

Development of Transgenic Chickpeas Resistant to Important Pests - from the Laboratory to the Market

Background

- **Chickpea** (*Cicer arietinum*) is the most important pulse crop of India and is cultivated on 7.5 million ha essentially in rainfed and semi arid regions. Chickpea is the major resource of protein in vegetarian diet. The production and productivity of the crop is drastically affected by various pests.
- **Pod borer** (*Helicoverpa armigera*) and **cowpea aphid** (*Aphis craccivora*) are two pests, which cause major losses in chickpea. Pod borer was reported to cause up to 40% loss of yield resulting in India in an estimated annual loss of US\$ 200 million.



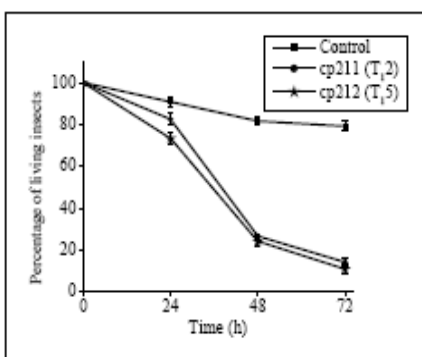
- No insect resistant varieties have so far been developed by conventional breeding techniques. Recent advances in gene technology have made it possible to incorporate genes into chickpea with potential to improve its resistance to insect pests.

Novel plants resistant to sucking pests using ASAL (garlic lectin) gene

Technology Developer: Prof. Sampa Das, BOSE Institute, Calcutta, (sampa@bic.boseinst.ernet.in)

The insecticidal activity of carbohydrate binding leaf lectins against different insects belonging to the orders Coleoptera, Diptera, Lepidoptera and Homoptera have been well studied. It has been found that *Allium sativum* (garlic) Leaf Lectin (ASAL), a mannose binding homodimeric protein, is antagonistic to various sucking pests in the homopteran group including cowpea aphid (*Aphis craccivora*).

Researchers at Bose Institute have expressed the ASAL gene from garlic that has resulted in enhanced tolerance to sucking pests. This has been successfully demonstrated in model plant, mustard, tobacco and also in rice. On the same lines, transgenic chickpea plants have been developed containing the ASAL gene which showed improved resistance to the sucking pests. Tolerance to white fly has also been considerably exhibited, an important trait in controlling plant disease spread. The technology has been perfected for expression of the ASAL in different regions of the plant using site specific promoters. The transformed plants are available with complete confirmed molecular characterisation studies. Initial data has been generated under lab conditions and the mean percentage of living aphids on the plants was reduced down to 10%. Field trials for agronomic performance are to be carried out.



Bioassay of aphid on ASAL transgenic plants. The graph shows the percentage survival aphids on untransformed control plants and two transgenic plants

Toxicity Analysis: Preliminary allergenicity analysis was conducted in mice and it is reported that ASAL is digested within 30-40 minutes of ingestion with no residual traces in the gut or excreta.

IP Status: Patent No. 228783 application 889/KOL/2005 Date of Grant : 10.02.09 and application no. 481/KOL/2008 is under consideration.

Technology Specific Information: The researchers have identified a successful event that will have significant commercial potential. The product is developed under the aegis of the Indo-Swiss Collaboration in Biotechnology and the technology transfer and licensing is governed by the policy of the ISCB.

Impact of Technology: The transgenic chickpea plants could have a great impact on improving yield and reducing insecticide usage. In addition to chickpea, the ASAL technology has broad spectrum applications in other crops affected by sucking pests (e.g. cotton). The technology can be employed to express ASAL in desired part of the plant and therefore a non-target expression of the gene in the whole plant is avoided.

Resistance to pod borer using Bt technology

Technology Developer: Prof. Bidyut K. Sarmah, Assam Agricultural University, Jorhat (bidyutsarmah@yahoo.co.in)

The expression of Cry proteins derived from the soil bacterium *Bacillus thuringiensis* (Bt) have proved to be an effective method in controlling pod borer (*Helicoverpa armigera*) infestation in crops such as cotton or maize. Researchers at Assam Agricultural University in collaboration with Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia have developed marker free transgenic chickpea plants expressing Bt genes (Cry2Aa) which provide resistance to pod borer infestation.

The transformed plants are available with complete confirmed molecular characterisation studies. Initial data have been generated under laboratory conditions for demonstrating the effectiveness of the Bt genes. Some plants showed a near complete protection (over 98% larvae mortality) against pod borer. The field trials for agronomic performance are to be carried out.



Leaves of Bt-chickpea resistant to pod borer (right) when compared to the control (left)

Technology Specific Information: The researchers have successfully carried out molecular characterisation studies and are about to identify a successful event that will have significant commercial potential. The product is developed under the aegis of the Indo-Swiss Collaboration in Biotechnology and the technology transfer and licensing is governed by the policy of the ISCB.

Impact of Technology: Transgenic chickpea plants complete conventional breeding technologies and has the potential to reduce the annual yield loss of millions of dollars. The technology contributes to sustainable agriculture by diminution the use of insecticide. In addition to chickpea, the Bt technology has broad spectrum applications in other crops affected by lepidopteran pests.

Cooperation with private industry

With the objective of bringing research achievements to the end-user, the most promising technologies developed in the frame of the ISCB program were showcased to the private sector. The technology showcasing workshop held in Hyderabad on October 6, 2008 was attended by 12 seed companies.

Mahyco (Maharashtra Hybrid Seeds Company Limited) submitted offers to license the technologies developed at the **Assam Agricultural University** (Cry2Aa technology) and **Bose Institute** (ASAL technology). On behalf of the two institutes, the ISCB established a detailed **licensing agreement** with Mahyco. The key element of the proposed agreement is a non-exclusive licensing of the two technologies.

Cooperation with public partners

In addition to the agreement with a private partner, a licensing agreement with a public partner, **University of Agricultural Sciences Dharwad**, was established. ISCB will support the University in the further development of the technology. Cooperation with and transfer of technology to public and private partners is enabled in parallel, which allows efficient product development towards the end-user.

Transgenic Bt-chickpea plant

