Agri Articles

(e-Magazine for Agricultural Articles)

Volume: 02, Issue: 06 (NOV-DEC, 2022)

Available online at http://www.agriarticles.com

©Agri Articles, ISSN: 2582-9882

Status of Transgenic Crops in India

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Thirty genetically modified (GM) crops are available world over. Of these, 4 are monocots and the rest are dicots. Four of these are monocots, while the remaining are dicots. 23 food crops have undergone genetic modification. In the first 20 years (1996 to 2015), up to 18 million farmers in 28 countries yearly planted GM crops. Genetically modified (GM) crops have grown 100 times from 1.7 million ha in 1996 to 185.1 million ha in 2017. They are now the fastest-growing agricultural technology. At the moment, GM crops are grown in 44 nations. Insect resistant transgenic crops are highlighted in this article, with a focus on the state of rice, chickpeas, brinjal, and fibre and oilseed crops in India (cotton).

Rice

Stem borers, rice gall midges, Delphacid plant hoppers, leaf folders, cutworms, and rice hispa are the main insect pests that inflict economic harm (Prakash et al., 2014). In India, genetic engineering for the development of transgenic rice, notably with characteristics for insect resistance, has been practised since the 1990s. Trials of transgenic rice with traits of herbicide tolerance, particularly to glufosinate and glyphosate, disease resistance (blast and viral diseases), insect resistance (BPH and YSB), nutrition, abiotic stress (submergence and salt and drought tolerance), and yield enhancement were expected to be conducted between 2003 and 2012 in all parts of the world Of these, there was an 80% chance that the traits of herbicide tolerance, bacterial leaf blight tolerance, yellow stem borer resistance, and golden rice would be made available soon. Golden Rice has been made available for commercial cultivation in Bangladesh.

The Supreme Court of India received a writ petition from anti-GMO activists requesting a prohibition on the release of any genetically modified organisms (GMOs) into the environment until thorough, open, and stringent biosafety test standards are in place (Shashi Kumar et al.,2014) There have been few recent studies revealing advancements in Indian research on insect-transgenic rice. There is published research on transgenic rice that is insect resistant from various nations, namely China and the USA.

Chickpea

The chickpea (Cicer arietinum L.), a significant grain legume, comes in third in terms of production of food legumes worldwide. India is currently the world's largest user and importer of chickpeas, producing between 70 and 75 percent of all the beans grown worldwide. The primary field pest is the pod borer H. armigera, and farmer fields in India have recorded output losses of up to 40%. (Reed et al., 1987; Srivastava and Srivastava, 1990).

The cry1Ac gene was used in the first report of effective genetic modification of the chickpea nuclear genome (Kar et al., 1997). The principal lepidopteran pod borers are effectively resistant to transgenic plants that express the shortened native Bt cry1Ac gene in chickpea (Sanyal et al., 2004). Insect mortality was substantial (>80%) and protection was offered by chickpea plants expressing Cry1Ac protein above 10 ng mg1 soluble protein concentration, whereas plants expressing between 5 and 10 ng mg1 resulted in early pupation, significant weight loss (45–55%), and moderate mortality of insects.

By combining a synthetic Bt cry1Ab and a soybean trypsin inhibitor gene through A. tumefaciens-mediated genetic transformation, chickpea transgenic lines were created at ICRISAT. It was claimed that the transformation process produced a large number of indigenous chickpea varieties. With the help of the Indo Swiss and Indo Australian partnership, several transgenic chickpea lines were created at the AAU in Jorhat utilising shortened versions of the Bt cry2Aa or Bt-cry1Ac genes (AAU DBT Annual Report 2013-14). For introgression breeding, five different organisations (Sungroo seeds, New Delhi; ICRISAT, Hyderabad; IIPR, Kanpur; PAU, Ludhiana; and UAS, Dharwad) received three Cry2Aa transgenic lines and two Cry1Ac lines. In two areas of AP, India, biosafety tests were carried out using backcross variants of the Cry2Aa event (Sungroo Seeds New Delhi). In India, insect-resistant transgenic chickpea could be one of the first few crops to be commercialised if GM food crops are allowed for commercial cultivation.

Eggplant

There are several insects that harm brinjal, including thrips, jassids, aphids, and fruit and shoot borers (FSB). In India, the FSB Leucinodes orbonalis Guenee reduces yields by between 54 and 70%. (and Gaur, 2009). Insecticides are employed to control it because FSB resistant varieties are not available. After hatching, the FSB larvae are only briefly susceptible to insecticide sprays before they enter and bore into the fruit. Farmers spray the crop every other day as a result, leaving dangerous pesticide residues behind. India was the first country in the world to genetically modify brinjal. Furthermore, it was the first GM crop that was planned for release in India. In 2000, MAHYCO created Bt-brinjal expressing Cry1Ac for FSB-resistance. Transgenic plants were reportedly blamed for According to reports, the transgenic plants caused 100% mortality in the fruits and 98% larval mortality in the shoots (ISAAA, 2008).

The creation of genetically altered brinjal varieties also involved the Tamil Nadu Agricultural University in Coimbatore, the University of Agricultural Sciences in Dharwad (Karnataka), the Indian Institute of Vegetable Research, and the Indian Agricultural Research Institute. The progress of these trials was made between 2000 and 2010 under the country's created regulatory framework, which included seven tiers of regulatory bodies. Despite these regulatory procedures, a ban was imposed that stopped the first GM food crop in the nation from being officially released. Since then, Bangladesh and the Philippines have received the technology from MAHYCO (Meharunnahar and Paul, 2009). (ISAAA, 2009). Additionally, two expert committees were established to investigate how successive examples of two crops—Bt cotton and Bt brinjal—carrying the same cry1Ac transgene and going through the same approval processes resulted in diverse results. Despite criticism, the regulatory system that cleared Bt-cotton also approved Bt-brinjal. However, only Bt-cotton was made available for commercial use. According to the Environment Minister, there will be no Bt-eggplant cultivation in India until a "political, scientific and societal agreement was formed." Despite the fact that Bt brinjal effectively reduced the target pest and was proved to be safe for the environment and human health, a moratorium was implemented.

Cotton

In cotton, outbreaks of H. armigera, the American bollworm, were noted in the years 1983, 1990, 1995, 1997, 1998, and 2001. In the nation, cotton accounted for more than 50% of insecticide use. Bt-cotton that expresses the Bacillus thuringiensis toxin Cry was authorised for commercial production in India in 2002. The commercialization of six insect resistance trait events has been approved.

Of them, Mon531 (Cry1Ac) as Bollgard was authorised for commercial sale in 2002 and was well-liked until Bollgard II (with Cry1Ac and Cry2Ab) was released in 2006 and was meant to take the place of Bollgard. Up to 2012, roughly 30 seed firms in India released more than 1200 Bt cotton hybrids with the two gene event. According to reports, the single gene version of Bt was not protected by intellectual property laws in India, so the American seed business attempted to replace event MON531 with hybrids containing the two genes MON15985. Infestations of location-specific pests such as the stem weevil, tea mosquito bug, gall fly and mirid bugs have reduced the yield of Bt cotton. In Maharashtra and Gujarat, chaffer beetles are considered an emerging pest that do not require insecticides. In North India, there have been repeated cases of the leaf curl virus disease, which is spread by whiteflies (Monga et al., 2011).

After 2005, new pests like the mealybug Phenacoccus solenopsis expanded widely in India. Reduced pesticide use was one of the causes that led to the rise of small pests as economically significant pests. Since 2008, despite the requirement to treat Bt-seed with neonicotinoids, leaf hoppers have become season-long pests. BGII quickly took the place of BG. Maharashtra had an exceptional pink bollworm outbreak during the 2017–2018 cotton growing seasons. While Gujarat was able to reduce losses brought on by this insect, Maharashtra had an exceptional pink bollworm outbreak during the 2017–2018 cotton growing seasons. Geographic populations of H. armigera were monitored for changes in baseline susceptibility to Cry1Ac and Cry2Ab. The results showed that tolerance to Cry1Ac has increased more than 100-fold in populations from Parbhani and Akola, whereas populations from North India, particularly those from Sriganganagar, are still susceptible.

India continued to be a significant global producer of cotton despite these setbacks. The application of the garlic lectin gene against cotton-eating pests just received approval from the GEAC. A compact sucking pest-tolerant genotype with elite fibre qualities, Cry 1Ac was introgressed into native genotypes, which are suitable for high density planting systems.

Insect resistant transgenics in India

Many crops, including rice, chickpeas, pigeon peas, maize, and soybeans, have been altered using Bt genes; however, none of these have received Indian government approval for commercial production. Currently, three main types of GM biotech crops with insect resistance could be created: Toxin expression, gene silencing, and gene editing are the first three. Insect-resistant biotech crops have been developed using a variety of sources, including lectins, protease inhibitors, amylase inhibitors, spider toxins, scorpion toxins, etc. However, only Bt-toxin based transgenic crops have been used on a large scale. International businesses have thus far explicitly limited themselves to Bt-toxins. Worrisome reports of insect resistance to Bt-toxins in different parts of the world indicate the need for alternative toxin sources. Due to insect resistance and rising insect toleration of the poisons, the current cry1+cry2+VIP-based biotech crops are vanishing. There are currently no fresh signs of any intriguing new developments.

For the management of insect pests in any crop, including cotton and maize, there are genes or prospective transgenic events in the horizon. It requires at least 6-7 years of biosafety testing before a new event is authorised for commercial production. Furthermore, for cutting-edge technologies like RNA interference (RNAi) and CRISPR-Cas9-based gene editing, biosafety rules have not even been defined in India. There seems to be little hope for new biotech crops to be approved for commercial cultivation in Indian agriculture at least in the next 8-10 years. New technologies are necessary to achieve a break- through in yields and for effective plant protection against biotic and abiotic stress factors. Until then, Indian scientists must also work on developing strategies to harness the full potential of the existing biotech technologies such as Bt-cotton for the longest possible time.

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