

## SOIL AND FERTILITY CONSIDERATIONS FOR GROWING ALFALFA

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Alfalfa is a widely adapted crop which is grown across the United States and in many other countries. However, it is very sensitive to many soil and fertility factors which can limit its productivity. It is important to understand these factors in order to be a successful alfalfa producer.

### Soil Depth

Most crop plants are adversely affected by shallow soils. Alfalfa is one that is especially sensitive to soil depth. Alfalfa depends on its deep root system to supply water during dry periods. The roots of alfalfa have been observed growing as deep as 30 feet. While it is unlikely that they need to grow that deep, alfalfa roots are capable of effectively utilizing eight feet or more of soil depth. Since water is such a critical factor, the following example is given to show how soil rooting depth can affect the amount of water available to an alfalfa crop.

For this example, we will consider a typical silt loam soil found in Kentucky following a good rain which saturated the soil. First of all, not all of the water held by the soil is available to the crop. The part that is available is called the available water capacity (AWC) of the soil. We will assume that the average AWC of our soil is 1.8 inches of water per foot of soil depth. If the soil were two feet deep, it would supply 3.6 inches of water to the growing crop. Based on a requirement of 5.5 inches of available water to produce a ton of alfalfa hay, this soil could produce only 0.65 tons of alfalfa hay per acre. If the soil were eight feet deep, it could supply over 14 inches of water to the crop. This soil could produce 2.5 tons of alfalfa hay per acre.

From this example, it is easy to see why a deep soil has a greater alfalfa yield potential than a shallow soil does. Fortunately, we usually get additional water supplied to a growing crop through rain or irrigation. This helps to reduce the adverse effects of the shallow soils low water supplying capacity. However, in Kentucky we nearly always have period of low rainfall which lead to insufficient water supply. In these situations, the benefits of a deep soil become apparent.

Soil depth also affects the nutrient availability, but not to the same extent that it does water. This is due to the fact that nutrients are concentrated in the surface layer of the soil. Still, there are nutrients in the deeper soil layers that are available to alfalfa roots. These may be secondary and minor elements which are needed only in small quantities. A deep soil gives the alfalfa roots a better chance of finding the nutrients they need.

In the case of shallow soils, it becomes even more important to make sure the nutrients needed by the plants are made available. Even more attention will need to be given to soil testing and fertilizer application.

### Soil Drainage

Too much water in the soil is just as bad or worse for alfalfa plants than not having enough. There are several ways that excess water affects alfalfa plants. One of the most obvious is reduced oxygen availability. Water and air share the same pore space in the soil. The ideal situation is to have air in half the space and water in the other half. In this way, the plant roots have access to oxygen and still have enough water to grow. When the soil is poorly drained due to a restricting soil layer such as a hardpan or to a water table, all the soil pores become filled with water. The plant roots then "drown" because they can't get oxygen. The effects on the plant depend on how often the pore spaces are filled with water and how long they stay that way. If the soil is saturated for only short periods of time, as is the case with well-drained soils, the plant roots are not damaged. As the time of saturation increases, the effects progress from reduced growth to a thinning of the stand to a total loss of a stand.

Poor soil drainage can affect alfalfa plants by increasing the chances for diseases to develop. There are at least two ways this happens. First, the alfalfa roots are weakened by the shortage of oxygen discussed previously. This makes them less able to resist infection by disease organisms. Also, some disease organisms are favored by wet soil conditions. Their populations increase and they become more active enabling them to infect more plants.

Too much soil water has an adverse effect on the nitrogen fixing bacteria that alfalfa depends on to supply the large amounts of nitrogen it needs for good growth. These bacteria are affected directly by not having access to the air that provides the nitrogen for the nitrogen-fixing process. They are also affected indirectly through the reduced vigor of the alfalfa roots. The bacteria depend on these roots to supply food and protection. Without this, they cannot function.

Wet soils also contribute to alfalfa heaving problems in the winter. A wet soil expands more when it freezes than a dry soil does. This expansion pushes the surface roots upward causing the roots to be broken and the plants crown to be lifted out of the soil. At the same time, alfalfa roots in the wet soil are weakened and less able to withstand stress. Heaving can be a major cause of alfalfa stand loss on wet soils.

## Soil Acidity

It is known that alfalfa grows best in a soil with a pH near neutral (7.0). Most Kentucky soils are acid and must be limed in order to get a pH between 6.5 and 7.0 which is recommended for alfalfa. Records of the U.K. Soil Testing Labs show that about 60% of the samples tested for planting alfalfa had a pH of 6.0 or above. These soils would require only moderate rates of lime to raise the pH to 6.5 or above. Thirty percent would need somewhat higher rates. + Ten percent had pH levels below 5.3 and would require large amounts of lime to get them ready for alfalfa production. These should also have the lime applied at least six months before alfalfa is to be planted so it has time to dissolve and neutralize the acidity.

How does soil acidity affect the growth of alfalfa plants? One of the first to consider is the effect on availability of plant nutrients. A part of the acidification process itself involves the replacement of basic cations such as calcium, magnesium and potassium with the acidic hydrogen ions. The soil becomes more acidic as these nutrients are lost through leaching. Availability of the minor nutrient molybdenum is decreased in acid soils because it becomes less soluble due to reactions with iron and aluminum compounds. At the same time that nutrient availability is decreasing due to soil acidity, the levels of other elements such as hydrogen, aluminum and manganese can become high enough to be toxic to plants. This is most often seen in Kentucky as manganese toxicity of tobacco plants. All of these effects combine to reduce plant vigor and make it more difficult for the roots to find and take up the nutrients that are available.

Acid soils adversely affect some beneficial soil organisms. One of the groups affected is organic matter decay organisms. These are necessary to break down the dead plant and animal matter and recycle the nutrients. A more important group is the nitrogen-fixing bacteria. If the soil is too acid, the nitrogen-fixing bacteria will not be able to infect the alfalfa root and form nodules. When this happens, the plants become yellow and stunted. These are symptoms of nitrogen deficiency resulting from the absence of nitrogen fixing bacteria on the roots. The plants will probably never recover.

Fortunately, acid soils can be treated by the addition of lime to help overcome the problems. This needs to be done several months before alfalfa is to be planted because lime dissolves slowly in the soil. Also, the lime should be worked into the soil as much as possible. Lime is slow to move down into the soil; therefore, the subsoil layers are not affected greatly by surface applications. Soils with strongly acid subsoil layers make it more difficult to grow alfalfa. However, a good liming program with the surface plow layer is sufficient to produce a good crop of alfalfa on most Kentucky soils.

### Soil Fertility

A good supply of plant nutrients is very important in growing alfalfa because it is a heavy user of nutrients. Alfalfa has a long growing season - from early spring to late fall. It can be harvested four or five times a year and most of the top growth is removed from the field as hay. Therefore, a six-ton per acre hay crop can remove from the soil 90 pounds phosphate, 360 pounds of potash, 30 pounds each of magnesium and sulfur plus lesser amounts of the minor elements. Most of these nutrients must be returned to the soil in the form of fertilizers. Some soils, however, are able to supply large amounts of nutrients from their own reserves. For example, a study in Warren County showed that a Pembroke soil was able to supply over 300 pounds of potash per acre per year to an alfalfa crop over a six year period. The soil test level of potash in the surface layer decreased from 240 pounds per acre to 145 pounds per acre at the end of the experiment. It took as little as 100 to 150 pounds of potash per acre per year added as fertilizer to keep the soil test at the original level. This contribution from the soil helps reduce the cost of producing alfalfa.

Another "free" nutrient contribution comes in the form of nitrogen from the air. With the help of nitrogen fixing bacteria, alfalfa can remove from the air up to 300 pounds of nitrogen per acre. To add this in the form of fertilizer would cost about 75 dollars. This represents a big advantage of growing legumes.

Sulfur has also been a "free" nutrient for farmers in Kentucky. Adequate amounts have been supplied as impurities in phosphate fertilizer and deposits from the atmosphere. Sulfur is one of the major components of "acid" rain. With the use of high analysis, high purity fertilizer and efforts to reduce air pollution, there may come a need to start supplying the sulfur needs of crops as a fertilizer.

Some alfalfa growers have questioned the use of manures for fertilizing alfalfa. Manure should not be used on alfalfa for several reasons. It is better utilized by non-legume row crops or grasses. Alfalfa does not need added nitrogen which is a major nutrient in manure. Manure can lead to a greater risk of disease problems, especially in new stands of alfalfa. Manure can also lead to more weed problems by adding weed seed and by stimulating the growth of weeds already present.

### Conclusion

There are several soil factors which can affect the yield and longevity of an alfalfa stand. Most of these can be overcome, at least to some extent, through the use of good management practices. If we are able to recognize these factors, and are willing to apply the management practices needed, alfalfa can be grown almost anywhere in Kentucky.