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 vigourous growth of the plant. Such situations are only apparent when the plants are excavated and examined for the presence of active nitrogen-fixing nodules.

Profuse, healthy crown nodulation in chickpeas (l) and field peas (r).

NODULE ASSESSMENT EXAMPLE

Plant Growth/Vigour -5
Nodule Colour/ Number- 5
Nodule Position-2
Total Score-12
Effective Nodulation

Plant Growth/Vigour-3
Nodule Colour/Number-3
Nodule Position-2
Total Score-8
Nodulation Less Effective

Effective (l) vs. Less Effective (r) Nitrogen Fixation

ADDITIONAL INFORMATION SOURCES

1. **Saskatchewan Agriculture and Food**
   http://www.agr.gov.sk.ca/docs/crops/pulses/suspulse98.asp
2. **Alberta Agriculture, Food and Rural Development**
   Pulse Crops in Alberta (Agdex 142/20-1)
3. **Manitoba Agriculture and Food**
   http://www.gov.mb.ca/agriculture/crops/pulsecrops/bhb01s00.html

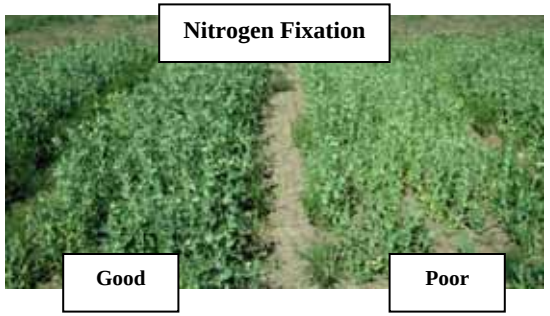
Nodulation and Nitrogen Fixation Field Guide for the Assessment of Pulse Crops

Accurate field measurements of nitrogen fixation responses to inoculation with *Rhizobium* 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 growers who may be unfamiliar with inoculant studies, in assessing nodulation and nitrogen fixing potential in the field.

NODULE ASSESSMENT TIMING

Nodulation assessments should be done during early flowering (See page 2 for Assessment Procedures). Nodule formation begins approximately 14 days after crop emergence, but under certain conditions formation may take 3-4 weeks. Nodule numbers and nitrogen fixation rates generally are at a maximum during early to mid-flowering. After flowering, nodule efficiency is reduced and they begin to shut down.



With permission from the original author, Lamorna Enterprises Ltd., Vancouver, B.C., this guide was adapted from the *B.C. Ministry of Forests Land Management Handbook Field Guide Insert 4*. It has been used and modified by Grow Tec over several years of large-seeded legume research trials.

ASSESSMENT PROCEDURES

Replicated Experimental Plots

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

1. Evaluate plant growth and vigour according to the assessment codes shown on the following page.
2. Select samples within the plot, avoiding edges & the area to be harvested for yield if possible.
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. Do not pull plants out of soil, nodules are delicately attached to roots and can be easily lost.
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.

Demonstration Plots and Commercial Fields

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



Proper assessment involves removing plants with a shovel and washing carefully with water.

ASSESSMENT CODES

1. PLANT AND GROWTH VIGOUR

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

Poor nitrogen fixation can cause nitrogen deficiency symptoms such as yellowing of the leaves at the base of the plant prior to flowering, and poor plant development.

2. NODULE COLOUR / NUMBER

Greater than 5 clusters or groups of pink pigmented nodules..... 5
3 – 5 clusters / groups of predominantly pink nodules 3
Less than 3 groups of nodules OR nodules whitish or greenish in colour .. 1
No nodules OR nodules white or green in colour..... 0

Determination of the efficiency of nitrogen fixation via nodule colour and the number of nodule clusters present. Carefully slice open the nodules. The strong pink colour of the nodules is caused by the presence of leghemoglobin, which must be present for active nitrogen fixation. If a nodule is brown, white or green, it is considered non-effective.

3. NODULE POSITION

Crown and lateral nodulation..... 3
Generally crown nodulation..... 2
Generally lateral nodulation..... 1

Predominantly crown nodulation is observed when seed is inoculated. Lateral nodulation is prevalent when native *Rhizobia* species exist in the soil or when granular inoculants are used. The crown region of a plant is generally the area of soil surrounding the seed. The approximate size of this region varies according to the crop. For example, the crown region for peas can be visualized as a cylinder extending approximately 8-10 cm deep from the soil surface with an 8 cm diameter.

TOTAL SCORE

11 – 13	**Effective nodulation.** Good nitrogen fixation potential.
7 – 10	**Nodulation less effective.** Fixation potential reduced. Were inoculation or growing conditions less than optimum?
1 – 6	**Generally unsatisfactory nodulation.** Requires evaluation of inoculants used, inoculation methods and of growing conditions on site.