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Taproots-The Key to Alfalfa Survival

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Introduction

Survival of alfalfa is closely tied to events that occur in plant organs remaining in the field overwinter or following harvest. This includes crowns, from which new shoot growth will arise, and a large carrot-like taproot (Fig. 1). Part of our research effort focuses on understanding changes in taproots which enable alfalfa plants to survive stresses like defoliation and winter. It is our hope that once factors essential for stress tolerance are identified, these will be used to increase efficiency of selection in variety improvement programs.

Taproot Starch

Alfalfa taproots can contain up to 50 % nonstructural carbohydrate on a dry wt. basis. The vast majority of this is in the form of starch. Following harvest, taproot starch is degraded to simple sugars (Fig. 2) that are subsequently utilized to support initial shoot regrowth. A similar breakdown of starch to simple sugars occurs in late fall and early winter (Fig. 3). In this case, however, the sugars are not used for growth, but instead accumulate in taproot cells to prevent them from freezing. This is one aspect of a process referred to as "hardening". Plants that fail to harden properly during fall often do not survive Indiana winters.

When alfalfa shoots have attained a height of about 12 inches in spring or during regrowth following defoliation, starches begin to reaccumulate in taproots. This reaccumulation of starch becomes especially rapid as plants make the transition from vegetative to reproductive development and begin to bloom. Untimely harvest before starches have reaccumulated in taproots places additional stress on plants, and could result in stand loss. This includes harvests in

September and October when early frost prior to reaccumulation of starches may prevent plants from hardening properly.

Taproot Proteins

Taproots also contain large quantities of proteins. Many of these proteins are enzymes that are important in regulating biochemical reactions in cells. We recently have obtained evidence which suggests that certain proteins accumulate in taproots during late regrowth and in fall in a manner analogous to starch. It is our belief that, like starch, these specific proteins are degraded after defoliation and in early spring to provide regrowing shoots with some of the nitrogen they need for growth (Fig. 4). Remobilization of these storage proteins would be especially important during times when nitrogen fixation (the reason you inoculate legumes like alfalfa) is low and unable to meet the nitrogen needs of the protein rich forage. This situation is likely to occur in early spring when soils are cold and immediately following defoliation.

Enhancing Taproot Performance
Producers can do several things to maximize persistence and performance of their alfalfa that have a direct impact on taproot function.

1. Select varieties that have resistance to diseases that impair taproot function. These include bacterial wilt and phytophthora root. rot, and where appropriate fusarium wilt and verticillium wilt.

2. Inoculate your seed with the proper strain of Rhizobium at planting. This ensures plants have the capacity to fix nitrogen and may lessen plant dependency on taproot nitrogen reserves.

3. Maintain soil fertility and pH levels. Proper taproot function depends on both of these factors.

4. Control insect infestations. Potato leafhoppers remove sugars directly from plant stems, while alfalfa weevil removes leaf area thereby reducing sugar production by the plant. Both insects can result in decreased taproot starch concentrations that could slow regrowth and decrease plant persistence.

5. Select a variety adapted to winters in your area. Unadapted varieties grown in temperate regions often are unable to harden properly and do not persist.

Figure 1. Taproots and crowns of alfalfa are all that remain in early spring and following harvest.

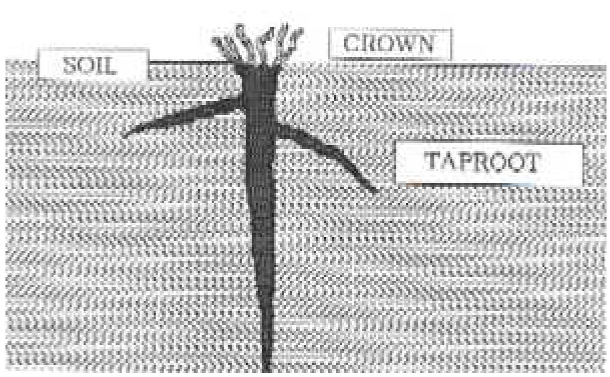

Figure 2. Taproot starch concentrations decline for two weeks following defoliation. Thereafter, starch is rapidly reaccumulated in taproots permitting plants to be harvested again after 28 days of regrowth.

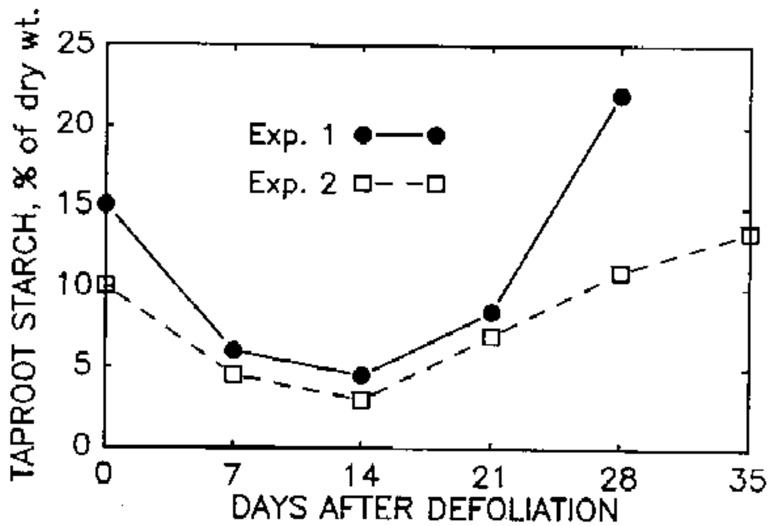

Figure 3. Taproot starch is converted to soluble sugars in fall and early winter. This is one change in taproot physiology that enables these tissues to survive low temperatures of winter. Growth resumed at ca. Day 180 and was accompanied by extensive depletion of starch and sugars from taproots.

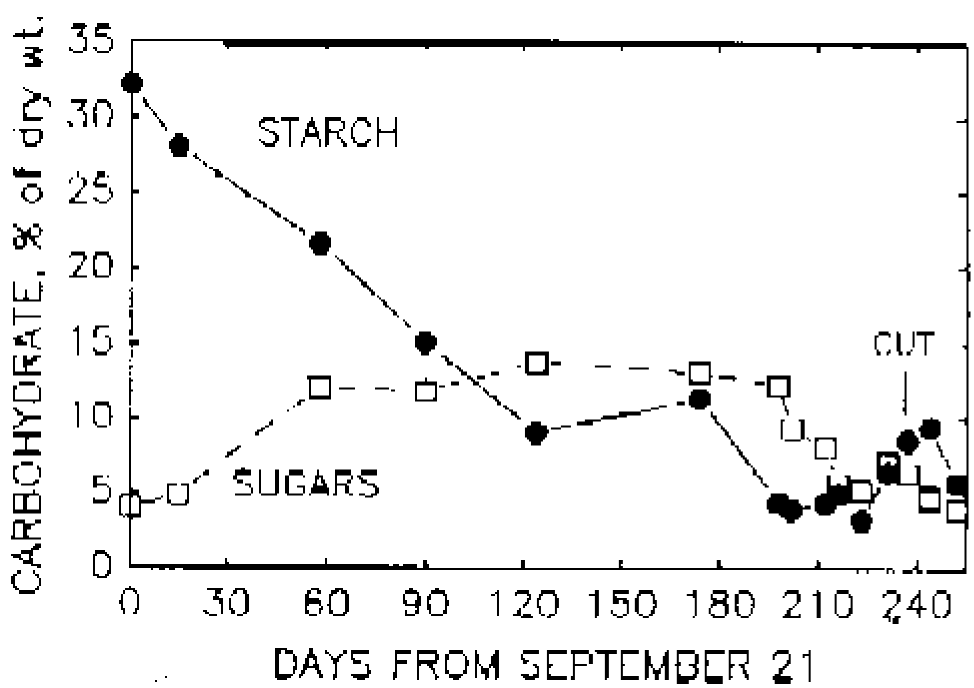

Figure 4. Protein concentration in taproots is maintained at high levels during fall and winter. When growth resumed at ca. Day 180, taproot proteins were

metabolized to supply regrowing shoots with protein necessary for growth and proper function.