SOUTH ASIA BIOSAFETY PROGRAM

April 2012
Vol.8 No.4
NEWSLETTER
for private circulation only - not for sale
www.cera-gmc.org

8th Anniversary Edition

SABP

The South Asia Biosafety Program (SABP) is an international developmental program initiated with support from the United States Agency for International Development (USAID). The program is implemented in India and Bangladesh and aims to work with national governmental agencies to facilitate the implementation of transparent, efficient and responsive regulatory frameworks for products of modern biotechnology that meet national goals as regards the safety of novel foods and feeds and environmental protection.

SABP is working with its in-country partners to:

- Identify and respond to technical training needs for food, feed and environmental safety assessment.
- Develop a sustainable network of trained, authoritative local experts to communicate both the benefits and the concerns associated with new agricultural biotechnologies to farmers and other stakeholder groups.
- Raise the profile of biotechnology and biosafety on the policy agenda within India and Bangladesh and address policy issues within the overall context of economic development, international trade, environmental safety and sustainability.

GM HORTICULTURAL CROPS: HARBINGER OF NEXT GREEN REVOLUTION

C. Aswath* and Vageesh, Division of Biotechnology, Indian Institute of Horticultural Research, Hesaraghatta Lake Post, Bangalore – 560 089, *Corresponding author: aswath@iihr.ernet.in

Horticulture is the sunrise sector in India and other developing world economies. It is the major foreign exchange earner and provider of food, nutritional and income security. There has been a perceptible shift in people's food habits in the last two decades, which is reflected in the switch from cereal-based to horticultural crops. During this period, economic growth in horticulture has far exceeded that in most agricultural commodities. Annual growth rates for vegetable supplies have surpassed cereals by 200% to 800% since the 1970s, accelerating in the 1990s. This trend is attributed largely to changing consumer preferences, powered by increased income and general standard of living-led awareness towards diverse and balanced nutrition. Growth potential for the production of horticultural commodities is strong in developing countries and emerging economies. In the last decade global agricultural production has stagnated at 1.5% amidst a declining agricultural share, horticulture has emerged as the key sector contributing to more than 25 to 30% of the gross value of agricultural inputs. However, productivity and marketable qualities of many horticultural crops suffer from biotic and abiotic stresses and post harvest losses. So far management of crop quality and productivity through conventional methods has not been very satisfactory. Biotechnology has therefore emerged as an important game changer with clear potential to sustainably address the problems of productivity and quality.

Insect resistant transgenic research at IIHR. Non-transgenic control tomato fruit destroyed by tomato fruit borer, *Helicoverpa armigera* (left) and borer-resistant Cry2A-Bt tomato fruit (right).

Indian Research Status on GM Horticultural Crops

Horticultural research in India is being carried out at 10 Indian Council of Agricultural Research (ICAR) institutes along with their associated 24 research stations, 6 directorates and 7 national research centres. Area-specific multidisciplinary research is also being conducted under different plans like All India Coordinated Research Projects, Network Projects and National Agricultural Innovation Project, apart from *ad hoc* projects on individual crops and problems. Genomic and transgenic platforms in major horticultural areas are underway. An ICAR Network Project on transgenic crops, continuing from 1995, aims to address major concerns of horticultural crops through the development of GM crops in banana, tomato, eggplant, papaya, potato, cassava and cole crops. An array of genes and specific promoters in various gene constructs is being used to develop the transgenics. Generous institutional support for GM research in horticultural crops is being provided and with it, many promising GM horticultural crops are under advanced testing for commercial release. Exciting times are ahead in the field of newer GM vistas with the utilization of nanobiotechnology, genomics and allele mining, high throughput assays, public-private partnerships, customized gene discovery and a streamlined biosafety and commercialization system.

Current GM-based Challenges in Horticultural Crops

However rosy the picture of GM biotechnology in horticulture is, there are many threats present that must be made a priority globally and in India with appropriate GM technology. Some of the issues include:

1. *Ralstonia solanacearum* resistant vegetables especially tomato
2. Peanut bud necrosis virus resistance in tomato
3. Watermelon bud necrosis resistance
4. Papaya ringspot virus resistance
5. Banana fungal and viral resistance
6. Abiotic stress tolerance and climate resilience across horticultural crops

The time has arrived for the GM crop development scientific community to engage policy makers, farming communities,

(continued on page 2 - see Horticulture)

Table 1: Status of biotechnological interventions of mitigating stresses and quality improvement in horticultural crops in India

No.	Crop	Stress/ Quality	Gene(s) Utilized	Status
1	Tomato	TLCV	Pathogen derived genes, RNAi, Ty1-5 markers	Advanced
		TOSPO	Pathogen derived	Event selection trial
		Fruit borer, *Helicoverpa armigera*	Bt, RNAi	Advanced, lab testing
		Nematode	*Mi* gene	Conceptual
		Drought/heat	*Dreb1A* and *Sbdreb2* transcription factors	Field testing
		Salt stress	Ion transporter genes	Lab testing
		Nutritional enhancement Anthocyanin content	*Delila* and *Rosea*	Green house
		Shelf life	Ethylene modulation genes	Field testing
		Early and late blight	Chitinase, PGIP and NPR1	Green house
		Molecular farming	Biosynthetic genes	Lab testing
2	Eggplant	Shoot and fruit borer, *Leucinodes orbonalis*	Bt	Advanced
3	Chillies pepper	*Alternaria*	Antifungal	Lab testing
4	Watermelon	Watermelon bud necrosis virus	Pathogen-derived	Advanced
5	Potato	Late blight & early blight	Antimicrobial	Advanced
		Nematode	-	Lab testing
		Protein quality	*Ama1* gene	Advanced
6	Onion	Purple blotch	Antifungal	Lab testing
7	Cabbage, cauliflower	Diamond back moth, *Plutella xylostella*	Bt	Advanced
8	Banana	Panama wilt	Antifungal	Advanced
		BBTV, Bract mosaic	Pathogen derived, RNAi approach	Field testing
		Nematode	-	Lab testing
9	Papaya	Ringspot	Coat protein, N	Field testing
10	Citrus	Tristeza and greening	-	Lab testing
11	Pomegranate	Bacterial nodal blight caused by *Xanthomonas axonopodis pv. punicii*	Xa21, AMP, Defensin and Pflp	Conceptual
12	Grapes	Downey mildew	Antifungal	Conceptual

academics, NGOs and all concerned in a participatory way with agricultural biotechnologies to be sensitized about the truly immense benefits of GM crops accrued by present day agriculture and horticulture. Common misconceptions need to be dispelled and certain real issues thoroughly addressed by researchers so there is no room for any doubt about the biosafety of transgenic crops on any front. Realization of solutions to the maladies of society using transgenic horticultural crops is possible with transgenic horticultural crops being the Holy Grail and becoming the beacon and harbinger of the much needed next green revolution. The status of research on transgenic vegetables and fruits for various traits that have been carried out in various laboratories of ICAR, is listed in Table 1.

WORKSHOP ON THE APPLICATION OF MODERN BIOTECHNOLOGY IN MUSLIM COUNTRIES - SPECIFIC ISSUES AND CHALLENGES

An international workshop organized by the Organisation of Islamic Cooperation (OIS) Standing Committee on Scientific and Technological Cooperation (COMSTECH) and Pakistan Biotechnology Information Center was held at the COMSTECH building in Islamabad, Pakistan February 27 to 29, 2012. Participants from organizations in Pakistan, Oman and Egypt and resource persons from Pakistan, Bangladesh, Egypt, Malaysia, Iran and the Philippines attended the workshop, which included seven scientific sessions, a final discussion, recommendations and a press briefing.

The South Asia Biosafety Program (SABP) was represented at the workshop by Prof. M. Imdadul Hoque, SABP Bangladesh Country Coordinator, who made a presentation on the status of agricultural biotechnology and SABP's contribution in the development of biosafety regulatory regimes in Bangladesh.

The conference adopted the following set of findings and recommendations based on the conference deliberations.

Facts and Findings

1. The population of the OIC nations has exceeded 1.8 billion with an annual increase of 1.8%.
2. Most of the Muslim countries are the net importers of food commodities.
3. Most of the world's malnourished and hunger-afflicted populations live in countries of the south, including OIC regions.
4. Most of the Muslim nations face constraints in expanding agriculture productivity due to urbanization, drought, salinity, desertification and other socio-economic issues.
5. Fortunately many of the Muslim countries have decent and existing science and technology infrastructure and life science manpower, particularly in agricultural sciences.
6. Political leadership in many OIC nations realizes the importance of the application of modern biotechnology to meet the enduring threat and burden of hunger, poverty, and disease.
7. Many OIC nations have been slow to create enabling environments for the rapid application of biotechnological innovation for the well being of their peoples. Many factors including lack of biosafety frameworks to implement strategies, insufficient understanding by policy makers about the tremendous benefits of biotechnology to a nation, and lack of end-user support mechanisms to ensure delivery of biotechnology related inputs (seeds, technology, know-how, etc.).

(continued on page 4 - see Challenges)

The Reading List

. . . new and notable articles

A CRITICAL REVIEW ON THE IMPROVEMENT OF PHOTOSYNTHETIC CARBON ASSIMILATION IN C_3 PLANTS USING GENETIC ENGINEERING

Ruan CJ, Shao HB, Teixeira da Silva JA.

Global warming is one of the most serious challenges facing us today. It may be linked to the increase in atmospheric CO_2 and other greenhouse gases (GHGs), leading to a rise in sea level, notable shifts in ecosystems, and in the frequency and intensity of wild fires. There is a strong interest in stabilizing the atmospheric concentration of CO_2 and other GHGs by decreasing carbon emission and/or increasing carbon sequestration. Biotic sequestration is an important and effective strategy to mitigate the effects of rising atmospheric CO_2 concentrations by increasing carbon sequestration and storage capacity of ecosystems using plant photosynthesis and by decreasing carbon emission using biofuel rather than fossil fuel. Improvement of photosynthetic carbon assimilation, using transgenic engineering, potentially provides a set of available and effective tools for enhancing plant carbon sequestration. In this review, firstly different biological methods of CO_2 assimilation in C_3, C_4 and CAM plants are introduced and three types of C_4 pathways which have high photosynthetic performance and have evolved as CO_2 pumps are briefly summarized. Then (i) the improvement of photosynthetic carbon assimilation of C_3 plants by transgenic engineering using non-C_4 genes, and (ii) the overexpression of individual or multiple C_4 cycle photosynthetic genes (*PEPC, PPDK, PCK, NADP-ME* and *NADP-MDH*) in transgenic C_3 plants (*e.g.*, tobacco, potato, rice and *Arabidopsis*) are highlighted. Some transgenic C_3 plants (*e.g.*, tobacco, rice and *Arabidopsis*) overexpressing the *FBP/SBPase*, *ictB* and cytochrome c_6 genes showed positive effects on photosynthetic efficiency and growth characteristics. However, over the last 28 years, efforts to overexpress individual, double or multiple C_4 enzymes in C_3 plants like tobacco, potato, rice, and *Arabidopsis* have produced mixed results that do not confirm or eliminate the possibility of improving photosynthesis of C_3 plants by this approach. Finally, a prospect is provided on the challenges of enhancing carbon assimilation of C_3 plants using transgenic engineering in the face of global warming, and the trends of the most promising approaches to improving the photosynthetic performance of C_3 plants.

CRITICAL REVIEWS IN BIOTECHNOLOGY *(2012) 32(1):1-21*

GENERATION OF TRANSGENIC PLANTAIN (*MUSA* SPP.) WITH RESISTANCE TO PLANT PATHOGENIC NEMATODES

Roderick H, Tripathi L, Babirye A, Wang D, Tripathi J, Urwin PE, Atkinson HJ.

Plant parasitic nematodes impose a severe constraint on plantain and banana productivity; however, the sterile nature of many cultivars precludes conventional breeding for resistance. Transgenic plantain cv. *Gonja manjaya* (*Musa* AAB) plants, expressing a maize cystatin that inhibits nematode digestive cysteine proteinases and a synthetic peptide that disrupts nematode chemoreception, were assessed for their ability to resist nematode infection. Lines were generated that expressed each gene singly or both together in a stacked defence. Nematode challenge with a single species or a mixed population identified 10 lines with significant resistance. The best level of resistance achieved against the major pest species *Radopholus similis* was 84% ± 8% for the cystatin, 66% ± 14% for the peptide and 70% ± 6% for the dual defence. In the mixed population, trial resistance was also demonstrated to H*elicotylenchus multicinctus*. A fluorescently labelled form of the chemodisruptive peptide underwent retrograde transport along certain sensory dendrites of *R. similis* as required to disrupt chemoreception. The peptide was degraded after 30 min in simulated intestinal fluid or boiling water and after 1h in nonsterile soil. *In silico* sequence analysis suggests that the peptide is not a mammalian antigen. This work establishes the mode of action of a novel nematode defence, develops the evidence for its safe and effective deployment against multiple nematode species and identifies transgenic plantain lines with a high level of resistance for a proposed field trial.

MOLECULAR PLANT PATHOLOGY *(2012)* MAR *21* [EPUB AHEAD OF PRINT]

COMPARABILITY OF IMAZAPYR-RESISTANT *ARABIDOPSIS* CREATED BY TRANSGENESIS AND MUTAGENESIS

Schnell J, Labbé H, Kovinich N, Manabe Y, Miki B.

The Arabidopsis *CSR1* gene codes for the enzyme acetohydroxyacid synthase (AHAS, EC 2.2.1.6), also known as acetolactate synthase, which catalyzes the first step in branched-chain amino acid biosynthesis. It is inhibited by several classes of herbicides, including the imidazolinone herbicides, such as imazapyr; however, a substitution mutation in *csr1-2* (Ser-653-Asn) confers selective resistance to the imidazolinones. The transcriptome of *csr1-2* seedlings grown in the presence of imazapyr has been shown in a previous study (Manabe in Plant Cell Physiol 48:1340-1358, 2007) to be identical to that of wild-type seedlings indicating that AHAS is the sole target of imazapyr and that the mutation is not associated with pleiotropic effects detectable by transcriptome analysis. In this study, a lethal null mutant, *csr1-7*, created by a T-DNA insertion into the *CSR1* gene was complemented with a randomly-inserted 35S/CSR1-2/NOS transgene in a subsequent genetic transformation event. A comparison of the *csr1-2* substitution mutant with the transgenic lines revealed that all were resistant to imazapyr; however, the transgenic lines yielded significantly higher levels of resistance and greater biomass accumulation in the presence of imazapyr. Microarray analysis revealed few differences in their transcriptomes. The most notable was a sevenfold to tenfold elevation in the *CSR1-2* transcript level. The data indicate that transgenesis did not create significant unintended pleiotropic effects on gene expression and that the mutant and transgenic lines were highly similar, except for the level of herbicide resistance.

TRANSGENIC RESEARCH *(2012)* MAR *21.* [EPUB AHEAD OF PRINT]

CHALLENGES - *continued from page 2*

8. Only three OIC nations (Pakistan, Egypt and Bukina Faso), out of 57 OIC countries have commercialized the biotechnology.

In light of the above facts, the participants of the workshop recommend the following:

General Recommendations

1. OIC nations move forward to create required regulatory frameworks, implementation mechanisms, human capital and enabling infrastructures for the application of biotechnology in their respective countries.
2. In this process, COMSTECH and other multilateral OIC organizations, within and outside the OIC system, should help with capacity building efforts.
3. Countries where biotechnology has already brought forward tremendous benefits in a short span of time should help the other OIC nations in their efforts to proceed by sharing their national experiences.
4. Political leadership and policy makers must realize that without safe and effective, as well as rapid applications of biotechnology, they will not be able to meet the challenges of the future.

Specific Recommendations

1. Islamic Educational, Scientific and Cultural Organization (ISESCO) help the OIC member states to compile country-specific biosafety rules through the provision of consultancy and training.
2. COMSTECH, through biotechnology information centres (BICs) in OIC member countries arrange the visits of policy makers of the member states to countries where commercialization of biotechnology has already been practiced.
3. COMSTECH should sponsor a foresight exercise of the benefits that commercialization of agricultural biotechnology can bring to various OIC countries.
4. COMSTECH is expected to strengthen the existing BIC network in OIC region so they can play their role in disseminating objective information about biotechnology and capacity building.

More information about the workshop can be found on the COMSTECH website.

CALENDAR OF EVENTS

Event	Organized by	Date and Venue	Website
INDIA			
National Seminar on Biotechnological Approaches in Pest Management	Department of Entomology and School of Agricultural Biotechnology, Punjab Agricultural University, Ludhiana	May 4 - 5, 2012 Ludhiana	http://web.pau.edu/content/banner/292.pdf
Transgenics: Creation, Detection, Breeding and Regulation	Barwale Foundation	May 8 - 10, 2012 Hyderabad	http://www.barwalefoundation.org/html/announcement-1.htm
6th International Congress on Legume Genetics and Genomics	International Crops Research Institute for the Semi-Arid Tropics	October 2 - 7, 2012, Hyderabad	http://www.icrisat.org/gt-bt/VI-ICLGG/homepage.htm
Silver Jubilee International Symposium on "Global Cotton Production Technologies vis-à-vis Climate Change	Cotton Research and Development Association and CCS Haryana Agricultural University, Hisar	October 10 - 12, 2012 Hisar	http://www.crdaindia.com/
International Symposium on New Paradigms in Sugarcane Research	Society for Sugarcane Research and Development and Sugarcane Breeding Institute	October 15 - 18, 2012 Coimbatore	http://www.sugarcane.res.in/images/sbi/Centenary/1st_circular_int_symposium.pdf
INTERNATIONAL			
Workshop on Biosafety of Genetically Engineered Crops: Best Practices from Laboratory to Farmer's Fields	ICGEB in collaboration with GENETECH, Colombo, Sri Lanka, University of Colombo, Sri Lanka, Michigan State University, USA, The National Science Foundation, Colombo, Sri Lanka and Embassy of USA, Colombo, Sri Lanka	May 21 - 25, 2012 Colombo, Sri Lanka	http://www.icgeb.org/meetings-2012.html
12th International Symposium on Biosafety of Genetically Modified Organisms (ISBGMO12)	International Society for Biosafety Research	September 17 – 20, 2012 St Louis, Missouri, USA	http://www.isbgmo.com/

SABP CONTACTS

India
Dr. Vibha Ahuja
General Manager
Biotech Consortium India Limited
Anuvrat Bhawan, 5th Floor
210, Deendayal Upadhyaya Marg
New Delhi 110 002 India
Email: vibhaahuja@biotech.co.in

Bangladesh
Prof. Dr. M. Imdadul Hoque
Department of Botany
University of Dhaka
Dhaka - 1000
Bangladesh
Email: mimdadul07@yahoo.com

Others
Center for Environmental Risk Assessment (CERA)
ILSI Research Foundation
1156 Fifteenth Street, N.W., 2nd Floor
Washington D.C. 20005-1743 USA
Email: info@cera-gmc.org

Center for Environmental Risk Assessment

IFPRI

USAID FROM THE AMERICAN PEOPLE

To receive an electronic copy of this newsletter send your name, institutional information and e-mail address to: info@cera-gmc.org