ARE YOU MAKING A PROFIT GROWING ALFALFA? CAN YOU MAKE MORE WITH FERTILIZER?

Roland D. Meyer, Daniel B. Marcum and Charles B. Wilson
Extension Soils Specialist and Farm Advisors
University of California, Davis, McArthur, and Yuba City

There are perhaps very few producers today who do not have as one of their highest priorities - the profitability of alfalfa. The question arises however as to how this can best be accomplished. Slight adjustments can possibly be made in cultural practices to reduce costs and/or increase profits through better marketing programs. Certainly fertilizer is among those input costs which need to be evaluated, either that sufficient quantities are being used or more than profitable amounts are being applied.

During the past several years fertilizer trials have been conducted which show rather dramatic alfalfa yield responses to phosphorus and potassium. These locations were identified with the aid of soil and plant tissue testing or plant deficiency symptom expression. A number of different fertilizer treatments were applied at each field site to develop an understanding of alfalfa yield response to several nutrients either alone or in combination. Figure 1 illustrates the alfalfa-orchardgrass yield response to phosphorus and potassium either alone or in combination. This type of yield response data is well suited to a particular kind of economic analysis which defines an optimum fertilizer rate. It is defined as the rate of fertilizer at which the yield increase caused by the last increment of fertilizer is exactly equal to the cost of that increment. As the figure illustrates, there is a curvilinear or quadratic line describing the forage response to applied phosphorus. Other yield responses are also shown but the phosphorus will be used as an example. The curvilinear relationship between yield and applied phosphorus can be expressed in the form $Y = a + bx + cx^2$. For use in the economic evaluation, the yield increase over the control may be expressed in the form $Y_1 = sx + tx^2$ where Y_1 is the estimated dry matter yield increase over the control, x is the rate of fertilizer application (lbs P_2O_5/A) and s and t are the constants or coefficients from the yield equation (s = b and t = c). Mathematically the optimum fertilizer rate is the rate at which the first derivative of the response equation is equal to the inverse price ratio.

$$\frac{Px}{Py} = s + 2tx \qquad \text{(Equation 1)}$$

where Px is the price of fertilizer (\$/lb P_2O_5), Py is the price or value of forage (\$/ton DM), s and t are the coefficients from the yield equation and x is the optimum fertilizer application rate (lbs P_2O_5/A).

A sample calculation is as follows:

Assume value of forage is \$70.00/ton DM
Yield equation is $Y = 2.80 + 0.00945\ x - 0.0000177\ x^2$
Thus $s = 0.00945$ and $t = -\ 0.0000177$
Price of fertilizer phosphorus is \$.28/lb P_2O_5 and \$5.00/acre application cost
Substituting in equation (1) above:

$$\frac{.25}{70.} = 0.009451 + 2\ (-0.0000177)\ x$$

$$.0000354\ x = .009451 - .003571$$

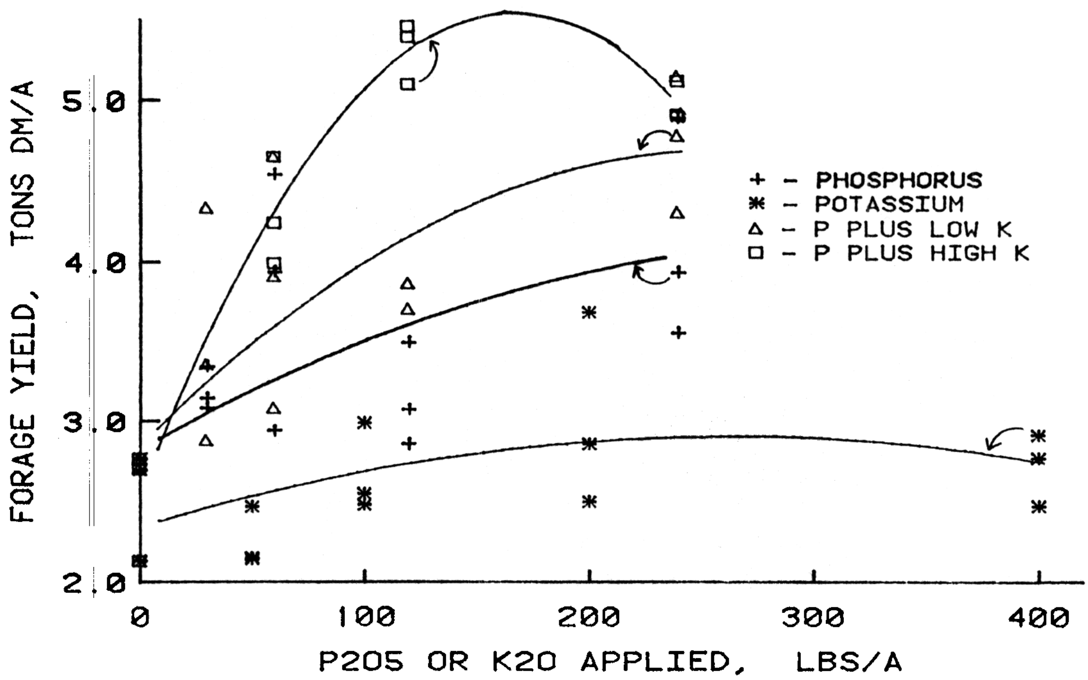
$$x = 166 \text{ lbs } P_2O_5\text{/acre}$$

The optimum economic rate of fertilizer application would be 166 lbs P_2O_5/acre. At this rate of fertilization the return per acre over that accrued with the control or no fertilizer treatment for the one year would have been $ 24.21. Since there would be a response to phosphorus for more than one year and the interest and other costs over several years would become important, the above calculation should be done over several time periods.

At another field site where alfalfa yield response was largely due to applied potassium the optimum economic rate of fertilizer application for the first year was 182 lbs K_2O per acre which resulted in a return over no fertilizer application of $25.59. Again, the optimum rate would also need to be calculated over several years of alfalfa production. Followup applications of phosphorus or potassium would also need to be included in the calculations for multi-year evaluations. Both of the above examples were selected to illustrate this particular technique and the yield responses on individual fields will undoubtedly be different. Some responses to fertilization may be equal to or greater than the examples given while others may be much smaller. Therefore, it is important for every grower to determine if and in which fields or even parts of fields an alfalfa yield response can be expected and whether it will be economical to apply fertilizer.

As I mentioned earlier the examples of fertilizer responses were sited with the help of soil and plant tissue tests or the identification of plant deficiency symptoms. These methods as well as using strips in the field where fertilizer is and is not applied and/or it is applied at double or even triple rates helps to develop the information on which economic decisions can be made. Over the past several years a number of growers have indicated their disappointment or maybe a sense of frustration with the use of soil and tissue tests. When one evaluates more carefully why this may be happening and where in the chain of events problems creep in, the greatest possibility is usually in the sampling of the field. Even when the person taking the sample exercises care in trying to obtain "a good representative sample" the results are often hard to explain when several years of testing indicates unexpected high and low values. This is largely because taking a better or more representative sample of a very heterogenous field which has an extremely wide range in fertility levels does not assist greatly in making decisions about the rate of fertilizer to apply.

Figure 1. Total alfalfa yield response in 1982 to fertilizer applied on soil surface on June 24, 1981.



Recognizing and identifying these widely differing areas of productivity is the first step in improving the usefulness of soil and tissue testing. This might be done most easily by observing the operation of the swather, size of the windrow or number of bales per given area to determine low, medium and high productivity. The suggested guidelines once these areas are identified is to draw a field map which indicates the regions of differing production. Next it is desirable to establish benchmark areas approximately 50' by 50' in size within each of the different productivity areas that can be sampled and monitored over several years time. These benchmark areas should be measured off from permanent markers such as trees, power poles or tags placed in fence rows so that the same small area can be resampled each time, be it several times in the same year or 2 or more year intervals. From each of these benchmark areas collect 10 to 15 random soil cores and/or 50 to 60 individual plant stems to submit to the laboratory for analysis. When the results have come back from the laboratory the decision can be made as to whether to fertilize the productivity areas delineated on the map differently or whether some other soil or cultural practices may be giving rise to the differing alfalfa yields.