

Midweek Review

• Female sterility of crop plants

Another negative-trait technological achievement

by Jagath Gunawardana

The development of genetic trait-control technologies, widely known as terminator-type technologies or traitor technologies, are continuing at an accelerated pace, despite public outcry. They are all designed to control essential traits in plants, including germination, through the use of chemicals, and thereby keep farmers under the control of agro-chemical and biotech companies. Since the patenting of the first two such techs in 1994, the five years to the end of 1998, saw a total of 44 such technologies being awarded patents. There was a quantum leap in 1999, with 50 being patented during the year alone. It is an increase of over 500% in comparison to the previous year and an increase of 214% of the total number. It shows clearly that, regardless of public opinion, large private interests in developed countries, ably backed by research institutes including universities of those countries, are pursuing a path of domination of agriculture, using genetic engineering and intellectual property laws as tools.

It was the genetic-engineering technology programmed to kill the embryos of seeds, dubbed as terminator by the public-interest group Rural Advancement Foundation International (RAFI) that made many focus their attention on the problem. This technology was patented in U.S.A. in March 1998 (U.S. 5,723,765) and in September 1998, Zeñeca got a patent (U.S. 5,808,034) for a technology designed to kill pollen and the male parts of flowers. This, for some reason, did not get the deserved attention in those countries. In pollination, pollen fertilizes the eggs-cells (ova) in plants to form embryos. Therefore, 1998 saw technologies that can successfully control two vital areas in the production of seed.

Among the technologies patented in 1999 are three that are able to cause death of the ova or egg cells of flowers, thus completing the vicious cycle of sterility of male and female parts of flower and embryos. One of the three is specific to ovules while the other two make ways to cause sterility in the male parts as well. A common feature in many genetic trait-control technologies is that the descriptions go to great lengths to show some advantages that result and some make only short or oblique references to how they can be used for negative purposes. The titles and the abstracts often do not provide even a clue to the intentions nor the range of possible uses. The impact is

ascertained only by going through the whole patent document and evaluating the possibilities.

The technology that specifically targets egg cells of flowers is titled "Ovule-specific Gene Expression" and had been given the patent U.S. 5,907,082 on 25.05.1999. The inventors are Sharman O'Neill and Jeannet Nadeau and the patent is assigned to the University of California (Oakland). The invention is summarized under twenty-two claims. The abstract simply states that "the present invention provides nucleic acid sequences from ovule-specific genes and the nucleic acids are useful in targetting gene expression in ovules or in modulating ovule development.

The background to the invention says that although there is a wealth of knowledge on ovule anatomy and morphology, little is known about the molecular basis of ovule development and function, due to the relative inaccessibility of the ovule within ovaries and the difficulty in getting enough tissues at necessary stages. During the past decade, several genes that confer female sterility had been identified.

These include genes known as Bel 1, Sin 1, Ovm 2 and Ovm 3 from Thale Cress (*Arabidopsis* spp) Several genes known to be important in the development of ovules have been identified and are known as ats and Sup, mutations like MSG in wheat, Sy-2 in *Solanum* and Gf in *Arabidopsis*. The patent states that such genes could be used to prevent the formation of seed or to have seedless fruit and the promoters (a promoter is the region of a gene that decides when, where and how long the gene should become active) of such genes can be used to give desired characteristics.

The inventors have been able to identify five new genes that are active in ovule. Four of these, namely O39, O108, O126 and O141 have been discovered in the *Phalanopsis* Orchids, the other named A20 from *Arabidopsis*. They have in addition identified a gene named O40 in *Phalanopsis* that encodes an enzyme of the Cytochrome P450 Mono-

oxygenases, which play a vital role in the biosynthesis of some hormones and other substances like fats and steroids and the detoxification of herbicides. This particular gene O40 has a promoter that gets activated in the pollen tubes. It is further stated that the gene O108 makes a hitherto unknown protein of unknown function. The patent describes the base sequences of all these six genes and the amino acid sequences corresponding to the base sequences. These descriptions cover 19 pages (from page 25 to 44) and are claimed in the patent as inventions. These are discoveries by the scientists as these genes have been in existence, though previously unknown. Under U.S. patent laws, a "discovery" can be treated as an "invention" and could be afforded pro-

In all genetic trait-control technologies, inducible promoters play a vital role. It is with these that a trait can be controlled. In the control of ovule-specific genes to prevent seed formation, these inducible promoters can be of two types. In the first type, the antisense gene is normally in an inactive (switched-off) state, so that an ovule-specific gene can express itself and the fruits will have seed which are able to germinate.

tection by a patent. This means that all such genes and their parts (including promoters) and the use of them, the proteins made by these genes are all private property, owned in this instance by the University of California.

The patent states that these genes and the technology could be used for two main purposes. One is the production of useful substances in fruits seeds and ova cells.

The other is the production of seedless fruit. In the production of useful substances the examples cited in the patent are the increased levels of Vitamins A, C and E, melatonin, increase of proteins, fats and carbohydrates or a desired pharmaceuticals. Other uses are the production of auxins (a group of hormones) in ova to increase the size of fruits, production of substances that confer resistance to diseases, in particular to fungal infections of seeds. To achieve these ends, they have proposed to use a promoter of a gene that is expressed in ova

cells and fuse it with the code that produces the desired substance. The code could be from any living plants or animals.

The other main use of these genes is to get seedless fruit. The prevention of seed formation. It is stated that gene O39 from *Phalanopsis* and A20 from *Arabidopsis* are particularly useful for this purpose. The formation of ova can be stopped by disrupting the activity (expression) of one of these genes. The recommended method is to use antisense suppression. This is done by linking the code or part of the same gene to a different promoter in a way that it intercepts the message conveyed by the desired gene. In effect it becomes unable to express itself. This kind of new gene is known as an antisense gene. In the

patent, it is stated that the antisense gene can be operationally linked to an inducible promoter. An inducible promoter is one that can be either switched-on (activated) or switched off (deactivated) by an external stimulus. This patent makes only one reference to inducible promoters in page 12 and cite only these that can be controlled by environmental conditions.

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This will activate the antisense gene that will in turn block the expression of the ovule-specific gene by interception its message, which will disrupt the further development of the ova cells. There could be no formation of seed, resulting in seedless fruit. In some fruits such as melons, seedless forms could be of much demand from consumers and food-pro-

cessing industry. Therefore, a grower of a variety of genetically modified types with the use of this technology can grow it normally and get the usual type of crop, or invest on the necessary chemical and get a more valuable harvest. The grower can save seed, but is dependent on the company in adding value to the crop.

In the other type, the inducible promoter would always be in the active (switched-on) position. There could be no seed from such a crop. The promoter has to be inactivated by the addition of the necessary chemical so that the ovule-specific gene is able to express itself and seeds can be formed. This can be used to modify crops where seeds are not desirable, but the difference is that the seeds will produce the crop with an added-value and that one had to buy the necessary seed every season. If the crop can be vegetatively propagated, this embodiment could be a defensive measure, preventing others from making hybrids. This type of inducible promoter is useful in keeping growers of essential crops dependent on a company in another way, where it is essential to have fertilization of ova to get a harvest. This is essential in cereals such as maize, corn and rice where the edible part is the starchy endosperm. If the ova is not fertilized, there could be no grain to be harvested and it is essential to use the recommended chemical to obtain a crop.

According to the patent, this invention can be used in all plants and they have specifically named 44 genera (page 13) which include grains such as *Avena* (oats), *Sorghum*, *Zea* (corn), *Oryza* (rice), vegetables such as *Vigna* (beans), *Glycine* (soya), *Brassica* (cabbage, cauliflower) and *Solanum* (brinjal, chillies), fruits like *Citrus* (oranges, lemon, grapefruit), *Prunus* (prunus), cucurbits (melons), root crops like *Manihot* (cassava), cash crops like *Helianthus* (sunflower), *Gossypium* (cotton) and *Nicotina* (tobacco).

Since the technique has been developed by a university, it is likely that the rights to use it (commercial rights) would be awarded to a seed company by an agreement. They will then be able to make use of it to achieve any of the objectives, including the control of farming. This last objective was pursued vigorously by companies by the control of agrochemicals, getting intellectual property cover over seeds and crop varieties. Unlike these, genetic trait control technologies seem to serve their objective better.

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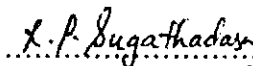
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