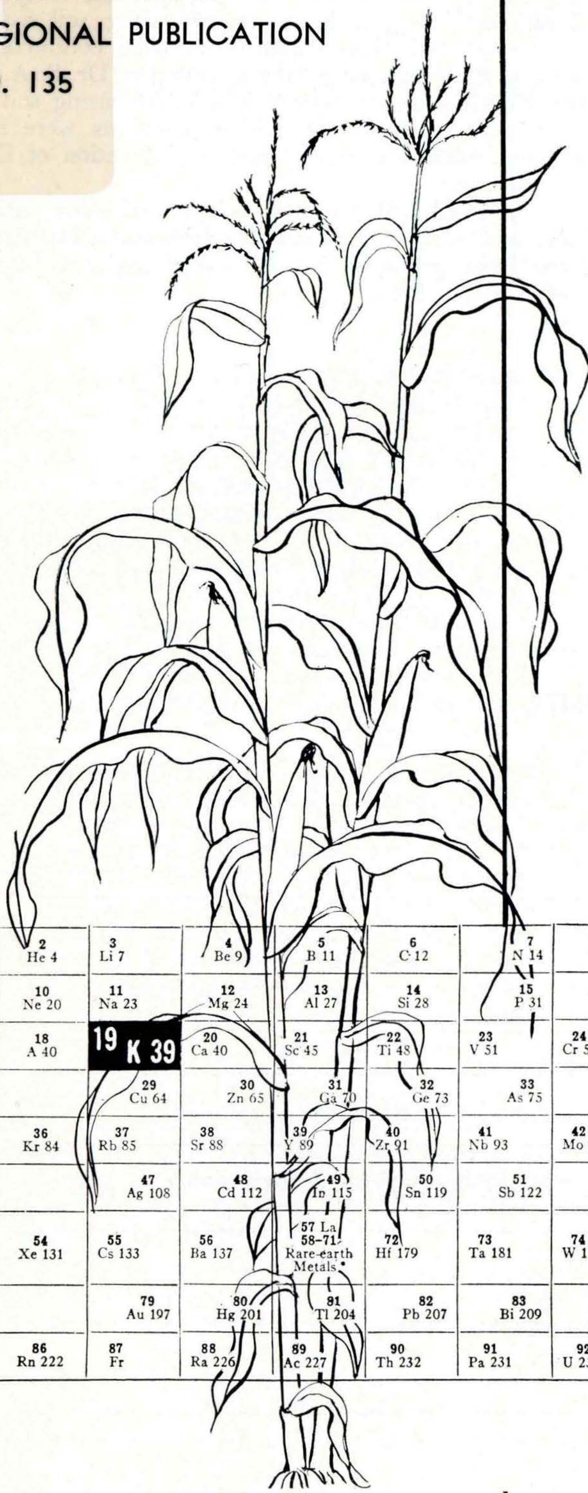
S
61
.R47
No.503
1962

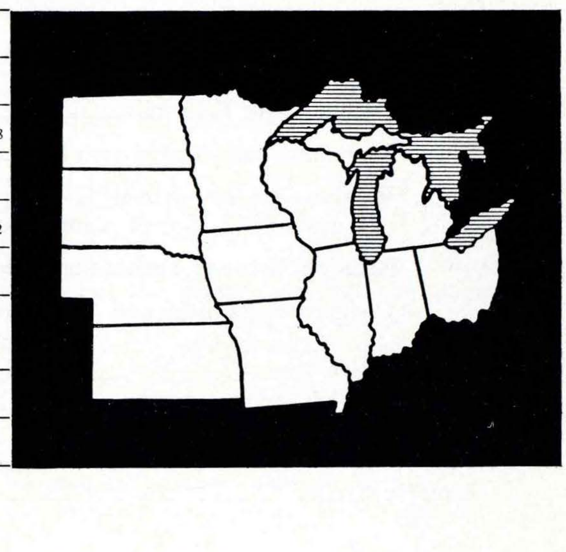
NORTH CENTRAL
REGIONAL PUBLICATION
NO. 135

NORTH CENTRAL REGIONAL POTASSIUM STUDIES

III. Field Studies With Corn



2	2	2 He 4	3 Li 7	4 Be 9	5 B 11	6 C 12	7 N 14	8 O 16	9 F 19	
3	3	10 Ne 20	11 Na 23	12 Mg 24	13 Al 27	14 Si 28	15 P 31	16 S 32	17 Cl 35.5	
4	4	18 A 40	19 K 39	20 Ca 40	21 Sc 45	22 Ti 48	23 V 51	24 Cr 52	25 Mn 55	26 Fe 55.8
	5		29 Cu 64	30 Zn 65	31 Ga 70	32 Ge 73	33 As 75	34 Se 79	35 Br 80	
5	6	36 Kr 84	37 Rb 85	38 Sr 88	39 Y 89	40 Zr 91	41 Nb 93	42 Mo 96	43 Tc	44 Ru 102
	7		47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	
6	8	54 Xe 131	55 Cs 133	56 Ba 137	57 La 58–71 Rare-earth Metals*	72 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190
	9		79 Au 197	80 Hg 201	81 Tl 204	82 Pb 207	83 Bi 209	84 Po 210	85 At	
7	10	86 Rn 222	87 Fr	88 Ra 226	89 Ac 227	90 Th 232	91 Pa 231	92 U 238 †		



Agricultural Experiment Stations of

Alaska
Illinois
Indiana
Iowa
Kansas
Michigan
Minnesota
Nebraska
North Dakota
Ohio
South Dakota
Wisconsin

United States Department of Agriculture cooperating

AGRICULTURAL AND HOME ECONOMICS EXPERIMENT STATION
IOWA STATE UNIVERSITY of Science and Technology, AMES, IOWA

RESEARCH BULLETIN 503

APRIL 1962

IOWA STATE TRAVELING LIBRARY
DES MOINES, IOWA

FOREWORD

This publication reports the results of research conducted cooperatively by members of the Potassium Subcommittee of the North Central Mineral Deficiencies Committee (NC-16) and by members of the NC-16 Committee and others in the 12 North Central states, Alaska and the United States Department of Agriculture. Uniform field experiments were conducted at 51 locations with corn in Illinois, Indiana, Iowa, Kansas, Michigan and Minnesota during 1957 and 1958. In these experiments potassium fertilizer was broadcast on the experimental plots and plowed under or disked in. Supplementary greenhouse studies using soil samples from the 1957 field experiments were conducted at Purdue University under the direction of Dr. S. A. Barber. Supplementary laboratory analyses using soil and plant samples from the field experiments were made at Iowa State University under the direction of Dr. J. J. Hanway.

The results of previous field experiments with alfalfa and of the supplementary greenhouse experiments have been reported in two other regional research bulletins (2, 9).

CONTENTS

North Central Regional Potassium Studies
III. Field Studies With Corn

By J. J. Hanway, S. A. Barber, R. H. Bray, A. C. Caldwell, M. Fried, L. T. Kurtz, K. Lawton, J. T. Pesek, K. Pretty, M. Reed and F. W. Smith[1]

Corn is sensitive to a deficiency of potassium (K),[2] and yields of corn on K-deficient soils often are increased by K fertilizer applications. K deficiencies in corn have been observed or yield increases have been obtained from K fertilizer applications on many soils in the North Central Region of the United States. However, many other soils in the region have high levels of available K, and applications of K fertilizers on these soils have not increased corn yields. Therefore, it is important to have effective methods of estimating plant availability of K in different soils and to develop methods of predicting the yield response which can be expected from applications of K fertilizer for corn grown on different soils.

The increases in yields of corn and other crops obtained from applications of K fertilizer have been shown in some studies to be inversely related to the level of exchangeable K in air-dry samples of the surface soil (5, 7). Therefore, this determination is commonly used in soil testing laboratories to estimate K availability. Other studies, however, have shown that the amount of exchangeable K in some soils is markedly changed by drying the soil (1, 2, 9, 17, 18). In some of these studies, the level of exchangeable K in undried soil samples provided a better estimate of K availability to plants than did the exchangeable K in dry soil samples (2, 9, 17). Matthews and Sherrell (18), on the other hand, studied the relation between exchangeable K in the soil and the yield of potatoes grown on sandy soils in Ontario, Canada and found a higher correlation with exchangeable K values for oven-dry soils than for undried soils.

Predicting the yield increase to be expected from K fertilizer applications is complicated by many factors that influence crop response to K fertilizer applications (15). Plants obtain K from subsurface layers in the soil; thus it may be important to consider the exchangeable K in these layers, in addition to that in the surface layer (9, 16, 21). Poor aeration restricts the ability of plant roots to absorb K from the soil (8, 14); thus poor aeration resulting from excess moisture, tillage methods, etc. may cause K deficiencies in plants even though the level of exchangeable K might otherwise be adequate (3, 15, 19). K uptake by plants is also restricted under conditions where soil moisture is limited (26, 27), where soil temperatures are low (11) and where there are high concentrations of other ions, especially calcium, magnesium or ammonium, in the soil solution (20). K in soil organic matter or organic soils has been found to be more readily available than K adsorbed on soil clays (13). Differences in plant population and in genetic characteristics of different hybrids would also be expected to result in differences in K uptake and yield responses obtained from K fertilizer applications. Thus, many factors may have to be considered in predicting the response to be expected from K fertilizer applications for corn on different soils.

Corn plants begin to absorb soil K early in the seedling stage (6) and take up K very rapidly during the vegetative growth period (22), but little or no K appears to be taken up during the grain formation period late in the season (22). K deficiency in corn appears first as decreased growth of the seedlings and young plants followed by a characteristic "firing," on the edges and tips of the lower leaves. In severe cases all leaves may show the "firing," and entire leaves on the lower part of the plant may die (12).

The K status of corn plants at most stages of growth is reflected in the K content of the different plant parts. Since all, or nearly all, of the K in corn plants is water soluble, it is not necessary to consider different forms of K in the plant in interpreting the results of plant analyses, but the plant part and the stage of development must be considered. Tyner (25) analyzed the sixth leaf from the base of the plant, sampled during the period of full silk, and suggested 1.30 percent K on an air-dry basis as being the critical level above which little or no increase in yield would be obtained from additional K applications. In his experiments he found an average increase in yield of 2.05 bushels per acre for each change of 0.1 percent K in the leaf.

The purpose of this study was to obtain information concerning: (a) the effect of K fertilizer applications on the yield and K content of corn plants under different soil and environmental conditions found in the North Central Region, (b) the amount of exchangeable K in field-moist and dried soil samples from different soil profiles, (c) relationships between exchangeable K in the soils and the K content and yield of corn as influenced by applications of K ferti-

[1] The manuscript was prepared by the first author. The other authors contributed by conducting the field and laboratory experiments or by assisting in planning and conducting the study and reviewing the manuscript. More complete information concerning the NC-16 Committee and others associated with this study is given on the back page of this bulletin.
[2] The symbol K will be used for potassium throughout this bulletin.

lizers and (d) the effect of other factors such as plant population, soil texture, etc. on these relationships.

EXPERIMENTAL METHODS

Field

Uniform field experiments with corn were established at 51 locations in Illinois, Indiana, Iowa, Kansas, Michigan and Minnesota during 1957 and 1958. Two experiments were discarded — one in Iowa because of an extremely variable stand and one in Michigan because of a severe zinc deficiency. Records and plant samples from the seven experiments in Kansas in 1957 were lost in a fire, and grain was not harvested from one experiment in Kansas in 1958. Therefore, corn-yield data were obtained from only 41 of the 51 experiments.

Detailed characteristics and information concerning the experiments are given in tables A-1, A-2 and A-3 of the appendix. As shown in table A-2, most experiments were conducted on sites that had been in a legume or legume-grass meadow the previous year. In a few cases, however, the previous crop was small grain, corn, soybeans or sorghum. Most experimental areas received a uniform application of N and P fertilizers either broadcast or split between a broadcast application and an application with a planter attachment. Differential plot treatments consisted of broadcast (and in most cases plowed under) applications of KCl at rates of 0, 25, 50, 75, 100 and 125 pounds of K per acre.[3] The experimental design used at most sites was a Latin square. Each plot was usually 4 to 6 rows wide and 30 to 50 feet long. Except in special cases, efforts were made to obtain uniform stands of 16,000 plants per acre of hybrids adapted to the location.

Before the application of any fertilizer, soil samples for laboratory analyses and greenhouse studies were collected from each experimental site. Each site was sampled to a depth of 36 inches by 6-inch increments to obtain samples for laboratory analyses. Separate samples, consisting of at least 10 cores each, were obtained from the 0-6 inch layer of each replicate. The subsurface samples were a composite of three replicates with at least two cores per replicate. These smaller samples were kept field moist and sent to Iowa State University for laboratory analyses. In 1957, bulk samples of approximately 300 pounds consisting of at least 20 subsamples from the experimental area were collected from the 0-6 inch layer of soil. At some sites a similar amount of soil from the 18-24 inch layer was obtained from a pit dug adjacent to the experimental area. These bulk samples were kept field moist and sent to Purdue University for a greenhouse study.

Plant samples were collected from all sites when the plants were in the silking stage. Whole-plant samples, usually consisting of eight plants per plot, were obtained by cutting the plants off just above the soil. At the same time, leaf samples, consisting of 20 leaves taken from opposite and just below the major earshoot of normal plants, were collected. At some of the sites whole-plant samples were also collected in a similar manner at an earlier date (2 to 4 weeks prior to silking) and at a later date (2 weeks or more after silking). All plant samples were dried at 65°C., weighed and ground, and representative subsamples were sent to Iowa State University for chemical analyses.

Grain yields were estimated by harvesting the ears from a representative area of each plot (usually about 1/200 of an acre). The yield of grain at 15.5 percent moisture and, for most experiments, the moisture content at harvest and the shelling percentage were determined.

Laboratory

K was extracted from the plant samples by shaking 0.50 gram of the oven-dry plant material in 100 ml. of 0.1575 **N** acetic acid for 30 minutes and filtering through a dry filter paper.

The field-moist soil samples were screened through a 1/4-inch screen and thoroughly mixed. Percent moisture in the samples was determined by weighing subsamples before and after oven drying at 100°C. for 24 hours. Exchangeable K was extracted from weighed samples (of approximately 10 grams) of the field-moist and oven-dry soil samples by shaking the soil sample for 30 minutes in 15 ml. of neutral 1**N** NH_4OAc, filtering, and leaching with an additional 60 ml. of 1 **N** NH_4OAc. The extracts were then made up to 100 ml. in volumetric flasks.

K in the plant and soil extracts was determined using a Perkin-Elmer model 52A flame photometer with lithium as an internal standard. K contents of the plant material and soils are expressed on an oven-dry basis.

A portion of each soil sample was air dried for at least 2 weeks at room temperature and analyzed in the Iowa State University Soil Testing Laboratory by the procedures used in that laboratory. The pH was determined with a glass electrode using a 1:2 soil:water ratio. K was extracted by shaking approximately 2 grams of soil (measured volumetrically) in 10 ml. of neutral 1**N** NH_4OAc for 5 minutes and filtering. K in the extract was determined using a flame photometer. P was extracted by shaking approximately 1½ grams of soil (measured volumetrically) in 10 ml. of Bray's No. 1 P extractant (0.025 **N** HCl and 0.03 **N** NH_4F) for 5 minutes and filtering. P in the extract was determined colorimetrically using ammonium molybdate and stannous chloride to develop the color.

Correlation Studies

Data from 31 of the field experiments were analyzed by multiple regression procedures. As stated previously, corn-yield data were not obtained from 10 of the 51 field experiments. Data from another 10 experiments were not used in the multiple regression analyses because of incomplete data, severe drouth, extremely variable stands or very high K contents in the soils and plants. These 10 experiments were: Illinois 397; Iowa 23; Kansas 5, 6 and 7 in 1958; Michigan 1, 2 and 3 in 1957; and Minnesota 2 in 1957 and 1958. The treatment means for the different levels of applied K in the

[3] These rates correspond to 0, 30, 60, 90, 120 and 150 pounds of K_2O per acre, respectively.

Table 1. Variables included in the multiple regression analyses and the symbols used to denote the individual variables.

Variable	Symbol
Exchangeable K in the 0-6 inch layer of soil (pp2m)	K_{S1}
Exchangeable K in the 6-12 inch layer of soil (pp2m)	K_{S2}
Exchangeable K in the 12-18 inch layer of soil (pp2m)	K_{S3}
Exchangeable K in the 18-24 inch layer of soil (pp2m)	K_{S4}
Exchangeable K in the 24-30 inch layer of soil (pp2m)	K_{S5}
Exchangeable K in the 30-36 inch layer of soil (pp2m)	K_{S6}
Exchangeable K in the 12-36 inch layer of soil (pp2m)	K_{S3-6}
Fertilizer K applied (pounds of K per acre)	K_F
Plant population (thousands of plants per acre)	S
Soil texture[a]	T
Leaf dry weight (grams per 20 leaves)	L
Percent K in leaves at silking time (no K applied)	CK%K
Percent K in leaves at silking time	%K
Increase in percent K in leaves resulting from K applications	Δ%K
Pounds of K per acre in corn plants at silking time	K_P
Yield of corn grain (bushels per acre)	Y
Increase in yield of grain resulting from K fertilizer (bushels per acre)	ΔY

[a] The following code was used for soil textures: sand=1, loamy sand=2, sandy loam=3, loam=4, silt loam=5 and silty clay loam=6.

31 experiments provided 184 observations for each of the dependent variables used in the multiple regression analyses.

The variables included in the multiple regression analyses and the symbols used to denote these variables in the following discussion are shown in table 1.

EXPERIMENTAL RESULTS

Exchangeable K in Soils

The percent moisture in the field-moist soil samples, level of exchangeable K in field-moist and oven-dry soil samples and the Soil Testing Laboratory results for the air-dry soils are reported in table A-4 of the appendix. The exchangeable K levels in the field-moist and oven-dry samples from the 0-6 inch and 30-36 inch soil layers and the changes in exchangeable K that occurred on drying these samples are summarized in table 2.

In mineral soils, the level of exchangeable K under field-moist conditions was almost always higher in surface-soil samples than in subsoil samples from the same location. Exchangeable K in the subsoils was consistently low. Only in seven soils from Kansas did the exchangeable K in field-moist 30-36 inch samples exceed 100 pp2m.

The change in exchangeable K that resulted from drying 0-6 inch soil samples varied in different parts of the region much the same as was found in a previous study (9). The exchangeable K in some of the surface-soil samples from Iowa and Kansas increased very much upon drying. A few soils from these states, however, showed little change, and two Kansas soils with high levels of exchangeable K showed small decreases upon drying. Drying surface soils from Michigan resulted in either no change or appreciable decreases in exchangeable K. Drying caused relatively little change in exchangeable K in surface soil samples from Indiana or the Cisne soils of Illinois. Changes from drying in surface samples from Minnesota ranged from small decreases in two sandy soils to appreciable increases in some silt loam soils.

Exchangeable K increased on drying in all samples from the 30-36 inch layer. In the sandy soils the increases were small, but in other soils the increases were as much as tenfold.

Table 2. Exchangeable K in field-moist and oven-dry soil samples from the 0-6 and the 30-36 inch layers at the different experimental field sites and the change in exchangeable K because of oven drying.

			Exchangeable K (pp2m)					
			0-6 inch			30-26 inch		
Experiment	Year	Soil type[a]	Field moist	Oven dried	Change after drying	Field moist	Oven dried	Change after drying
Ill. 1	1957	Cisne sil	73	96	23	50	204	154
Ill. 397	1958	Cisne sil	64	86	22	51	168	117
Ind. 1	1957	Fincastle sil	126	134	8	80	254	174
Ind. 2	1957	Fincastle sil	104	125	21	42	292	250
Ind. 3	1957	Elston l	130	150	20	84	122	38
Ind. 4	1957	Fincastle sil	112	156	44	58	284	226
Ind. 5	1958	Fincastle sil	121	151	30	52	225	173
Ind. 6	1958	Crosby fsl	128	110	—18	29	31	2
Ind. 7	1958	Miami l	103	87	—16	52	138	86
Ind. 8	1958	Sidell sil	170	213	43	66	254	188
Iowa 17	1957	Floyd sil	151	185	34	20	203	183
Iowa 18	1957	Carrington sil	146	166	20	31	255	224
Iowa 19	1957	Fayette sil	160	232	72	48	322	274
Iowa 20	1957	Clyde sil	100	279	179	28	218	190
Iowa 21	1957	Carrington sil	102	139	37	35	156	121
Iowa 22	1957	Fayette sil	138	170	32	44	304	260
Iowa 23	1958	Weller sil	78	112	34	70	364	294
Iowa 24	1958	Carrington sil	153	178	25	33	172	139
Iowa 25	1958	Fayette sil	244	269	25	39	359	320
Iowa 26	1958	Fayette sil	79	163	84	54	360	306
Iowa 27	1958	Clyde sil	158	171	13	35[b]	219[b]	184
Iowa 28	1958	Webster sicl	112	359	247	37	298	261
Iowa 29	1958	Primghar sil	348	456	108	74	478	404
Kan. 1	1957	Bates sil	91	100	9	32	158	126
Kan. 3	1957	Summit sil	262	334	72	126	558	432
Kan. 4	1957	Labette sil	935	910	—25	144	568	424
Kan. 5	1957	Summit sil	427	484	57	104	318	214
Kan. 6	1957	Laurel fsl	455	474	19	314	374	60
Kan. 7	1957	Wabash sil	559	795	236	112	332	220
Kan. 8	1957	Cherokee sil	149	211	62	86	316	230
Kan. 1	1958	Summit sil	232	344	112	90	492	402
Kan. 2	1958	Boone l	150	243	93	67	330	263
Kan. 3	1958	Parsons sil	173	243	70	60	275	215
Kan. 4	1958	Cherokee sil	136	190	54	81	410	329
Kan. 5	1958	Geary sil	602	650	48	194	553	359
Kan. 6	1958	Sarpy sil	605	565	—40	220	284	64
Kan. 7	1958	?	232	363	131	100	372	272
Mich. 1	1957	Fox l	450	304	—146	94	139	45
Mich. 2	1957	Oshtema s	94	78	—16	11	12	1
Mich. 3	1957	Metea sl	164	112	—52	68	129	61
Mich. 4	1957	Houghton muck	574	554	—20	204[c]	232[c]	28
Mich. 1	1958	Fox sl	86	89	3	32	78	46
Mich. 2	1958	Kalamazoo sl	284	222	—62	48	71	23
Mich. 3	1958	Conover l	80	84	4	36	77	41
Mich. 4	1958	Parkhill l	97	74	—23	30	61	31
Minn. 1	1957	Hubbard ls	146	132	—14	44	72	28
Minn. 2	1957	Zimmerman fs	111	100	—11	40	46	6
Minn. 3	1957	Skyberg sil	85	140	55	57	190	133
Minn. 4	1957	Skyberg sil	133	178	45	32	206	174
Minn. 1	1958	Floyd sil	119	199	80	26	177	151
Minn. 2	1958	Organic	192	202	10	140	170	30
Average			210	246	36	73	249	176

[a] c=clay; si=silt; s=sand; l=loam; fs=fine sand. The textural classifications shown are those designated by the persons who conducted the field experiments and are probably not always consistent or accurate.
[b] 18-24 inch.
[c] 12-18 inch.

The relationship between exchangeable K in the field-moist and the oven-dry 0-6 inch and the 30-36 inch samples for different states and different textural classes is shown in fig. 1. There was an increase in exchangeable K from drying in the silty clay loam and in all silt loams except in one 0-6 inch sample from Kansas that was very high in exchangeable K. However, exchangeable K decreased or changed very little with drying in all but one of the 0-6 inch samples of the loams, sandy loams, loamy sands and sands. The exception was a Boone loam from Kansas. Exchangeable K in the 30-36 inch samples from the silty clay loam and the silt loams increased markedly because of drying. Increases from drying also occurred, but to a lesser degree, in all the samples from the 30-36 inch depth in the loams and sands—except in one Kansas loam where the increase was large. Exchangeable K in the two organic soils from

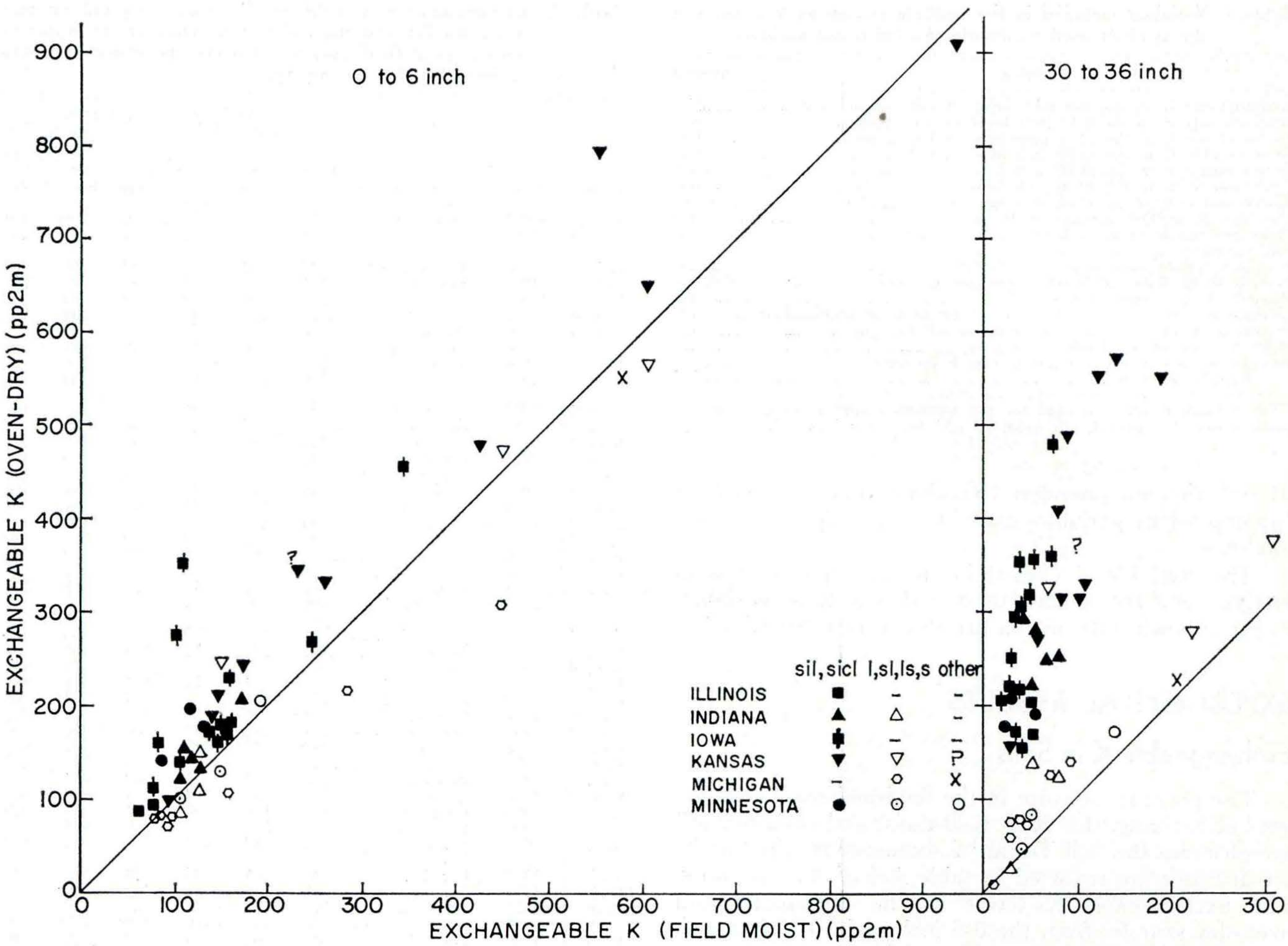
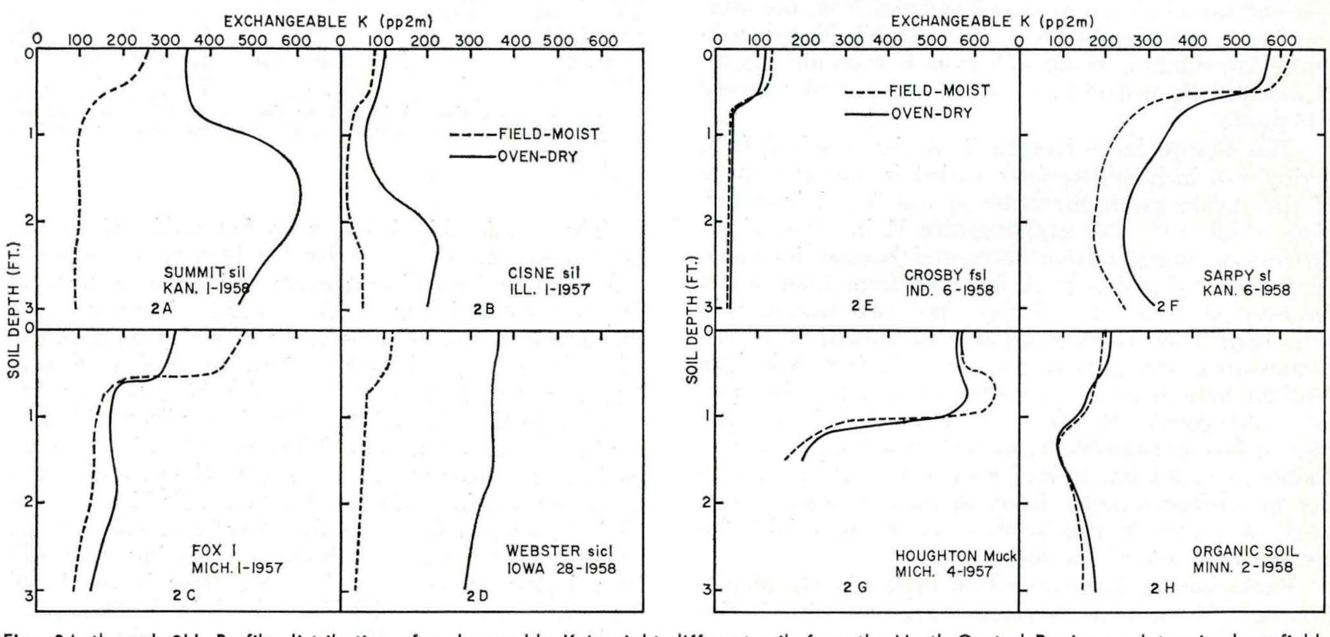


Fig. 1. Relation between exchangeable K in field-moist and oven-dry soil samples from the 0-6 inch and the 30-36 inch depths as influenced by soil texture. (The diagonal line indicates where the field-moist and oven-dry values are equal. Textural designations refer to the textures of the 0-6 inch samples.)



Figs. 2A through 2H. Profile distribution of exchangeable K in eight different soils from the North Central Region as determined on field-moist and oven-dry samples.

Michigan and Minnesota was not influenced appreciably by drying. These relationships indicate that the texture and the level of exchangeable K in the soil, rather than geographic location, are the primary factors influencing the change in exchangeable K that is observed on drying. The type of clay present may be an important consideration, but this study does not provide information concerning the kinds of clay minerals present in the soils.[4]

The profile distribution of exchangeable K in field-moist soils and the effect of drying on the profile distribution of exchangeable K found in soils in this study were similar to previous findings (9, 10). Some of the different types of profile distributions of exchangeable K are illustrated in figs. 2A through 2H.

The effect of oven drying on the level of exchangeable K varied with depth in the profile. Drying usually increased exchangeable K throughout the profile, but the increases were generally much greater in the subsoil than in the surface soil. Figures 2A and 2B illustrate this for two silt loam soils and show how the magnitude of the change resulting from drying varies in different soils. Drying often decreased exchangeable K in the surface soil but increased it in the subsoil, as shown for the Fox loam in fig. 2C. In a few soils, however, the increase from drying was similar in the surface and subsoil layers, as shown for the Webster soil in fig. 2D. In sandy soils, as shown in figs. 2E and 2F, drying usually had little effect on exchangeable K—often decreasing it slightly in the surface soil and increasing it slightly in the subsoil.

The profile distribution of exchangeable K in two organic soils is shown in figs. 2G and 2H. Exchangeable K, expressed on an oven-dry weight basis, was very high in the surface layers of the Houghton muck but decreased markedly in the subsoil. Exchangeable K in the organic soil from Minnesota showed a decrease followed by an increase with depth. Drying had no appreciable effect on the exchangeable K extracted from these organic soils.

K Content and Yield of Corn

The dry weight and K content of the corn leaves and plants and corn grain yield data for the different field experiments are reported in tables A-5 and A-6 of the appendix.

DRY MATTER ACCUMULATION AND K CONTENT OF CORN PLANTS DURING THE SEASON

Whole-plant samples were collected from 42 of the field experiments at silking time. Additional whole-plant samples were collected from 20 of the field experiments at varying periods of time before and/or after silking. These additional samples provide information concerning dry matter accumulation, K uptake by the corn plants and the K content of the corn plants during the growing season. The data from these 20 experiments are summarized in table 3.

Since each of the 20 experiments was sampled at silking time, the values at silking time provided a standard of reference for comparing the results of the other samplings. Figure 3 summarizes the dry weights and K contents of the plants from the early and late samplings in relation to the values obtained at silking. In this figure, determinations made on samples collected at the time of silking were assigned a relative value of 100, and time of sampling was represented as days before and after silking. Since the period from silking to maturity appears to be relatively constant (24), days after silking should be a reasonably accurate estimate of the stage of development at the time of sampling after silking. The length of time from emergence to silking is much more variable (23), so the use of days before silking is a less desirable estimate of the stage of development.[5] However, days from silking was used for the period prior to silking as a matter of convenience and consistency in presenting the data.

Within each experiment, the relative dry weights of the plants, percent K in the plants and the pounds of K per acre in the plants at the samplings before or after silking in relation to the values at silking time were similar for all levels of K fertilizer application. Therefore, an average value for all treatments in each experiment was used in fig. 3.

As all values are in relation to those at silking, the regressions for dry weight, percent K in the plants prior to silking and pounds of K in the plants prior to silking were forced through the value of 100 at silking by using

[4] Mineralogical studies using soil samples from the 1957 field experiments are being conducted at the University of Wisconsin.

[5] The dates of planting in these experiments varied from May 9 to June 15, and the dates of silking varied from July 22 to Sept. 6. The length of time from planting to silking varied from 59 to 108 days in the different experiments.

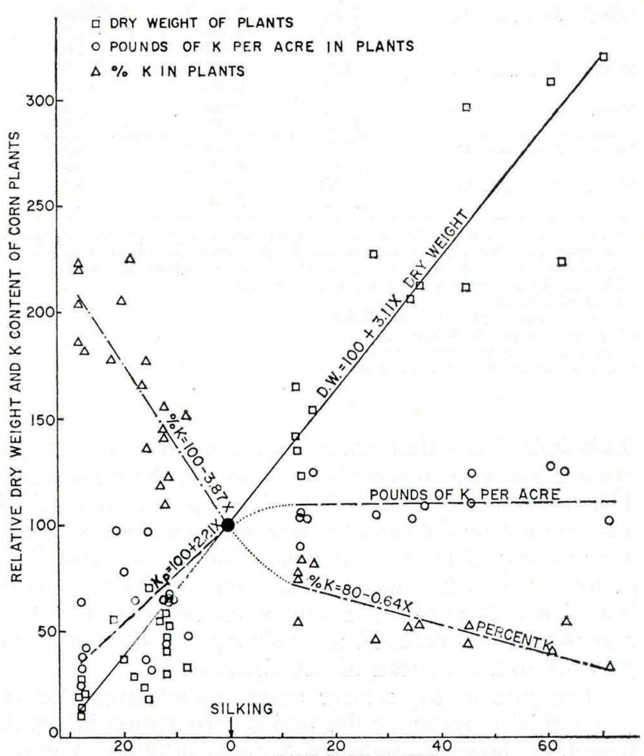


Fig. 3. Dry weights of corn plants, pounds of K per acre in the plants and percent K in the plants at various times before and after silking relative to the values at silking time.

Table 3. Effect of K fertilizer applications on the dry weight and K content of corn plants at different times during the growing season in the different field experiments.

Experiment	Year	Date sampled	Dry weight (lb./A) No K applied	Dry weight (lb./A) Increase from added K[a]	Percent K No K applied	Percent K Increase from added K[b]	Pounds K/A in the plants No K applied	Pounds K/A in the plants Increase from added K[b]	Pounds K/A in the plants Extrapolated K value[c]
Ill. 1	1957	7/29	1,040	—20[d]	1.63	1.18**	17	11*	158
		8/16[e]	3,125	1,829**[d]	0.71	0.47*	22	38**	55
Ill. 397	1958	7/15	949	168	1.74	0.67**	17	10*	164
		8/8[e]	4,461	586	0.87	0.53**	39	31**	124
Iowa 17	1957	7/10	2,067	256	2.01	0.45*	42	14*	329
		7/22[e]	3,853	—130	1.82	0.41*	70	13*	540
		9/5	10,710	—100	0.79	0.29*	85	32**	257
Iowa 18	1957	7/10	1,863	—136	2.73	0.57**	51	8	624
		7/22[e]	4,286	1	1.70	0.33**	73	17**	436
		9/5	8,537	810	0.94	0.11**	80	12	698
Iowa 19	1957	7/17	1,032	35	2.97	0.39**	31	6**	562
		8/1[e]	5,877	0	1.76	0.21*	104	16	599
		9/4	11,323	924	0.93	0.10*	105	16*	616
Iowa 20	1957	7/15	833	130	2.44	0.58*	20	9**	225
		7/31[e]	3,910	383	1.32	0.33*	52	17*	329
		9/5	8,103	900	0.75	0.19**	61	20**	303
Iowa 21[f]	1957	7/16	1,183	400	2.46	0.87**	29	18**	159
		7/24[e]	3,926	517	1.48	0.71**	58	37**	169
		8/27	6,827	—390	0.78	0.36**	53	22**	230
Iowa 22	1957	7/20	1,434	—45	1.79	0.42**	26	3	952
		8/1[e]	4,532	459	1.41	0.19*	64	15*	1,169
		8/27	10,568	441	0.68	0.04	72	10	774
Iowa 23	1958	7/10	2,209	964**	1.18	0.87**	26	36**	82
		7/23[e]	4,720	744	1.01	0.90**	48	56**	80
		8/7	6,648	1,825	0.92	0.45**	61	49**	138
Iowa 25	1958	7/15	439	—6	5.11	0.16	22	2	1,393
		8/12[e]	4,116	—4	2.17	0.41**	89	16*	572
		8/25	5,671	234	1.65	0.35**	94	24**	393
Iowa 26	1958	7/15	926	268	2.08	1.43**	19	22**	85
		8/12[e]	4,459	1,360*	1.20	0.70**	53	52**	107
		8/26	6,480	241	1.00	0.55**	65	39**	166
Iowa 27	1958	7/16	606	88	3.51	1.16*	21	12*	168
		8/13[e]	4,896	233	1.41	0.72**	69	43**	159
		8/26	6,239	690	1.27	0.43*	79	39*	193
Iowa 28	1958	7/21	2,673	555	2.10	0.81**	56	32*	188
		8/1[e]	5,565	433	1.78	0.54**	99	40**	244
		8/14	8,967	866	1.06	0.30**	95	34*	257
Mich. 1	1957	7/23	2,953	—298	4.76	0.34	141	—2	......
		8/8[e]	6,247	95	3.32	0.03	207	—22	......
		10/8	19,240	2,580	1.31	0.09	252	41*	586
Mich. 2	1957	7/23	2,935	371	3.24	0.33	95	24	395
		8/7[e]	4,428	304	2.06	0.66*	91	36*	264
		10/8	11,000	—1,400	1.41	—0.04	155	—27**	......
Mich. 3[g]	1957	7/26	2,546	—398	3.55	0.88**	90	4	2,503
		8/15[e]	6,833	—211	1.86	0.24*	127	11	1,058
		10/11	8,880	360	0.84	0.10	75	9	903
Mich. 3	1958	8/1	1,774	70	1.74	0.89**	31	19*	186
		8/29[e]	6,700	—20	0.89	0.30**	60	21**	286
Mich. 4	1958	7/31	3,060	300	1.86	0.52**	57	23**	235
		8/22[e]	5,220	840*	1.10	0.37**	57	16**	374
Minn. 3	1957	8/3[e]	3,659	382*	1.46	1.10**	53	47**	118
		10/13	12,600	400	0.55	0.24*	69	33**	194
Minn. 4	1957	9/6[e]	6,997	822	0.69	0.35**	48	30**	169
		10/12	9,600	170	0.53	0.24**	51	25**	202

[a] Difference in dry weight of plants from plots with 125 lbs. K per acre and plots with no K applied.
[b] Increase per 100 pounds of applied K per acre (based on regression equation of the form $y=a+bK_F$ where K_F equals lbs. of K applied per acre).
[c] Negative value of K applied obtained by extrapolating regression equation to the point where pounds of K in the plants equals zero.
[d] Increase from 100 pounds of applied K per acre.
[e] Date of silking.
[f] Severe drouth damage after silking.
[g] Water damage, N deficient.
** Significant at the 1-percent level.
* Significant at the 5-percent level.

deviations from that value and uncorrected sums of squares and crossproducts in calculating the regressions. The pounds of K in the plants had apparently reached a maximum by the time the first samples were collected after silking. Therefore, the data for the pounds of K in the plants after silking were represented by a horizontal line through the mean of the observations. The regression for percent K after silking was calculated to pass through the mean of the observations.

The rate of dry matter accumulation appeared to be essentially linear for the period represented in fig. 3. K uptake, however, followed a much different pattern. Prior to silking the value for pounds of K in the plants relative to that at silking was higher than the relative dry weights of the plants. At silking, the plants had accumulated 90 percent of the total K taken up during the season. By 10-15 days after silking, K uptake by the plants was complete, and the amount of K in the plants remained constant after that time.

Data from two experiments not illustrated in fig. 3 showed an appreciable loss of K from the plants after silking. A severe drouth at the site of Iowa 21 and water damage on Michigan 3 in 1957 apparently resulted in loss of K from the plants after silking, as shown in table 3.

The relative percent K in the plants decreased rapidly until a short time after silking and then decreased slowly until the end of the season. The actual percent K in the plants varied from a maximum of greater than 5 percent in some plants sampled about

Table 4. Effect of K fertilizer applications on dry weight and K content of corn plants and of corn leaves at silking time in the different field experiments.

			Leaves[a]				Whole plants					
			Dry Weight (g.)		% K		Dry Weight (lbs./A)		% K		Pounds of K per acre in plants	
Experiment	Year	Date sampled	No K	Increase[b] from added K	No K applied	Increase from added K[c]	No K applied	Increase from added K[b]	No K applied	Increase from added K[c]	No K applied	Increase from added K[c]
Ill. 1	1957	8/16	99	15**	0.88	0.81**	3,125	1,829**[d]	0.71	0.47*	22	38**
Ill. 397	1958	8/8	....	....	1.50	0.63**	4,461	586	0.87	0.53**	39	31**
Ind. 1	1957	8/8	56	—2	0.79	0.63**	4,155	—247	0.64	0.47**	27	19*
Ind. 2	1957	8/9	51	—1	1.04	0.50**	3,924	83	0.85	0.35**	33	16*
Ind. 3	1957	8/9	55	1	1.61	0.27**	4,976	—430	1.10	0.38**	55	17**
Ind. 4	1957	8/4	57	—3	1.76	0.28**	4,901	223	1.42	0.48**	70	27**
Ind. 5	1958	8/11	77	1	1.77	0.49**	6,015	316	0.90	0.33**	54	24**
Ind. 6	1958	8/8	82	—2	2.10	0.58**	5,253	—521	1.38	0.58**	72	25**
Ind. 7	1958	8/12	84	0	1.70	0.80**	5,458	953*	1.04	0.57**	57	51*
Ind. 8	1958	8/11	99	2	2.18	0.30*	6,079	—342	1.74	0.54**	106	30*
Iowa 17	1957	7/22	90	—1	1.40	0.39**	3,853	—130	1.82	0.41*	70	13*
Iowa 18	1957	7/22	85	—1	1.62	0.20**	4,286	1	1.70	0.33**	73	17*
Iowa 19	1957	8/1	86	3	1.69	0.26**	5,877	0	1.76	0.21*	104	16
Iowa 20	1957	7/31	92	4	1.10	0.54**	3,910	383	1.32	0.33*	52	17*
Iowa 21	1957	7/24	89	1	1.41	0.69**	3,926	517	1.48	0.71**	58	37**
Iowa 22	1957	8/1	93	—1	1.16	0.32**	4,532	459	1.41	0.19*	64	15*
Iowa 23	1958	7/23	109	—6	1.23	0.69**	4,720	744	1.01	0.90**	48	56**
Iowa 25	1958	8/12	96	0	2.30	0.31**	4,116	—4	2.17	0.41**	89	16*
Iowa 26	1958	8/12	89	0	1.38	0.65**	4,459	1,360*	1.20	0.70**	53	52**
Iowa 27	1958	8/13	103	7	1.49	0.64**	4,896	233	1.41	0.72**	69	43**
Iowa 28	1958	8/1	119	—2	1.70	0.39**	5,565	433	1.78	0.54**	99	40**
Iowa 29	1958	8/5	114	6	2.11	0.19*	5,465	—99	1.90	0.29**	104	12
Kan. 1	1958	....	....	....	2.52	0.22*	....	....	2.06	0.23	....	....
Kan. 2	1958	7/28	135	5	2.26	0.33*	2,571	1,081	2.23	0.17**	57	18
Kan. 3	1958	7/28	101	—3	1.93	0.21**	6,218	—801	1.52	0.19*	95	5
Kan. 4	1958	7/24	115	1	1.79	0.29**	6,969	407	1.22	0.40*	85	38**
Kan. 5	1958	7/23	126	3	2.58	—0.08	6,135	—223	2.34	0.07	144	—2
Kan. 6	1958	7/23	112	1	3.02	—0.02	7,181	—1,737	2.97	—0.02	213	—32
Kan. 7	1958	8/4	109	—9	3.05	0.04	5,083	—35	2.80	0.17*	142	10
Mich. 1	1957	8/8	130	—7	3.14	0.21*	6,247	95	3.32	0.03	207	—22
Mich. 2	1957	8/7	117	—2	2.68	0.55**	4,428	304	2.06	0.66**	91	36*
Mich. 3	1957	8/15	108	0	2.80	0.32**	6,833	—211	1.86	0.24*	127	11
Mich. 1	1958	8/12	111	0	1.36	0.39**	6,040	880	1.06	0.15*	64	18**
Mich. 2	1958	8/15	81	—4	2.96	0.10**	6,980	300	2.00	0.14	140	16*
Mich. 3	1958	8/29	92	—5	0.96	0.69**	6,700	—20	0.89	0.30**	60	21**
Mich. 4	1958	8/22	79	3	1.75	0.37**	5,220	840*	1.10	0.37**	57	16**
Minn. 1	1957	8/12	73	3	2.24	0.28**	3,848	17	1.98	0.36**	76	12*
Minn. 2	1957	8/14	47	1	1.41	0.38**	....	....	1.06	0.21**	....	....
Minn. 3	1957	8/3	97	3	1.00	0.64**	3,659	382*	1.46	1.10**	53	47**
Minn. 4	1957	9/6	78	0	0.89	0.58**	6,997	822	0.69	0.35**	48	30**
Minn. 1	1958	8/18	73	19**	0.60	0.66**	3,300	3,300**	0.71	0.58**	23	52**
Minn. 2	1958	8/22	88	—4	0.63	1.25**	3,600	800	0.76	0.98**	27	46**
Average			92	1	1.73	0.42	5,049	314	1.52	0.41	78	23

[a] Leaves from opposite and just below the major ear of 20 plants.
[b] Difference in dry weight from plots with 125 pounds of K per acre and and plots with no K.
[c] Increase from 100 pounds of K per acre calculated from a regression of the form: $y=a+bK_F$ where K_F equals the pounds of applied K per acre.
[d] Increase from 100 pounds of applied K per acre.
** Significant at the 1-percent level.
* Significant at the 5-percent level.

a month before silking to a low of 0.53 percent in some plants at maturity. Data in table 3 indicate that in most experiments the increase in percent K in the plants resulting from applications of K fertilizer decreased as the season progressed.

The increase in pounds of K per acre in the plants from K fertilizer applications was generally much higher at silking time than at the early sampling, but there was no consistent relationship between the increase at silking time and that at the later sampling. Neither did the extrapolated K values reported in table 3 show any consistent change with time of sampling in the different experiments.

PLANT WEIGHT AND K CONTENT AT SILKING TIME

The dry weights and K contents of the leaves and plants from the 42 field experiments sampled at silking time are summarized in table 4.

There were large differences among different experiments in the dry weights of the corn plants and of the leaves at silking time. The dry weight of plants varied from 2,571 to 7,181 pounds per acre and averaged 5,049 pounds. The dry weight of 20 leaves varied from 47 to 135 grams and averaged 92 grams. Part of the difference in dry weights of the plants at silking time may be due to some inconsistency in sampling at the same stage of plant development in all experiments, but it is believed that most experiments were sampled very close to the desired stage of development. The variability between replicates of individual experiments was often very large, indicating that eight plants per plot is probably not an adequate sample for the estimation of dry weights of the plants. This variability within individual experiments is reflected in the increases in dry weights of the plants from K fertilizer applications reported in table 4 where some relatively large increases or decreases are not statistically significant. There was much less variability within individual experiments in the dry weights of 20 leaves than was observed in the dry weights of eight plants.

The application of K fertilizer increased the dry weight of the plants significantly in only six experiments and the dry weights of the leaves significantly in only two experiments. Increases in the yield of grain from applications of K fertilizer were large in the two experiments where the dry weights of the leaves were increased.

The K content of corn leaves at silking time from plots that had received no K fertilizer varied from 0.60 to 3.14 percent in different experiments and averaged 1.73 percent. Increases in the percent K in the leaves resulting from K fertilizer applications were highly significant in all experiments, except where the percent K in leaves from plots that received no K fertilizer was high. The largest increase in percent K in the leaves from K fertilization occured on a K-deficient, organic soil in Minnesota where an increase of 1.25 percent K per 100 pounds of K applied was observed. The average increase in percent K resulting from K fertilizer applications was 0.42 percent per 100 pounds of K applied.

The K contents of the whole plants at silking time varied from 0.64 to 3.32 percent in the different experiments and averaged 1.52 percent. Applications of K fertilizer increased the percent K in the plants in all except five of the field experiments. In these five experiments, the percent K in the plants from plots that received no K fertilizer was high (2.00 percent or higher). The maximum increase in percent K in the plants resulting from applied K was 1.10 percent per 100 pounds of applied K per acre. The average increase in percent K in the plants was 0.41 per 100 pounds of applied K per acre.

Although, in general, the percent K in the leaves was closely related to that in the whole plant, in some individual experiments the percent K in the leaves was much higher and in other experiments it was much lower than that in the whole plants. This may have been due in part to errors in time of sampling since the percent K in the whole plant would be expected to decrease much faster with time than would that in the leaves. Varietal differences and other factors may also result in different distributions of K within the plants.

At silking time the total amount of K in the aboveground portion of the plants from plots that received no K fertilizer varied from 22 to 213 pounds per acre and averaged 78 pounds per acre. Applications of K fertilizer significantly increased the amount of K taken up by the corn plants in most of the experiments, except where the K contents of the plants from the unfertilized plots were high. The statistical significance of these increases in pounds of K in the plants was generally lower than was found for percent K because of the variability within individual experiments in the dry weights of the plants.

Since the increases in pounds of K per acre in the plants from K fertilizer applications is expressed as pounds of K per 100 pounds of K applied, it can be considered as the percent recovery of applied K in the above-ground parts of the plants at silking time. There was a maximum recovery in the above-ground plant parts of 56 percent of the applied K in one experiment and an average of 23 percent for all experiments.

GRAIN YIELD

The plant populations, yield of grain, moisture content of the grain and the shelling percentage for the different experiments are summarized in table 5. Plant populations varied from 5,900 to 17,700 plants per acre and averaged 13,500 plants. Thus, poor stands were the cause of low yields and possibly limited the yield response obtained from K fertilizer applications in some experiments.

Grain yields of the plots that received no K fertilizer varied from 33 to 127 bushels per acre and averaged 79.4 bushels per acre for all experiments. Grain yields were increased significantly by K fertilizer applications in 11 of the 41 field experiments that were harvested.

The percent moisture in the grain at harvest was significantly influenced by K fertilization in only one experiment—Minnesota 1-1958. In that experiment a fertilizer application of 125 pounds of K per acre resulted in a moisture content of 33 percent as compared with 50 percent in the grain from untreated plots. The largest increase in grain yield from K fertilization, 52 bushels per acre, also occured in this experiment.

Application of K fertilizer had little effect on the shelling percentage of the corn. Increases in the shelling percentage because of K fertilization were statistically significant in six experiments, but they were small (3 percent or less) and were not associated with increases in yield.

Table 5. Effect of K applications on the yield of grain, percent moisture in the grain and shelling percentage in the different field experiments.

Expt.	Year	Average No. of plants per acre (thousands)	Grain yield (bu./A.)		% H_2O in grain		Shelling pct.	
			Check yield	Increase[a] from added K	No K fertilizer	Increase from added K[b]	No K fertilizer	Increase from added K[b]
Ill. 1	1957	9.5	57	38**	....	....	82	1
Ill. 397[c]	1958	11.6	75	9	17	1	79	2
Ind. 1	1957	10.2	63	9	31	—1	84	1
Ind. 2	1957	11.3	74	1	38	—3	86	0
Ind. 3	1957	8.6	91	1	26	3	85	1
Ind. 4	1957	11.9	113	6	36	0	85	2
Ind. 5	1958	15.0	99	—1	35	1	86	1
Ind. 6	1958	14.8	90	1	22	0	84	1
Ind. 7	1958	15.2	95	15**	30	0	83	1
Ind. 8	1958	14.8	127	8	30	0	83	3
Iowa 17	1957	14.0	97	8	49	0	84	1*
Iowa 18	1957	13.9	90	1	52	3	84	0
Iowa 19	1957	14.2	111	5*	58	3	85	0
Iowa 20	1957	14.1	59	16*	36	2	81	3**
Iowa 21[c]	1957	14.2	33	3	31	0	84	2*
Iowa 22	1957	11.6	90	15*	52	6	83	0
Iowa 23	1958	13.6	100	26**	29	1	84	2
Iowa 25	1958	12.4	75	1	43	—1	81	—1
Iowa 26	1958	13.0	77	9	33	0	85	—1
Iowa 27	1958	13.4	76	10*	41	—3	78	1
Iowa 28	1958	14.7	94	11	37	—2	80	3
Iowa 29	1958	12.8	82	—3	21	1	....	..
Kan. 2	1958	5.9	46	8	22	2	84	0
Kan. 3	1958	14.7	98	5	7	1	86	—1
Kan. 4	1958	15.4	108	1	9	0	87	—1
Kan. 5[c]	1958	11.1	87	—2	22	—1	85	—1
Kan. 6[c]	1958	17.7	103	—3	7	1	86	—1
Kan. 7[c]	1958	16.7	80	8	12	0	82	0
Mich. 1[c]	1957	13.2	73	—3	32	1	80	—4
Mich. 2[c]	1957	9.8	33	—4	36	—1	75	0
Mich. 3[c]	1957	14.2	64	8	37	—2	80	0
Mich. 1	1958	10.6	52	8	47	—1	80	1
Mich. 2	1958	13.8	87	—1	39	—2	84	0
Mich. 3	1958	13.5	68	11**	31	—2	82	0
Mich. 4	1958	14.9	76	—3	37	—1	82	—2
Minn. 1	1957	15.2	99	1	20	0	80	2**
Minn. 2[c]	1957	16.0	62	—8	23	0	84	2*
Minn. 3	1957	16.2	93	26**	38	—3	78	3*
Minn. 4	1957	16.0	72	14*	51	—3	82	0
Minn. 1	1958	16.0	49	52**	50	—17**	85	—2
Minn. 2[c]	1958	16.1	39	14*	60	—2	66	4
Average		13.5	79.4	7.8	33.2	—0.5	82.4	0.8

[a] Increase in yield from 125 pounds of K per acre based on a regression equation fitted to treatment means of the form: $y=a+b_1K_F+b_2K_F^2$ where K_F=pounds of K applied per acre.
[b] Difference between means for 125 pounds of added K per acre and no K.
[c] Data from these experiments were not used in later multiple regression analyses.
** Significant at the 1-percent level.
* Significant at the 5-percent level.

Relation Between Percent K in Corn Leaves at Silking Time and K Content and Grain Yield of Corn Plants

The multiple regression equations and the coefficients of determination for these relationships are reported in table A-7 of the appendix. These were calculated using data from 31 field experiments.

UPTAKE OF APPLIED K BY THE CORN PLANTS

The increase in percent K in the leaves resulting from K applications (calculated as described in table 4) was inversely related to the percent K in the leaves from plots that received no K fertilizer. This relationship is shown in fig. 4. Part of the variability in the relationship illustrated in fig. 4 appeared to be related to soil texture. The increase in percent K in the leaves from K fertilization observed in six of the field experiments was much greater than that observed in the majority of the experiments. These six experiments were on loams or sands and on an organic soil. However, the increase in percent K on nine of the loams and sands appeared to follow the same relationship as that observed for finer textured silt loams and the silty clay loam. It appears that the applied fertilizer was more available in the organic soil and some of the sandy soils than it was in the finer textured soils.

The effect of different rates of application of K fertilizer on the percent K in corn leaves at silking time in relation to the percent K in leaves from plots

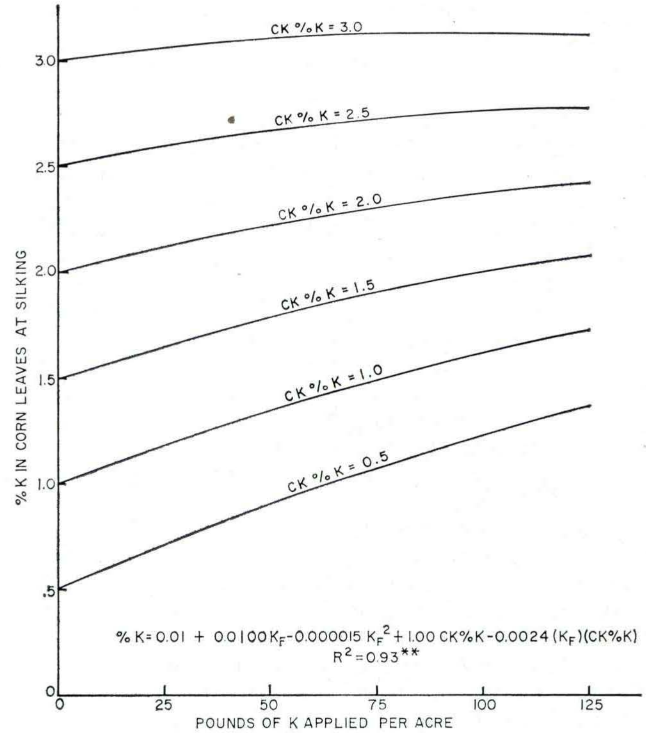


Fig. 5. The effect of applied fertilizer K on the percent K in corn leaves at silking time in relation to the percent K in leaves from plots that received no K fertilizer.

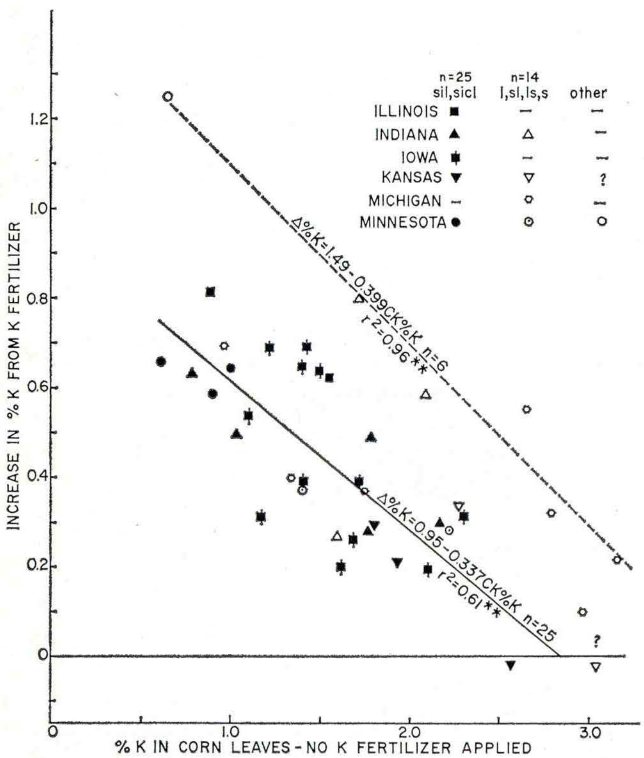


Fig. 4. Relation between the increase in percent K in corn leaves at silking time from K fertilizer applications of 100 pounds of K per acre and the percent K in leaves from plots that received no K fertilizer.

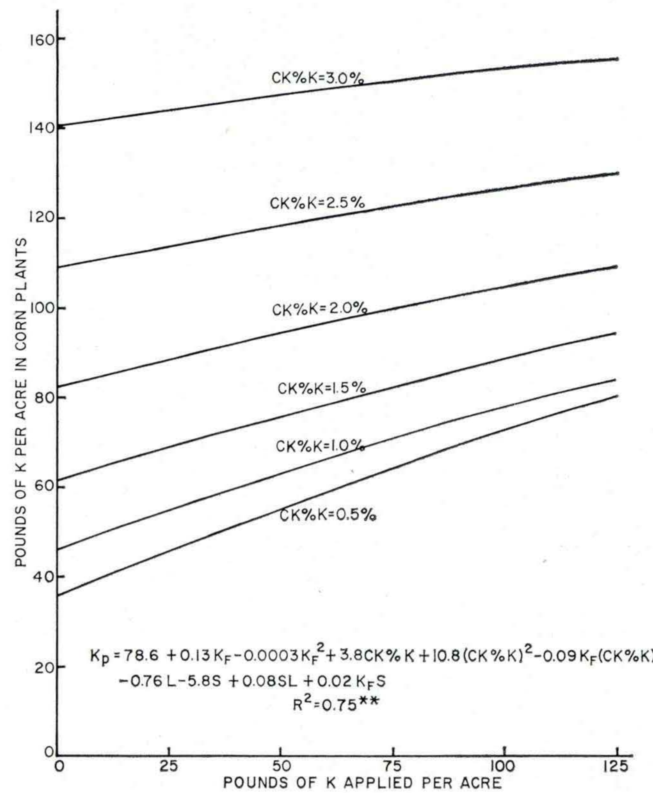


Fig. 6. The uptake of applied fertilizer K by corn plants at silking time in relation to the percent K in the corn leaves from plots without K fertilizer (S=13.3; L=93.1).

that received no K fertilizer is shown in fig. 5. Data from the organic soil from Minnesota and three of the loams and sands from Michigan, where larger than normal increases in percent K were observed, were not included in this portion of the study.

Within each experiment the increase in percent K in the corn leaves resulting from K fertilizer applications was essentially linear over the range of K applications used in this study. However, the data of fig. 5 suggest that the relationship would be curvilinear over a greater range of K applications.

The pounds of K per acre in the corn plants at silking time in relation to the percent K in the corn leaves at silking time and the amount of fertilizer K applied is shown in fig. 6. Including data for plant population (S) and leaf weight (L) significantly improved the degree of correlation for this relationship. The average value for these variables for all experiments was used in preparing fig. 6.

The relationship between pounds of K in the corn plants and pounds of K applied was very nearly linear over the range of K applications used in each field experiment, as was true for the relationship with percent K in the corn leaves. Futhermore, the increase in the pounds of K in the plants resulting from K fertilizer applications was inversely related to the percent K in the leaves from unfertilized plots, as was true for the increase in percent K in the leaves from applied K.

YIELD INCREASES FROM K FERTILIZER APPLICATIONS

The simple relationship between percent K in the corn leaves at silking and the increase in yield of grain obtained from an application of 125 pounds of K per acre is shown in fig. 7. This figure includes the data from all 41 field experiments from which yield data were obtained — even though drouth, excess moisture, variable stands, etc. were known to limit the yields and yield responses observed in several of the experiments. As was shown in table 5, all except one of the yield increases that were greater than 10 bushels per acre were statistically significant, and only one of those less than 10 bushels per acre was statistically significant.

Statistically significant yield increases were obtained only where the percent K in leaves from unfertilized plots was 1.7 or less. The regression equation indicates that no increase in yield would be expected when the K content of the leaves is slightly above 2.0 percent.

Since yield increases of less than 10 bushels per acre were generally not statistically significant, it is not possible with these data to establish a critical percent K in the corn leaves (above which no yield increase would be expected) with a high degree of precision. However, in all but two experiments where the percent K in the leaves was less than 1.3 there was a significant increase in yield. This indicates that the percent K in the leaves does provide a good estimate of the K status of the plants and the probable response that can be expected from applications of K fertilizer.

The relation between the K content of corn leaves at silking time from plots that received no K fertilizer and the yield increases obtained from different rates of application of K fertilizer is shown in fig. 8. Including the plant population and leaf weight as variables in the regression equation significantly increased the degree of correlation.

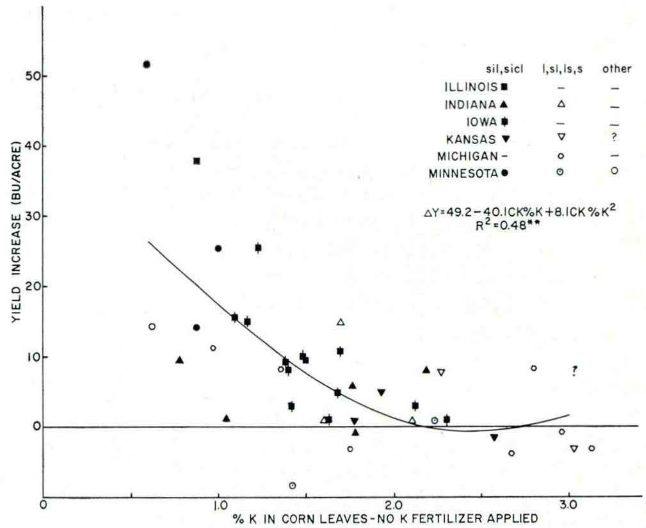


Fig. 7. Relation between percent K in corn leaves at silking time from plots that received no K fertilizer and the increase in yield of grain resulting from a fertilizer application of 125 pounds of K per acre.

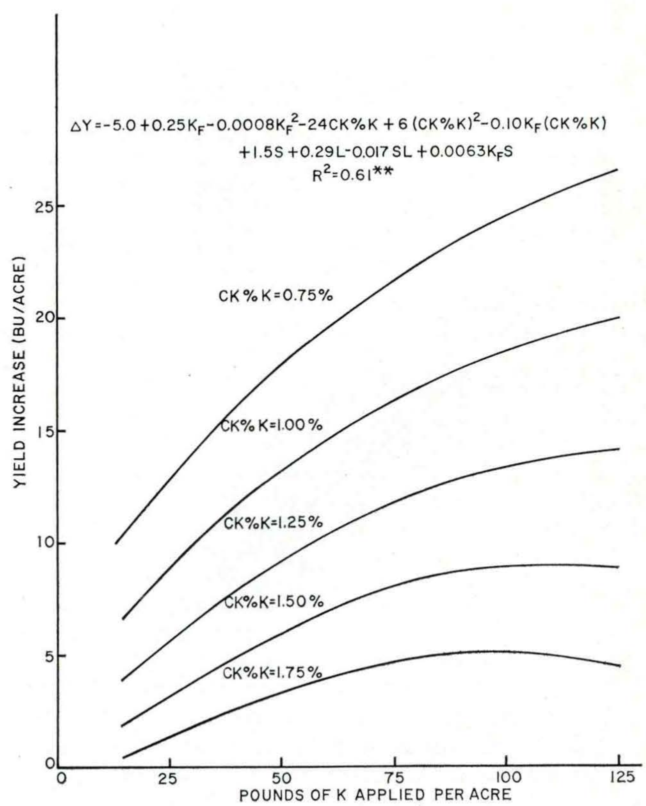


Fig. 8. Predicted yield increases of corn grain from K fertilizer applications in relation to the percent K in corn leaves at silking time from plots that received no K fertilizer (S=13.3; L=93.1).

Table 6. Multiple regression equations relating the K contents of the corn leaves and plants at silking time and the grain yields obtained to the percent K in the corn leaves from plots without K fertilizer, the amount of K fertilizer applied and other variables based on data from 31 field experiments.

Equation	a	Ck%K	(Ck%K)²	K_F	K_F^2	K_F(Ck%K)	△%K	(Ck%K)(△%K)	S	L	SL	K_FS	R^2
					%K in corn leaves at silking time (%K)								
1	0.19	+0.85**		+0.0063**	—0.000016**				+0.004	—0.00			0.92**
2	0.01	+1.00**		+0.0100**	—0.000015*	—0.0024**							
					Increase in %K in corn leaves at silking time from K fertilizer applications (△%K)								
1a	0.19	—0.15**		+0.0063**	—0.000016*				+0.004	—0.00			0.66**
2a	—0.04	+0.07	—0.02	+0.0100**	—0.000015*	—0.0024**							0.70**
					Pounds of K per acre in corn plants at silking time (K_p)								
1b	78.6	+3.8	+10.8**	+0.13	—0.0003	—0.09*			—5.8**	—0.76**	+0.08**	+0.02*	0.75**
2b	89.2	+10.5	+10.6**				+71**	—18†	—7.6**	—1.11**	+0.11**		0.75**
					Yield of corn grain, bushels per acre (Y)								
1c	83.7	+58**	—13**	+0.17	—0.0007	—0.095*			—4.1*	—0.97**	+0.08**	+0.01	0.45**
2c	58.7	+78**	—19**				+53**	—31**	—3.3†	—0.93**	+0.07**		0.46**
					Increase in yield of corn grain from K fertilizer applications (△Y)								
1d	—5.0	—24**	+6**	+0.25**	—0.0008**	—0.10**			+1.5†	+0.29**	—0.017*	+0.0063‡	0.61**
2d	—4.6	—18**	+4**				+40**	—16**	+1.1‡	+0.21*	—0.009		0.64**

** Significant at the 1-percent level.
* Significant at the 5-percent level.
† Significant at the 10-percent level.
‡ Significant at the 20-percent level.

EFFECTS OF DIFFERENT VARIABLES ON THE K CONTENT OF THE PLANTS AND THE GRAIN YIELDS.

The multiple regression equations and the coefficients of determination (R^2) for relationships between the percent K in the corn leaves at silking time, the K contents of the plants, and the grain yields are reported in table A-7 of the appendix and are partially summarized in table 6.

There was little difference in the R^2 values obtained whether a variable for the amount of K applied (K_F) was included or a variable for the increase in percent K in the corn leaves resulting from K fertilizer applications (Δ%K) was included. Δ%K was highly correlated with K_F, as is indicated in fig. 5.

Including variables for plant population (S) or leaf weight (L) did not increase the R^2 value for % K or Δ%K, but the coefficients for these variables were significant in the relationships with the pounds of K per acre in the corn plants at silking time (K_p), the yield of corn grain (Y), and the increase in yield of corn grain resulting from K fertilizer applications (ΔY). Thus, it appears that the number of plants per acre and the size of the plants, as indicated by leaf weights, had little effect on the concentration of K in the plants but did influence the total amount of K taken up per acre by the plants and the final yield of grain per acre.

Relation Between Exchangeable Soil K and the K Content and Grain Yield of Corn Plants

K CONTENT OF CORN PLANTS

The relation between exchangeable K in field-moist soil samples from the 0-6 inch depth and the percent K in corn leaves at silking time is shown in fig. 9. The data for the organic soil from Minnesota is shown in the following figures, but was not used in calculating the regression equations. As would be expected, the percent K in the corn leaves from the organic soil is low in relation to the amount of exchangeable K when exchangeable K is expressed on a dry-weight basis as was done here. The weight per unit volume is very much less for organic than for mineral soils. The data from a Kansas soil (No. 7-1958) is also shown in the figures by the symbol "?" but is not included in the regressions. This was an unusual soil with a silt loam to silty clay loam texture in the surface 18 inches underlain with sandy material. The exchangeable K in the 6-12 inch layer of this Kansas soil was much higher than in the 0-6 inch layer.

The percent K in the corn leaves is highly correlated with the exchangeable K content of the field-moist, 0-6 inch soil samples. However, the relationship between the K in the leaves and in the soil is very different for the fine-textured soils than for the coarse-textured soils. The percent K in the corn leaves at any given level of exchangeable K in the soils is much higher on the loams and sands than on the silt loams and the silty clay loam. It appears obvious that a given level of exchangeable K generally indicates a higher level of K availability in the coarse-textured soils. It would have been desirable to have grouped the soils according to percent clay rather than this crude textural classification that was used, but data from mechanical analyses of the soils were not available.

The relation between exchangeable K in field-moist, 0-6 inch soil samples and the pounds of K per acre in the corn plants at silking time is shown in fig. 10. Since the amount of K per acre in the corn plants was shown to be related to the number of plants per acre, the values used in fig. 10 were adjusted to a mean plant population of 13,300 plants per acre according to the regression equation: adjusted $K_p = K_p - 4.55\ (S\text{-}13.3)$. As was indicated by the data in fig. 3, the amount of K in the plants at silking time generally represented about 90 percent of the total K taken up by the plants during the season.

The amount of K in the corn plants was highly

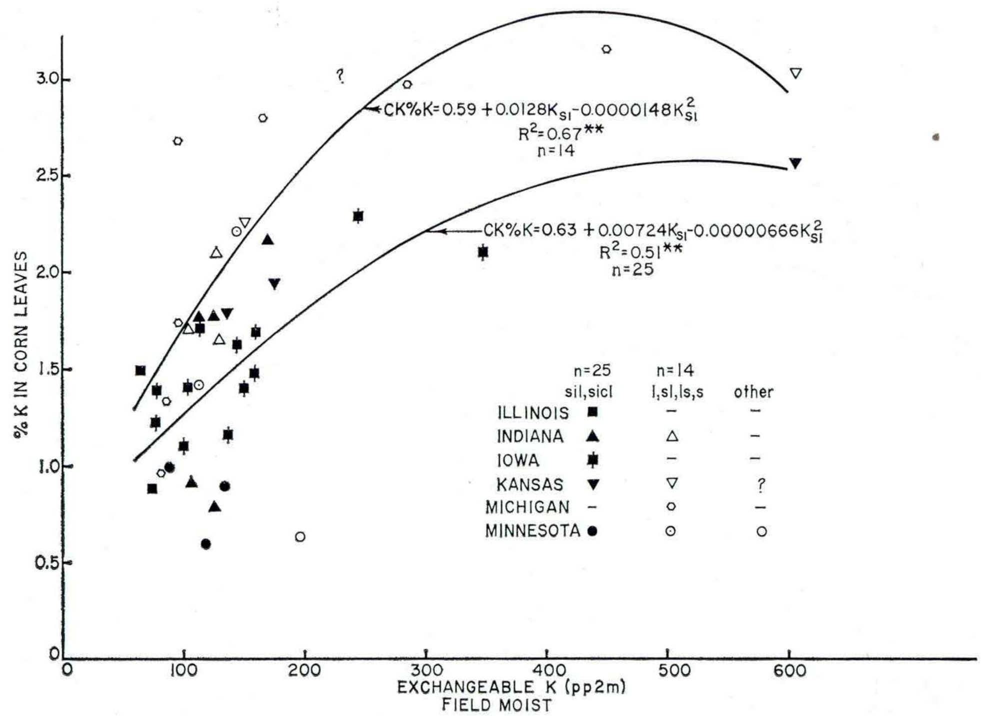


Fig. 9. Relation between exchangeable K in field-moist soil samples from the 0-6 inch depth and percent K in corn leaves at silking time from plots that received no K fertilizer.

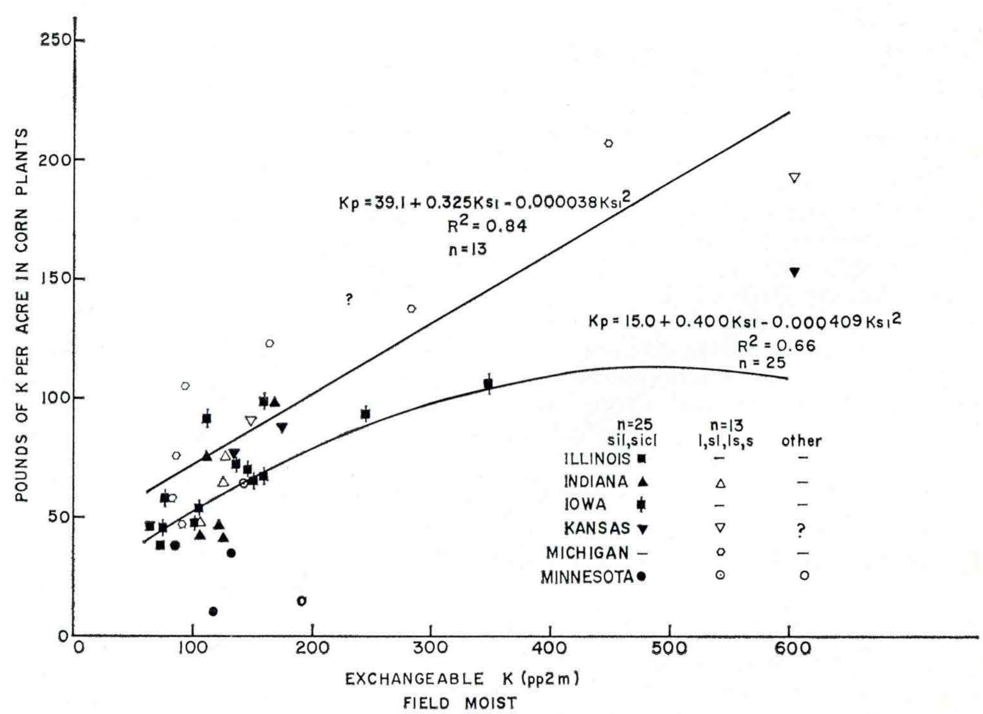


Fig. 10. Relation between exchangeable K in field-moist soil samples from the 0-6 inch depth and the pounds of K per acre in the above-ground parts of corn plants at silking time from plots that received no K fertilizer.

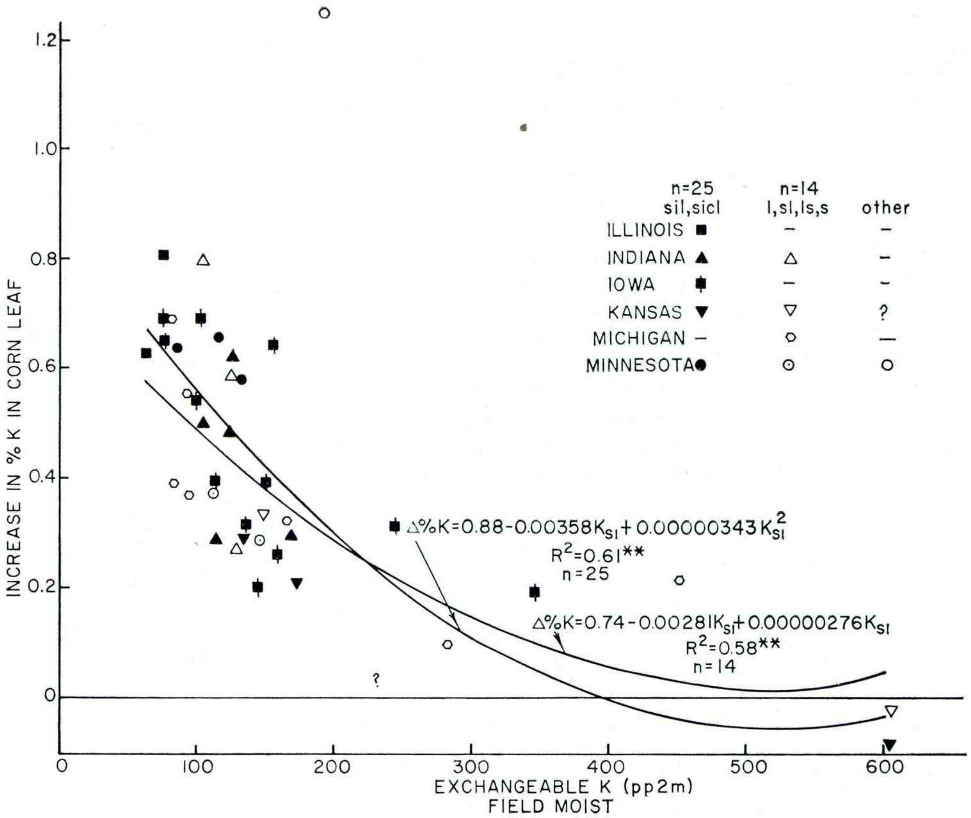


Fig. 11. Relation between exchangable K in field-moist soil samples from the 0-6 inch depth and the increase in percent K in corn leaves at silking time resulting from a fertilizer application of 100 pounds of K per acre.

correlated with the exchangeable K in the surface soil for both textural groups of soils. At any given level of exchangeable K in the soil, there was more K in the corn plants from the coarser textured loams and sands than from the finer textured silt loams and the silty clay loam.

INCREASE IN K CONTENT OF CORN PLANTS FROM K FERTILIZER APPLICATIONS

The increase in percent K in the corn leaves at silking time resulting from K fertilizer applications (calculated as described in table 4) was inversely related to the level of exchangeable K in field-moist, 0-6 inch soil samples as shown in fig. 11. At low levels of exchangeable soil K, K fertilizer applications increased the percent K in corn leaves appreciably, but at high levels of exchangeable K in the soil there was no increase in percent K in the leaves as a result of K fertilizer applications. There was no significant difference in the relationship between the two textural groups of soils. It should be remembered, however, that the leaves from the unfertilized plots on the coarser textured soils were higher in percent K (see fig. 9) and the increase in percent K from K fertilizer applications is inversely related to the percent K in the leaves from plots without K fertilizer (see fig. 4). Therefore, this similarity observed in fig. 11 does not necessarily indicate a similar availability of added K in the two groups of soils.

The predicted percentages of K in corn leaves at silking time as influenced by the exchangeable K level of the soil and the amount of K fertilizer applied are shown in fig. 12. This relationship is based on data from

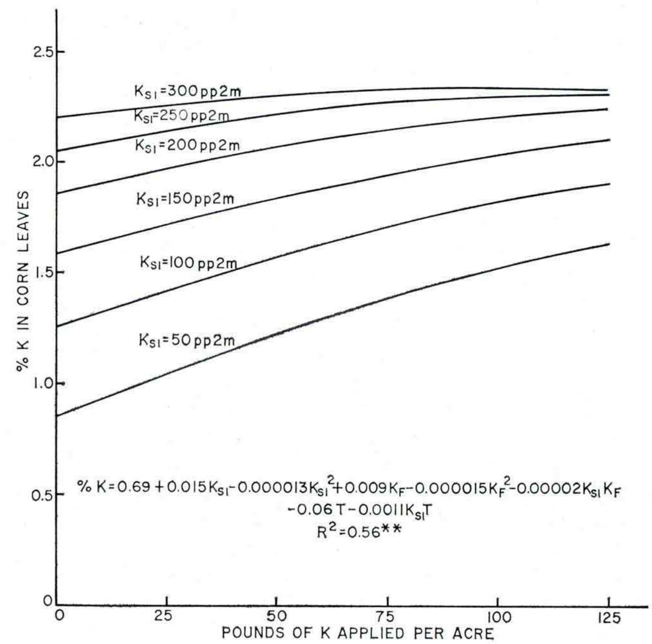


Fig. 12. Predicted effect of K fertilizer applications on the percent K in corn leaves at silking time as influenced by the level of exchangeable K in the field-moist 0-6 inch layer of soil (T=5).

31 field experiments. The predicted increase in percent K is large at low levels of exchangable K, but becomes very small as the exchangeable K in the surface soil approaches 300 pp2m. Including a variable for soil texture in the regression equation significantly increased the degree of correlation. The relationship shown in

fig. 12 was calculated using the coded value of 5 for a silt loam texture. Higher percentages of K in the leaves would be predicted for coarser textured soils.

The increase in pounds of K per acre in the corn plants resulting from K fertilization (calculated as described in table 4) was also inversely related to the level of exchangeable K in the field-moist soil. This is shown in fig. 13. Over most of the range of the observations there was no marked difference in the two textural groups of soils, although uptake of fertilizer K tended to be lower on the coarse-textured soils. Two of the sandy soils with high levels of exchangeable K showed negative increases in pounds of K in the plants following the application of K fertilizer, but these were not statistically significant and are probably due to experimental error. The regressions indicate that there would be no increase in the amount of K taken up by the corn plants from K fertilizer applications where exchangeable K in the soil exceeds 300 to 400 pp2m, but at low levels of exchangeable K as much as half of the applied K may be taken up by the corn plants.

The predicted pounds of K per acre found in corn plants at silking time as influenced by the amount of K fertilizer applied and the level of exchangeable K in the surface soil are shown in fig. 14. The uptake of fertilizer K increased linearly with the amount of K fertilizer applied over the range of applications used in this study, but much more was taken up at low levels of exchangeable soil K than at high levels. Including data for soil texture and plant population in the multiple regression equation significantly increased the degree of correlation. The relationship shown in fig. 14 was calculated for a silt loam texture (T=5) and for the average stand (S) of 13,300 plants per acre.

GRAIN YIELD INCREASES FROM K FERTILIZER APPLICATIONS

The relation between the level of exchangeable K in field-moist, 0-6 inch soil samples and the increases in grain yield obtained from K fertilizer applications is shown in fig. 15. The degree of correlation between exchangeable K in the soil and the yield increases was low for both textural groups of soils. This resulted from the failure to obtain significant yield increases in many experiments where the exchangeable K in the soil was low. There were no significant yield increases where exchangeable K exceeded 160 pp2m except on the organic soil from Minnesota which had 192 pp2m of exchangeable K. No significant yield increases occurred on sands. Significant yield increases of 11 and 15 bushels per acre were obtained on two loam soils with exchangeable K contents of 80 and 103 pp2m, respectively. The large increases in yield of greater than 20 bushels per acre occurred on silt loam soils with exchangeable K contents ranging from 73 to 119 pp2m.

Since, as was shown earlier, the added fertilizer K was taken up by the corn plants to increase the percent K in the plants grown on all of these low K soils, the lack of response must be explained in other ways than the failure of the plants to take up the fertilizer K. Poor stands and drouth limited the yields and yield increases in some of the experiments. In other experiments it appears that the plants from sites with low levels of exchangeable K contained adequate amounts of K. This was especially true for sandy soils under favorable moisture conditions.

The predicted yield increases to be expected from K fertilizer applications at different levels of exchange-

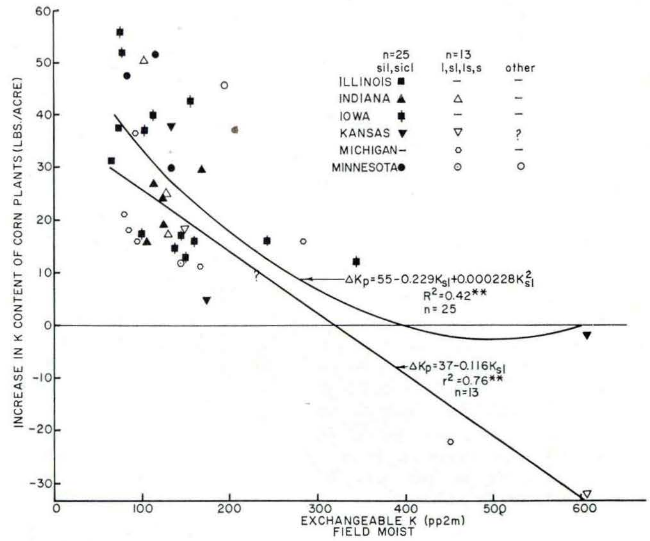


Fig. 13. Relation between exchangeable K in field-moist soil samples from the 0-6 inch depth and the increase in pounds of K per acre in the above-ground parts of the corn plants at silking time resulting from K fertilizer applications of 100 pounds of K per acre.

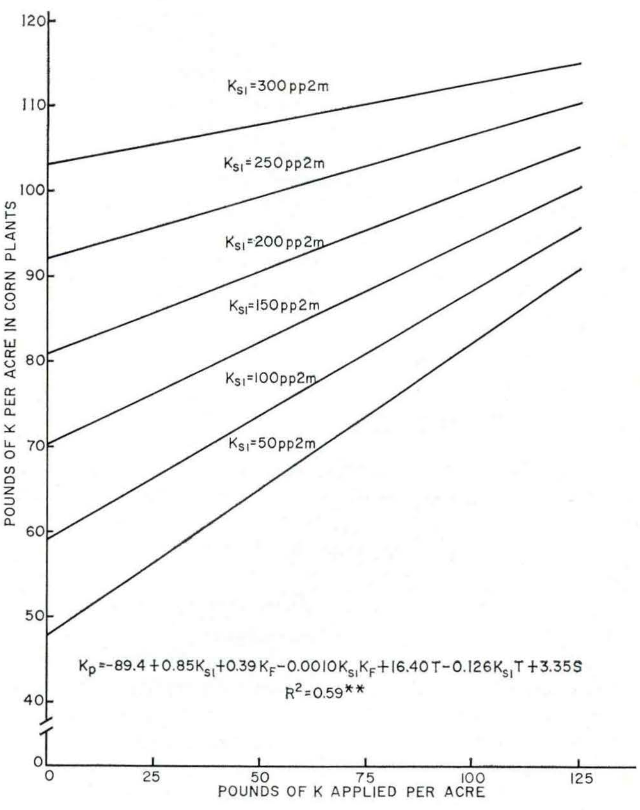


Fig. 14. Predicted pounds of K per acre in corn plants at silking time as influenced by the amount of K fertilizer applied and the level of exchangeable K in the field-moist 0-6 inch layer of soil (T=5; S=13.3).

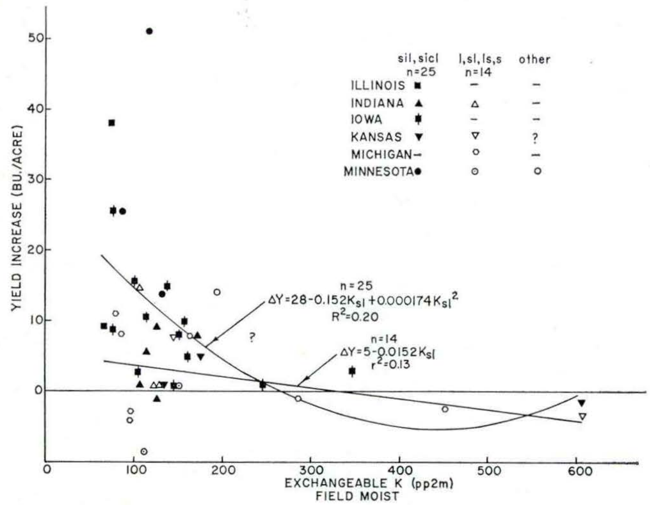


Fig. 15. Relation between exchangeable K in field-moist soil samples from the 0-6 inch depth and the increase in grain yield obtained from a fertilizer application supplying 125 pounds of K per acre.

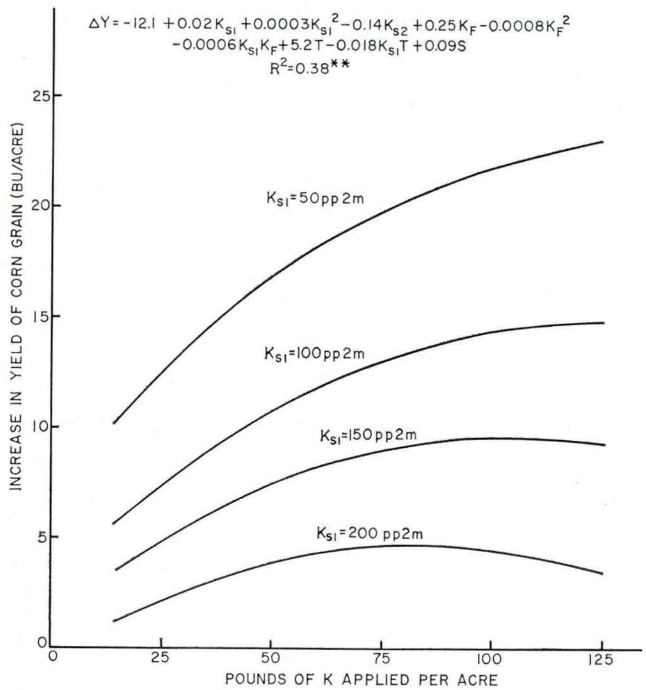


Fig. 16. Predicted increases in yield of corn grain from different rates of application of K fertilizer as influenced by the level of exchangeable K in the field-moist 0-6 inch layer of soil (S=13.3; T=5).

able soil K in the 0-6 inch layer of field-moist soil are shown in fig. 16. The relationship illustrated was calculated for a plant population of 13,300 and a soil of silt loam texture. This relationship is very similar to that obtained by Dumenil, **et al.** (7) with data from 144 field experiments in Iowa.

EFFECT OF SUBSOIL K AND OTHER VARIABLES ON THE RELATIONSHIPS.

Multiple regression equations and the coefficients of determination for the relationships between exchangeable K in the field-moist soil and the K contents and grain yields of the corn plants are reported in tables A-8 and A-9 of the appendix and are partially summarized in table 7. These were calculated using data from 31 field experiments.

The regression coefficients for exchangeable K in the field-moist 0-6 inch layer of soil (K_{S1}) were significant in all the equations for %K, K_P and Y, and the curvilinear component (K_{S1}^2) was significant in these relationships except for the relation with K_P. For the relationships concerning changes resulting from K fertilizer applications, Δ %K and Δ Y, the values for K^2_{S1} were consistently significant but those for K_{S1} were not. The regression coefficients for exchangeable K in the 6-12 inch layer of soil (K_{S2}) were significant in many of the equations and were significant in all of the equations for Δ%K and Δ Y in which only changes from applied K fertilizer were being considered. However, deleting this variable from the equations generally resulted in little reduction in the R^2 value. The coefficients for exchangeable K in layers of soil below 12 inches varied considerably in their significance. Deleting these variables generally resulted in relatively small decreases in the R^2 values, except in the relationships with yield (Y) where the coefficients for K_{S5} and K_{S6} were highly significant and deletion of these variables reduced the R^2 value appreciably.

The linear component for the amount of K fertilizer applied (K_F) was highly significant in all equations, except for that with the yield of grain (Y). The curvilinear component (K_F^2) was significant in equations for Δ%K and Δ Y where only changes resulting from applied K fertilizer were being considered. The interaction between K fertilizer applied and exchangeable K in the 0-6 inch layer of soil ($K_{S1}K_F$) was significant in all equations, except those for the relationship with yield of grain (Y).

The coefficients for soil texture (T) and/or the interaction between texture and exchangeable K in the 0-6 inch layer ($K_{S1}T$) were significant for all the relationships, except those concerned with the increase in percent K in the leaves from K fertilizer applications (Δ%K). The coefficients for plant population (S) were highly significant in the equations for pounds of K in the corn plants (K_p) and yield of grain (Y) but not for the other relationships. Deleting the variables for soil texture reduced the R^2 value for %K, and deleting the variables for soil texture and plant population reduced the R^2 values for K_p and Y appreciably, but deleting these variables had little effect on the R^2 values of Δ%K and ΔY where only increases from K fertilizer applications were being considered.

In general, it appears that the exchangeable K in the field-moist, 0-6 inch layer of soil (K_{S1}) and the amount of K fertilizer applied (K_F) were important variables to be considered in all of the relationships with the K contents of the corn plants and the yields of corn grain. The relationships with these variables were curvilinear, and the interactions between these variables were significant. The amount of exchangeable K in the layers of soil below 6 inches appeared to have some value in improving the correlations in most of the relationships.

A given level of exchangeable K in the field-moist

Table 7. Multiple regression equations relating the K contents and the grain yield of corn to exchangeable K in field-moist soils, the amount of K fertilizer applied and other variables based on data from 31 field experiments.[a]

Equation No.	a	Partial regression coefficients (b_i) K_{S1} x10^3	K_{S1}^2 x10^6	K_{S2} x10^3	$K_{S1}K_{S2}$ x10^5	K_{S3} x10^3	K_{S4} x10^3	K_{S5} x10^3	K_{S6} x10^3	K_{S3-6} x10^3	$K_{S1}K_{S3-6}$ x10^5	$K_{S2}K_{S3-6}$ x10^5	K_F x10^3	K_F^2 x10^6	$K_{S1}K_F$ x10^5	T x10^2	$K_{S1}T$ x10^4	S x10^3	R^2
									%K in corn leaves at silking time (%K)										
1	0.47	+20**	—22**	+2.6‡	...	—6.1*	—15**	+25**	—4.4	...	...	...	+9.3**	—15	—2.2*	—12‡	—12†	+6.6	0.69**
2	0.52	+20**	—22**	+2.7‡	...	—6.4*	—15**	+25**	—4.7	...	...	...	+9.4**	—15	—2.2*	—11	—13*	...	0.69**
3	0.52	+15**	—81**	—8.9	+21**	...	...	...	...	+37**	—1.2	—42	+9.0**	—15	—2.0*	—27**	+3†	...	0.62**
4	0.28	+21**	—13*	+0.5	...	—6.0*	...	...	...	...	...	...	+9.3**	—15	—2.1*	+6	—21**	...	0.59**
5	1.11	+13**	—17**	—4.6*	...	...	...	...	...	+5.5*	...	...	+9.1**	—15	—2.0*	—21**	+1	...	0.58**
6	0.69	+15**	—13*	...	...	...	...	...	...	...	...	...	+9.2**	—15	—2.1*	—6	—11	...	0.56**
7	0.38	+11**	—13*	...	...	...	...	...	...	...	...	...	+9.2**	—15	—2.1†	...	...	...	0.42**
									Increase in %K in corn leaves from K fertilizer applications (△%K)										
1a	0.26	—2.5†	+6.2**	—2.7**	...	+0.4	—1.7	+4.7*	—2.5‡	...	...	...	+9.1**	—15*	—2.0**	—1.5	+2.2	+2.4	0.78**
2a	0.13	—1.1†	+15.3**	—10.1**	+1.2	...	...	...	...	+8.3*	—11.6**	+10.8**	+9.1**	—15**	—2.0**	...	...	...	0.79**
3a	0.26	—1.6*	+7.0**	—2.8**	...	...	...	...	...	+0.4	...	...	+9.1**	—15*	—2.0**	...	...	...	0.77**
4a	0.28	—3.4**	+8.3**	...	...	...	...	...	...	...	...	...	+9.1**	—15*	—2.0**	...	...	...	0.73**
									Pounds per acre of K in corn plants at silking time (K_p)										
1b	—64.8	+798**	—7,118**	—941 *	+1,906**	...	...	...	...	+2,383**	+114	—3,224**	+423**	—271	—96*	—419*	+166*	+3,044**	0.66**
2b	—81.2	+768**	—308‡	+1	...	+206‡	—561*	+587†	—23	...	...	...	+422**	—233	—99†	+961†	—824*	+3,676**	0.61**
3b	—92.5	+876**	—143	—97	...	+101	...	...	...	...	...	...	+423**	—250	—98†	+1,571**	—1,162**	+3,382**	0.59**
4b	—89.4	+853**	...	...	...	...	...	...	...	...	...	...	+395**	...	—99†	+1,640**	—1,265**	+3,350**	0.59**
5b	26.7	+295**	...	...	...	...	...	...	...	...	...	...	+428**	...	—115†	...	...	...	0.44**
									Yield of corn grain, bushels per acre (Y)										
1c	—74.4	+620**	—803**	+97	...	—36	—279‡	—735**	+1,316**	...	...	...	+199*	—590	—48†	+1,021**	—561*	+4,789**	0.62**
2c	—64.1	+399*	—2,441**	—396	+697**	...	...	...	...	+1,809**	—288	—1,204*	+192†	—626	—42	+474**	—68	+4,393**	0.48**
3c	—44.8	+292**	—613**	—140†	...	...	...	...	...	+583**	...	...	+190†	—612	—42	+672**	—142*	+4,640**	0.45**
4c	—25.1	+355*	—524*	+152†	...	—88	...	...	...	...	...	...	+211	—645	—50	+960*	—380‡	+3,601**	0.36**
5c	—29.9	+410**	—571*	...	...	...	...	...	...	...	...	...	+212†	—647	—50	+1,038**	—361‡	+3,545**	0.35**
6c	57.6	+311**	—715**	...	...	...	...	...	...	...	...	...	+264†	—787	—66	...	...	...	0.08*
									Increase in yield of corn grain from K fertilizer applications (△Y)										
1d	—10.4	—44	+314**	—234**	...	+98‡	+153‡	—60	—63	...	...	...	+249**	—797*	—58*	+465*	—69	+186	0.42**
2d	—4.4	+139†	—1,067*	—608**	+345**	...	...	...	...	+276	—160	—52	+257**	—800*	—62**	+257**	+50‡	—53	0.42**
3d	—8.2	—68	+264*	—207**	...	+143**	...	...	...	...	...	...	+249**	—793*	—58**	+343†	+6	+248	0.41**
4d	—4.5	—53	+234*	—150**	...	...	...	...	...	+60	...	...	+251**	—792*	—59**	+241**	+14	+240	0.38**
5d	—12.1	+20	+279*	—136**	...	...	...	...	...	...	...	...	+254**	—796*	—60**	+519**	—178‡	+85	0.38**
6d	—3.4	—117†	+326**	...	...	...	...	...	...	...	...	...	+249**	—792*	—58*	+279‡	—61	+279	0.32**
7d	12.3	—137**	+307**	...	...	...	...	...	...	...	...	...	+253**	—803*	—59*	...	...	...	0.29**

[a] The equations have the general form: $\hat{Y}=a+\Sigma b_i X_i$.
** Significant at the 1-percent level.
* Significant at the 5-percent level.
† Significant at the 10-percent level.
‡ Significant at the 20-percent level.

soil indicated a higher availability of K to plants in coarse-textured soils than in finer textured soils.

Plant population was an important variable to be considered in predicting total grain yields or pounds of K per acre in the corn plants but was not significant in predictions of percent K in the plants or the increase in grain yield because of K fertilizer applications.

EFFECT OF DETERMINING EXCHANGEABLE K ON MOIST VS. DRIED SOIL SAMPLES

The coefficients of determination (R^2) for different multiple regression equations relating K contents and yields of the corn plants to exchangeable K determined on field-moist, air-dry and oven-dry soil samples are reported in table 8. The multiple regression equations obtained using exchangeable K values for air-dry and oven-dry soil samples are reported in table A-10 of the appendix. The degree of correlation is consistently as high or higher for the field-moist values as for the air-dry or oven-dry values. The fact that the degree of correlation for the field-moist values is considerably higher in several cases indicates that exchangeable K determined on field-moist soil samples provides a better estimate of K uptake by corn plants in the field than does the exchangeable K determined on dry soil samples. This is in agreement with the results of previous studies (2, 9).

Table 8. Effect of drying soil samples prior to determination of exchangeable K on the degree of correlation between exchangeable K in the soil and the yield, K content and responses of corn to K fertilizer applications.

	R^2		
	Field moist	Air dry[a]	Oven dry
%K in corn leaves (%K)			
$K_{S1},K_{S1}^2,K_{S2},K_{S3},K_{S4},K_{S5},K_{S6},K_F,K_F^2,K_{S1}K_F,T,K_{S1T}$	0.69**	0.51**	0.56**
K_{S1},K_{S1}^2 $K_F,K_F^2,K_{S1}K_F,T,K_{S1T}$	0.56**	0.42**	0.45**
Increase in %K (△ %K)			
$K_{S1},K_{S1}^2,K_{S2},K_{S3},K_{S4},K_{S5},K_{S6},K_F,K_F^2,K_{S1}K_F$	0.78**	0.75**	0.69**
K_{S1},K_{S1}^2 $K_F,K_F^2,K_{S1}K_F$	0.73**	0.73**	0.65**
Pounds of K/acre (K_p)			
$K_{S1},K_{S1}^2,K_{S2},K_{S3},K_{S4},K_{S5},K_{S6},K_F,K_F^2,K_{S1}K_F,T,K_{S1T},S$	0.61**	0.60**	0.60**
K_{S1},K_{S1}^2 $K_F,K_F^2,K_{S1}K_F,T,K_{S1T},S$	0.59**	0.50**	0.51**
Yield of grain (Y)			
$K_{S1},K_{S1}^2,K_{S2},K_{S3},K_{S4},K_{S5},K_{S6},K_F,K_F^2,K_{S1}K_F,T,K_{S1T},S$	0.62**	0.53**	0.43**
K_{S1},K_{S1}^2 $K_F,K_F^2,K_{S1}K_F,T,K_{S1T},S$	0.35**	0.34**	0.34**
Yield increase (△Y)			
$K_{S1},K_{S1}^2,K_{S2},K_{S3},K_{S4},K_{S5},K_{S6},K_F,K_F^2,K_{S1}K_F,T,K_{S1T},S$	0.42**	0.39**	0.27**
K_{S1},K_{S1}^2 $K_F,K_F^2,K_{S1}K_F,T,K_{S1T},S$	0.32**	0.24**	0.20**

[a] Air dried for at least 2 weeks before exchangeable K was determined in Soil Testing Laboratory.
** Significant at the 1-percent level.

The relationship between the exchangeable K content of oven-dry soil samples from the 0-6 inch layer and the percent K in the corn leaves at silking time is shown in fig. 17. This can be compared with the relationship illustrated in fig. 9 for exchangeable K determined on field-moist soil samples. In the relationship for the dry soils, as with the moist soils, there was a definite difference between the coarse and fine-textured soils. For both textural groups of soils the correlation coefficients are lower for the oven-dry samples than for the field-moist samples. As was shown in fig. 1,

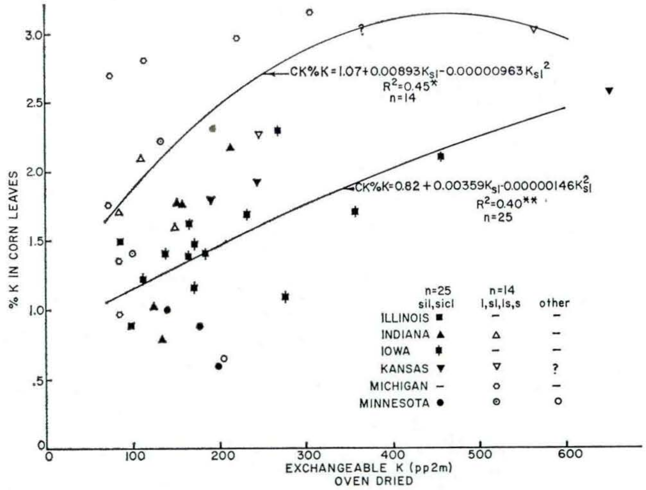


Fig. 17. Relation between exchangeable K in oven-dry soil samples from the 0-6 inch depth and percent K in corn leaves at silking time from plots that received no K fertilizer.

exchangeable K in most of the loams and sands decreased on drying, whereas exchangeable K in the silt loams and the silty clay loam generally increased on drying. Therefore, drying increased the differences attributable to soil texture in the relationship between leaf and soil K.

Comparison of Field and Greenhouse Results

Soil samples from the 1957 field experiments were used in a greenhouse study for which the results were reported previously (2). In the greenhouse study exchangeable K in field-moist soil samples was very highly correlated with the K content of millet plants grown on the soil samples. In this regard the greenhouse and field results were similar. Recovery of added K, as measured by the difference in K content of plants from pots that received K fertilizer and those that received no K fertilizer, however, was much higher in the greenhouse than in the field.

SUMMARY AND CONCLUSIONS

Uniform field experiments in which K fertilizers were applied at different rates (0, 25, 50, 75, 100 and 125 pounds of K per acre) for corn were established at 51 locations in six North Central states during 1957 and 1958. Laboratory analyses were made on soil samples from each field experimental site. Data concerning grain yields and K contents of the corn plants were obtained from 41 of the field experiments.

Exchangeable K in field-moist soil samples from the 0-6 inch layer of soil varied from 64 to 935 pp2m and averaged 210 pp2m.

At the time of silking, the corn plants contained 90 percent of the total K taken up during the season, and K uptake appeared to be complete by 10 to 15 days after silking.

The amount of K in plants at silking time from plots that received no K fertilizer varied from 22 to 213 pounds per acre and averaged 78 pounds. The average increase in K content of the plants resulting from K fertilizer application was equal to 23 percent of the amount applied.

Grain yields from plots that received no K fertilizer varied from 33 to 127 bushels per acre and averaged 79 bushels. Grain yields were significantly increased in 11 experiments by application of K fertilizer. Applications of K fertilizer had little or no effect on the shelling percentages. The applications decreased moisture percentages in the grain at harvest in only one experiment, where a large increase in the grain yield also resulted.

The K content of the corn plants was highly correlated with the exchangeable K content of the soil. However, at a given level of exchangeable K in the soil, plants grown on coarse-textured loams and sands contained more K than plants grown on finer textured silt loam soils.

Uptake of fertilizer K was inversely related to the level of exchangeable K in the soil and to the percent K in corn leaves from plots that received no fertilizer K. Increases in yield of corn grain obtained from K fertilizer applications were more highly correlated with the percent K in corn leaves at silking time than with exchangeable K contents of the soils.

The number of corn plants per acre did not appear to influence the percent K in the plants but did influence total K uptake per acre and yield of grain.

Exchangeable K determined on field-moist samples provided a better estimate of the amount of K in corn plants and increases in grain yields caused by K fertilizer applications than did exchangeable K determined on air-dry or oven-dry soil samples.

Including data for the exchangeable K contents of subsoil layers in multiple regression equations relating K contents of the corn plants and yield of corn grain to exchangeable K contents of the soils generally improved the degree of correlation.

LITERATURE CITED

1. Attoe, O. J. Potassium fixation and release in soils occurring under moist and drying conditions. Soil Sci. Soc. Amer. Proc. 11:145-149. 1947.

2. Barber, S. A. *et al.* North central regional potassium studies: II. Greenhouse experiments with millet. Purdue Univ. Agr. Exp. Sta. Res. Bul. 717. (North Central Regional Publ. No. 123) 1961.

3. Bower, C. A., G. M. Browning and R. A. Norton. Comparative effects of plowing and other methods of seedbed preparation on nutrient element deficiencies in corn. Soil Sci. Soc. Amer. Proc. 9:141-146. 1945.

4. Bower, C. A. and W. H. Pierre. Potassium response of various crops on a high-lime soil in relation to their contents of potassium, calcium, magnesium and sodium. Jour. Amer. Soc. Agron. 36:608-614. 1944.

5. Bray, R. H. Soil-plant relations. 1. The quantitative relation of exchangeable potassium to crop yields and crop response to potash additions. Soil Sci. 58: 305-324. 1944.

6. Davidson, J. Removal of plant food in thinning corn. Jour. Amer. Soc. Agron. 18:962-967. 1926.

7. Dumenil, L., J. Hanway, H. R. Meldrum and J. T. Pesek. Your corn may need potassium. Iowa Farm Sci. 13:235-236. May 1959.

8. Hammond, L. C., W. H. Allaway and W. E. Loomis. Effects of oxygen and carbon dioxide levels upon the absorption of potassium by plants. Plant Physiol. 30:155-161. 1955.

9. Hanway, J. J. *et al.* North central regional potassium studies: I. Field studies with alfalfa. (North Central Regional Publication No. 124.) Iowa Agr. and Home Econ. Exp. Sta. Res. Bul. 494. 1961.

10. Hanway, J. J., and A. D. Scott. Soil potassium-moisture relations: II. Profile distribution of exchangeable K in Iowa soils as influenced by drying and rewetting. Soil Sci. Soc. Amer. Proc. 21:501-504. 1957.

11. Hoagland, D. R. and T. C. Broyer. General nature of the process of salt accumulation by roots with description of experimental methods. Plant Physiol. 11:471-507. 1936.

12. Hoffer, G. N., and B. A. Krantz. Deficiency symptoms of corn and small grain. In "Hunger Signs in Crops." pp 59-105. American Society of Agronomy and National Fertilizer Association, Washington, D. C.

13. Jones, U. S. Availability of humate potassium. Soil Sci. Soc. Amer. Proc. 12:373-378. 1947.

14. Lawton, K. Influence of soil aeration on the growth and accumulation of nutrients by corn plants. Soil Sci. Soc. Amer. Proc. 10:263-268. 1946.

15. Lawton, K., and R. L. Cook. Potassium in plant nutrition. In A. G. Norman, ed. Advances in Agronomy. 6:253-298. 1954. Academic Press Inc., New York.

16. Lawton, K., and M. B. Tesar. Yield, potassium content and root distribution of alfalfa and bromegrass grown under three levels of applied potash in the greenhouse. Agron. Jour. 50:148-151. 1958.

17. Luebs, R. E., G. Stanford and A. D. Scott. Relation of available potassium to soil moisture. Soil Sci. Soc. Amer. Proc. 20:45-50. 1956.

18. Matthews, B. C., and C. G. Sherrell. Effect of drying on exchangeable potassium of Ontario soils and the relation of exchangeable potassium to crop yield. Can. Jour. Soil Sci. 40:35-41. 1960.

19. Page, J. B., C. J. Willard and G. W. McGuen. Progress report on tillage methods in preparing land for corn. Soil Sci. Soc. Amer. Proc. 11:77-80. 1946.

20. Pierre, W. H., and C. A. Bower. Potassium absorption by plants as affected by cationic relationships. Soil Sci. 55:23-36. 1943.

21. Pratt, P. F., W. W. Jones and F. T. Bingham. Magnesium and potassium content of orange leaves in relation to exchangeable magnesium and potassium in soil at various depths. Amer. Soc. Hort. Sci. 70:245-251. 1957.

22. Sayre, J. D. Mineral accumulation in corn. Plant Physiol. 23:267-281. 1948.

23. Shaw, R. H., and H. C. S. Thom. On the phenology of field corn, the vegetative period. Agron. Jour. 43:9-15. 1951.

24. Shaw, R. H., and H. C. S. Thom. On the phenology of field corn, silking to maturity. Agron. Jour. 43: 541-546. 1951.

25. Tyner, E. H. The relation of corn yields to leaf nitrogen, phosphorus, and potassium content. Soil Sci. Soc. Amer. Proc. 11:317-327. 1947.

26. Van der Paauw, F. Relation between the potash requirements of crops and meteorological conditions. Plant and Soil. 9:254. 1958.

27. Wadleigh, C. H., and L. A. Richards. Soil moisture and the mineral nutrition of plants. In E. Truog, ed. "Mineral Nutrition of Plants." pp. 411-450. The University of Wisconsin Press, Madison, Wisconsin.

APPENDIX

Table A-1. General characteristics of the sites on which regional field experiments with corn were conducted.

Experiment	Year	Soil type	Location (county)	% Slope	Internal drainage	Remarks (Climatic conditions, etc.)
Ill. 1	1957	Cisne sil	Jasper	0-1	poor	wet early season, variable stand
Ill. 397	1958	Cisne sil	Richland	½-1½	poor	very wet season
Ind. 1	1957	Fincastle sil	Tippecanoe	1-2	slow	many missing plots
Ind. 2	1957	Fincastle sil	Clinton	1-2	slow	very wet at planting, poor stands
Ind. 3	1957	Elston 1	Tippecanoe	0-5	porous	poor stand, severe wind lodging in July
Ind. 4	1957	Fincastle sil	Tippecanoe	1-2	slow	—
Ind. 5	1958	Fincastle sil	Parke	0-2	fair	double normal rainfall, N deficient
Ind. 6	1958	Crosby fsl	Cass	1-3	good	double normal rainfall, N deficient
Ind. 7	1958	Miami 1	Fulton	0-2	good	double normal rainfall, N deficient
Ind. 8	1958	Sidell sil	Tippecanoe	2-4	good	double normal rainfall, N deficient
Iowa 17	1957	Floyd sil	Fayette	—	—	dry in early August
Iowa 18	1957	Carrington sil	Fayette	—	—	dry in early August
Iowa 19	1957	Fayette sil	Allamakee	—	—	very good conditions
Iowa 20	1957	Clyde sil	Bremer	—	—	—
Iowa 21	1957	Carrington sil	Bremer	—	—	severe drouth in August K deficiency symptoms early
Iowa 22	1957	Fayette sil	Dubuque	—	—	—
Iowa 23	1957	Weller sil	Lee	3	—	large "starter" response, very good season
Iowa 24	1957	Carrington sil	Fayette	—	—	discarded because of variable stand
Iowa 25	1957	Fayette sil	Allamakee	2	—	low moisture all summer
Iowa 26	1957	Fayette sil	Allamakee	—	—	low moisture all summer; nonuniform stand and growth
Iowa 27	1957	Clyde sil	Fayette	<1	—	dry at planting, variable stand, late maturity
Iowa 28	1957	Webster sil	Story	—	—	wet June, good season
Iowa 29	1957	Primghar sil	O'Brien	2	good	—
Kan. 1	1957	Bates sil	Cherokee	—	—	—
Kan. 3	1957	Summit sil	Johnson	—	—	—
Kan. 4	1957	Labette sil	Johnson	—	—	—
Kan. 5	1957	Summit sil	Johnson	—	—	—
Kan. 6	1957	Laurel fsl	Riley	—	—	—
Kan. 7	1957	Wabash sil	Riley	—	—	—
Kan. 8	1957	Cherokee sil	Cherokee	—	—	—
Kan. 1	1958	Summit sil	Leavenworth	—	—	—
Kan. 2	1958	Boone 1	Leavenworth	—	—	—
Kan. 3	1958	Parsons sil	Neosho	—	—	—
Kan. 4	1958	Cherokee sil	Cherokee	—	—	—
Kan. 5	1958	Geary sil	Riley	—	—	—
Kan. 6	1958	Sarpy sil	Riley	—	—	—
Kan. 7	1958	....	Jefferson	—	—	—
Mich. 1	1957	Fox 1	Kalamazoo	5	good	wet early season, uneven stand and growth
Mich. 2	1957	Oshtema s	Kalamazoo	5	excessive	wet early season, severe drouth at tasseling
Mich. 3	1957	Metea sl	Ingham	flat	mod. good	wet early season, uneven stand and growth
Mich. 4	1957	Houghton muck	Clinton	—	—	discarded because of severe zinc deficiency
Mich. 1	1958	Fox sl	Kalamazoo	slight	good	dry, cool early season; harvested early to permit ensilage
Mich. 2	1958	Kalamazoo sl	Kalamazoo	none	mod.	dry, cool early season; frost before fully mature.
Mich. 3	1958	Conover 1	Ingham	very slight	good	dry, cool early season; quackgrass spray retarded early growth; frost before mature.
Mich. 4	1958	Parkhill 1	Sanilac	none	tiled	dry, cool early season; immature when frosted.
Minn. 1	1957	Hubbard ls	Anoka	0-2	very rapid	—
Minn. 2	1957	Zimmerman fs	Sherburne	2-3	very rapid	—
Minn. 3	1957	Skyberg sil	Dodge	2-3	poor	—
Minn. 4	1957	Skyberg sil	Mower	2-3	poor	—
Minn. 1	1958	Floyd sil	Dodge	1-3	tiled	cool June & July
Minn. 2	1958	Organic	Wright	0-1	tiled	cool June & July; immature at harvest

Table A-2. Previous crop, fertilizer and planting information for regional field experiments with corn.

Experiment		Year	Previous crop	Basic fertilizer treatment (lbs. /A.) Broadcast N	Broadcast P_2O_5	Planter attachment N	Planter attachment P_2O_5	Method of[a] applying K fertilizer	Planting Date	Planting Method[b]	Hybrid
Ill.	1	1957	....	280	200	....	....	D.I.	6/11	3/40″	....
Ill.	397	1958	Small grain	100	110	....	....	Band	5/29	......	Pioneer 339
Ind.	1	1957	Soybeans	210	135	....	....	P.U.	6/3	......	Ind. 813
Ind.	2	1957	Clover-timothy	150	135	....	....	D.I.	6/3	......	Ind. 813
Ind.	3	1957	Corn	150	135	....	....	P.U.	5/30	......	Ind. 813
Ind.	4	1957	Wheat	150	135	....	....	P.U.	6/5	......	Ind. 813
Ind.	5	1958	Clover (hog pasture)	100	135	....	....	P.U.	5/15	......	....
Ind.	6	1958	Alfalfa	100	135	16	72	P.U.	5/23	1/8-9″	....
Ind.	7	1958	Dairy pasture	100	135	16	72	P.U.	5/23	1/6″	....
Ind.	8	1958	Clover	100	135	16	22	P.U.	5/19	2/12.7″	....
Iowa	17	1957	Alfalfa, Ladino	80	120	12	48	P.U.	5/24	4/40″	Pioneer 349
Iowa	18	1957	Alfalfa, Ladino	80	120	12	48	P.U.	5/24	4/40″	Pioneer 349
Iowa	19	1957	Alfalfa-brome	80	120	12	48	P.U.	5/24	3/19″	Pioneer 349
Iowa	20	1957	Alfalfa	80	120	12	48	P.U.	5/23	4/40″	Funks G-33A
Iowa	21	1957	Alfalfa	80	120	12	48	P.U.	5/9	4/40″	Pioneer 371
Iowa	22	1957	Alfalfa	80	120	12	48	P.U.	5/24	2/14.5″	....
Iowa	23	1958	Hay	80	120	8	32	P.U.	5/12	2/14.5″	Funks G 75A
Iowa	24	1958	....	80	120	8	32	P.U.	......	......	....
Iowa	25	1958	Pasture	80	120	8	32	P.U.	5/19	6/40″	Pioneer 371
Iowa	26	1958	Alfalfa	80	120	8	32	P.U.	5/13	6/40″	Pioneer 354
Iowa	27	1958	Pasture	80	120	8	32	P.U.	5/19	6/40″	Pioneer 349
Iowa	28	1958	Alfalfa	80	120	8	32	P.U.	5/20	......	....
Iowa	29	1958	Soybeans	48	60	....	....	P.U.	4/26	......	Pioneer 354
Kan.	1	1957	....	....	....	....	....	......	......	......	....
Kan.	3	1957	....	....	....	....	....	......	......	......	....
Kan.	4	1957	....	....	....	....	....	......	......	......	....
Kan.	5	1957	....	....	....	....	....	......	......	......	....
Kan.	6	1957	....	....	....	....	....	......	......	......	....
Kan.	7	1957	....	....	....	....	....	......	......	......	....
Kan.	8	1957	....	....	....	....	....	......	......	......	....
Kan.	1	1958	Corn	80	120	....	....	......	5/14	......	....
Kan.	2	1958	Sm. grain, Lespedeza	80	120	....	....	......	5/14	......	....
Kan.	3	1958	Corn	80	120	....	....	......	4/28	......	....
Kan.	4	1958	Corn	80	120	....	....	......	4/29	......	....
Kan.	5	1958	Wheat	80	120	....	....	......	5/8	......	....
Kan.	6	1958	Alfalfa	80	120	....	....	......	5/26	......	....
Kan.	7	1958	Sorghum	80	120	....	....	......	6/2	......	....
Mich.	1	1957	Pasture[c]	80	120	....	....	P.U.	5/9	......	Mich. 480
Mich.	2	1957	Pasture	80	120	....	....	P.U.	5/12	......	Mich. 480
Mich.	3	1957	Red clover (pasture)	80	120	....	....	D.I.	5/27	......	Mich. 480
Mich.	4	1957	....	....	....	....	....	......	......	......	....
Mich.	1	1958	Alfalfa	66	120	16	22	P.U.	5/10	......	Mich. 350
Mich.	2	1958	Silage corn	66	120	16	22	P.U.	5/16	......	Mich. 350
Mich.	3	1958	Alfalfa	66	125	16	22	P.U.	5/13	......	Mich. 350
Mich.	4	1958	Fallow	66	125	16	22	P.U.	5/16	......	Mich. 350
Minn.	1	1957	Alfalfa	80	120	16	20	BR.	5/30	2/20″	Pioneer 379A
Minn.	2	1957	Alfalfa-brome	80	120	16	20	P.U.	5/23	2/20″	Haapaln 300B
Minn.	3	1957	Alfalfa	80	120	16	20	BR.	5/11	2/20″	Pioneer 349
Minn.	4	1957	Alfalfa	80	120	16	20	P.U.	6/15	2/20″	Minhybrid 409
Minn.	1	1958	Alfalfa	80	120	16	20	BR.	5/17	2/20″	Northrup-King KB4
Minn.	2	1958	Corn	80	120	16	20	BR.	5/19	1/10″	Pioneer 390

[a] P.U. = plowed under; D.I. = Disked in; BR = Broadcast.
[b] Kernels dropped per hill/spacing of hills in row in inches. In some experiments the plants were then thinned to a uniform stand.
[c] 275 lbs. K_2O/A applied over previous 4 years.

Table A-3. Monthly precipitation at the experimental sites of some of the 1958 regional field experiments with corn.

Experiment		Inches of precipitation Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
Ind.	5	......	......	......	......	3.2	6.1	7.7	4.5	......	......
Ind.	6	......	......	......	......	1.5	10.4	5.0	3.9	......	......
Ind.	7	......	......	......	......	1.0	14.8	5.2	3.4	......	......
Ind.	8	......	......	......	......	1.0	8.9	9.6	5.2	2.4	......
Iowa	23	......	......	......	......	5.0	4.5	9.5	3.0	2.8	1.8
Iowa	25	......	......	......	......	1.5	2.3	2.2	2.9	2.9	0.1
Kan.	1	2.2	1.0	3.6	2.9	2.2	6.6	10.6	2.4	4.1	2.4
Kan.	2	2.2	1.0	3.6	2.9	2.2	6.6	10.6	2.4	4.1	2.4
Kan.	3	0.8	0.8	4.9	3.4	5.2	5.1	9.7	1.0	2.2	0.1
Kan.	4	0.9	1.0	5.0	3.3	5.1	3.9	13.0	1.0	5.9	0.1
Kan.	5	1.3	1.4	2.2	1.1	2.2	7.6	12.4	3.9	7.6	2.4
Kan.	6	......	......	......	1.1	2.3	4.9	13.4	4.4	7.1	1.5
Kan.	7	1.3	1.2	3.0	2.4	2.6	6.6	9.2	2.8	4.2	2.3
Mich.	1	......	......	......	......	1.4	6.3	3.3	4.3	2.4	1.8
Mich.	2	......	......	......	......	1.4	6.3	3.3	4.3	2.4	1.8
Mich.	3	......	......	......	......	0.4	3.3	4.3	3.2	2.3	......
Mich.	4	......	......	......	......	0.7	1.4	3.0	3.7	2.4	......
Minn.	1	......	......	......	......	......	5.6	3.1	1.2	1.5	1.3
Minn.	2	......	......	......	......	......	3.0	2.1	6.4	2.6	......

Table A-4. Chemical characteristics of the soils on which north central regional field experiments with corn were conducted.

Experiment		Year	Soil type	Sample depth (inches)	Laboratory analyses: Field moist: % H_2O	Field moist: Exch. K pp2m	Oven-dry: Exch. K pp2m	Soil tests (air-dry): K pp2m	Soil tests (air-dry): pH	Soil tests (air-dry): P pp2m
Ill.	1	1957	Cisne sil	0-6	7	73	96	77	5.4	14
				6-12	8	28	70	65	4.6	3
				12-18	8	14	58	69	4.7	1
				18-24	14	18	124	145	5.0	<1
				24-30	20	42	228	229	5.2	<1
				30-36	14	50	204	231	5.2	<1
Ill.	397	1958	Cisne sil	0-6	12	64	86	54	5.8	6
				6-12	15	44	71	51	4.8	2
				12-18	13	38	66	48	4.8	2
				18-24	14	42	82	78	5.0	1
				24-30	15	46	134	127	5.3	1
				30-36	18	51	168	153	5.2	1
Ind.	1	1957	Fincastle sil	0-6	20	126	134	99	5.4[a]	7
				6-12	14	96	139	108	5.2	4
				12-18	15	88	228	159	5.0	2
				18-24	15	90	270	191	4.9	1
				24-30	16	78	304	198	5.0	1
				30-36	14	80	254	171	5.2	1
Ind.	2	1957	Fincastle sil	0-6	17	104	125	100	5.5	2
				6-12	20	90	178	147	5.7	5[a]
				12-18	19	57	208[a]	217[a]	5.7	2
				18-24	14	56	356	217	6.2	<1
				24-30	13	46	280	205	6.7	<1
				30-36	17	42	292	197	7.0	1
Ind.	3	1957	Elston l	0-6	13	130	150	136	6.4	4
				6-12	11	92	136	135	5.9	4
				12-18	11	78	138	126	5.7	4
				18-24	10	72	139	132	5.6	4
				24-30	9	66	129	118	5.6	4
				30-36	14	84	122	112	5.6	6
Ind.	4	1957	Fincastle sil	0-6	17	112[a]	156[a]	116[a]	6.7[a]	4
				6-12	17	86	196	103	6.8	1
				12-18	17	64	236	139	6.4	1
				18-24	16	65	313	193	6.3[a]	1
				24-30	13	58	336	173	6.4[a]	1
				30-36	16	58[a]	284[a]	212[a]	6.8	1
Ind.	5	1958	Fincastle sil	0-6	23	121[b]	152[b]	66[b]	6.8	3
				6-12	17	79	166	97	6.4	1
				12-18	23	66	288	137	6.0	<1
				18-24	23	53	296	115	6.6	<1
				24-30	23	48	248	71	7.2	<1
				30-36	19	52	225	63	7.8	<1
Ind.	6	1958	Crosby fsl	0-6	9	128	110	110	6.2	40[a]
				6-12	9	39	41	32	5.8	39
				12-18	8	36	38	20	5.7	18
				18-24	8	28	32	20	5.6	8
				24-30	8	28	31	28	5.6	7
				30-36	6	29	31	26	5.6	4
Ind.	7	1958	Miami l	0-6	14	103	87	70	6.7	13
				6-12	11	47	50	38	5.8	11
				12-18	10	40	54	36	5.5	9
				18-24	13	38	86	52	5.4	8
				24-30	16	56	148	87	5.3	4
				30-36	13	52	138	75	6.4[a]	6
Ind.	8	1958	Sidell sil	0-6	28	170	213	128	5.0	2
				6-12	30	88	178	108	5.0	<1
				12-18	30	71	264	153	5.0	<1
				18-24	29	68	300	173	5.1	<1
				24-30	26	66	285	168	5.6	<1
				30-36	25	66	254	110	7.3	<1
Iowa	17	1957	Floyd sil	0-6	30	151[a]	185	133[a]	6.8	4
				6-12	26	73	169	85	6.6	3
				12-18	23	54	222	94	7.0	1
				18-24	15	30	220	50	7.2	<1
				24-30	11	20	208	52	7.6	<1
				30-36	10	20	203	45	8.0	<1
Iowa	18	1957	Carrington sil	0-6	24	146	166	138	5.6	2
				6-12	25	90	132	100	5.5	2
				12-18	25	56	142	96	5.4	2
				18-24	20	36	202	171	5.2	1
				24-30	15	32	257	160	5.6	<1
				30-36	12	31	255	90	6.0	<1
Iowa	19	1957	Fayette sil	0-6	25	160	232	170	6.7	6
				6-12	25	96	198	123	5.9	4
				12-18	24	84	214	164	5.4	2
				18-24	22	58	267	199	5.4	3
				24-30	20	48	302	229	5.4	8
				30-36	18	48	322	257	5.4	10
Iowa	20	1957	Clyde sil	0-6	29	100	279	161	7.1	4
				6-12	30	78	308	182	6.9	2
				12-18	24	74	340	206	7.2	1
				18-24	17	40	346	181	7.4	<1
				24-30	12	32	295	159	7.5	<1
				30-36	8	28	218	108	7.5	<1
Iowa	21	1957	Carrington sil	0-6	14	102	139	106	6.9	4
				6-12	17	68	132	98	6.0	3
				12-18	15	57	144	120	5.8	2
				18-24	12	42	154	126	5.8	1
				24-30	8	38	152	112	6.2	1
				30-36	7	35	156	106	6.7	1
Iowa	22	1957	Fayette sil	0-6	22	138	170	115	7.5	3
				6-12	22	68	168	93	6.9	3
				12-18	27	50	232	170	5.5	2
				18-24	22	44	278	208	5.2	4
				24-30	20	37	284	199	5.2	6
				30-36	17	44	304	225	5.4	10
Iowa	23	1958	Weller sil	0-6	25	78	112	55	6.0[a]	1
				6-12	22	38	114	84	5.0	<1
				12-18	21	42	208	178	5.0	1
				18-24	25	57	376	273	5.0	6
				24-30	27	56	380	274	5.1	10
				30-36	23	70	364	259	5.2	18
Iowa	24	1958	Carrington sil	0-6	18	153[a]	178	127	6.3	6
				6-12	21	75	120	82	5.4	1
				12-18	20	50	126	89	5.2	1
				18-24	17	38	146	110	5.2	<1
				24-30	14	30	174	130	5.2	<1
				30-36	9	33	172	141	5.4	<1
Iowa	25	1958	Fayette sil	0-6	30	244[a]	269[a]	141	6.3	5
				6-12	27	98	194	111	5.7	4
				12-18	25	70	232	125	5.4	2
				18-24	24	46	331	173	5.2	5
				24-30	23	42	366	192	5.2	16
				30-36	23	39	359	192	5.2	24
Iowa	26	1958	Fayette sil	0-6	23	79	163	74	6.3	3
				6-12	21	44	260	158	5.6	8
				12-18	24	46	348	202	5.2	14
				18-24	22	43	372	222	5.2	23
				24-30	22	50	366	197	5.4	30
				30-36	23	54	360	181	5.4	29
Iowa	27	1958	Clyde sil	0-6	34	158[a]	171[a]	107	6.2	5
				6-12	28	76	154	93	6.1	2
				12-18	18	51	196	65	6.3	2
				18-24	16	35	219	69	6.4	<1
				24-30	—	—	—	54	6.5	<1
				30-36	—	—	—	52	6.6	<1
Iowa	28	1958	Webster sicl	0-6	25	112	359	149	7.8	1
				6-12	22	64	348	123	8.0	1
				12-18	19	51	350	115	8.0	<1
				18-24	21	47	345	104	8.0	1
				24-30	16	47	312	105	8.0	<1
				30-36	18	37	298	89	8.0	<1
Iowa	29	1958	Primghar sil	0-6	29	348	456	276[a]	5.6	4
				6-12	32	167	399	221	5.8	1
				12-18	29	108	424	221	5.9	1
				18-24	26	92	446	214	6.1	1
				24-30	25	84	469	176	6.3	1
				30-36	26	74	478	176	6.8	1
Kan.	1	1957	Bates sil	0-6	19	91	100	89	6.9	2
				6-12	19	41	123	110	5.6	1
				12-18	22	51	247	184	6.0	<1
				18-24	19	54	210	194	6.3	<1
				24-30	14	32	164	121	6.6	<1
				30-36	15	32	158	105	6.6	<1
Kan.	3	1957	Summit sil	0-6	16	262	334	255	6.0	8
				6-12	19	84	264	188	5.4	4
				12-18	20	90	392	301	5.4	2
				18-24	22	112	606	381	5.8	2
				24-30	20	112	624	<400	6.6	1
				30-36	16	126	558	<400	7.2	1
Kan.	4	1957	Labette sil	0-6	16	935	910	<400	6.3[a]	16
				6-12	21	205	332	247	5.7	2
				12-18	22	156	418[a]	263[a]	5.6	1
				18-24	22	171	448[a]	330[a]	5.6	1
				24-30	22	165	557[a]	370	5.6	2
				30-36	22	144	568[a]	378	5.8	8

Table A-4 (continued)

Experiment		Year	Soil type	Sample depth (inches)	Laboratory analyses					
					Field moist		Oven-dry	Soil tests (air-dry)		
					% H_2O	Exch. K pp2m	Exch. K pp2m	K pp2m	pH	P pp2m
Kan.	5	1957	Summit sil	0-6	17	427	484	<400	6.5	2
				6-12	21	86	274	239	5.7	<1
				12-18	19	218	313	258	5.9	1
				18-24	20	134	323	277	5.8	1
				24-30	16	112	347	260	5.8	<1
				30-36	13	104	318	259	6.2	<1
Kan.	6	1957	Laurel fsl	0-6	2	455[a]	474[a]	<400	7.8	13
				6-12	3	344	373	338	7.4	11
				12-18	4	384[a]	415[a]	350[a]	7.5	10
				18-24	12	394[a]	476[a]	318[a]	7.5	2
				24-30	9	350[a]	445[a]	306[a]	7.6	3
				30-36	6	314[a]	374[a]	296[a]	7.6	3
Kan.	7	1957	Wabash sil	0-6	24	559[a]	795[a]	>400	6.2[a]	12
				6-12	27	420[a]	654[a]	>400	6.6[a]	10
				12-18	26	207[a]	558[a]	365	8.2	2
				18-24	24	184	528	372	5.6	8
				24-30	21	145	432	257	6.6[a]	3
				30-36	16	112	332	212[a]	7.4[a]	2
Kan.	8	1957	Cherokee	0-6	15	149	211	165	6.9	9
			sil	6-12	27	87	391[a]	333[a]	5.2	1
				12-18	28	100	432[a]	378	5.0	<1
				18-24	23	86	422[a]	372	5.0	<1
				24-30	20	88	377[a]	329	4.8	<1
				30-36	19	86	316[a]	252	4.7	<1
Kan.	1	1958	Summit sil	0-6	25	232	344	174	6.7	9
				6-12	24	104	366	216	5.6	2
				12-18	25	99	575	281	5.6	1
				18-24	27	102	616	280	5.9	<1
				24-30	25	94	563	235	6.2	<1
				30-36	24	90	492	253	6.3	<1
Kan.	2	1958	Boone 1	0-6	23	150[c]	243[c]	158[c]	5.7	6
				6-12	18	68	298	135	6.0	<1
				12-18	24	76	385	138	6.5	<1
				18-24	21	78	342	128	6.8	<1
				24-30	19	80	335	105	7.2	<1
				30-36	23	67	330	107	7.4	<1
Kan.	3	1958	Parsons	0-6	20	173	243	137	5.8	4
			sil	6-12	23	141	299	161	5.4	<1
				12-18	24	66	367	179	5.8	<1
				18-24	23	84	345	149	6.4	<1
				24-30	19	64	326	129	6.6	<1
				30-36	18	60	275	127	6.7	<1
Kan.	4	1958	Cherokee	0-6	16	136	190	122	5.9	3
			sil	6-12	16	82	186	115	5.4	<1
				12-18	21	70	290	176	5.0	<1
				18-24	23	73	412	226	4.9	<1
				24-30	20	78	418	184	4.9	<1
				30-36	19	81	410	176	4.6	<1
Kan.	5	1958	Geary sil	0-6	17	602	650	>400	5.3	15
				6-12	23	202	390	215	5.6	3
				12-18	25	173	383	217	5.5	2
				18-24	23	166	426	250	5.8	2
				24-30	23	190	492	272	5.9	2
				30-36	22	194	553	317	6.1	2
Kan.	6	1958	Sarpy sl	0-6	17	605	565	>400	7.9	31
				6-12	15	266	372	195	7.6	7
				12-18	12	198	308	167	7.6	2
				18-24	9	180	252	150	8.1	2
				24-30	7	173	240	158	8.4	1
				30-36	9	220	284	177	8.4	<1
Kan.	7	1958	?	0-6	16	232	363	197	6.2	7
				6-12	19	397	412	230	6.1	4
				12-18	21	134	392	212	6.1	1
				18-24	18	110	350	179	6.0	1
				24-30	16	99	338	165	6.0	<1
				30-36	17	100	372	179	6.4	<1
Mich.	1	1957	Fox 1	0-6	12	450[a]	304[a]	340[a]	6.5[a]	27
				6-12	10	152	166	176	6.1	23
				12-18	8	135	166	182	5.1	20
				18-24	10	137	184	172	4.9	22
				24-30	7	113	166	164	5.0	25
				30-36	5	94	139	140	5.2	26
Mich.	2	1957	Oshtema s	0-6	2	94[a]	78[a]	107[a]	7.1	23
				6-12	2	33	30	48	6.9	30
				12-18	1	24	25	38	6.9	18
				18-24	1	13	17	20	6.6	19
				24-30	1	13	16	20	6.8	13
				30-36	1	11	12	18	6.8	18
Mich.	3	1957	Metea sl	0-6	16	164	112	129	6.1[a]	16
				6-12	13	95	78	66	5.3	12
				12-18	11	61	70	50	5.4	10
				18-24	11	44	66	40	5.5	7
				24-30	12	60	93	48	5.4	4
				30-36	13	68	129	58	5.7	3
Mich.	4	1957	Houghton	0-6	94	574	554	249	7.0	10
			muck	6-12	152	645	584	278	6.8	5
				12-18	134	204	232	142	6.7	<1
				18-24	—	—	—	—	—	—
				24-30	—	—	—	—	—	—
				30-36	—	—	—	—	—	—
Mich.	1	1958	Fox sl	0-6	9	86	89	81	5.4	34
				6-12	9	44	66	49	6.0[a]	28
				12-18	8	56	54	89	5.5[a]	12
				18-24	7	48	105	81	5.8[a]	11
				24-30	6	28	86	72	5.8[a]	8
				30-36	6	32	78	60	5.5[a]	6
Mich.	2	1958	Kalamazoo	0-6	12	284[d]	222[d]	211[d]	6.2	36
			sl	6-12	18	160	221	150	5.9	19
				12-18	22	154	254	198	5.1	15
				18-24	14	85	134	107	5.2	15
				24-30	14	68	106	96	5.5	10
				30-36	11	48	71	69	5.6	8
Mich.	3	1958	Conover 1	0-6	12	80	84	56	6.6	4
				6-12	13	41	94	45	6.8	1
				12-18	12	46	192	70	7.3	<1
				18-24	12	35	119	53	8.0	<1
				24-30	12	39	94	48	8.2	<1
				30-36	10	36	77	39	8.3	<1
Mich.	4	1958	Parkhill 1	0-6	23	97	74	39	6.1	5
				6-12	23	46	66	36	6.6	3
				12-18	19	27	57	36	6.8	1
				18-24	19	28	67	34	7.0	<1
				24-30	19	27	66	25	7.2	<1
				30-36	20	30	61	26	7.7	<1
Minn.	1	1957	Hubbard	0-6	7	146	132	177	6.4[a]	16
			ls	6-12	6	60	74	78	6.3	10
				12-18	6	58	72	74	5.6	5
				18-24	6	54	67	66	5.7	8
				24-30	6	45	57	64	5.8	8
				30-36	6	44	72	64	5.8	6
Minn.	2	1957	Zimmerman	0-6	7	111	100	109	5.6	17
			fs	6-12	6	50	58	50	6.2	16
				12-18	5	50	54	46	5.6	12
				18-24	5	47	52	50	5.6	10
				24-30	5	40	43	39	5.8	9
				30-36	5	40	46	39	5.8	8
Minn.	3	1957	Skyberg sil	0-6	13	85	140	91	7.0	4
				6-12	14	47	160	100	6.2	2
				12-18	12	40	246	200	5.2	2
				18-24	10	42	246	214	5.0	4
				24-30	9	51	208	180	5.3	4
				30-36	7	57	190	157	5.4	4
Minn.	4	1957	Skyberg sil	0-6	19	133	178	127	6.6	8
				6-12	20	54	160	150	5.6	2
				12-18	18	52	218	191	5.6	2
				18-24	17	50	270[a]	263[a]	5.5	2
				24-30	12	36	268[a]	235[a]	5.6	4
				30-36	10	32	206[a]	215[a]	5.8	4
Minn.	1	1958	Floyd sil	0-6	31	119	199	99	6.8	7
				6-12	27	45	204	130	5.8	3
				12-18	27	52	244	127	5.7	3
				18-24	24	36	244	121	5.8	3
				24-30	20	34	246	148	6.0	4
				30-36	14	26	177	74	6.0	2
Minn.	2	1958	Organic	0-6	161	192	202	33	6.8	10
				6-12	170	168	152	30	6.8	7
				12-18	267	94	92	18	6.2	4
				18-24	223	111	122	29	6.2	3
				24-30	196	134	156	45	6.0	2
				30-36	176	140	170	52	6.0	1

[a] Variable between replicates.
[b] Omit replicate No. 6.
[c] Omit replicate No. 4.
[d] Omit replicate No. 1.

Table A-5. Yield and composition of corn plants from the north central regional field experiments.

Experiment	Year	Lbs. of K/A[a]	No. of plants per acre (thousands)	Plant samples: Early sampling, Whole plants, Dry wt. (lbs/A)	Early sampling, Whole plants, % K	Sampling at silking time, Whole plants, Dry wt. (lbs/A)	Sampling at silking time, Whole plants, % K	Sampling at silking time, Leaves[b], Dry wt. (gm)	Sampling at silking time, Leaves[b], % K	Late sampling, Whole plants, Dry wt. (lbs/A)	Late sampling, Whole plants, % K	Grain: Yield bu./A.	Grain: % H_2O	Grain: Shelling percent
Ill. 1	1957			July 29		Aug. 16				Nov. 6		Nov. 6		
		0	9.3	1,040	1.63	3,125	0.71	99	0.88	2,647[c]	0.48	57	....	82
		25	8.8	1,168	1.87	3,277	0.90	107	1.08	2,818	0.59	63	....	82
		50	8.8	1,138	2.07	4,601	0.87	116	1.30	3,042	0.62	74	....	83
		100	10.3	1,020	2.81	4,954	1.21	114	1.69	3,809	0.70	95	....	84
		200	10.3	1,288	3.88	4,321	1.79	112	2.18	4,215	1.10	91	....	83
Ill. 397	1958			July 15		Aug. 8				Oct. 24		Oct. 31		
		0	11.3	949	1.74	4,461	0.87	......	1.50	2,567[d]	0.60	75	17	79
		25	11.0	878	1.85	4,223	0.99	......	1.63	2,358	0.72	71	18	79
		50	12.2	1,174	2.10	5,026	1.10	......	1.98	2,639	0.75	82	18	80
		75	11.6	1,214	2.20	5,222	1.34	......	2.14	2,517	0.84	79	19	81
		100	11.5	1,097	2.43	4,671	1.38	......	2.20	2,505	1.06	83	17	81
		125	12.1	1,117	2.55	5,047	1.52	......	2.23	2,921	1.12	83	18	81
Ind. 1	1957					Aug. 8						Nov. 12		
		0	10.1			4,155	0.64	56	0.79			63	31	84
		25	9.1			3,693	0.64	56	0.83			72	....	....
		50	11.2			4,727	0.88	56	1.26			74	....	....
		75	11.0			4,493	0.98	56	1.41			67	....	....
		100	10.5			4,322	1.08	53	1.42			67	....	....
		125	9.6			3,908	1.18	54	1.51			76	30	85
Ind. 2	1957					Aug. 9						Oct. 10		
		0	10.9			3,924	0.85	51	1.04			74	38	86
		25	11.9			4,404	1.00	52	1.15			72	....	....
		50	11.6			4,693	1.01	50	1.31			77	....	....
		75	10.4			4,020	1.19	52	1.50			79	....	....
		100	12.5			4,930	1.24	45	1.60			74	....	....
		125	10.7			4,007	1.28	50	1.60			75	35	86
		F test	**			....	......	....	......			N.S.	....	....
Ind. 3	1957					Aug. 9						Oct. 3		
		0	8.8			4,976	1.10	55	1.61			91	26	85
		25	8.2			4,554	1.32	57	1.69			94	....	....
		50	8.4			4,653	1.39	58	1.83			95	....	....
		75	8.5			4,714	1.49	56	1.88			93	....	....
		100	8.7			5,026	1.53	56	1.97			96	....	....
		125	8.7			4,546	1.62	57	1.90			92	29	86
		F test	N.S.			....	......	....	......			N.S.	....	....
Ind. 4	1957					Aug. 4						Oct. 21		
		0	11.6			4,901	1.42	57	1.76			113	36	85
		25	11.4			5,148	1.51	57	1.85			113	....	....
		50	11.6			5,081	1.58	54	1.99			115	....	....
		75	13.3			5,175	1.77	56	1.98			120	....	....
		100	11.9			5,237	1.85	56	2.04			118	....	....
		125	11.5			5,124	2.02	54	2.13			116	36	87
		F test	N.S.			....	......	....	......			......	....	....
Ind. 5	1958					Aug. 11						Oct. 6		
		0	14.6			6,015	0.90	77	1.77			99	35	86
		25	15.0			5,948	0.99	80	1.86			99	....	....
		50	15.0			6,544	1.13	77	2.02			94	....	....
		75	15.1			6,120	1.09	81	2.20			99	....	....
		100	15.6			6,482	1.22	75	2.29			104	....	....
		125	15.0			6,331	1.34	78	2.34			99	36	87
		F test	N.S.			N.S.	......	N.S.	......			N.S.	....	....
Ind. 6	1958					Aug. 8						Oct. 28		
		0	14.7			5,253	1.38	82	2.10			90	22	84
		25	14.7			5,120	1.55	84	2.44			91	....	....
		50	15.2			5,200	1.59	84	2.54			92	....	....
		75	14.7			5,323	1.86	81	2.70			84	....	....
		100	14.8			5,047	1.93	84	2.81			93	....	....
		125	14.6			4,732	2.11	80	2.86			91	22	85
		F test	N.S.			N.S.	......	N.S.	......			N.S.	....	....
Ind. 7	1958					Aug. 12						Oct. 30		
		0	15.4			5,458	1.04	84	1.70			95	30	83
		25	14.6			5,828	1.34	87	2.19			104	....	....
		50	15.0			6,463	1.40	85	2.28			107	....	....
		75	15.0			6,459	1.51	83	2.49			107	....	....
		100	15.5			7,409	1.84	87	2.71			112	....	....
		125	15.5			6,411	1.72	84	2.74			110	30	84
		F test	N.S.			*	......	N.S.	......			*	....	....
Ind. 8	1958					Aug. 11						Oct. 22		
		0	14.3			6,079	1.74	99	2.18			127	30	83
		25	14.7			5,320	1.70	98	2.07			128	30	84
		50	14.4			5,463	1.94	95	2.28			128	31	84
		75	15.2			5,506	2.10	98	2.33			133	29	85
		100	15.3			5,760	2.22	99	2.42			139	32	86
		125	15.0			5,737	2.34	101	2.50			132	30	86
		F test	N.S.			N.S.	......	N.S.	......			N.S.	N.S.	N.S.

Table A-5 (continued)

Experiment		Year	Lbs. of K/A[a]	No. of plants per acre (thousands)	Plant samples: Early sampling, Whole plants, Dry wt. (lbs/A)	% K	Sampling at silking time, Whole plants, Dry wt. (lbs/A)	% K	Leaves[b] Dry wt. (gm)	%[a] K	Late sampling, Whole plants, Dry wt. (lbs/A)	% K	Grain: Yield bu./A.	% H_2O	Shelling pencent
Iowa	17	1957			July 10		July 22				Sept. 5		Nov. 9		
			0	13.9	2,067	2.01	3,853	1.82	90	1.40	10,710	0.79	97	49	84
			25	14.0	2,257	2.38	3,727	2.17	90	1.49	11,010	0.85	102	47	83
			50	14.1	2,257	2.26	3,847	2.00	90	1.61	11,447	0.83	106	45	84
			75	14.2	2,250	2.37	3,697	2.16	88	1.68	11,663	0.89	108	47	85
			100	13.8	2,337	2.58	3,740	2.38	92	1.83	11,557	0.97	103	50	83
			125	13.8	2,323	2.65	3,723	2.37	89	1.86	10,610	1.22	107	49	85
			F test........	N.S.	N.S.	......	N.S.	......	N.S.	......	N.S.	......	N.S.	N.S.	*
Iowa	18	1957			July 10		July 22				Sept. 5		Nov. 9		
			0	14.1	1,863	2.73	4,286	1.70	85	1.62	8,537	0.94	90	52	84
			25	13.8	1,660	2.79	4,290	1.86	87	1.68	9,350	1.01	88	55	84
			50	14.0	2,020	3.04	4,087	1.88	86	1.74	9,340	0.98	89	51	84
			75	13.9	1,850	3.16	4,263	2.00	84	1.77	9,100	0.99	89	54	85
			100	14.0	1,739	3.30	4,523	2.04	87	1.78	8,683	1.09	88	54	84
			125	13.7	1,727	3.39	4,287	2.14	84	1.90	9,347	1.08	91	55	84
			F test........	N.S.	N.S.	......	N.S.	......	N.S.	......	N.S.	......	N.S.	N.S.	N.S.
Iowa	19	1957			July 17		Aug. 1				Sept. 4		Oct. 12		
			0	14.4	1,032	2.97	5,877	1.76	86	1.69	11,323	0.93	111	58	85
			25	14.3	1,015	3.18	5,783	1.69	88	1.75	12,410	0.80	113	60	85
			50	14.2	1,043	3.22	5,387	1.80	88	1.80	12,070	0.92	114	59	84
			75	14.1	1,052	3.23	6,067	1.81	88	1.89	12,213	0.94	118	60	85
			100	14.3	1,060	3.41	6,267	1.96	88	1.96	12,180	1.02	116	63	86
			125	14.2	1,067	3.52	5,877	1.96	89	2.00	12,247	0.96	116	61	85
			F test........	N.S.	N.S.	......	N.S.	......	N.S.	......	N.S.	......	N.S.	N.S.	N.S.
Iowa	20	1957			July 15		July 31				Sept. 5		Nov. 11		
			0	14.1	833	2.44	3,910	1.32	92	1.10	8,103	0.75	59	36	81
			25	13.9	903	2.19	4,167	1.50	94	1.26	9,247	0.73	72	37	84
			50	13.5	917	2.64	4,050	1.56	92	1.49	8,590	0.76	72	38	84
			75	14.4	1,027	2.74	4,383	1.75	97	1.54	8,763	0.86	74	40	84
			100	14.4	1,027	2.84	4,107	1.75	92	1.66	8,890	0.91	74	39	84
			125	14.3	963	3.04	4,293	1.71	96	1.79	9,003	0.96	77	38	84
			F test........	*	....	......	....	......	....	......	....	......	**	N.S.	**
Iowa	21	1957			July 16		July 24				Aug. 27		Oct. 13		
			0	14.3	1,183	2.46	3,926	1.48	89	1.41	6,827	0.78	33	31	84
			25	14.1	1,330	2.58	4,190	1.74	93	1.67	6,655	0.80	35	29	86
			50	13.9	1,333	2.97	4,133	1.97	89	1.81	6,500	0.94	32	34	83
			75	14.2	1,323	3.36	4,270	2.23	93	2.03	6,543	1.04	33	33	85
			100	14.3	1,283	3.33	4,280	2.23	89	2.12	6,727	1.12	34	33	88
			125	14.3	1,583	3.46	4,443	2.38	90	2.31	6,437	1.19	36	31	86
			F test........	N.S.	....	......	....	......	....	......	....	......	N.S.	N.S.	*
Iowa	22	1957			July 20		Aug. 1				Aug. 27		Oct. 13		
			0	11.3	1,434	1.79	4,532	1.41	93	1.16	10,568	0.68	90	52	83
			25	11.6	1,550	2.23	5,181	1.48	91	1.33	11,219	0.69	103	57	84
			50	11.8	1,679	2.18	4,984	1.63	94	1.44	11,405	0.75	113	60	85
			75	11.8	1,579	2.26	4,878	1.54	92	1.44	11,960	0.76	108	59	82
			100	12.0	1,402	2.50	5,469	1.59	92	1.56	12,528	0.73	108	59	83
			125	10.9	1,389	2.34	4,991	1.70	92	1.58	11,009	0.73	107	58	83
			F test........	N.S.	N.S.	......	N.S.	......	N.S.	......	N.S.	......	**	N.S.	N.S.
Iowa	23	1958			July 10		July 23				Aug. 7		Oct. 9		
			0	12.3	2,209	1.18	4,720	1.01	109	1.23	6,648	0.92	100	29	84
			25	13.3	2,735	1.49	5,300	1.12	104	1.54	8,371	1.03	113	31	85
			50	13.4	3,063	1.68	4,880	1.38	105	1.64	8,289	1.17	119	30	85
			75	14.3	3,122	1.84	5,358	1.69	105	1.83	7,836	1.26	123	31	85
			100	14.0	3,060	2.03	5,721	1.81	105	1.92	8,758	1.35	128	30	85
			125	14.1	3,173	2.35	5,464	2.10	103	2.18	8,473	1.50	126	30	86
			F test........	**	**	......	....	......	....	......	....	......	**	N.S.	N.S.
Iowa	25	1958			July 15		Aug. 12				Aug. 25		Oct. 14		
			0	12.1	439	5.11	4,116	2.17	96	2.30	5,671	1.65	75	43	81
			25	12.7	449	4.68	4,386	2.19	98	2.46	5,908	1.68	72	45	80
			50	12.1	394	4.82	4,096	2.48	93	2.56	5,949	1.83	72	44	80
			75	12.7	476	4.82	4,578	2.51	94	2.65	6,248	1.96	75	42	78
			100	12.4	462	5.11	4,079	2.54	98	2.63	6,023	2.00	75	42	80
			125	12.2	433	5.14	4,112	2.68	96	2.72	5,905	2.05	75	42	80
			F test........	N.S.	N.S.	......	N.S.	......	N.S.	......	N.S.	......	N.S.	N.S.	N.S.
Iowa	26	1958			July 15		Aug. 12				Aug. 26		Oct. 14		
			0	11.9	926	2.08	4,459	1.20	89	1.38	6,480	1.00	77	33	85
			25	13.1	1,100	2.60	5,337	1.25	95	1.74	6,709	1.10	90	31	85
			50	12.4	1,041	2.62	5,914	1.49	86	1.86	6,742	1.23	82	32	85
			75	13.1	1,030	3.03	5,255	1.70	89	2.01	6,550	1.38	85	32	84
			100	13.7	1,324	3.38	6,035	1.88	92	2.17	6,889	1.54	88	29	84
			125	13.2	1,194	4.03	5,819	2.00	89	2.23	6,721	1.67	86	33	84
			F test........	N.S.	N.S.	......	*	......	N.S.	......	N.S.	......	N.S.	N.S.	N.S.
Iowa	27	1958			July 16		Aug. 13				Aug. 26		Oct. 15		
			0	12.8	606	3.51	4,896	1.41	103	1.49	6,239	1.27	76	41	78
			25	13.1	612	3.38	4,581	1.53	104	1.63	6,150	1.11	79	40	80
			50	13.5	718	3.90	5,019	1.90	104	1.92	6,880	1.45	90	38	80
			75	14.2	756	4.75	5,333	1.99	108	2.08	7,672	1.56	88	38	78
			100	13.8	770	4.26	5,214	2.27	103	2.25	6,892	1.72	86	39	79
			125	13.2	694	4.85	5,129	2.21	110	2.20	6,929	1.63	87	38	79
			F test........	N.S.	N.S.	......	N.S.	......	N.S.	......	N.S.	......	**	N.S.	N.S.

Table A-5 (continued)

Experiment		Year	Lbs. of K/A[a]	No. of plants per acre (thousands)	Plant samples: Early sampling, Whole plants, Dry wt. (lbs/A)	Early sampling, Whole plants, % K	Sampling at silking time, Whole plants, Dry wt. (lbs/A)	Silking, Whole plants, % K	Silking, Leaves[b], Dry wt. (gm)	Silking, Leaves[b], % K	Late sampling, Whole plants, Dry wt. (lbs/A)	Late sampling, Whole plants, % K	Grain: Yield bu./A.	Grain: % H_2O	Grain: Shelling pencent
Iowa	28	1958			July 21		Aug. 1				Aug. 14		Sept. 30		
			0	14.2	2,673	2.10	5,565	1.78	119	1.70	8,967	1.06	94	37	80
			25	13.9	2,870	2.41	5,284	2.00	117	1.80	9,192	1.03	94	38	82
			50	15.1	3,233	2.78	5,414	2.29	116	2.02	8,930	1.17	103	38	82
			75	14.9	3,099	2.56	5,292	2.17	116	2.07	8,628	1.24	100	38	83
			100	14.4	2,902	2.94	5,749	2.31	116	2.14	9,261	1.25	98	39	83
			125	15.9	3,228	3.25	5,998	2.56	117	2.17	9,833	1.44	109	39	83
			F test........	N.S.	N.S.	......	N.S.	......	N.S.	......	N.S.	......	*	N.S.	N.S.
Iowa	29	1958					Aug. 5						Oct. 9		
			0	12.8			5,465	1.90	114	2.11			82	21	....
			25	12.8			5,252	1.97	114	2.21			87	21	....
			50	12.8			4,520	2.16	114	2.24			83	21	....
			75	12.8			4,907	2.20	118	2.31			83	21	....
			100	12.8			4,783	2.18	119	2.38			81	22	....
			125	12.8			5,366	2.28	120	2.32			80	22	....
Kan.	1	1958					July 28								
			0	......			....	2.06		2.52					
			25	......			....	2.36		2.62					
			50	......			....	2.40		2.79					
			75	......			....	2.29		2.70	Not harvested				
			100	......			....	2.38		2.85					
			125	......			....	2.48		2.79					
Kan.	2	1958					July 28						Oct. 2		
			0	5.2			2,571	2.23	135	2.26			46	22	84
			25	6.1			3,185	2.34	131	2.58			50	24	84
			50	5.9			2,909	2.30	138	2.44			52	24	85
			75	6.1			2,929	2.34	137	2.62			55	22	85
			100	6.2			2,915	2.40	138	2.69			50	23	84
			125	7.0			3,652	2.48	140	2.74			57	24	84
			F test........	......			....	......	....	......			N.S.	....	....
Kan.	3	1958					July 24						Oct. 30		
			0	14.8			6,218	1.52	101	1.93			98	7	86
			25	14.8			5,333	1.71	101	2.01			97	8	85
			50	14.6			5,850	1.68	103	2.03			102	8	85
			75	14.8			5,880	1.76	106	2.16			100	8	85
			100	14.7			5,625	1.71	101	2.12			106	8	85
			125	14.4			5,417	1.84	98	2.20			101	8	85
			F test........	......			....	......	....	......			N.S.	....	....
Kan.	4	1958					July 24						Oct. 30		
			0	15.2			6,969	1.22	115	1.79			108	9	87
			25	15.1			6,469	1.26	115	1.94			106	9	86
			50	15.2			7,849	1.20	113	1.96			110	9	87
			75	15.3			6,679	1.62	114	2.06			109	9	86
			100	16.1			7,983	1.56	105	2.12			112	9	85
			125	15.3			7,376	1.65	116	2.17			108	9	86
			F test........	......			....	......	....	......			N.S.	....	....
Kan.	5	1958					July 23						Oct. 8		
			0	10.9			6,135	2.34	126	2.58			87	22	85
			25	11.8			6,028	2.38	130	2.50			91	21	85
			50	10.6			5,880	2.26	126	2.52			90	20	84
			75	11.4			6,108	2.50	128	2.46			94	20	85
			100	11.2			5,690	2.40	127	2.56			82	22	85
			125	10.9			5,812	2.41	129	2.41			88	21	84
			F test........	......			....	......	....	......			N.S.	....	....
Kan.	6	1958					July 23						Oct. 9		
			0	18.0			7,181	2.97	112	3.02			103	7	86
			25	18.1			6,944	2.88	110	3.00			99	8	85
			50	17.6			6,623	2.96	118	3.01			101	8	85
			75	18.1			6,743	3.05	117	3.01			95	8	85
			100	17.4			6,767	2.97	111	2.94			102	8	85
			125	17.0			5,444	2.85	113	3.02			99	8	85
			F test........	......			....	......	....	......			N.S.	....	....
Kan.	7	1958					Aug. 4						Oct. 20		
			0	16.4			5,083	2.80	109	3.05			80	12	82
			25	16.7			5,266	2.90	103	3.00			90	11	82
			50	16.4			4,707	2.86	102	3.17			84	12	82
			75	17.6			5,516	2.96	108	3.04			93	12	82
			100	16.4			5,164	2.92	106	3.10			83	12	82
			125	16.8			5,048	3.07	100	3.08			90	12	82
			F test........	......			....	......	....	......			**	....	....
Mich.	1	1957			July 23		Aug. 8				Oct. 8		Oct. 8		
			0	13.2	2,953	4.76	6,247	3.32	130	3.14	19,240	1.31	73	32	80
			25	13.3	2,832	4.63	6,305	3.49	126	3.29	18,100	1.35	60	35	76
			50	13.0	3,069	4.76	6,666	3.33	127	3.40	20,560	1.25	74	38	80
			75	13.3	2,953	5.11	6,788	3.21	125	3.34	18,700	1.40	67	34	79
			100	12.7	2,695	4.83	5,741	3.46	126	3.39	19,060	1.39	77	36	81
			125	13.5	2,655	5.17	6,342	3.41	123	3.47	21,820	1.42	66	33	76
			F test........	N.S.	N.S.	......	N.S.	......	N.S.	......	N.S.	......	N.S.	N.S.	N.S.

Table A-5 (continued)

Experiment		Year	Lbs. of K/A[a]	No. of plants per acre (thousands)	Plant samples: Early sampling, Whole plants, Dry wt. (lbs/A)	Early sampling, Whole plants, % K	Sampling at silking time, Whole plants, Dry wt. (lbs/A)	Silking, Whole plants, % K	Silking, Leaves[b], Dry wt. (gm)	Silking, Leaves[b], % K	Late sampling, Whole plants, Dry wt. (lbs/A)	Late sampling, Whole plants, % K	Grain: Yield bu./A.	Grain: % H_2O	Grain: Shelling pencent
Mich.	2	1957			July 23		Aug. 7				Oct. 8		Oct. 9		
			0	9.8	2,935	3.24	4,428	2.06	117	2.68	11,000	1.41	33	36	75
			25	9.7	2,933	3.46	4,364	2.23	111	2.83	10,720	1.46	31	37	74
			50	10.0	3,275	3.41	4,505	2.78	111	2.96	10,200	1.41	28	37	74
			75	10.2	3,080	3.65	4,391	2.83	111	3.13	9,920	1.41	36	35	77
			100	9.9	3,531	3.79	4,536	2.83	114	3.30	8,500	1.45	30	33	76
			125	9.4	3,306	3.57	4,732	2.85	115	3.33	9,600	1.34	28	35	75
			F test	N.S.	N.S.	......	N.S.	......	N.S.	......	N.S.	......	**	N.S.	N.S.
Mich.	3	1957			July 26		Aug. 15				Oct. 11		Oct. 11		
			0	14.9	2,546	3.55	6,833	1.86	108	2.80	8,880	0.84	64	37	80
			25	15.0	2,410	3.70	6,274	1.87	107	2.95	9,300	0.92	80	32	80
			50	14.9	2,812	4.09	6,447	1.98	110	3.05	8,820	0.99	72	34	79
			75	12.9	2,709	4.23	6,589	1.92	107	3.13	8,800	1.00	64	35	79
			100	12.9	2,044	4.38	5,940	2.12	109	3.18	8,800	1.08	62	37	76
			125	14.9	2,148	4.49	6,622	2.14	108	3.20	9,240	0.92	78	35	80
			F test	N.S.	*	......	N.S.	......	N.S.	......	N.S.	......	N.S.	N.S.	N.S.
Mich.	1	1958					Aug. 12						Sept. 17		
			0	9.6			6,040	1.06	111	1.36			52	47	80
			25	10.7			6,340	1.16	107	1.64			66	47	82
			50	10.7			6,840	1.08	110	1.64			58	46	82
			75	10.7			6,740	1.19	113	1.67			66	46	81
			100	10.4			6,860	1.19	105	1.76			59	48	81
			125	11.5			6,920	1.29	111	1.97			62	46	81
			F test	N.S.			N.S.	......	N.S.	......			N.S.	N.S.	N.S.
Mich.	2	1958					Aug. 15						Oct. 8		
			0	14.2			6,980	2.00	81	2.92			87	39	84
			25	13.2			6,920	2.12	74	2.92			82	37	83
			50	14.4			6,760	2.21	74	2.94			86	39	83
			75	13.5			7,500	2.18	75	3.00			84	37	83
			100	13.4			7,100	2.26	77	3.02			80	38	83
			125	13.9			7,280	2.17	77	3.02			88	37	84
			F test	N.S.			N.S.	......	N.S.	......			N.S.	N.S.	N.S.
Mich.	3	1958			Aug. 1		Aug. 29						Oct. 30		
			0	13.1	1,774	1.74	6,700	0.89	92	0.96			68	31	82
			25	13.4	1,996	1.91	6,820	0.91	94	1.12			74	30	82
			50	13.3	2,076	2.36	7,380	1.03	88	1.38			83	29	83
			75	14.2	2,296	2.60	7,520	1.10	87	1.51			85	31	83
			100	13.4	2,054	2.66	7,160	1.14	88	1.66			82	30	83
			125	13.4	1,844	2.80	6,680	1.26	87	1.81			79	29	82
			F test	**	**	......	N.S.	......	N.S.	......			**	N.S.	N.S.
Mich.	4	1958			July 31		Aug. 22						Oct. 22		
			0	14.6	3,060	1.86	5,220	1.10	79	1.75			76	37	82
			25	14.7	2,960	1.89	5,740	1.15	78	1.93			73	39	82
			50	14.9	2,960	2.27	5,600	1.17	96	1.92			70	39	82
			75	15.0	3,120	2.34	5,140	1.32	80	2.00			75	38	82
			100	15.1	3,060	2.32	5,660	1.35	88	2.19			74	37	80
			125	15.1	3,360	2.49	6,060	1.28	82	2.23			72	36	80
			F test	N.S.	N.S.	......	*	......	N.S.	......			N.S.	N.S.	N.S.
Minn.	1	1957					Aug. 12						Nov. 5		
			0	16			3,848	1.98	73	2.24			99	20	80
			25	15			4,071	2.04	72	2.29			100	20	80
			50	15			4,094	2.19	71	2.42			101	20	80
			75	15			3,832	2.18	71	2.40			94	20	80
			100	15			3,911	2.39	74	2.58			96	20	80
			125	15			3,865	2.40	76	2.56			102	20	82
			F test	N.S.			N.S.	......	N.S.	......			*	N.S.	**
Minn.	2	1957					Aug. 14						Nov. 2		
			0	16			....	1.06	47	1.41			62	23	84
			25	16			....	1.17	50	1.63			64	23	84
			50	16			....	1.14	48	1.56			55	25	85
			75	16			....	1.24	49	1.78			59	23	85
			100	16			....	1.28	50	1.84			63	24	85
			125	16			....	1.34	48	1.91			51	23	86
			F test	N.S.			....	......	**	......			*	N.S.	*
Minn.	3	1957					Aug. 3				Oct. 13		Oct. 13		
			0	16			3,659	1.46	97	1.00	12,600	0.55	93	38	78
			25	16			3,927	1.57	99	1.16	13,000	0.53	104	36	79
			50	16			4,871	1.90	100	1.42	13,000	0.61	111	36	80
			75	16			4,139	2.20	99	1.44	13,000	0.60	112	36	80
			100	17			4,067	2.40	98	1.58	13,000	0.71	117	36	81
			125	16			4,041	2.82	100	1.86	13,000	0.86	120	35	81
			F test	N.S.			*	......	N.S.	......	N.S.	......	**	N.S.	*
Minn.	4	1957					Sept. 6				Oct. 12		Oct. 12		
			0	16			6,997	0.69	78	0.89	9,600	0.53	72	51	82
			25	16			7,912	0.82	81	1.18	9,820	0.59	78	49	82
			50	16			7,520	0.80	84	1.23	9,160	0.62	83	49	82
			75	16			7,853	1.02	81	1.45	9,710	0.70	80	50	81
			100	16			7,537	1.01	81	1.57	10,180	0.79	85	49	82
			125	16			7,819	1.15	78	1.62	9,770	0.81	86	48	82
			F test	N.S.			N.S.	......	N.S.	......	N.S.	......	N.S.	N.S.	N.S.

IOWA STATE TRAVELING LIBRARY
DES MOINES, IOWA

Table A-5 (continued)

Experiment		Year	Lbs. of K/A[a]	No. of plants per acre (thousands)	Plant samples: Early sampling, Whole plants, Dry wt. (lbs/A)	Early sampling, Whole plants, % K	Sampling at silking time, Whole plants, Dry wt. (lbs/A)	Sampling at silking time, Whole plants, % K	Sampling at silking time, Leaves[b], Dry wt. (gm)	Sampling at silking time, Leaves[b], % K	Late sampling, Whole plants, Dry wt. (lbs/A)	Late sampling, Whole plants, % K	Grain: Yield bu./A.	Grain: % H_2O	Grain: Shelling pencent
Minn.	1	1958					Aug. 18						Oct. 25		
			0	16			3,300	0.71	73	0.60			49	50	85
			25	16			5,100	0.74	83	0.76			72	40	82
			50	16			5,900	1.00	84	0.90			77	38	80
			75	16			5,700	0.94	88	0.98			90	36	83
			100	16			5,900	1.12	91	1.35			96	34	83
			125	16			6,600	1.50	92	1.39			101	33	83
			F test........	......			**	......	**	......			**	**	N.S.
Minn.	2	1958					Aug. 22						Oct. 14		
			0	15.0			3,600	0.76	88	0.63			39	60	66
			25	15.9			4,300	1.25	88	1.10			56	55	71
			50	16.5			4,200	1.42	87	1.43			56	56	71
			75	16.5			4,200	1.72	84	1.66			57	56	71
			100	16.3			4,100	1.82	87	1.98			57	57	73
			125	16.4			4,400	2.08	84	2.24			54	58	70
			F test........	N.S.			N.S.	......	N.S.	......			*	N.S.	N.S.

N.S. Not significant at the 5-percent level.
* Significant at the 5-percent level.
** Significant at the 1-percent level.
[a] 0, 25, 50, 75, 100 and 125 pounds of K per acre correspond to 0, 30, 60, 90, 120 and 150 pounds of K_2O per acre.
[b] Leaves from opposite and just below the major ear of 20 normal plants.
[c] Stover only.
[d] Yield corrected for stand by covariance.

Table A-6. Pounds per acre of K in corn plants at different times in the growing season as influenced by K fertilizer applications.

Experiment		Year	Sampling date	Percent H_2O in plants	Pounds of K/acre taken up by corn plants — Pounds K applied/acre: 0	25	50	75	100	125
Ill.	1	1957	7/29	....	17	22	24	....	29	....
			8/16	....	22	30	40	....	60	....
Ill.	397	1958	7/15	....	17	16	25	27	27	28
			8/8	....	39	42	55	70	64	77
Ind.	1	1957	8/8	....	27	24	42	44	47	46
Ind.	2	1957	8/9	....	33	44	47	48	61	51
Ind.	3	1957	8/9	....	55	60	65	70	77	74
Ind.	4	1957	8/4	....	70	78	80	92	97	104
Ind.	5	1958	8/7	....	54	59	74	67	79	85
Ind.	6	1958	8/8	....	72	79	83	99	99	100
Ind.	7	1958	8/12	....	57	78	90	98	136	110
Ind.	8	1958	8/11	....	106	90	106	116	128	134
Iowa	17	1957	7/10	89	42	54	51	53	60	62
			7/22	87	70	81	77	80	89	88
			9/5	73	85	94	95	104	112	129
Iowa	18	1957	7/10	88	51	46	61	59	57	59
			7/22	84	73	78	77	85	92	92
			9/5	75	80	94	92	90	95	101
Iowa	19	1957	7/17	90	31	32	34	35	36	38
			8/1	84	104	98	97	110	123	115
			9/4	72	105	99	111	115	124	118
Iowa	20	1957	7/15	89	20	20	24	28	29	29
			7/31	86	52	62	63	77	72	73
			9/5	73	61	68	65	75	81	86
Iowa	21	1957	7/16	88	29	34	40	44	43	55
			7/24	83	58	73	81	95	95	106
			8/27	65	53	53	61	68	75	77
Iowa	22	1957	7/20	90	26	35	37	36	35	32
			8/1	86	64	77	81	75	87	85
			8/27	73	72	77	86	91	91	80
Iowa	23	1958	7/10	88	26	41	51	57	62	75
			7/23	85	48	59	67	91	104	115
			8/7	83	61	86	97	99	118	127
Iowa	25	1958	7/15	89	22	21	19	23	24	22
			8/12	85	89	96	102	115	104	110
			8/25	83	94	99	109	122	121	121
Iowa	26	1958	7/15	90	19	29	27	31	45	48
			8/12	84	53	67	88	89	113	116
			8/26	81	65	74	83	90	106	112
Iowa	27	1958	7/16	85	21	21	28	36	33	34
			8/13	87	69	70	95	106	118	113
			8/26	85	79	68	100	120	119	113
Iowa	28	1958	7/21	89	56	69	90	79	85	105
			8/1	87	99	106	124	115	133	154
			8/14	83	95	95	104	107	116	142
Iowa	29	1958	8/5	....	104	103	98	108	104	122
Kan.	2	1958	7/28	80	57	75	67	69	70	91
Kan.	3	1958	7/24	80	95	91	98	103	96	100
Kan.	4	1958	7/24	81	85	82	94	108	125	122
Kan.	5	1958	7/23	79	144	143	133	153	137	140
Kan.	6	1958	7/23	85	213	200	196	206	201	155
Kan.	7	1958	8/4	85	142	153	135	163	151	155
Mich.	1	1957	7/23	86	141	131	146	151	130	137
			8/8	77	207	220	222	218	199	182
			10/8	75	252	244	257	262	265	310
Mich.	2	1957	7/23	81	95	101	112	112	134	118
			8/7	75	91	97	125	124	128	135
			10/8	59	155	156	144	140	123	129
Mich.	3	1957	7/26	86	90	89	115	115	90	96
			8/15	76	127	117	128	126	126	142
			10/11	46	75	86	87	88	95	85
Mich.	1	1958	8/12	76	64	74	74	80	82	89
Mich.	2	1958	8/15	78	140	147	149	164	160	158
Mich.	3	1958	8/1	90	31	38	49	60	55	52
			8/29	79	60	62	76	83	82	84
Mich.	4	1958	7/31	84	57	56	67	73	71	87
			8/22	81	57	66	66	68	76	78
Minn.	1	1957	8/12	84	76	83	90	84	93	93
Minn.	2	1957	8/14	....	....	....	....	....	....	....
Minn.	3	1957	8/3	88	53	62	92	91	98	114
			10/13	45	69	69	79	80	92	112
Minn.	4	1957	9/6	82	48	65	60	80	76	90
			10/12	66	51	58	57	68	80	79
Minn.	1	1958	8/18	83	23	38	59	54	66	99
Minn.	2	1958	8/22	86	27	54	60	72	75	91

Table A-7. Multiple regression equations relating the K content and the yield of corn to the percent K in the corn leaves at silking time, the amount of K fertilizer applied, and other variables based on data from 31 field experiments.[a]

Equation No.	a	CK%K	$CK\%K^2$	K_F x10^3	K_F^2 x10^6	K_F(CK%K) x10^3	△ %K	(CK%K) (△ %K)	S x10^3	L x10^2	SL x10^2	K_FS x10^2	CK Y	R^2
				Partial regression coefficients (b_i)										
				%K in corn leaves at silking time (%K)										
1	0.19	+0.85		+6.3	—16				+4.5	—0.01				0.92**
		0.02		0.9	7				4.7	0.05				
2	0.01	+1.00		+10.0	—15	—2.4								0.93**
		0.03		1.1	7	0.5								
3	—0.04	+1.07	—0.022	+10.0	—15	—2.4								0.93**
		0.10	0.029	1.1	7	0.5								
				Increase in %K in corn leaves from K fertilizer applications (△%K)										
1a	0.19	+0.15		+6.3	—16	—16			+4.5	—0.01				0.66**
		0.02		0.9	7				4.7	0.05				
2a	—0.04	+0.07	—0.022	+10.0	—15	—2.4								0.70**
		0.10	0.029	1.1	7	0.5								
3a	0.01	—0.00		+10.0	—15	—2.4								0.70**
		0.03		1.1	7	0.5								
				Pounds of K per acre in corn plants at silking time (Kp)										
1b	78.6	+3.8	+10.8	+128	—311	—93			—5,808	—76.2	+8.2	+2.3		0.75**
		10.6	3.1	172	654	45			1,851	20.2	1.7	1.0		
2b	89.2	+10.5	+10.6				+71	—18	—7,624	—11.1	+11.0			0.75**
		13.0	3.5				14	9	1,806	2.1	2.0			
				Yield of corn grain, bushels per acre (Y)										
1c	83.7	+58	—13	+168	—708	—95			—4,103	—97	+7.5	+1.0		0.45**
		11	3	181	686	48			1,942	21	1.8	1.1		
2c	58.7	+78	—19				+53	—31	—3,271	—93	+7.1			0.46**
		13	4				14	10	1,862	22	1.8			
3c	27.1	+8.2					+17	—8	+3,901	—3.2				0.27**
		3.5					15	10	526	5.5				
				Increase in yield of corn grain from K fertilizer applications (△Y)										
1d	—5.0	—24	+6	+247	—773	—104			+1,533	+29	—1.7	+0.6		0.61**
		5	1	75	283	20			801	9	0.7	0.4		
2d	—4.6	—18	+4				+40	—16	+1,089	+21	—0.9			0.64**
		5	1				6	4	752	9	0.7			
3d	—4.5	—2.5					+47	—22	+162	+87			—0.4	0.61**
		1.3					6	4	219	20			2.9	

[a] The equations have the general form. $\hat{Y} = a + \Sigma b_i x_i$. The standard error associated with each partial regression coefficient is shown below the partial regression coefficient.

** Significant at the 1-percent level.

Table A-8. Multiple regression equations relating the K content and the grain yield of corn to exchangeable K in the field-moist soil, the amount of K fertilizer applied, and other variables, based on data from 31 field experiments.[a]

Equation No.	a	K_{S1} x10^3	K_{S1}^2 x10^6	K_{S2} x10^3	$K_{S1}K_{S2}$ x10^5	K_{S3} x10^3	K_{S4} x10^3	K_{S5} x10^3	K_{S6} x10^3	K_{S3-6} x10^3	$K_{S1}K_{S3-6}$ x10^5	$K_{S2}K_{S3-6}$ x10^5	K_F x10^3	K_F^2 x10^6	$K_{S1}K_F$ x10^5	T x10^2	$K_{S1}T$ x10^4	S x10^3	CK Y x10^2	R^2
		Partial regression coefficients (b_i)																		
%K in corn leaves at silking time (%K)																				
1	0.47	+19.9	−22.02	+2.6		−6.1	−14.8	+25.2	−4.4				+9.3	−14.6	−2.2	−12.2	−11.8	+6.6		0.69**
		3.4	4.5	1.9		2.6	4.3	5.1	3.8				2.2	14.1	0.9	9.0	6.0	10.4		
2	0.52	+20.3	−21.9	+2.7		−6.4	−14.8	+25.2	−4.7				+9.4	−14.9	−2.2	−11.1	−12.5			0.69**
		3.4	4.5	1.9		2.6	4.2	5.0	3.7				2.2	14.0	0.9	8.8	5.9			
3	0.52	+15.1	−80.6	−8.9	+20.7					+37.1	−1.2	−42.3	+9.0	−15.4	−2.0	−26.7	+3.2			0.62**
		3.5	19.1	7.2	5.4					10.4	7.6	11.4	2.4	15.5	1.0	3.9	1.7			
4	0.28	+21.4	−12.6	+0.5		−6.0							+9.3	−15.1	−2.1	+5.7	−20.6			0.59**
		3.4	4.9	1.9		2.3							2.5	15.9	1.0	8.7	5.9			
5	0.49	+18.0	−13.5	−2.7									+9.2	−15.2	−2.1	−1.2	−13.3			0.57**
		3.2	4.9	1.5									2.5	16.2	1.0	8.4	5.3			
6	1.11	+13.2	−17.3	−4.6						+5.5			+9.1	−15.3	−2.0	−21.0	+0.7			0.58**
		2.3	5.1	1.8						2.4			2.5	16.2	1.0	3.7	1.6			
7	0.69	+15.4	−12.6										+9.2	−15.2	−2.1	−5.8	−11.1			0.56**
		2.9	4.9										2.5	16.3	1.0	8.1	5.1			
8	0.38	+10.8	−13.4										+9.2	−15.2	−2.1					0.42**
		2.3	5.6										2.9	18.6	1.2					
9	0.41	+10.8	−13.4										+7.3		−2.1					0.42**
		2.3	5.6										1.7		1.1					
Increase in %K in corn leaves from K fertilizer applications (△%K)																				
1a	0.26	−2.5	+6.2	−2.7		+0.4	−1.7	+4.7	−2.5				+9.1	−15.2	−2.0	−1.5	+2.2	+2.4		0.78**
		1.4	1.9	0.8		1.1	1.8	2.1	1.6				0.9	5.8	0.4	3.7	2.5	4.3		
2a	0.24	−1.5	+6.3	−2.3		−0.5	−1.5	+4.6	−2.4				+9.1	−15.2	−2.0					0.78**
		0.8	1.8	0.7		0.8	1.6	1.9	1.5				0.9	5.8	0.4					
3a	0.13	+1.1	+15.3	−10.1	+1.2					+8.3	−11.6	+10.8	+9.1	−15.3	−2.0					0.79**
		1.2	6.3	2.6	1.9					3.6	2.7	3.9	0.9	5.6	0.3					
4a	0.28	−1.7	+7.2	−2.5		−0.2							+9.1	−15.3	−2.0					0.77**
		0.8	1.8	0.6		0.7							0.9	5.9	0.4					
5a	0.26	−1.6	+7.0	−2.8						+0.4			+9.1	−15.3	−2.0					0.77**
		0.8	1.8	0.6						0.8			0.9	5.9	0.4					
6a	0.27	−1.7	+7.2	−2.6									+9.1	−15.3	−2.0					0.77**
		0.8	1.8	0.5									0.9	5.8	0.4					
7a	0.28	−3.4	+8.3										+9.1	−15.3	−2.0					0.73**
		0.8	1.9										1.0	6.3	0.4					
Pounds of K per acre in corn plants at silking time (Kp)																				
1b	−64.8	+798	−7,118	−941	+1,906					+2,383	+114	−3,224	+423	−271	−96	−419	+166	+3,044		0.66**
		179	997	364	28					517	379	57	120	770	48	196	84	588		
2b	−81.2	+768	−380	+1		+206	−561	+587	−23				+422	−233	−99	+961	−824	+3,676		0.61**
		202	267	114		155	251	299	224				129	832	51	532	354	617		
3b	−39.8	+424	−287	−121		+101				+358			+407	−227	−91	−1,094	−75	+4,160		0.56**
		126	276	101		128				136			137	880	54	202	88	636		
4b	−92.5	+876	−143	−97									+423	−250	−98	+1,571	−1,162	+3,382		0.59**
		188	258	101									131	844	52	475	322	599		
5b	−92.3	+891	−116										+425	−249	−99	+1,618	−1,251	+3,335		0.59**
		152	256										131	842	52	421	267	569		
6b	−89.4	+853											+395		−99	+1,640	−1,265	+3,350		0.59**
		125											78		52	416	264	565		
7b	26.7	+295											+428		−115					0.44**
		45											90		60					
Yield of corn grain, bushels per acre (Y)																				
1c	−74.4	+620	−803	+97		−36	−279	−735	+1,316				+199	−590	−48	+1,021	−561	+4,789		0.62**
		140	185	79		11	174	207	155				90	577	36	368	246	427		
2c	−64.1	+399	−2,441	−396	+697					+1,809	−288	−1,204	+192	−626	−42	+474	−68	+4,393		0.48**
		157	871	318	245					452	331	499	105	674	42	171	73	514		
3c	−44.8	+292	−613	−140						583			+190	−612	−42	+672	−142	+4,640		0.45**
		98	216	79						106			107	688	42	158	69	497		
4c	−25.1	+355	−524	+152		−88							+211	−645	−50	+960	−380	+3,601		0.36**
		165	226	89		113							115	741	46	417	282	526		
5c	−22.9	+301	−534	+108									+208	−644	−48	+846	−267	+3,700		0.36**
		150	226	69									115	740	46	390	242	509		
6c	−29.9	+410	−571										+212	−647	−50	+1,038	−361	+3,545		0.35**
		134	226										115	743	46	372	236	502		
7c	57.6	+311	−715										+264	−787	−66					0.08*
		110	264										136	877	54					

Table A-8 (continued)

Equation No.	a	K_{S1} x10^3	K_{S1}^2 x10^6	K_{S2} x10^3	$K_{S1}K_{S2}$ x10^5	K_{S3} x10^3	K_{S4} x10^3	K_{S5} x10^3	K_{S6} x10^3	K_{S3-6} x10^3	$K_{S1}K_{S3-6}$ x10^5	$K_{S2}K_{S3-6}$ x10^5	K_F x10^3	K_F^2 x10^6	$K_{S1}K_F$ x10^5	T x10^2	$K_{S1}T$ x10^4	S x10^3	CK Y x10^2	R^2
		Partial regression coefficients (b_i)																		
						Increase in yield of corn grain from K fertilizer applications (△Y)														
1d	—23.2	+88	+92	—168		+72	+67	—195	+211				+239	—756	—56	+575	—167	+1,101	—20	0.48**
		86	117	48		62	102	123	108				52	333	21	214	143	317	4	
2d	—10.4	—44	+314	—234		+98	+153	—60	—63				+249	—797	—58	+465	—69	+186		0.42**
		85	113	48		65	106	126	95				55	352	22	225	150	261		
3d	—4.4	+139	—1,067	—608	+345					+276	—160	—52	+257	—800	—62	+257	+50	—53		0.42**
		81	453	165	127					235	172	259	54	350	22	89	38	267		
4d	—8.2	—68	+264	—207		+143							+249	—793	—58	+343	+6	+248		0.41**
		78	107	42		53							55	352	22	198	134	249		
5d	—4.5	—53	+234	—150						+60			+251	—792	—59	+241	+14	+240		0.38**
		51	113	41						56			56	359	22	83	36	260		
6d	—12.1	+20	+279	—136									+254	—796	—60	+519	—178	+85		0.38**
		7	109	33									56	358	22	188	117	246		
7d	—3.4	—117	+326										+249	—792	—58	+279	—61	+279		0.32**
		67	113										58	373	23	187	119	252		
8d	12.3	—137	+307										+253	—803	—59					0.29**
		48	114										59	380	23					

[a] The equations have the general form: $\hat{Y} = a + \Sigma b_i X_i$. The standard error associated with each partial regression coefficient is shown below the partial regression coefficient.
** Significant at the 1-percent level.
* Significant at the 5-percent level.

Table A-9. Multiple regression equations relating the K content and grain yield of corn to the exchangeable K in field moist soils, amount of K fertilizer applied, and other variables. Based on data from 31 field experiments.[a]

Equation No.	a	$K_{S1}^{1/2}$ x10^2	K_{S1} x10^3	K_{S2} x10^3	K_{S3} x10^3	K_{S4} x10^3	K_{S5} x10^3	K_{S6} x10^3	$K_F^{1/2}$ x10^2	K_F x10^3	$K_{S1}^{1/2}K_F^{1/2}$ x10^2	T x10^2	$K_{S1}^{1/2}T$ x10^2	S x10^3	CK Y x10^2	R^2
		Partial regression coefficients (b_i)														
		% K in corn leaves at silking time (%K)														
1	2.40	+55.4	—9.0	+2.4	—5.7	—15.3	+25.4	—4.6	+9.8	+2.8	—0.68	+9.0	—3.2	+4.9		0.68**
		10.4	3.2	2.0	2.6	4.3	5.1	3.8	3.7	1.8	0.27	18.3	1.5	10.6		
		Pounds of K per acre in corn plants at silking time (K_p)														
1a	—167	+1,641	—57	+4	+257	—610	+628	—48	+387	+240	—32	+1,905	—179	+3,679		0.60**
		611	190	114	151	253	301	225	215	103	16	1,107	90	622		
		Yield of corn grain, bushels per acre (Y)														
1b	—204	+2,411	—577	+88	—19	—324	—704	+1,311	+287	—24	—16	+2,056	—156	+4,700		0.63**
		416	129	78	103	173	205	158	146	70	11	729	61	4,239		
		Increase in yield of corn grain from K fertilizer applications ($\triangle$Y)														
1c	—41	+197	+58	—164	+75	+60	—192	+213	+332	—25	—19	+822	—41	+1,117	—20	0.49**
		269	83	47	60	102	122	106	85	41	6	428	36	313	4	

[a] The equations have the general form: $\hat{Y}=a+\Sigma b_iX_i$. A square root transformation of some of the data was used in these equations. The standard error associated with each partial regression coefficient is shown below the partial regression coefficients.
** Significant at the 1-percent level.

Table A-10. Multiple regression equations relating the K content and the yield of corn to the exchangeable K in air-dry and oven-dry soil samples, the amount of K fertilizer applied and other variables. Based on data from 31 field experiments.[a]

Equation No.	Dryness of soil sample	a	K_{S1} x10^3	K_{S1}^2 x10^6	K_{S2} x10^3	K_{S3} x10^3	K_{S4} x10^3	K_{S5} x10^3	K_{S6} x10^3	K_F x10^3	K_F^2 x10^6	$K_{S1}K_F$ x10^5	T x10^2	$K_{S1}T$ x10^4	S x10^3	R^2
			Partial regression coefficients (b_i)													
			%K in corn leaves at silking time (%K)													
1	Air-dry	1.92	+4.7	+0.6	—2.8	+0.1	+1.5	—6.1	+2.8	+9.5	—15.3	—2.7	—14.1	+5.3		0.51**
			2.4	7.4	1.8	1.6	1.8	1.7	1.2	2.8	17.4	1.3	5.0	2.8		
2	Air-dry	2.09	+2.8	+5.7						+9.6	—15.1	—2.7	—23.1	+2.1		0.42**
			2.5	7.8						3.0	18.8	1.4	5.0	2.7		
3	Oven-dry	2.79	+4.3	—9.2	—3.1	+3.4	—3.8	—1.9	+5.3	+8.4	—15.3	—1.1	—50.7	+8.3		0.56**
			2.9	3.0	1.4	1.1	1.2	1.5	1.1	2.5	16.6	0.7	12.2	5.8		
4	Oven-dry	2.66	+3.1	—5.7						+8.3	—15.4	—1.1	—42.4	+6.1		0.45**
			2.3	3.2						2.8	18.3	0.8	9.5	5.3		
			Increase in K in corn leaves from K fertilizer applications ($\triangle$%K)													
1a	Air-dry	0.10	—2.2	+5.5	+1.4	—0.8	—0.9	+1.3	—0.1	+9.5	—15.3	—2.6				0.75**
			0.8	2.5	0.5	0.5	0.6	0.6	0.4	1.0	6.1	0.5				
2a	Air-dry	0.11	—1.5	+4.4						+9.4	—15.4	—2.6				0.73**
			0.8	2.5						1.0	6.3	0.5				
3a	Oven-dry	0.18	—2.7	+4.6	—0.0	+0.3	—0.3	+1.7	—1.2	+8.3	—15.4	—1.1				0.69**
			0.7	1.1	0.6	0.4	0.5	0.6	0.5	1.0	6.9	0.3				
4a	Oven-dry	0.16	—1.5	+2.9						+8.2	—15.5	—1.1				0.65**
			0.6	1.1						1.1	7.1	0.3				
			Pounds per acre of K in corn plants at silking time (K_P)													
1b	Air-dry	19.8	+405	—378	—429	+322	—148	—140	+100	+436	—253	—125	+141	+450	+3,531	0.60**
			116	359	89	76	87	84	61	133	842	64	247	134	634	
2b	Air-dry	10.7	+285	—57						+435	—230	—126	—304	+137	+3,903	0.49**
			124	387						148	932	70	248	133	631	
3b	Oven-dry	19.7	+245	—570	—6	+115	—212	—174	+322	+343	—223	—35	—1,414	+353	+4,392	0.60**
			148	153	77	55	61	78	61	129	844	38	621	298	672	
4b	Oven-dry	49.4	+145	—446						+352	—272	—35	—1,712	+519	+3,291	0.51**
			118	162						140	919	41	488	273	637	
			Yield of corn grain, bushels per acre (Y)													
1c	Air-dry	—22.2	+425	—596	—331	+101	+80	—157	+139	+199	—632	—49	+839	—162	+3,903	0.53**
			88	273	68	58	66	64	47	101	640	48	188	102	482	
2c	Air-dry	—11.9	+284	—575						+200	—643	—49	+727	—173	+3,697	0.34**
			99	310						118	747	56	199	107	506	
3c	Oven-dry	14.2	+116	—395	—99	+45	—32	—111	+180	+163	—633	—13	—58	+193	+4,040	0.43**
			124	128	64	46	51	65	51	108	707	32	520	249	563	
4c	Oven-dry	20.6	+9	—284						+169	—651	—14	+171	+232	+3,545	0.34**
			96	132						115	750	34	398	223	520	
			Increase in yield of corn grain from K fertilizer applications ($\triangle$Y)													
1d	Air-dry	—7.6	—45	+93	+27	+38	—142	+214	—69	+244	—793	—61	+60	—36	+192	0.39**
			49	153	39	32	37	36	26	57	359	27	105	57	270	
2d	Air-dry	—10.3	+4	—27						+238	—802	—57	+198	—20	+208	0.24**
			53	164						63	397	30	105	57	269	
3d	Oven-dry	—9.6	—58	+69	+19	+2	—26	+120	—98	+193	—801	—13	+254	—12	+218	0.27**
			69	71	36	25	28	36	29	60	339	18	289	139	313	
4d	Oven-dry	—24.9	+42	+47						+190	—797	—12	+548	—165	+381	0.20**
			52	72						62	405	18	215	120	281	

[a] The equations have the general form; $\hat{Y}=a+\Sigma b_iX_i$. The standard error associated with each partial regression coefficient is shown below the partial regression coefficient.
** Significant at the 1-percent level.

STATE LIBRARY OF IOWA
3 1723 02094 9863

LOCATION OF UNIFORM REGIONAL FIELD EXPERIMENTS ON CORN

NC-16 Technical Committee — Mineral Deficiencies in Soils, Including Minor Elements, Their Influence on Crops, and the Efficient Use of Various Fertilizers

W. M. Laughlin .... *Alaska*
R. H. Bray,* L. T. Kurtz .... *Illinois*
S. A. Barber .... *Indiana*
C. A. Black,* J. T. Pesek .... *Iowa*
F. W. Smith .... *Kansas*
J. F. Davis, K. Lawton* .... *Michigan*
A. C. Caldwell .... *Minnesota*
G. H. Wagner, E. R. Graham* .... *Missouri*
R. A. Olson .... *Nebraska*
E. B. Norum,* R. A. Young .... *North Dakota*
H. J. Mederski .... *Ohio*
F. E. Shubeck, P. L. Carson,* L. O. Fine* .... *South Dakota*
L. E. Engelbert,* J. Murdock .... *Wisconsin*
J. W. Ketcheson .... *Ontario, Canada*
R. G. Menzel, M. Fried .... *ARS, USDA*
G. M. Browning (Iowa) .... *Administrative Advisor*
* Indicates a former member of the committee.

Potassium Subcommittee of NC-16

J. J. Hanway, chairman .... *Iowa*
S. A. Barber .... *Indiana*
M. Fried .... *ARS, USDA*
G. Stanford, R. H. Bray and P. F. Pratt also served on this subcommittee when the work was initiated.