Bulletin 760

Most Asked Agronomic Questions

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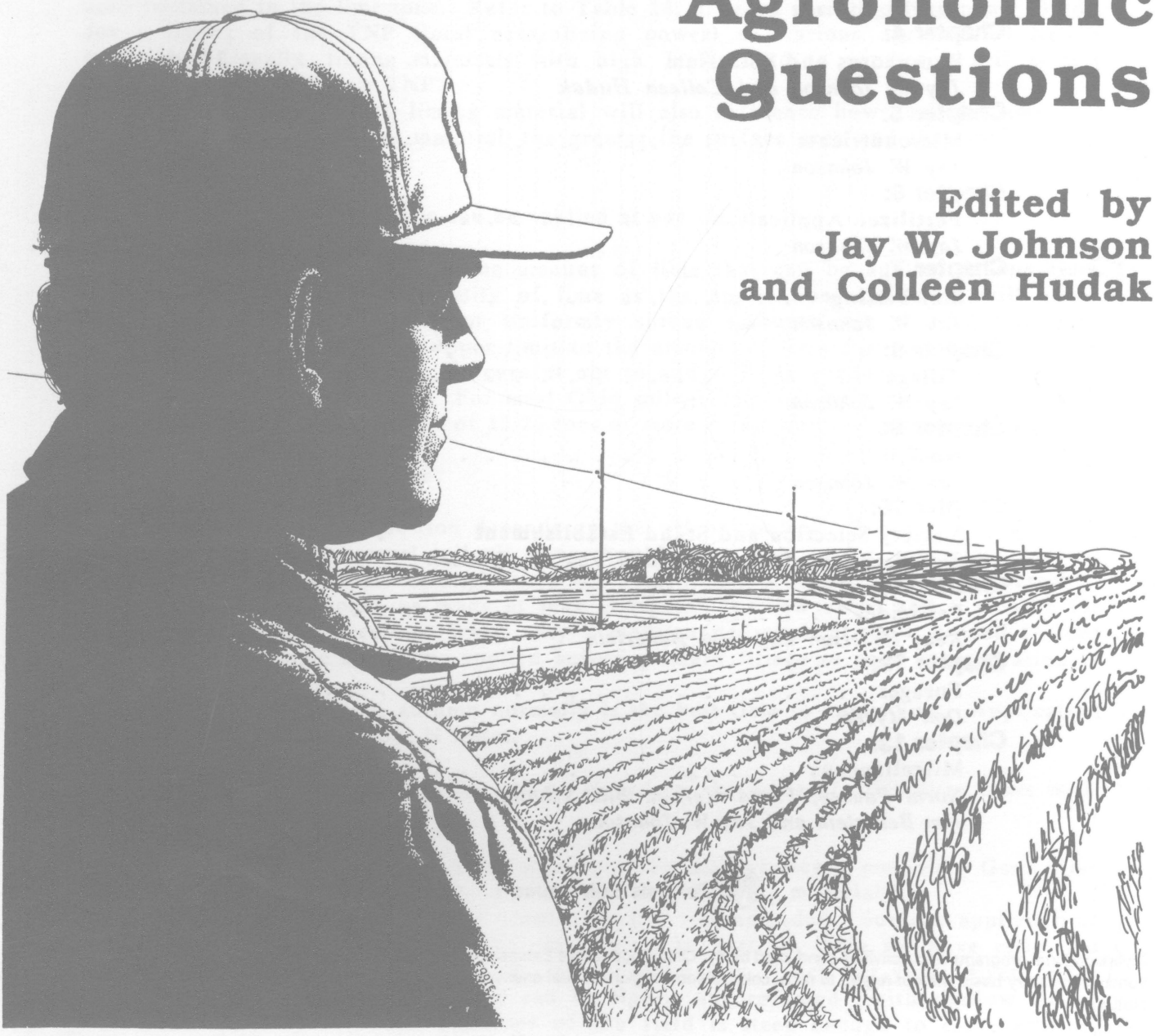

THE OHIO STATE UNIVERSITY

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Chapter 1: Liming and pH

Jay W. Johnson
Don Myers

1. How long does it take for lime to work?

The length of time that it takes for lime to neutralize soil acidity depends upon the type of lime used. Liming materials differ widely in their neutralizing powers due to variations in the percentage of calcium and/or magnesium and impurities (silt, clay, etc.) contained in the limestone. Refer to Table 14, p. 18 of the Ohio Agronomy Guide, for a listing of the TNP (total neutralizing power) of various agricultural liming materials. Usually, liming materials with high TNP's tend to neutralize soil acidity faster than those with low TNP's.

The coarseness of the liming material will also influence how fast the lime will react. The finer the liming material, the greater the surface area and the faster it will react with acid soil.

2. How little or how much lime can be applied at one time?

There is no lower limit to the amount of lime that can be applied at one time. You can apply as small a quantity of lime as the application equipment will allow. Typically, an applicator will not uniformly spread amounts less than 2 tons/acre. Likewise, there is no definite upper limit to the amount of lime that can be applied at one time. You must, however, be careful not to add such an excessive amount of lime that the soil pH rises above 8. For most Ohio soils, there will be a risk of over-liming if the application is in the range of 15-20 tons or more of agricultural ground lime/A.

3. When should lime be applied?

The answer to this question depends on the pH of the soil. When large additions of lime are needed to correct soil pH, lime should be applied as far preceding planting as is practical so that there is ample time for neutralization of soil acidity. Preferably, such an application would be made at least 3 months for row crops and 6 months for forage crops prior to seeding. When only a maintenance application is needed (2 tons or less per acre), lime should be applied before primary tillage so good incorporation is obtained.

Under no-till systems, autumn normally is the best time to apply lime. Application at this time tends to minimize N losses.

4. Should lime be worked into the soil or placed on the surface? Will lime react with herbicides etc.?

Tillage should be used to work lime into the soil whenever possible. Good lime soil contact will help maximize the effectiveness of the liming material.

Surface applications of lime are not normally recommended. Surface applied lime moves into the soil profile at a very slow rate. In fact, in Ohio we have estimated that lime will move downward at a rate of approximately 1 inch per year. Even under no-till systems, it is best if the lime can be lightly incorporated with shallow tillage such as a disk. If, however, the slope of the field is steep enough to cause erosion, leave the lime on the no-till surface.

Lime does not typically react with herbicides; nevertheless, it may have an effect on the chemical activity of some herbicides. For example, soil pH levels less than 5.5 may reduce the activity of triazine herbicides (atrazine, Bladex, and Sencor), but soil pH's greater than 6.5 may tend to increase their activity and/or carry over potential.

5. What is the relation of tillage practices to lime?

As mentioned above, tillage allows for mechanical mixing of the lime with the soil. When reduced tillage systems are used, there will be a limited amount of mixing of lime and soil. In addition, surface applications of nitrogen fertilizers will tend to lower the pH in the top 1 inch of soil. Thus, no-till systems need to be closely monitored for pH changes. Soil samples should be taken more frequently when no-till is adopted. In addition, two soil samples are recommended for no-till cultural practices with row crops: (1. a 1 inch shallow sample for surface pH and (2. an 8 inch sample for the normal plow layer pH and nutrient levels. In general, more frequent lime additions are needed under no-till. For more information on this topic refer to the extension fact sheet, "Soil Sampling for Established No-till Fields" (SFT-29).

6. Acid subsoils are normal in our area. For corn and alfalfa, what are the subsoil pH levels that are troublesome? If adjustments to subsoil pH are needed, is there any practical, effective technique to raise the pH other than maintaining a plow layer pH at or near 7.0 and waiting years? How can we speed the increase?

If pH levels in the subsoil are below 5.5 for corn or below 6.0 for alfalfa, corrective applications of lime are needed. The pH level in the topsoil should be raised to pH 6.5 for corn or 7.0 for alfalfa and maintained at this level. As water flows through the soil profile, the added lime will be carried into the subsoil and gradually increase the subsoil pH. This downward movement will take years. There is no practical method to speed up this process except incorporating lime directly with tillage or by injection.

7. Types of lime and carriers such as Mg and Ca. When to use what?

On a soil that has a Mg content between 10% and 50% of the CEC, the lime carrier is usually not important. You can use either a calcitic or dolomitic lime. If the Mg level is below 10%, you should use a dolomitic carrier. This becomes particularly important if you are growing a grass crop for forage because the use of dolomitic lime should raise Mg levels in the grass and help to prevent grass tetany.

8. How does agricultural slag compare with lime as a neutralizing material? Is ag slag as good a liming material as ag ground?

Agricultural slag is a generalized term for fused calcium magnesium silicates. This material is normally a by-product of the steel industry. Generally, agricultural slag has less neutralizing power/ton of lime than does agricultural ground limestone; thus, higher rates of agricultural slag are typically required. When used at the appropriate rate, agricultural slag can be an effective liming material. One should, however, be aware of the total composition of the agricultural slag that is used. Some materials that are sold as agricultural slag may have high levels of heavy metals, water and be course, thus slowing the soil reaction.

9. What are the advantages and disadvantages of liquid lime verses dry lime?

Liquid lime is approximately 50% $CaCO_3$ and 50% H_2O. It has the advantage of providing better uniformity of spread over the field in comparison to dry lime.

There are 3 main disadvantages of liquid lime. First, there are normally higher operational costs since you must haul both water and lime across the field. Secondly, more frequent lime applications are often needed since liquid lime reacts quicker than does a dry lime. Finally, over-liming is more likely to occur with liquid lime. You must be very careful of the rate at which it is applied. Because it has such a fast reaction time, you may run the risk of increasing the pH too high and thus accelerating denitrification or surface volatilization of urea, especially under no-till systems. As mentioned earlier, over liming will also tend to increase the activity of triazine herbicides.

10. The cost effectiveness of liquid lime products versus agricultural lime.

To make a decision about the cost effectiveness of these two products, one must compare both the total neutralizing power/unit weight of each and the cost/unit weight of each.

11. Why is there such a spread between LTI and pH?

PH is an unbuffered measure of the hydrogen ion concentration in the soil whereas LTI (lime test index) is a buffered measurement of total soil acidity. Soils with low buffering capacities (low C.E.C.) there can be a large spread between LTI and pH. At high pH's (>6.2), LTI is not very reliable for many soils.

12. A testing laboratory in our area often recommends liming soils above pH 7.0, claiming improved nutrient availability will result. Is there any merit to this?

Soil pH has a large influence on the availability of plant nutrients. Figure 7, p. 15 of the Ohio Agronomy Guide, shows the relative availability of twelve essential plant elements at different pH values for mineral soils. Notice that at the pH range between 6 and 7 most of the essential elements are readily available. This is the reason that we recommend liming to this pH range.

Adding additional lime to raise the pH above 7 may give increased availability of molybdenum, but deficiencies in this micronutrient are rarely reported in Ohio. Thus, in practical terms, liming to pHs above 7 will not lead to improved crop nutrition.

Chapter 2: Starter Fertilizers

Jay W. Johnson

1. What is the best placement for starter fertilizer?

For both corn and soybeans, the best placement for starter fertilizer usually is 2 inches to the side and 2 inches below the seed. In using this type of placement, be careful that the total amount of salts (N and K_2O) does not exceed 100 lb./A for corn or 70 lb./A for 30 inch row soybeans. If the salt index is greater than these critical levels, you should increase the seeding distance. Using a starter placement closer than 2 X 2 inches may result in reduced germination or salt injury to the seedling.

2. Will starter fertilizer banded over the row behind the planter press wheel be effective?

The N portion of a starter fertilizer usually is effective if banded over the press wheel. This element is very mobile in soil. It can easily move from the band downward into the soil profile, thereby contacting the growing roots of the new seedlings.

P and K, on the other hand, are considered immobile elements in the soil. When these nutrients are banded over the press wheel, uptake is often inefficient because absorption can only occur if the seedlings' roots grow up to the surface band.

3. How much starter fertilizer should I use?

The amount of starter fertilizer that is needed depends on three factors: the soil test levels of P and K, the crop to be grown, and the climatic conditions of the area.

If at least 20 lbs. P_2O_5 and 20 lbs. of K_2O per acre are applied with the planter as a starter fertilizer, Table 20 on p. 22 of the Ohio Agronomy Guide can be used to calculate the necessary P and K conversions from the annual recommendations.

4. What is the ideal starter program for corn?

Any starter program must be based on a specific farming situation. In particular, one must take into consideration the present availability of soil nutrients as well as other specific soil properties and weather conditions. No one starter program will be appropriate for all situations. In every case, however, the goal of a starter fertilizer will be to provide adequate N, P, and K for the early vigorous growth of the seedlings.

5. Do soybeans need fertilizer at planting?

Our research shows that for soybeans a broadcast application of fertilizer is just as effective as a row starter.

Reference: "Effect of Applied and Residual P and K on Soybeans," 1984 Soil Fertility Research

6. What are the benefits of placing a complete fertilizer solution with the seed as a pop-up on no-till? How much can you use and not hurt germination?

When a fertilizer solution is used as a "pop-up" application, it tends to scarify the seeds and thus can cause them to germinate a little faster than normal.

Nevertheless, placing fertilizer directly on the seed may cause seedling damage; as a result, reduced rates of germination are often seen when "pop-up" fertilizers are used. Some risk is always present, even when small amounts of fertilizer are used. It is hard to predict whether the benefits of a pop-up will outweigh the risks.

7. How important is potassium in a starter band if a broadcast application has been made?

On soils with a high capacity for K fixation, row applications of 40 lbs./A of K_2O are recommended whenever the soil test is low or medium.

Our research has shown that starter K is needed for corn if the soil test level of K is low and if the broadcast treatment is not incorporated under low residue conditions.

For soybeans we have not been able to demonstrate a difference between starter bands and broadcast applications of K.

8. Do I need a starter fertilizer for corn if the soil test is high in P and K?

On soils testing high for P and K, we have not been able to demonstrate a need for starter fertilizer containing these elements. In general, Ohio soils warm up early enough in the spring that there is adequate release of these nutrients, and thus good early growth of seedlings results even without the use of starter P and K.

Nevertheless, research data from Wisconsin has shown that on soils that tend to be cold and wet during early spring, the use of starter P and K can be of benefit, even when the soil test levels of P and K are high. In northern Ohio where seedling growth is sometimes delayed by cool, wet conditions, starter P and K may also be of some benefit. In addition, on high clay content lakebed soils, there has been found to be a much higher efficiency of K, which is placed in the row, as compared to broadcast applications.

9. If P and K are high (and a starter fertilizer is not needed), how do I get the starter N in?

There are several pure nitrogen sources that can be used as starter fertilizer: 28% U.A.N., NH_4NO_3, $(NH_4)_2SO_4$, and urea.

10. How much nitrogen should be applied per acre as starter for conventional and no-till corn and/or soybeans?

The rate of starter N to use for corn depends upon the total N program that is adopted. Usually when a broadcast or pre-plant program is employed, it is recommended that only a small amount of N be included in the starter. When most of the N will be applied as a side-dress, a little more N should be used in the starter program. As a rule of thumb, 20-30 lbs. N/A is recommended for use as a starter with conventionally tilled corn while 20-50 lbs. N/A is recommended for no-till corn.

We have not been able to demonstrate a need for the use of starter N with soybeans grown in Ohio.

11. If a micronutrient such as zinc is recommended, how much will be needed in a starter band to equal the broadcast rate in performance? How does chelate or polyphosphate sequestered zinc compare with inorganic zinc?

When using zinc salt ($ZnSO_4$) as the zinc source, apply 1/10 the rate in a starter band to equal the recommended broadcast rate.

Zinc chelates are often not the preferred product for use in Ohio because of their typically higher cost; the exception to this is that they must be used if a liquid starter program is chosen. Substances in the liquid starters can react with $ZnSO_4$ to form Zn compounds, which are unavailable for plant uptake.

12. What should be the starter band rate of S and micronutrients compared to broadcast?

Since sulfur (SO_4^{2-}) is very mobile in the soil, the same rate of it can be used in a starter band as would be used in a broadcast application.

13. Concentrated liquid starters are popular in our area (NaChurs, Alpine, First, P & L etc.). These companies claim that 10 gallons of 9-18-9 will supply all of the P_2O_5 necessary for corn, because 100% of the P_2O_5 is available to the crop the year it is applied. Customers pay a premium for concentrates. Do concentrates perform agronomically better than any other row starter? Are their claims justified?

Due to their low salt content, use of concentrated liquid starters may be of benefit on soils with high salt buildup. On the humid soils of the Midwest, however, salt buildup is generally not a problem. On these soils, the concentrated liquid starters have been found to be no better than traditional 9-18-9 fertilizers. Thus, the claims of improved nutrient availability for liquid starters appear to be unjustified.

Reference: "Compendium of Research Reports on Use of Nontraditional Materials for Crop Production," NCR #103 Committee

14. Is liquid fertilizer better than dry fertilizer for corn as a starter fertilizer?

Liquid and dry fertilizers are of equal value/lb. of fertilizer nutrient.

15. Is manufactured fertilizer better than blended fertilizer for a corn starter?

Because a manufactured fertilizer has its product (N,P,K) combined in each pellet, it probably allows for a more even distribution of applied nutrients in the soil than does a blended fertilizer. Plants, however, are able to absorb nutrients from a zone of soil surrounding their root systems. Thus, from the practical stand point of plant uptake of nutrients, there is little difference between blended and manufactured fertilizer. Both types of fertilizers should result in equally adequate plant nutrition.

Chapter 3: Nitrogen

Jay W. Johnson

1. What form of nitrogen should I use?

The form of nitrogen that a farmer should choose depends on several factors: (1. the availability and (2. cost of N carriers (3. equipment needs (4. soil properties and (5. cropping system.

Research has shown little difference in corn yield as a result of using different N sources in production systems using conventional tillage. This can probably be attributed to the quick contact between soil and fertilizer in these systems. Nevertheless, soil moisture levels often affect the amount of N loss from the various carriers. In general, on wet soils that are conventionally tilled, an ammonium form of N is preferred because it may reduce the risk of N loss due to denitrification. On dry soils, the choice of N source usually should be based on which is most economical to buy.

In no-till systems quick N-soil contact may not be possible when fertilizer is broadcast as surface residue may intercept it and cause loss of applied N. Research shows that in no-till systems the preference list of N fertilizers is: anhydrous ammonia, ammonium nitrate, N solutions, and urea.

Refer to the publications "Selecting Forms of Nitrogen Fertilizer" (SFT-28) and "Nitrogen Fertilizers in No-till Corn Production" (SFT-25) for further information on this topic.

2. What is the most economical form of nitrogen to use?

Traditionally, anhydrous ammonia has been the cheapest N source to buy. All other N carriers are made from anhydrous, and thus they are more expensive due to the increased cost of processing. Nevertheless, in many parts of Ohio, anhydrous ammonia is not readily available; in such areas, use of either urea or 28% N solution would be recommended.

3. How do I determine rates of N application for corn?

The amount of N recommended for corn depends upon the present yield goal and the previously grown crop. Table 32 on p. 31 of the Ohio Agronomy Guide presents the current N recommendations. These are based on growth response curves obtained in N fertility experiments conducted in Ohio.

Many other factors also can influence the amount of N fertilization that is needed. The amount of N released annually from a soil, the degree of N lost from a soil, and the time of N application are a few of these factors.

4. If a farmer continually applies nitrogen for a 150 bushel corn crop, but routinely yields 115-125 bu, what are the potential dangers of nitrate problems in tile drained or ground water?

If a farmer uses a N program that has the potential to supply 25 bushels of grain more than he is actually producing, he will be applying an excess of 40-50 lbs. N/year. On coarse soils, this unused N is likely to move into tile drain or ground water, thereby raising nitrate levels. On poorly drained soils; however, much of the excess N will be lost to the atmosphere through denitrification; thus, on these soils there should be little increase in the N concentration of drainage water.

5. With the concern over ground water contamination, what guidelines should be followed for nitrogen fertilization of corn?

Currently, corn yields in Ohio are not at levels that would be expected from the amounts of N being applied. This indicates that in many cases, factors other than N rate are limiting yield. A farmer in this situation is urged to choose a yield goal based on experience with his particular soil and growing conditions and to apply only the amount of N required to reach this yield level. Fertilizing N by these guidelines will not only save money for the farmer but will also protect our groundwater from unnecessary contamination.

6. When does the corn crop actually utilize differing amounts of nitrogen during the season?

The uptake of N parallels the growth of the corn plant. It is used to make proteins. The most rapid vegetative growth of corn is from June to mid-July. As grain develops from mid-July to mid-August, the plant stores large amounts of proteins in the grain.

A corn plant takes up most of its nitrogen between June and mid-August.
Reference: Hanway, In Modern Corn Production by Aldrich, S.R., Scott, W.O. and Hoeft, R.G., 1986. page 101.

7. Do the highest yielding corn hybrids need nitrogen later in their development?

Research has shown that some high yielding corn hybrids do use N later in their development, but this has not been found to be generally true of all high yielding corn hybrids. At the present time, there is not enough data on this subject to justify changing N programs based on specific hybrids.

8. How late can you apply nitrogen to a deficient field of corn and get a profitable yield response?

A corn plant takes up to one-half of its N requirement after tasseling. Thus, you can expect a yield increase from any N addition applied up through early grain fill, provided the corn plants are not damaged during the application process.

9. Does it pay to use a split application of nitrogen?

On soils where there is a potential for N loss, a split application (pre-plant plus sidedress) has proven to be effective in increasing the efficiency of the N program.

In contrast, where soils are well drained and N loss is minimal, there is no advantage to a split application program.

10. What is the best placement (row middle or near row) for sidedress nitrogen on corn, both no-till and conventional.

Sidedressed N should be applied near the actively feeding roots of the crop. Research has shown that roots tend to grow laterally at about the same rate that top growth of the plant occurs. Therefore, if sidedressed N is applied to corn plants that have not yet experienced much top growth, it is preferable to place the N rather close to the row. On the other hand, when sidedressed N is applied to plants that are at least 14-16 inches in height, a middle of the row placement should be adequate.

11. What is the relative effectiveness of dribbling 28% solution versus sidedress injection?

Most research shows that, in general, these two methods of sidedressing are equal in their effectiveness. Nevertheless, when conditions are excessively dry after application, the preferred method is injection. The reason for this is that injection places the N deep below the soil surface where moisture conditions are favorable for plant uptake. In contrast, when a dribbled (surface) application of 28% N is followed by a period of dry weather, little of the applied N is carried down to where the roots are actively feeding, and thus the application tends to be inefficient.

12. What is your opinion of urea (granular or prilled) as a sidedress for corn?

Broadcasting urea as a sidedress for corn, whether in a granular or prilled form, will often result in burn to plant tissue. Provided they can be applied without substantial damage to the plants, both granular urea and prilled urea have been found to be equally effective as a sidedress application of N for corn.

13. Can nitrogen be fall applied?

Yes, but fall application of N should be restricted to well drained, low organic matter soils. All fall applied nitrogen should be anhydrous ammonia with N-Serve. (See "Nitrification Inhibitors Potential Use in Ohio", Agronomic Tips, SFT-24.)

14. How much loss can result from the fall application of nitrogen?

The amount of N that will be lost from fall application is highly variable. It depends to a large extent on the internal drainage of the soil and the weather conditions during a particular year. Long term research has shown that, on average, 40-80 puonds of N are lost from a fall application as compared to a spring application.

15. Explain the economics of N-Serve and similar products.

N-Serve is the tradename for the chemical nitrapyrin. This product works by reducing the number of Nitrosomonas bacteria. These are the bacteria that are responsible for the conversion of NH_4-N to NO_3-N (nitrification). Use of N-Serve has been found to delay nitrification for a period of approximately 4-6 weeks. Keeping N in the NH_4 form is important because it can substantially reduce the loss of fertilizer N due to denitrification.

Denitrification usually accounts for approximately 80% of the N lost from most soils. In this process, nitrates are biochemically reduced to N gases (N_2 or N_2O), which are then lost through volatilization. Wet soils and warm temperatures are conditions that promote denitrification. When spring weather favors the presence of such conditions, use of N-Serve can prove to be very economical because NH_4-N can not undergo denitrification, thus potential N losses will be reduced. How great can these losses be? It has been estimated that once nitrification has occurred and the NO_3-N form exists in the soil, there will be a 50% loss of applied N after 7 days of continuously wet soils. After 10 days of wet soils, there will be a 100% loss of NO_3-N. N-Serve can be good insurance against such drastic losses. Nevertheless, during a dry spring when denitrification is unlikely, N-Serve will be of no benefit in reducing N losses, thus it will be of no economic value.

16. Are there new additives on the market that can reduce N losses?

Ammonium thiosulfate is a new product that is claimed to cut N losses by reducing both nitrification and surface volatilization. These claims are supported by limited data. Most research suggests that it has little effect on these two processes.

DCD is another new nitrification inhibitor. It has been found to be relatively effective in delaying nitrification; nevertheless, use of it may not be economically practical that it must be applied in large quantities for it to be beneficial.

17. Is there a benefit of NH_3 over 28% N? If so, how much added 28% N does it take to offset the difference?

Long term research has shown that, on average, anhydrous ammonia is approximately 10% more effective as a N carrier in corn production than are urea based fertilizers. The reason for this difference in effectiveness is that anhydrous tends to have less N loss from denitrification, surface volatilization, and leaching than the urea products. If, however, conditions are such that little N loss will occur, urea based fertilizers are equivalent to anhydrous ammonia in their efficiency.

18. What is the nutrient loss from various sources of surface-applied nitrogen?

When urea based N products (urea or 28% N) are used, one can expect, on average, a 3% loss/day for N left on the soil surface. If the soil surface has a high pH (>6.5) or if the soil surface is moist when the urea product is applied, losses can be substantially higher. In addition, warm temperatures can accelerate the loss of surface applied nitrogen.

In a 1981 study, Fox and Hoffman found that NH_3 volatilization loss from urea-based carriers (urea and U.A.N.) ranged from 0 to 35%. Rainfall after fertilizer application was found to affect the amount of NH_3 volatilization. Their results showed that:

(1. If at least 10 mm of rain falls within 2 days after urea application, no NH_3 volatilization loss will occur.
(2. If 10 mm or more rain falls 3 days after urea application, volatilization losses will be minor (<10%).
(3. If 3-5 mm of rain falls within 5 days, or 7-9 mm within 9 days, volatilization losses will be moderate (10-30%).
(4. If no rain falls within 6 days, the loss can be substantial (>30%).

Reference: Fox, R.H. and L.D. Hoffman. 1981. The Effect of N Fertilizer Source on Grain Yield, N Uptake, Soil pH, and Lime Requirement in No-till Corn. Agron.J. 73:891-894.

19. How much incorporation is required for urea?

Urea must come into direct contact with the soil if surface volatilization is to be minimized. Usually light discing is adequate to mix urea into the soil. If the soil surface is covered with heavy residue, more tillage will be needed.

20. What is the best way to fertilize no-till corn using urea as the nitrogen source?

Use of urea on no-till fields may cause serious problems in certain years. Many of the problems can often be overcome by proper application. To reduce the amount of ammonia volatilization from urea, the urea must come into direct contact with the soil.

Banding urea between corn rows and below residue is one way to avoid N loss from urea. If a farmer chooses to broadcast urea instead, he is urged to do so prior to anticipated rains, which will wash the urea into the soil. Generally, urea should only be broadcast with no-till production if one-half inch of rain is assured within 7 days after application. Also, farmers should broadcast urea early in the season (early April) as cooler temperatures will slow N loss. Urea should never be broadcast over freshly limed soils because high pH can greatly accelerate N losses. If the surface pH is greater than 6.5, another source of N should be used.

21. How much nitrogen do I lose when broadcasting urea or ammonium nitrate on wheat/pasture?

As mentioned above, several factors (moisture, pH, temperature, etc.) will influence the amount of N that will be lost from a broadcast application of urea. In general, losses of surface applied N are not substantial in wheat because urea is typically broadcast in March when temperatures are low. In contrast, a large N loss may be expected if urea is broadcast on pasture during mid-summer.

When ammonium nitrate is the carrier, you should not expect N losses from surface volatilization.

22. Should I apply urea (N) by airplane to growing corn? If so, how much?

An aerial application of urea will cause some burn to the corn plants. The degree of plant burning is usually less, however, with urea than with other N products. If the N rate is kept below 50 lb./A, the burn is often minimal. Even at higher N rates, the burn is normally not so severe that it outweighs the benefits received from the N addition.

23. What is the evaporation rate of liquid nitrogen when applying in heat such as 90 degrees (F) or higher?

As mentioned previously, Fox and Hoffman found approximately a 3% loss per day that urea based products were left on the soil surface. Their research was conducted during the spring when temperatures averaged 70 degrees (F). Thermodynamic studies have shown that a chemical reaction will double for every 18 degrees (F) increase in temperature. Therefore, at 90 degrees (F), there should be approximately a 6% loss/day.

Reference: Fox, R.H. and L.D. Hoffman. 1981. The Effect of N Fertilizer Source on Grain Yield, N Uptake, Soil pH, and Lime Requirement in No-till Corn. Agron. J. 73:891-894.

24. What are the reasons to use ammonium sulfate?

Under most circumstances, ammonium sulfate is not the fertilizer of choice because there are some major disadvantages to the use of it. First, it has a low analysis of N (approximately 21-22% N). This means that, compared to other N carriers, a larger volume of fertilizer is needed to apply the same rate of nitrogen. A second disadvantage to ammonium sulfate is that there is a large amount of acidity associated with it; as a result of this, more lime is normally needed to keep the soil neutralized.

Nevertheless, there are at least four situations in which ammonium sulfate would be the preferred nitrogen source for crop production:

(1. Soils which need corrective measures for high pH. Ammonium sulfate has 3 times the acid supplying power compared to other N sources.

(2. Soils which need supplemental sulfur. Ammonium sulfate is approximately 25% sulfate (SO_4^{2-}); sulfur in this form is available for plant uptake.

(3. No-till systems where surface volatilization of urea would be expected.

(4. Whenever the cost of ammonium sulfate per pound is cheaper than the other N carriers.

25. How much credit for N can I expect from a good crop of soybeans?

You can expect approximately 1 pound N per bushel of soybeans produced.

26. Should I apply a little nitrogen (starter fertilizer) with my soybean and alfalfa fertilizer program? Does it make any difference if the field has not grown soybeans or alfalfa previously?

On cold, wet soils that are low in nitrogen, a little N fertilizer may help insure good, early growth of these two crops. These conditions, however, are not typically found in Ohio. Thus, the use of starter nitrogen is not usually recommended for soybeans grown in our state, especially since it will tend to delay nodulation. A small quantity of N is recommended with the starter fertilizer when seeding alfalfa.

If the field does not have a history of soybeans or alfalfa, use of starter N may be a good idea. Normally, in such fields it will take several weeks to establish a strong Rhizobia population. (These are the bacteria responsible for nitrogen fixation.) If adverse conditions (low nutrient levels, low pH, etc.) occur, the establishment of Rhizobia may be delayed even longer. Therefore, if you hope to maximize yields during the first year of establishment, a N application should be considered.

27. What are the prospects of producing corn with nitrogen fixing bacteria?

The native N fixing bacteria of the soil will normally only produce 3-25 lbs. N/A/yr. Whenever a bacterium is added to the soil, it must compete with the native bacteria that are already present in the field. To date, no new N fixing bacterium has been found that can survive under field conditions and can fix N in amounts adequate for high corn yields.

28. High fertility (N) for high yield wheat. What kind and how much? When should it be applied?

Research has shown that good, uniform distribution of N throughout the wheat field is more critical than the form (carrier) of the N. Liquid N programs normally tend to give a more even distribution than granular programs.

The amount of N that should be used is dependent upon yield potential. Refer to pages 41-42 of the Ohio Agronomy Guide for recommended rates of N fertilization for wheat. For stiff strawed, short varieties, rates of 100 pounds of N or more are commonly applied. When thin strawed, tall varieties are grown, the N rate should be kept below 100 pounds N per acre to prevent excessive lodging.

Our research indicates that maximum wheat yields can be produced by a fertilizer program that has a small amount of N applied in the fall with the remainder top dressed in the spring. Programs that use a spring application of split N have not proven to be any better than spring programs using a single application.

29. How much N should I put on in fall for wheat?

When using a split N program (fall application plus spring top dress), it is recommended that no more than 20 pounds N per acre be applied in the fall. If the total N program is to be applied in the fall, the N rate would be the same as a spring program. We recommend that a total fall program be used only on well drained, light colored soils; also, suitable N stabilizers should be applied along with the N.

30. We have a competitor making his own liquid nitrogen by combining urea and water or ammonium sulfate and water. What is the highest nitrogen solution he can make? Will this cause burn to emerged crops like wheat and corn? Will there be more loss of nitrogen with these products than with 28% U.A.N. and/or NH_3?

Based on the water solubility of these two N carriers, the highest N content of a urea based solution would be approximately 30% (N) while for an ammonium sulfate solution the highest N concentration would be approximately 14% (N).

At high concentrations, N solutions will cause burn to green tissue. In general, rates in excess of 50 pounds N per acre will result in tissue burn.

A substantial amount of N loss should be expected to occur when urea solution is applied. Some surface volatilization should also result from an application of an ammonium sulfate solution. In general, the N loss from both of these solutions should be greater than what would be expected from use of 28% N. Since NH_3 is not applied foliar, a direct comparison can not be made as to the amount of N that will be lost from it.

31. Does anhydrous kill the earthworms in my soil?

Yes. When anhydrous ammonia is knifed into the soil, approximately 15% of the earthworm population is initially killed. Nevertheless, the anhydrous ammonia does increase the amount of available nutrients; as a result, earthworms will gradually move back into the application zone where they will multiply rapidly due to the fertile conditions. Consequently, 6-8 weeks after injection of anhydrous ammonia, the total number of earthworms is usually larger than what was originally present.

32. If my corn/soybeans are yellow, does this mean I should add more nitrogen even though I followed fertilizer recommendations?

When corn or soybean plants are yellow, this usually indicates a lack of chlorophyll development. It is true that N deficient plants normally have poor chlorophyll development and thus have a yellow color; however, many other plant deficiencies and diseases have similar signs of yellowed tissue. Thus, the total production program should be evaluated so that the exact cause of the problem can be discovered. Adding more N may or may not be the correct solution.

Chapter 4: Phosphorus and Potassium

Jay W. Johnson
Colleen Hudak

1. Please explain the relationship of total soil phosphorus to available phosphorus and P_2O_5.

The "available soil phosphorus" is related to the Bray P_1 test. This test is a relative index of the amount of phosphorus that the plant is likely to have available for uptake. The "total soil phosphorus" is usually much higher than the available index because it also includes the mineral and organic phosphorus of the soil.

The P content of fertilizer is expressed as the percentage of available P in terms of P_2O_5. Every pound of P_2O_5 contains 0.44 pounds of available P.

2. Why is the buildup of phosphorus slow?

On average, 10 units (lbs.) of P_2O_5 fertilizer are required to raise the P soil test value one unit (lb.) Thus, unless you add excessive amounts of phosphorus fertilizer, the buildup of soil phosphorus is always a very slow process.

3. What forms of phosphorus are the best buy?

Research has shown that the various forms (carriers) of phosphorus react similarly when they are applied to soil; therefore, the best fertilizer buy is simply the least expensive per pound of phosphorus.

4. When is the phosphorus level too high?

The phosphorus level of the soil is considered "too high" if it interferes with the uptake of other essential elements. Zn is usually the first element to have restricted uptake when soil P becomes high. This effect on Zn uptake is pH dependent: the higher the pH, the worse the problem becomes. As a general rule of thumb, the P level of soils with pH's greater than 6.5 should not exceed 60-90 pounds Bray P_1 per acre.

5. When white potash is spread on a field, you can't see it after a few hours, but red potash is visible all day. Is this observation significant?

No. This observation has no agronomic significance in terms of crop response to added K. Red potash obtains its color form a relatively insoluble iron coating; the potash itself (KCl) is just as soluble as white potash.

6. Vegetable growers prefer white potash because they feel it gives a healthier plant and a higher quality produce. Does research back this up?

Research indicates that agronomically there is no difference in plant response to red and white potash. Both contain the same active ingredient, KCl, and thus would be expected to give similar results.

7. White potash has a sodium level of approximately 1% and red potash approximately 4%. Does this affect crop production?

These differing amounts of sodium should not affect crop production. Sodium is an element that is non-essential for plant growth. Small quantities of sodium appear to have no effect on yield.

8. Are there potential buildup dangers with the continued use of chloride-based fertilizers?

Salt buildup is usually not a problem on humid Midwest soils having CEC's greater than 5. Typically, these soils can tolerate annual applications of 250 pounds Cl per year (500 lbs. KCl/year) without risk of chloride buildup.

Reference: Diagnosis and Improvement of Saline and Alkali Soils, U.S. Dept. of Agriculture, Agricultural Handbook #60.

9. We decrease yields when we apply high rates (120-150 lbs.) of K in the spring with herbicides. We have read about the Cl effect on soybeans. Could this be the problem? Would Ridomil help alleviate this?

Although some Cl is required for optimum growth, very high levels of it can cause problems to occur. There is evidence that adding Cl to some soils can stimulate plant growth; other research has suggested that Cl additions will decrease growth. The only evidence that has associated decreased growth of soybeans with Cl was obtained from research conducted at very high levels of Cl.

Cl buildup in the soil can result in salt damage to plants; this is often manifested in root injury and subsequent fungal diseases. If the decrease in yield is due to a disease that Ridomil has activity on, use of this product may prove beneficial. Ridomil, however, does not have any direct effect on the Cl concentration in the soil.

10. Are wood ashes useful as a K fertilizer?

Wood ashes are relatively high in potassium. If used in low or moderate rates, they can be good sources of this nutrient. Wood ashes are also high in several other salt products. For this reason, high application rates should be avoided as salt problems may occur.

11. How much potash to apply for soybeans and when? Does an annual application of potassium pay in soybeans or can I put it on with corn the previous year?

The desired rate of potash application is dependent on three principal factors: soil test value for potassium (lb. K/A), yield goal, and the CEC of the soil. Refer to Table 54, p. 48 of the Ohio Agronomy Guide, for recommended rates of potassium application for soybeans.

Soybeans seem to be relatively insensitive to the time of year of potassium application. We have found only a small advantage (approximately 1 bu/A) to spring application of potash as compared to a fall application. Research has shown that a direct application of potash to soybeans has a slight advantage over applying it the previous year to corn.

Reference: "Response of Soybeans to Added Potassium'" 1976 Soil Fertility Research Progress Report

Chapter 5: Micronutrients

Jay W. Johnson

1. Should micronutrients (Zn, Mn, etc.) be used with corn and soybeans? Is the use of micronutrients an economic advantage?

Although most Ohio soils contain adequate quantities of micronutrients, some soils are deficient in these nutrients. Table # 11, p. 17 of the Ohio Agronomy Guide, gives the crop and soil conditions where micronutrient deficiencies might be expected to occur in Ohio. In general, a micronutrient should only be applied to a crop if a need for that micronutrient has been demonstrated. Plant analysis is usually the best tool for establishing nutritional deficiencies.

Application of micronutrients will be an economic advantage if a deficiency exists that is limiting yield or crop quality. If micronutrients are added to plants that have not shown a need for such additions, there is a low probability of getting a return on the investment. In fact, one can actually run the risk of reduced profits due to toxic levels of these nutrients. Soybeans are particularly sensitive to excess Mn. Toxicity of this element has been demonstrated in some acid soils in eastern Ohio.

2. What are the deficiency symptoms of the various micronutrients? Can soil and leaf analysis help determine if micronutrients need to be added?

Few micronutrients exhibit distinct, easily recognizable deficiency symptoms in the field. Instead, most micronutrient deficiencies show up as a general stunting of plant growth, and thus it is hard to determine which micronutrients are actually present in inadequate amounts. Refer to the book entitled Hunger Signs in Crops for a discussion of the visual signs of micronutrient deficiencies in various crops.

A far more reliable index of micronutrient health is leaf analysis. Soil tests can also be used as an indicator if leaf analysis is not readily available.

Reference: Sprague, Howard B., ed. Hunger Signs in Crops; a Symposium. 3rd ed. New York: David McKay Company, Inc., 1964.

3. Discuss the need for supplementation of S, B, and Zn on agronomic crops (corn, soybeans, alfalfa).

Crops vary in their responsiveness to the different micronutrients. Corn appears to be most responsive to addition of zinc and boron while alfalfa is most responsive to sulfur and boron. The soybean plant is generally a good feeder of all three nutrients (Zn, B, and S). Refer to Table 25 on p. 25 of the Ohio Agronomy Guide for further information on crop responses to micronutrients on organic soils.

4. When should I apply S, Zn, B, and other minor elements?

Mobile elements such as sulfur and boron should always be applied immediately before the cropping year in a pre-plant, direct application.

Immobile elements (Zn, Mg, etc.) are usually adequate in most Midwestern soils. If, however, specific soil conditions cause restricted uptake of these elements, a direct application (preplant or starter) should be used.

5. What is the best way to apply Mn on soybeans - granulated or spray?

To prevent a manganese deficiency in soybeans, we recommend a foliar application of 4 to 8 pounds of manganese sulfate when the plants have two or three trifoliate leaves. If soybeans are planted in rows wider than 20 inches and the planter is capable of applying a row fertilizer, then an alternate method to prevent Mn deficiency would be the use of an acid-forming row fertilizer such as 200 pounds of 0-20-20.

6. Should sulfur be applied as a micronutrient?

Most Ohio soils receive approximately 10-15 pounds S per year from rainwater. This amount varies greatly, fields close to coal burning industrial plants can receive several times these levels from the rainwater. This amount alone is inadequate for plant growth. The primary source of sulfur is normally the weathering of soil organic matter. On soils having low organic matter (<2%) or on soils which are coarse textured and have been heavily leached, there is a high probability that the sulfur content of the soil is low. The best way to determine if a S deficiency exists is through plant analysis. When analysis demonstrates a need for S, a crop response to sulfur supplementation is likely.

7. What effect does sulfur have on wheat yields?

Wheat is a crop that typically requires a relatively high amount of supplemental sulfur. One reason for this need is that wheat experiences its most rapid growth during early spring when the rate of S release from soil organic matter is quite slow. On coarse, sandy soils, especially those low in organic matter, wheat can be expected to have a yield response to added S.

8. What are the factors affecting zinc availability? Is it economically profitable to apply Zn on corn?

The availability of Zn has been found to be directly related to 3 soil factors: (1. the amount of Zn supplying minerals (2. the amount of available phosphate and (3. soil pH. In general, Ohio soils have an adequate Zn supply; however, on soils having both high pH values and high levels of phosphate, a large amount of the available Zn is complexed to form $ZnPO_4$. When Zn is found precipitated in this form, it is relatively unavailable and Zn deficiencies can occur. Zn levels can also be inadequate on acidic, sandy soils where most of the available Zn has been leached away. In addition, organic soils often have low Zn reserves.

Grass crops such as corn are normally more sensitive to Zn deficiencies than are forage crops such as alfalfa. Use of supplemental zinc for corn is recommended whenever zinc availability in the soil is restricted. A profitable yield response to zinc should be expected under such circumstances.

9. What are your findings about the proper zinc to phosphorus ratio?

Research from many sources indicates that the P to Zn ratio in leaf tissue should be 100-150:1. Whenever the P content of a plant increases, so must the Zn concentration in order that this ratio be maintained.

Chapter 6: Fertilizer Application

Jay W. Johnson

1. Some companies say a pound of nutrient is a pound of nutrient; others say method of application and product choice are important. Which is correct?

As established by law, fertilizer is sold on an index of relative availability; this index is found on the label of each fertilizer product sold. As a result, if products which have the same quoted amount of nutrients are compared, one will find that the fertilizer products are agronomically equivalent in terms of crop response.

Changing the method of application can improve the efficiency of a fertilizer. For example, banding a fertilizer close to the seed row has been shown to improve the uptake of nutrients contained in that fertilizer; however, the same improved efficiency can be gained through the banding of any of various fertilizer products.

2. Competition constantly interchanges availability and solubility. Please define these terms, and compare liquids to dry in both definitions.

"Plant availability" is an indication of what quantity of nutrients in an applied fertilizer is able to be taken up by a crop under field conditions.

"Water solubility" is the percent of nutrients that are dissolved by water. In a true liquid, 100 percent of the nutrients are dissolved.

Fertilizers are sold on the basis of an index of relative availability. Based on this index, liquid and dry fertilizers supply equal quantities of nutrients for uptake.

3. Can you fertilize only for the crop planted or do you have to take "tie up of nutrients" into consideration?

In general, crop removal alone is not a good index of fertilizer needs. Annual fertilizer recommendations are based on crop response data (the fertilizer needed to produce a particular crop under the specific conditions where the correlation research is conducted). Normally, if the fertilizer recommendation as based on crop response data is lower than that calculated from crop removal, we make a recommendation equal to crop removal so that the fertility level of the soil will not be depleted.

4. Should I apply most of my fertilizer broadcast or in the row for corn? Is there any difference in yield when fertilizing broadcast versus in-row?

When selecting a fertility program, one should consider soil test levels. If the soil test levels of P and K are medium to low, a row application is usually more effective than a broadcast application. If soil fertility is high, then either method of application (row or broadcast) should be of equal value.

5. Even on high test soils we recommend some row fertilizer. Would this be used early or late in the season by corn plants?

The nutrients from a row fertilizer are used relatively early in the season. Usually, roots are actively feeding in this fertilizer zone approximately 2-4 weeks after emergence.

6. How beneficial is banding (not row applied) versus broadcast applications?

Research has shown that on low fertility soils there is a slight advantage to banding of immobile elements like phosphorus and potassium.

Based on soil test results, less than 10 percent of Ohio soils would be expected to show a benefit from banding of P and K fertilizers as compared to broadcast applications.

7. How can I cut my fertilizer costs? When can I cut back on P and K?

To determine the most efficient fertilizer program for agronomic crops, the user must consider both the amount of nutrients that his soil will supply and the overall yield potential of his soil. Soil tests and plant analyses are good indicators of the nutrient supplying power of a soil. Based on these indexes and the expected yield, a farmer should be able to make an intelligent, well informed decision about fertilizer inputs. Refer to Extension Bulletin # 749, Reducing Crop Production Costs, for further information on developing efficient fertility programs for agronomic crops.

Under typical Midwest farming conditions, no further yield response to added P is expected for corn or soybeans whenever the Bray P_1 level exceeds 40-60 pounds P per acre. Similarly, when the level of exchangeable K exceeds 300 pounds K per acre on silt loam soils or 350 pounds K per acre on clay loam soils, no further response to fertilizer K is normally seen.

8. How best to fertilize economically in a crop rotation?

In developing a fertility program for a crop rotation, one should determine the dominant fertilizer need for each crop of the rotation and then each year concentrate most heavily on that particular plant nutrient, being careful, however, not to neglect other nutrient requirements. For example, in the year that corn is grown, one must be sure there is adequate nitrogen present but at the same time not ignore P and K needs. With wheat, phosphorus needs should be satisfied first.

9. Is feeding corn a good fertility program economical by following soybeans with no fertility?

When soils tests (P and K) are high at the start of a corn/soybean rotation, it should make little difference in yield whether the applied fertilizer is added to the corn crop or to the soybean crop. Nevertheless, in such a high fertility situation, there may be some merit to adding all the fertilizer to corn as you will need to apply N to this crop anyway.

In contrast, under low fertility conditions, there seems to be a slight advantage to adding most of the P to corn and most of the K to the soybeans.

10. With medium soil test levels, can I fertilize every other year? All of P_2O_5 on corn this year and all of K_2O on beans next year?

If a soil test is medium to low, we recommend an annual application of both P and K to obtain maximum return on your fertilizer dollar. If, however, a soil test is medium to high, adding all of the P to corn and all of the K to beans can be an effective program to optimize returns in a corn/soybean rotation.

11. What considerations should be addressed in deciding the merit of P and K application in soybean production?

When considering the merit of any fertilizer application, one must assess its effect both on crop yield and crop quality. Soybean plants are good feeders of P. Normally, they can produce good quality beans at optimum yields even when the soil test level of Bray P_1 is relatively low (approximately 30 lbs. P/A). In contrast, on soils having low levels of exchangeable K, addition of K fertilizer has been shown to improve soybean yields. Likewise, K applications are known to improve soybean quality. In Ohio the desired soil test potassium level for soybeans is 280 + (5 X CEC). This recommendation is 60 pounds per acre higher than for most other crops.

12. Will I see a yield response by applying fertilizer on soybeans when the field already tested high in P & K ?

No. If a soil tests high in both P and K, a yield response from a fertilizer application (P and K) should not be expected for any crop.

13. Is it better to apply fertilizer at the time of planting wheat or put it all on in early winter?

P and K fertilizers should be applied at the time of seeding wheat. If these immobile nutrients are applied after planting, uptake can be hindered. The reason for this is that P and K will tend to remain above the rooting zone and thus will not be available for uptake.

14. What is the highest rate of nitrogen to apply to corn and get maximum return? phosphorus? potash?

Research conducted in Ohio has shown that an application of 200-250 pounds N per acre can give maximum returns on the dollar invested, provided good cultural practices are employed. Refer to Table 32, p. 31 of the Ohio Agronomy Guide, for examples of N recommendations for corn.

For P and K, the highest rate to use for maximum returns depends on relative soil availability, which is determined by soil testing. Refer to Tables 33 and 34, p. 32 of the Ohio Agronomy Guide, for examples of P and K recommendations for corn at various soil test values and yield goals. These recommendations are based on correlation data obtained from research conducted in Ohio.

15. Do blend fertilizers separate when spread with a "spinner" type spreader?

With a "spinner" type spreader, the spread pattern that results depends on the size and the density of the materials that are being applied. Traditionally, there has tended to be a slight separation of blended fertilizers, with lighter materials not being spread in as wide a pattern as the heavier ones. In recent years, the fertilizer industry has tried to counteract this problem by changing the size of fertilizer particles so that all would be spread with approximately equal patterns. As a result, there is now little separation of blend fertilizers when spinner type spreaders are employed.

16. Are liquid fertilizers equal to or better than dry fertilizers? Are liquid fertilizers more available than granular fertilizers?

Based on equivalent rates of applied nutrients, research has shown that liquid and dry fertilizers are of equal value to most agronomic crops. There is no difference in availability between liquid and dry fertilizers.

Reference: "Mineral Nutrient Sources" in Compendium of Research Reports on Use of Nontraditional Materials for Crop Production, NCR # 103 Committee.

17. When suspension grade fertilizers are used, the entire fertilizer needs (NPK) of the crop can be applied in one trip across the field, along with herbicides. Economically, this is equal to or better than dry. Are we seeing a growth in the use of suspension grade fertilizers? Agronomically, is it a sound practice?

Based on statistics of recent fertilizer sales in the Midwest, there appears to be relatively little change in the amount of fluid fertilizer that is being sold as compared to the total amount of fertilizer marketed. The percentage of the fluid fertilizer sales that are suspension grade fertilizers (as opposed to true liquids) is increasing only slightly in the Midwest. The growth of suspension grade fertilizers will probably continue to be slow in the Midwest as they are relatively unstable in cool climates. (These products must be used soon after purchase; if they are not, they tend to coagulate.) The short storage time of suspension grade fertilizers makes them unattractive to many farmers.

As long as fertilizer nutrients are applied in an appropriate manner, there is no difference in crop response whether the product which is used is dry, liquid, or a suspension. These three forms of fertilizer are of equal value to a crop.

Reference: Hargett and Berry. 1986 Fertilizer Summary Data. TVA Publication ISSN:01461850.

19. Does foliar application of liquid fertilizer do me any good?

Foliar application of liquid fertilizer has been found to be an effective method of correcting nutrient deficiencies in perennial crops like fruit trees (apples, peaches, etc.). For annual crops, however, there is little evidence that foliar application of liquid fertilizer is preferable to soil applied. An exception to this is that for soybeans and alfalfa foliar applied Mn tends to be more effective than soil application.

Chapter 7: Soil Testing

Jay W. Johnson

1. Should I take a soil sample more often than every three years?

Soil testing once every three years is adequate for most agronomic crops unless specific nutritional problems are suspected in a field.

When new fields are established, it is a good policy to soil test on an annual basis so that background data can be established. Likewise, annual testing should be done on existing fields if their background history is unknown.

You will also want to soil test annually whenever a high cash value crop is grown. In addition, frequent soil testing is recommended for fast growing crops like vegetables because small differences in soil test levels can greatly influence their performance.

2. What yield goal should I put on soil tests?

The following factors should be considered when determining yield goals:
(1. The soil productivity index. This has been determined on a relative scale for all Ohio soils. Refer to the publication Ohio Soils With Yield Data and Productivity Index, Bulletin #685 (Agdex #524), for guidelines on soil productivity indexes in Ohio.
(2. Drainage classification of a soil. Refer to the appropriate soil survey report for your county.
(3. Weather patterns for a given area. Information concerning these patterns is normally available from the local weather bureau. For additional information on climate and its influence on crop production, refer to pp. 4-5 of the Ohio Agronomy Guide or to the Agronomy Department Publication Series 211, "Ohio Crop and Weather Summary".
(4. Relative inputs of pesticides.
(5. Management ability of the producer.

The yield goal that you choose should be in the range of 100-125 percent greater than the long term yield average for a given field. Traditionally, most farmers are not able to increase yield levels more than 10-20 percent per year. If a unrealistically high yield goal is given on the soil test form, the resulting recommendation may be for more fertilizer than the crop can actually use and thus part of the fertilizer input may be wasted.

3. Why do state labs and private labs not agree on many of their recommendations?

Most state labs base their fertilizer recommendations on growth response curves developed by their local college of agriculture; thus, recommendations from state labs are backed up by locally conducted research. Because private labs are not obligated to base recommendations on such local research data, their recommendations can sometimes differ from those of a state lab.

4. Why are some soils more productive than others?

There are several factors that determine how productive a soil will be. One of these factors is soil nutrient availability. The CEC (Cation Exchange Capacity) is a relative index for the ability of a soil to retain cations. In general, the greater the CEC of a mineral soil, the greater is its capacity to hold cations on its exchange complex, and thus the greater is its nutrient supplying power.

Another important factor in determining soil productivity is the available water. In fact, the supply of available water is usually the dominant parameter in most Midwest

soils. It is related to many important soil properties: soil texture, soil compaction, rooting depth, CEC, etc.

The CEC of a soil is often a good indicator of the relative amount of available water. Soils with low CEC values (<10) are usually sandy and have a relatively low water holding capacity while CEC's in the range of 10-20 are normally silt loams and have a high water holding capacity. Clay loams and clays typically have CEC values between 20 and 30; these soils have an intermediate amount of available water. When CEC values exceed 30, the soil is usually an organic soil or a muck soil.

5. Different soils seem to respond differently in terms of crop yields. Should we be paying more attention to soil types when fertilizing agronomic crops to maximize returns on our inputs? What management differences do you recommend for different soil types?

Yes. We should pay close attention to soil type when determining fertilizer needs because it affects both the nutrient supplying power and the water availability of the soil and thus, our potential yield levels.

How a soil should be managed for general crop production depends on several soil parameters: slope, drainage classification, texture classification, previous crop residue, etc.

In general, different soil types do not necessitate the need for changes in fertilizer management practices. There is an exception to this general rule soils with high CEC values often have a tendency to fix K; therefore, they have a greater need for row application of K. Refer to p. 32 of the Ohio Agronomy Guide for a discussion of the K recommendations for various soils.

6. How can we get a handle on phosphorus and potassium released from the soil?

A soil test provides a relative index of the amount of P or K that is available from the soil for plant growth. In most cases, this information is adequate for determining the nutrient availability for a crop.

In order to get additional details on the total amount of P or K released from a soil, one would have to obtain mineralogical information as well as weather data so that the relative weathering rate of the given soil could be determined.

7. Based on soil test reports, what is the lowest level of N-P-K that can be economically applied?

Reducing fertilizer rates below the levels recommended by the OSU soil testing service (REAL) will usually result in a decrease in your overall economic return/fertilizer dollar. Our fertilizer recommendations are based on soil test results and yield goals, and they always take into account the economic value of the fertilizer application. These economic values are accessed according to the expected crop response to the fertilizer additions as well as to the need for maintaining fertility levels in a field.

8. Discuss nutrient ratios and nutrient imbalance.

The desired concentration of a nutrient element should fall within the sufficiency range for that element. Typical sufficiency ranges for corn, soybeans, alfalfa, and sugar beets are presented in Table 3 of the Ohio Agronomy Guide (p. 10). As long as nutrient concentrations are within the guidelines outlined by this table, optimal growth would be expected. When the concentration of one or more nutrients strays below or

above the limits of the sufficiency range, the growth pattern of the plant may change, often resulting in lower yields.

The balance among elements should also be considered when interpreting a plant analysis. Interrelationships among elements should be investigated when dealing with suspected deficiencies. For example, the ratio of potassium to magnesium, the ratio of zinc to phosphorus, and the ratio of manganese to iron can be helpful in diagnosing suspected magnesium, iron, manganese, or zinc deficiencies.

Chapter 8: Tillage

Jay W. Johnson

1. Is deep chisel plowing better for the soil than regular plowing? Why or why not? In what cases will it be most beneficial?

Chisel plowing is a tillage system that fractures the plow layer with a minimum amount of incorporation of surface residue. For maximum effectiveness, the soil must be relatively dry at the time of chisel plowing.

Most chisel systems used in Ohio will provide tillage to a depth of approximately 10-12". This is the same depth to which most moldboard plow systems are designed to till; thus, depth of tillage usually does not differ greatly between the two systems.

Because a chisel plow system leaves residue near the soil surface, it can help to prevent the formation of surface crusts, thereby improving water infiltration. On soils that have a tendency to crust, this effect can often lead to increased productivity. On the other hand, use of a chisel system together with surface application of immobile nutrients sometimes results in poor plant uptake due to stratification of fertilizer nutrients in the top few inches of the plow layer. To minimize this effect, we recommend that on low fertility soils, immobile nutrients be deep placed with the planter.

2. How do we determine if we have soil compaction and how bad it is as far as its effect on yield?

The simplest way to determine whether or not you have a compaction problem is to go out into your field with a shovel. If you find that the soil is hard to dig, it is safe to assume that you have soil compaction. Other indicators of soil compaction may also be present: slow drainage, N deficiency problems, and shallow rooting of crops are all possible signs of compaction.

The effect that soil compaction will have on yield depends on the particular growing season. During years in which adequate water and nutrients are present, compaction will not have any impact on yield. On the other hand, when a crop is stressed by too little water and nutrients, or even by too much water, compaction will tend to decrease yields. Soil compaction may cause as much as a 15-50 percent decrease in yield.

Reference: Steinhardt, Gary C. 1985. "Basic Considerations of Soil Compaction, Tillage, and Crop Problems." Proceedings of the Fifteenth North Central Extension-Industry Soil Fertility Workshop. Bulletin #729.

3. What are some practical methods to reduce soil compaction? How can you get jobs done on time without compaction?

To avoid compaction, one should always be sure that the soil is relatively dry when you are performing field operations. Another good method to reduce soil compaction is crop rotation. In particular, the root systems of forage crops (ex.

alfalfa, clover, grasses) are often useful in breaking up compaction zones. There are also deep tillage tools (ex. subsoilers or paraplows) that can go below compacted regions and mechanically loosen them. In cases where mechanical tools are used, the soil must be relatively dry in the compacted zone for adequate shattering to occur. Other methods for reducing soil compaction include improving drainage and decreasing the load on equipment that is hauled into the field. Finally, soil compaction can be decreased by using a controlled traffic system where the same wheel tracks are used for every field operation; often the use of such a system will allow the timely performance of field operations.

4. If shallow tillage is the only tillage method used in a corn/soybean/wheat/meadow rotation, can increased biological activity be expected to release nutrients previously unavailable to plants, thus decreasing the need for commercial fertilizers?

With a shallow tillage system, the amount of organic matter that accumulates in the upper region of the soil profile often increases with time. As the organic matter content increases, usually so does the amount of biological activity. The net result can be an increase in the availability of some nutrients in this surface zone.

In many cases, however, this increase in the biological activity of the surface layer will result in less organic matter and thus reduced biological activity deeper in the soil profile. Therefore, the net effect of shallow tillage may or may not translate into greater nutrient release and improved availability since many crops have roots that feed deep in the soil profile.

More specifically, whether or not use of a shallow tillage system will result in reduced fertilizer needs will depend on such factors as the crop grown, the mineralogy of the soil, and the distribution of nutrients in the soil profile. Also, some nutrients will tend to be more affected than others. For example, the nitrogen concentration of a soil is closely tied to the activity of soil microbes while the potassium level of a soil depends more on inorganic cycling.

Chapter 9: No-Till

Jay W. Johnson

1. Can no-till work in all types of soils?

While it is generally possible to produce a crop by using no-tillage on any field, maximum returns will normally be achieved by matching the proper tillage system to the soil type.

Our experience with no-till agriculture has shown that no-till works best on soils that have relatively good drainage. On soils with relatively poor drainage, corn has been successfully grown without tillage if the corn follows soybeans in a crop rotation. Corn following corn has proven to be unsatisfactory on untilled, wet soils.

2. Should P and K be incorporated in some way with no-till?

Immobile nutrients like P and K are most efficiently taken up if they are placed in moist soils where roots are actively feeding. Under high residue conditions, it is difficult to measure a yield advantage from incorporation of nutrients. Under low residue situations, however, research has shown that it is important to place immobile nutrients into the soil to insure uptake. We have found that a band placement, below and to the side of the seed, is the most efficient method of P and K application in no-till corn production.

Reference: "Response of No-till Corn to N, P, or K," 1982 Soil Fertility Research

3. How much and when should P & K be applied to no-till corn? Ridge till corn?

The rate of P and K to apply to corn is dependent on the soil test levels of these nutrients, yield goals, and to some extent the method of application.

As mentioned above, a planter banded placement of P and K is recommended in no-till corn. If these two nutrients must be surface applied, it is best to apply them in the fall so that you can maximize their movement into the soil by extending the time for leaching. This is especially important when residue levels are low since under such conditions root proliferation near the soil surface would be minimal.

When a ridge till system is used for corn, P and K are also best applied through the row. The nutrients from a broadcast application will move into the row zone when the ridges are formed. Traditionally, the ridges are made in June. As a result, fertilizer that was added in the spring will not be incorporated into the ridge until it is too late to benefit the current crop; therefore, when surface application is used in ridge till systems, the native fertility levels must be high for a broadcast program to give optimum yields.

4. How can we build up soil levels of P and K in a no-till system?

If the main objective of the fertilizer program is to build soil levels of P and K under a no-till system and if large quantities of fertilizer will be needed to do this, most of the fertilizer must be broadcast so that salt problems will be minimized.

It normally takes 10 lbs. of P_2O_5 and 2-10 lbs. of K_2O per acre to increase soil test values 1 lb./A for a 6 2/3 inch acre slice? Without mixing, P and K will move very slowly into the soil profile (about 1/2-1 inch per year). Therefore, a buildup program is very slow for the 4-8 inch soil depth.

We recommend that only 20-100 units of fertilizer be applied annually through the planter.

For information on the use of N fertilizer under no-till conditions, refer to the section entitled "Nitrogen".

5. What is going to be the result of long term use of anhydrous and lime applied only to soil surface?

In a continuous no-till program, injection of anhydrous ammonia at a depth of 6-8 inches will cause the formation of an acid zone below the surface applied lime. Nevertheless, research conducted at Iowa State has found that this acid zone will tend to disperse through the top 6-8 inches of soil. In addition, some of the surface applied lime should leach down and help neutralize the acid. To date, no negative, long term effects of using anhydrous ammonia in conjunction with surface applied lime have been observed.

6. Can we expect to achieve high yields continuously using no-till technology or do we need to plan periodically to plow a field to get mixing and distribution of nutrients? If mixing is suggested, what time frame should be considered and what technology is most likely to give the desired result?

After approximately 25 years of experience with no-till systems on fertile soils, we have not been able to demonstrate the need for plowing to improve the distribution of nutrients within the top 6 inches of soil. Nevertheless, on soils that have a relatively low fertility level, some mixing and redistribution of nutrients may be desireable. This remixing could enhance root proliferation, which could in turn improve water and nutrient uptake. A good, practical rotation would be to have corn/soybeans for 2-3 years, followed by a small grain or forage crop seeded in summer or fall. Prior to the seeding of the small grain or forage, you could add any needed lime and perform deep tillage. Tillage done during summer or early fall usually causes minimal erosion. Also, the small grain or forage would provide vegetative cover during the fall and winter; this

cover would help to protect the soil from erosion. In general, a tillage operation would only need to occur once every 3-5 years on most Ohio soils.

7. Discuss no-till corn use of surface applied N-P-K, especially in long-lay meadows with low P & K soil test levels.

In no-till fields that follow a long term meadow, surface applied fertilizers have been adequate in most of Ohio. The meadow crop normally produces high residue conditions at the soil surface, and this in turn allows good, shallow root growth of the corn crop. As a consequence, the uptake of P and K during the first year following meadow is normally satisfactory for no-till corn.

Traditionally, the soil test levels of P and K are often very low in meadow fields; however, following the killing of the meadow with herbicides, the root and top growth will begin to decay, thereby releasing large amounts of P and K. Thus, little yield response can be demonstrated from the use of fertilizer the first year after meadow. It is advisable to take another soil test at the end of the first year so that the fertilizer needs can be established for the second year of corn.

Chapter 10: Variety Selection and Stand Establishment

Jim Beuerlein, Don Myers
Jay W. Johnson

1. How should I choose what variety of alfalfa/corn hybrid, etc. to use?

Variety or hybrid choices should be based on crop performance data generated under conditions (ie. soil type, environment, etc.) similar to the ones that the farmer is working with. In addition to yield potential, parameters such as standability, insect resistance, disease resistance, winter hardiness, and maturity should be considered. Ohio State annually conducts performance trials on most agronomic crops at various locations throughout the state. The results of these performance trials can be obtained from your local county agent.

2. What information is available regarding corn hybrid and/or soybean varietal selection based upon soil type and soil fertility levels?

There is a limited amount of research that seems to indicate that there is a need to separate corn hybrids or soybean varieties on the basis of fertility levels and soil types.

Work conducted by Dr. Charles Tsai of Purdue University has shown that there is a differential in N uptake for various corn hybrids. This research, however, is in its early stages, and no recommendations are yet available based on it.

The success of various corn hybrids or soybean varieties on different soil types is often related to how droughty particular soils are. Many seed companies do indicate how drought susceptible their hybrids or varieties tend to be. On droughty soils, choose hybrids or varieties that wiil perform well under water stress conditions.

Reference: Tsai, C.Y., et. al. 1984. Relationship of N Deposition to Grain Yield and N Response of Three Maize Hybrids. Crop Science 24:272-281.

3. How early can we plant corn? How late?

When you are deciding how early to plant corn, one important factor to consider is the condition of the soil; is the soil dry enough to avoid compaction problems? In addition, one needs to evaluate the long term weather patterns for the area. Corn seed

will normally have adequate vigor to emerge for at least 3 weeks; therefore, planting 3 weeks prior to expected emergence is usually safe for corn. It takes approximately 150 heat units for corn to emerge. In central Ohio, we usually accumulate this number of heat units by the last week of April or the first week of May. Thus, the earliest recommended time to plant corn in central and southern Ohio would be the first week of April. In northern Ohio, the earliest planting time for corn would be mid April.

Farmers should strive to have their corn planted by early May whenever possible. In most years yields will decline and grain moisture at harvest will increase if corn is planted after this time.

Therefore, the recommended time for planting corn in northern Ohio is April 15-May 10 and in southern Ohio April 10 - May 10.

4. What should you do in the spring when its early and the ground is dry? Plant deep or shallow? Work fine or leave coarse? Cultipack or not? Plant or wait?

If it is after the earliest recommended planting date and if the soil is sufficiently dry, crops can be planted early in the spring. An early planting (before May 1st) gives a higher probability for adequate moisture for emergence. Normally, we recommend a slightly shallower planting (1/4-1/2 inch shallower) early in the season.

How fine the soil should be worked really depends on the soil texture. As a general rule of thumb, however, we recommend a coarser seed bed early in the season because coarse seed beds tend to improve water infiltration. Later in the season, a finer seed bed is desireable. A fine seed bed improves seed/soil contact and decreases evaporative losses of water. Cultipacking is normally recommended when we want a fine seed bed.

Planting should be delayed if it is prior to the earliest recommended planting date. You should also postpone planting if the soil has enough water for seeds to sprout but not enough water to allow emergence.

5. With the newer corn hybrids, is it necessary to worry about soil temperature when planting corn early?

There is relatively little data to support the need for more concern about soil temperature with the new hybrids as compared to the old ones. Refer to the current "Ohio Corn Performance Test" for ratings of the emergence of various corn hybrids.

6. How can I determine whether I should replant or leave a stand of corn? How to compare date of first planting, replanting, and % stand loss?

In determining whether or not to replant corn, three factors should be considered: the population of the current stand, the distribution of the current stand, and the date of replanting. If the current distribution is relatively uniform, you can expect to lose approximately 1-1.5 bushels of corn/day for any planting that is delayed beyond the first week in May in central Ohio. For established populations, you can expect approximately a 4 bushel decrease per 1,000 stand loss. Thus, for every 1,000 plants lost (assuming no replanting costs), you could delay planting approximately 3 days after the first week of May with equal yields expected.

For example, if you lose 5,000 plants/A, you would expect a total yield decrease of 20 bushels. A 20 bushel decrease in yield is equivalent to a full stand planted 17 days after the first week in May (ie., approximately May 24). Therefore, if you could accomplish replanting prior to May 24, it might be to your advantage to replant, but after May 24 there would be no benefit gained from replanting.

If the plants are well distributed, 15,000 corn plants seeded before May 10, would be expected to yield in the range of 125 to 140 bu/a.

7. How early can I plant soybeans?

If soil conditions are satisfactory, anytime after april 20, 25 and 30 for southern, central and northern Ohio respectively. Yield loss due to delayed planting ranges from one-third bushel to more than 1 bushel per acre per day, depending on the row width, plant type, and actual date of planting.

8. Is there an ideal row width to use for soybeans?

Any row width is satisfactory as long as a closed canopy (row middles filled in) develops prior to flowering. In general, the earlier you plant, the wider the rows can be and still meet this requirement. Although growing conditions will influence the actual time that it takes for a soybean crop to form a complete canopy, an average time frame is 30 days for 7 inch rows, 45 days for 15 inch rows, and 70 days for 30 inch rows. Therefore, for an early May planting, soybean rows usually need to be 15 inches or less.

9. What seeding rates should be used for small grains and forages?

Information concerning the appropriate seeding rates for a number of small grains is given on pp. 39-41 of the Ohio Agronomy Guide. In this same publication on p. 63, you will find a table listing the seeding rates of various forage crops.

Chapter 11: Pesticides

Kent Harrison
Jim Beuerlein

1. Should weeds be controlled pre-emergent or post-emergent for corn and soybeans?

The answer to this question depends upon the specific weed species that need to be controlled. In general, there are economical methods available for both pre-emergent and post-emergent treatments as well as combination pre-emergent/post emergent treatments.

As a general rule of thumb, it is a good, cost effective policy to use a pre-emergent, soil applied herbicide to control routine, annual weed species; this should be followed up with post-emergent control measures as the need arises. For perennial weeds, post-emergent control is still the only option available.

2. How can we reduce costs? Can we use less herbicides and cultivate more? What system is reliable and economical?

There is no one perfect system for weed control. Factors such as soil type, cultural practices, specific weed problems, and objectives of the grower will influence the choice of a weed control program. Cultivation requires wide rows, so for soybeans there is a yield loss associated with having wider rows to accommodate cultivation. Cultivation does not remove weeds close to the row and can destroy some of the crop's root system. For specific tips on reducing costs, refer to Reducing Crop Production Costs, Bulletin #749.

3. What are common herbicide carry over problems?

Atrazine carry over is a common problem when corn is followed by small grains, alfalfa, or soybeans. Although only limited data has been collected thus far, there seems to be potential carry over problems with some of the new soybean herbicides.

For example, a crop of corn, sugar beets, tomatoes, or alfalfa following use of Scepter, Preview, or Lorox-Plus may suffer herbicide injury. In addition, carry over problems have been found when small grains follow use of Command.

4. Triazine carry over problems. How can I determine if the level is too high to establish grain and/or meadow seeding?

A bioassay is the most reliable method to determine whether or not levels of triazine are too high. Take several random soil samples (0-4 inches) in the field that is in question. Plant the crop in this soil the season prior to seeding and observe the seedlings for symptoms of herbicide injury.

There are also testing labs that will do soil analysis for triazine residues. In general, for samples taken at a depth of 0-3 inches, the following guidelines are recommended:

(1. If the triazine level is 0.17 parts per million (ppm) or less, it is safe to plant oats and alfalfa.

(2. If the triazine level is less than 0.35 ppm, it is safe to plant soybeans.

(3. If the triazine level is greater than 0.35 ppm, it is only safe to plant corn.

If soil samples are taken from 0 to 6 inches, these recommended tolerances can be cut in half.

5. How much do herbicides injure crops if no weeds are present? Can you put a dollar value on this? (Example 2,4-D and Banvel on corn)

Although most herbicides do not cause sufficient crop injury to cause yield reductions, some herbicides will cause severe crop injury under certain environmental conditions. Normally, these conditions are specified on the label of the product, and the consumer is warned to avoid application under these conditions. For example, 2,4-D and Banvel can cause corn injury if applied during extremely hot, humid weather or if applied at the wrong stage of plant growth. It is impossible to put a dollar value on "typical injury" to a weed-free crop since the amount of injury that can occur is directly influenced by the environment.

Most commercial herbicide products have had research conducted on them to determine their safety in weed free crops. In general, if herbicides are applied according to label instructions and if all restrictions are carefully observed, no reduction in yield would be expected.

6. What is the health safety, both personal and environmental, of commonly used chemicals?

Some herbicides are more dangerous for the grower to handle than others. We know that the herbicides on the market today are, in general, safe as far as short term effects, but research has not yet addressed the long term effects of these products.

The U.S. Environmental Protection Agency (EPA) has been assigned the responsibility to oversee the safety of all agronomic chemicals. They require toxicology data on each pesticide, and they establish tolerance levels. Only those products that fall within the window of "reasonable" safety will be marketed, and their registration is always subject to review by the EPA.

7. How do I control perennial vegetation (sumac, milkweed, dogbane, etc.) in no-till corn?

Each weed species may require a different control method. In general, control of perennial vegetation in no-till corn usually involves repeated treatment with Banvel (or Banvel plus 2,4-D) or spot application with Roundup. Fall applications of Roundup or Banvel are generally more effective than spring or summer treatments, and must be made before the first killing frost. When perennial weeds become a serious problem in no-till corn, the best solution is to rotate to soybeans and then to control these weeds with a different group of herbicides.

8. What can be used to control broadleaf weeds in corn on very high organic matter soil?

There are very few soil applied herbicides that can be used to control broadleaved weeds in organic soils. In most situations of this type, you must depend on post-emergent herbicide programs: target specific weeds with specific post-emergent chemicals.

9. Considerations and concerns in the selection and use of spray adjuvants.

In general, use only the adjuvants specified on the herbicide label. In addition to the traditional surfactants and crop oils, many products are now labeled with low rates of liquid fertilizers. Herbicide labels which claim increased performance on certain weeds using low rates of liquid fertilizer (e.g. 28% N) are generally true.

10. Explain the use of Apron-Ridomil on different crops.

Ridomil (2E and 5G) is a systemic fungicide manufactured by CIBA-GEIGY for control of certain diseases in tobacco, soybeans, alfalfa, nonbearing deciduous fruits and nuts, conifers in nurseries, and certain vegetable crops. Check the product label for the specific diseases it will control in each crop and for the recommended methods of soil application.

Ridomil MZ58 is a wettable powder labeled for controlling diseases in potatoes, tomatoes, onions, cucumbers, melons, and squash. Ridomil 5G is a granular fungicide for control of Phytophthora root rot in avocado and soybeans. Specific information concerning proper application methods are found on the product labels.

Apron contains the same active ingredient as Ridomil, but is formulated for seed treatment to control seed rot and damping-off diseases of certain crops (soybeans, alfalfa, wheat, corn, field beans, ryegrass, forage grasses, etc.).

Chapter 12: Forages

Don Myers

1. Should I make forage seedings in spring or late summer?

Summer seeding of alfalfa is a rapidly increasing practice. Recent surveys indicate that approximately 40 percent of the alfalfa seedings in Ohio are now made in August. The remaining alfalfa fields (60%) are seeded in spring. Approximately half of these spring seedings are made without a small grain. The majority of the other legume species (Red clover, birdsfoot trefoil, etc.) are spring seeded.

There are several reasons for the rising interest in August seedings of alfalfa. The seeding is usually made following a small grain crop. After the small grain is harvested and the straw removed, the seeding operation is performed. Thus, a summer seeding allows a farmer to maximize the yield of his small grain without harming the establishment of his forage crop. Another advantage to an August seeding is that weed competition is often much less at this time than in the spring. Finally, summer seeding of alfalfa usually works well into the management scheme of most farms. During August the producer is normally less pressed for time than in the spring.

Many farmers are choosing to make part of their seedings in spring and part in summer. In this way, they can distribute their labor commitments and also the risk of failure, should uncontrollable factors (weather, insects, disease, etc.) occur. In general, if the seedings are properly done and if the new stands are then properly managed, the chance of success should be equal with spring and summer seedings of alfalfa. Other legume species are normally better adapted to spring seeding.

2. When should lime and fertilizer be applied to make necessary corrections prior to seeding alfalfa?

If the pH is lower than 6.2, lime and fertilizer should be applied at least 6 months prior to seeding.

3. How come my no-till forage seeding resulted in a poor stand?

There are a number of reasons that this could have occurred. As you search for the particular problem(s) that was responsible for your poor stand, we suggest you carefully reexamine the following aspects of your forage program:

(1. Soil fertility - What was the soil pH and the residual levels of the major nutrients at the time of seeding? Whenever the soil pH is too acidic or the P level is too low, corrections need to be made well in advance of seeding. Because the fertilizer nutrients must be surface applied in a no-till system, they need to be added at least 1 year, and possibly 2 years, prior to seeding.

(2. Soil properties - Are there problems with drainage or compaction?

(3. Existing vegetation - Did you make the seeding into an aggressive perennial?

(4. Herbicide program - Could there have been damage to the stand from herbicide residuals?

(5. Seeding - Was the seeding timely? Was the seeding made shallow enough? Did you get an acceptable seed/soil contact with the no-till drill?

Even when a producer has paid close attention to the above details, poor stands can still occur. There are many factors over which we have little control (weather, insects, diseases, etc.).

4. Can a no-till seeding of alfalfa be made into old sod in the spring?

Yes, some producers have been successful with spring seedings of alfalfa into old sod. In general, it is too difficult to attempt to kill the sod and seed during the spring. Therefore, we recommend that the old sod be killed the preceding fall with a non-selective herbicide (Roundup). The killed residue should be left on the soil surface over winter. Seeding can then be done the following spring during mid to late April.

Even though some producers are successful with such spring seedings, a more reliable method is to kill the sod during summer and then seed sometime during August. Therefore, when possible, a farmer should seed alfalfa into sod during the summer.

5. When should alfalfa be fertilized?

We recommend a split application of K: 1/2 should be applied following the first cut and 1/2 following the last regular cut (approximately mid-September). If, however, you can only apply K once, then a mid-September application is preferable.

A single application of P is adequate. This can be applied after either the first or the last harvest of the year. If desired, P can be split applied with K.

6. Why the high fertility recommendations on CRP forages?

The Conservation Reserve Program (CRP) makes no provision for fertilizer application following seeding. Therefore, if adequate vegetative cover is to be maintained in CRP fields for the 10 year period mandated by the program, some minimum level of soil fertility is needed prior to seeding the vegetative cover. This minimum soil fertility level has been determined to be 30 lbs./A P (Bray P_1) and 220 lbs./A exchangeable K.

The Soil Conservation Service (SCS) oversees all CRP fields; it must assure the persistence of a vegetative cover that is adequate to retard soil loss. Thus, SCS is making fertilizer recommendations for CRP fields based upon the above minimum levels. The recommendation for soil test values between 30 and 90 lbs. P/A and 220 and 400 lbs./A exchangeable K is to apply 20-40-40 as a starter fertilizer at seeding.

If the soil analysis for a CRP field is extremely low and thus a large quantity of fertilizer appears to be needed to raise the soil fertility to the minimum CRP levels, we suggest that another soil sample be obtained. By definition, CRP land was to have been recently planted in a row crop. It seems improbable that a row crop could have been grown on a soil having such low fertility.

7. Does the nitrogen production gained by including a legume in a pasture seeding justify the extra seed cost and P & K need? What if its CRP ground?

Yes. Including a legume eliminates the need for nitrogen fertilizer, thereby reducing input costs. We always recommend that a legume be included in a pasture mix so that both the quantity and the quality of the pasture mix are maintained.

Vegetative cover must be maintained on all CRP (Conservation Reserve Program). Even though the monetary return may be less on a CRP field, we suggest that a legume be seeded along with the grass because it will add increased vigor to the forage stand. In addition, legumes can help improve soil aggregation and allow easier root, water, and air penetration of the soil.

8. Is it economical to apply 150-200 pounds of nitrogen to tall grasses? When is the most efficient time?

There should be an additional 20 pounds of dry matter produced for each pound of N added. This extra dry matter will subsequently be converted into animal product. As a general rule of thumb, 20 pounds of dry matter will equal one pound of beef. Therefore, one pound of N fertilizer should result in one additional pound of beef. To determine whether or not this is an economical practice, you must compare the cost of the N fertilizer with the value of this additional beef production.

If 150-200 pounds of N are applied, we recommend a split application - 1/2 in early spring prior to the initiation of new growth (March to early April) and 1/2 in early summer (mid-June). The greatest response to N fertilization will occur in early spring. Therefore, if only a single N application can be made, an early spring application will be most efficient.

9. What specific inoculum should be used for alfalfa?

Rhizobium meliloti is the bacterial species that should be used to inoculate alfalfa. In farm supply stores, this bacterium is normally sold as an alfalfa/clover (combination) inoculum.

10. How can one control weeds in alfalfa?

A weed control program must be able to selectively remove problem weeds from a field without causing serious injury to the alfalfa itself. In deciding on a plan for weed control, you must ask yourself several questions so that you can identify the specific weed problem that you are trying to deal with. First, are the major weeds grasses or broadleaved species? Are they summer or winter annuals? Are they summer or winter perennials? Second, one must know whether the field is an established stand or a new seeding as approaches for weed control will be different in these fields. Finally, consult the Ohio Agronomy Guide, Table 72 on p. 71, for a rating of the relative effectiveness of forage herbicides on the major weeds you have identified, and using this information, formulate a weed control program. Specific information concerning rates and methods of application for the herbicides are contained in Table 71 (p. 69-71) of the Ohio Agronomy Guide.

There have been a few recent changes in herbicide recommendations for forages. Poast is now labeled for use with alfalfa, both in new stands and established stands. In addition, Dinitro is now illegal to use.

Chapter 13: Miscellaneous

Norm Fausey, Floyd Herum
Bill Schnug, Jim Beuerlein
Jay W. Johnson

1. How to improve drainage when water sets over tile?

The probable cause of this problem is soil compaction. There are several approaches to help alleviate this condition. First, the use of a blind inlet would involve excavating and then putting a permeable material like gravel over the drain. An alternate approach would be to provide additional surface drainage by land forming. This would eliminate problem low spots. Finally, a farmer may choose to adopt a different tillage program. Good results with ridge till systems have been demonstrated on poorly drained soils.

2. Does the use of 25 foot tile spacings on Mahoning soils increase yield in field crops?

Normally, 45-55 foot tile spacings are recommended on Mahoning soils. Using 25 foot tile spacings may result in a slight yield increase, but the profit from this yield increase could not repay the installation costs. We recommend that more attention be paid to surface drainage. A farmer may want to consider the use of land smoothing.

3. Yellow, water-damaged soybeans. Will these be helped by manganese and 28% N?

The N fixing process will normally shut down if the root system of a soybean plant has been submerged. If N fertilizer is applied, it will tend to delay the resumption of N fixation. Therefore, unless the soybeans have been weakened by being submerged for a long period of time, the use of N fertilizer is not recommended.

The addition of Mn is only recommended if the Mn level of the plant is low. This is often the case in soils which have high pH values.

4. How to explain to farmers that shrinkage occurs in grain drying? How much is to be expected?

There are two kinds of grain shrinkage. The first is simply due to the removal of water. When the grain is dried, the seeds "shrink" to a smaller size because the space originally occupied by water is no longer needed, resulting in an increase in seed density (test weight). After drying each seed will weigh less because the weight of water is gone. It takes fewer pounds to make a bushel of grain. In corn and soybeans you can expect between 20% - 50% shrinkage from water removal alone.

The second type of shrinkage is dry matter shrinkage. This is usually associated with physical damage done to the seeds during the process of drying and handling. For example, small pieces of seed can be chipped off by the augers that move the grain. Normally, between 1/2% - 1% shrinkage will occur from dry matter loss.

5. Why does winter wheat not survive some winters? What can we do to prevent winter kill of wheat?

The primary reason for winter kill in wheat is adversely cold weather and lack of snow cover. Whenever the temperatures drop to near zero and there is no protecting snow cover, there is a high risk that plant tissues will be destroyed by the extreme

cold. Plants that have been weakened by other conditions (diseases, insects, etc.) are particularly susceptible to the stress of low temperatures.

Suffocation is another cause of winter kill in wheat. If ice forms on the soil surface, it can cut off the oxygen supply to wheat plants below. Also, puddling of water can reduce the oxygen flow to wheat.

A third cause of winter kill is heaving. Freezing and thawing of the soil can literally lift the wheat plants out of the ground.

There are two principal ways to protect a wheat crop against winter kill. Plant winter hardy varieties and plant at the proper time. Most stand losses are associated with late planting. Wheat should be seeded no later than 3 weeks after the fly-safe date.

6. What are some of the cultural practices for millet?

The Foxtail millets are the most widely grown group of millets in this country. Their principal use is in hay production; occasionally they are fed green or turned into silage. The Foxtail group does not tolerate grazing but may be pastured in an emergency.

The Foxtail millets prefer a rich, loamy, well-drained soil. They are very susceptible to cold, especially when they are young. The seed can be sown broadcast from May to July at a rate of approximately 50 pounds per acre.

7. How can I increase my organic matter? How long a period of time will this take?

The level of organic matter in a soil is determined by the environment in which the soil was developed. Moisture and temperature are two environmental factors that greatly affect the amount of soil organic matter. When organic materials are added to a soil, there will be a temporary increase in the organic matter content, but eventually this will return to the equilibrium level dictated by the environment. Changing tillage practices can cause a redistribution of organic matter. Under no-till levels of organic matter tend to increase while levels of organic matter lower in the soil profile tend to decrease. If you want to increase the organic matter of your soil and maintain it at this higher level, you must use annual additions of organic materials.

8. What effect does organic matter have on pH, fertilizers, and chemicals?

Organic matter acts as a buffer for pH changes. It also buffers the absorption and release of fertilizers and various agronomic chemicals. Therefore, when high levels of organic matter are present, we normally see slower changes in the level of soil acidity and in the concentrations of other chemical constituents.

9. What are the economics of crop scouting and management programs? Can they save money?

The usefulness of such programs depends on each farmer's management skills. If he does not monitor his crops closely or is unable to recognize problems that occur, then a scouting program would be economically justified. A scouting program would be of little value to a person who has the ability and does monitor his crops well.

10. Agri SC (soil conditioner) is marketed in our area. Is it of value? Any specific research on it?

Research conducted by several private, independent sources has shown very little yield response from use of the Agri SC product.

Reference: "Soil Conditioners," in Compendium of Research Reports on Use of Nontraditional Materials for Crop Production, NCR # 103 Committee.

11. Will gypsum "loosen" clay soils?

Gypsum is actually calcium sulfate. Adding it to soils with a high clay content can improve the tilth of the soil. Usually, this effect is relatively short lived and requires the use of rather large quantities of gypsum.