PEA GROWTH MODELLING: RESPONSE OF N FIXATION TO DROUGHT

D.L. McNeil, S. Marquez Berber

Plant Science Department
Lincoln College
Canterbury, New Zealand

ABSTRACT

A model of pea N fixation and drought interactions is proposed. The design is described for a series of trials being undertaken by the authors to test the model and thereby develop a strategy to alleviate potential N fixation problems in drought stressed peas.

Additional Key Words: Pisum sativum, *water stress, nitrogen fertilization, super nodulation.*

INTRODUCTION

This is a description of work in progress rather than final results and must therefore be regarded as highly speculative. The research is aimed at two ends: (1) To test a theoretical model of the response of nitrogen fixation and dependant growth of a pea crop to a period of water stress; (2) To evaluate two alternative methods for overcoming yield reductions predicted by the model.

The model has been developed from observations on a variety of legume crops but is as yet untested.

THE MODEL

Trials conducted on soybeans (McNeil & La Rue, 1984) have indicated that a stress applied to N fixing nodules could reduce total plant yield. In these trials small doses of applied NO_3^- were sufficient to substantially reduce N fixation and consequently yield (Table 1).

Presumably NO_3^- inhibition of N fixation more than compensated for the additional N available from the nitrate. This produced a 33% reduction in seed N yield compared to unfertilized controls, for a treatment receiving 40 kg N/ha.

Other stresses have been demonstrated to reduce N fixation in legumes. Water stress has substantial effects (Sprent & Bradford, 1977). A single drought stress and stress induced by nwaterlogging have been shown to significantly reduce yields in chickpeas in Northern Australia (McNeil, *et al.*, 1986).

TABLE 1: Effect of applied nitrate on soybean yield and N fixation (after McNeil & La Rue, 1984).

NO_3^- added week 3 kg N/ha	NO_3^-added week 8 kg N/ha	Seed yield g N/Plant	Plant N from fixation %
0	0	0.82	83%
20	0	0.78	67%
20	20	0.55	56%
100	0	0.77	59%
100	100	0.89	54%

The following model (Figure 1) is proposed for the response of peas to water stress.

(1) Plant GR (Growth Rate) = The lower of (a) light limited C fixation rate, (b) N fixation rate.

Under normal circumstances these two are in balance (between t_0 and t_1, Figure 1).

(2) With application of drought both rates (a) and (b) fall substantially in balance (t_1, Figure 1).

(3) With removal of drought the light limited C fixation rate recovers rapidly (t_2, Figure 1) but N fixation may take longer due to a need to re-establish effective nodule mass (t_3, Figure 1).

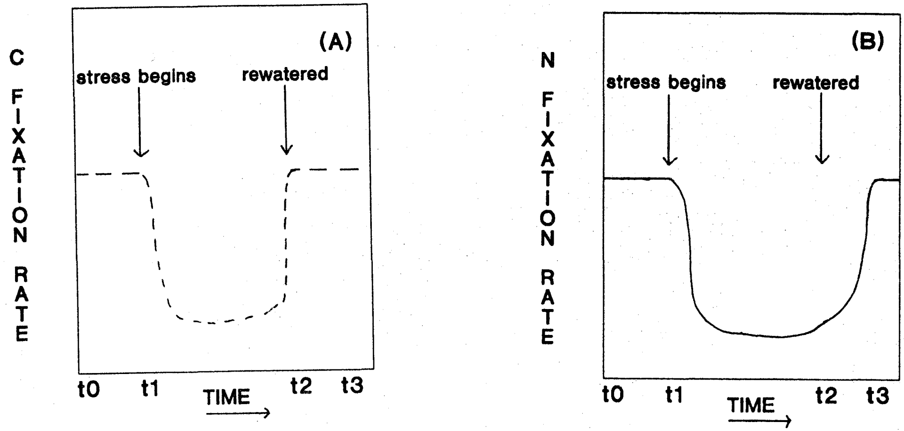

Figure 1. Proposed model of pea growth responses to water stress.

These responses result in a period of growth (between t_2 and t_3, Figure 1) strongly limited by N fixation rate after drought stress.

This response is similar to that postulated after a NO_3^- stress using the data given in Table 1.

Measurements of N fixation and growth rates following a drought stress and comparisons with responses of non-fixing plants should indicate whether the N fixation limited growth period between t_2 and t_3 in Figure 1 actually exists.

OPTIONS FOR OVERCOMING THE PROBLEM

It is of great importance for crop modelling that the understanding gained of crop responses should lead to a method for improving crop performance. Two are suggested by this model.

(a) If N was added at or prior to t_2 then growth could recover based on NO_3^- reduction rather than N fixation. This possibility is suggested by Table 1, where addition of 200 kg N/ha actually increased yields relative to unstressed controls.

(b) If the potential N fixation rate was raised then it would be less limiting. This could occur if supernodulating peas (Postma *et al.*, 1986) were drought stressed.

Both of the above options are being tested.

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