THE IMPORTANCE OF MYCORRHIZAL INFECTION FOR THE GROWTH AND DEVELOPMENT OF THE PEA PLANT

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In the autumn of 1978 an area of land on the John Innes Farm was treated with a nematicide, Telone, and a sterilant, Basamid, in order to kill the Trichodorus nematode and the weeds which were maintaining Pea Early Browning Virus (PEBV) and thus inhibiting the planned development of a dried pea breeding program.

It was realized that these treatments would be likely to disturb the microflora and fauna of the soil and so, before drilling any pea seed, the soil was tested for the presence of effective strains of Rhizobium. These tests proved positive and drilling went ahead as planned in April, 1979, the resulting plants exhibiting an encouraging vigor. Examination of the root systems of young plants showed that infection with Rhizobium had taken place and that the nodules which had developed were effective. However, by the time flowering began, the plants showed signs of wilting and became pale green. Growth slowed and the production of flowering nodes was reduced. The root systems proved to be very atypical at this stage in being hair-like, shallow, with very few main penetrating "tap roots", and almost devoid of nodules.

Drs. Mosse and (layman of Rothamsted Experimental Station agreed to examine the root systems of these pea plants for mycorrhizal infection and quickly confirmed that there was none. In contrast, pea plants growing on unsterilized land nearby were heavily infected. The absence of a mycorr-hizal relationship with a plant is likely to result in a deficiency of phosphates since the fungal hyphae are particularly efficient in the uptake of phosphates and, in effect, increase the size of the plant root system. This deficiency was confirmed when the amount of phosphorous in dry matter was shown, by the Agricultural Development and Advisory Service in Cambridge, to be 0.21% in plants from normal soil and 0.09% in plants from sterilized soil.

It was important to confirm the relationship between soil treatment, mycorrhizal infection, and pea plant growth and so, in collaboration with Drs. Mosse and Dayman, a small trial was initiated in August, 1979. Peas were sown on sterilized soil in microplots some of which had added nitrogen, some had added phosphate, some were inoculated with mycorrhiza, and some were left as controls. With the advance of autumn it was impossible to grow the plants through to maturity and they were therefore harvested at the early flowering stage which was nine weeks after sowing. Examination of the roots showed that only plants from plots inoculated with mycorrhiza had been infected, the remainder being devoid of any fungal relationship. Obvious differences in plant growth according to treatment were to be seen and these arc summarized as a series of dry-weight values in Table 1.

Table 1. Mean dry weights in gms and their standard errors based on samples of ten pea plants from eight treatment plots sown on sterilized soil in mid-August and harvested nine weeks later.

150 kg P/ha	75 kg P/ha	15 kg P/ha	15 kg P/ha + mixed mycorrhiza
1.60 + 0.23	1.70 ± 0.26	0.99 ± 0.09	2.65 * 0.25
Control	100 units N/ha	mixed mycorrhiza	Yellow vesicular mycorrhiza
0.99 i 0.07	1.02 i 0.10	2.42 * 0.26	2.20 - 0.16

The addition of phosphate to the sterilized soil, which already contained 30-40 mg/liter, did lead to improvement in plant growth but none of the treatments was as effective as inoculation with mycorrhiza. Even in the absence of additional phosphate the mycorrhizal relationship led to the development of larger plants. The addition of nitrogen was not beneficial to plant development.

Soil sterilization therefore did not solve the problem of using virus-infected land in a breeding program since the resulting plants were atypical. Neither was the phosphate deficiency overcome by adding extra phosphate since the plants did not take it up. An alternative approach is now being applied which relies upon the continuous use of herbicides for two seasons to kill all hosts of PEBV but hopefully leaving sufficient of the mycorrhizal population unharmed.

Soil sterilization has, however, demonstrated the importance of the three-way symbiotic relationship between the bacteria, the fungi, and the pea plants and is likely to lead to a series of more detailed studies which, as well as being of academic interest and value, could also be of importance in the agronomy of the crop. It is a relationship which seems to have been somewhat neglected in Pisum and one about which readers of this Newsletter should be reminded.