Suggestions for enhancing nitrogen-fixation in grain legumes

Grain legumes or pulses are an important source of protein, especially for the vegetarian population. However, their production has stagnated over the years mainly because of their cultivation on marginal and sub-marginal lands. For their nitrogen nutrition, they can benefit from the complementary operation of both nitrate assimilation and biological nitrogen-fixation, which is dependent on renewable energy sources. The reduction of dinitrogen to ammonia is catalysed by the enzyme nitrogenase which is present in nodules formed due to an interaction between a legume species and compatible rhizobia. However, fertilizer nitrogen or nitrate nitrogen obtained through nitrification process in the soil, when present in excess, is known to inhibit nodule formation and function[1].

Pulse breeding is generally done under high fertility conditions and without *Rhizobium* inoculation. Many breeders have adopted the approach of adding large amounts of N-fertilizers to help reduce variability due to environmental factors in their selection plots, rather than ensuring that the plants are effectively nodulated. This approach may have resulted in selection against nitrogen-fixation, while selecting for other desired traits[2]. When pulse breeding is done, soil N status is not known or monitored. Moreover, once a crop is sown, breeders are not required to keep track of whether nodules have been formed. As a package of practices, however, farmers are advised to grow pulses after *Rhizobium* inoculation and with a starter dose of 20–25 kg N/ha to support seedling growth. Thus, our research efforts and techniques do not completely match with the goal of enhancing nitrogen-fixation in pulses. As such, there have been few concerted efforts to enhance the potential for nitrogen-fixation in grain legumes through plant breeding.

The pulse physiology will also be different under biologically fixed nitrogen nutrition than when grown on combined nitrogen. No data are available to show whether yields of a particular pulse realized at farmers' fields under low fertility conditions, would be comparable for the varieties bred under low fertility as well as high fertility conditions. This necessitates that the performance of all the released varieties should be assessed under low as well as high-fertility conditions, for making proper recommendations. Since the simplest way to increase the fixation of nitrogen is to select promising materials in N-limited soils, legume varieties meant for low fertility conditions should be bred and tested under low fertility conditions. Nodule number and nodule mass can be used as a simple criterion for selection programmes in soil with a poor capacity to supply combined N. Of course, total N accumulation by the pulse crop is the best criterion. This will go a long way in enhancing scientific knowledge for pulse breeding and also for pulse production on sustainable basis.

1. Streeter, J. G., *Crit. Rev. Plant Sci.*, 1988, **7**, 1–23.
2. Giller, K. E., *Nitrogen Fixation in Tropical Cropping Systems*, CABI Publishing, Oxon, 2001, pp. 167–168.

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Raising the standards of Indian science

I read the correspondence by Arunachalam (*Curr. Sci.*, 2002, **83**, 195–196) with much interest. Although I was not following the debate on improving the impact of Indian science, I always thought of finding some ways of improving the image of Indian science. One issue that has worried me is the quality of the review process. I have observed that papers for one of the prestigious Indian journals (for biology/biochemistry) were reviewed by 'scientists who are inexperienced and out-of-touch with current trends'.

Obviously, such papers, when read by other investigators (especially from the West), are found to be of poor quality, and thus the works are not considered to be important. Unfortunately, such papers will bring down the impact factor of the journal, even though high quality works are also published in the same journal. It is time for India to utilize fully her own asset, the computer technology. Just like the *Journal of Biological Chemistry* which has introduced computerized submission and review processes, Indian journals should follow suit. Investigators of Indian origin living in the West may be delighted to participate in reviewing the papers. I do not, in any way, imply that scientists living in India are not qualified. Also, I do not intend to suggest that the impact factor will improve just because scientists from the West have reviewed the works published in these journals.

I would also suggest that the journals should include the reviewer/editor's name (if he/she is well-known) in the paper, as *PNAS* (*USA*) does. This will be extremely helpful in raising the standards of Indian science, and will bring recognition to the laboratory where the work was done.

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