POTATO ROOT GROWTH AND FUNCTION

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Potato yield and quality is influenced by mineral nutritional balance in the developing plant. Management schemes designed to optimize this balance should be supported by a working knowledge of plant, soil and environmental variables influencing the rates of mineral accumulation in the tuber. In the last few years, we have been characterizing potato root developmental patterns and functional behavior in relation to nutrient uptake and movement in the plant.

Rooting patterns

Our general procedure for sampling potato roots in the field was described previously (Nelson et al., 1989). A general developmental pattern observed at the time of tuber initiation indicates the appearance of numerous adventitious roots originating from 8 to 15 nodes of the stem between the base and the soil surface (Fig. 1). We have designated these as stem nodal roots. Some of these nodes also give rise to tuber bearing stolons. Co-emerging roots at the same nodes have been defined by Kratzke and Palta (1986) as "junction roots". Stem nodal roots eventually extend to depths of 40-60 cm, and comprise the bulk of the potato root system (Fig. 2). Stem nodal roots are important in the absorption and transport of nutrients to the stems and leaves, and may also provide a direct path for nutrient transport to tubers in some situations. Their distribution can be influenced by soil physical properties, fertilizer and irrigation management. For example, root systems developed different patterns under two irrigation regimes in a Quincy sand (Fig. 2). At 102 days after planting (DAP), roots under optimal irrigation scheduling was more evenly distributed throughout the soil profile, with extensive rooting occurring underneath the furrow. In contrast, distribution of stem nodal roots under suboptimal irrigation was more sparse underneath the furrow. As we have observed in previous years, total root length proliferates during early vegetative growth, but then levels off or declines during tuber development (Fig. 4). This may be explained by competition between roots and tubers for limited carbyhydrate supply from the leaves.

Roots originating from stolon tissue are defined as "stolon roots" (Kratzke and Palta, 1985). These roots are believed to play an important role in the direct transport of phloem-immobile nutrients, e.g. Ca, to the tuber. Their distribution under field conditions has been found to be sparse (Fig. 3) relative to the stem nodal roots.

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These roots tend to be concentrated underneath the hill in the tuber forming zone of the soil profile. They are quite fine and fragile roots, with only limited lateral branching. Roots have also been reported to originate directly from the tuber (Kratzke and Palta, 1985), and these roots, when present are thought to be involved with direct absorption of nutrients into the tuber. However, under the conditions of our experiments, we have not observed tuber roots on developing tubers.

Transport pathways to the potato tuber

Transport of mobile nutrients such as N, P, S, Cl likely occurs from leaves and stems to the tuber through phloem tissue along with sugars required for tuber development. However, for nutrients that are found in lower concentrations in the phloem such as Ca, it is being questioned whether this pathway sufficiently supplies enough Ca to meet tuber demands. Other evidence suggests that elements of limited phloem mobility may also be supplied directly to the tuber through the stolon roots tuber roots, or tuber periderm itself (Kraus and Marschner, 1971; Kratzke and Palta, 1986). If these pathways are important contributors to the overall accumulation of these nutrients, then the distribution of the stolons, tubers, and associated roots has an important bearing on 1) where these nutrients should be made available in the soil profile through proper fertility management, and 2) what environmental factors will optimize the growth rates and absorption rates of these roots.

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REFERENCES

Kratzke, M. G. and J. P. Palta. 1985. Evidence for the existence of functional roots on potato tubers and stolons: significance in water transport of the tuber. Am. Potato J. 62: 227-236.

Kratzke, M. G. and J. P. Palta. 1986. Calcium accumulation in potato tubers. Role of the basal roots. Hortscience 21: 1022-1024.

Nelson, D. P., W. L. Pan, and S. Roberts. 1989. Soil fertility and potato root growth. Proc. 28th Ann. Washington State Potato Conf., Moses Lake. pp. 24-33.

Figure 1. Typical rooting pattern of a potato plant near tuber initiation.

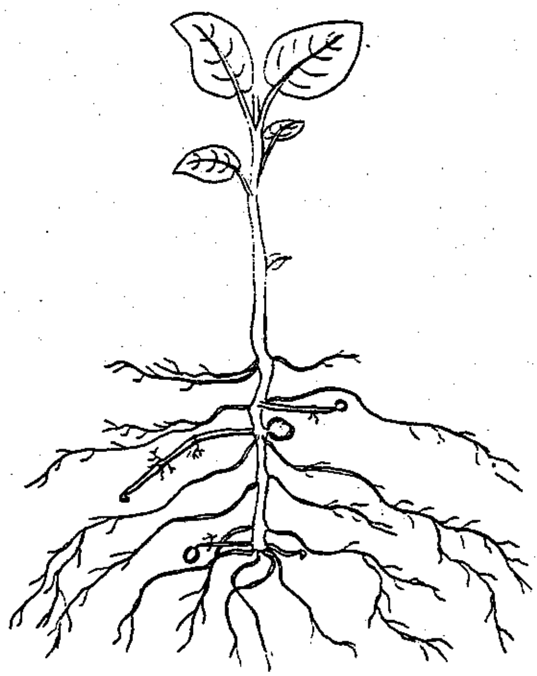

Figure 2. Distribution of stem nodal root length (RL) 102 days after planting under normal irrigation (N Irrig) and dry irrigation (D irrig). Coordinates are plotted by depth from the top of the hill (Depth) and distance from the top of the hill (DFH). The normal irrigation plots were watered to 95% field capacity, while the dry irrigation plots were watered to 75% field capacity.

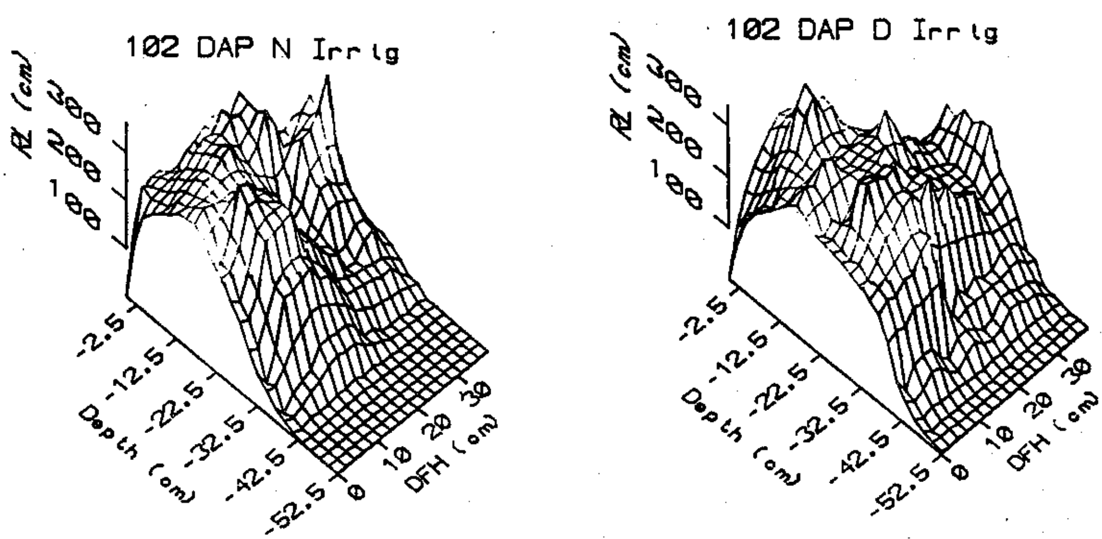

Figure 3. Distribution of stolon nodal roots in the same samplings described in Figure 2.

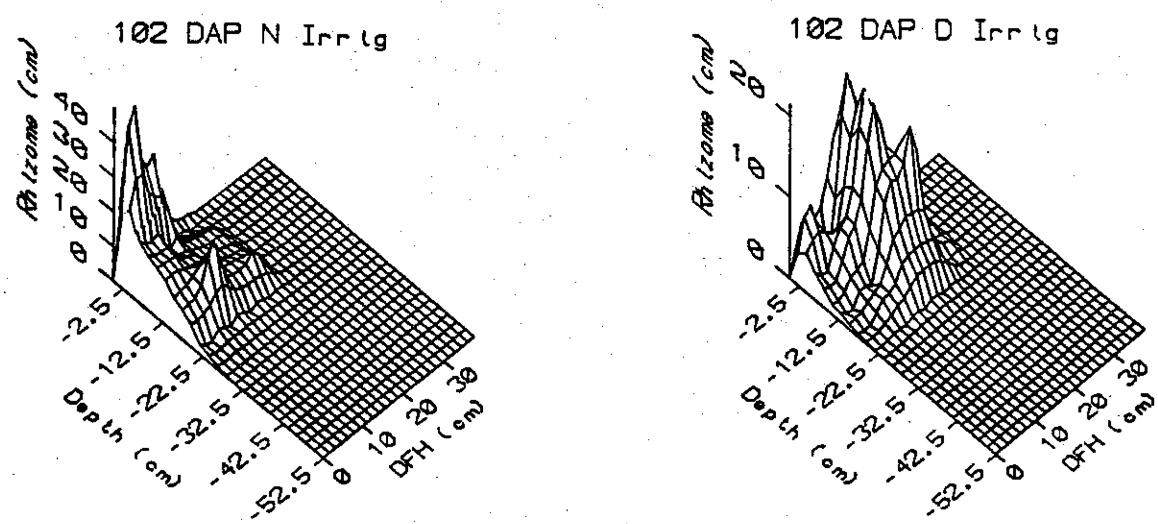

Figure 4. Total root length and stolon (rhizome) lengths at 75 and 102 days after planting under normal and dry irrigation regimes.