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Fact Sheet

Fact Sheet 511

Nitrogen Management for High Yield Small Grain Production

In recent years, the media, industries, academic communities and other groups have focused increasing attention on profitably maximizing crop yields. Recordbreaking yields are not as important as profitability and efficiency. For many reasons, fertilizer nutrients must be managed more efficiently to achieve better profit margins and to reduce potential contamination of our valuable surface and ground waters.

The typical American farmer has long been recognized as the world's most efficient food producer. But this distinction is not completely accurate today. For instance, average wheat yields in the United Kingdom and several other European countries exceed 80 bushels per acre compared to slightly more than half that for Maryland and the rest of the United States. Obviously, there is great potential for increasing wheat yields in Maryland, but proper management techniques must first be implemented to make these increases profitable.

The University of Maryland Agronomy Department has conducted research on nitrogen management of small grains for many years. As a result, Maryland's average wheat yields have increased from 36 bushels per acre in 1982 to 53 bushels per acre in 1988. In fact, many of Maryland's farmers are now consistently reporting wheat yields of 60 to 80 or even 100 bushels per acre. This same group of farmers just as consistently express disappointment if they fail to harvest more than 40 to 50 bushels per acre, a yield considered excellent just a few years ago.

As a result of this research, some important observations have been made relative to efficient nitrogen management. The benefits from some of these observations are at least partially responsible for achieving higher yields:

- Analytical methods for accurately predicting nitrogen recommendations for small grains are still in the experimental stage.
- Previously accepted guidelines do not apply under today's intensive management, high yield oriented goals. Much more emphasis should be placed on stand and growth stage, and less on the calendar. The calendar does not always coincide with the plant growth stage in which maximum nutrient demand occurs.
- Other valuable management techniques may already be available; for example: choosing the proper nitrogen rate and nitrogen source, using the most efficient application method, properly spacing surface bands for nitrogen solutions, choosing the proper time of application (split versus single applications), considering the pros and cons of nitrogen stabilizers, using manure in place of or as a supplement to commercial fertilizers and residual nitrogen following a legume crop, and others.

- Wheat varieties that consistently perform well under standard nitrogen management regimes can be expected to perform well also under high yield management regimes.

Nitrogen Rate

Variety and Residual Soil Nitrogen

Some of the most basic information required for good nitrogen management includes knowing the relationship between the small grain variety's genetic potential for a profitable response to nitrogen, and the nitrogen supplying power of the soil. For example, will the variety grown respond profitably to additional nitrogen? Much of the answer to this question depends on the nitrogen supplying potential of the soil. How much nitrogen was applied to the previous crop? Was the previous crop a legume which could have left a significant nitrogen contribution in the soil?

Next we must estimate whether all of the nitrogen that was applied to the previous crop was utilized. Or did dry weather or some other factor restrict nitrogen uptake by the previous crop which may have resulted in higher than normal nitrogen carryover? If nitrogen was left over from the previous crop, did normal or higher than normal precipitation remove this nitrogen from the soil, or did lower than normal precipitation allow the nitrogen to be carried over and remain available for the succeeding small grain crop? All of these factors must be considered before making a value judgment.

Unfortunately, there is no reliable nitrogen soil test yet available to help make this judgment. It is up to the grower to learn as much as possible about the characteristics of the variety he intends to plant as well as previous cropping history. Results from the statewide small grain variety tests can be extremely helpful, in the selection of the best adapted varieties for a particular situation. (See Agronomy Mimeo 19, *1988 Maryland Barley and. Wheat Variety Performance,* which is issued annually in late summer).

Nitrogen Soil and Plant Tests

Recent nitrogen studies in Maryland and Virginia, using deep soil sampling (up to 36 inches deep) and plant tissue testing at Feekes Growth Stage 5, have shown promise and may become useful in the future for determining the total nitrogen needs of barley and wheat. But the data is still too inconclusive to be useful in developing a reliable, objective nitrogen rate recommendation.

Finally, if the decision is made to apply additional nitrogen because soil nitrogen levels are lower than desirable, then it must be known whether the small grain variety has the genetic potential to utilize that nitrogen efficiently. There can be considerable variability between varieties relative to nitrogen utilization. For instance, on the average, many varieties often respond profitably to about 80 pounds of nitrogen per acre. But in some cases, a higher or a lower rate, or even a split nitrogen application may be more desirable, and most profitable. For more helpful information, refer to FS 446, *Managing Wheat for Maximum Economic Yields in Maryland.*

Lodging

Another important consideration is lodging. Specifically, will the variety in question resist lodging under high levels of nitrogen management, or will weak straw strength cause the ripening plant to fall to the ground making harvesting difficult? If the plant is likely to resist lodging under intensive management, then does that variety also have the genetic capability of producing high grain yields? Obviously, determining the most efficient level of nitrogen fertilizer to topdress on small grains in the late winter and/or early spring is not an easy decision to make. Each decision should be based upon a close consideration of the factors outlined previously and made strictly on a site-specific basis.

Nitrogen Sources

Some current guidelines on nitrogen management evolved after many years of research and practical experience. A few more recently developed principles are based on our experiences with no-tillage corn production. But, unlike the research with no-till corn which has shown that significant differences frequently exist in nitrogen efficiency among nitrogen sources, this has not been the case with small grains. Most nitrogen sources normally perform equally well on small grains.

Differences in crop response between small grain and corn cropping systems due to the nitrogen source, is apparently temperature related. Although exceptions can occur, experience shows that normally under Maryland growing conditions, one nitrogen source is about as effective as another for topdressing small grains in late winter or early spring. Soil temperatures are generally much lower during the growing season for small grains than for corn, thus ammonium nitrate, ammonium sulfate, 30-percent urea-ammonium nitrate (UAN) solution and urea all perform more nearly equally when top-dressed on small grains. Nitrogen losses by ammonia volatilization are less serious for cool- than for warm-season crops.

Nitrogen Application Methods

Research shows that wide differences in nitrogen efficiency often exist in warm season crops when comparing application methods for urea or 30 percent UAN solution. But again, this has not been demonstrated to be the case on small grains. That is, at recommended nitrogen rates, broadcast UAN appears to be about as efficiently utilized as dribbled UAN, assuming that surface bands are not spaced too far apart. Ammonium nitrate and urea are usually about equally efficient when surface applied. The absence of yield differences between nitrogen application methods on small grains is apparently largely due to cooler temperatures during the growing season.

Nitrogen applications at green-up can usually be broadcast safely without serious damage to the plants, assuming that recommended nitrogen rates are applied. This is normally true for both dry and liquid fertilizers. But, when nitrogen solutions are broadcast after the plants have progressed to a more mature growth stage, such as Feekes' Growth Stage 5 or 6, some leaf burning can be expected, although at recommended rates (60 pounds per acre or less), this burning will probably not depress grain yields significantly. This practice is not recommended.

Obviously, the preferred method is to dribble nitrogen solutions at these later growth stages. Dribbling (sometimes referred to as "streaming" or "surface banding") places more of the nitrogen solution in contact with the soil and in closer proximity to the plant roots rather than placing it on the vegetative part of the plant (such as occurs when nitrogen solutions are broadcast), permitting salt injury. Broadcast applications of UAN solution on vegetative parts of the plant are also more susceptible to ammonia volatilization losses.

Surface Bands for Nitrogen Solutions

Research with no-tillage corn has shown that nitrogen solution efficiency is the same for both 30-and 60-inch band spacings; that is, a band between every row is as good as a band between every other row. The guideline seems to be that nitrogen bands should not be placed any further apart than twice the row width. Research with small grains, however, has shown that yields following UAN dribbled in bands 30 inches apart were often significantly lower than those obtained when bands were just 15 inches apart.

In practice there appears to be no difference in efficiency between the 10-, 15- and 20-inch band spacings. Separating bands as much as 20 inches for 7- or 8-inch rows will probably not reduce yields. However, at the 20-inch spacing, uneven plant heights (alternating short and tall rows) have frequently been observed. To avoid this problem, it is recommended that surface bands should be no more than 15 inches apart for 7- or 8-inch rows. For narrower rows, the bands should be spaced at closer intervals, perhaps as close as 10 inches. Bands closer than 10 inches are not recommended.

Time of Nitrogen Application

Contrary to earlier thinking, it now appears that a single delayed nitrogen application, at perhaps a lower rate, may be more efficient than topdressing with a single larger nitrogen rate at green-up in late February or early March.

More recent research shows that grain yields tended to improve at a given nitrogen rate when the application date is delayed. When applied earlier than Feekes' Growth Stage 5, a slightly higher nitrogen rate is required to achieve the same yield. If applied when the plant is more mature, more of the nitrogen is apparently used to increase grain yields rather than to increase vegetative growth, often resulting in lodging. However, lodging has not been as serious following a split compared to a single nitrogen application.

If the small grain stand is satisfactory at green-up and each plant has approximately three to four tillers, then the traditional green-up nitrogen topdress application should be delayed to late Growth Stage 4 or to early Growth Stage 5. A slightly lower nitrogen rate should be considered for this delayed application.

Split Nitrogen Applications

Many growers are interested in the benefits of split nitrogen topdressing. Split nitrogen applications frequently do result in higher grain yields, but not always. The benefits are less certain on the heavier textured soils that are less subject to leaching. Split nitrogen applications on soils more subject to leaching often result in better nitrogen utilization and higher yields. When there is a difference between single and split nitrogen applications, it is usually (not always) in favor of the split.

What is the key factor in determining whether or not a split nitrogen application will be beneficial? It appears that the answer may depend on the kind of stand being topdressed; that is, is it a "well tillered" stand, or is it a thin stand? The well tillered stand, or a good stand in narrow rows, apparently does not benefit as much from the split nitrogen application as does the poor stand. Wheat planted in 4-inch rows generally responds less to split nitrogen applications than does wheat planted in 7- or 8-inch rows. The unsatisfactorily thin stand needs more nitrogen at an earlier date to increase the number of tillers in order to respond more efficiently to the later nitrogen application.

Apparently, in well tillered stands, the later applied nitrogen is used more for grain production. The earlier applied nitrogen is used more for increasing tillering. The decision on whether or not to recommend a split nitrogen application depends heavily upon the degree of tillering at green-up. A good stand should have a minimum of approximately 60 tillers per square foot at green-up. If the number of tillers at green-up is less than 60 per square foot, then a split nitrogen application may be beneficial.

Poultry Manure

Poultry manure is an excellent source of nutrients for fertilizing small grains. However, to utilize poultry manure effectively, there are at least two important matters to consider: 1) determine the nutrient content of the manure through a manure analysis (including estimated available nitrogen), and 2) manage manure the same as you would a valuable commercially purchased fertilizer.

For maximum efficiency, poultry manure must be applied at the proper time and at a rate consistent with the yield and stand capabilities of the variety. A manure analysis is the best way to determine the fertilizer value of manure. Frequently, 3 to 5 tons per acre of average poultry manure is required (depending upon how it was stored and applied) to supply the equivalent of 120 pounds of nitrogen per acre from a commercial fertilizer. If properly managed, poultry manure can be used just as effectively as commercial fertilizer nitrogen in the production of small grain.

Nitrogen Stabilizers

Research with no-tillage corn shows that nitrogen stabilizers such as N-SERVE or DCD (dicyan-diamid) when combined with urea or UAN solution, have not significantly improved nitrogen efficiency. Only slightly more encouraging results have been obtained when DCD was mixed with urea or UAN before being topdressed on wheat in the spring. Nitrogen stabilizers have not been shown to be consistently profitable on small grains.

Summary

The first step in nitrogen management is to test your soil to ensure that other nutrients besides nitrogen are present in adequate quantities. Apply phosphorus and potash if needed. Apply lime to adjust soil pH to the recommended level.

Next, select the proper nitrogen rate according to the characteristics of the plant variety and the crop history of the field planted. Be sure to account for nitrogen carried over from previous fertilizer applications, manure applications and legumes.

Select the best nitrogen fertilizer. Normally, any commercial nitrogen fertilizer or poultry manure will be acceptable as long as the recommended nitrogen rate is applied and the material is managed properly.

Utilize manure, if available, to supply recommended nitrogen. The other nutrients supplied by manure are a bonus. If a soil test indicates an excessive buildup of phosphorus and potash, use a commercial nitrogen fertilizer on those fields and reserve the use of manure for fields where soil tests indicate a need for phosphorus and potash. Have the manure analyzed and the amount of available nitrogen estimated.

If using a commercial nitrogen fertilizer, purchase as economically as possible. Base purchases upon cost per pound of nutrients. The physical and chemical qualities of the material as well as services provided with the purchase may also have value and should be considered.

Granulated or prilled (dry) nitrogen fertilizers can usually be broadcast safely at recommended rates and growth stages with little or no salt (burning) injury to the crop. Dry fertilizers should not be applied when the plants are wet (dew on leaves). Liquid nitrogen applied at later growth stages (for example, Feekes' Growth Stages 4 to 6) should be dribbled in bands 10 to 15 inches apart. Within limits, the narrower the row width, the closer the spacing of bands should be, with a minimum of 10 inches.

Split nitrogen applications may be beneficial and may increase yields, if at green-up, tillering is found to be less than three to four good tillers per plant. If there are at least 60 tillers per square foot at green-up, a single nitrogen application at Growth Stages 4 to 6 should be adequate. If there are less than 60 tillers per square foot, a split nitrogen application may be more desirable with the first application at green-up and the second at Growth Stages 4 to 6. If a single nitrogen application is recommended, a maximum of 60 to 80 pounds of nitrogen per acre should be applied at Growth Stage 5. The lower rate should be applied on medium to heavy textured soils where nitrogen carryover from the previous crop may be higher or if the stand is considered vulnerable to lodging.

If a split nitrogen application is recommended, one half of the nitrogen should be applied at green-up, and the other half at Growth Stage 5 or 6. Each application should be limited to no more than 50 to 60 pounds of nitrogen per acre.

Nitrogen stabilizers such as DCD or N-SERVE may or may not be beneficial and cost effective. To date, when mixed with urea or UAN solution and applied either the previous fall or in the spring, no consistent positive value has been demonstrated for these materials under Maryland growing conditions.

For additional information on managing small grains for high yields and maximum profits, please refer to Agronomy Mimeo 19, *1988 Maryland Barley and Wheat Variety Performance,* Agronomy Mimeo 28, *Intensive Wheat Management Guidelines for Maryland* and Fact Sheet 446, *Managing Wheat for Maximum Economic Yields in Maryland.*

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