

Field Guide to Nodulation and Nitrogen Fixation Assessment

Land Management Handbook
FIELD GUIDE INSERT 4

ISBN 0-7726-7279-2

May 1991



NODULATION AND NITROGEN FIXATION ASSESSMENT

Accurate field measurements of nitrogen fixation responses to inoculation with *Rhizobium* in large scale experimental legume trials and commercial plantings are often difficult, undependable, or prohibitively costly. For most field applications at the development level, however, nitrogen fixation potential can be evaluated through an assessment of nodulation and plant growth characteristics.

This guide is intended to help field staff, who may be unfamiliar with inoculant studies, in assessing nodulation and nitrogen fixing potential in large scale field and commercial plantings. The guide was developed by Lamorna Enterprises Ltd., Vancouver, B.C., under contract to and in collaboration with the B.C. Ministry of Forests. The procedure was developed from published work, and from observation of nodulation under field conditions. A preliminary field evaluation of the guide was carried out by B.C. Ministry of Forests staff in the summer of 1990.

ASSESSMENT PROCEDURE

1. SAMPLING - replicated experimental plots:

Each plot should be sampled randomly, using 2-10 sample plants per plot, depending on the size of the plot and density of legumes.

1. Select samples within the plot.
2. Evaluate plant growth and vigour according to the assessment codes shown on the following page.
3. Carefully excavate soil at the sample site: a minimum of two plants per sample is essential. If plants are sparsely distributed or obviously variable in appearance, individual plants may be sampled, but sample number should be increased to compensate.
4. Carefully examine plant roots to assess the nodules. Depending on the soil type and condition, this may require gently agitating the roots in water.
5. Assess the overall nodulation by comparing the calculated scores to those provided for the three categories in the assessment guide.

2. SAMPLING - demonstration plots and commercial plantings:

For a larger area, sampling is most effectively done using one or more transects across the site and a sampling frequency appropriate for the area. Once sample points have been selected, the procedures outlined in steps 2 to 5 above should be followed.



Profuse healthy nodulation on legume roots illustrating the spherical form of some nodule types. The strong pink colour of active nodules is caused by the presence of heme proteins.

ASSESSMENT CODES

1. PLANT GROWTH AND VIGOUR

Plants green and vigorous	5
Plants green and relatively small	3
Plants slightly chlorotic	2
Plants very chlorotic	1

2. NODULE NUMBER

Some nodules [5-50]	5
Many nodules [>50]	
- pink pigmentation	5
- mainly white or smaller	3
Few nodules [<5]	
- pink pigmentation	3
- slightly pigmented	2

None 0

Effective nitrogen fixation is not always correlated with very high nodule number. A few large nodules may provide the equivalent fixation of many smaller nodules. Nodule size is also related to the legume species. The scoring system attempts to balance the effect of numbers and the effect of nodule size.

3. NODULE POSITION

The crown region includes the 5 cm of the taproot immediately below the cotyledons, and any lateral roots within a 1-cm radius of this region of the taproot (see diagram).

Predominantly crown	5
Crown nodules + nodulated laterals	3
Lateral nodules only	1

In inoculation trials, crown nodulation is often the result of nodules formed by the inoculant strain, especially in the first 2 years.

4. NODULE COLOUR

Predominantly pink	5
Some pink or whitish with green areas..	2
White or greenish colour	0

5. NODULE APPEARANCE

Effectiveness assessment by nodule appearance is very subjective. It incorporates some of the information used in the other categories. More experienced workers are likely to find it a useful category than would less experienced workers. Effective nodules are a good size for the species in question and have a healthy pink appearance.

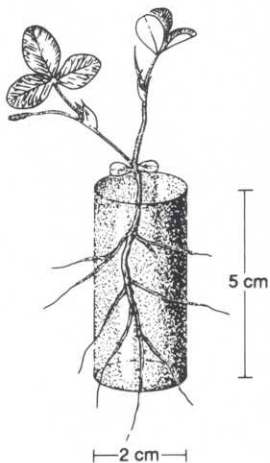
Effective	5
Intermediate	3
Ineffective	0

TOTAL SCORES

[20-25]...**Effective nodulation.** Good nitrogen fixation potential.

[15-20]...**Nodulation less effective.** Fixation potential reduced. Were inoculation or growing conditions less than optimum?

[0-14]...**Generally unsatisfactory nodulation.** Requires evaluation of strains used and of growing conditions on site.



Crown nodulation in alsike clover

Crown region:

Nodulation within the area defined by the shading is defined as crown nodulation.

In the field, a healthy plant does not always reflect effective nodulation and active nitrogen fixation. Localized soil environments, particularly with variations in soil nitrogen, may stimulate vigorous growth of the legume in the first 1-2 years after planting, even in the absence of nodulation. Such situations are only apparent when the plants are excavated and examined for the presence of active nitrogen-fixing nodules. The two plants shown below illustrate the different scoring patterns for two apparently equally healthy plants.

Plant growth	5
Nodule number	0
Nodule position	-
Nodule colour	-
Nodule appearance	-



Total score	5
Interpretation	Ineffective

5
5
5
5
5



Total score	25
Interpretation	Effective

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