Nitrogen Fixation Research through Cooperation

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Abstract

This paper briefly describes the activities of Nitrogen Fixing Legumes in Asia (NiFLA). The Working Group supported experiments of some members by providing seeds of nonnodulating, high- and low-nodulating lines of some chickpea cultivars, literature search outputs, reprints of publications, and rhizobial strains. A germplasm set of at least 800 rhizobial strains of chickpea, groundnut, and pigeonpea were given to a research group each in Australia and India, with the understanding that they will maintain and provide these strains to scientists on request. The Working Group also served as a platform for scientists to share their research findings, including those of project PN 9210, funded by the Australian Centre for International Agricultural Research in Australia, Nepal, Pakistan, and Vietnam. An informal newsletter, AWGBNFL Notes (later renamed NiFLA Notes), of the Working Group is published twice a year (January and July), and has been the main communication channel among the members.

Introduction

From the later half of 1980s when nitrogen fixation research at ICRISAT was at a low profile, there were steady requests from the national agricultural research systems (NARS) of several Asian countries for support on production and use of rhizobial inoculants. During this time, convincing data on natural occurrence of intracultivaral variability for nodulation capacity, including on nonnodulation, were gathered (ICRISAT 1992, Rupela 1992). Unlike the supernodulating mutants of soybean (Wu and Harper 1991) and phaseolus bean (Buttery et al. 1990), the high-nodulating selections of chickpea developed at ICRISAT generally yielded

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greater, even if marginally, than their parents (Dudeja et al., these proceedings), and required verification in different environments. A working group approach, as highlighted by Gowda et al. (these proceedings), was considered the best method to evaluate the newly developed nodulation variants, and support Asian NARS for rhizobial inoculants. The Asia Working Group on Biological Nitrogen Fixation in Legumes (AWGBNFL) was therefore formed by ICRISAT as part of the Cereals and Legumes Asia Network (CLAN) during the Inter-Congress Conference of Commission IV of the International Society of Soil Science, 1–3 Dec 1992, in Dhaka, Bangladesh, and O P Rupela was asked to coordinate the activities of the group. The working group was renamed in 1995, as the Working Group on Nitrogen Fixing Legumes in Asia (NiFLA). The concept, objectives, expected outputs (Table 1), and structure (Fig. 1) of NiFLA were endorsed by the members through a questionnaire and a subsequent meeting during 6–8 Dec 1993. The activities of NiFLA are communicated to all members through its informal newsletter AWGBNFL Notes (now 'NiFLA Notes'). This paper presented in the Workshop constitutes the coordinator's report on the Working Group (WG).

Table 1. Concept and objectives of, and expected outputs from the Working Group on Nitrogen Fixing Legumes in Asia.

Concept

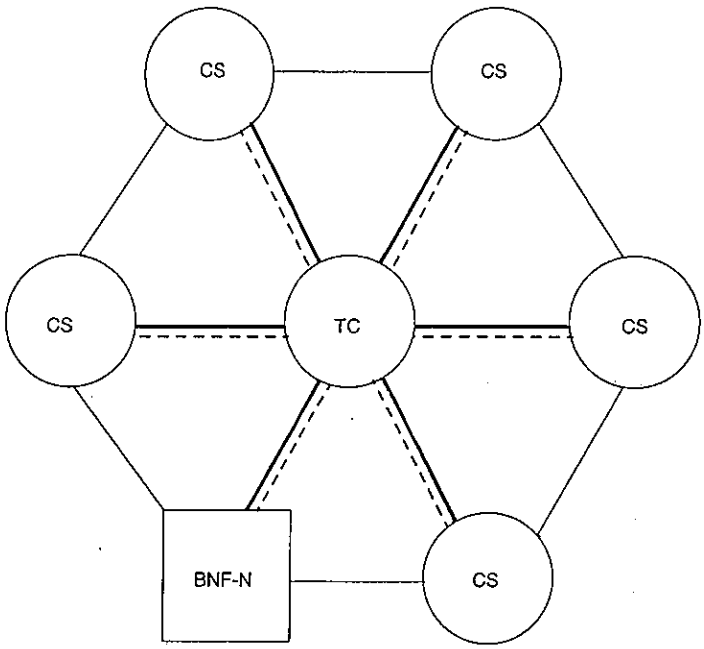
A group of researchers working to achieve mutually agreed research objectives through sharing of research responsibilities and resources.

Objectives

- Validate best-bet BNF technology on farmers' fields, and use this experience to update the technology.
- Characterize BNF constraints and identify solutions through host-plant selection.
- Stimulate research to identify host plants and bacteria that will develop constraint-tolerant symbioses.
- Quantify realizable benefits from BNF in different agroecological environments.
- Facilitate linkages among and between participants to achieve the above objectives.

Expected Output

- Viable projects with realizable goals.
- Better awareness of existing knowledge and experience among BNF workers in Asia.
- Cultivars with optimum symbioses with native and/or inoculant rhizobia.
- Generation of self reliance and expertise in the conduct of BNF research among the participating national programs.
- Understanding and enhancing the role of legumes in sustaining high yields of different cropping systems in a nonexploitative manner.



TC = Technical coordinator
CS = Country scientist(s)
BNF-N = Existing networks on biological nitrogen fixation
——— = Link between country scientist(s) and coordination unit
- - - - = Linkages among country scientists and BNF networks through technical coordinator
——— = Direct linkages among country scientists and BNF networks

Figure 1. Structure of the Working Group on Nitrogen Fixing Legumes in Asia (NiFLA).

Supporting Research Efforts of Members

Most researchers in Asian countries were already conducting research/ demonstrations on rhizobial inoculants when NiFLA was set up. The Nitrogen fixation by Tropical Agricultural Legumes (NifTAL) project, University of Hawaii, has since 1980, made a significant contribution worldwide, by standardizing such experiments (Singleton, these proceedings). The WG also attempted to improve the standardization of these experiments to better evaluate the contributions from rhizobial inoculants in a multilocational trial. Most on-farm experiments, with few exceptions, were nonreplicated. It is possible to statistically analyze such nonreplicated multitreatment, multilocational experiments in a given year, using residual maximum likelihood (REML) analyses. The WG suggested that members

subject their data to REML analyses to be more confident in using the results of these experiments. Some members did not have access to the appropriate software, and were assisted by the WG (Khurana et al., these proceedings).

Nodulation observations (counting and weighing of nodules) are difficult to take in on-farm experiments and researchers generally ignore them. The WG proposed the use of a visual rating scale (Corbin et al. 1977, Rupela 1990, Rupela and Johansen 1995) for the different legumes. Reference photographs of visual rating scales for nodulation of chickpea, groundnut, and pigeonpea were provided on request.

In many situations, the benefits from the use of rhizobial inoculants are small (Singleton et al., these proceedings) and invisible. Inclusion of a nonnodulating line as treatment can highlight the value of legumes in general, and may enhance appreciation of the small benefits. Development and use of appropriate nonnodulating lines of a given legume were proposed, to highlight the value of legumes. Nonnodulating lines of chickpea, groundnut, and pigeonpea were provided on request.

To provide researchers with easy access to the rhizobial germplasm and to share resources, one set of the rhizobial collection at ICRISAT was transferred to Dr K V B R Tilak of the Division of Microbiology, Indian Agricultural Research Institute, New Delhi, 110012, India. It comprised more than 800 strains of rhizobia nodulating chickpea, groundnut, and pigeonpea. Another set of the same strains was handed over to Dr P J Dart of the University of Queensland, Brisbane, Qld 4072, Australia, and Dr R A Date of the Tropical Agriculture, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Cunningham Laboratory, Brisbane, Qld 4072, Australia. The collection in Australia will be jointly managed by the University of Queensland and CSIRO. Any of these strains, from Australia and India, will be provided to interested researchers free of charge on request.

Additional Research Topic

Most biological nitrogen fixation (BNF) researchers in Asian countries are largely involved in research related to the identification of efficient rhizobia, their multiplication and use. The host plant plays an important part in its symbiosis with rhizobial strains (Bliss 1985). Nodulation variants generated at ICRISAT Asia Center (Rupela 1994) were provided to interested members to study/authenticate the importance of the host plant in the symbiosis. Two of the three papers on nodulation variants in these proceedings (Dudeja et al. and Khanam et al.) are results of this effort. These should convince involved scientists that they can contribute by developing high BNF lines of legumes, to obtain potential benefits of legumes in cropping systems, in addition to providing efficient rhizobial strains.

This prompted Dr B Venkateswarlu (these proceedings) to explore groundnut, and Dr S S Dudeja (Dudeja 1996) to explore pigeonpea for the presence of intracultivaral variability for nodulation capacity. It is strongly believed that use of these nodulation variants in research will enhance understanding of N_2 fixation by legumes.

Providing a Platform

As indicated earlier, an informal newsletter, 'NiFLA Notes', is the communication channel among the members. It is now mailed to about 300 members and 87 libraries in 11 countries. Meetings of the WG members during 6–8 Dec 1993, and 20–24 Aug 1996, served as platforms for members to share their research findings. These meetings brought together researchers from the public sector, private sector, and nongovernmental organizations, involved in the production and distribution of bioinoculants. The 1996 Workshop (these proceedings) also served as a platform to review a project (PN 9210) 'Management of legume N_2 fixation for rainfed cereal production in Australia, Nepal, Pakistan, and Vietnam', funded by the Australian Centre for International Agrucultural Research, which also partly funded this workshop.

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