North Dakota State University
NDSU Extension Service

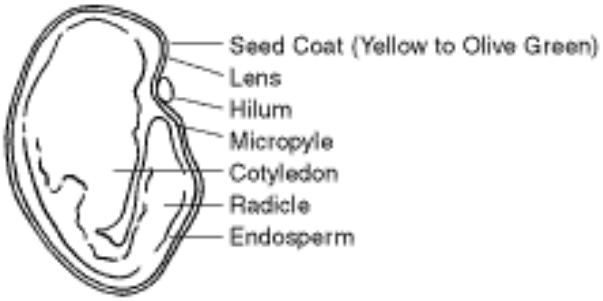
Alfalfa

Seed Germination
Seedling Growth
Vegetative Development

R-648, (Revised), January 1999
Dwain Meyer, Professor of Plant Sciences, Agricultural Experiment Station

Alfalfa is a dicotyledonous plant. That is, the seed (Figure 1) is composed of two embryonic or seed leaves called cotyledons. In addition, the seed contains the primary root or radicle, the shoot growing point or epicotyl located above the cotyledons, and the endosperm or food storage area. Externally the seed has several visible structures – the hilum or point of attachment in the seed pod, the lens or a weak point in the seed coat, and the micropyle, which is a remnant of the tiny opening the pollen tube grew through during the process of fertilizing the female ovary.

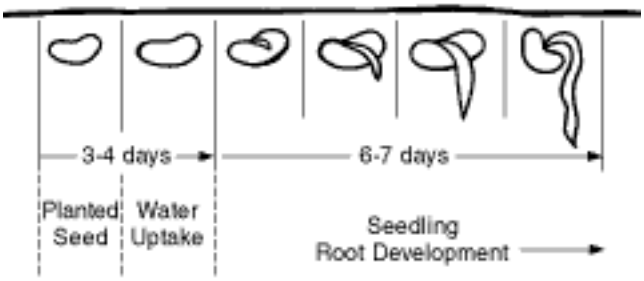
Figure 1. Alfalfa seed structure



Alfalfa Seed Structure

Germination is the resumption of growth by the embryo within the seed leading to the development of a new plant. The germination process (Figure 2) is complete as soon as the radicle ruptures the seed coat. The process is influenced by available soil moisture, soil temperature, and the nature of the soil surrounding the seed (i.e., salty vs. normal soil) or residual herbicides that may be present in the soil.

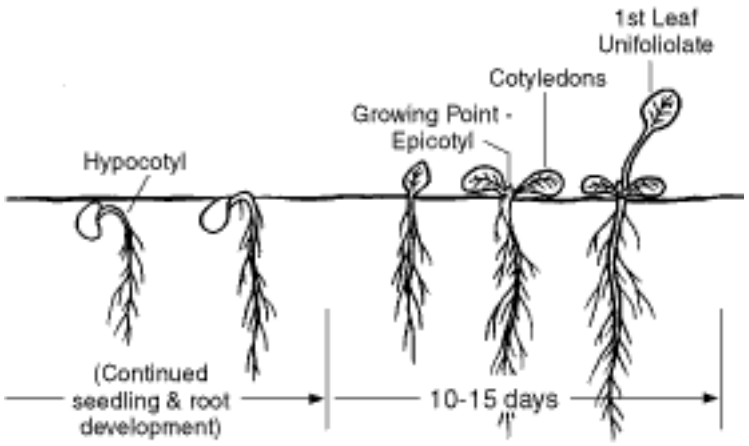
Figure 2. Germination and seedling root growth



Alfalfa Germination Process

Seedling growth is the developmental period of the young plant from the time germination is completed until it can manufacture enough food through photosynthesis to sustain growth. The seedling root is the first structure to emerge from the seed during germination (Figure 2). It penetrates the soil very rapidly, forming a slender, usually unbranched taproot, which may penetrate 5 to 6 feet into the soil during the first growing season. Once the seedling root is anchored firmly in the soil, the seedling axis below the cotyledons elongates in an arch (hypocotyl arch) pulling the cotyledons upward to the soil surface (Figure 3). Seed germination and seedling emergence occur in about three to seven days. Fewer days may be required for seedling emergence under ideal soil moisture and temperature conditions. As the hypocotyl arch emerges from the soil, growth stops on the side exposed to light and continues on the underside until the seedling is in an upright position. This raises the cotyledons above the soil surface where they expand. The growing point (epicotyl) of the seedling is now exposed. The first true leaf is unifoliolate and emerges from a bud at the first stem node above the cotyledons. Seedling growth is complete. Under good growing conditions, the seedling is developed fully 10 to 15 days after planting.

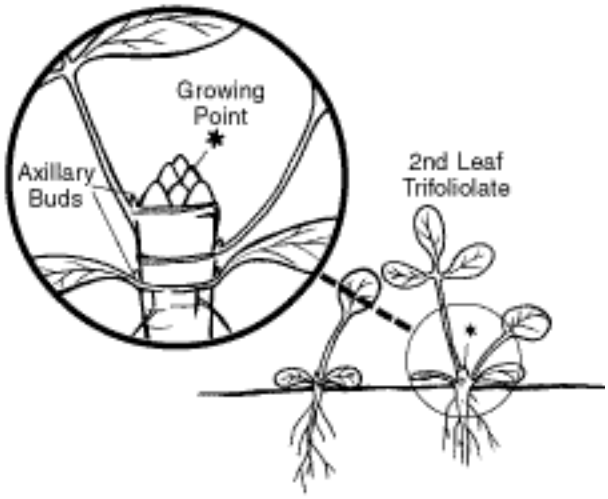
Figure 3. Seedling emergence through unifoliolate leaf stage



Alfalfa Seedling Growth

A fully developed alfalfa seedling does not assure plant establishment. It must continue to develop deeper roots and grow more leaves to survive and become an established stand. Vegetative growth continues through cell division and expansion in the epicotyl or growing point of the young plant. The second leaf of the alfalfa plant is usually trifoliolate (three leaflets) and originates from the second primary stem node (Figure 4). All subsequent leaves are trifoliolates except in new multifoliolate varieties that have 5, 7, or 9 leaflets per leaf. The unifoliolate leaf and all subsequent trifoliolate/multifoliolate leaves are useful characters to distinguish alfalfa from weed seedlings in stand evaluation.

Figure 4. Unifoliolate through fourth trifoliolate leaf stage

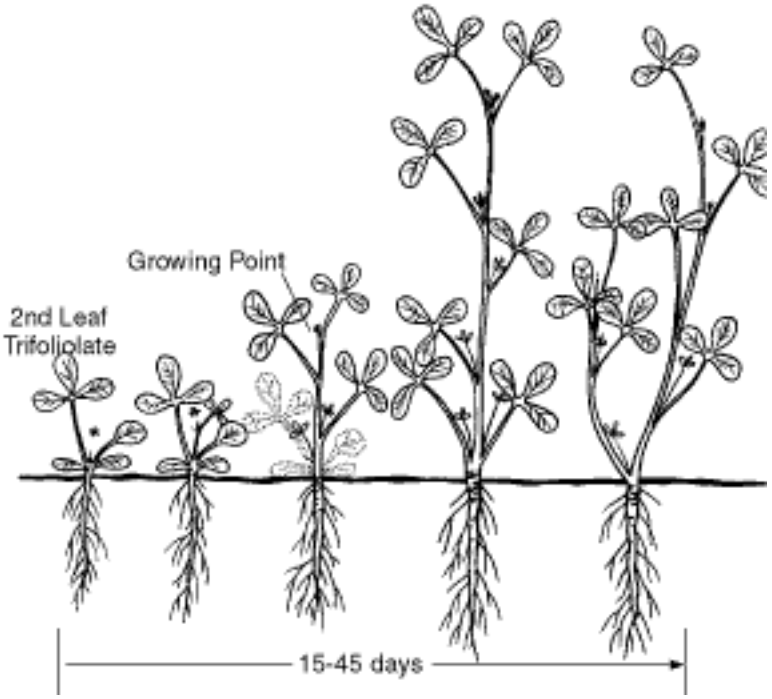


Axillary buds develop in the axils of all leaves (Figure 4). After three or more trifoliolate/multifoliolate leaves have appeared on the primary stem, new secondary stem growth may occur from any of the axillary buds, but frequently only one axillary bud stem (usually the unifoliolate) develops early, especially if seedlings are shaded in a companion crop or under competition from weed growth or other alfalfa plants.

Alfalfa First Trifoliolate Leaf and Buds

The primary and secondary stem(s) of the young plant increase in length by cell division and internode elongation from the first stem node upwards. The second and subsequent leaves (Figure 5) are trifoliolate/multifoliolate and develop alternately at each stem node as growth continues. Once the first true trifoliolate leaf develops, further growth and development is best described by the number of trifoliolate/multifoliolate leaves that develop on the main shoot as the plant continues to grow. Any axillary buds in axils of leaves can develop new stem tissue and generally do in less competitive conditions.

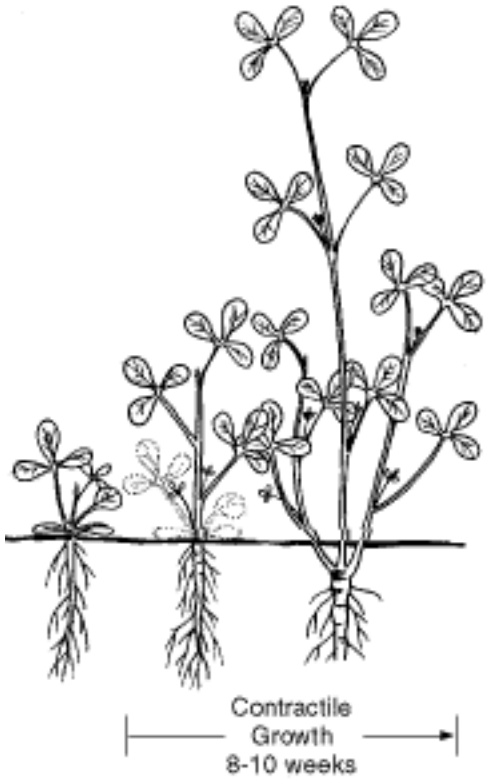
Figure 5. First-year vegetative growth and development



Alfalfa First-Year Vegetative Development

Growth and development of new shoots from axillary buds gives the young plant a branched appearance, especially if light is adequate and the stand is not too thick. Vigorously growing alfalfa plants quite often have three and sometimes four secondary shoots in addition to the primary or central stem, which forms the characteristic first-year crown (Figure 6). The branches from the unifoliolate leaf bud appears first, followed by branches from the cotyledonary and first trifoliolate leaf buds. Fewer branches may form the crown with late seedings, under severe companion crop competition, or with high seeding rates. Under these conditions the cotyledonary, unifoliolate, and first trifoliolate leaf buds may remain dormant or may give rise to a branch rhizome or underground stem in the fall.

Figure 6. Crown development showing contractile growth



The young alfalfa plant, at about 8 to 10 weeks of age, undergoes a growth phase known as contractile growth (Figure 6). This process in alfalfa and sweetclover involves a change in the shape of cells in the hypocotyl or seedling axis below the cotyledons and upper portion of the primary root from long and narrow to short and wide as a result of carbohydrate or food storage. This shift pulls the lower stem nodes beneath the soil surface. Most winter hardy alfalfa varieties have several nodes pulled well below the soil surface (1 to 3 inches) in the seeding year. Contractile growth greatly aids winter survival of alfalfa by providing soil insulation for the perennial over-wintering crown structures.

Crown Development

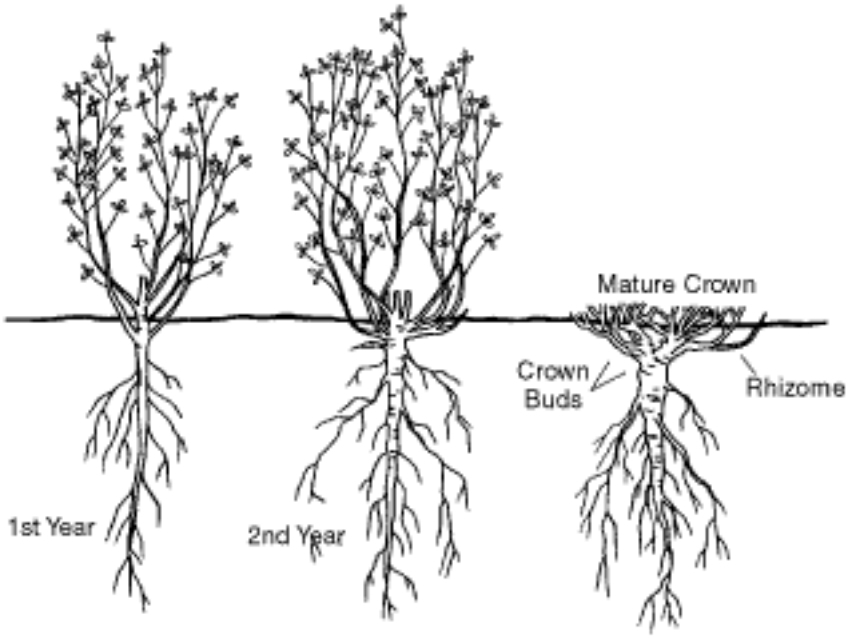
The lower internodes or nodes of the primary or secondary stems may produce adventitious or crown buds. Crown buds or dominant axillary buds produce the vegetative regrowth following harvest the seedling year, or these buds may give rise to branch rhizomes in the fall. The branch rhizome is the structure from which new growth will initiate in the spring unless winter injury occurs. The branch rhizome must be developed adequately in the fall by the first killing frost or the seeding will fail, even under the most ideal growing conditions. In most years, alfalfa seeded later than about August 15 under good moisture (irrigation) conditions in North Dakota will not have adequate time to initiate branch rhizomes before the first killing frost. A dryland seeding after the first week of August is **not** recommended because of the increased risk of

stand loss.

A crown of a perennial can be described best as the young overwintering stem tissue. The crown in the fall of the first year may be as small as the lower portion of the main stem and dormant cotyledonary node buds, or as large as the lower portion of the main stem (i.e., colytedonary, unifoliolate, and first trifoliolate leaf nodes), the secondary stems from these nodes, and the branch rhizomes that develop. Spring growth will occur from the rudimentary leaves on the branch rhizome if winter injury hasn't "burnt" them off. If winter injury has occurred, spring growth will initiate from adventitious buds on the branch rhizome or from a dormant crown bud. But, spring growth is much slower in this case. All subsequent growth in the first-harvest year occurs from adventitious or dormant crown buds.

The crown of the alfalfa plant increases in size during the second year. Branch rhizomes develop on last year's branch rhizome. These grow outward and upward increasing the circumference of the plant. After two to four years, the typical multibranched crown of alfalfa develops (Figure 7).

Figure 7. Fully developed alfalfa crown



Alfalfa Wintering Structures

The crown and associated root tissue are the storage center for carbohydrates (food) produced through the process of photosynthesis. The carbohydrates are used to develop cold resistance or winter hardiness, for plant respiration during winter, and to provide the energy source for the initiation of the new growth in the spring and following each harvest. First-year management influences subsequent growth. Alfalfa management is discussed in R-571, Alfalfa Management in North Dakota.

R-648, (Revised), January 1999

North Dakota State University
NDSU Extension Service