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Uptake and Translocation of Radioactive Phosphorous in Wheat (*Triticum aestivum* L.)

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Abstract: The study deals with a series of experiments to investigate absorption of radioactive phosphate from different parts of young *Triticum aestivum* L. (wheat variety Sutlej– 86) plants. Considerable transport of P^{32} occurred when the labelled phosphate was fed through roots. The plants showed considerable variation in the rate of absorption and translocation of P^{32} with respect to time. Absorption through leaves was found at a lower level compared to roots. Downward movement of P^{32} was minimal. Therefore it can be concluded that only root has the capability to provide feeding route for plant.

Key words: Wheat, P^{32}, autoradiography

INTRODUCTION

Phosphorous is the second most important nutrient for plants, next to nitrogen and is taken up by the roots. It is found in plants as a constituent of nucleic acids, phospholipids, the coenzymes NAD and NADP and most importantly, as a constituent of ATP (Mohar and Schopfer, 1995).

Heavy concentration of phosphorous is found in the meristematic region of actively growing plant where it is involved in the synthesis of nucleo-proteins. Sugahara *et al.* (1972) investigated the incorporation of P^{32} into the protein fraction of *Spinacea oleracea* fragments through cyclic and non-cyclic photophosphorylation. Phospholipids, along with proteins, may be important constituents of cell membrane. The coenzyme NAD and NADP are important in oxidation-reduction reactions in which hydrogen transfer reaction takes place and in many other important processes like photosynthesis, glycolysis, respiration and fatty acid synthesis. Green plants absorb water and inorganic salts from soil by unicellular root hairs and translocate to the plant by the processes of diffusion, imbibition and osmosis. The translocation of minerals in plants, when considered in its entirety, involves the upward movement of inorganic materials acquired by the roots, their distribution within the shoot and any redistribution via the vascular tissue from the initial site of deposition to any other part of the plant. Uptake and translocation of phosphorous also depends upon salinity of the soil. Flade (1973) and Attumi *et al.* (1999) studied the effect of salinity of soil on the distribution of P^{32} in runner bean and tomato, soya bean plants respectively. The absorption of water in both vapor and liquid form occurs to small extent through aerial part of the plant and its translocation depends upon the water potential of the leaf cells and permeability of the cutin layer (Breazeale *et al.,* 1950).

By using autoradiography one can measure the distribution of radio-nuclide in any substance. Shuakat *et al.* (1975) adopted this technique for the study of distribution of C^{14} and the effect of triazine herbicides on *Pinus* spp. Since roots tend to smear the activity while the plant is being prepared for the radiograph therefore, Overman *et al.* (1958) suggested that the root be cut off and thrown away.The present work is aimed to study the uptake and translocation behavior of P^{32} in wheat plant through root and the aerial parts of the plant.

MATERIALS AND METHODS

Ten to fifteen seeds of wheat were soaked in distilled water for 1 h and surface sterilized for five minutes with calcium hypochlorite. Pot experiment was adopted for germination in a growth chamber (26°C day and 20°C night) in February 2001 for one week. Sterilized seeds were distributed per pot containing half strength Hoagland solution (Chapmann, 1976). After one week plants were carefully washed without damaging tender roots. The tube was masked with masking tape and placed in a lead container. The masked test tube was then clamped on a stand and the whole assembly was later erected in a zinc tray, which contained 7.48×10^{-3} thick absorbing layer of wax.

Uptake of P^{32}: 10 μ Ci P^{32} (phosphoric acid) solution was poured into the tube and the solution diluted until all the roots were dipped completely. The Gieger Muller tube was placed near any one leaf of the plant. The G.M. counter was operated at a predetermined plateau 760 volt (Skoog and West, 1976). The counts were recorded at the intervals of 15, 30,45 and 60 min.

Translocation of P^{32}: In the second method plants parts, either roots (feeding from root) or the leaf (feeding from aerial part of plant) were completely dipped into 10 μ Ci P^{32} solution. These plants were left for 1.5 h and subsequently they were washed properly. They were transferred to the pot again. To obtain time scan data, plants were analyzed after 4, 6, 8, 12 h (for short term) and 24, 48, 72 h (for long term) translocation pattern. Powdered plant material was used for the analysis (Alvi *et al.,* 2003).

Autoradiographic study: Autoradiography was performed to study the tagged phosphate among the roots, stem and leaves. For this purpose the P^{32} solution was poured into the test tube. The roots of the plants were placed into the solution for 1/ 2, 1, 8 and 24 h. After the time had elapsed the plant was carefully withdrawn and taken into a dark room. It was wrapped in wrapping paper of thickness of 1.97×10^{-3} inches and sandwiched by enveloping it in between photographic films and dark colour sheet for over-night and the autoradiograph was developed.

RESULTS AND DISCUSSION

Uptake of P^{32}: The absorption of tagged phosphate in wheat plants showed that absorption of P^{32} increased with the passage of time (Fig. 1a-d). After 4 h, the activity of P^{32} acquired a constant level. Some fluctuations are observed in the activity vs time graph shown in Fig. a, the precise picture of this graph was obtained by increasing the interval between two observations, such as 30, 45, 60 min. These fluctuations may be attributed due to the random phenomena of activity (Naqvi, 1990). Sud *et al.* (1998) demonstrated that the uptake of P^{32} differs widely from soil to soil.

Translocation of P^{32} by root: The translocation of P^{32} when taken up by the root, showed that initially translocation of P^{32} from root to shoot is very rapid. However, after 12 h it gets slower and most of P^{32} gets accumulated in the leaves (Fig. 2a). Change of the rate of movement of P^{32} is due to the change in water potential gradient in plant (Biddulph and Markle, 1944). Initially potential gradient is high within the plant. As the upward movement of water takes place this becomes low and movement of water along with mineral (P^{32}) gets slow. Distribution of P^{32} in the plants was studied by many workers and has been reported (Alvi *et al.,* 2003; Attumi *et al.,* 1999; Shaukat *et al.,* 1975).

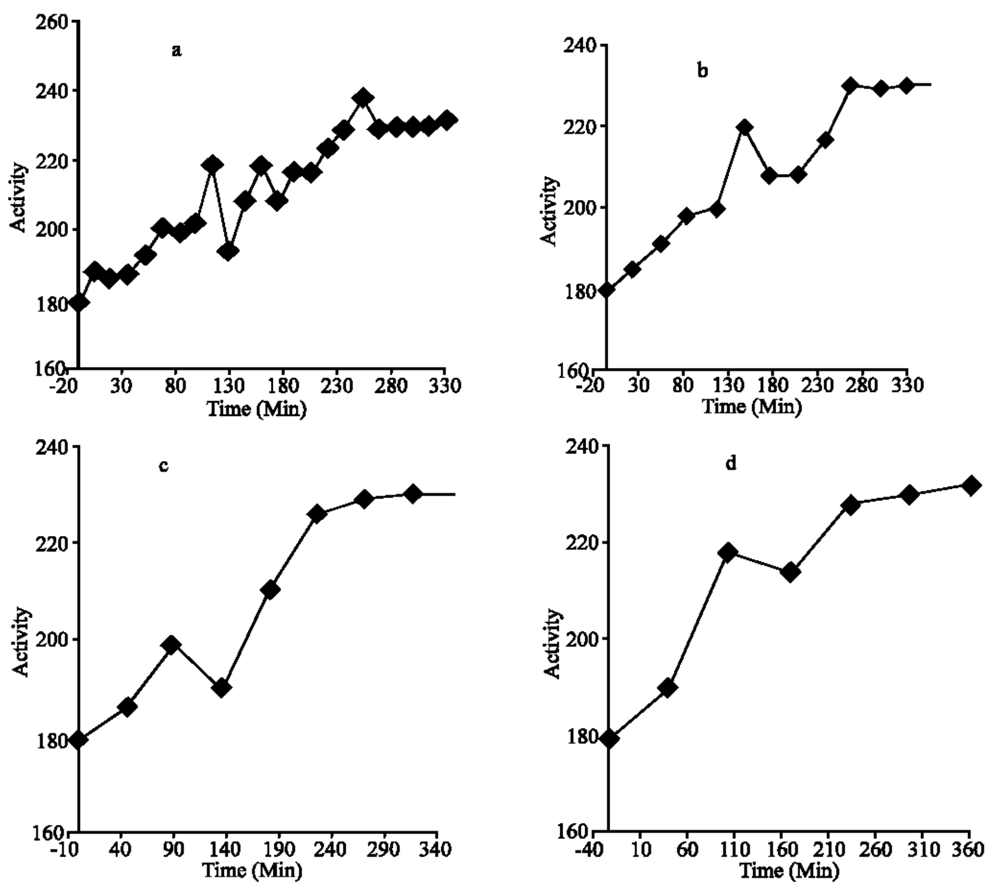

Fig. 1: Absorption of P^{32} by roots at different time intervals in min (a) 15 (b) 30 (c) 45 and (d) 60

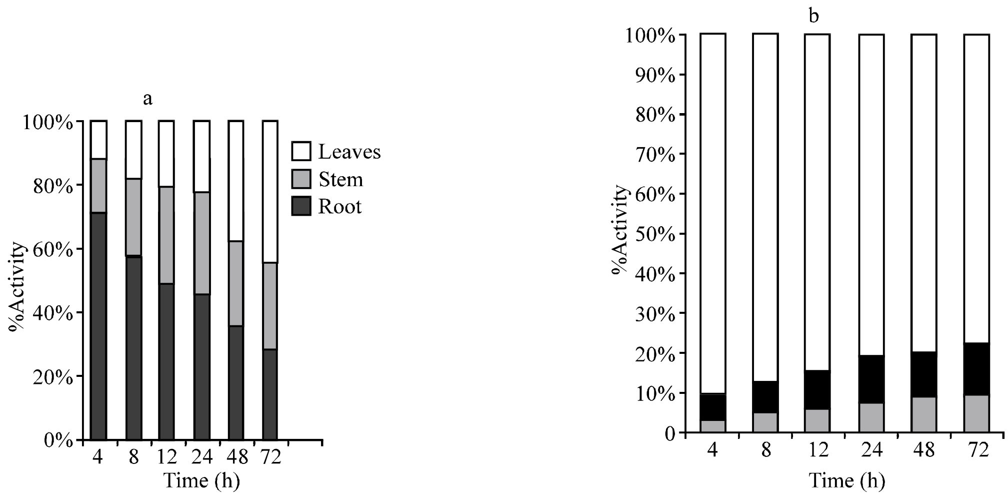

Fig. 2: Percentage of radioactivity (P^{32}) in different parts of the plant following uptake of P^{32} by (a) roots (b) leaves

Plate 1: Autoradiograph of wheat plant representing uptake of radio-active P^{32} after ½ and 1 hour

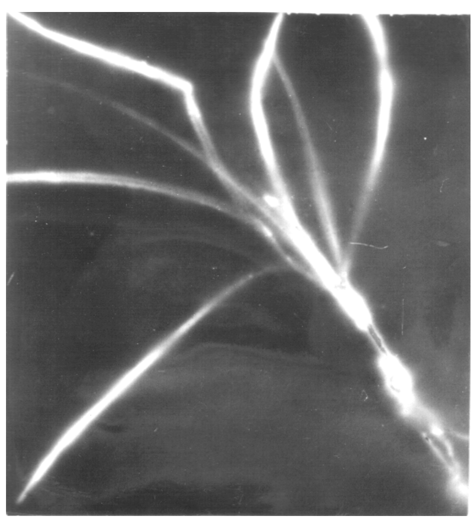

Plate 2: Autoradiograph of wheat plant representing uptake of radio-active P^{32} after 8 hour

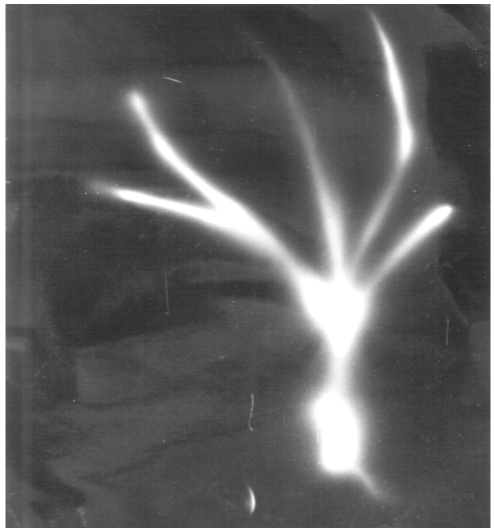

Plate 3: Autoradiograph of wheat plant representing uptake of radio-active P^{32} after 24 hours

Translocation of P^{32} by leaves: Translocation of P^{32} by the leaves showed (Fig. 2b) that most of the P^{32} accumulated in the leaves and downward movement was slow. Biddulph and Markle (1944) showed that this downward movement of inorganic salts from leaves requires living cells i.e pholoem acts as as a channel for translocation. Some upward movement also occurs which is erratic and up to 40%. Our results showed that the movement of P^{32} is considerably slow in downward direction (Fig. 2b). Sosebee *et al.* (1971) and Breazlea *el al.* (1950) concluded that translocation of P^{32} decreases with the increase in water stress.

Autoradiographic study: Autoradiographic study also supports the absorption and distribution mechanism (Plates 1-3). Portion that exhibits thicker tracks on the photographic plates indicates enhanced absorption of tagged phosphorous, in the particular region. Results shown in Plate 1 exhibit activity of absorbed P^{32} by the plant after half and 1 h of incorporation. There is appreciably more activity at 1 h compared to 1/2 h subsequent to P^{32} supply in the rooting medium. Plate 2 shows that most of the activity concentrates in the stem. Root and leaves have small quantity of the P^{32}. Plate 3 indicates the maximum transport of P^{32} in the shoot and leaves of the plant, whereas root has very low level of P^{32}

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