DIFFUSION OF PHOSPHATE TO
PLANT ROOTS IN SOIL

II. UPTAKE ALONG THE ROOTS AT DIFFERENT
TIMES AND THE EFFECT OF DIFFERENT
LEVELS OF PHOSPHORUS

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SUMMARY

Autoradiographs of rape (Brassica napus L.) seedlings growing in a Begbroke Sandy Loam treated to different P levels showed P accumulations near root apices of primary and lateral roots, without corresponding depletion from the adjacent soil, indicating marked translocation.

Laterals less than 2 days old did not deplete the soil despite considerable P accumulations in them. Their growth and P uptake were enhanced when the growth of the primary root was checked. The length of root hairs decreased markedly with increasing P supply.

The P depletion zones developed in the same way at all points along the primary axis (except for a short length behind the apex). At the highest P level the concentration of exchangeable P at the root surface was lowered by about 30% on day 2, by about 40% on day 4 and rose slowly after day 8.

Whereas in P treated soils the depletion from within the root hair cylinder was fairly uniform, in the low P soil there was a continuous decrease in P concentrations toward the root surface, within the root hair zone.

INTRODUCTION

In Paper I of this series we described a method, using autoradiography with $^{33}$P, for the quantitative evaluation of the phosphorus depletion zones around plant roots growing in a soil. This technique offers the possibility, not only of knowing the phosphate concentration gradients around roots in situ at any given time, but also following the changes in the gradient around a given part of the root with time.
Many reports have appeared in recent years on the uptake of ions from different parts of roots. However, Bowen states: 'No one pattern of ion uptake along roots can be assumed to hold for all conditions of growth', and if so, the results of most of the work reported in the literature are only of limited relevance to a plant that is continuously growing in a soil, for one or more of the following reasons:

(i) in most of these experiments, uptakes were studied with excised or short lengths of intact roots (a) grown entirely in solution, (b) initially grown in soil and then transferred to solution for measuring uptakes;

(ii) uptakes were measured in all cases over short periods of time, i.e. from a few minutes to a few hours and

(iii) only a single measurement of uptake was made after a given absorption period from any given bit of root.

The objectives of the present work were: (i) to study the diffusion of phosphate to roots of rape seedlings in a soil at different levels of phosphorus and (ii) to follow the uptake of phosphorus along the length of a continuously growing root with time, in situ in the soil, by successive autoradiography of the same root at different times.

EXPERIMENTAL

The experiments reported here were made on a Begbroke Sandy Loam, the salient characteristics of which were reported in Paper 1. There were two additional P levels, one below (Treatment P0) and the other above (Treatment P2) the P status of the soil used in the previous experiment (Treatment P1). Part of the results obtained for P1 reported earlier, which are relevant to this paper will be recalled here for comparison.

Unless otherwise stated, the experimental conditions were similar to those reported earlier. Details of the P treatments are given in Table 1.

The soil particle size (<0.152 mm), bulk density of packing (1.1 air dry g/ml), moisture content (v1 = 0.41) and the preparation of the block were as before. The only difference was in the size of blocks: P0: 15 cm × 2 cm × 0.75 cm and P2: 15 cm × 4 cm × 0.75 cm.

Sowing and plant growth

On the seventh day from labelling, one germinated rape seed (Var. Emerald) was sown per block and grown for 5 days in the case of Treatment P0 and for 13 days in the case of Treatment P2.