Transgenic Plants at Ås

During the last few months, national newspapers have written articles (1, 2) about Jihong Liu Clarke's applied research at Bioforsk-Ås on transgenic poinsettia and tobacco plants with agricultural potential. Is Norway in the process of developing gene-modified plants for the market?

Nearly thirty years ago, researchers working at Monsanto Corporation laboratories in St. Louis, USA published an article in Science (3), demonstrating the use of plasmids in Agrobacterium to generate genetically-modified (GM) plants. This landmark achievement set the stage for an intensive research effort, leading to the successful introduction of GM plants to the world market on a large scale during the mid-1990s. Interestingly, only two types of genes have dominated the international plant GM market; namely, genes from Bacillus thuringiensis (BT) for insect resistance and a bacterial gene for glyphosate (Roundup) resistance. In Norway and in Europe, generally, there has been a skeptical public attitude vis-à-vis GM plants.

As though things are starting to change, Jihong Liu Clarke at Bioforsk-Ås is now coordinating research together with collaborators in Denmark and Germany to use transgenic technology for producing GM plants with agricultural potential. Liu Clarke is originally from China where she received both her B.S. and M.S. degrees. She came to

Ås in 1997 and has had a position as researcher at Bioforsk since 2003. One of team's early achievements was to develop a protocol, using Agrobacterium to transform poinsettia. This method is protected by a European Patent.

In a collaboration with Henrik Lutken at the University of Copenhagen, Liu Clarke have produced transgenic poinsettia with shortened internodes. Lutken had earlier developed an Agrobacterium plasmid containing genes for both kanamycin resistance and the SHORT INTERNODE (AtSHI) gene from Arabidopsis (Fig. 1). The practical goal of this research is to develop an alternative to existing methods that involve spraying plants with expensive anti-hormone chemicals. There is a good possibility that use of these chemicals will be banned by the EU within the next few years. Fig. 2 shows a comparison of transgenic versus control poinsettia plants. Introduction of the AtSHI gene led to shorter, more compact plants but it did not result in negative effects such as inhibition or delay of flowering.

Another avenue of research at Bioforsk-Ås involves plant-produced vaccines. Longtime attendees of NBS Contact meetings might remember Charles Arntzen's talk in 2000, describing his pioneering work on producing vaccine for an E. coli-caused diarrhea in transgenic potatoes (6). Since that time, Arntzen has developed transgenic maize for the same purpose. He has also developed transgenic technologies directed against hepatitis B. On a worldwide basis, these projects represent 2 of at least 23 projects, using transgenic plants to produce medically useful proteins as vaccine or antibodies (7). These projects are at various stages of completion in relation to approval and marketing. In the USA, Pfizer and Israel-based Protalix have obtained approval for a plant-derived (transgenic carrot cells) glucocerebrosidase known as Elelyso and used for treatment of Gaucher's disease. In general, experts point to several advantages of these kinds of plant transgenic technologies; low costs in developing transgenic plants, ease of scaling-up

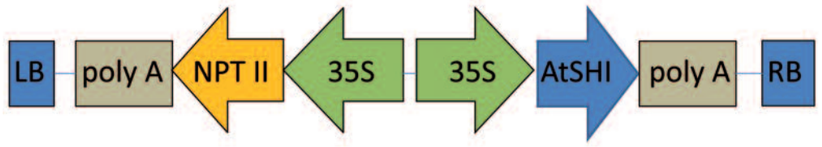

Fig. 1. Diagram of the construct used in an Agrobacterium plasmid to transfer genes for kanamycin resistance and SHORT INTERNODES into poinsettia. Components of this construct from left to right are as follows: LB, a sequence defining the left limit of the transferred DNA; poly A, transcription termination sequence; NPT II, structural gene for kanamycin resistance; 35S, a plant promoter sequence derived from cauliflower mosaic virus driving expression of the NPT II gene; 35S promoter driving expression of AtSHI; AtSHI, structural gene for SHORT INTERNODE gene; poly A, transcription termination sequence; RB, a sequence defining the right limit of the transferred DNA.

FORFATTER: JOHN EINSET,
UNIVERSITET FOR MILJØ- OG BIOVITENSKAP, ÅS.
E-post: john.einset@umb.no

Fig. 2. Comparison of plant heights for three independent AtSHI transgenic lines (left) versus non-transgenic poinsettia (right). On average, the transgenic plants had reduced plant height (21–52%) and shortened internode lengths (31–49%) compared to control plants.

production, biocontainment and lack of problems associated with human or animal pathogens.

Liu Clarke's project on plant-based vaccines involves an international collaboration with scientists from Germany, Austria and India to produce a vaccine for dengue virus. The construct being used expresses four different versions of the virus envelope protein domain III. To maximize expression, the team uses a chloroplast transformation method (8) based on particle bombardment of plants. So far, they have produced stably transformed tobacco and lettuce plants expressing the test vaccine. So, progress is being made on at least two fronts at Bioforsk-Ås. In answer to NBS-Nytt's question as to whether we can expect these GM plants to be on the market soon, Liu Clarke said: "Given the skepticism against GMO, it's unlikely that transgenic plants based on our research will appear in Norway in the near future. There is also the cost-of- approval aspect. The costs involved in field testing and obtaining regulatory approval are formidable, much more than the costs involved in the research so far. Rather than product development, our objective has been to do research that shows the potential of GM technologies."

References

1. Bakken, JD: Nå kommer GMO-julestjernene. Nationen, 21 December 2012.
2. Brøyn, MB: Tobakk og grønnsaker blir livsviktig vaksine. Aftenposten, 6 March 2013.
3. Horsch, RB et al.: Science 227 (1985) 1229-1232.
4. Lutken, H et al.: Plant Biotech J 8 (2010) 211–222.
5. Islam, MA et al.: PLoS ONE 8 (2013) e53377.
6. Tacket, CO et al.: Nat Med 4 (1998) 607-609.
7. Yusibov, Y et al.: Human Vaccines 7 (2011) 313-321.
8. Clarke, JL & Daniell, H: Plant Mol Biol 76 (2011) 211–220.