative interactions. "There are many beneficial bacteria in soil that stimulate plants and these are the ones that inoculants must suppress in order to be successful. At XiteBio our whole philosophy is of using naturally-occurring microbes to boost the existing properties of plants and soils and so these competitive interactions seemed unnecessary." Instead of competing, inoculants powered by AGPT™ not only introduce nitrogen-fixing rhizobia but also invigorate the native microflora, and create synergy between them. "AGPT™ may be the first technology to really modernize legume production in Canada, but I'm confident that there will be more exciting developments in the future," says Dr. Banerjee.

Future of the Biological Market

With eight acquisitions of biological companies in just the last three years, the worldwide focus on biological products is increasing. "When the biggest players in the agri-inputs industry invest billions of dollars into beginning and diversifying their biological research divisions, you know there will be new applications emerging in an expanding marketplace," says Dr. Banerjee. Those new applications could include further expanding the applications of inoculants beyond the traditional usage on legumes and using biologicals to target specific aspects of crop development such as the oil content and quality of oilseeds or the protein content of wheat. Developing biopesticide products to target noxious weeds, insects, bacterial, and fungal pathogens is already an area that has the potential for massive expansion in the coming decades.

Biological products have matured over the past century from their humble beginnings to the diversity of products available today. Based on the worldwide activity and interest in biological and microbial actives, as well as many still under explored applications, the coming years promise exciting developments in the microbial inoculant and agri-input industry.

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