THE EFFECT OF DEPTH OF PLACEMENT OF PHOSPHORUS FERTILISER ON THE GROWTH AND DEVELOPMENT OF FIELD PEAS

By

Mohammadali H. Derafshi
B.Sc. Agric. (Tehran, Iran)
M. Sc. Agric. Technology. (Texas A&I, U.S.A.)

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ABSTRACT

This thesis reports on the results of 3 glasshouse and 3 field experiments.

The glasshouse experiments measured the effects of depth of placement and level of phosphorus (P) on the growth of field peas (*Pisum sativum* L. cv. Alma). In one experiment, interactions between these treatments and variations in seed P content were also determined at an early stage of growth.

An alkaline, P deficient, virgin sandy loam soil was used in all glasshouse experiments. KH₂PO₄ was used in multiple P levels and in different experiments was placed either at seed level or banded at 4, 7, 10 or 12 cm below the seed. Sequential measurements of plant growth, including shoots, nodules and roots at various depths were undertaken. P concentration and P content in shoots and roots were also measured.

Glasshouse experiment findings:

The results from the glasshouse experiments indicated that, although at early harvests (3 and 4 weeks after sowing) applying P fertiliser with the seed (WS) was better than placing P at 4 cm below the seed (B4), in later harvests (6 and 7 weeks after sowing) B4 appeared to be as effective as WS and in some cases (e.g., nodule fresh weight) was even better than WS.

Root growth was stimulated by the P applied in the zone of fertiliser placement. However, maximum root lengths were obtained at moderate levels of P and were reduced at high levels of P. The reduction of root growth at higher P levels may have been due to the levels being toxic for root growth. This hypothesis is supported by the plant (foliar) symptoms which were observed on some old leaves of the plants in higher P treatments. The alternative hypothesis is that, where the P concentration around the roots is sufficiently high to supply adequate P for plant growth, plants preferably utilise their potential for shoot growth rather than root growth; thus, root proliferation at higher P levels was less than root proliferation at lower P levels.
Nodulation in field peas was very sensitive to P deficiency and no active nodules were produced on plants without P fertiliser. Furthermore, the external P requirement for nodule fresh weight, at all harvests of these experiments, was higher than for shoot yield. These results are in contrast with the findings of Robson (1983) and Jakobsen (1985). The results presented here suggest that P supply affects nodulation in field peas dramatically and directly rather than indirectly by enhancement of plant growth, as concluded by previous workers.

Variations in the seed P content had a minor impact on growth and P uptake of pea seedlings even when grown under severely P deficient conditions. Where seed of high P content was sown and P fertiliser was placed deep (B12) a significant increase in shoot yield and nodulation occurred compared to where seed of low P content was sown.

The effectiveness of P applied at different soil depths was estimated from the slope of the relationship between the level of applied P and shoot dry matter within the zone of P deficiency. The data showed that the most effective method of P application was WS and B4 in Experiments 1 and 2, respectively and the effectiveness of applied P fertiliser was reduced where P was placed deeper than 7 cm below the seed.

Field experiment findings:

Two field experiments were conducted in 1994 and 1995 on an alkaline clay loam of moderately low soil P status located at Roseworthy, South Australia. Triple superphosphate was applied to field peas at different P levels (0, 5, 10, 20 and 40 kg ha⁻¹) and comparisons were made between applying the P with the seed, surface broadcasting P with and without incorporation and banding P 4, 7 and 10 cm below the seed. The field experiments were conducted under very dry conditions in 1994 (total rainfall 249 mm) and repeated in a season of moderate rainfall (382 mm) in 1995.

Samples of shoots and roots were taken at weeks 7, 12 and 17 in 1994 (Experiment 1) and at weeks 7 and 12 in 1995 (Experiment 2) and shoot and root dry matter (in both
experiments), nodule fresh weight and intact and sectioned root length (only in Experiment 2) were measured. Shoot P concentration and content were also determined at both harvests of Experiment 2.

In both experiments, response to the applied P fertiliser was highly significant. In the drought affected 1994 experiment, shoot and grain yield were unaffected by the methods of P placement. However, in the 1995 experiment, the B5 treatment produced a superior response in most of the parameters measured, but this occurred mostly at 12 weeks after sowing and only at near optimal P levels (40 kg P ha⁻¹). At sub-optimal P supply (<20 kg P ha⁻¹), differences between methods of P placement were not significant. This indicates that in a moderately P deficient soil considerable P is taken up from the local soil P in the near surface soil horizon.

Effectiveness of the P fertiliser at B5 was superior to WS and B10 (10 cm below the seed). The optimal level of P in the B5 treatment for 1.0 and 1.2 tonne per hectare of seed yield production was 10 and 24 kg P ha⁻¹ respectively, whereas, in the WS and B10 treatments this appeared to be 10 kg P ha⁻¹ for 1.0 tonne per hectare (not determined for 1.2 tonne per hectare) and 14 and 30 kg P ha⁻¹ for 1.0 and 1.2 tonne per hectare of seed yield respectively.

The 1994 experiment was re-sown with wheat in 1995 to measure the residual effectiveness of P fertiliser treatments applied in 1994. No basal fertilisers were applied to the wheat. Shoot yield was measured at 10 and 20 weeks after sowing and seed yield was determined at grain maturity. Shoots from the second harvest were analysed for P concentration and content. P concentrations in the youngest emerged leaf blade ('YEB') collected 10 weeks from sowing were also measured. The results from this experiment indicated that, there was a strong residual response by the wheat to fertiliser P applied in 1994, but the response was independent of the method of P placement.

The results of all the field and glasshouse experiments suggest that placing P fertiliser 4-5 cm below the seed of field pea crops will be beneficial in terms of nodulation, P
uptake and grain yield and grain P concentration. An additional advantage of deeper
P placement is the avoidance of possible P toxicity effects on young seedlings or
rhizobia at higher P levels applied with the seed.