FROM THE GROUND UP

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AGRONOMY NEWS

Volume 16, Number 11 NOVEMBER 1996

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CCA EXTENDS WAIVER

The Certified Crop Advisors Board extended the waiver of fees for the CCA exam through 1997 for public and not-for-profit employees. Extension educators may take either of the 1997 exams without paying the national fee. It is anticipated that all will be required to pay the full fees in 1998 and beyond. To date, over 8,000 individuals have successfully completed the CCA exam and have been certified. To remain certified, individuals must take at least 40 units (generally hours) of continuing education during every two-year period. The CCA Board and Advisory Committee is devoting considerable attention to assuring adequate educational opportunities are available to help keep CCA members current. It is a great opportunity/ responsibility for Extension, teaching, and research staff to provide some of this education. ☛Waskom

LET IT SNOW, LET IT SNOW, LET IT SNOW! BUT WHAT'S HAPPENING DOWN BELOW?

It's that time of year again. Time to put up your combine and get out your skis!. While you're heading down the slopes, do you ever wonder what's going on below you? No, I'm not referring to the bodies (and remnants) of skiers who have gone before. But what about the impact of snow on soil temperature and microbial activity?

Snow cover moderates soil temperature change by acting as an insulator, and, therefore soils with snow cover are less subject to large daily temperature changes. When there is no snow cover, frost penetrates deepest. A very dense, wet snow cover is similar to flooded conditions with limited aeration, but a light, fluffy snow would have greater air-filled porosity and greater potential for gaseous diffusion through the snow cover.

Why is gaseous diffusion important? Gaseous diffusion plays an important role in potential contributions to global warming by methane (from landfills and ruminant livestock) and carbon dioxide (from microbial and plant respiration). Diffusion of gases is critically important in relation to N use efficiency, losses of ammonia and nitrous oxide to air, and nitrate losses to

groundwater. Maximization of ammonia volatilization losses is sometimes encouraged by livestock manure managers in order to minimize the potential for nitrate leaching. In other situations, ammonia loss is related to odor problems and complaints from the neighbors. Ammonia volatilization is influenced by soil temperature; as soil temperature decreases, volatilization of ammonia is also decreased.

Therefore, manure applications to frozen soils are discouraged since the manure can not be effectively incorporated into frozen soils.

As soil temperatures decline, microbial populations and activity decrease and respiration (both by roots and microbes) and other bacterial processes (such as mineralization, nitrification, and denitrification) decline. However, individual microbial species differ in their optimal temperature range. Most microbial activity stops at 0 C (32 F), but psychrophilic bacteria are capable of growth below freezing temperatures. Vapor movement tends to go from warm to cold parts of the soil, due to the higher velocity of the warm gas molecules.

Wide climatic variations occur within short distances in Colorado. Average annual snowfall varies from nearly 25 feet at Cumbres Pass to less than 25 inches at Manassa in only a 30-mile distance. In general, temperature declines and precipitation increases with increasing elevation. Near the soil surface, soil temperatures follow air temperatures quite closely. As depths increase, soil temperature lags behind air temperature changes, and the annual range of soil temperatures diminishes. At 2 feet deep, the seasonal cycle lags behind the surface by two to three weeks, but at 9 feet deep, the temperatures lag by nearly three months of the surface temperatures. The deeper the depth, the less temperature change on a daily basis.

Currently, the economic loss to U.S. producers associated with ECB damage is estimated to be nearly $800 million annually on 20 million acres.

The first fall frost is agronomically important because if it arrives early, yield and quality can be damaged. The freezing and thawing action in the spring can have a significant effect on crop stand establishment and winter hardiness of perennials. The number of thaw cycles is greater in the spring than in the fall at all elevations. The process of freezing and thawing can create fractures in the soil which enhance gaseous diffusion.

Land application of manure and sewage sludge should be managed with the concepts discussed above in mind. Recommendations pertaining to these applications usually state to incorporate manure as soon as possible to minimize ammonia volatilization. Therefore, manure applications to frozen soils are discouraged since the manure can not be effectively incorporated into frozen soils. In addition, when the snow melts, there is enhanced runoff potential of manure nutrients. When soil temperatures are low, the microbial process of mineralization is slowed considerably. Thus, the organic N is not transformed to inorganic forms until the temperatures rise in the spring. However, the N already in the ammonium form could be volatilized during thawing periods. If manure is not incorporated into soil, the gaseous diffusion process is enhanced due to reduced length of the diffusion pathway and reduced ammonium fixation.

So as you careen down the mountain on your skis, think about all those other processes which slow down at low temperatures--besides your ability to make good judgments. Go inside by the fire, get some hot-buttered rum, and think about the N losses back at home drifting away above your fields where you haven't incorporated your manure application yet. ☛Davis

MANAGING CORN PESTS WITH BT CORN

Bt-corn has been heavily featured in many farm-oriented publications in 1996 and some growers will have first-hand experience growing it in 1996. Bt-corn refers to corn that has been genetically engineered using recombinant DNA technology to express a protein that is toxic to certain groups of insects, including European Corn Borer (ECB). Currently, the economic loss to U.S. producers associated with ECB damage is estimated to be nearly $800 million annually on 20 million acres. Although several companies have been working on Bt-corn, only two, Ciba and Mycogen, had Bt-corn hybrids registered by the EPA and available for sale in 1996. Registrations for Bt-corn from other companies are pending. Ciba Seeds' Bt-corn has the trademark Maxi[illegible]er

hybrid corn with KnockOut. Mycogen's Bt-corn products are called Naturegard. These two companies produced enough Bt-corn seed to plant an estimated 400,000 to 650,000 acres in 1996. Monstanto has also developed Bt-corn and their products will be marketed in 1997 under the trademark of YieldGard. The marketing of the Monsanto Bt product will occur through collaborative arrangements with other seed companies including Dekalb, Golden Harvest, and Northrup King. Pioneer Hi-Bred Int., ICI, and Cargill are also planning to offer Bt-corn hybrids in 1997. The preceding list of companies offering Bt-corn is not intended to be exhaustive, as several company registrations are pending.

The following represents a question and answer discussion regarding Bt-corn prepared by Frank B. Peairs Extension Entomologist Department of Bioagricultural Sciences and Pest Management at Colorado State University.

Some Questions and Answers

1. ***What is Bt?*** Bt is shorthand for a common soil-inhabiting bacteria called *Bacillus thuringiensis*. Bt also refers to insecticide products made from the bacteria.

2. ***What does Bt have to do with insect pests?*** Some strains of Bt kill insects because they produce toxins called *insecticidal crystal proteins* or *delta endotoxins* (Δtx).

3. ***How is the insect exposed to Bt?*** Δtx are stomach poisons. In other words, to be effective they have to be eaten by the insect.

4. ***How does Bt kill insects?*** Δtx rapidly paralyze the insect's digestive system, so damage to the plant stops soon after the insect is exposed to the crystals. Mortality may take several days, so the effects of Δtx are very different from what we expect from conventional insecticides.

5. ***What pests are controlled by Bt?*** Different strains of *Bacillus thuringiensis* produce different forms of Δtx -- many are toxic to caterpillars such as European corn borer, while others are toxic to flies (mosquitoes, for example) or beetles (Colorado potato beetle, for example).

6. ***Are Bt insecticides something new?*** Insecticides consisting of dead Bt and Δtx have been sold for many years (for example, Bactimos, Biobit, Dipel, Javelin, Teknar, Vectobac).

7. ***Is Bt safe?*** The Δtx are considered to be much more selective and safer for humans and nontarget organisms than most conventional insecticides.

8. ***What is Bt corn?*** Production of Δtx is controlled by a single gene in the bacteria. A modified version of this gene can be put in corn. Corn plants containing the gene will produce Δtx and be toxic to insects that are susceptible to that form of the protein.

9. ***Why use the Bt gene in corn?*** A problem with Bt insecticides is that the Δtx break down quickly when exposed to UV light. Δtx produced in the plant remain effective because they are protected from UV light. Also, several of the major pests of corn are difficult and expensive to control with conventional insecticides, but are susceptible to Δtx. Finally, the biotechnology to insert the toxin producing Bt gene into corn is available.

10. ***Is the entire corn plant toxic?*** It depends where Δtx are produced. In the plant it is controlled by two factors, the *event* and the *promoter.* Different seed companies use different *events* and *promoters,* so their hybrids will also be different in what plant tissues produce Δtx. The Insertion *event* is physical act of putting the Bt gene into corn plant genetic material. This is when the physical location of the Bt gene is determined (which chromosome, what part of the chromosome, etc). Gene location affects where in the plant Δtx are produced and how much Δtx is produced. Currently, we do not have the technology to control Bt gene location, so each *event*

results in plants that differ in where and in how much Δtx are produced. The *promoter* is a genetic switch that tells the inserted Bt gene when and where to produce Δtx. Several different *promoters* are available and the choice of promoter also affects where and how much Δtx is produced in the corn plant, leading to differences among hybrids.

11. ***Will all Bt corn hybrids give the same level of control?*** *Events* and *promoters* also affect how much Δtx are produced in each tissue, so hybrids are expected to provide different levels of control. Select Bt corn hybrids carefully and ask for insect control data that are specific for the ones that you are interested in growing.

12. ***Can I grow Bt corn next year?*** Several seed corn companies have produced hybrids that produce Δtx. These were available on a limited basis this year and should be widely available in 1997.

13. ***Will Bt corn do well in my area?*** Only a few hybrids, with a limited range of adaptation, are currently on the market. A wider selection of hybrids will become available over the next several years, providing more options in terms of maturity, area of adaptation, etc. Study performance tests from your area to select a well-adapted hybrid.

14 ***Is Bt the only trait that has been genetically engineered into corn?*** Other hybrids with genetically engineered traits, such as herbicide resistance and improved feed quality, are available or will be available soon.

15. ***Is corn the only crop that has been genetically engineered with Bt?*** No, other crops have been modified to produce Δtx, including cotton and potato.

16. ***What kind of European corn borer control can I expect from Bt corn?*** Control of first generation is expected to be excellent. Control of second generation European corn borer varies among hybrids but control should be as good or better than is generally achieved with a single well-timed insecticide treatment.

17. ***What about the other corn pests that I have to deal with every year?*** Bt corn will control some other corn pests such as southwestern corn borer, but will have no effect on others such as corn rootworms and western bean cutworm.

18. ***Are there other advantages to using Bt corn instead of an insecticide to control corn borers?*** Bt corn will control corn borers without affecting predators and other beneficial insects. This may make management of other pests, such as spider mites, easier.

19. ***Are there disadvantages to using Bt corn compared to conventional corn borer control?*** There wi cost premium to Bt corn seed regardless of whether there is an economic corn borer infestation. Conventional chemical control allows you to wait and see if an infestation develops.

20. ***What will be the cost premium for Bt corn seed?*** It will cost about $8.00 per acre to use Bt corn. This figure will probably drop to $4.00 - $5.00 per acre as more hybrids become available and more companies enter the market.

21. ***Can I plant Bt corn and forget about insects and mites?*** Insect and mite scouting and management will still be necessary since only a couple of corn pests are controlled. The table below gives the major corn pests and the expected (not all the necessary research has been done) effect on them by Bt corn.

22. ***When should I start using Bt corn in my operation?*** If you are interested in this new technology, now is a good time to start testing Bt corn hybrids to convince yourself that they are an effective and economical option for your operation.

23. ***How severe does my yearly corn borer problem have to be to justify switching to Bt corn?*** Take a look at your average expenditures for corn borer management (scouting, insecticides, application) and your average losses to corn borers over the last 5 years. Your annual total of management costs and crop value lost should be similar to the cost of switching.

24. ***Should I plant all of my corn acreage to Bt corn?*** No (see questions 25-27)! How much you do plant depends a lot on how severe and consistent your corn borer problem is. Your average annual total of management costs and crop value lost to corn borers over the last 5 years should give you a rough idea of how much to spend on Bt corn seed premiums. Use this seed in situations with higher corn borer risk (with European corn borer, for example, in the earliest and latest planted fields).

25. ***Will corn borers eventually overcome the Δtx produced by Bt corn, as greenbugs do to the resistance in sorghum hybrids?*** Insects can develop resistance to Δtx. This is a major concern for all Bt-modified crops because they put so much selective pressure on the pest.

26. ***What are seed corn companies doing to avoid corn borers becoming resistant to Bt corn?*** Seed corn companies will have some sort of resistance management requirement for their hybrids, but details are not yet available. For example, Bt cotton growers are required to plant 5% of their acres to susceptible cotton that cannot be treated with any form of Bt.

27. ***What can I, as a grower, do to help avoid the development of corn borers that are resistant to Bt corn?*** Follow the resistance management recommendations provided by Cooperative Extension specialists and by your seed company. Use good agronomic practices to avoid unneeded crop stress. Report any suspected failures to the seed company and to local Cooperative Extension entomologists.

28. ***How do I tell if I have a Bt corn failure?*** Identifying resistance to Bt corn is a complicated process. A few damaged plants in a field may not be a sign that resistance has developed. For example, the occasional susceptible plant may get into a field either from the seed source or as volunteer plants. If frequency of damaged plants seems unusually high, however, it should be reported.

29. ***Are there ways to make future Bt corn hybrids less prone to resistance development?*** Some future hybrids will have combinations of different Δtx forms that should have fewer problems with resistance development. Others may have different genes that produce different toxins such as scorpion venom. Hybrids with toxin combinations should be less likely to have problems with resistance development in pest insects.

CORN PEST	EFFECT OF BT CORN	COMMENTS
Armyworm	Not controlled	Some effect on growth rates, some control may occur if infestation starts with small larvae. Potential for control with other Δtx forms
Corn rootworm adults	Not controlled	
Corn rootworm larvae	Not controlled	Hybrids with Δtx toxic to rootworm larvae under development.
Corn leaf aphid	Not controlled	Less insecticide use for corn borers could make aphid less of a problem since outbreaks are often triggered by chemical control of other pests.
Corn earworm	Some suppression in some hybrids	Δtx must be produced in silk, which some hybrids don't do. Will control larvae that feed in whorl early in season (not common).
Cutworms	Not controlled	
European corn borer	Controlled	Main target of Bt corn. Research results indicate 100% control of first generation and slightly lower control of second generation.
Fall armyworm	Not controlled	
Grasshoppers	Not controlled	
Southwestern corn borer	Controlled by some hybrids	Not tested as much as European corn borer.
Spider mites	Not controlled	Less insecticide use for corn borers could make spider mites less of a problem since outbreaks are often triggered by chemical control of other pests.
Western bean cutworm	Not controlled	
Wireworms	Not controlled	

Acknowledgments

I would like to thank Gary Hein, University of Nebraska, Scottsbluff, Jerry Johnson, Stan Pilcher, and Elaine Roberts, all of Colorado State University, and Phil Soderbeck, Kansas State University, Garden City, for reading and commenting on earlier versions.

INTEGRATED CROP MANAGEMENT WORKSHOPS

Theoretical and practical aspects of soil, crop and pest management will be the topics of the 1996 Integrated Crop Management Workshops.

The workshops, offered December 9-10 at Friendship Hall in Montrose, December 11-12 at the University of Southern Colorado Student Center in Pueblo, and December 16-17 at the Colorado State University Lory Student Center in Fort Collins, are sponsored by

Colorado State University Cooperative Extension. Hands-on programs will provide continuing education for consultants, managers, crop advisers, sales and technical personnel. Topics to be discussed include:

- making better variety decisions;
- predictability of variety performance;
- herbicide formulations, surfactants, and mode of action;
- reducing weed control costs;
- fertilizer selection, management and application;
- fertigation; and
- soil compaction.

Each 1.5-hour session will provide 1.5 continuing education units for Certified Crop Advisers, for a total of 12 units.

Workshop preregistration, due by November 15, is $50.00 for one day and $80.00 for two days. Late registration is an additional $10.00. Registration includes lunch and reference materials.

For additional information or to register, contact Pamela Chase, Department of Soil and Crop Sciences, Plant Sciences Building, Colorado State University, Fort Collins, CO 80523, telephone 970/491-6201, fax 970/491-2758.

Professional development funds have been obtained and registration fees will be waived for all Cooperative Extension staff attending. However, if you are interested in attending, we would still appreciate that you contact us and preregister to maintain an accurate enrollment count. ☛Shanahan

Based on USDA statistics, total US dry bean production is down in 1996 compared to 1995 or 1994, while domestic consumption is slightly higher than five years ago, and the export market remains firm.

PLANNING YOUR 1997 BEAN CROP

It's not too early to start planning the 1997 bean crop. Now is the time to take soil samples and consider which bean varieties you want to grow next year. With relatively moderate bean prices and high corn and wheat prices, many growers may concentrate on corn and wheat production. However, the long term future of pinto beans looks good for the US producers. Based on USDA statistics, total US dry bean production is down in 1996 compared to 1995 or 1994, while domestic consumption is slightly higher than five years ago, and the export market remains firm.

Soil samples should be taken before the fields become frozen and/or inaccessible. Sampling the soil to determine the soil pH, salt content, organic matter, phosphorus, potassium, and micronutrient content should be taken from the tillage zone, 8 inches or deeper. Samples for soil N should be taken down to 12 inches in the soil profile. The appropriate number of samples will depend on the amount of variation in the field. Large fields that are very uniform may need only one or two samples per acre. Combine the samples collected within each field or sampling area, mix thoroughly and submit a representative subsample to a reputable soil testing laboratory. Fields that vary in soil texture, slope or other factors should be partitioned into smaller areas which can be fertilized according to their specific nutrient needs. If a field is partitioned, it is essential to draw a good field map with the areas clearly numbered or labeled to correspond with the soil samples taken in that portion of the field. Fields with variation should be more extensively sampled than more uniform fields.

Now is also a good time to select the varieties to plant in 1997. Results from the Colorado State University Crop Testing Program are available from Cooperative Extension offices, on the Internet, and have been published in the Colorado Bean News. Results from numerous strip trials conducted in eastern Colorado and western Nebraska will be available soon. Among the newer varieties, such as, Apache, Chase, Vision, Maverick and others, all have some weakness. Apache appears to be one of the best, combining acceptable maturity, rust resistance and good seed quality; however, it is susceptible to common bacterial blight and has average yield performance. Chase has high yield potential, rust resistance and broad spectrum disease resistance but is somewhat late and has

poor seed quality. Vision has high yield potential, rust resistance and excellent upright architecture but is late maturing. Maverick has upright growth habit rust resistance but is somewhat late and has moderate seed quality and yield. A new experimental line from the USDA, USWA 19, appears to have excellent potential because it combines acceptable maturity, good seed quality and high yield potential, but seed supplies will not be available in 1997. Some of the established varieties such as Bill Z, UI-126 and others still perform better than the newer varieties if a good integrated pest management program is utilized. ☛Brick

For sites contaminated with toxic metals and/or radionuclides, hyperaccumulator plants (plants that can accumulate heavy or trace metals up to several thousandfold in excess of the soil or root substrate concentrations) are grown to "biomine" the soil.

Sunflower acts in rhizofiltration. It has been used in removing radioactive waste from water and has been used to remove uranium, strontium, and cesium.

INCREASING POTENTIAL OF NEW CROPS IN PHYTOREMEDIATION

Efforts to clean up our air, water and soil are increasingly focusing on the use of plants as a low cost alternative to conventional methods of environmental remediation. Phytoremediation is an emerging cleanup technology based on the well-known ability of plants to take up and concentrate contaminants in their tissues. The use of plants to clean-up contaminated environments has an intuitive appeal. In natural ecosystems plants act to filter and recycle potentially toxic substances generated by nature itself. Plants are effective at remediating soils contaminated with organic chemical wastes such as solvents, petrochemicals, wood preservatives, explosives, and pesticides.

For sites contaminated with toxic metals and/or radionuclides, hyperaccumulator plants (plants that can accumulate heavy or trace metals up to several thousandfold in excess of the soil or root substrate concentrations) are grown to "biomine" the soil. The plants are then harvested and thermally treated or bioprocessed to further concentrate the contaminants prior to final disposal. Advantages of Phytoremediation are:

- much more cost-effective than conventional technologies
- the only technology feasible for large land areas
- organic pollutants can be degraded to CO2 and water
- treatment is in situ and does not require removal and isolation of contaminated soil
- plants can tap into and use polluted ground water to prevent contaminants from spreading off the site
- contaminated land can be reclaimed for agricultural use

Currently, the major drawback of phytoremediation is the slow rate at which contaminants are removed.

Four methods of phytoremediation technology are possible: rhizofiltration, phytoextraction, phytostabilization and phytodegradation. Rhizofiltration involves absorption of heavy metals and radioactive elements from water by roots with potential distribution to stems and leaves. Phytoextraction involves extraction by roots, stems and leaves. Phytostabilization uses plants tolerant of the contaminants to contain mobility and prevent additional movement of the contaminant. Phytodegradation involves using plants to breakdown contaminants, especially organics.

Several new crops and relatively new crops can be used in phytoremediation efforts. One example is sunflower. Sunflower acts in rhizofiltration. It has been used in removing radioactive waste from water and has been used to remove uranium, strontium, and cesium. Uranium accumulates in the roots and strontium and cesium in the stems and leaves. Estimates of cost to remove these metals range from $2 to $6 per 1,000 gallons of water - a bargain when compared to $80 per 1,000 gallons for conventional processing. Another example is brown mustard. Brown mustard is an oilseed crop capable of removing both heavy metals (selenium) and radioactive contaminants (cesium-137 and strontium-90). Phytodegradation of organics such as petroleum hydrocarbons, solvents and TNT, are being investigated using rye grass, fescues and clovers. While the crops used generally cannot be used to feed livestock, additional technologies may soon decontaminate the vegetation making it suitable as livestock feed. The

USDA expects phytoremediation could become a major industry within 5 years. (This article was adapted for a USDA-ERS publication (Aug. 96.) Industrial Uses of Agricultural Materials-Situation and Outlook Report. ☛DJohnson

NEWSLETTER AVAILABLE ON WEB

As of now, our Newsletter will also be available on our department Web page. The address for this page is:

http//www.colostate.edu/Depts/Soil Crop/.

It can be found under Extension information on this page. The file is in the Adobe Acrobat PDF format and can be viewed and printed with the same software as used for SIAs. ☛Shanahan

FAX

Just a reminder that we now have our own fax machine. The number is:

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Sincerely,

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