

DEC 05 1978

Archive Version

**Summary of  
Corn and Soybean  
Leaf Analysis,  
1977 and 1970-77**

**EC933 10/78/1M  
Extension Division,  
University of Missouri-Columbia**



## TABLE OF CONTENTS

	<i>Page</i>
Samples Analyzed during 1977 and the period 1970-77 .....	4
Evaluation of Nutrient Status of Corn Leaf Samples .....	5
Nutrient Status of Corn Leaf Samples Collected 1970-77 Related to Soil Analyses and Fertilizer Treatments .....	7
Fertilizer Use Reported with the Corn Leaf Samples Submitted .....	10
Evaluation of Nutrient Status of Soybean Leaf Samples .....	11
Nutrient Status of Soybean Leaf Samples Collected 1970-77 Related to Soil Analyses and Fertilizer Treatments .....	13
Fertilizer Use Reported with Soybean Leaf Samples Submitted .....	14
Summary of Nutrient Status of Corn and Soybean Leaf Samples Analyzed 1970-77 .....	14





# Summary of Corn and Soybean Leaf Analysis in Missouri 1977 and 1970-77

Roger G. Hanson

C. Marshall Christy

Jeanne L. Sebaugh

Elemental analysis of plant leaves collected at a specific stage of growth is a diagnostic tool available to growers to evaluate the nutrient status of the plant.

Soil testing is widely used by Missouri growers, to monitor the fertility level of soil. Missouri does not offer a soil test for all essential plant nutrients. Therefore, along with a soil test, analysis of plant leaves can be used to determine if there is an imbalance of plant nutrients, deficiency or possible excess of secondary and micronutrients.

Numerous factors can effect the nutrient status of the plant—soil moisture status, growth stage of the plant, variety, stresses caused by weeds, insects and diseases and the fertility level of the soil.

This summary includes information obtained from leaf analysis of corn and soybeans during the 1977 growing season and a composite of all corn and soybean leaf analysis during the period 1970-1977. A limited number of alfalfa, small grains, forages and sorghum analyses are available, but not included in this summary.

Each grower that participates in this program receives an interpreted copy of his results indicating which elements are in sufficient supply and which are either at the low or the high to excess level. Those samples exhibiting imbalance can be used to determine areas where soil fertility work should be intensified to pin-point problems.

Acknowledgement: The authors acknowledge the area agronomists who utilize plant analyses as a strong point of their agronomic programs that provide these data. Appreciation is expressed to "Robby" for keypunching the data and Ms. Rebecca Manford for preparation of the publication.

## Samples Analyzed during 1977 and 1970-77.

The number of corn and soybean leaf samples analyzed through University of Missouri Extension during 1977 and 1970-77 are summarized in Table 1.

Table 1. Plant sample numbers by Region 1970-77 and 1977.

Crop	Soil Region					Total
	1	2	3	4	Other	
1970-77						
Corn	595	364	540	118	168	1785
Soybeans	119	59	147	15	32	375
1977						
Corn	14	0	55	2	0	71
Soybeans	5	0	1	3	0	9

These results indicate that 1,785 corn leaf samples and 375 soybean leaf samples handled by University of Missouri Extension were analyzed in the state over an eight-year period. There is no way of knowing how many are analyzed through private enterprise. Farmers in Soil Regions 1, 2, 3 and 4 of north Missouri use this service more than farmers in other areas of the state. The areas encompassed in Soil Regions are presented in Figure 1.

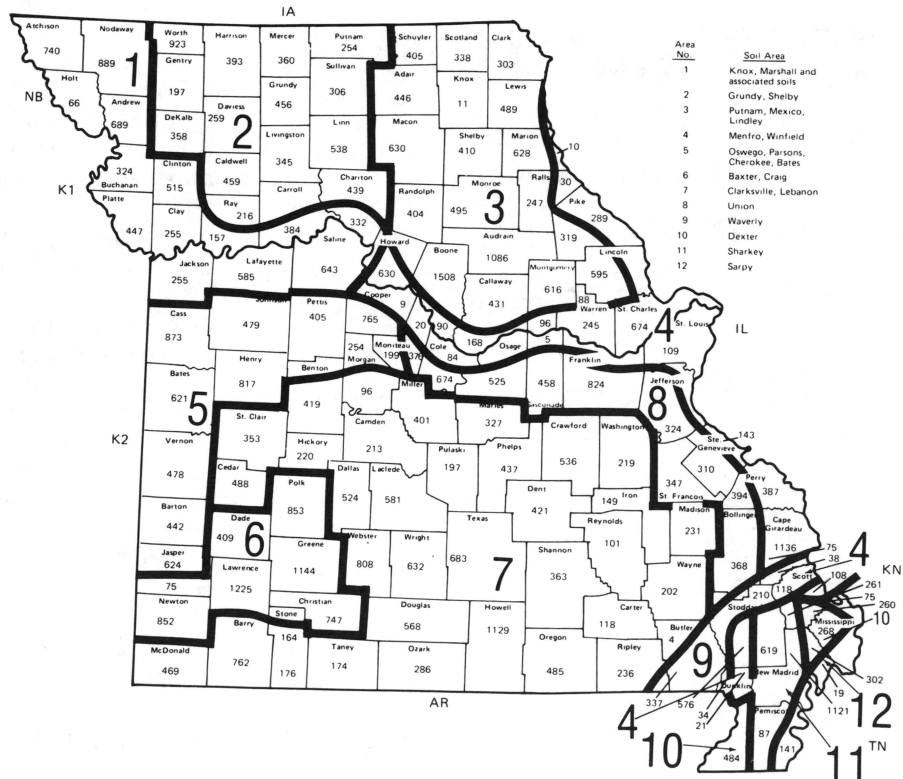


Figure 1. Soil regions in Missouri.

## Evaluation of Nutrient Status of Corn Leaf Samples.

The 1,785 corn leaf samples submitted during the eight-year period were grouped according to the average nutrient composition of the leaves and percent of samples low and deficient in respective plant nutrients.

### Nutrient Concentrations in Leaf Samples 1970-77.

The average nutrient compositions of the corn samples submitted from 1970-77 are presented in Table 2.

Table 2. Average nutrient concentrations of 1,785 corn leaf samples collected 1970-77.

	Soil Region					Total
	1	2	3	4	Other	
	Percent Concentration					
N	2.7	2.7	2.8	2.5	2.7	2.7
P	0.3	0.3	0.3	0.3	0.3	0.3
K	2.1	2.0	1.8	2.0	2.1	2.0
Ca	0.4	0.5	0.4	0.5	0.5	0.4
Mg	0.4	0.3	0.4	0.3	0.3	0.4
	Parts per Million (PPM)					
Cu	8	8	8	10	8	8
Fe	80	91	84	109	96	87
Zn	73	56	62	37	37	60
B	16	14	15	12	12	15
Mn	44	52	58	63	61	53
No. Samples	595	364	540	118	168	1785

The average nutrient composition of the plant samples does not appear to vary greatly from one Region to another, but, there are some exceptions. The nitrogen content in Soil Regions 1, 2, 4 and all others, appear to be on the margin of low to sufficient.

The zinc content was found to be lowest in Region 4

and "other" Regions and highest in Region 1.

Nutrient Status of Corn Leaf Samples Collected in 1977. The numbers and percentages of 71 corn leaf samples found to be deficient, low, and low and deficient in respective nutrients during 1977 are presented in Table 3.

Table 3. Percent of 71 corn leaf samples evaluated "low" and "deficient" collected in 1977.

	Deficient			Low			Low and Deficient %
	Conc. %	No. Samp.	% Samp.	Conc. %	Samp.	% Samp.	
	(Less than)						
N	2.45	1	1.4	2.46-2.75	3	4.2	5.6
P	0.15	0	0	0.16-0.24	1	1.4	1.4
K	1.25	5	7.0	1.26-1.70	19	26.8	33.8
Ca	0.10	0	0	0.11-0.20	0	0	0
Mg	0.10	0	0	0.11-0.20	12	16.9	16.9
	PPM						
Cu	2	0	0	3-5	3	4.2	4.2
Fe	10	0	0	10-20	0	0	0
Zn	15	3	4.2	16-20	2	2.8	7.0
B	2	2	2.8	3-5	16	22.5	25.4
Mn	15	0	0	16-19	0	0	0

Potassium appears to be at the lowest level and most deficient, followed by Boron. Magnesium was low in 16.9 percent of the samples; none were deficient.

Nutrient Status of Corn Leaf Samples Collected 1970-77. The percentages of corn leaf samples analyzed in 1970-77 that were "low", "deficient" and "low and deficient" in plant nutrient status are presented in Table 4.

Table 4. Percent of 1,785 corn leaf samples, by Soil Region, "low", "deficient" and "low and deficient" in nutrient status collected during 1970-77.

		Soil Regions						Total
		1	2	3	4	Other		
A. SAMPLES "LOW"								
	Conc. %				Percent			
N	2.46-2.75	26.0	33.5	26.6	31.4	35.1	28.4	
P	.16-.24	19.2	34.1	23.3	26.3	26.2	24.6	
K	1.26-1.70	11.4	20.0	26.5	20.3	23.2	19.4	
Ca	.11-.20	.7	0	.2	0	1.2	.4	
Mg	.11-.20	14.3	18.7	10.4	28.8	27.4	16.2	
PPM								
Cu	3-5	8.1	9.9	17.8	11.0	16.1	11.1	
Fe	10-20	5.5	3.3	13.5	1.7	2.1	7.0	
Zn	16-20	8.4	2.7	5.6	8.5	6.6	6.2	
B	3-5	12.6	18.1	21.1	28.0	38.1	19.5	
Mn	16-19	4.0	1.9	1.1	2.5	2.4	2.5	
B. SAMPLES "DEFICIENT"								
N	2.45	24.7	27.7	25.7	40.7	28.6	27.1	
P	0.15	2.4	1.6	1.5	9.3	5.9	2.7	
K	1.25	9.7	9.9	19.8	13.6	14.3	13.5	
Ca	0.10	16.5	3.0	23.3	6.8	1.3	13.4	
Mg	0.10	1.0	.3	.6	4.2	2.4	1.1	
PPM								
Cu	2	19.0	21.7	10.7	6.8	10.1	14.7	
Fe	10	22.3	19.0	13.7	5.9	7.1	16.5	
Zn	15	1.8	1.4	1.5	3.4	11.9	2.7	
B	2	11.9	10.7	8.6	1.7	12.5	10.0	
Mn	15	30.9	23.1	28.7	12.7	14.9	25.9	
C. SAMPLES "LOW AND DEFICIENT"								
N	2.76	50.8	61.3	50.4	72.0	63.7	55.4	
P	0.25	21.5	35.7	24.8	35.6	32.1	27.3	
K	1.71	21.2	29.9	46.3	33.9	37.5	32.9	
Ca	0.21	19.4	3.8	23.5	6.8	2.6	15.3	
Mg	0.21	15.3	19.0	10.9	33.1	29.8	17.3	
PPM								
Cu	6	30.1	32.6	28.4	19.1	26.5	29.1	
Fe	21	27.9	22.3	27.2	7.6	10.1	23.5	
Zn	21	10.3	4.1	7.0	11.9	18.5	8.9	
B	6	24.5	28.8	29.8	29.7	50.6	29.8	
Mn	20	35.0	25.0	29.8	15.3	17.3	28.4	

Nitrogen most often measured low and deficient, with 28.4 percent of the samples low and 27.1 percent deficient. A total of 55.4 percent of the samples evaluated were both low and deficient in nitrogen.

Potassium was the element found to be next highest in numbers of samples evaluated low and deficient. Of particular interest, 25.9 percent of the corn leaf samples analyzed were deficient in manganese.

There has been a rapid increase in the number of samples assessed as deficient in manganese during the 1976 and 1977 cropping years. This increase has

been most notable in Soil Region 1 in northwest Missouri and Soil Region 3 in northeast Missouri. With respect to phosphorus status 24.6% are judged to be low but only 2.7% evaluated to be deficient.

Further study should be made of soil types in northeast and northwest Missouri with manganese and the soil types with potassium deficiencies in northeast Missouri.

### Nutrient Status of Corn Leaf Samples Collected 1970-77 Related to Soil Analyses and Fertilizer Treatments.

Concentration of plant nutrients in corn leaves collected from 1970-77 at various pH ranges is presented in Table 5.

Table 5. Nutrient concentration of corn leaf samples related to soil acidity(pH<sub>s</sub>).

	Soil pH <sub>s</sub>						Avg.
	< 4.9	5.0-5.4	5.5-5.9	6.0-6.4	6.5-7.0	> 7.0	
Percent Concentration							
N	2.66	2.75	2.69	2.68	2.73	2.80	2.70
P	0.28	0.27	0.27	0.27	0.29	0.30	0.28
K	2.08	2.00	1.91	1.92	2.07	2.15	1.98
Ca	0.42	0.44	0.47	0.47	0.38	0.37	0.44
Mg	0.37	0.32	0.34	0.34	0.37	0.35	0.35
Parts Per Million(PPM)							
Cu	7	9	8	8	8	10	8
Fe	79	85	77	90	91	127	87
Zn	53	78	62	50	61	83	60
B	20	13	13	13	16	17	15
Mn	68	69	52	49	43	46	53
No. Samples	176	244	438	562	282	83	1785
% Total Samples	9.9	13.7	24.5	31.5	15.8	4.6	100

There appeared to be an increase in nitrogen, copper and iron concentration in the leaves with increase in pH<sub>s</sub>. Conversely only manganese appeared to decrease with a decrease in soil pH<sub>s</sub>.

Phosphorus concentrations of corn leaf samples in relationship with available soil phosphorus and phosphorus fertilizer applications are presented in Table 6.

Table 6. Phosphorus concentration of corn leaf samples in relationship to phosphorus soil test level and phosphorus treatment.

Soil P <sub>2</sub> O <sub>5</sub> Level lbs/A	Samples No. %		Lbs. Phosphate(P <sub>2</sub> O <sub>5</sub> ) Applied/A					Avg.
			0-30	31-40	41-80	81-100	>100	
% "P" Concentration in Tissue								
< 50	160	9.0	0.28	0.27	0.27	0.30	0.26	0.28
51-100	207	11.6	0.26	0.24	0.25	0.26	0.27	0.26
101-150	279	15.6	0.27	0.25	0.26	0.27	0.31	0.27
151-200	221	12.4	0.27	0.26	0.28	0.28	0.29	0.28
>200	918	51.4	0.28	0.27	0.28	0.29	0.30	0.28
Avg. Conc. Number			0.28	0.26	0.27	0.28	0.29	0.28
Samples 1,785			386	141	823	297	138	
% Samples			21.6	7.9	46.1	16.7	7.7	

Indications are that, even with low levels of soil available phosphorus and with or without applications of phosphorus fertilizer, the phosphorus level in the corn leaves were adequate. There appeared to be no relationship between the corn leaf phosphorus concentration and phosphorus soil test level or fertilizer phosphorus applied.

Potassium concentrations of corn leaf samples in relationship with exchangeable soil potassium and potassium fertilizer application are presented in Table 7.

Table 7. Potassium concentration of corn leaf samples in relationship to potassium soil test level and potassium treatment.

Exchange Soil K lbs/A	Samples No. %		Lbs. Potash(K <sub>2</sub> O) Applied/A					Avg.
			0.20	21-50	51-80	81-130	>130	
			% K Concentration in Tissue					
<120	248	13.9	1.83	1.75	1.77	1.85	1.67	1.79
121-160	244	13.7	1.87	1.45	1.66	1.62	1.77	1.67
161-200	293	16.4	1.92	1.53	1.93	1.76	1.81	1.80
201-240	196	11.0	1.92	2.13	1.94	2.04	2.03	2.00
241-280	189	10.6	2.13	1.97	2.11	2.11	2.04	2.08
281-320	192	10.8	2.25	2.07	2.24	2.01	2.16	2.14
321-360	108	6.0	2.32	2.15	2.32	1.98	2.26	2.21
>360	315	17.6	2.36	2.39	2.22	2.16	2.32	2.29
Avg. Conc.			2.06	2.01	2.02	1.90	1.97	1.98
Number Samples 1,785			377	247	325	553	283	
% Samples			21.1	13.8	18.2	31.0	15.9	

The Potassium concentration in the corn leaf increased with increasing levels of exchangeable potassium in all ranges of fertilizer potassium applied. There was no trend in relationship between corn leaf potassium concentration and the potassium fertilizer that was applied.

Magnesium concentrations of corn leaf samples in relationship with soil potassium levels and potassium fertilizer applications are presented in Table 8.

Table 8. Magnesium concentration of corn leaf samples in relationship to soil potassium levels and potassium treatments.

Exchange Soil K lbs/A	Samples No. %		Lbs. Potash(K <sub>2</sub> O) Applied/A					Avg.
			0-20	21-50	51-80	81-130	>130	
			% "Magnesium" Concentration in Tissue					
<80	118	6.6	.45	.45	.33	.43	.57	.46
81-120	130	7.3	.38	.45	.35	.40	.40	.40
121-160	244	13.7	.33	.38	.38	.39	.39	.38
161-200	293	16.4	.35	.32	.33	.38	.40	.36
201-240	196	11.0	.35	.36	.34	.32	.35	.34
241-280	189	10.6	.32	.35	.40	.31	.40	.35
281-320	192	10.8	.33	.31	.31	.34	.29	.32
321-360	108	6.0	.29	.30	.29	.31	.38	.31
>360	315	17.6	.31	.29	.33	.27	.33	.31
Avg. Conc.			.35	.34	.34	.35	.38	.35
Number Samples 1,785			377	247	325	553	283	
% Samples			21.1	13.8	18.2	31.0	15.9	

The magnesium concentration in the corn leaf samples decreased with increasing levels of soil exchangeable potassium at all levels of fertilizer potassium applied. There was no change in corn leaf magnesium concentration with increasing quantities of potassium fertilizer applied. Apparently soil exchangeable potassium has a greater effect upon leaf magnesium concentration than does the quantity applied as fertilizer.

Zinc concentrations of corn leaf samples in relationship with soil available phosphorus and phosphorus fertilizer applications are presented in Table 9.

Table 9. Zinc concentration of corn leaf samples in relationship to Soil Phosphorus levels and Phosphorus treatments.

Soil P <sub>2</sub> O <sub>5</sub> Level lbs./A	Samples No. %		Lbs. Phosphate(P <sub>2</sub> O <sub>5</sub> ) Applied/A					Avg.
			0.30	31-40	41-80	81-100	>100	
			PPM "Zn" Concentration in Tissue					
<50	160	9.0	43	48	59	66	55	52
51-100	207	11.6	45	38	58	45	58	52
101-150	279	15.6	53	44	59	58	56	56
151-200	221	12.4	43	41	125	67	49	89
>200	918	51.4	82	34	50	64	52	58
Avg. Conc.			64	38	63	62	54	60
Number Samples	1,785		386	141	823	297	138	
% Samples			21.6	7.9	46.1	16.7	7.7	

Zinc concentration in these corn leaf samples are considered to be in the sufficient or high range and possibly reflect situations where the growers have included zinc with their fertility program.

Nutrient concentrations of corn leaf samples in relationship with nitrogen concentrations are presented in Table 10.

Table 10. Nutrient concentration of corn leaf samples in relationship to "nitrogen" concentration of the tissue.

Nutrient	% Nitrogen Concentration in Tissue				
	< 2.0	2.00-2.45	2.46-2.75	2.76-3.50	>3.50
<u>Percent Concentration</u>					
P	.22	.26	.27	.29	.30
K	1.76	1.93	1.91	2.05	2.85
Ca	.53	.52	.50	.36	.55
Mg	.32	.36	.34	.36	.36
<u>Parts Per Million</u>					
Cu	7	8	8	8	7
Fe	80	91	90	82	134
Zn	52	48	62	66	75
B	10	12	13	16	34
Mn	52	56	55	49	60
Mo	1	2	2	2	2
Al	74	73	81	70	181
Number Samples	88	380	506	777	34

With increasing concentration of leaf nitrogen there was increase in leaf phosphorus, potassium, iron, zinc, boron and manganese. The corn leaf concentration of calcium, magnesium and copper appeared to be unaffected by increasing concentrations of corn leaf nitrogen.



Relationships between nitrogen concentration of corn leaf samples influenced by soil cation exchange capacity are presented in Table 11.

Table 11. Nitrogen concentration of corn leaf samples in relationship to Soil Cation Exchange Capacity (C.E.C.).

Soil C.E.C.	Samples		Average % Concentration
	No.	%	
< 10.0	256	14.3	2.74
10.1-18.0	906	50.8	2.71
18.1-24.0	581	32.6	2.68
> 24.0	42	2.3	2.61
Total	1,785		Avg. 2.70

The results indicated that leaf nitrogen would be high in soils with low cation exchange capacity and would be lower for soils of high cation exchange capacity.

### Fertilizer Use Reported with Corn Leaf Samples Submitted

Numbers of corn leaf samples submitted with fertilizer application information are presented in Table 12.

Table 12. Number of corn leaf samples submitted with fertilizer applications from 1970-77.

	Reg. 1	Reg. 2	Reg. 3	Reg. 4	Other	Total	%
Nitrogen (N)	562	342	479	97	146	1626	91.1
Phosphate ( $P_2O_5$ )	482	299	470	84	145	1480	82.9
Potash ( $K_2O$ )	477	294	473	82	145	1470	82.4

The data indicate that high percentage of the growers using this service supply fairly complete information with their leaf sample.

Quantities of nitrogen, phosphorus and potassium applied to the fields represented by corn leaf samples submitted are presented in Table 13 for 1977 and in Table 14 for the period 1970-77 is represented.

Table 13. Number of corn leaf samples reporting fertilizer use and average application in 1977.

	Samples		Avg. lbs/A
	No.	% of Total	
Nitrogen (N)	67	94.4	197
Phosphate ( $P_2O_5$ )	63	88.7	91
Potash ( $K_2O$ )	64	90.1	127

Table 14. Average fertilizer use reported on corn during period 1970-77.

	Pounds Per Acre					Avg.
	Reg. 1	Reg. 2	Reg. 3	Reg. 4	Other	
Nitrogen (N)	163	153	157	148	166	159
Phosphate ( $P_2O_5$ )	65	83	72	57	78	72
Potash ( $K_3O$ )	83	102	114	72	99	98

The evaluation indicates that the average N, P and K applications of 1977 were substantially higher than the average application over the eight-year period.

The data indicate that growers desiring maximum yields were the ones most utilizing this service in 1977 and/or the overall use of fertilizer by the growers has been increasing since this type of summary was started in 1970.

### Evaluation of Nutrient Status of Soybean Leaf Samples

During 1977 there were nine soybean samples submitted, 375 during the 1970-77 period.

**Nutrient Concentration of Soybean Leaf Samples 1970-77.** Average nutrient concentrations of the soybean leaf samples collected from 1970-77 are presented in Table 15. Average nutrient concentration of the samples varied between soil regions. However, on the average, none of the regions in which samples were submitted appeared to have an out-of-balance or low or deficient nutrient concentration.

Table 15. Average nutrient concentration of 375 soybean leaf samples collected from 1970-77.

	Soil Region					Average
	1	2	3	4	Other	
<u>Percent Concentration</u>						
N	4.9	4.8	4.6	4.6	4.6	4.7
P	0.4	0.3	0.4	0.3	0.4	0.4
K	2.1	2.1	1.9	1.9	2.0	2.0
Ca	0.8	1.1	1.3	1.0	1.1	1.1
Mg	0.5	0.5	0.5	0.6	0.5	0.5
<u>Parts Per Million Concentration (PPM)</u>						
Cu	7	10	10	17	10	10
Fe	94	145	212	184	127	155
Zn	104	69	74	71	54	81
B	50	49	48	43	40	48
Mn	39	54	73	52	70	58
Mo	2	2	2	2	2	2
Total Samples	119	59	147	18	32	375

**Nutrient Status of Soybean Leaf Samples Collected in 1977.** A summary of analysis of soybean samples that were low or deficient in plant nutrients in 1977 is presented in Table 16. In this small quantity of samples,

one was low in nitrogen, one in potassium, one in boron, and two in copper. This evaluation does not indicate if those low levels were all the same sample or if separate samples were involved.

Table 16. Soybean sample "low" or "deficient" analyzed in 1977.

	Deficient			Low			Low and Deficient
	Conc. %	No. Samp.	% Samp.	Conc. %	No. Samp.	% Samp.	
(Less than)							
N	4.00	0	-	4.00-4.50	1	11.1	11.1
P	0.15	0	-	.16- .25	0	-	-
K	1.25	0	-	1.26-1.70	1	11.1	11.1
Ca	0.20	0	-	.21- .35	0	-	-
Mg	0.10	0	-	.11- .25	0	-	-
<u>PPM</u>							
Cu	4	0	-	5-9	2	22.2	22.2
Fe	30	0	-	31-50	0	-	-
Zn	15	0	-	16-20	0	-	-
B	10	0	-	11-20	1	11.1	11.1
Mn	14	0	-	15-20	0	-	-

Nutrient Status of Soybean Leaf Samples Collected 1970-77. The percentages of soybean leaf samples deficient in plant nutrients that were collected during 1970-77 period is presented in Table 17. These evaluations indicate that of the nutrients involved in the analysis copper, potassium and nitrogen were deficient in the greatest number of samples submitted over the eight-year period. Copper deficiency appeared more often in those samples coming from the "other" region category, representing southeast Missouri, and Regions 3 and 4. Potassium deficiencies appear to be more prevalent in Region 3 of northeast Missouri. Nitrogen deficiencies are most represented in Region 4.

Table 17. Percent of 375 soybean leaf samples, by soil region, "deficient" in nutrient status collected 1970-77.

	Conc. % (Less than)	Soil Region					Average
		1	2	3	4	Other	
N	4.00	20.3	10.2	14.3	33.3	21.9	17.1
P	0.15	7.6	13.6	16.3	22.2	12.5	13.1
K	1.25	19.3	13.6	24.5	11.1	12.5	19.5
Ca	0.20	30.9	0	0	0	0	0.3
Mg	0.10	3.4	3.4	0.7	0	6.3	2.4
	<u>PPM</u>						
Cu	4	21.4	15.3	19.9	26.7	34.4	21.2
Fe	30	0.8	1.7	0.7	0	0	0.8
Zn	15	0	0	0	0	0	0
B	10	0	1.7	1.5	5.6	0	1.1
Mn	14	3.4	0	1.4	0	3.1	1.9
Mo	0.4	0	0	0	0	0	0
Total Samples		119	59	147	18	32	375

The percentages of soybean leaf samples evaluated as low and deficient in plant nutrient status during the 1970-77 are presented in Table 18.

Table 18. Percent of soybean leaf samples, by soil region, "low" and "deficient" in plant nutrient status collected during 1970-77.

	Conc. % (Less than)	Soil Region					Average
		1	2	3	4	Other	
N	4.51	26.3	20.3	32.7	38.9	37.5	29.4
P	0.26	7.6	13.6	17.0	22.2	15.6	13.6
K	1.71	21.8	22.0	48.3	27.8	18.8	32.3
Ca	0.36	29.5	2.0	4.8	16.7	0	12.5
Mg	0.26	3.4	3.4	1.4	0	6.3	2.7
	<u>PPM</u>						
Cu	10	58.0	30.5	35.5	26.7	40.6	41.8
Fe	51	37.8	16.9	19.0	16.7	6.3	23.5
Zn	21	0	0	0.7	0	0	0.3
B	21	0	1.7	3.8	5.6	6.3	2.5
Mn	21	4.2	3.4	2.7	0	3.1	3.2
Mo	1	7.4	6.5	0	0	6.3	3.7
Total Samples		119	59	147	18	32	375

This evaluation indicates that copper had the highest incidences of low to deficient status, followed by potassium, then nitrogen. Low and deficient copper levels appeared to be most concentrated in northwest and southeast Missouri. Low potassium was found to be most prevalent in those samples submitted from Region 3 in northeast Missouri and Region 4 in east-central Missouri. The low and deficient levels of soybean leaf nitrogen concentration were most prevalent in Region 4 and in southeast Missouri.

## Nutrient Status of Soybean Leaf Samples, Collected 1970-77, Related to Soil Analyses and Fertilizer Treatment

Nutrient concentrations of soybean leaf samples in relationship with soil acidity are presented in Table 19.

Table 19. Nutrient concentration of soybean leaf samples related to soil acidity (pH<sub>s</sub>).

	Soil pH <sub>s</sub>							Avg.
	< 4.4	4.5-4.9	5.0-5.4	5.5-5.9	6.0-6.4	6.5-6.9	> 7.0	
	<u>Percent Concentration</u>							
N	4.64	4.39	4.92	4.72	4.67	4.87	4.81	4.73
P	.36	.32	.37	.34	.36	.39	.40	.36
K	2.07	2.33	2.18	1.99	1.91	1.93	2.17	2.00
Ca	.92	1.21	1.03	1.18	1.12	1.04	.94	1.10
Mg	.79	.56	.57	.51	.50	.55	.53	.54
	<u>Parts Per Million</u>							
Cu	7	8	10	10	9	9	11	9
Fe	56	103	142	200	133	169	188	156
Zn	81	84	84	81	83	73	76	81
B	52	52	50	50	47	43	46	48
Mn	69	77	62	58	49	65	55	58
Mo	2	2	2	2	2	2	2	2
Number Samples	23	14	34	106	124	49	25	375
% Total Samples	6.0	3.7	9.1	28.3	33.1	13.1	6.7	

Relationships of plant nutrient status to soil acidity are difficult to define. However, the following trends were observed.

- Calcium and iron appeared to be higher from those soils lower in acidity.
- Leaf magnesium and zinc appeared to be lower for those soils with lower acidity.

Soybean leaf phosphorus concentrations in relationship with soil available phosphorus and phosphorus fertilizer applied are presented in Table 20.

Table 20. Phosphorus concentration of soybean leaf samples in relationship to phosphorus soil test and phosphorus treatment.

Soil P <sub>2</sub> O <sub>5</sub> Level lbs/A	Number Samples	Lbs. Phosphate (P <sub>2</sub> O <sub>5</sub> ) applied/A					Avg.
		0-30	31-40	41-80	81-100	>100	
		<u>Percent "P" Concentration in Tissue</u>					
< 50	39	0.39	0.23	0.36	0.36	0.30	0.36
51-100	47	0.33	0.25	0.37	0.32	0.40	0.36
101-150	67	0.37	0.35	0.35	0.35	0.36	0.35
151-200	57	0.45	0.33	0.30	0.38	0.36	0.35
>200	165	0.40	0.37	0.35	0.39	0.37	0.37
Avg. Conc.		0.39	0.34	0.35	0.38	0.36	0.36
Number Samples	375	61	41	148	74	51	

There appeared to be little relationship between soil available phosphorus and soybean leaf phosphorus level or the fertilizer phosphorus applied. Leaf phosphorus was high which may account for this relationship.

Soybean leaf potassium concentrations in relationship to soil exchangeable potassium and potassium fertilizer applications are presented in Table 21.

Table 21. Potassium concentration of soybean leaf samples in relationship to potassium soil test level and potassium treatment.

Exchange Soil K lbs/A	Number Samples	Lbs. Potash ( $K_2O$ ) applied/A					Avg.
		0-20	21-50	51-80	81-130	>130	
		<u>Percent K Concentration in Tissue</u>					
<80	32	2.06	-	1.09	1.61	1.82	1.78
81-120	31	1.55	.84	1.47	1.54	1.38	1.48
121-160	75	2.09	1.86	1.76	1.69	1.67	1.80
161-200	66	2.03	1.85	1.64	2.26	1.81	2.05
201-240	39	2.23	1.93	1.99	2.58	1.75	2.27
241-280	44	2.48	1.93	1.66	2.19	1.94	2.12
281-320	21	2.37	2.36	1.95	2.25	1.74	2.20
321-360	12	2.40	1.44	1.75	2.04	1.61	1.95
>360	55	2.48	1.72	2.54	2.26	1.97	2.31
Avg. Conc.		2.14	1.88	2.00	2.05	1.75	2.00
Number Samples	375	63	38	58	172	44	

Potassium leaf concentrations were higher from those soils exhibiting high level of exchangeable potassium. Apparently there was little relationship between soybean leaf potassium and potassium fertilizer applications.

### Fertilizer Use Reported with Soybean Leaf Samples Submitted

The average quantities of nitrogen, phosphorus and potassium applied to soybeans represented by the samples submitted in the period 1970-77 are presented in Table 22.

Table 22. Number of soybean leaf samples reporting fertilizer use and average application 1970-77.

	<u>No. Reported</u>	<u>% of Total</u>	<u>Avg. lbs/A</u>
Nitrogen (N)	98	26.1	32
Phosphate ( $P_2O_5$ )	151	40.3	51
Potash ( $K_2O$ )	158	44.8	95

The percent of the samples submitted that indicated fertilizer applications for soybeans was much less than it is for corn. This could indicate that many growers do not apply fertilizer for soybeans but anticipate adequate yields from residual fertility levels.

### Summary of Nutrient Status of Corn and Soybean Leaf Samples Analyzed

The data over the eight year period indicate the average leaf nutrient concentrations for the two crops and the incidences of nutrient concentrations considered to be deficient.

Average Nutrient Concentration of Corn and Soybean Leaf Samples. The average nutrient concentrations of corn and soybean leaf samples collected from 1970-77 are presented in Table 23.

Table 23. Average nutrient concentration of corn and soybean leaf samples collected 1970-77.

Nutrient	1785 Corn	375 Soybeans
	%	%
N	2.70	4.73
P	.28	.36
K	1.98	2.00
Ca	.44	1.10
Mg	.35	0.54
	PPM	PPM
Cu	8	9
Fe	87	156
Zn	60	81
B	15	48
Mn	53	58
Mo	-	2.1

Average nutrient concentrations for corn were assessed to be sufficient for all nutrients except nitrogen which is at the borderline between low and sufficient levels. All nutrient levels for soybeans were evaluated to be sufficient for normal plant growth. Additional evaluation is necessary to determine if there were grower leaf samples submitted that were deficient in level of plant nutrients.

Evaluation of Nutrient Status of Corn and Soybean Leaf Samples. Evaluation of nutrients judged to be at deficient levels for the total corn and soybean leaf samples submitted by growers during 1970-77 is presented in Table 24.

Table 24. Percent of corn and soybean leaf samples analyzed "deficient" in plant nutrients during 1970-77.

Corn - 1785 Samples		Soybeans - 375 Samples	
Nutrient	% of Samples	Nutrient	% of Samples
N	27	N	17
P	3	P	13
K	14	K	19
Ca	13	Ca	0
Mg	1	Mg	2
Cu	15	Cu	21
Fe	17	Fe	1
Zn	3	Zn	0
B	10	B	1
Mn	26	Mn	2
		Mo	0

For corn, this evaluation indicates that 27 percent of the leaf samples were deficient in nitrogen, 26 percent deficient in manganese, 17 percent in iron, 15 percent in copper, and 14 percent in potassium, and lesser numbers deficient for the other plant nutrients. Results of this evaluation would indicate a need to determine if there are some soil resource areas in Missouri in which a shortage of soil available manganese exists and if this reduces corn yields.

For soybeans, copper was most frequently indicated as deficient, followed by potassium and nitrogen. It may prove worthwhile to determine if there is a specific area from which the soybean samples were collected that exhibit a lower copper leaf level. There are indications that those samples exhibiting deficiency levels of copper are concentrated in two areas of the state and follow-up research may be warranted.

**Macro-Nutrient Status of Corn Leaf Samples by Year.**  
The percentages of corn leaf samples analyzed deficient in the macro-nutrients; nitrogen, phosphorus, potassium, calcium and magnesium by year are presented in Table 25.

Table 25. Percent of corn leaf samples analyzed "deficient" in macro-nutrients by year.

	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
	Wet	Normal	Dry	Wet	Dry	Dry	Dry	Dry
<u>Percent of Samples</u>								
N	45.5	41.9	23.3	34.5	37.0	12.9	9.5	1.4
P	4.1	.7	.8	14.8	0	0	.1	0
K	14.4	22.5	44.9	6.1	3.3	3.4	11.3	7.0
Ca	0	0	0	0	0	0	0	0
Mg	2.5	.7	.8	2.4	7.2	.3	.1	0
Number Samples	318	284	227	162	181	325	168	71

The percent of samples analyzed as being deficient in leaf nitrogen steadily decreased from 1970 to 1977. Weather conditions affect the nitrogen concentration in the plant which is one of the indications of this information. Also, corn growers who are excellent managers and have high fertility programs are expected to be those most frequently using this analytical tool.

The high incident of samples exhibiting deficient potassium was noted in those samples during 1972 which was a dry year following 1971 which was a relative normal year in precipitation. Only 1973 indicated a noticeable number of samples exhibiting deficiency levels in phosphorus.

**Fertilizer Applications on Corn and Soybean Leaf Samples Analyzed.** The average annual fertilizer applications to the fields from which the corn and soybean leaf samples represented from 1970-77 are summarized in Table 26.

Table 26. Average annual fertilizer applications on corn and soybean leaf samples analyzed 1970-77.

Nutrient	Crop	
	Corn	Soybean
	<u>lbs/A</u>	
Nitrogen (N)	159	32
Phosphorus ( $P_2O_5$ )	72	51
Potassium ( $K_2O$ )	98	95

This evaluation indicates that over the eight-year period the average quantity of fertilizer reported to be applied to corn was 159 pounds of nitrogen per acre, 72 pounds of  $P_2O_5$  per acre and 98 pounds of  $K_2O$  per acre.

For soybeans, the application was 32 pounds of nitrogen per acre, 51 pounds of  $P_2O_5$  per acre and 95 pounds of  $K_2O$  per acre. This evaluation would indicate that, on an average, the fertility program for corn ought to be adequate for maintenance and, for soybeans, nitrogen is properly being applied where little return would be expected from this plant nutrient.



## References

- BROWN, J.R. and R. G. Hanson. 1977. Micro and Secondary Nutrients in Missouri. EC 929 September. Extension Division-University of Missouri.
- MORTVEDT, J. J., P.M. Giordano and W. L. Lindsey, Editors. 1972. Micronutrients in Agriculture. Soil Science Society of America. Madison, Wisconsin.
- WALSH, L. M. and J. D. Beaton, Editors. 1973. Soil Testing and Plant Analysis. Soil Science Society of America. Madison, Wisconsin.



■ Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914 in cooperation with the United States Department of Agriculture. Carl N. Scheneman, Vice President for Extension, Cooperative Extension Service, University of Missouri and Lincoln University, Columbia, Missouri 65211. ■ An equal opportunity institution.