COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE

Agronomy notes

Vol. 33, No. 1, 2001

Zinc Fertilizer Rates and Mehlich III Soil Test Levels for Corn

Lloyd Murdock and Paula Howe

Zinc (Zn) is the micronutrient most often deficient for corn in Kentucky. This problem occurs every year but is more commonly seen in years with a cool, wet spring. Although the environment, soil type and past erosion each have an effect, the most important factors controlling plant available Zn are the soil pH, extractable soil phosphorus (P) and extractable soil Zn. While the amount of Zn in the plant increases as the available soil Zn increases, increasing levels of soil P and pH are strongly associated with reduced levels of Zn in the plant.

The amount of Zn in the soil necessary for adequate plant Zn must increase as the pH and P in the soil increases, and this is reflected in the UK fertilizer Zn recommendation (Table 1). Most studies to determine the Zn fertilizer rates for Zn deficient soils were conducted in an area of Kentucky which has soils that are naturally high in P. The original research that determined the adequate soil test levels of Zn for corn was also located on these soils and was based on a 0.1 N HCl extractant.

The University of Kentucky soil testing laboratories now use a Mehlich III extractant for all soil nutrients including Zn. An extensive laboratory correlation was completed to relate 0.1N HCl soil Zn levels with Mehlich III levels. However, there was still a question as to how well these correlated numbers relate to what is found in the field. It was also felt that the Zn fertilizer recommendation rates were too high for the soils not very high in soil test P.

A series of studies was completed to determine the accuracy of the Mehlich III Zn soil test to correctly predict a Zn deficient corn crop. The second objective of these studies was to determine the accuracy of the recommended Zn fertilizer rates and change them if necessary.

Field Survey

Methods

A field survey was used to determine the accuracy of the Mehlich III Zn soil test by relating the Zn soil test levels to corn tissue analysis. The survey was conducted on 33 cornfields in six counties in Western Kentucky. Many of the fields had a history of Zn deficiency for corn, or they had a low Zn soil test. Each field was soil sampled at a 0-2, 2-4 and 4-6 inch depths.

Corn ear leaf samples were collected at initial silking. Based on previous research by the University of Kentucky and other universities, 17 ppm ear leaf Zn or greater is considered adequate.

In the present Zn fertilizer recommendation table (Table 1), the soil pH along with the extractable P and Zn are all considered in determining Zn fertilizer recommendations. As the pH and P increases, the soil test Zn level needed for adequate plant nutrition increases. Using the ear leaf Zn content, we were able to confirm the accuracy of these recommendations. There were two types of accurate predictions: 1) the Zn soil test was below the critical Zn level found in Table 1 and there was less than 17 ppm of Zn in the ear leaf or, 2) the Zn soil test was above the critical Zn level and there was 17 ppm or greater of Zn in the corn ear leaf.

Results

The present Zn fertilizer recommendations in Table 1 accurately predicted the need for Zn fertilizer 81% of the time in the no-till fields with a sampling depth of 0 to 4 inches (Table 2). The recommended soil depth for sampling no-till fields for all soil test nutrients is 4 inches. The present recommendations were correct in predicting need for Zn fertilizer 71% of the time for the conventional till fields with a sample depth of 0-6 inches. The recommended soil depth for sampling conventional fields for soil test nutrients is 6 inches.

The accuracy of the present recommendations in predicting the need for Zn fertilizer was similar for the two tillage systems and higher than expected for a micronutrient. Even though the incorrect predictions or errors occurred on only 19% of the no-till fields and 29% on conventional tilled fields, they were still a concern. The errors were divided into two categories. A type 1 error was labeled as one where Zn fertilizer is recommended but not needed. This is considered a safe error because it will not cause the producer a yearly yield loss although it would increase his input costs until the Zn soil test increased to a level where Zn was no longer recommended. The type 2 was one in which Zn was not recommended but was needed. This error would cost the producer a yearly yield loss and is considered the least desirable type of error. This type of error occurred only one time in this study.

Conclusions

The accuracy of the Zn soil test in identifying the need for Zn fertilizer, as determined by this survey, is quite good and higher than expected. The number of fields in the survey (33) is relatively small, but we believe that it gives us a better understanding of the Zn soil test and recommendation accuracy. The method of selecting the surveyed fields skewed the surveyed population towards fields being at the lower end of the soil test Zn levels. This would focus the study more towards the problem fields. Based on experience, we expect a large percentage of fields in Kentucky to have adequate soil Zn levels and not experience Zn deficiencies. Logically, we then conclude that the accuracy of the Zn soil test should be at least as good or better for all fields as it was for the fields in the survey.

These results indicate that the Mehlich III extractable Zn soil test, as now used to recommend Zn fertilizer, is reasonably accurate and gave us confidence that it is quite useful to the corn producers in the state.

Table 1. Soil Test Information to Determine the Zinc Fertilizer Requirements for Corn

To determine if zinc is needed, find the appropriate soil test P level in the left column and read across the table to the appropriate soil pH level. If soil test zinc is less than that shown for the appropriate soil test P level and pH, apply fertilizer zinc.

	Soil Water pH				
	pH 6.0 - 6.4	pH 6.5 - 6.8	pH 6.9 - 7.2	pH 7.3 - 7.6	
Soil Test P (lb/ac)[1]	Soil Test Zn (lb/ac)[1]				Zn (lb/ac) Recommended as Broadcast
50	1.1 - 1.8	1.9 - 2.5	2.6 - 3.2	3.3 - 3.9	10-20
100	1.6 - 2.3	2.5 – 3.0	3.2 - 3.7	3.9 - 4.4	10-20
150	1.9 - 2.6	2.8 - 3.3	3.5 - 4.0	4.2 - 4.7	10-20
200	2.1 - 2.8	3.0 - 3.5	3.7 - 4.2	4.4 - 5.0	20-30
250	2.3 - 3.0	3.2 - 3.7	3.9 - 4.4	4.6 - 5.1	20-30
300	2.4 - 3.2	3.3 - 3.9	4.0 - 4.6	4.7 - 5.3	20-30
350	2.6 - 3.3	3.4 - 4.0	4.2 - 4.7	4.9 - 5.4	20-30
400	2.7 - 3.4	3.6 - 4.1	4.3 - 4.8	5.9 - 5.5	20-30
450	2.8 - 3.5	3.6 - 4.2	4.3 - 4.9	5.1 - 5.6	20-30
500	2.8 - 3.6	3.7 - 4.3	4.4 - 5.0	5.1 - 5.7	20-30

[1] *Zinc and phosphorus levels shown are from soil extraction by the Mehlich III procedure.*

Table 2. Accuracy of the Zinc Soil Test Recommendation as Determined by Tissue Analysis of Corn

				Error (%)	
Number of Fields	Tillage	Sample Depth	Correct (%)	Type 1[a]	Type 2[b]
26	No-Till	0-4"	81	15	4
7	Conventional	0-6"	71	29	0

[a] Type 1 error - Recommends zinc when not needed.
[b] Type 2 error - Zinc not recommended but needed.

Zn Fertilizer Rate Study

Most of the original fertilizer Zn rate studies were carried out on soils that were naturally very high in soil test P because Zn deficiencies of corn most commonly occurred on these soils. Twenty to thirty lbs/ac of Zn as a broadcast application of $ZnSO_4$ corrected these deficiencies. This application rate was sufficient to prevent Zn deficiencies for a number of years. Most of the corn in the state, however, is grown on soils that are not high in soil test P. Therefore, we looked at the effect of Zn on soils that were not high in soil test P.

Methods

Three zinc fertilizer rate studies were conducted in Trigg County to determine the relationship between soil pH, zinc fertilizer rate and the zinc content in the corn ear leaf. The studies were conducted at two sites for two years. Five levels of zinc in the form of $ZnSO_4$ were added using four replications on each study. The soil test levels of phosphorus, zinc, pH and the ear leaf zinc concentration for the two sites are seen in Table 3. The effectiveness of Zn fertilizer was evaluated by determining Zn concentration in the ear leaf at initial silking.

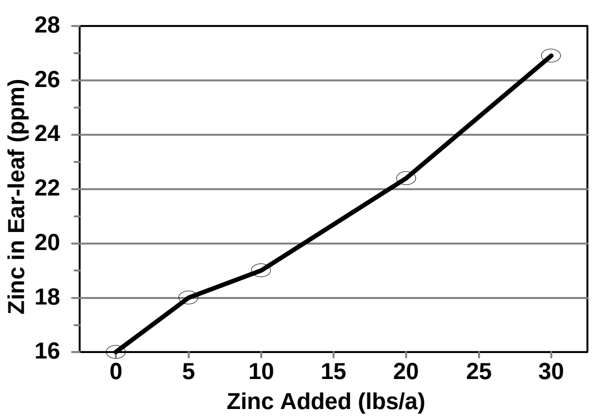
Results

The results of three experiments were very similar so they were combined and are found in Figure 1. A Zn deficiency was considered to be less than 17 ppm in the ear leaf. The results obtained from the three experiments show the Zn concentration in ear-leaf increased by 1.75 ppm for each 5 lbs/ac of Zn added up to the rate of 30 lbs/ac (the highest rate used). Therefore, the Zn in the ear-leaf increased by 3.5 ppm when 10 lb/ac of Zn was added and 5.3 ppm when 15 lb/ac of Zn was added.

Table 3. Soil Test Information and Plant Zn Levels from Two Sites Used to Study Zn Fertilizer Rates

Site	Soil Zn	Soil P	Soil pH	Ear leaf Zn
	lb/A	lb/A		ppm
1	1.6	104	6.5	16
2	0.9	69	6.8	13

Figure 1. Effect of Zn Application Rates on the Concentration of Zn in the Corn Ear Leaf



Conclusions

Based on information found in the field survey (data not shown), if Zn is deficient in the fields, 10 lb/ac of added Zn will be sufficient to prevent a Zn deficiency 83% of the time and a 15 lb/ac rate would be sufficient 100% of the time. It was concluded that the Zn fertilizer recommendation should be 10 to 20 lbs of Zn/ac for soil with less than 150 lb/ac soil test P rather than 20 to 30 lbs/ac. This recommendation is based on soil pH and Mehlich III extractable Zn and P soil test levels.

Morris J. Bitzer
Extension Specialist