

## Ripe time for academia–industry partnership in production of abiotic stress-tolerant crops

The drought period is over with the arrival of the monsoon, but soon it will be the management of floods which will be the cause of worry. High and low temperature stresses are likewise seasonal factors which have detrimental effects on crops. On the other hand, intensity of salt stress is an ever-increasing problem. It is therefore heartening to note that internationally plant scientists are not all that far behind in production of abiotic stress-tolerant transgenic plants. For instance, let us take the case of drought stress which made a significant impact on crops in states like Gujarat and Rajasthan this year. Tarczynski *et al.*<sup>1</sup> from the University of Arizona, USA made a path-breaking contribution in showing that when levels of mannitol are increased in the tobacco plant by introducing a mannitol-synthesizing gene taken from *E. coli*, its osmotic stress tolerance is significantly enhanced. In 1997, it was shown that increasing levels of ononitols (a sugar alcohol) also have a positive effect in increasing water stress tolerance<sup>2</sup>. Holmstrom *et al.*<sup>3</sup> from Sweden produced transgenic plants which over-produced

trehalose sugar and there was a marked increase in water stress tolerance of the resulting plants. Pilon-Smits *et al.*<sup>4</sup> from The Netherlands showed that the transgenic plants over-synthesizing fructans are relatively more drought-tolerant. Hayaishi *et al.*<sup>5</sup> from Japan have shown that increasing levels of glycinebetaine in transgenic plants increase water stress tolerance, low temperature tolerance, salt tolerance and even high temperature tolerance. Kishore *et al.*<sup>6</sup> from Ohio State University, USA have shown that over-production of proline increased root biomass and flower development in drought stress conditions. Xu *et al.*<sup>7</sup> from Cornell University, USA produced transgenic rice plants that over-synthesized a protein which is normally present in seeds. As a result, there was a higher growth rate of the transformed plants than the non-transformed plants. McKersie *et al.*<sup>8</sup> from the University of Guelph, Canada have shown that if damage to stress cells is mitigated through suitable mechanisms, drought stress tolerance is significantly increased. Admittedly, there are certain relevant reservations on these reports

such as the fact that the above experiments have mostly been conducted in laboratory conditions so far and carried out using certain model plant systems. The level of drought tolerance achieved in these experiments is also not well-quantified. However, the on-going R&D aims at taking care of these shortcomings while extending these findings further to important crops like rice, wheat and maize. Transgenic plants showing high level tolerance to salt stress, temperature stress and flooding stress have also been produced in the laboratory<sup>9,10</sup>.

However, while genetic engineering of plants for several different agronomic traits (i.e. herbicide resistance, improved nutritional quality, etc.), including resistance against biotic stress factors (i.e. virus resistance, insect resistance, fungus resistance, etc.) has received tremendous support from the private seed companies, there is a notable reluctance on the part of private seed companies in adopting tolerance to abiotic stresses on the same footing. Therefore, research on abiotic stresses has so far been supported through public sector, governmental and other

donor agencies only. The recent success in production of different abiotic stress-tolerant plants warrants that time is ripe for private seed companies to take up this venture too. There will be gains to both sides if the industry–academic heads put their efforts together. Loss of crop yield due to abiotic stresses is tremendous (rice yield is affected more by abiotic stresses than by biotic stresses<sup>1</sup>). Therefore, agricultural production will get a significant boost, resulting in higher production to meet the demand of the masses as well as higher monetary benefits to the farmers and to the concerned industries. Further, this may give the much-needed impetus to the relevant R&D for the academia. There are several bottlenecks for which solutions need to be searched such as: (i) identification, isolation and cloning of novel genes for abiotic stress tolerance may allow gene pyramiding for higher level stress tolerance, (ii) establishment of gene transfer methods for crops which are grown under stress-prone areas but have been ignored in genetic transformation work, and (iii) regulation of expression of abiotic stress tolerance genes in requisite amounts and tissues so that

growth penalty on transgenics is minimized. More money to academia for basic work on these themes would be of great value. Agriculture is still our main force, driving our economy. Abiotic stresses are more pertinent to the Indian ecosystems than to the West where agriculture is a more organized sector. Thus initiatives to combat abiotic stresses by combining academia and industry must be our priority.

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