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Fruit & Shoot Borer Resistant (Bt) Brinjal

Frequently Asked Questions

Brinjal, also called eggplant and aubergine, is a popular year-round vegetable crop grown in the subtropics and tropics. The crop is mainly cultivated on small family farms and is an important source of nutrition and cash income for many resource-constrained farmers. It supplies 25 calories per serving and has virtually no fat. Its "meaty" texture makes brinjal a staple in vegetarian diets.

In India, brinjal is cultivated on 512,800 hectares and 8,450,200 metric tons were produced in 2007 (FAOSTAT, 2007). The main growing areas are in the states of Andhra Pradesh, Bihar, Karnataka, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh, and West Bengal.

In Bangladesh, brinjal crops cover 57,745 hectares with a production of 339,795 metric tons (Bureau of Bangladesh Statistics, 2007). Brinjal constitutes about 25.4% of the total vegetable area of the country. The main growing districts are: Bogra, Chittagong, Comilla, Dhaka, Dinajpur, Faridpur, Jamalpur, Jessore, Khagrachari, Khulna, Mymensingh, Rangamati, Rangpur, Rajshahi, Sylhet, and Tangail (Bureau of Bangladesh Statistics, 2007).

In the Philippines, it is estimated that over 21,000 hectares are devoted to brinjal production and that their annual production of more than 198,000 metric tons is valued at US $ 32 million (FAOSTAT, 2007). Brinjal accounts for 28% of the country's total volume of vegetable production. The major growing areas are at the low elevation areas of Cagayan Valley, the Ilocos Region, Central Luzon, Southern Tagalog, Central Visayas, and Western Visayas.

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What is FSBR-brinjal or Bt. Brinjal?

FSBR-brinjal refers to fruit and shoot borer resistant brinjal. It is also called Bt. brinjal which was evolved through genetic engineering (see Box 1). Contrary to popular misconception, the “Bt” in Bt. brinjal does not stand for “Biotechnology”. It is actually short for Bacillus thuringiensis, a soil bacterium that harbours a gene called cry1-Ac. The cry1-Ac gene produces an insecticidal protein that is effective in controlling the larvae of certain moths that bore into and feed on the shoots, leaves and fruit of plants like brinjal. This protein is toxic to a narrow range of insects, but is not harmful to animals or humans.

In the last few years, several crops have been genetically engineered to produce their own Bt. protein, making them resistant to specific groups of insects. Bt. brinjal is genetically engineered to contain its own FSB resistance mechanism - the Bt gene, cry1-Ac.

What is genetic engineering?

Genetic engineering involves the introduction of a specific gene into the genome of a plant to obtain a desired trait. The gene introduced may come from another plant species or from any other organisms. While traditional plant breeding involves crossing related plants, genetic engineering uses modern biotechnology tools that allow breeders to be more precise and enables the introduction of useful traits that are otherwise difficult to achieve by conventional means.

The goals of genetic engineering are the same as with traditional breeding. Scientists may aim to improve crop performance in the field by conferring pest and disease resistance, herbicide resistance, or tolerance to environmental stresses (such as salinity and drought or flooding). They may also aim to develop products with enhanced value, such as improved post-harvest life, nutritional value, or other health benefits.

What is fruit and shoot borer (FSB)?

The brinjal FSB is the most destructive insect pest for brinjal in South and South East Asia. The FSB is a small larva that bores inside shoots, resulting in the withering of the shoots. It also bores into and feeds on young and maturing fruit, making the fruit inedible and unfit for the market. Damage from the FSB starts at the nursery stage and continues until harvest.

Why Bt. Brinjal?

Bt. Brinjal provides an effective environmentally friendly and economically sustainable solution to crop losses resulting from fruit and shoot borer infestation. The cry1-Ac protein produced in Bt brinjal is similar in structure and activity to that found in nature and is already available and used commercially in the form of Bt-based biopesticides. However, pesticidal sprays are only effective during a brief window then the larvae hatches from the egg and bores into the fruit or shoot of the brinjal plant. Once the larvae takes refuge within the fruit they are safe from surface sprays however intensive they may be, and are free to destroy the crop from within. Bt. brinjal, in which the cry1-Ac gene is genetically engineered into the Brinjal, ensures a built in resistance against the fruit and shoot borer larvae (see Box 2 to learn why brinjal was chosen to be the first genetically engineered food crop in India).

Why brinjal at all as the first genetically engineered food crop?

Brinjal is a vegetable that is very popular in Asian countries such as India, Bangladesh, Philippines and China. It is grown year round mainly by small family farms in these countries and is an important source of nutrition and income for many resource poor farmers. Supplying about 25 calories per serving with virtually no fat, the vegetable is a staple in vegetarian diets throughout South Asia and is one of the cheapest vegetable to procure by resource poor communities.

However, a large percentage of the crop does not make it to the market because of Fruit and Shoot Borer (FSB) infestation that can render as much as 70% of the crop unusable. This results in an immense drain on the income of small and medium farmers not only from the loss in marketable yield, but also from the large amounts spent on pesticide sprays in an attempt to curb infestation. The unrestrained spraying of chemical pesticides adversely affects the health of farmers and farm workers. Also, pesticide residues from such concentrated use tend to remain for longer periods on the vegetable, ultimately affecting the consumers' health.

How does genetically engineering Fruit and Shoot Borer (FSB) resistance into brinjal help farmers and consumers?

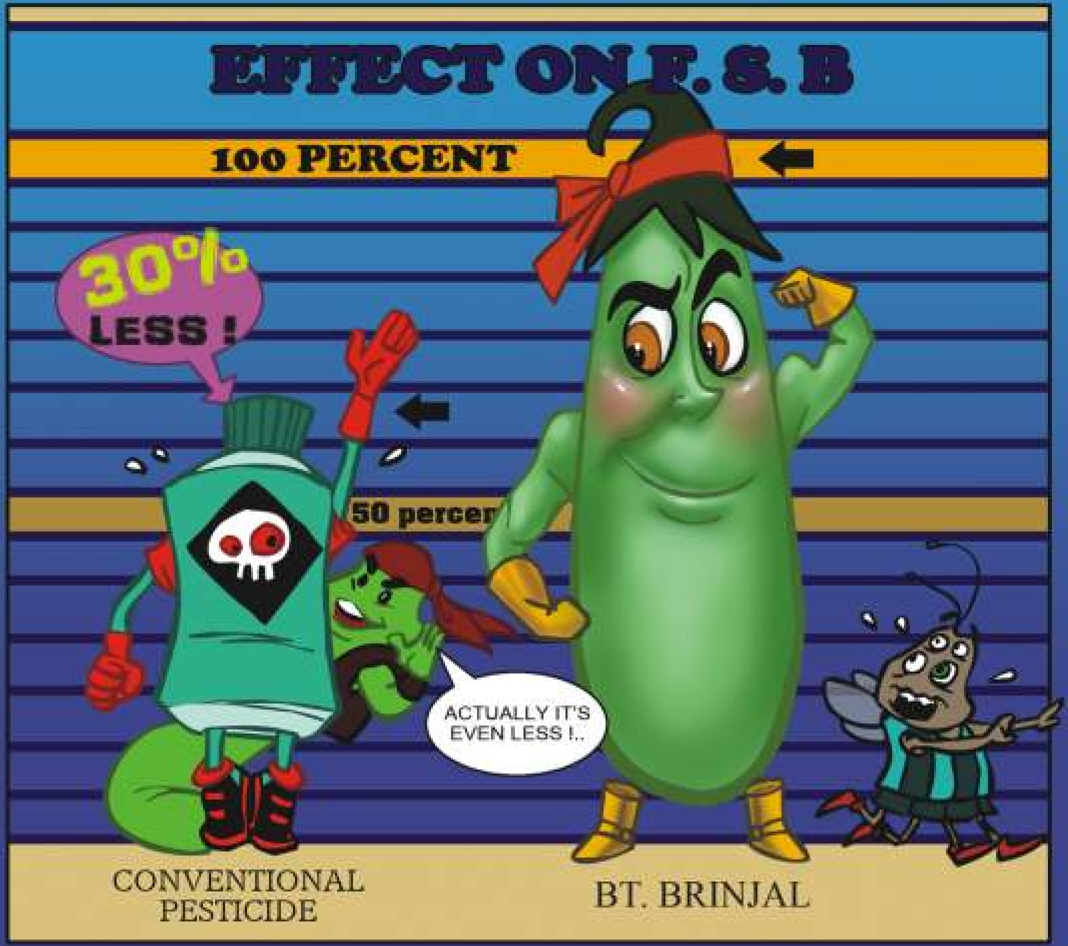
Currently, farmers use labour-intensive practices to control FSB such as the prompt manual removal of wilted shoots. The trapping of male moths using pheromones to prevent mating and the use of nylon netting is done to protect the plants. These efforts are usually insufficient, thereby forcing farmers to rely heavily on insecticide sprays to control FSB. However, FSB is only vulnerable to sprays for a few hours before it bores into the plant, forcing farmers to spray insecticides as often as every 2-3 days (AVRDC, 2001). Intensive use of insecticides poses a serious threat to human health and the environment. Heavy use of pesticide sprays also adds to the cost of production.

With Bt. brinjal, the farmers will gain increased productivity, profits and health benefits while the consumers will get access to pesticide-free safer fruits. The increased productivity will help to maintain low prices for the consumer while the farmers will gain from higher marketable yields.

How does Bt. technology differ from conventional insecticides in controlling pests?

Conventional insecticides are generally sprayed on the crops to destroy pests. The shortfalls in this system are many. Insecticidal sprays are effective only during a brief window which is between the hatching of larvae and its penetration into the fruit and shoot of the plant. Once the larva bores into the plant, it is impervious to insecticidal sprays. To avoid this possibility, farmers tend to resort to saturation spraying, a process that not only adversely affects the environment, but also their health and that of the end consumers. These sprays also destroy non target insects and organisms which are beneficial to plants.

In Bt. brinjal, the insecticidal protein is expressed by the plant itself and the borer is killed as it tries to bore into the plant. However, Bt. brinjal is harmless to the beneficial insects and non target organisms.



How effective is Bt. brinjal against FSB infestation?

Bacillus thuringiensis microbial formulations have been shown to be very specific to target insect pests. Tests have shown that Bt. brinjal's effectiveness is 100% insect mortality in shoots and fruits, compared to 30% or less with conventional pesticide treated varieties.

What are the advantages of selecting Bt. varieties of brinjal for sowing?

ABSPII has conducted a detailed socio-economic impact study to estimate the costs and benefits of introducing Bt. brinjal. Scientists and economists in the ABSPII consortium anticipate the following benefits to farmers:

- When used in conjunction with good farming practices, Bt-brinjal crops will produce more undamaged fruit than non-bioengineered brinjal crops. Higher yields will lead to increased income for farmers.
- As the FSBR-brinjal will require fewer insecticidal sprays, farmer and farm workers' exposure to insecticides will be minimized.
- The pricing of varieties distributed through the public system will be based on a cost-recovery model in order to bring high quality seeds to economically weaker farming communities in the region.
- Farmers will be able to continue the practice they currently follow for varieties and for hybrids.

Is Bt. brinjal safe to eat?

The experience of millions of consumers of Bt products for nearly ten years and the use of Bt as a biopesticide for more than 60 years indicates an excellent track record of safety to humans and the environment. Scientists have conducted rigorous tests as per the stringent requirements of regulatory bodies to ensure that Bt-brinjal is safe for human consumption.

Nutritional content: FSBR-brinjal is compositionally identical to normal brinjal except for the additional Bt protein. It therefore has the same nutritional value as non-FSBR-brinjal.

Toxicity: FSBR brinjal has been tested on a number of different animal groups to show that it is not toxic to any group. These include, but are not limited to, fish, chicken, rabbit, goat, rats and buffalo. These studies have confirmed the long history of food safety of the Cry1-Ac protein to animals and humans.

Allergenicity: The FSBR-brinjal has been tested to ascertain that it contains no new allergenic compounds and it is found to be non-allergenic.

Is there any difference between Bt. brinjal and normal brinjal in nutritional quality?

Bt. brinjal looks and has the same nutrient composition as the normal brinjal except for the additional Bt. protein that renders it resistant to the fruit and shoot borer. It retains the same nutritional value as non-Bt. brinjal and feeding tests with different animal groups that included fish, chicken, rabbit, goat, rats and buffalo revealed no toxicity or new allergenic compounds.

What other pest beside fruit and shoot borer is Bt. brinjal effective against?

Bt. brinjal is specifically targeted against the fruit and shoot borer and related pests in brinjal such as the fruit borer and stem borer. As such it is ineffective against other insects. This helps ensure that beneficial insects and organisms continue to thrive and are not affected as usually occurs in the case of pesticide sprays.

What is the effect of Bt. brinjal pollen on other plants?

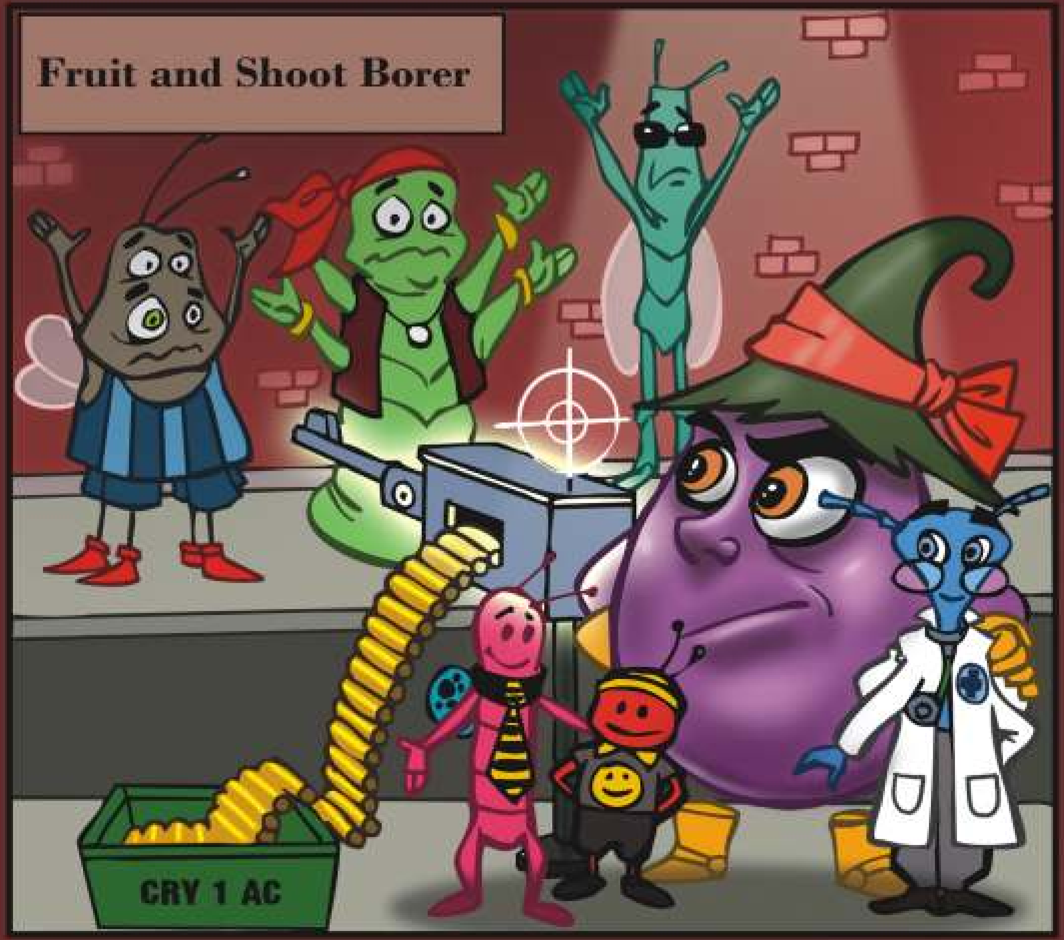
Field tests have shown that there are no adverse effects resulting from pollen transfer from Bt. Brinjal to other plants because of genetic incompatibility.

Are there potential impacts on biodiversity?

The centre of origin for brinjal is not clear. However, the maximum varietal distribution of brinjal may be observed in South and South East Asia. Researchers have studied brinjal crossing behaviour and Bt brinjal behaves in a similar fashion. It does not show any changes in its pollen dispersal or crossability than what has been reported in conventional brinjal. As the Cry1-Ac gene does not confer any change in plant habit or behaviour, it will have no impact on diversity.

How is Bt. brinjal beneficial to the environment?

Because Bt-brinjal will significantly reduce the need for insecticides, use of the new variety will lead to lower levels of insecticide residues in the soil and groundwater (Shelton et al 2002). This would offer significant environmental improvement.



Are there potential impacts on non-target insects or other animals?

Most insecticide sprays kill more than just the target pest and can even kill beneficial insects and animals. Evidence from Bt. crops grown in other countries has shown a greater biodiversity of insects when such spraying is reduced. Bt. brinjal targets the fruit and shoot borer, fruit borer and stem borer and other lepidopteron pests. It does not affect non-target or beneficial insects.

There are reports that indicate that Bt. cotton is responsible for increased suicides among farmers in India. What is the reality and what would happen when Bt. brinjal comes to market?

In the early 90s, when the first reports of the farmers' distress reached the public eye, many were quick to blame Bt. cotton. However, detailed research by various investigators has revealed a whole range of causes for the sad situation. As India was rapidly moving away from the rural economy into a primarily urban industrial society, the government and society had begun to shift development focus to urban industry. At the same time, a downturn in the urban economy was pushing a large number of distressed non-farmers to try their hand at cultivation. These stresses pushed many into a corner where suicide became an option for them. At least one study also indicated the dramatic misuse of spurious agricultural chemicals in farmer households in the absence of any guidance on how to correctly use the approved chemicals that lead to the death of farmers.

How affordable will the Bt. brinjal seeds be?

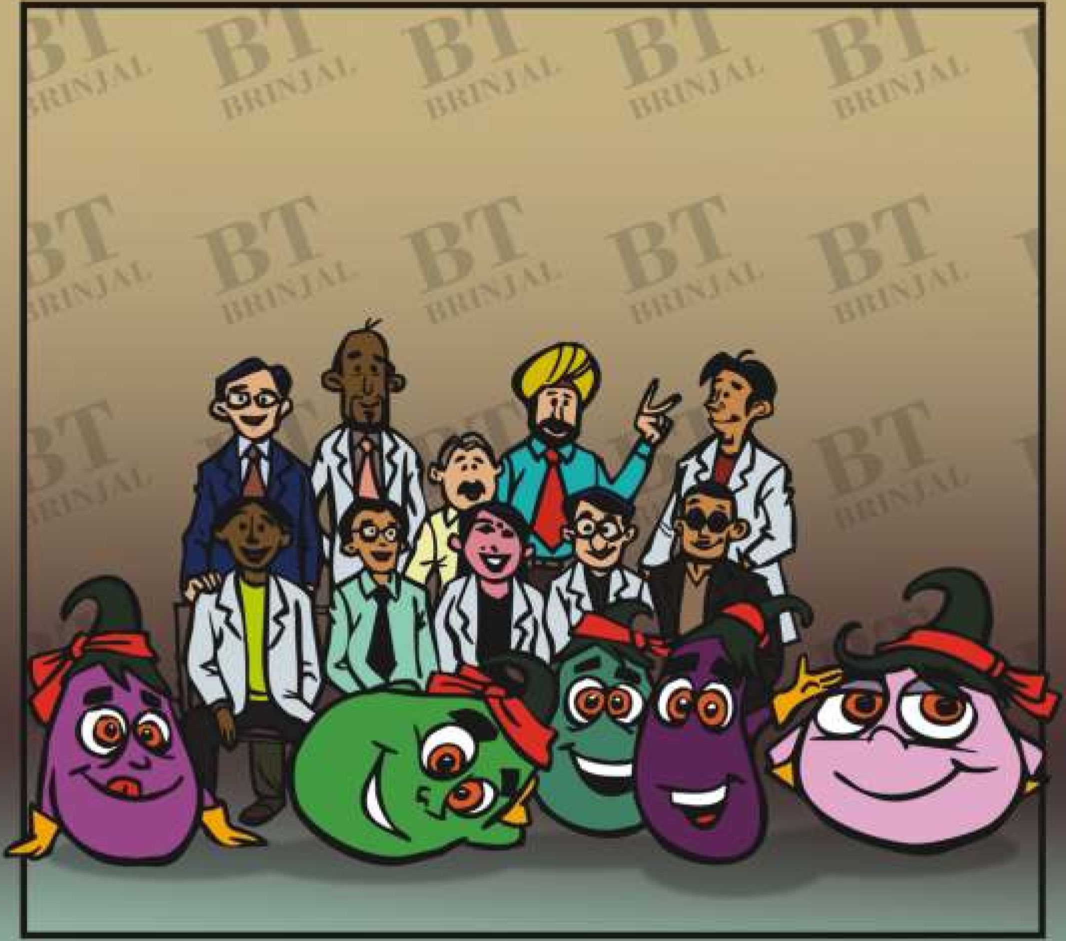
Bt. brinjal seeds will be very affordable and remain well within the reach of small and medium farmers as the seeds for open pollinated varieties will be made available to them through a public distribution system coordinated by state agricultural universities. These universities already have tried and tested extension services that have successfully helped resource constrained small and medium farmers over the years. The hybrid seeds will be made available by the private sector to those farmers growing or preferring to grow hybrid seeds in India, Bangladesh and the Philippines.

Isn't it true that Bt. brinjal seeds are sterile after one harvest forcing farmers to buy seed for every planting?

There is no truth in this statement. Bt. brinjal will be available as open pollinated varieties that will reach the farmers at low cost through a public distribution system by the various agricultural universities and research institutions involved in the project. These varieties will be qualitatively the same as existing varieties currently grown by the farmers apart from immunity to FSB. Farmers can save seeds from their harvest for planting future generations. For hybrids, in any case currently for non-Bt. brinjal, the farmers are sourcing fresh seeds from the private sector year after year.

Of late, agricultural universities and research institutions have advised farmers to use less pesticides and chemical sprays for crops and go "organic". How does Bt-brinjal fit in with this policy?

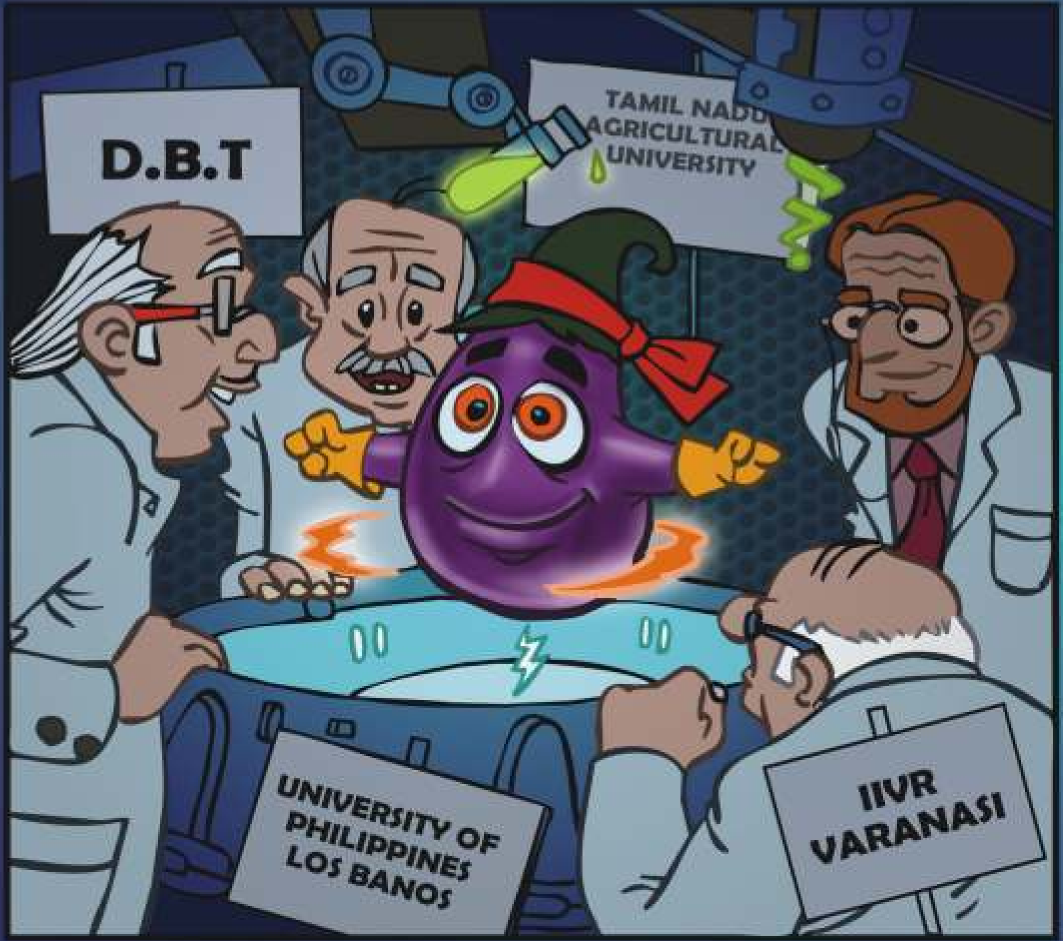
There is no effective counter to pests such as the fruit and shoot borer in organic cultivation of brinjal. Most available methods fall far short of effective goals at pest control and are labour and resource intensive rendering them impractical and prohibitive. Bt. Brinjal, on the other hand, uses a gene from a naturally occurring soil bacterium to produce a protein that effectively combats the fruit and shoot borer, significantly reducing pesticide usage for this pest. This is a major step towards the stated goal.



Who are the partners who have been involved in this project?

Bt Brinjal has been developed in a Public Private Partnership (PPP) mode under the aegis of ABSPII (Agriculture Biotechnology Support Project II; See Box 3.) wherein the Bt technology available with M/s Maharashtra Hybrid Seeds Company Ltd. (Mahyco) has been donated to Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu; University of Agricultural Sciences (UAS), Dharwad, Karnataka; and the Indian Institute of Vegetable Research (IIVR), Varanasi. As part of this global consortium, the technology has also been transferred to the University of Philippines Los Baños (UPLB) and Bangladesh Agricultural Research Institute (BARI), Bangladesh. Sathguru Management Consultants is the project manager for ABSPII and has been instrumental in facilitating technology transfer and coordinating intra-country partnerships.

In the Philippines, the International Service for the Acquisition of Agri-biotech Applications (ISAAA), along with the Program for Biosafety Systems (PBS) and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), collaborates with ABSPII on capacity building and IEC activities.



How has national research organizations helped in developing Bt. brinjal?

Keeping in view the enormous scientific, social and economic impact that Bt brinjal can bring to farmers when introduced in public cultivars (varieties), the Department of Biotechnology (DBT), Government of India has generously supported the Indian Institute of Vegetable Research, Varanasi; Tamil Nadu Agricultural University, Coimbatore; and University of Agriculture Sciences, Dharwad to develop regionally important varieties that are resistant to fruit and shoot borer and to deliver the approved products to farmers on a not-for-profit basis. The project is supported by the National Research System keeping in view the enormous socio economic impact anticipated from this developmental effort. Similarly, Government research agencies in Bangladesh (Bangladesh Agriculture Research Institute) and in Philippines (University of Philippines, Los Baños) have been encouraged and supported by their respective Government agencies to engage in development of Bt Brinjal for introduction in Bangladesh and Philippines.

What is ABSPII?

ABSPII (Agricultural Biotechnology Support Project II) is a USAID-funded consortium of public and private institutions led by Cornell University that supports scientists, regulators, extension workers, farmers and the general public in developing countries to make informed decisions about agricultural biotechnology. Where demand exists, ABSPII focuses on the safe and effective development and commercialization of bio-engineered crops as a complement to traditional agricultural approaches. The project's ultimate goal is to help boost food security, economic growth, nutrition and environmental quality in East and West Africa, Indonesia, India, Bangladesh and the Philippines.

What are the long term effects of Bt brinjal on soil?

The field trial findings demonstrate that Bt brinjal event EE-1, expressing Cry1Ac protein, does not have any significant effect on soil micro flora (both fungi and bacteria), and soil invertebrates such as earthworm, collembola and nematodes. This is in agreement with numerous published studies which have shown that B. thuringiensis and Bt proteins act specifically on the target insect pests and that they do not have any deleterious effect on non-target organisms. No Cry1Ac protein was detected in any of the soil samples from Bt brinjal field plots, which demonstrates that the protein is rapidly degraded. In fact cry1Ac gene has been derived from a common soil bacterium and therefore it is expected that soil micro organisms are already exposed to these proteins within the environment.

Does Bt gene render non target pests to aggravate in brinjal?

The Cry1 Ac protein is highly specific to lepidopteron pests and is not expected to adversely affect non-target organism (invertebrates and vertebrates including birds, mammals and human), because they do not have the receptor proteins found in the midgut of target insects. In addition to that the protocol adopted to conduct these trials had specific on assessment of the effect of Bt brinjal on non-target pests (sucking pest and secondary lepidopteron) and beneficial insects of brinjal. Non-target insect pests include leaf roller Epilachna beetle, grey weevil, root grub, and sucking pests, leafhoppers, thrips, whiteflies, mites. The vast data collected in all these years from field trials conducted at various locations showed that non-target sucking pest counts did not vary significantly among Bt and non-Bt brinjal plants.

Is Bt brinjal a threat to Ayurveda and Sidda medicinal systems?

Bt brinjal does not pose any threat to Ayurveda or Sidda medicinal systems. Though Ashwagandha, a key medicinal plant in the Ayurvedic and Sidda traditions, belongs to the Solanaceous family, it does not in any way mean that it is under threat by Bt. brinjal. Cultivated Bt. brinjal cannot cross with the species nor does it pose any threat to its existence in nature.

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