Cooperative Extension
Colorado State University, Fort Collins, Colorado 80523

Colorado State University

AGRON-GRAM

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CONTAMINATION OF GARDEN SOILS WITH HEAVY METALS IN COLORADO

Garden soils may become contaminated with heavy metals from old mine dumps, metal ore smelters, automobile emissions in high traffic areas and sometimes from deteriorating paints from old homes. Ingestion of contaminated garden soils poses the largest health hazard, especially to children. Growing leafy vegetables in contaminated soils is another route through which metals can be ingested. If you live in an old mining town and your garden is located on metal mine dump materials, if you live on high traffic avenues or near a metal smelter, or in any way you suspect metal contamination, you should have your soil tested. At Colorado State University, we have developed a soil test, ammonium bicarbonate-diethylene triamine pentaacetic acid (AB-DTPA), that can determine soil fertility and heavy metal contamination simultaneously. In 1977, we started using this test and the inductively-coupled plasma spectrometer (ICP machine) which determines many elements simultaneously. The combination of the AB-DTPA test and ICP machine has proven very efficient and useful. In 1977, we received garden soil samples from Aspen, Colorado for a routine soil fertility test. Heavy metal tests were run on the new ICP machine from which we discovered very high levels of lead, cadmium and zinc. Had these samples been sent to other laboratories for a soil fertility test, the heavy metal contamination would not have been discovered. Further testing by the Colorado State Department of Health and the United States Environmental Protection Agency (EPA) have confirmed our findings. United States EPA is committed to clean up the contaminated sites in Aspen in 1991. If your garden soil is contaminated with heavy metals, it should be replaced with non-contaminated soil. Houses located on mine dump materials should be surrounded with turf grass, preventing soil erosion or exposure. Alternatively, the contaminated soil in your yard may be removed and replaced with clean soil, if economically feasible. Lawn clippings should be handled properly as determined on a site- specific basis. If you live close to a metal smelter, have your garden soil analyzed for heavy metals. If outside dust settles in your house, have it analyzed also. If the soil or dust samples are contaminated, contact the State Department of Health and your local County Extension Agent for instructions. (Soltanpour)

COLORADO SOIL FERTILITY SUMMARY

The Colorado State University Soil Testing Laboratory has provided an annual summary of farm samples submitted to the laboratory for the last three years. Annual county summaries are available on request. The data given in Table 1 is the statewide summary of farm samples submitted to the laboratory between July 1, 1987 and June 30, 1990. Each soil test is broken down into six ranges. The number below the range for each test is given in percent distribution of the total farm samples. For some tests, a rating is given for the values (i.e. Very Low, Low, Medium, High, and Very High). Keep in mind that the rating in Table 1 should be used only as a general guide for a soil test value. These values should not be compared to other labs because of different analytical techniques, reporting values and calibration standards. Actual rating of soil test values vary from crop to crop. For example, a soil test value of 8 ppm P (phosphorus) is "Medium" for alfalfa but would be "High" for corn.

The summary provides interesting information relative to routine analysis of soil samples submitted to the laboratory. For example, 85% of the soil samples tested in the alkaline range (above pH 7.0) and only 2% of the samples tested below pH 6.0. Agricultural limestone can be beneficial on soils with a pH 6.0 or less if the subsoil is acid. Eight percent of the samples tested had a conductivity of 4.1 mmhos/cm or higher. Soils testing above 4.0 mmhos/cm are considered saline. It is important to plant the more salt tolerant crops in soils testing above 4.0 mmhos/cm (see SIA No. .505, Crop tolerance to salinity).

Organic matter is the storehouse for nitrogen (N) and other essential plant nutrients. The summary shows that 15% of the soils contain 1.0% or less organic matter. Nitrogen is nutrient most frequently found deficient for crop production. The summary indicated that 45% of the fields tested 10 ppm or less of nitrate nitrogen (NO_3 -N) in the surface sample. Ten parts per million represent about 36 lb/A NO_3 -N fertilizer equivalent in an acre foot of soil. Fifty nine percent of the fields were in the very low to low category for available soil P. The large number of samples testing very low to low for P illustrated a widespread deficiency for field crop samples. Soil testing is the best way to determine phosphorus needs. Only 2% of the soils tested low in potassium (K) while 91% were in the high or very high category.

Zinc (Zn) and iron (Fe) are the only two micronutrient deficiencies that have been verified by actual crop responses in Colorado. Even then, responses have been obtained for only a few "sensitive crops" grown in the state. Crops sensitive to low soil availability of Zn and Fe include corn, sorghum, sudan, potatoes, and beans. Thirty five percent of the fields tested were very low or low in available Zn and thirteen percent were rated marginal. Only 3% of the fields tested low, 8% were marginal, and 89% of the fields showed adequate Fe.

Manganese (Mn) and copper (Cu) deficiencies have not been verified by actual crop response in Colorado. The Colorado State University Soil Testing Laboratory does test for both Mn and Cu on all routine samples. Only 1% of the samples tested low in Mn and 2% were low in Cu.

In summary, only five nutrients are deficient for field crops in Colorado. As indicated in Table 1, they are N, P, K, Zn and Fe. Several experimental locations have shown a response to sulfur (S). The occurrence of other nutrient deficiencies is rare.

The Soil Testing Laboratory also offers an analysis on a request basis for other plant nutrients such as S, boron (B) and molybdenum (Mo). However, these plant nutrients were not included in the summary because of the small number of samples analyzed.
(Follett)

Table 1 Summary of farm soil samples analyzed by Colorado State University Soil Testing Laboratory July 1, 1987 to June 30, 1990.

SOIL TEST	RANGE					
	Acid Range - - - - -		Alkaline Range -			
Soil pH	0-6.0	6.1-7.0	7.1-7.5	7.6-8.0	8.1-8.5	>8.5
% Distribution	2	13	14	47	23	1
	V. Low	Low	Moderate	High	Very High - - - - - - -	
Salts (mmhos/cm)	0-1.0	1.1-2.0	2.1-4.0	4.1-8.0	8.1-12.0	>12.0
% Distribution	73	10	9	5	1	2
% Organic matter	0-0.5	0.6-1.0	1.1-1.5	1.5-2.0	2.1-4.0	>4.0
% Distribution	4	11	21	24	30	10
ppm Nitrate - N	0-5	6-10	11-20	21-30	31-50	>50
% Distribution	23	22	24	12	11	8
	V. Low	Low	Medium	High	Very High - - - - - - -	
ppm P (phosphorus)	0-3.5	3.6-7.5	7.6-11.5	11.6-15.5	15.6-20.5	>20.5
% Distribution	31	28	16	7	5	13
	Low	Medium	High	Very High - - - - - - - - - - - - - - - - -		
ppm K (potassium)	0-60	61-120	121-180	181-300	301-500	>500
% Distribution	2	7	15	34	27	15
	V. Low	Low	Marginal	Adequate - - - - - - - - - - - - - - - - -		
ppm Zn (zinc)	0-0.5	0.5-1.0	1.1-1.5	1.6-2.5	2.6-4.0	>4.0
% Distribution	15	20	13	20	15	17
	Low	Marginal	Adequate -			
ppm Fe (iron)	0-3.0	3.1-5.0	5.1-10.0	10.1-15.0	15.1-25.0	>25.0
% Distribution	3	8	29	20	16	24
	Low	Adequate -				
ppm Mn (manganese)	0-0.5	0.6-2.0	2.1-3.0	3.1-4.0	4.1-6.0	>6.0
% Distribution	1	25	20	15	17	22
	Low	Adequate -				
ppm Cu (copper)	0-0.5	0.6-2.0	2.1-3.0	3.1-4.0	4.1-6.0	>6.0
% Distribution	2	35	25	15	11	12

TESTS FOR AVAILABLE PHOSPHORUS

The amount of available phosphorus extracted from soils can depend on the type of extractant used. The most commonly used extractants in Colorado are ammonium bicarbonate-diethylene triamine pentaacetic acid (AB-DTPA), sodium bicarbonate (Olsen), and a combination of hydrochloric acid and ammonium fluoride (Bray). The Colorado State University Soil Testing Laboratory uses the AB-DTPA test for phosphorus. It is a useful reagent because it can extract phosphorus, nitrate, potassium, and micronutrients simultaneously in calcareous soils. After phosphorus is extracted, it is quantified by measuring the color intensity of a reduced molybdophosphoric blue complex. Soil fertility recommendations for Colorado are based on the AB-DTPA extractant where low phosphorus is 0-3 ppm; medium is 4-7 ppm; high is 8-11 ppm; and very high in greater than 11 ppm.

Some laboratories use another common test called the Olsen's Test where phosphorus is extracted with sodium bicarbonate. In calcareous soils containing calcium phosphates, sodium bicarbonate will decrease the concentration of Ca in solution by causing precipitation of calcium as $CaCO_3$ (a principle similar to the AB-DTPA test). The precipitation of Ca causes the concentration of phosphorus in solution to increase. Sodium bicarbonate will also dissolve iron and aluminum phosphate since the solubility of iron and aluminum is depressed. Generally, twice as much phosphorus is extracted with sodium bicarbonate as compared to AB-DTPA. Ranges for phosphorus availability using sodium bicarbonate as the extractant are low, 0-7 ppm; medium, 8-14 ppm; high, 15-22 ppm; and very high, greater than 22 ppm. Keep in mind that fertility recommendations for Colorado are not based on the sodium bicarbonate extractant. If the "Guide to Fertilizer Recommendations in Colorado" (Cooperative Extension publication XCM-37) is to be used, the Soil test P values in the tables should be multiplied by 2 so that they can be compared to Olsen's laboratory procedures.

Another extractant for available phosphorus is commonly called the Bray test. There are two types of Bray tests. Bray P1 (Bray-1) uses a single solution of 0.03N ammonium fluoride (NH_4F) and 0.025N hydrochloric acid (HCl) while Bray P2 (Bray-2) uses a 0.03N NH_4F and 0.1N HCl. These extractants will easily dissolve acid soluble calcium phosphates. They are most successful on acid soils. There is enough lime in calcareous soils to neutralize the HCl, which makes the extractant less effective. Ranges for phosphorus availability using Bray extractants are very low, 0-3 ppm; low, 3-7 ppm; medium, 7-20 ppm; and high, greater than 20 ppm. Again soil fertility recommendations are not based on the Bray extractant and it is difficult to relate phosphorus levels of soils extracted with Bray reagents to P levels from soils extracted with AB-DTPA. While the Soil Testing Laboratory can do the Bray test, it is generally not performed unless the customer specifically requests it or the soils are quite acid.

The extractants for phosphorus can make a difference in the amount of phosphorus determined to be available to plants. Being aware of the types of tests used to extract phosphorus could make a difference in the amount of P_2O_5 applied to the soil to correct deficiencies.
(Self)

ROTATION and TILLAGE

Many terms about conservation tillage have been coined during the last 20 years including minimum till, chemical fallow, reduced till, and no till. During this period, crop rotation may have taken the back seat. Crop rotation needs to be re-examined.

Historically, crop rotations have been recommended to improve soil physical condition, help maintain organic matter and nitrogen availability, reduce erosion. Crop rotation develops different root feeding patterns resulting in improved water and fertilizer efficiency. Researchers still have much to learn about interactions between rotations and CT. Most research has been done with corn, soybeans and alfalfa but evidence indicates that rotations are going to be as important as they were 30 years ago.

We know that when planting soybean before corn, we should then get a 10-15 bushel yield increase. Pinto beans in the rotation are expected to cause similar responses in Colorado. Corn planted after alfalfa will get about 50-70 pounds of N from the previous crop and rotating corn each year should eliminate the need for corn rootworm control. Yield increases or expense savings are real and improve net income.

Rotations will reduce crops disease. Certain pathogens remain from one year to the next in the soil, living on plant refuse. When susceptible crops are grown continually, pathogens may increase to a point where control can be difficult and costly. It is for this group of pests that rotation has the most potential as a control measure. White mold, Sclerotinia sclerotiorum, a very tenacious disease capable of infecting dry beans, sunflower, safflower, canola and other crops is prevalent throughout the state. Fusarium solani and Rhizoctonia solani are capable of causing root rots in a wide host range. Disease caused from these pathogens usually can be reduced by crop rotation. Barley Yellow Dwarf and Wheat Streak Mosaic, both insect-transmitted viruses, may come from infested adjacent fields. Goss's wilt may create severe problems on early, susceptible corn varieties, planted to continuous corn. Another serious pest is the Russian Wheat Aphid, which thrives on wheat or barley and will survive and multiply on other small grains and wheat grasses. Pest management, while much improved, is still not without problems, even when rotations are practiced. Insects like the European corn-borer and cutworms may still be a problem. A corn-dry bean rotation may reduce disease but may increase western cutworm attack. Corn planted next to winter wheat may contribute to the incidence of Wheat Streak Mosaic, and sunflowers planted after dry beans may increase white mold.

Weed control has seen much improvement in recent years and rotation has potential for further improving weed management. Not all weeds can be controlled by crop rotation, but weed problems are likely to be less severe on farms where rotations are practiced. Rotating, for example, from corn to beans, will allow the grower to use different herbicides designed to fight grass weeds, a major problem in CT farming.

The soil environment is changed when either tillage or crop sequence change. Tillage changes allowing heavy surface residue will improve surface soil moisture and decrease surface soil temperatures. The upper soil profile is usually more compacted on CT fields as opposed to using the moldboard plow. Pesticide degradation may or may not change depending on surface organic matter, the amount of clay present in the soil and the type of chemical involved

Crops in a rotation help determine whether you can expect a soil loss from wind or water. In most cases, you would expect rotations to be a good soil conservation strategy. Dry bean fields are subject to erosion after harvest unless clods are brought to the surface. Some producers have been successful planting winter wheat after dry beans on irrigated fields reducing exposure time of bare soil.

Rotations and conservation tillage work together to boost the benefits of each. Sound rotational planning can reduce soil fertility demands, pesticide applications, conserve water and reduce insect and disease severity while still maintaining yield. This is really just good sound management. (Croissant)

CERTIFIED FORAGE TESTING LABS

Fall is an important time of the year for marketing forage crops. It has become more common for potential buyers and sellers of forages to use the laboratory analysis results indicating quality for marketing purposes, with visual analysis becoming less important. Crude protein (CP) and acid detergent fiber (ADF) have become the accepted ways of representing the value of forages for livestock performance. However, results may vary, depending upon the laboratory conducting the analysis. In an effort to standardize forage testing nationwide, the American Forage & Grassland Council and National Hay Association have established a voluntary national testing program. Potential labs interested in becoming certified are given forages samples for analysis. If the determined values for CP and ADF for the test sample fall within an acceptable range of accuracy, the lab receives certification. Listed below are the Colorado labs which have been certified for 1990:

Agricultural Consultants, Inc.
240 South Main
Brighton, CO 80601

Denver Grain Inspection
204 South Main
Wiley, CO 81092

Fas-Test Forage Lab., Inc.
P.O. Box K
Windsor, CO 80550

Monfort of Colorado, Inc.
P.O. Box G
Greeley, CO 80632

Weld County Agric. Labs
1527 First Ave.
Greeley, CO 80631
(Shanahan)

SEED STORAGE

With most seed crops harvested, the next step in seed production is the storage, until the conditioning process begins. In Colorado we are blessed with a climate that is conducive to good seed storage, i.e. moderate temperatures and low humidity. But just because conditions are good doesn't mean that the quality storage is automatic. A successful seed storage program doesn't just happen--it must be planned.

Some seed storage problems are:

- Low quality seed being placed into storage.
- Seed stored with high moisture content.
- Old seed.
- Storage of short lived seeds (onions or soybeans).
- Unfavorable warehouse conditions.

Seedsmen should be aware of these potential problems and adjust seed management practices to improve quality.

Low quality seed placed in storage is a major problem in Colorado. Research has shown that seed, damaged in the field during harvest, tends to deteriorate quicker than high quality seed. Because of this deterioration, we find that planning for storage begins in the field. Therefore, timely harvest and knowledge of harvest equipment are an important part of a good storage program.

Once seed is in storage, we must contend with several principles affecting storability. They are:

- Good storage decreases the rate of seed deterioration.
- Seed deterioration is an irreversible process.
- The deterioration rate varies between species, varieties, lots and individual seeds.

Increased problems with growth rate, storability, resistance to environmental stress, uniformity, emergence and yield are all problems that can arise due to seed deterioration caused by storage problems.

Seed storage problems occasionally occur. Loss of seed vigor ultimately ends in seed death. However, if the problem is recurring, the seedsman should carefully analyze the situation and think through his overall storage requirements and facilities in terms of what is known about seed storage. Corrective actions will then be more likely to alleviate the problem.

We must remember that a seed is a living organism and it must be stored in a method that will allow it to maintain that life. (Stanelle)

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Shanahan, John F. Extension Agronomist-Forage, Colorado State University
Soltanpour, Parvis N., Extension Agronomist-Soils Fertility, Colorado State University
Stanelle, James R., Manager, Colorado Seed Growers Association, Colorado State Univ.

Sincerely,

Robert L Croissant

Robert L. Croissant
Extension Agronomist - Crops