



Insect-resistant GM-crops

An example of greed, not a case of myopia

By Jagath Gunawardena

A large number of genetically modified crop varieties (GM-crops) have been grown in year 2000, covering an extent of 44.2 million hectares belonging to 16 countries. A look at the new traits conferred to these crops through genetic engineering techniques show that they were dominated by only two traits — herbicide resistance and insect (or pest) resistance. The land area covered by GM-crops that had all other traits was about 1% of the total. The predominant trait in these was herbicide tolerance that accounted for 80% while insect resistance was limited to 26%. The disparity in an add-up of these two figures is due to 7% of the crop area was planted with GM-crops that had both these traits together. Most of the insect resistant crops were varieties of cotton and maize, with potatoes coming a distant third.

Unlike those herbicide tolerant crops that increase the inputs (herbicide use), insect resistant GM-crops have been hailed as those that cut down the amount of poisonous pesticides and being more effective in combating pests than using pesticides. Some have even cited such GM-crops as examples of those that can help poorer countries with serious pest problems. Therefore, it is useful to look at the genes behind insect resistance, the present status of these crops, the emerging trends and future prospects. Insect resistant GM-crops are often referred to as Bt-crops. This is because they all contain a gene known as the Bt-gene, that comes from different sub-species and variations of a single species of soil bacterium known as *Bacillus thuringiensis*.

This bacterium has been described from specimens collected from the Thuringia Province in Germany in 1911 and has been named after the locality, but had been first obtained in Japan in 1901 from a silkworm larvae by a scientist named Ishawata. There are more than 35 sub-species and over 800 different strains. These produce different types of Cry-proteins that are effective against different pests. It had been used as an insecticide preparation in France since 1938 and in the USA since 1950's. These became popular for being specific, effective, relatively safe and not harmful to many other beneficial animals. The risks for workers and the habitats are also relatively low. These Bt-preparations are often described as the single most important insecticide ever discovered due to the effectiveness and low risks. In USA, the sale of these formulations earns over 60 million dollars annually and has captured about 90% of the organic pesticide market. These preparations are sold under a wide range of trade names such as Dipel, Foil, Thuricide, Vectobac, Foray, M-Trak, Biobit, Javelin, Trident, Di Terra and

Mosquito Attack.

It was therefore natural that the development of genetic engineering saw various effects to isolate the different Bt-genes that produce the correspondingly different Cry-proteins effective against different groups of pests. Parellel to these developments, but unnoticed by many, were the efforts by these companies to "own" as many different Bt-genes as possible. This goal was achieved through the patenting of the different strains of *B. thuringiensis*, the different Bt-genes and the different Cry-proteins encoded in these genes. All these have become privately owned properties of companies, who have the exclusive rights to use them. Any other company or institution that intends using a privately owned Bt-gene needs to get a licence from the owner, or wait until the patent lapses after 20 years. Even variations of known strains and sub-species are being patented. An example is the sub-species *B. thuringiensis tenebrionis* that is effective against beetle leaves. This was isolated in 1982 and the sub-species and all preparations using it were covered by a patent EP 149162. A variant of this that produces higher yields of the particular Cry-protein is the subject of patent US 5279962.

The isolation of these Bt-genes and the insertion of these into the genetic-make-up of crop plants became a success and there were crops that could secrete the Cry-proteins in their tissues. A pest feeding on the crop would ingest the toxic proteins in lethal amounts. The first crop that was able to do so was a variety of tobacco made by Plant Genetic Systems and tested in USA and France in 1986. Commercial growing of Bt-crops started only in 1995, with the registering of Bt-corn in USA, followed by Bt-cotton. The corn variety, named Maximizer was developed by Novartis (now Syngenta) and the cotton variety named Bollguard was by Monsanto (now Pharmacia). The area covered by Bt-crops in 2000 was dominated by varieties of corn and cotton, with a combined total of 11.3 million hectares. Two varieties of potatoes known as New Leaf and New Leaf Plus developed by Monsanto and grown in USA, Canada, Mexico, Argentina and Japan was a distant third.

Unlike the herbicide tolerant crops that needs increased application of a herbicide, these Bt-crops reduce the amount of external applications of pesticides. Since a particular

Cry-protein is not toxic to all the insects, an infestation by a different pest needs external application of insecticides. Farmers growing Bt-cotton in USA in 1998 have reduced the number of pesticide applications from five to one. These initial successes have convinced the farmers so much that these have shown the highest adoption rates recorded by any crop. In the cotton growing states of USA, the adoption rate in some areas had been high as 70%. The total area covered by Bt-corn in 1997 was 2.4 million hectares and had increased to 8.2 million hectares in 2000, an increase of over 330% during these three years.

In Bt-crops, the toxins are secreted in all the tissues throughout the lifespan of the crop.

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Although it has been hailed as a positive feature, it could raise other serious implications in the long term. Unlike in the use of Bt-sprays, these crops make the toxins available for the pests for a long, continuous period of time. This help develop pesticide resistance in pest populations quite fast. The development of pesticide resistance in various pests have become a growing problem throughout the world. According to a report by the Food and Agriculture Organization (FAO) in 1991, more than 500 species of insects have developed resistance to more than one pesticide. A projection made by World Watch Institute (Vital Signs) this number would increase to more than 600 species by this year (2002).

The ability of insects to develop resistance to Bt-toxins was shown in 1985 which showed that the Indiana Leaf Moth having developed resistance to Bt-sprays in USA. Resistance developed by Diamond back Moths to Bt-sprays was reported from USA, Japan, China, Thailand and Malaysia during 1990. Experiments done during the same period have revealed that 13 species of insect pests have developed resistance to Bt-toxins. All these were resistance developed to Bt-sprays that do not persist in the environment for a long period of time. Even before the Bt-crops were

planted in the fields, scientists have been proposing various strategies to help protect the efficiency of Bt-toxins against crop pests. These are designed to prevent resistance developing or at least to delay the development of resistance so as to prolong the useful period of Bt-pesticides. These include the use of different pesticides in a single crop and to minimize exposure to Bt-toxins by using them only when other methods fail.

The widespread planting of Bt-crops runs contrary to these strategies by exposing the insects continuously to these toxins, helping resistant individuals to propagate. Even in Bt-crops, there have been various suggestions to help limit the exposure of insects to these toxins.

One suggestion is to limit the expression of them to various parts and not in the whole plant. This may not be that successful because the target pest may be one that specifically attack the very same part and therefore be continuously exposed to the toxins. Another is to keep the Bt-gene silent in a crop plant until it is needed by a pest attack. One

technology that has provided an answer to this is the "Gene Switch" developed by Zeneca (now part of Syngenta) and patented under WO 0009704. This provides for the linking-up of the Bt-gene to an expression unit that can be activated by the addition of a chemical. A quite simple method is to plant 20% of the land with non-Bt crop varieties to reduce the selection pressure.

The emergence of Bt-resistant insects could undermine the already large and still growing profit base of the companies. This probability has not escaped the attention of the companies who have been producing Bt-crops. For example, Mycogen, a company that owns many different Bt-strains and crop varieties (including Nature Gard corn released in 1996) has stated that they believe that their technologies could not be effective for more than another ten years. It is expected that by this time, resistant insects would make Bt-crops useless. More damaging would be the inability to use Bt-preparations in pest control in the future. Therefore, one would have expected the companies who made Bt-crops to show a great deal of restraint in order to keep their varieties useful for a long time. Instead, what is seen is that companies are doing the exact opposite by the aggressive

promotion of Bt-crops.

This course of action taken by the companies would seem bizarre, myopic and even as self-destructive. This is because the society at large, including the scientists, tend to look at such situations with a logical assumption. The assumption is that the companies would be the main beneficiaries from the ability to continuously use a resource that bring them profits and it is therefore would be to their interest to ensure that a resource is sustainably used and managed. Companies, particularly the transnationals (or TNC's) do not think in terms of resources, but only in terms of profits and how to increase them still further. For them, there is no logical reason to embark on a course of action that would reduce the profits that are available at present and in the near future. Similarly, companies that produce Bt-crops neither interested nor worried about maintaining the suseptibility of pests to Bt-toxins, but only about how to increase their profits by the sale of Bt-crops and any restraints and limitations on their part will only reduce the profits clearly available to them in the future.

From the point of view of companies, the future has lurking dangers and uncertainties. The problem of insects developing resistance is only one. The other potential danger is that a rival may discover a much better gene or genes that would be more appealing to farmers and could reduce or even end the demand for Bt-crops. Another is that the patents expire with time and the monopolies held by a company would then enter the public domain, a point from which they would not be able to gather exclusive profits. It is therefore advantageous for a company to recoup the expenditure spent on making Bt-crops and gather as much profits as soon as possible. To do this, it has to outmanouver competitors as well and any restraint in the part of one would only help a rival. A company that can earn more can invest more in other profitable ventures and would be able to maintain or even increase the profits.

It is this same corporate logic that finished off the whaling industry, made fishes such as sardines, anchovies, pilchards and mackerel to the point of economic extinction. The companies that engaged in fishing these species invested their profits in other profitable businesses. It is the same that befell the pearl fisheries in the north-west of Sri Lanka. Although Bt-crops have the potential to help developing countries in the future, it is being eroded fast due to corporate activities of the developed countries. If the present trend continues, not only the Bt-crops, but all Bt-preparations would become useless. It is yet another example of the possible dangers of letting corporate interests to take its own course without proper interventions on the part of governments.

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