EFFECTS OF SOILS AND FERTILITY ON ALFALFA PRODUCTION

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Alfalfa can be grown anywhere in Kentucky and on a wide range of soil types. This statement seems to contrast with what we are accustomed to hearing in regard to alfalfa. The usual statement is: "Alfalfa requires a deep, well drained and highly fertile soil . . .". Actually, the two statements are not conflicting. They just represent the plant-soil interactions. The first looks at what is possible while the other is concerned with the ideal situation. In order to understand these different perspectives, we need to consider how soil characteristics affect the alfalfa plant.

Soil Depth

The alfalfa plant has the potential to grow roots to great depths. They have been observed growing as deep as 30 feet in some situations. It is unlikely that alfalfa roots grow to that depth very often or that they benefit from it. However, they are capable of effectively rooting to depths of four to eight feet. The alfalfa roots can explore this volume of soil for nutrients and water. Since water is 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 following a good rain and the soil is holding all the water it can.

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. In this hypothetical example, we will assume that the soil has an AWC of 1.8 inches of water per foot of soil depth. A soil two feet deep could supply 3.6 inches of water compared to over 14 inches of water for a soil eight feet deep. If we figure that each ton of alfalfa hay produced requires 5.5 inches of available water, the potential yields for the two soils are 0.65 tons/A for the shallow soil and 2.5 tons/A for the eight feet depth soil.

From this it is easy to see that a deep soil has a greater alfalfa yield potential than a shallow soil does. Fortunately, we normally have more water available in the form of rain or irrigation while the alfalfa is growing. This reduces the adverse effects of the shallow soils' low water supplying potential.

Nutrient availability is also affected by soil depth, but not to the same degree as water. This is due to the fact that nutrients are concentrated in surface layers of the soil. Still, there are available nutrients in the deeper soil layers which alfalfa plants can use. These may be secondary and minor elements which

are needed only in small quantities. In this way, the deep soils give the alfalfa plant a better chance of finding the nutrients it needs.

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

Soil Drainage

Too much water in the soil is just as bad for alfalfa plants as not 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 water. When the soil is full of water, the plant roots "drown" because they can't get oxygen. The effects on the plant depend on how often this happens and how long the soil is saturated. If the soil is saturated for only short periods of time, no adverse effects are observed. As the time of saturation increases, the effects progress from reduced growth to thinning of the stand to a total loss of stand.

Too much water in the soil can affect alfalfa plants by increasing the chances for diseases. 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.

Poor soil drainage has an adverse effect on the nitrogen fixing bacteria of alfalfa. The bacteria are affected directly by not having access to the air that provides them with nitrogen. They are also affected indirectly through the reduced vigor of the alfalfa roots. The bacteria depend on the 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. This increases the pressure on the plant roots. At the same time, alfalfa roots in the wet soil are probably weakened and less able to withstand stress. The roots are broken and the plants are lifted out of the soil to die.

Soil Acidity

Alfalfa is known to grow best in a soil with a pH near neutral (7.0). Most Kentucky soils are acid and must be limed in order to

have a pH between 6.5 and 7.0. How does soil acidity affect alfalfa plants? First of all, the availability of plant nutrients is reduced. Part of the acidification process in soils is the replacement of basic cations such as calcium, magnesium and potassium with hydrogen ions. Molybdenum availability is also decreased in acid soils. As plant nutrients decrease due to soil acidity, other elements such as hydrogen, aluminum and manganese can build up to toxic levels. This reduces the plants vigor and makes 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 group 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 are stunted and yellowed. 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 problem. 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 of lime. Soils with strongly acid subsoil layers make it more difficult to grow alfalfa. A good liming program with the surface plow layer is sufficient to produce a good crop of alfalfa on most soils in Kentucky.

Soil Fertility

Alfalfa is a heavy user of plant nutrients. It grows from early spring to late fall; is harvested four or more times each year, and most of the top growth is removed from the field. In order to produce a six ton per acre hay yield, alfalfa takes up 90 pounds of phosphate, 360 pounds of potash and 30 pounds each of magnesium and sulfur. Most of these nutrients can be added to the soil in the form of fertilizers. Some soils are able to supply the 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. Only 100 to 150 pounds of potash per year was enough to maintain the soil test level. In this case, the cost of producing a crop is reduced. The large amounts of nitrogen needed (up to 300 pounds per acre or more) should be supplied from the air by the nitrogen fixing bacteria. Sulfur is supplied by the soil and from the atmosphere through precipitation.

Conclusion

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