

Roots: The 'Foundation' of Crop Plants

by Richard Waldren

SCIENCE

Richard (Rick) Waldren is an agronomist and professor at Univ. Neb.-Lincoln.

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Roots are one of the main organs of the crop plant, but are the least conspicuous and often do not receive the attention they deserve. Much less effort has been directed toward the study of growth and physiology of roots than to the stems and leaves above the ground. This is partly because conducting studies of roots in the soil is difficult and awkward. To remove all or even a part of the root system for observation or measurement destroys some of the root system and alters the soil environment. However, crop producers and researchers are becoming increasingly aware of the importance of the root system and the root environment as primary factors controlling crop growth and subsequent yield.

The physiological functions of roots are most commonly studied in water or sand cultures in a greenhouse or growth chamber. Although these studies are carefully conducted, the results must be applied to soil and field conditions with caution.



Photo by Dirceu Gassen, Coplantio.

A corn seedling developing normally in a no-till soil. By the time you see the shoot, the roots have already spread considerably. Note the 'crown' (nodal) roots beginning to develop from the stem tissue above the seed, which will become the dominant portion of the root system in a few weeks.

Root Structure & Growth

In any explanation of root growth, the structure most commonly shown and discussed is the root tip. The root tip and its structure are emphasized because root growth originates in this area and nearly all of the absorption activity occurs at the root tip region, which extends from the tip itself through the region of root hairs. Although this region probably represents less than one percent of the total root mass, there are hundreds of thousands of root tips in the total root system and the metabolic activity that occurs in this region determines the growth and development of the entire plant.

The root structure develops in the following manner. An apical (as in 'apex,' or outermost point) meristem is at the tip of the root. In this meristematic region, cells divide rapidly. Forward of this meristematic region is the root cap that is continually regenerated by new cells from the meristematic region. The root cap protects the rest of the root tip as it grows through the soil. The cells of the root cap are continually sloughed off as the root tip is pushed through the soil by the cell division and elongation immediately behind the cap. This sloughing of root cap cells deposits a microscopically thin gelatinous coating on the adjacent soil particles, which eases root growth through the soil. It is estimated that this sloughing of root cap cells plus other root secretions (exudates) may use 20 to 30% of the plant's carbohydrates (sugars) produced during photosynthesis.

Other cells produced in the meristematic region develop into other root tissues. The root grows some by cell division, but the primary region of root extension, that is, increases in length, occurs directly behind the

Roots do not sense the location of favorable temperatures or moisture and grow to it. Instead, during the course of normal growth patterns, roots encounter favorable environments and respond by proliferating in those zones.