

## Nitrogen fixation in grain legumes

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Peas are the most important grain legume in New Zealand and 21,000 ha are sown annually. Past research has concentrated on irrigation timing, plant population (1) and disease resistance. Intensification of cropping and a reduction in the frequency of pasture in crop rotations has led to increased fertilizer N inputs to maintain soil N and cereal crop yields. Nitrogen fixation by peas and other grain legumes, and their ability to improve soil fertility, has therefore become an important area of study in Canterbury cropping land.

### Methods

Field trials were conducted over three seasons. In an initial study, fertility changes caused by peas, lupins, barley and fallow were measured by subsequent Tama ryegrass (2). N fixation was measured by Acetylene Reduction, roots being incubated for 1 hour in a 10% acetylene:air mixture.

Further trials with peas have studied 1) the effect of straw incorporation, irrigation, and N fertilizer on N fixation, 2) sowing date and effect of soil moisture in two cultivars, 3) N fixation by eight cultivars, and 4) diurnal variation in N fixation rates.

### Results and Discussion

In a low-fertility soil, lupins fixed 175, field peas 65 and garden peas (harvested green) 19 kg N/ha, and seed N removal was 155, 52 and 14 kg N/ha respectively. Lupins fixed N over a longer period than peas, and grain yields were 3430 kg/ha compared with 1820 kg/ha in field peas. Although garden pea

N fixation ceased at green pea harvest, low N removal in seed resulted in Tama and wheat yields similar to fallow. Tama yields after lupins were higher and after field peas lower than after fallow. Wheat yields after legumes increased by 73% when compared with the 1540 kg/ha obtained after barley, but there were no differences between yields of wheat after legumes and fallow.

Under cultivation, soil mineral-N levels are normally higher than under pasture; thus grain legumes, when compared with pasture legumes, may gain a greater proportion of their N from the soil.

Pea N-fixation has been increased most by irrigation, although straw incorporation, which reduced mineral-N levels, increased N-fixation. Where eight pea cultivars were compared, Maple peas fixed 43 kg N/ha while other cultivars fixed less than 29 kg N/ha. Most cultivars reached peak N-fixation rates at flowering but Maple pea N-fixation peaked before flowering. The reason for this earlier peak is unclear.

The three 24-hour studies of diurnal variation in peas showed contrasting cycles. Before water stress and flowering occurred, no diurnal cycling was evident. When plants were water-stressed, fixation increased as dewfall replenished leaf turgor during the night. During pod fill, N-fixation was limited from 2300 to 1100 hours N.Z.S.T.

The studies have shown some benefits from using grain legumes in rotations and elucidated some factors affecting the rate of fixation. Future study could include critical soil conditions limiting grain legume growth, Rhizobium: cultivar interactions for optimum N fixation and the effect of a wide range of grain legumes on soil fertility.

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2. Rhodes, P.J. 1980. M.Agr.Sc. Thesis, Lincoln College.