Seed yields of grasses were not affected by trace element treatments on mineral soils (table 3). On peat (field 1), the yield of bluegrass seed was increased by 124 pounds per acre with the combined treatment of B, Cu, Mn, Zn. Copper alone increased the seed yield on peat by 60 pounds per acre, a difference that was significant at the 18% level.

Effects of trace element treatments on the chemical composition of grass tissue are shown in tables 4, 5 and 6. The B, Cu, Mn, Zn contents of tissue were increased with the rates of trace elements used on organic as well as on mineral soils. Most significant, however, may be the effect of copper treatment on the Cu content of bluegrass tissue on peat. The Cu content was increased to 8 ppm with an application of 50 pounds per acre of copper sulfate. Only 2 or 3 ppm of Cu were found in tissue without the copper treatment. According to studies conducted elsewhere, when the tissue of grasses contains less than 6 ppm Cu, responsive crops are likely to show deficiencies.

Table 3. Effect of Trace Element Applications on the Seed Yields of Kentucky Bluegrass and Timothy, 1969.

Treatments of Trace Elements	Field 1 Bluegrass Peat (E.B.)	Field 2 Bluegrass Vfsl (E.H.)	Field 3 Timothy sil (C.V.)
		Yield of seed, lbs/acre	
None	320 a#	295	402
Boron (B)	296 a	316	432
Copper (Cu)	381 ab	301	417
Manganese (Mn)	325 a	329	434
Zinc (Zn)	360 ab	303	433
B, Cu, Mn, Zn	444 b	299	391
Significance	*	N.S.	N.S.
CV(%)	21	14	10

All plots received the following amounts of plant nutrients: Field No. 1, 12 + 48 + 48; Field No. 2, 60 + 30 + 30; Field No. 3, 90 + 45 + 45. All fertilizer materials were applied on October 15, 1968.

#Means in vertical columns followed by different letters are significantly different at 5% level.

Table 4. Effect of Trace Element Applications on the Chemical Composition of Kentucky bluegrass tissue, 1969. Field 1. E. B. Roseau County, Peat.

Treatment	B	Cu	Mn	Zn
	Parts per million in dry matter			
None	7 a	3 a	43 b	19 a
B	15 b	3 a	46 b	18 a
Cu	7 a	8 b	33 a	18 a
Mn	8 a	2 a	66 c	20 a
Zn	8 a	2 a	42 b	30 c
B, Cu, Mn, Zn	15 b	8 b	40 ab	25 b
Significance	**	**	**	**
CV(%)	24	42	13	10

Table 5. Effect of Trace Element Applications on the Chemical Composition of Kentucky blugrass tissue, 1969. Field 2. E. H. Lake of the Woods County, Vfs1.

Treatment	B	Cu	Mn	Zn
	Parts per million in dry matter			
None	6 a	5 a	28 a	14 a
B	10 b	5 a	27 a	13 a
Cu	6 a	9 b	26 a	14 a
Mn	6 a	4 a	45 c	15 a
Zn	6 a	4 a	27 a	18 b
B, Cu, Mn, Zn	11 b	9 b	36 b	19 b
Significance	**	**	**	**
CV(%)	16	34	19	7

Table 6. Effect of Trace Element Applications on the Chemical Composition of Timothy Tissue, 1969. Field 3. C. V. Roseau County, Sil.

Treatment	B	Cu	Mn	Zn
	Parts per million in dry matter			
None	6 a	4 a	16 a	16 a
B	9 b	4 a	16 a	16 a
Cu	6 a	6 ab	15 a	15 a
Mn	6 a	4 a	19 b	17 a
Zn	6 a	4 a	16 a	23 b
B, Cu, Mn, Zn	8 b	7 b	16 a	22 b
Significance	**	**	**	**
CV (%)	7	25	5	5

SOYBEAN NITROGEN FERTILIZER STUDIES

G. E. Ham, S. D. Evans, W. W. Nelson and R. D. Frazier

Ammonium nitrate, urea, urea plus sulfur and sulfur-coated urea sources of nitrogen were compared at Lamberton, Morris and Waseca. At Waseca, urea-formaldehyde was compared also. Nonnodulating and nodulating isolines of Chippewa maturity and Chippewa 64 soybeans were grown on the plots. The seed yields for 1969 are shown in Tables 1, 2 and 3. Nitrogen fertilizer significantly increased seed yields at all locations. Rainfall was less than normal at Morris and the yields reflect this. At Lamberton and Waseca, rainfall was nearer to normal, although a dry period occurred in late August at both locations. The nodulating plants were well-nodulated at all locations. In nitrogen fertilizer placement studies at Rosemount, seed placement and banded ammonium nitrate was compared at the rates indicated in Table 4. Seed yields were increased by as much as 13 bushels per acre. These results indicate that nitrogen fertilizer for soybeans needs further consideration.

Table 1. Effect of nitrogen fertilizer on 1969 soybean seed yield at Morris, Minnesota when different sources of nitrogen fertilizer at the rate of 200 pounds N per acre were disced into the soil in the spring of 1969.

Nitrogen Source	Soybean Variety		
	Nonnods	Nods	Chippewa 64
	bu/acre	bu/acre	bu/acre
Check	14.0 a	16.5 a	15.5 a
Ammonium nitrate	19.1 b	20.0 b	18.2 b
Urea	21.6 c	21.3 b	22.6 c
Urea + sulfur	18.9 b	20.1 b	18.5 b
Sulfur-coated urea	20.4 bc	19.1 b	19.4 b

Yields followed by the same letter under a variety are not significantly different from each other.

Table 2. Effect of nitrogen fertilizer on 1969 soybean seed yield at Lamberton, Minnesota when different sources of nitrogen fertilizer at the rate of 200 pounds N per acre were disced into the soil in the spring of 1969.

Nitrogen Source	Soybean Variety		
	Nonnods	Nods	Chippewa 64
	bu/acre	bu/acre	bu/acre
Check	20.3 a	27.7 bc	27.8 a
Ammonium nitrate	27.4 c	29.7 c	30.3 b
Urea	24.7 b	24.6 a	28.9 ab
Urea + sulfur	27.4 c	29.2 bc	30.2 b
Sulfur-coated urea	28.2 c	27.1 b	31.1 b

Yields followed by the same letter under a variety are not significantly different from each other.

Table 3. Effect of nitrogen fertilizer on 1969 soybean seed yield at Waseca, Minnesota when different sources of nitrogen fertilizer at the rate of 200 pounds N per acre were disced into the soil in the spring of 1969.

Nitrogen Source	Soybean Variety		
	Nonnods	Nods	Chippewa 64
	bu/acre	bu/acre	bu/acre
Check	32.1 a	40.0 a	34.1 a
Ammonium nitrate	43.8 b	45.0 bc	40.2 bcd
Urea	44.9 c	44.3 bc	40.9 cd
Urea + sulfur	43.4 bc	41.7 abc	42.0 d
Sulfur-coated urea	40.9 b	41.2 ab	36.9 ab
Urea-formaldehyde	40.5 b	42.5 abc	37.9 bc

Yields followed by the same letter under a variety are not significantly different from each other.

Table 4. Effect on soybean seed yield when different nitrogen fertilizer rates and placements were applied to Merit soybeans grown at Rosemount, Minnesota in 1969.

Treatment		Seed Yield bu/acre
Check		28.1 a
Seed placement:	5#N	27.8 a
	10#N	39.1 b
	15#N	40.9 b
Band:	50#N	41.3 b
	100#N	36.3 b
	200#N	31.6 a
10#N Seed placement: and 100#N Band		37.5 b
10#N Seed placement: and 50#N Band		39.0 b

Yields followed by the same letter under a variety are not significantly different from each other.

SOYBEAN FERTILIZER PLACEMENT STUDY

G. E. Ham, W. W. Nelson, R. D. Frazier and S. D. Evans

Fertilizer treatments consisting of banded starter, starter in contact with the seed and a combination of banded and seed placement were superimposed on broadcast fertilizer treatments at Lamberton, Morris and Waseca. Treatments, fertilizer rates and seed yields are shown in Tables 1, 2 and 3. The yields at Morris were low due to lack of rainfall. The largest response was obtained from broadcast fertilizer applications. Starter fertilizer had less effect on seed yields either with or without broadcast fertilizer even though starter and broadcast effects were significant. At Lamberton the yields and the responses were largely due to greater rainfall. The largest response was to combinations of starter and broadcast fertilizer. Band fertilizer increased the yield of the broadcast check by 2.1, 2.6 and 3.9 bushels per acre even though the soil test level of the broadcast check was 25 pounds per acre at the beginning of the 1969 season. Foliar analyses indicated that the yield increases were from P additions. These data indicate the influence of variety on fertilizer response in this case. The yield increase with Corsoy was 17 bushels per acre, compared to about 10 bushels for Chippewa even though the checks of both varieties yielded about 25 bushels per acre. Similarly, adequate fertility is essential in order for a variety to perform at its maximum. At Waseca seed yields were not increased in most cases by broadcast or starter fertilizer. Seed yields were decreased significantly in many cases.

Table 1. Effect on soybean seed yield when different fertilizer placements were applied to soybeans grown at Morris, Minnesota in 1969.

Starter fertilizer	Chippewa 64		Merit		Traverse	
	No broadcast	Broadcast	No broadcast	Broadcast	No broadcast	Broadcast
	bu/acre	bu/acre	bu/acre	bu/acre	bu/acre	bu/acre
Check	17.7 a	22.2 bc	18.4 a	23.1 bc	19.8 a	23.2 bc
Band (2x2)	20.1 ab	22.0 bc	18.2 a	23.1 bc	21.6 ab	24.1 bc
Seed placement	21.2 bc	23.2 bc	20.5 ab	24.5 c	19.6 a	23.7 bc
Band & seed placement	21.3 bc	20.8 bc	17.8 a	21.8 bc	21.4 ab	24.9 c

Fertilizer rates:

Band	10 + 20 + 10
Seed placement	4 + 8 + 4
Broadcast	0 + 60 + 30

Soil test values:

pH	7.7
P	7 lbs/acre (low)
K	300 lbs/acre (high)

Means under a variety followed by the same letter are not different at 5% level of significance (lsd test).

Table 2. Effect on soybean seed yield when different fertilizer placements were applied to soybeans grown at Lamberton, Minnesota in 1969.

Starter fertilizer	Chippewa 64		Corsoy		Hark	
	No broadcast	Broadcast	No broadcast	Broadcast	No broadcast	Broadcast
	bu/acre	bu/acre	bu/acre	bu/acre	bu/acre	bu/acre
Check	25.5 a	33.7 bcd	25.8 a	39.8 c	24.5 a	36.1 c
Band (2x2)	33.5 bc	35.8 cd	36.9 b	42.4 de	33.3 b	40.0 d
Seed placement	32.6 b	35.4 cd	34.7 b	40.3 cd	33.0 b	37.3 c
Band & seed placement	34.2 bcd	36.1 d	41.0 cd	43.5 e	36.6 c	38.3 cd

Fertilizer rates:

Band	15 + 20 + 18
Seed placement	5 + 7 + 6
Broadcast	0 + 60 + 30

Soil test values:

pH 5.7
P 10 lbs/acre (low)
K 290 lbs/acre (high)

Means under a variety followed by the same letter are not different at 5% level of significance (lsd test).

Table 3. Effect on soybean seed yield when different fertilizer placements were applied to soybeans grown at Waseca, Minnesota in 1969.

Starter fertilizer	Chippewa 64		Corsoy		Hark	
	No broadcast	Broadcast	No broadcast	Broadcast	No broadcast	Broadcast
	bu/acre	bu/acre	bu/acre	bu/acre	bu/acre	bu/acre
Check	38.1 bc	37.2 ab	43.9 c	40.2 ab	41.4 a	40.8 a
Band (2x2)	40.5 c	34.6 a	43.6 c	39.1 a	41.3 a	39.7 a
Seed placement	37.2 ab	34.8 a	42.4 bc	41.9 abc	39.2 a	38.6 a
Band & seed placement	37.9 bc	37.0 ab	40.7 abc	41.7 abc	41.6 a	39.7 a

Fertilizer rates:

Band	16 + 40 + 53
Seed placement	4 + 8 + 12
Broadcast	0 +100 +150

Soil test values:

pH 7.1
P 71 lbs/acre (very high)
K 333 lbs/acre (very high)

Means under a variety followed by the same letter are not different at 5% level of significance (lsd test).

Table 4. Effect on soybean seed yield when different fertilizers were applied to Chippewa 64 soybeans grown at Waseca, Minnesota in 1969.

Treatment	Fertilizer Depth	
	6 inches	14 inches
	bu/acre	bu/acre
Check	37.4 a	
Check (plus knife)	38.1 a	38.2 a
500 + 0 + 0	38.5 a	38.3 a
0 + 200 + 300	36.1 a	37.3 a
500 + 200 + 300	38.6 a	37.0 a

Means under a variety followed by the same letter are not different at 5% level of significance (lsd test).

EFFECT OF MICRONUTRIENTS ON SOYBEAN SEED YIELDS

G. E. Ham and R. D. Frazier

Micronutrients were applied to soybeans grown at Waseca and Clear Lake. At Waseca, the soil treatments consisted of 10 pounds per acre sulfate source (elemental basis) and 3 pounds per acre chelate and silviplex sources (elemental basis). Foliar treatments were 3.0 pounds per acre sulfate source and 0.6 pounds per acre chelate and silviplex sources. At Clear Lake all treatments were foliar. Sulfate sources were applied at the rate of 3.0 and 6.0 pounds per acre (elemental basis) as low and high treatments in Table 1. Silviplex and chelate sources were applied at the rates of 0.6 and 1.2 pounds per acre. No significant yield increases were obtained from the treatments at either location. The coefficient of variation was 18.6% and 7.6% at Clear Lake and Waseca, respectively. The large variation at Clear Lake was due to lack of water during one day spell irregular irrigation patterns. Foliar analyses are being conducted to determine if the nutrients were taken up by the plants and to compare uptake from the various sources of micronutrients.

Table 1. Effect on soybean seed yield when different micronutrients were applied as foliar treatments to soybeans grown at Clear Lake, Minnesota in 1969.

Treatment	Soybean Variety			
	Chippewa 64		Merit	
	Low[a]	High[a]	Low[a]	High[a]
	bu/acre	bu/acre	bu/acre	bu/acre
Check	27.8		19.3	
Fe-chelate	28.4	28.4	23.7	-
Fe-silviplex	28.3	23.8	-	-
Fe-sulfate	29.6	23.6	20.2	17.8
Mn-chelate	30.7	25.6	23.8	-
Mn-silviplex	27.6	22.0	-	-
Mn-sulfate	25.9	20.0	21.0	21.9
Cu-chelate	27.8	27.3	23.2	-
Cu-silviplex	30.3	25.7	-	-
Cu-sulfate	29.4	24.4	20.0	20.6
Zn-chelate	29.2	24.7	25.3	-
Zn-silviplex	24.8	25.1	-	-
Zn-sulfate	26.3	24.9	24.4	18.6
Multiplex	28.4	28.1	24.9	27.1

Table 2. Effect on soybean seed yield when different micronutrients were applied to Chippewa 64 soybeans grown at Waseca, Minnesota in 1969.

Treatment	Foliar bu/acre	Soil bu/acre
Check	39.4	-
Fe-chelate	38.4	40.0
Fe-silviplex	37.9	-
Fe-sulfate	38.0	39.0
Mn-chelate	39.7	40.4
Mn-silviplex	39.1	-
Mn-sulfate	35.9	39.2
Cu-chelate	40.8	40.0
Cu-silviplex	38.8	-
Cu-sulfate	38.4	40.0
Zn-chelate	37.8	38.9
Zn-silviplex	39.7	-
Zn-sulfate	38.4	38.5

FOUR YEARS (1966-69) OF EXPERIMENTS WITH DIFFERENT ZINC FERTILIZER SOURCES AND PHOSPHATE FOR CONTINUOUS CORN ON A ZINC DEFICIENT HAMERLY LOAM NEAR BENSON, MINNESOTA IN SWIFT COUNTY

O.M. Gunderson, J.M. MacGregor, S.D. Evans and R.G. Munter

An investigation of commercial sources of zinc and the effect of heavy phosphate fertilization was commenced with field corn in the spring of 1966 with two main objectives:

(1) To determine the relative effectiveness of several commercially available zinc compounds on corn growth, yield and composition.

(2) The comparative effect of heavy phosphate fertilization on zinc availability to growing field corn and yield.

A zinc deficient calcareous loam had been previously observed on the Richard Mikkelson farm at the junction of Highways 22 and 29 and 5 year lease arrangements were completed with the owner on a 7 acre tract. Two randomized block experiments were established about the middle of May, 1966, each consisting of 7 treatments in quadruplicate. Three rates of granular zinc sulfate to supply 10, 20, and 40 pounds of zinc per acre, ZnMNS to supply 10 pounds of zinc per acre, and the solid granular chelated zinc (Zn 45) to supply 2.5 lbs of zinc per acre were broadcast and plowed down both in 1966 and in 1967. The seventh treatment consisted of 0.5 lbs of chelated zinc per acre as Zn 45 applied in the granular form along the corn row in each of the first 3 years, and as a liquid row application in 1969.

The phosphate interaction experiment was located a few hundred feet distant, being of the same size and design with annual phosphate treatments being plowed down and zinc as the sulfate applied during the first 2 years. The farm operator also applied a total of 100+40+40 per acre in 1966 over the entire area.

Zinc deficient soils are usually low lying calcareous areas subject to poor drainage and excessive moisture in the spring. Late corn planting generally is the rule. These low-lying areas are also subject to relatively poor air drainage, and are generally subject to early fall frost which necessitates the planting of early maturing corn (and even this often fails to mature). The extreme variability in zinc supplying power of such soils, even in limited areas, is well known, making adequate treatment replication extremely difficult and often unsatisfactory.

The soil of each plot was sampled in 1968 and analyzed for available zinc as reported on page 123, Soil Series 84. Severity of visual zinc deficiencies of the growing plants, zinc and phosphorus analyses of the sixth corn leaf determined, and ear corn yield have been obtained in each of the four years. These are reported in the following three tables.

Table 1 shows a direct relationship between zinc deficiency symptoms and the ear corn yields obtained. Zinc treatments which resulted in more normal plant growth produced significantly higher yields. The 40 pound per acre rate of zinc as the sulfate (a total of 80 pounds Zn/A) resulted in essentially normal plant growth, but application rates of half or even a quarter of this resulted in equivalent increases in corn yields. The ZnMNS treatment was only slightly less effective with the chelated form of zinc being ineffective on both visual deficiency symptom removal and on corn yield.

The effect of heavy annual phosphate applications at rates of 320 or 640 pounds of P_2O_5 per acre resulted in severe Zn deficiency symptoms and decreases in ear corn yield. Granular zinc sulfate plowed down in both 1966 and 1967 (supplying a total of 20 pounds of zinc per acre) resulted in normal plant growth and grain yield.

Table 1. Visual Zinc Deficiency Symptoms of Plants and Ear Corn Yields With Zinc Fertilization of a Zinc Deficient Loam Near Benson (Swift County) - 1966-69.

(Ear corn at 15.5% moisture)

1966 & 1967 Zinc treatments (lbs/A)	1966 Visual (a) rating	1966 Bu/A	1967 Visual (a) rating	1967 Bu/A	1968 Visual(a) rating	1968 Bu/A	1969 Visual(a) rating	1969 Bu/A	4 year average Visual (a) rating	4 year average Bu/A
No Zinc	5.1	92.0 bc	3.2	56.1 a	3.0	71.3 a	6.8	90.8 NS	4.5	77.5 a
10 as $ZnSO_4$ (P.D.)	7.9	115.4 a	7.1	77.5 a	6.5	92.4 a	8.2	96.1 NS	7.4	95.4 c
20 " " "	8.1	111.8 a	8.6	75.6 a	8.7	94.8 a	9.2	97.3 NS	8.7	94.3 c
40 " " "	9.0	109.3 a	8.5	81.7 a	9.0	88.8 a	10.0	90.1 NS	9.1	92.5 c
10 as ZnMNS (PD)	8.7	103.8 ab	8.0	79.2 a	7.5	86.9 a	8.5	94.7 NS	8.2	91.2 bc
0.5 Zn as Zn 45 (annually row)	2.6	85.5 c	6.4	69.7 a	6.0	93.4 a	8.0	83.3 NS	5.8	83.0 ab
2.5 Zn as Zn 45 (bdct. & P.D. in '66 & '67)	6.0	93.3 bc	3.9	58.4 a	3.0	79.0 a	4.5	81.0 NS	4.4	77.9 a
Phosphate-Zinc Interaction Experiment										
40 P_2O_5-annual PD	7.0	98.4 ab	7.5	68.5 a	7.0	86.9 abc	6.8	96.8 abc	7.1	87.7 c
80 " " "	7.0	96.9 ab	7.0	65.8 a	5.7	94.5 bc	7.3	104.2 abc	6.8	90.4 cd
160 " " "	5.7	96.3 ab	8.0	60.8 a	6.2	100.0 c	6.8	94.4 ab	6.7	87.9 c
320 " " "	3.9	96.8 ab	5.0	50.2 a	3.2	81.4 ab	4.8	89.7 ab	4.2	79.5 b
640 " " "	2.7	83.4 b	3.5	34.3 a	2.5	72.0 a	2.5	82.2 a	2.8	68.0 a
320 " " " + 10 Zn as $ZnSO_4$ ('66 & '67)	8.5	113.6 a	8.4	74.8 a	8.7	92.6 bc	9.8	110.6 bc	8.9	97.9 de
640 P_2O_5 annual PD + 10 Zn as $ZnSO_4$ in '66 & '67)	7.9	107.6 a	8.5	74.7 a	8.2	100.6 c	8.3	117.2 c	8.2	100.0 e

(a) ranged from 0 representing severe zinc deficiency symptoms to 10 representing apparently normal plant growth.
Zn 45 applied as granules in 1966, 1967, 1968 and as a liquid in 1969.

Table 2 illustrates the zinc-phosphorus relationship occurring in the sixth corn leaf during the four years of the study. It is evident that the $ZnSO_4$ treatments increased leaf zinc concentrations, whereas the ZnMNS and the two Zn 45 treatments failed to supply available Zn. Increasing Zn concentrations in the corn leaves resulted in lower P content.

Heavy P fertilization with no zinc treatments increased P leaf content and this was materially lowered by the addition of the two 10 lb Zn/A treatments applied in 1966 and in 1967.

Table 3 shows the four year average relationship between the P:Zn concentrations in the sixth corn leaf and the yields of ear corn. Corn yields were apparently depressed where the P:Zn ratio exceeded 400, with the maximum yields occurring when the ratio was about half of that value.

Table 2. Zinc and Phosphorus Concentrations and P:Zn Ratios in Sixth Corn Leaves Grown After Zinc or Phosphate Fertilization on a Zinc Deficient Calcareous Loam Near Benson. (1966-69)

1966 & 1967 zinc treatments(lbs/A)	1966			1967			1968			1969		
	ppm Zn	%P	P/Zn	ppm Zn	%P	P/Zn	ppm Zn	%P	P/Zn	ppm Zn	%P	P/Zn
No Zinc	7.2 c	0.400 a	556	9.2 d	0.367 a	399	14.8 a	0.410 cd	277	13.8 a	0.339 NS	246
10 as $ZnSO_4$ (PD)	11.7 bc	0.297 bc	254	13.8 c	0.304 bc	220	16.4 ab	0.338 d	206	17.6 a	0.272 NS	155
20 " " "	14.0 b	0.259 c	185	18.2 b	0.273 c	150	23.4 bc	0.462 bc	197	28.0 b	0.265 NS	95
40 " " "	18.0 a	0.259 c	143	26.5 a	0.281 bc	106	29.4 c	0.511 b	174	42.6 c	0.302 NS	71
10 " ZnMNS (PD)	9.3 bc	0.326 abc	351	12.8 cd	0.285 bc	223	15.3 a	0.630 a	412	18.2 a	0.284 NS	156
0.5 Zn as Zn 45 (annually row)	8.6 c	0.394 a	458	11.8 cd	0.331 ab	281	12.1 a	0.351 d	290	15.6 a	0.382 NS	245
2.5 Zn as Zn 45 (bdct. & PD in '66 & '67)	8.3 c	0.372 ab	448	11.5 cd	0.323 abc	281	12.7 a	0.458 bc	361	14.9 a	0.325 NS	218
Phosphate-Zinc Interaction Experiment												
40 P_2O_5-annual PD	10.0 ab	0.351 bc	351	10.2 abc	0.317 c	311	13.3 a	0.410	308	17.1 a	0.362	212
80 " " "	10.2 ab	0.313 bc	307	12.5 ab	0.312 c	250	16.1 a	0.338	210	18.4 a	0.350	190
160 " " "	8.4 bc	0.359 bc	427	10.5 abc	0.323 c	308	13.1 a	0.462	353	15.1 a	0.385	255
320 " " "	7.5 c	0.400 b	533	9.0 bc	0.436 b	484	12.7 a	0.510	402	14.2 a	0.410	289
640 " " "	7.3 c	0.486 a	666	8.2 c	0.570 a	695	9.3 a	0.630	677	13.4 a	0.600	448
320 " " " + 10 Zn as $ZnSO_4$ ('66 &'67)	12.4 a	0.325 bc	262	13.2 a	0.308 c	233	15.4 a	0.351	228	28.4 b	0.321	113
640 P_2O_5 annual PD + 10 Zn as $ZnSO_4$ in ('66-'67)	11.0 a	0.304 c	276	12.0 ab	0.310 c	258	17.3 a	0.458	265	27.1 b	0.289	107

Table 3. Average Phosphorus:Zinc Ratio of the Sixth Corn Leaf and Average Ear Corn Yield When Grown on a Zinc Deficient Calcareous Loam Over a 4-Year Period (1966-69) Near Benson, Minnesota.

1966 & 1967 Zinc treatments(lbs/A)	Average P/Zn ratio in 6th corn leaf	Average 4 year corn yield(bu/A)
No Zinc	370 c	77.5 a
10 as $ZnSO_4$ (PD)	209 ab	95.4 c
20 " " "	157 a	94.3 c
40 " " "	124 a	92.5 c
10 " ZnMNS "	286 bc	91.2 bc
0.5 Zn as Zn 45 (annually row)	319 c	83.0 ab
2.5 Zn as Zn 45 (bdct. & PD in '66 & '67)	327 c	77.9 a
Phosphate-Zinc Interaction Experiment		
40 P_2O_5 annual PD	296 b	87.7 c
80 " " "	239 a	90.4 cd
160 " " "	336 b	87.9 c
320 " " "	427 c	79.5 b
640 " " "	622 d	68.0 a
320 " " " + 10 Zn as $ZnSO_4$ ('66 & '67)	209 a	97.9 de
640 P_2O_5 annual PD + 10 Zn as $ZnSO_4$ in ('66 & '67)	227 a	100.0 e