Cooperative Extension
Colorado State University, Fort Collins, Colorado 80523

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SOME BASIC PRINCIPLES OF FIELD PLOT TECHNIQUE

Agricultural producers and Extension personnel are exposed to research data which is used to promote a product or variety of a crop. This data originates from many areas including university reports, seed companies and chemical companies. These reports are reputable and accurate; however, there are some reports that may show partial information and are designed to inform only the positive. It is important to be able to evaluate the quality and reliability of the data we read. For this, we need to understand a few basic experimental procedure principles.

There are three essential features of a good experiment ensuring reliable and repeatable results. These features are 1) randomization, 2) replication and, 3) freedom from bias. Each feature is equally important and must be rigidly followed. Any violation causes questionable results and interpretations.

To assure proper randomization, one simply must be sure that treatments are assigned to experimental units at random and not in a way which would bias the results. Assignment of treatments at random can be done by simply picking numbers out of a hat or using a random number table. A common violation of randomization occurs when treatments are assigned to experimental units in some preferential manner so that the product the researcher is selling is assigned to the more favorable experimental units. This technique is easily exploited in nonreplicated strip plots. Therefore, if you are viewing strip plots in which one company has all their product grouped together and their competitors in another group, the treatments were likely not assigned at random.

Replication refers to the procedure of repeating treatments more than once to measure experimental error. Three or four replicates are often used in agronomic research. Experimental error is calculated as the sum of the differences among the replicates which receive the same treatment. Without replication, it is impossible to determine if the differences observed among the products tested are different due to experimental error or if they are real. Replication of treatments can occur at various locations as with using strip plots at multiple locations. However, when replication occurs over locations, the environmental effects become confounded (mixed in with) with the experimental error. Consequently, precision is lost.

During all phases of the experiment the researcher must be careful to keep the data unbiased. A good example of biased data collection occurs when the researcher knows each treatment during data collection. To prevent bias, the researcher should always keep plot identity anonymous. It is more difficult to keep data collection unbiased with large experimental units such as strip tests due to the familiarity the researcher becomes with the visual appearance of the plots.

The field site should be uniform for soil texture, slope, fertility, weed problems, and all previous and current agronomic practices. Avoid conducting research near roadways, field paths, or where the plots may be influenced by the environment. It is always advisable to place a border around the entire experiment to avoid a "border effect" often seen at the edge or end of most fields. Alleys also can cause border effect, so limit them in size and cut them as late in the growing season as possible.

There are many other attributes to good field research. In future articles I'll discuss some other ways to access the accuracy of research results such as knowing the coefficient of variation and the use and misuse of methods to determine whether treatment means are significantly different. Terms such as Tukey's Q, CV, LSD, Duncans, and r values will be described in the next newsletter. (Brick)

SHOULD WOOD ASHES BE PUT ON GARDENS?

During cooler weather, home owners begin using fireplaces and wood burning stoves. Questions regarding the dumping of wood ashes on garden or flower beds are common. Those in the eastern and southern United States claim that wood ashes sweeten "sour soil". In regions where soils are acidic and deficient in potassium and other essential nutrients, an application of wood ashes may be beneficial. However, this practice can be detrimental to Colorado soils.

Wood ashes have a pH of 10 to 11, are high in soluble salts, contain about 5 percent potassium, 20 percent calcium and traces of other minerals. They can increase the salt content of the soil and raise the pH level. The pH symbol indicates the degree of acidity or alkalinity where values of 0 to 7 are acid and 7 to 14 are alkaline. A pH of 7 is neutral.

The first patent issued in the United States dealt with the preparation of fertilizer potassium carbonate, or potash, by leaching and concentrating wood ashes. The process used about five acres of timber to produce a ton of potash. The product from leaching hardwood ashes into large iron pots was called potash.

An experiment conducted at Colorado State University on a garden soil revealed that one part wood ashes to 20 parts of soil increased the soluble salt level to 5.6 millimhos per centimeter (mmhos/cm). One part wood ashes to four parts of soil increased soil pH to 8.5 and soluble salt level to 11.7 mmhos/cm.

In Colorado, most of our soils are on the alkaline side with a pH of 7.5 or higher and most have an abundance of potassium. Therefore, the addition of wood ashes to most Colorado soils can increase the salinity of the soil and decrease the availability of certain plant nutrients by increasing the soil pH. An increase in soil pH may decrease availability of iron, zinc, and even phosphorus. Most garden plants do best if soil pH is 6.5 to 7.5 and soluble salt level is less than 4.0 mmhos/cm. Yields of tomatoes, cucumbers, potatoes, sweet corn, beans and other popular vegetables may be reduced by

25 percent or more if soluble salt levels exceed 5.0 mmhos/cm. Yields may be reduced by 50 percent if levels are above 8.0 mmhos/cm. Most ornamentals are equally sensitive to low to moderate salt concentrations.

Wood ashes are not recommended for garden soils in Colorado. Spread the ashes on icy patches on the walk or dispose of them properly. Make sure the ashes are wet down and cool before disposal. Hot ashes in a paper sack in the garage can be extremely dangerous. (Follett)

CROP RESIDUES FOR LIVESTOCK FEED

Crop residue, that portion of the harvested crop remaining after the grain or marketable portion of the plant has been removed, is an important source of livestock feed in Colorado. Large amounts of crop residues are produced annually. Common residues from cereal grains are: straw from wheat, barley, rye, corn stalks, grain sorghum residue and sugar beet tops. Dry bean and other crop residue are of lesser importance.

These residues can and do provide a sizeable contribution to the total feed supply for livestock production in Colorado. Discussion will address the various crop residues and how to best utilize them in a beef or sheep feeding program.

The quantity of residue produced by various crops is given in Table 1. Using estimates from this table, one could expect approximately 7500 lbs/acre of residue from corn producing 150 bu/acre or 2800 lbs/acre of residue from winter wheat producing 35 bu/acre.

Table 1. Pounds of crop residue/unit of production.

Crop	Unit	LBS
Rye	bu	100
Wheat	bu	80
Barley	bu	50
Oats	bu	40
Corn	bu	50
Sorghum	bu	50
Sugar beets	ton	150

Residue quality is determined by the protein and energy or digestible dry matter (DDM) content as these are the nutrients most important to livestock performance. Corn or sorghum residue and sugar beet tops typically have the highest quality as indicated by greater DDM values (Table 2). Whereas, the cereal grain residues are generally lower in quality. All crop residues are highest in quality at time of grain harvest. Then quality declines with extended time in the field. However, sorghum residue does not decrease in quality as rapidly as corn. An advantage of using crop residues is that the cost of production is generally associated with the production of the grain or marketable product.

Table 2. Crude Protein and Digestible Dry Matter (DDM) of Various Crops at Maturity.

Crop	% Crude Protein	% DDM
Rye	3.0	31
Wheat	3.6	45
Barley	4.1	48
Pats	4.4	50
Corn	4.2	52
Sorghum	6.0	52
Sugar beets	12.7	52

Crop residues are most economically used by grazing. However, because of their lower quality, cereal grain residues do not lend themselves well to grazing. Corn and sorghum residues are well utilized in forage systems, particularly for beef cows. Sugar beet tops are also frequently utilized by beef and sheep producers for grazing purposes.

In general, gestating beef cows can be maintained for approximately 80 days on 2 acres per cow when grazing irrigated corn or sorghum residues. Livestock will also probably require 1/2 to 1 lb/day of a 40% protein supplement as well as vitamin and mineral supplements. A Nebraska study involving grazing gestating cows during fall and early winter on corn and sorghum residues indicated that cows performed equally well on both residues. However, beef cow performance can generally be expected to decline if grazing is allowed to continue beyond early winter, since feed availability and quality decline as the season progresses. This is because livestock typically graze the highest quality (leaves and grain) residue first and leave the lower quality stalks until last. Nutritionally, this is contrary to the needs of the cow. In midgestation, the cow's needs are increasing as the fetus grows. Thus, little supplementation is needed during the first 30 days of grazing. Some protein supplement should be fed thereafter. An excellent practice is grazing of corn or sorghum fields with alfalfa fields after the fall-hardening period for alfalfa to provide protein supplementation.

The quality of crop residues is generally considered inadequate to provide for much weight gain in young cattle or sheep. Thus, young livestock must be supplemented at all times with protein and energy in order to insure adequate performance.

When grazing corn and sorghum residues, it is important to exercise caution regarding management of livestock. Often times, 60 to 150 lbs/acre of grain may remain in the field after harvest. While the grain is an excellent feed for livestock, overconsumption may produce acidosis or founder in cows. There is less problem with grain remaining in the field with sorghum than corn. Additionally, the regrowth that occurs after grain harvest of sorghum may be high in prussic acid or nitrates, particularly after a frost. Both of these compounds can be lethal to livestock if ingested in significant quantities.

Sugar beet tops have long been utilized as a crop residue with very little waste. The best use of beet tops is with sheep, but cattle will also perform well grazing beet tops.

Throughout this discussion the use of protein supplements was mentioned frequently. The type of protein supplements referred to are the naturally occurring proteins such as those from soybean, cottonseed and sunflower. Other protein supplements may contain non-protein forms of nitrogen that must be converted into protein in the rumen. To accomplish this, the rumen must have readily available forms of energy. Low quality crop residues do not have large amounts of available energy to facilitate this conversion. Thus, use of natural occurring protein supplementations with crop residue utilization programs are encouraged to maximize animal performance.

When grazing crop residues in Colorado, it is important to remember that some residue should remain in the field to protect the soil from wind and water erosion. The amount of residue required will depend upon the type of residue and soil type. However, in general, a minimum of 1200 lbs/acre of cereal grain residue and 2550 lbs/acre of corn or sorghum residue is required to provide soil erosion control. Using the residue production figures in Table 1, dryland crops of wheat (35 bu/acre), corn (60 bu/acre) and sorghum (50 bu/acre) would not provide much opportunity for grazing or harvesting of these crop residues and still provide soil erosion control. Therefore, most residue utilization programs should make use of crop residues produced on irrigated land, where residue production levels are much greater. (Shanahan)

UPDATE ON CROPS TESTING PUBLICATION

Harvest operations are complete and all of the data has been analyzed with the computer. Draft copies of Drybean and Corn data have been sent to cooperators for proofing. We are presently doing the final proofing of our information and expect to have publications in the mail on the following dates: Drybeans - December 14th, Corn - January 4th, Wheat (Final Summary) - January 11th, Sunflowers - January 18th and Western Slope Wheat, Oats and Barley - January 25th. (Echols)

SAMPLING SOILS FOR FERTILIZER RECOMMENDATIONS

Soil samples taken for fertilizer recommendations must be representative of the field. To be representative, the sample should indicate average, as opposed to exact, nutrient levels in the field. To determine exact nutrient levels in the field by using a probe of about an inch in diameter, you would need to take about 2,000,000 soil cores per acre. This would take about 11 years to accomplish when sampling at the rate of one sample per minute using an 8-hour day. Of course, it is neither necessary nor practical to be exact. In practice, we take a composite soil sample estimating the mean nutrient value for the field. The closeness of the sample mean to the true mean (called sampling error) depends on the degree of heterogeneity of a soil test value in the field and the number of soil samples taken per field. For example, a soil sample composited from 20 cores from a 20-acre sugarbeet field in eastern Colorado and analyzed for NO_3-N will have a test value in a plus or minus 26% zone around experimental results. Thirty six cores should be taken in order to reduce the error to plus or minus 20%. The 20-26% level of error should be tolerated for practical purpose. For example, to reduce the sampling error to 15% will require 78 cores, which means with more than doubling the core number, we have reduced the sampling error by only 5%.

The sampler should ask three questions before soil sampling: 1) what sampling plan to use, 2) how many cores to take per field and 3) how deep to sample. The answers to these questions should be site and crop specific. We found that in eastern Colorado fields, the grid system of sampling is better than random sampling for NO_3-N. The soil type and cropping and management history should be used as the basis of dividing a farm into different soil sampling fields. This method of segregation will reduce the sampling error and consequently the required number of cores to take per field. The depth of sampling depends on the rooting depth of crops and the ability of nutrients to move into deeper soil layers. Four foot deep samples are desirable for wheat but only 2 foot deep samples are recommended for onions when testing NO_3 -N. Nitrogen is soluble and moves with soil water. Phosphorus does not move into the subsoil and a surface sample is best. In Colorado we recommend taking 1 foot samples in 1 foot increments for NO_3-N and using the top increment for organic matter, phosphorus, potassium zinc, iron and other micronutrients.

For a nitrate test, 4 foot deep samples are recommended for deep-rooted crops such as corn and wheat, but usually, the farmers send us 1 foot deep samples. From this, we estimate profile NO_3-N from the shallow sample. For 80% of the farms, our estimates are fairly accurate. But, on the remaining 20%, the estimates are misleading. Therefore, to improve accuracy, farmers should insist on deeper sampling. The soil samples should be spread on a clean paper and air dried within a few hours to stop NO_3-N release. Moist, warm, bagged samples continue to release NO_3 -N which results in an underestimation of fertilizer needs. For soil sampling, stainless steel or other non-contaminating probes should be used to prevent sample contamination with micronutrients.

In summary, the soil sampler should pay attention to all details such as using clean and non-contaminating tools, drying the sample within a specified time period and other factors discussed above.
(Soltanpour)

Due to a printer error in last month's **AGRONOGRAM** (November, 1990), two lines of text were omitted from the article entitled **Nitrogen Fixation**, pages 2 and 3. Beginning at the top of page 3, the article should have read as follows:

"Moderate phosphorus levels promote fixation. Rhizobia tolerate low temperatures better than high temperatures. Soils high in..."
The rest of the text is correct.

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Sincerely,

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