Legumes Role On The Range

Can Yellow Sweet clover and Forager be used as an effective management tool to raise the concentration of protein in areas where the protein value of native grass is low? This high school student conducted research to find out.

By Meghan Johnson, Representing the New Mexico SRM Section

There is an annual concern among livestock producers about the quality of forage and the relationship of economical livestock and wildlife production being determined by the concentration of protein in the forage. Yet, the addition of a usable form of nitrogen into rangeland soil appears to be economically and logistically impossible. Thus, supplemental feeding seems to be the only way to insure adequate animal intake of protein.

Research indicates that biological nitrogen fixation is possible by growing legumes. This is done by the bacteria *Rhizobium*, which has the capability of converting nitrogen gas (N_2), which is available in the atmosphere, into a usable nitrogen, ammonia (NH_3).

I developed a study to determine if specific legumes could be used as an effective management tool to raise the concentration of protein in areas where the protein value of native grass is low. Phase I of this project was designed to determine the possibility that the forage growing in the presence of Yellow Sweet clover (*Melilotus officinalis*), a legume, would have a higher concentration of nitrogen, or potential protein, than the forage growing where the clover was absent.

Phase II of this project focused on inter-seeding Yellow Sweet clover (*Melilotus officinalis*) and Forager Alfalfa (*Medicago sativa, var. forager*) to determine if these legumes could be used as effective management tools to increase the crude protein on native rangeland.

Eight plots were established and analysis took place both prior to inter-seeding and also one year following.

The study site was established on rangelands in Northeastern New Mexico where elevations vary from 6,600 to 8,000 feet and are typical of high rolling plains and short grass prairies. The predominant forages are Blue Grama (*Boutelou gracilis*) and Western Wheatgrass (*Agropyron smithii*). The economy is based on the production of livestock and wildlife.

Understanding Protein & Nitrogen

In studying the needs and requirements for protein, I discovered that nitrogen was needed by the plant in conjunction with water to produce protein (*High Protein Wheat, from Agdex 112/20-4 March, 1997*). Nitrogen is

Photo by Jim Youkom

a primary nutrient for all green plants, and approximately 80 percent of the atmosphere is made up of nitrogen gas (N_2).

Unfortunately N_2 is unusable by most living organisms. Therefore, nitrogen must be modified before it can be used by most living organisms. The fixing of nitrogen, or nitrogen fixation, is a process where certain bacteria in the soil convert atmospheric nitrogen (N_2) to ammonia (NH_3). The ammonia will then dissolve in water and become ammonium (NH_4) which is a form plants can use in biosynthesis of amino acids, proteins, and nucleic acids. This process then determines the protein value of the plant. (*Encarta Encyclopedia, Vol. 4, nitrogen fixation*)

Since plant tissues are the only source of nitrogen for herbivores (*Encarta Encyclopedia, Vol. 4, nitrogen fixation*), it stands to reason that the protein being desired could be raised in the natural forage by increasing the nitrogen available in native rangeland. Addition of a usable form of nitrogen in the form of fertilizer is economically impossible on native range land, but biological nitrogen fixation is possible using legumes.

Legume nitrogen fixation starts with the formation of a nodule on the root. The host plant supplies all the necessary nutrients and energy for the bacteria *Rhizobium* and in turn, the bacteria convert the atmospheric N_2 into biologically useful NH_3 Ammonia. This can be absorbed by the plant and plant populations in close proximity to it because as the bacteria die, they release nitrogen into the environment (*Nitrogen fixation, Guide A-129 NMSU*).

In Phase I of Nitrogen Fixation by Legumes to Improve the Quality and Quantity of Forage on Native Rangelands, it was found that populations of Yellow Sweet clover (*Melilotus officinalis*) are present in the Northeastern New Mexico areas growing in old abandoned fields that were re-seeded. In a study over a two year period, cattle grazing on forage where Yellow Sweet clover (*Melilotus officinalis*) was present received a higher concentration of protein than when they grazed on a forage with no clover present. (*NRCS-USDA test 1999–2000, Ben Creighton ranch*).

Other information suggested that the legume crops could be followed by other forage crops to capitalize on the added soil nitrogen (*North Central Soil Conservation Laboratory*), but no data was found on the influence of protein on native range plants growing in conjunction with a legume. This research showed that when Yellow Sweet clover (*Melilotus officinalis*) was present at sites with Blue Grama (*Bouteloua gracilis*) and Western Wheatgrass (*Agropyron smithii*), the grasses generally exhibited a higher concentration of protein than when grown alone.

Phase II focused on the application of Phase I's findings. If the presence of Yellow Sweet clover (*Melilotus officinalis*) or any other legume, caused nitrogen fixation to improve the status of protein in native rangelands, then inter-seeding in these native rangelands could be used as an effective management tool. This investigation required the establishment of plots in native rangelands where no legumes grew and to inter-seed Yellow Sweet clover (*Melilotus Officinalis*) and Forager Alfalfa (*Medicago sativa, var. forager*). Evaluations of native plant protein prior to plantings and one year following plantings were chosen to obtain study results.

My hypothesis was that: When Yellow Sweet clover (*Melilotus Officinalis*) and Forager Alfalfa (*Medicago sativa, var. forager*) are inter-seeded at a site with native grasses, the legumes will improve the protein value in the native grasses.

Setting up the study included the following procedures:

1) Locate plots on Floyd ranch, Taylor Canyon pasture located 5 miles north of T.O. Ranch headquarters on Highway 87 in Colfax County.
2) Establish eight plots, 9 feet wide by 180 feet long, with 9 feet of untouched land between each.
3) September 2000, set plots as follows:
   a. Control 1 - nothing done to soil
   b. Mix 1 - Disk and seed Forager Alfalfa and Yellow Sweet clover
   c. Alfalfa 1 - Disk and seed Forager Alfalfa
   d. Clover 1 - Disk and seed Yellow Sweet clover
   e. Control 2 - Disk only with no inter-seeding
   f. Mix 2 - Disk and seed Forager Alfalfa and Yellow Sweet clover
   g. Clover 2 - Disk and seed Yellow Sweet clover
   h. Alfalfa 2 - Disk and seed Forager Alfalfa
4) Take two plant samples from each plot for analysis.
5) Using a small tractor, disk, and seeder spreader, plant plots according to plan.
6) Take plant samples to NMSU Clayton Livestock Research Center for drying and analysis for crude protein.
7) September 2001, take two plant samples from each plot.
8) Send samples to NMSU Clayton Livestock Research Center for drying and analysis for crude protein.
9) Record and analyze all data.

What did we find?

When the plots were planted in September, 2000, we had received only 0.25 inches of rain. We received no more in September, however, it started to snow in November, 2000 and between then and March, 2001 we received 42 inches of snow. In May, 2001, we received another 6.6 inches of rain. Early observations of the plots showed an estimated 80% germination of the Forager Alfalfa (*Medicago sativa, var. forager*) and 90% germination of Yellow Sweet clover (*Melilotus officinalis*).

In June, 2001 we received only 0.5 inches of rain. The temperature raised to an unprecedented 95 degrees Fahrenheit and 178 head of mature elk moved into the plots. They remained in the area throughout the remainder of August, 2001; thus, when the plots were evaluated in September, 2001, the grass was short and there was no presence of the Forager Alfalfa or of the Yellow Sweet clover except for three dried stems in the Mix 2 plot.

However, when the data was collected and analyzed, we saw a total increase in the average crude protein of 6.43%. Every plot showed an increase in crude protein, including Control plots.

The analysis showed an increase in total grass production with an increase in grass diversity. The weed density increased in the disked rows as well, mostly of the sunflower population. However, there were no significant differences in Fringe Sage and Snake Broomweed.

My hypothesis was correct. The crude protein did increase in the plots where Forager Alfalfa (*Medicago sativa, var. forager*) and Yellow Sweet clover (*Melilotus officinalis*) were inter-seeded. However, the crude protein also increased in the control plots.

My first thought was that there was an increase in Control 2 plot because of an effect from the disking. However, there was also an increase in Control 1 plot where nothing was done. My second thought was that the weather may have influenced the crude protein increase, but there is really no way to prove this. Another possibility was the elk, but there is also no way to prove that.

Therefore, although I would like to say that my hypothesis was correct, I can only say that it is not proven and that this investigation was inconclusive and must be repeated. The data that was collected brought up many questions about increasing crude protein in native rangelands and demand further studies in order to be answered.

Meghan Johnson's paper earned third place in the High School Youth Forum competition held at the 2002 SRM Annual Meeting in Kansas City.