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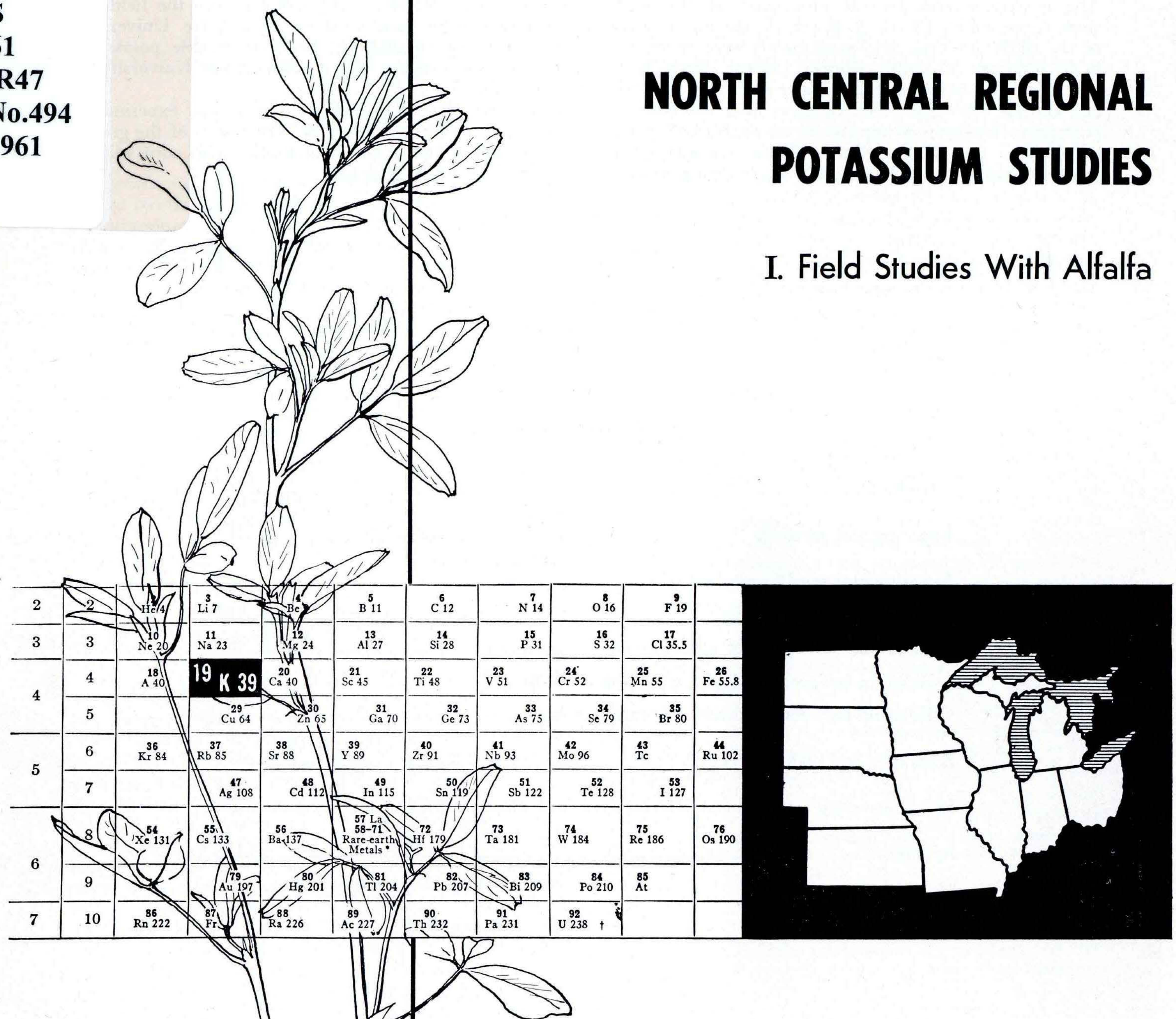
NORTH CENTRAL REGIONAL POTASSIUM STUDIES

I. Field Studies With Alfalfa



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FOREWORD

This publication is the result of research conducted cooperatively by members of the Potassium Subcommittee of the North Central Mineral Deficiencies Committee (NC-16) and by members of NC-16 and others in the 12 North Central states, Alaska, the United States Department of Agriculture and Ontario, Canada. The objectives and general procedures of the study were suggested by Dr. C. A. Black. As the initial phase of the study, uniform field experiments were conducted at 89 locations in Alaska, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Nebraska and Ontario, Canada during 1955 and 1956. In these field experiments, potassium fertilizer was topdressed on established stands of alfalfa 1 year after seeding. Alfalfa was selected as the test crop in these initial field experiments since it is grown in all parts of the region and since much potassium fertilizer is used for alfalfa and other leguminous crops. Supplementary greenhouse studies using soil samples from the field experimental sites were conducted by the United States Department of Agriculture and Purdue University. Supplementary laboratory studies using soil and plant samples from the field experiments were conducted at Iowa State University. The effect of freezing on the exchangeable potassium in some soil samples was studied at the University of Wisconsin.

During 1957 and 1958, uniform field experiments were also conducted with corn. The results of the greenhouse studies and of the field studies with corn will be reported in other bulletins.

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North Central Regional Potassium Studies

I. Field Studies With Alfalfa

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Potassium (K)[2] availability varies widely in soils of the North Central Region of the United States and the adjoining areas of Canada. Soils in the western part of the region generally contain adequate amounts of plant-available K, but in other parts of the region, soils vary from those with abundant supplies of available K to those that are very deficient. Present techniques for predicting crop requirements for K fertilizer on different soils based on the determination of all or a portion of the exchangeable K in the plow layer are often inadequate, even when applied within restricted soil areas. In view of the wide range of K availability in different soils of the region, more effective methods of assessing the K status of the soils must be developed if efficient use of K fertilizers is to be accomplished. Therefore, the major objective of this study was to investigate the relationship between crop yield response from K fertilizer or uptake of soil K by plants in the field and different laboratory indexes of "plant-available K."

Because of the general relationships that have been found between exchangeable K in the soil and the crop yield response obtained from added K, most soil testing laboratories base K fertilizer recommendations upon the exchangeable K content of soil samples from the plow layer. Exchangeable K is usually extracted from air-dried soil samples with solutions of sodium or ammonium salts or dilute acids. Different studies on soils of the North Central Region have shown that the amount of exchangeable K extracted from soil samples often is increased by drying the sample prior to extraction (1, 7, 9, 10, 17, 18, 20, 21, 22). This, however, does not occur in all soils. In some soils there is no appreciable effect of drying on the exchangeable K, and in a few soils the exchangeable K content is decreased by drying. Drying generally decreases exchangeable K when the initial level of exchangeable and soluble K in the soil is high, and it increases exchangeable K when these forms of K are relatively low (18, 21). When drying results in an increase in exchangeable K, it also results in increased availability of the soil K to plants (1, 17, 22). These studies indicate that plant availability of K in soils in the field could be predicted more accurately from the exchangeable K content of undried soil samples than from air-dried samples (17), but no correlations with crop response in the field have been obtained to substantiate this.

It is generally assumed that alfalfa plants obtain appreciable amounts of K from the subsurface horizons on the soil. Lawton *et al.* (16) showed that absorption of fertilizer phosphorus by alfalfa was highest when fertilizer was placed at the surface or 3-inch depth, intermediate at the 6-inch depth and lowest at the 12-inch or lower depths. Results of a greenhouse experiment by Lawton and Tesar (15) indicate that, although alfalfa absorbed the greatest amount of K from the 0-8 inch depth, appreciable amounts were absorbed from the 8-16 inch depth. Few studies have been made, however, to determine whether including the amount of exchangeable K in the subsoil with that in the surface soil would improve the correlations obtained between exchangeable K in the soil and crop response to added fertilizer K. Black (4) has proposed a method for evaluating the contribution of nutrients from different depths in the soil by means of multiple regression. Some investigators (12, 19, 26) have shown that the relation between exchangeable K in the soil and the percent K in leaves from apple and orange orchards could be improved by including the exchangeable K from subsoil horizons. In these studies, however, the amount of exchangeable K was determined from air-dried soil samples. Results of Hanway and Scott (9) indicate that the increase in exchangeable K from drying is usually much greater in subsoil samples than in samples from surface soils.

The K content of alfalfa harvested in the bloom stage may vary from less than 0.5 to more than 3.0 percent on a dry-weight basis (3). Several investigators have shown a definite relationship to exist between the exchangeable K content of the soil and/or the amount of K applied as fertilizer and the percent K in the alfalfa plants (2, 3, 6, 8, 11, 13, 14, 23, 24, 25, 27). Generally in these studies, when the percent K in the plants was below a certain critical percentage, increases in percent K in the plants were associated with increases in yield. The critical percentage of K in alfalfa plants above which little or no increase in yield will be obtained from additional K is usually considered to be within the range of 1.25 to 2.0 percent (2, 3, 8, 13).

[1] The manuscript was prepared by the first author. The other authors contributed by conducting the field or 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 in the listing of the committee on page 188.

[2] The symbol K will be used for potassium throughout this bulletin.

Jackson *et al.* designated 1.25 as the lower limit of the optimum range for good survival and high yields. Stivers and Ohlrogge (25) state that the percentage of K in alfalfa necessary for its survival is 0.9 to 1.1. These and other results indicate that the K content of alfalfa plants provides a good estimate of the K status of the plants and that differences in K contents of alfalfa plants would reflect differences in the availability of soil K to the plants.

EXPERIMENTAL METHODS

FIELD

During 1955 and 1956, 89 field experiments with alfalfa were conducted in seven of the North Central states, Alaska and Ontario, Canada, (see table A-1 in the appendix). At each field site, a uniform amount of superphosphate to supply at least 120 pounds of P_2O_5 per acre was broadcast over the entire experimental area. Differential treatments consisted of topdressed (broadcast) applications of potassium chloride at rates of 0, 20, 40, 60, 80, 120, 240 and 360 pounds of K_2O per acre in 1955; the same rates up to 80 and, in some experiments, up to 120 pounds of K_2O per acre were used in 1956. In most experiments the plots were 9 x 15 feet in size and were arranged in a randomized block design with six replications. Most experiments were conducted on pure stands of alfalfa seeded the previous year, but in a few cases clover (and/or grass) was grown with the alfalfa. In these cases the yield and composition of each component are shown separately in table A-2 in the appendix. Dry matter yields were determined from the green weight of hay cut from a swath 3 x 12 feet, or a similar area harvested in quadrants, and the percent dry matter in the hay which was determined by drying at 65°C. Plant samples for chemical analyses were collected at each cutting by taking at least 50 standing alfalfa shoots at random from the sides of the swath cut for yield determinations. These plant samples were dried and ground, and a composite sample for each K treatment (composited according to the yield of each plot) was sent to Iowa State University for K analyses.

Prior to the application of fertilizer, soil samples were obtained from each site for laboratory and greenhouse studies. A bulk sample consisting of a composite of 20 subsamples from the 0-6 inch layer of soil from the experimental area was obtained from each field experiment. In 1956, bulk samples from the 18-24 inch layer, taken from a pit dug adjacent to the experimental plots, were also collected from some of the sites. The 1955 bulk samples were air dried and sent to the Plant Industry Station, Beltsville, Maryland, for a greenhouse experiment. The 1956 bulk samples were kept field moist and sent to Purdue University for a greenhouse experiment. The results of these greenhouse experiments will be published in another bulletin. To obtain smaller soil samples for laboratory analyses, each location was sampled to a depth of 36 inches by 6-inch increments. Separate samples, consisting of at least 10 cores each, were obtained from the 0-6 inch layer of each replicate in each experiment. The subsurface samples consisted of composites of two replicates in 1955 and three replicates in 1956 with at least two cores per replicate. These samples were kept field moist and sent to Iowa State University for laboratory analyses.

LABORATORY

K was extracted from the plant samples by shaking 0.50 gram of 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 ¼-inch screen and thoroughly mixed. A small portion of each sample was air dried for 2 weeks in a controlled temperature-humidity room at 5°C. and approximately 40 percent relative humidity. This resulted in less drying than would occur at room temperature or a lower relative humidity. Percent moisture in the field-moist and air-dried samples was determined by oven drying weighed samples at 110°C. for 24 hours. Exchangeable K was extracted from weighed samples of approximately 10 grams of the field-moist, air-dried and oven-dried soil samples by shaking 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 on a Perkin-Elmer model 52A flame photometer using lithium as an internal standard. K contents of the plant material and the 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 tested in the Iowa State University Soil Testing Laboratory by the standard procedures used in that laboratory. A glass electrode using a 1:2 soil:water ratio was used to determine pH. K was extracted by shaking two 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. Phosphorus was extracted by shaking 1½ grams of soil (measured volumetrically) in 10 ml. of Bray's No. 1 phosphorus extractant (0.025 *N* HCl and 0.03 *N* NH_4F) for 5 minutes and filtering. Phosphorus in the extract was determined colorimetrically using ammonium molybdate and stannous chloride to develop the color.

Portions of selected soil samples were sent to the University of Wisconsin where exchangeable K was determined after the field-moist samples had been kept frozen at –4°C. for 7 months. K was extracted with Neutral 1*N* NH_4OAc. The soil to solution ratio used was 1 to 10. K in the extract was determined on a Beckman model Du flame photometer.

CORRELATION STUDIES

For studies of correlations between field, greenhouse and laboratory results, different indexes of the availability of K to plants were used. These indexes included: (1) percent K in plants from plots that received no K fertilizer application, (2) pounds of K taken up by plants from plots that received no K fertilizer application and (3) E_k values calculated as shown in fig. 6. Percent recovery of applied K was calculated from the slope of the regression equation relating pounds of K taken up by the plants to pounds of K_2O applied to the soil over the range of K fertilizer applications where the relationship was linear. Exchangeable K was used as the laboratory estimate of K availability in soils.

EXPERIMENTAL RESULTS AND DISCUSSION

EXCHANGEABLE K IN SOILS

Exchangeable K in field-moist, air-dried and oven-dried soil samples and other soil test results for the soils used in this study are reported in table A-1 of the appendix. The exchangeable K in field-moist and oven-dried samples from the 0-6 and 30-36 inch depth and the changes in exchangeable K resulting from drying are summarized in table 1. The relationship between the field-moist and oven-dried values is shown in fig. 1 for all of these samples with the exception of three samples that had exchangeable K contents greater than 1,000 pp2m. The profile distribution of exchangeable K in field-moist, air-dry and oven-dry samples for some typical soils is shown in fig. 2.

Exchangeable K under field-moist conditions was almost always higher in the surface soil samples than in samples from the corresponding subsoil horizons. The field-moist subsoil samples from most soil profiles were low in exchangeable K. Only 18 profiles contained more than 100 pp2m of exchangeable K in the 30-36 inch layer, and only one of these contained more than 222 pp2m. All of these 18 soils were from the western part of the North Central Region (Kansas, Nebraska and Minnesota) or from Ontario. Even in these states, 29 soil profiles contained less than 100 pp2m of exchangeable K in the 30-36 inch layer, and some subsoils from Minnesota and Ontario contained less than 30 pp2m of exchangeable K. The exchangeable K in field-moist samples from the 30-36 inch layer of 40 profiles from Indiana, Michigan, Illinois and Iowa ranged from 22 to 80 pp2m and averaged 44 pp2m.

The effect of oven drying on the exchangeable K content of soil samples varied with depth as shown by the relationships in fig. 1. When all samples represented in fig. 1 were considered, there was a much higher degree of correlation between the exchangeable K contents of field-moist and oven-dried samples for the 0-6 inch depth ($r = 0.96$) than for the 30-36 inch depth ($r = 0.57$). This higher degree of correlation, however, is partially due to the greater range of values for the 0-6 inch samples. When only the 0-6 inch samples with exchangeable K contents between 100 and 250 pp2m

TABLE 1. EXCHANGEABLE K IN FIELD-MOIST AND OVEN-DRIED SAMPLES FROM THE 0-6 AND 30-36 INCH SOIL LAYERS AT THE DIFFERENT FIELD EXPERIMENTAL SITES AND THE CHANGES IN EXCHANGEABLE K AFTER OVEN DRYING EXPRESSED AS PP2M.

Expt.		Year	Soil type[a]	0-6 inch layer			30-36 inch layer		
				Field moist	Oven dried	Change after drying	Field moist	Oven dried	Change after drying
Alaska	1	1956	Knik sil	165	129	–36	34	65	31
Illinois	1	1956	Oconee sil	151	216	65	80	372	292
,,	2	,,	Ebbert sil	92	132	40	53	316	263
Indiana	1	1955	Brookston sil	150	205	55	65	336	271
,,	2	,,	Miami sil	90	99	9	53	181	128
,,	3	,,	Reesville sil	84	115	31	39	274	235
,,	4	,,	Brookston sil	158	237	79	73	465	392
,,	5	,,	Miami l	123	119	–4	46	139	93
,,	6	,,	Brookston sil	131	151	20	65	251	186
,,	7	,,	Brookston sil	117	106	–11	26	140	114
,,	8	,,	Miami l	91	91	0	42	183	141
,,	1	1956	Crosby fsl	95	82	–13	67	191	124
,,	2	,,	Brookston sil	103	104	1	33	88	55
,,	3	,,	Coloma lfs	111	98	–13	36	39	3
,,	4	,,	Brookston sil	131	123	–8	39	142	103
,,	5	,,	Tracy lfs	76	76	0	37	70	33
,,	6	,,	Tracy lfs	90	86	–4	35	37	2
,,	7	,,	Brookston sicl	111	114	3	22	70	48
,,	8	,,	Tracy lfs	104	95	–9	38	60	22
Iowa	1	1955	Clinton sil	239	264	25	67	572	505
,,	2	,,	Clinton sil	122	232	110	47	514	467
,,	3	,,	Clarion sil	143	212	69	33	181	148
,,	4	,,	Clarion sil	138	208	70	27	196	169
,,	5	,,	Tama sil	440	526	86	46	452	406
,,	6	,,	Tama sil	219	319	100	57	485	428
,,	7	,,	Fayette sil	140	180	40	44	431	387
,,	8	,,	Fayette sil	145	162	17	57	438	381
,,	9	,,	Carrington l	139	153	14	27	209	182
,,	10	,,	Carrington sl	164	171	7	30	236	206
,,	11	1956	Fayette sil	159	205	46	44	329	285
,,	12	,,	Fayette sil	128	161	33	40	324	284
,,	13	,,	Carrington l	124	162	38	28	196	168
,,	14	,,	Carrington l	121	143	22	28	152	124
,,	15	,,	Floyd l	121	193	72	30	204	174
,,	16	,,	Clyde l	210	245	35	38	274	236
Kansas	1	1955	Cherokee sil	102	137	35	66	277	211
,,	2	,,	Bates vfsl	65	100	35	47	230	183
,,	3	,,	Parsons sil	145	264	119	84	357	273
,,	4	,,	Bates vfsl	254	296	42	112	340	228
,,	5	,,	Woodson sil	262	368	106	86	460	374
,,	6	,,	Hobbs-like sil	565	645	80	219	478	259
,,	7	,,	Geary sicl	675	800	125	131	461	330
,,	1	1956	Hobbs-like sil	522	612	90	222	548	326
,,	2	,,	Geary sicl	567	639	72	121	476	355
,,	3	,,	Sarpy fsl	531	574	43	149	288	139
,,	4	,,	Cherokee sil	82	110	28	103	252	148
,,	5	,,	Parsons sil	106	142	36	133	292	159
,,	6	,,	Parsons sil	129	200	71	181	419	238
,,	7	,,	Woodson sil	134	210	76	136	502	366
,,	8	,,	Cherokee sil	151	192	41	128	345	217
,,	9	,,	Parsons sil	111	149	38	62	183	121
,,	10	,,	Bates vfsl	172	191	19	130	313	183
Michigan	1	1955	Fox sl	232	173	–59	....	....	....
,,	2	,,	Hillsdale sl	199	138	–61	61	140	79
,,	1	1956	Bellefontaine sl	151	120	–31	69	158	89
,,	2	,,	Fox sl	180	166	–14	28	54	26
,,	3	,,	Conover l	80	86	6	38	160	122
,,	4	,,	Miami l	209	174	–35	64	110	46
,,	5	,,	Bellefontaine sl	65	60	–5	30	42	8
Minnesota	1	1955	Nicollet cl	217	250	33	68	367	299
,,	2	,,	Clarion cl	507	543	36	60	259	199
,,	3	,,	Fayette sil	162	197	35	65	380	315
,,	4	,,	Aastad sil	1010	1061	51	99	351	252
,,	5	,,	Menahga sl	166	154	–12	119	97	–22
,,	6	,,	Rothsay scl	529	647	118	62	331	269
,,	7	,,	Beltrami vfsl	123	116	–7	51	246	195
,,	8	,,	Fargo sic	592	910	318	141	566	425
,,	9	,,	Bearden sicl	480	755	275	144	461	317
,,	1	1956	Floyd cl	107	177	70	31	201	170
,,	2	,,	Hubbard ls	72	79	7	30	64	34
,,	3	,,	Lino lfs	87	79	–8	41	88	45
,,	4	,,	Hayden fsl	121	118	–3	52	286	234
,,	5	,,	Milaca fsl	68	57	–11	31	53	22
,,	6	,,	Milaca fsl	90	95	5	34	58	24
,,	7	,,	Crown fsl	98	101	3	26	24	–2
Nebraska	1	1955	Thurman ls	247	258	11	89	134	45
,,	2	,,	Hall sil	1488	1525	37	1358	1462	104
,,	1	1956	Moody vfsl	254	282	28	59	218	159
,,	2	,,	Thurman ls	340	341	1	68	110	42
Ontario	1	1955	Guelph l	82	93	11	47	62	15
,,	2	,,	Burford l	142	128	–14	93	141	48
,,	3	,,	Haldimand c	418	287	–131	133	261	128
,,	4	,,	Fox sl	66	70	4	26	42	16
,,	1	1956	Guelph l	94	108	14	75	96	21
,,	2	,,	Fox sl	52	64	12	14	22	8
,,	3	,,	Dumfries l	163	145	–18	21	35	14
,,	4	,,	Perth cl	117	175	58	89	175	86
,,	5	,,	Huron cl	202	248	46	86	179	93
,,	6	,,	Haldimand cl	285	331	46	138	262	124

[a] c = clay, si = silt, s = sand, l = loam, fs = fine sand, v = very.

in the field-moist condition were considered, the correlation between field-moist and oven-dried values was not so high ($r = 0.61$).

As shown in fig. 2, the profile distribution of exchangeable K in most soils was markedly modified by drying the soil samples prior to extraction of the exchangeable K. Table 1 shows that exchangeable K was increased by oven drying by more than 20 pp2m in almost all subsoil samples and in over half of the surface soil samples. The increases from drying were usually much greater in subsoil samples than in surface soil samples, although in several surface soil samples the increase from oven drying was greater than 100 pp2m. In some subsoil samples there was a tenfold increase in exchangeable K. Thus, fig. 2A shows the most common profile distribution of exchangeable K as influenced by moisture content of the samples tested. In more than one-third of the surface soils, drying resulted in little or no change (20 pp2m or less) in exchangeable K. Data from this type of soil are illustrated in fig. 2B. In six of the surface soils, a decrease of greater than 20 pp2m in exchangeable K resulted from drying, and this brought about a profile distribution in most of these soils similar to that shown in fig. 2C. Figure 2D shows the profile distribution commonly found in sandy soils. At all depths in most sandy soils there was only a small increase in exchangeable K resulting from drying, but all determinations for exchangeable K were very low.

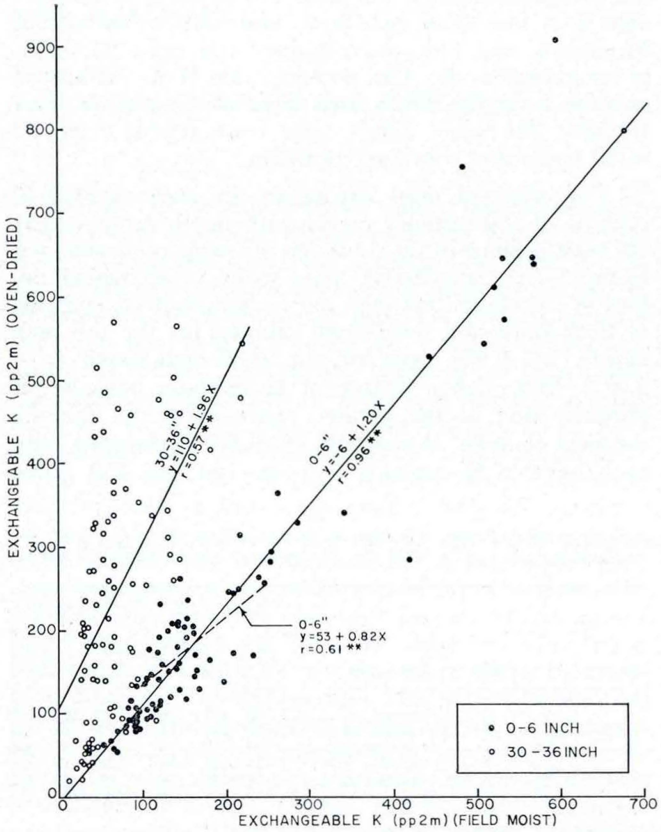

Fig. 1. The relation between exchangeable K contents of field-moist and oven-dried soil samples from the 0-6 and 30-36 inch soil layers.

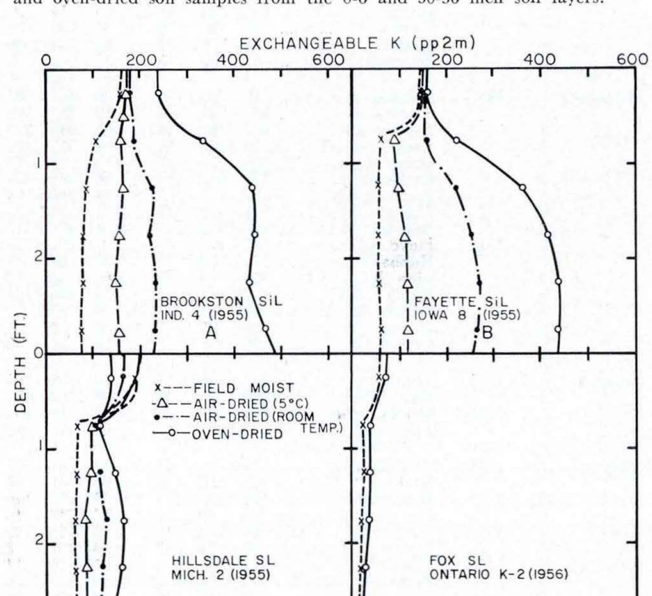

Fig. 2. Profile distribution of exchangeable K in typical soils of the North Central Region as determined on field-moist and dried soil samples.

For samples in which changes in exchangeable K occurred upon drying, the amount of exchangeable K extracted depended upon the degree of drying. The air-dried values were intermediate between the field-moist and oven-dried values. Air drying at the constant temperature and humidity used in this study resulted in less moisture loss and less change in the exchangeable K than did drying at room temperature in the soil testing laboratory. In most laboratories, exchangeable K is usually determined on air-dried soil samples. The data reported here indicated that the changes observed in exchangeable K resulting from air drying will be less than those indicated for oven drying. The changes from air drying were often appreciable, however, and the values observed will vary with the degree of drying achieved.

Some less common profile distributions of exchangeable K are shown in fig. 3. Figure 3A represents a sandy soil with a relatively high exchangeable K content. In this soil the exchangeable K at all depths in the profile was decreased by drying. In the Bates very fine sandy loam, fig. 3B, exchangeable K in moist samples increased with depth to the 12-18 inch layer and then decreased with depth below this layer. Drying produced an increase in exchangeable K at all depths except in the 12-18 inch layer. Exchangeable K in the moist soil was the highest in this layer, and drying resulted in a decrease in exchangeable K. A similar phenomenon was observed in the Knik silt loam soil from Alaska and to a lesser extent in a few other soils.

In most soil profiles the exchangeable K content in field-moist soil samples decreased with depth in the profile or decreased to a minimum value and then remained relatively constant below that depth. In a few soils, however, as illustrated in figs. 3C and 3D, the exchangeable K in undried samples decreased with depth to a minimum value and then increased with increasing depth. A few soils, other than those for which the data are illustrated here, showed these variations to lesser degrees.

The change in exchangeable K that resulted from drying 0-6 inch samples varied in different parts of the

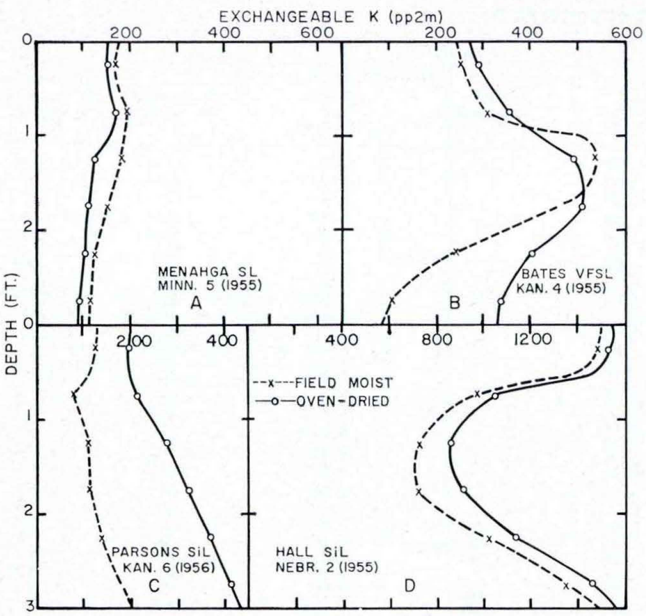

Fig. 3. Unusual profile distribution of exchangeable K observed in some soils of the North Central Region as determined on field-moist and dried soil samples.

TABLE 2. THE EFFECT OF FREEZING ON EXCHANGEABLE K IN CERTAIN SOILS AS COMPARED WITH THE EFFECT OF AIR DRYING AND OVEN DRYING. [a]

Experimental site	Sample depth (inches)	Replicate	Exchangeable K (pp2m) Moist	Frozen	Air dried	Oven dried
Iowa 7	18-24	1 & 2	40	80	98	421
Minnesota 1	18-24	3 & 6	53	100	88	340
Indiana 1	18-24	3 & 4	61	113	156	447
Indiana 1	0- 6	4	106	135	120	205
Iowa 2	0- 6	2	132	159	158	281
Ontario 3	18-24	1 & 2	145	263	206	348
Minnesota 1	0- 6	6	220	185	218	214
Ontario 3	0- 6	1	398	382	384	172

[a] Samples from 1955 field experiments.

TABLE 3. THE EFFECT OF DRYING ON EXCHANGEABLE K IN SOIL SAMPLES FROM THE 0-6 INCH LAYER OF DIFFERENT REPLICATES OF THE MINNESOTA NO. 2 (1955) FIELD EXPERIMENT ON A CLARION CLAY LOAM.

Field replicate sampled	Exchangeable K (pp2m) Field moist	Oven dried	Change after drying
3	144	254	+ 110
2	221	303	+ 82
1	274	324	+ 48
4	369	494	+ 125
6	662	649	— 13
5	1,370	1,235	— 135

region. In surface soils from Illinois, Iowa, Kansas and Nebraska there were no decreases, and most soils showed significant increases in exchangeable K because of drying; whereas, in surface soils from Michigan, drying resulted in essentially no change or in significant decreases in exchangeable K. Only 3 of the 16 surface soils from Indiana showed significant increases in exchangeable K from drying, and there was essentially no change in the other 13 soils. Exchangeable K in the one surface soil from Alaska decreased on drying. Changes produced by drying the surface soils from Minnesota varied from essentially no change to large increases, and changes in surface soils from Ontario varied from a large decrease in one soil to significant increases in others. In general, surface soils from the eastern part of the region showed less change in exchangeable K resulting from drying than did soils from the western part of the region, except that sandy soils, irrespective of location, showed little change from drying.

Freezing appears to have a dessication effect on exchangeable K, resulting in increases or decreases in exchangeable K the same as air drying or oven drying. Data from a few samples are shown in table 2. The changes in exchangeable K produced by freezing were relatively small and comparable to those produced by air drying at low temperature in the constant temperature-humidity room, but were much smaller than those produced by oven drying the soil samples.

As has been shown by other workers (18, 21), drying may result in either increases, no change or decreases in exchangeable K in soil samples depending upon the level of exchangeable K in the soil sample. This is shown in table 3 by the exchangeable K content of moist and oven-dried samples from a Minnesota soil where the exchangeable K in the soil varied extremely in different replicates of the field experiment. Samples from replicates low in exchangeable K showed an increase from drying, whereas those from replicates with high exchangeable K showed a decrease from drying.

YIELD AND K CONTENT OF ALFALFA

The dry-matter yields and the percent K in the plants for all field experiments are reported in table A-2 of the appendix and are partially summarized in table 4.

The yields of hay for the first and second cuttings from the unfertilized plots of the different experiments are compared in fig. 4. The correlation between the yields of the two cuttings was very low ($r = 0.48^{**}$) but still highly significant. In general, the second-cutting yields were lower than those of the first cutting, but in some experiments drouth seriously limited first-cutting yields, and later rains resulted in yields of the second cutting that exceeded those of the first. Yields of first cutting averaged 3,200 pounds per acre and ranged from 280 to 5,880 pounds per acre in the different experiments.

Even though there was a poor relation between yields of the two cuttings of alfalfa, the percentage of K in the unfertilized plants from the two cuttings was highly correlated, as shown in fig. 5. Where more than two cuttings were made, this same relationship held for all cuttings. It appears that different environmental conditions at different times in the growing season markedly influenced yields but, at most sites, did not result in appreciable changes in the K concentration in the unfertilized plants. This indicates that the percent K in alfalfa plants of any cutting could be used as an index of K availability to the plants.

Figure 5 also indicates the generally high level of K availability in the sites selected for these experiments. The K content of the alfalfa plants from the first cutting at different sites ranged from 0.64 to 4.50 percent and averaged 2.0 percent. The percent K in the plants

TABLE 4. SUMMARY OF RESULTS FROM FIELD EXPERIMENTS WITH ALFALFA.

Expt. No.		Year	Soil type	Exch. K[a]	First cutting: Check plots: % K	First cutting: Check plots: Yield (lb/A)	First cutting: Response to K fertilizer: Yield increase lb/A[b]	First cutting: Response to K fertilizer: Increase in % K[c]	First cutting: Response to K fertilizer: % recovery of added K[c]	Second cutting: % recovery of added K[c]
Alaska	1[d2]	1956	Knik sil	165	1.30	2,280	....	0.25	0	....
Illinois	1	,,	Oconee sil	151	1.77	2,860	....	0.42*	12**	0
,,	2	,,	Ebbert sil	92	1.78	2,590	....	0.34*	17*	10
Indiana	1	1955	Brookston sil	150	1.79	3,230	....	0.72*	41*	16
,,	2	,,	Miami sil	90	1.78	2,770	....	1.05**	43**	31
,,	3	,,	Reesville sil	84	1.44	3,360	....	0.70	36*	11
,,	4	,,	Brookston sil	158	1.99	4,090	....	0.52	24	23*
,,	5	,,	Miami l	123	1.82	3,650	....	0.62*	36*	12
,,	6	,,	Brookston sil	131	1.70	4,100	260	0.92*	58*	25*
,,	7	,,	Brookston sil	117	1.59	4,990	460	0.66*	53*	15
,,	8[d2]	,,	Miami l	91	1.63	4,370	....	0.48	16	20
,,	1	1956	Crosby fsl	95	1.60	4,260	....	0.57*	37**	....
,,	2	,,	Brookston sil	103	1.62	3,860	....	0.51	22	....
,,	3	,,	Coloma lfs	111	1.98	3,860	....	0.40	21	....
,,	4	,,	Brookston sil	131	2.38	4,730	....	0.49	29	....
,,	5	,,	Tracy lfs	76	1.95	3,820	....	0.77**	45*	....
,,	6	,,	Tracy lfs	90	1.86	3,030	....	0.84**	29*	....
,,	7	,,	Brookston sicl	111	1.90	3,540	....	0.90*	25*	....
,,	8	,,	Tracy lfs	104	1.74	3,250	....	0.84*	31**	....
Iowa	1	1955	Clinton sil	239	2.75	5,240	....	0.38**	31*	17
,,	2	,,	Clinton sil	122	2.07	4,170	....	0.62*	46*	6
,,	3	,,	Clarion sil	143	1.80	3,700	....	0.12	3	0
,,	4	,,	Clarion sil	138	1.66	4,550	680	0.44**	45*	1
,,	5[d1]	,,	Tama sil	440	2.68	3,420	....	0.00	17**	12
,,	6	,,	Tama sil	219	1.68	3,450	....	0.45*	22	19*
,,	7	,,	Fayette sil	140	1.79	4,030	460	0.56*	43*	9
,,	8	,,	Fayette sil	145	2.05	3,900	540	0.45*	36*	16
,,	9	,,	Carrington l	139	1.70	3,510	420	0.84**	48*	8
,,	10	,,	Carrington sl	164	2.07	4,170	450	0.83**	60*	5
,,	11	1956	Fayette sil	159	1.72	2,690	430	0.45*	29*	....
,,	12	,,	Fayette sil	128	1.68	3,340	....	0.78*	30**	....
,,	13	,,	Carrington l	124	1.68	3,450	....	0.52*	29**	....
,,	14	,,	Carrington l	121	1.48	3,780	....	0.65*	31	....
,,	16	,,	Clyde l	210	1.81	4,280	....	0.42*	24	....
Kansas	1	1955	Cherokee sil	102	1.80	2,440	....	0.51*	19	11
,,	2	,,	Bates vfsl	65	1.14	2,500	....	0.81**	24**	23
,,	3	,,	Parsons sil	145	1.87	2,460	....	0.21	12	....
,,	4[d1]	,,	Bates vfsl	254	2.13	1,750	....	0.54	19	0
,,	5[d2]	,,	Woodson sil	262	1.84	3,920	....	0.01	0	1
,,	6[d1]	,,	Hobbs-like sil	565	2.48	810	....	0.08	1	7
,,	7[d1]	,,	Geary sicl	675	2.34	1,280	....	−0.14	0	0
,,	1[d1]	1956	Hobbs-like sil	522	2.57	800	....	−0.22	0	3
,,	2[d1]	,,	Geary sicl	567	3.48	3,840	....	−0.12	0	0
,,	3[d1]	,,	Sarpy fsl	531	4.50	1,240	....	0.26	17*	0
,,	4[d3]	,,	Cherokee sil	82	2.94	600	....	−0.03	0	7
,,	5[d3]	,,	Parsons sil	106	2.32	1,260	....	−0.06	1	2
,,	6[d3]	,,	Parsons sil	129	2.94	820	....	0.14	0	....
,,	7[d5]	,,	Woodson sil	134	....	1,620	....	....	....	14**
,,	8[d3]	,,	Cherokee sil	151	2.34	740	....	0.10	5	....
,,	9[d3]	,,	Parsons sil	111	1.62	580	....	−0.06	1	....
,,	10[d3]	,,	Bates vfsl	172	2.20	280	....	0.17	1	....
Michigan	1[d5]	1955	Fox sl	232	1.93	2,160	760	0.32	40*	....
,,	2	,,	Hillsdale sl	199	2.14	2,680	....	0.28*	26*	....
,,	1	1956	Bellefontaine sl	151	2.03	4,340	980	0.34	48	....
,,	2	,,	Fox sl	180	1.87	3,780	560	1.17**	67**	....
,,	3	,,	Conover l	80	1.47	4,240	....	0.10	17	....
,,	4	,,	Miami l	209	2.13	5,100	710	....	....	....
,,	5	,,	Bellefontaine sl	65	1.60	3,220	510	0.83*	52**	....
Minnesota	1	1955	Nicollet cl	217	1.54	5,020	....	0.41	12*	8
,,	2[d1]	,,	Clarion cl	507	1.76	4.620	....	0.00	24	8
,,	3[d2]	,,	Fayette sil	162	1.76	5,880	....	0.55**	23	....
,,	4[d1]	,,	Aastad sil	1,010	2.76	3,280	....	0.02	14	7
,,	5	,,	Menahga sl	166	2.81	4,420	....	0.13	0.17*	....
,,	6[d1]	,,	Rothsay sicl	529	2.26	4,440	560	0.00	0.17**	15
,,	8[d1]	,,	Fargo sc	592	3.46	2,480	....	−0.01	7	....
,,	9[d1]	,,	Bearden sicl	480	3.34	3,240	....	0.01	2	2
,,	1[d2]	1956	Floyd cl	107	0.78	3,760	....	0.32	23	20**
,,	2	,,	Hubbard ls	72	0.93	1,460	....	0.72**	17**	18*
,,	3	,,	Lino lfs	87	0.96	4,360	....	0.59**	35*	....
,,	4	,,	Hayden fsl	121	1.32	4,160	....	0.52	30	6
,,	5	,,	Milaca fsl	68	0.64	2,840	....	0.82**	29*	28**
Nebraska	1[d2]	1955	Thurman ls	247	3.55	4,230	....	−0.58	0	5
,,	2[d1]	,,	Hall sil	1,488	3.52	4,240	....	0.10	2	4
,,	1[d2]	1956	Moody vfsl	254	2.67	1,850	....	0.06	0	0
,,	2[d2]	,,	Thurman ls	340	3.60	4,890	....	0.22	14	17
Ontario	1	1955	Guelph l	82	0.73	3,840	....	0.61**	39*	3*
,,	2	,,	Burford l	142	1.22	3,860	....	0.60**	29*	8
,,	3[d1]	,,	Haldimand c	418	2.56	2,370	....	0.06	2	8
,,	4	,,	Fox sl	66	0.89	2,430	....	0.32*	14	0
,,	1	1956	Guelph l	94	1.77	3,830	....	0.92	65**	25**
,,	2	,,	Fox sl	52	1.05	1,650	510*	1.04*	34*	20**
,,	3	,,	Dumfries l	163	1.95	3,350	....	1.29**	52*	0
,,	4	,,	Perth cl	117	1.65	1,820	....	1.04**	31**	12
,,	5[d2]	,,	Huron cl	202	1.87	2,670	....	0.30**	13	4
,,	6[d4]	,,	Haldimand cl	285	1.99	2,440	....	0.22**	12	11**

[a] In field-moist 0-6 inch soil samples; pp2m.
[b] Significant yield increases from 80 pounds K_20/A.
[c] Based on linear regression between pounds K_20 applied per acre (up to 80 pounds/acre), and percent K in plants or pounds K/A in plants. Increase in percent K is the increase per 100 pounds K_20 applied per acre.
[d] Experiments not included in correlation studies because: [d1]—Exchangeable K was greater than 400 pp2m. [d2]—Alfalfa yields were variable between replicates. [d3]—Alfalfa yields were very low (usually because of drouth). [d4]—Exchangeable K was variable between replicates. [d5]—The data were incomplete because of incomplete sampling.
* Significant at 5-percent level.
** Significant at 1-percent level.

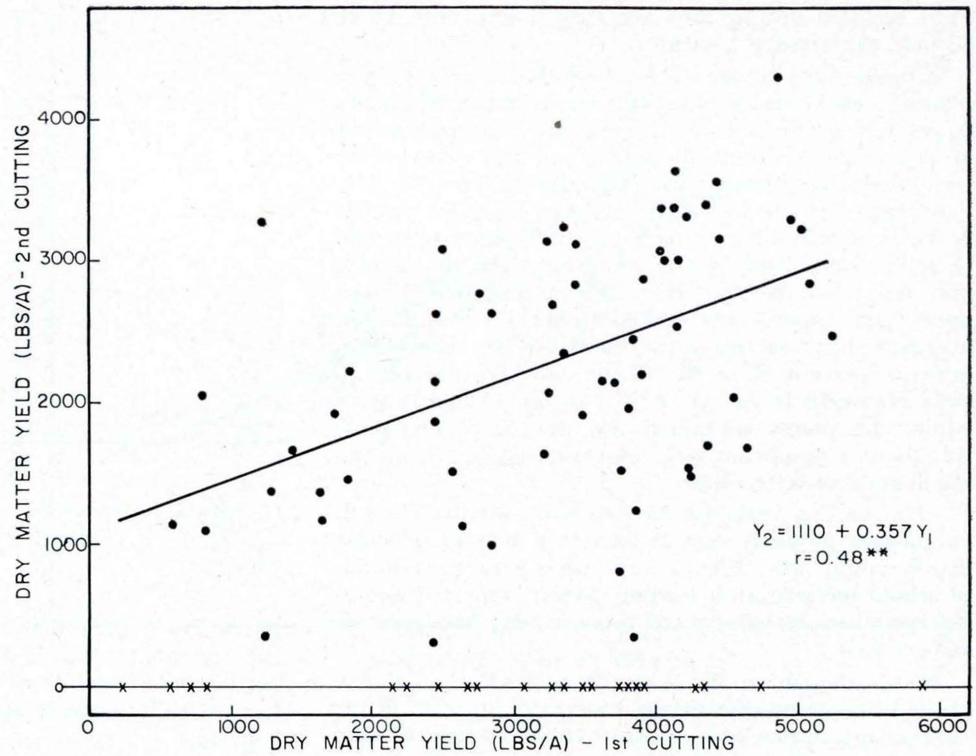

Fig. 4. Relation between dry matter yields of alfalfa from first and second cuttings of North Central Regional field experiments; 1955 and 1956 (x indicates that yields were not obtained for the second cutting).

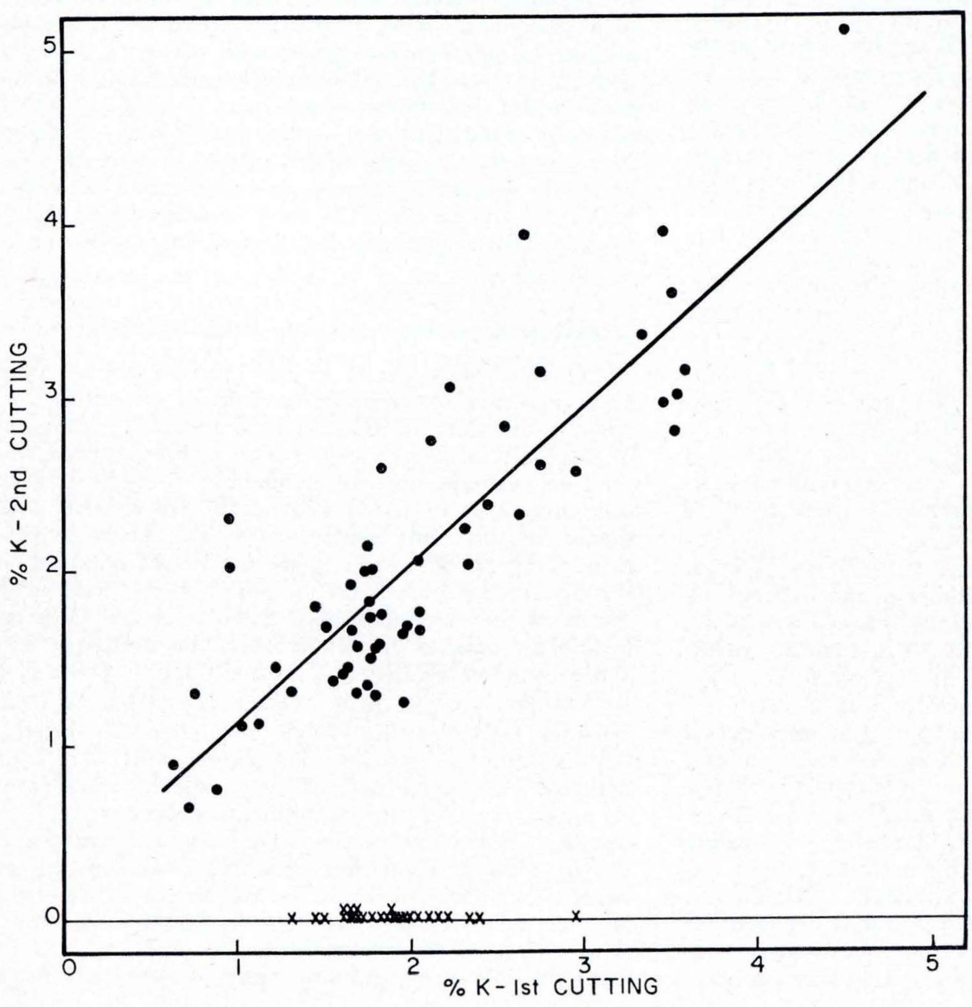

Fig. 5. Relation between percent K in alfalfa plants of first and second cuttings from unfertilized plots of North Central Regional field experiments (x indicates that samples were not obtained from the second cutting).

$\%K_2 = 0.23 + 0.90\%K_1$
$r = 0.86^{**}$

from the first cutting was less than 1.4 in only 11 of 88 field experiments harvested.

Considering the generally high K content of the plants from the check plots, one would not expect many large yield increases to have resulted from applications of potassium fertilizer. In only 15 of the experiments were there significant yield increases (table 4). The significant first-cutting yield increases from 80 pounds K_2O per acre in these 15 experiments ranged from 260 to 980 pounds of hay per acre and averaged 560 pounds per acre. The percent K in the alfalfa plants from these same experiments ranged from 1.05 to 2.26 and averaged 1.81. In this study there was no relationship between percent K in the plants and the increases in yield obtained. In fact, in only 1 of the 11 experiments where the plants contained less than 1.4 percent K was there a significant yield increase resulting from the application of K fertilizer.

The lack of response to potassium fertilizer application was probably due in part to a bias in selecting experimental sites. Selecting only sites with good stands of alfalfa the year after seeding caused many potassium-deficient sites to be rejected because they had poor alfalfa stands.

Even though applications of K fertilizer did not result in many significant yield increases, in most of the experiments appreciable amounts of the applied K were taken up by the plants. The percent K in the plants and the recovery of added K by the plants were linearly related to the amount of K applied up to application rates of 80 pounds of K_2O per acre at most locations. A lower percentage recovery at higher rates of application usually resulted in deviations from linearity for rates above 80 pounds of K_2O per acre. Because of this, the estimates reported in table 4 of the increase in percent K in the plants resulting from applications of K fertilizer and the estimates of the percent of fertilizer K recovered in the plants were based only on K_2O applications up to the 80-pound-per-acre rate. These estimates were calculated from the slopes of the linear regressions for the relationships between: (1) the percent K in the plants and the pounds of K_2O applied per acre and (2) pounds of K per acre taken up by the plants and pounds of K_2O applied per acre. The relationship between pounds of K in the alfalfa and pounds of K_2O applied for a typical experiment is illustrated in fig. 6. In this example, percent recovery equals $0.22 \times 1.2 \times 100 = 26$.

An application of 100 pounds of K_2O per acre increased the percent K in the alfalfa of the first cutting by as much as 1.29. The average increase was 0.42. Percent recovery of applied K in the first cutting varied from 0 to 67 percent in different experiments and averaged 27 percent. Percent recovery was inversely related to the percent K in the plants from unfertilized plots ($r = -0.32^{**}$) and directly related to dry matter yields of the unfertilized plots ($r = 0.40^{**}$). These two variables account for only a small part of the variability in the percent recovery, however, indicating that other individual, unidentified factors might explain more of the observed variations. Undoubtedly, moisture conditions, and possibly reactions between the fertilizer and the soil, were important. Recovery of added K by the plants in the second cutting was generally

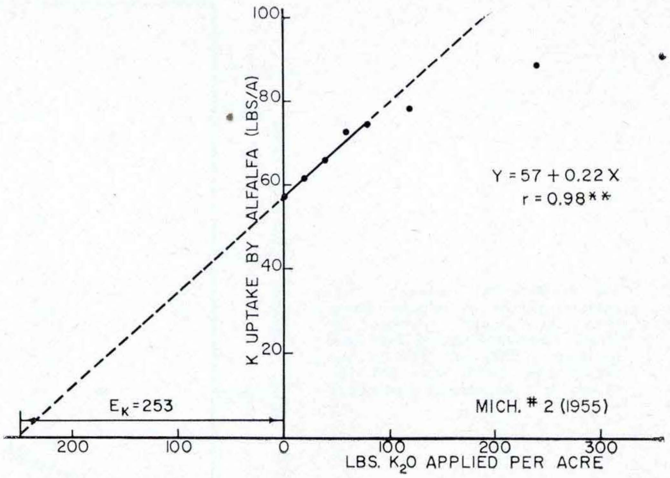

Fig. 6. Relation between the amount of K fertilizer applied per acre and the pounds of K per acre in the alfalfa plants from a typical field experiment. (The three points at the right were not included in the regression.)

much lower than that for the first cutting. In the 54 experiments for which recovery was calculated for both cuttings, the total recovery in the two cuttings ranged from 0 to 90 percent and averaged 33 percent of that applied.

Although alfalfa requires large amounts of K for near maximum yields, it does not compete effectively with other plants such as grasses and weeds for K under conditions where K availability is low (3, 5, 11). Therefore, under K-deficient conditions, grasses and other plants growing with the alfalfa usually have a higher K content than do the alfalfa plants. In nine of these regional experiments there were mixed stands of alfalfa with grass and/or clover. In these experiments, K in the grass or clover averaged 0.4 percent higher than that in the alfalfa.

RELATION BETWEEN FIELD AND GREENHOUSE RESULTS

The use of pot tests in the greenhouse has often been advocated as a better method of measuring nutrient availability in soils than a chemical extraction of the soil, because in pot tests growing plants are used to evaluate nutrient availability to plants. Since soil samples from most of the field experiments conducted in this study were used in greenhouse experiments, it is possible to compare the results obtained in the greenhouse with those obtained in the field. The results of the greenhouse experiment will be published in another bulletin, but comparisons between the field and greenhouse results are presented here.

The soil samples from the 1955 experiments were air dried before potting for the greenhouse experiment, but the samples from the 1956 experiments were kept undried. There were not sufficient yield increases from K applications in the experiments of either year to permit a comparison of yield responses in the field and the greenhouse. Therefore, comparisons were made between: (1) the percent K in the alfalfa in the field and the millet in the greenhouse, (2) the amount of K removed by the plants from the untreated soil in the field and the greenhouse and (3) the recovery of

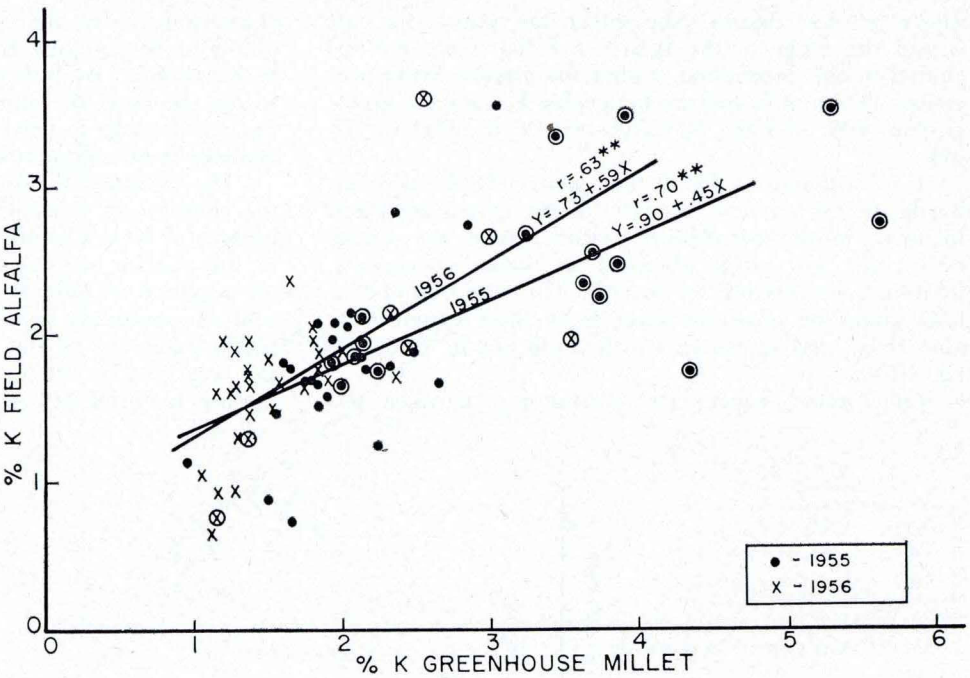

Fig. 7. Relation between percent K in alfalfa (first cutting) from field experiments and percent K in millet plants grown on surface soil samples in the greenhouse. (Soil samples for the greenhouse experiments were air dried in 1955 but were not dried in 1956. Circled values are from field experiments that were not included in later correlation studies with soil analyses.)

added K by the plants in the field and the greenhouse.

The relation between the percent K of the first-cutting alfalfa plants in the field and the millet in the greenhouse is illustrated in fig. 7. It can be seen that there is a general relationship between the K contents of plants in the field and the greenhouse. The correlation coefficients ($r = 0.70^{**}$ in 1955; $r = 0.63^{**}$ in 1956) are significant at the 1-percent level. The percent K in the greenhouse millet, however, does not permit a very accurate estimate of the percent K in the field alfalfa.

The amounts of K taken up by the plants from the soil without added fertilizer K in the field and in the greenhouse were related ($r = 0.42^{*}$ in 1955, and $r = 0.35^{*}$ in 1956). These values, however, were not as highly correlated as were those for percent K in the plants.

The correlation between percent recovery of applied K by the plants in the field and the greenhouse was significant at the 1-percent level in 1955 ($r = 0.55^{**}$), but was not significant in 1956 ($r = 0.13$).

Part of the difference between field and greenhouse results is undoubtedly due to plant uptake of K from the subsoil in the field; however, differences in other factors such as moisture, temperature, aeration, and intensity of K removal are probably of equal and perhaps even greater importance. The difference in the plants grown (alfalfa and millet) might also be expected to cause differences between the field and greenhouse results. These various factors appear to have less influence on the percent K in the plants than on the dry-matter yield.

RELATION BETWEEN FIELD AND LABORATORY RESULTS

Correlation studies between field and laboratory results were restricted to the results from 51 of the 89 field experiments. No alfalfa was harvested from four of the experiments. Other experiments were not included where: (1) the exchangeable K in the soil exceeded 400 pp2m, (2) the alfalfa yields were variable between replicates resulting in little or no relationship between K treatments and yield or K uptake by the plants, (3) alfalfa yields were very low (usually because of drouth), (4) exchangeable K was extremely variable between replicates and (5) incomplete sampling resulted in incomplete data for exchangeable K of the soil or the K content of the plants.

Three indexes of K availability to the alfalfa plants in these experiments were used. These included: (1) the concentration of K in the plants of the first cutting from check plots (percent K), (2) the amount of K taken up from the soil by the plants of the first cutting (pounds K/A) and (3) the availability of soil K in relation to that of applied fertilizer K (E_k values calculated as shown in fig. 6). These three indexes of K availability to plants were related as shown in table 5. The degree of correlation between percent K and pounds K/A was higher than that between either of these two variables and the E_k values. This would be expected, since percent K was one of the two factors used to calculate pounds K/A.

The relationship between the indexes of K availability to alfalfa plants and the exchangeable K in field-moist 0-6 inch soil samples is shown in figs. 8, 9 and 10. All the values included in the correlation studies are

TABLE 5. CORRELATIONS BETWEEN PAIRS OF THE THREE INDEXES OF K AVAILABILITY TO ALFALFA PLANTS USED IN CORRELATION STUDIES.

Estimates of K availability[a]	Correlation coefficient (r)
%K and lbs. K/A	0.83**
%K and E_k	0.56**
Lbs. K/A and E_k	0.58**

[a] %K = percent K in first cutting of alfalfa.
Lbs. K/A = pounds of K per acre removed in the first cutting of alfalfa.
E_k = extrapolated K value (see fig. 6).
** Significant at the 1-percent level.

shown in these figures. Also shown are values that fall within the range of the figures but that were not included in the correlation studies for reasons listed previously. Three soils had exchangeable K contents greater than 600, and the E_k values exceeded 1,000 for 18 soils.

It is apparent in fig. 9 that pounds K/A taken up by the plants was low in many of the experiments not included in the correlation studies. These low values reflect the low yields obtained in these experiments, in most cases because of drouth. This also resulted in low uptake of added fertilizer K in these experiments and, thus, high E_k values which could not be shown in fig. 10.

One would expect the relationship between exchangeable K in the soil and the percent K in the plants or the pounds K/A taken up by the plants to be curvilinear. As indicated in figs. 8 and 9, however, within the range of values used in the correlation studies the relationship is very nearly linear, so all regression analyses were calculated on a linear basis.

The coefficients of determination (r^2 or R^2) for the simple and multiple linear regressions relating the indexes of K availability to plants and exchangeable K in the soil for various depths and moisture conditions are reported in table 6. These data show that the percent of variability in the indexes of K availability to plants explained by the exchangeable K content of the soil was greatest for the field-moist soil samples or for samples air dried at constant temperature. This air dry-

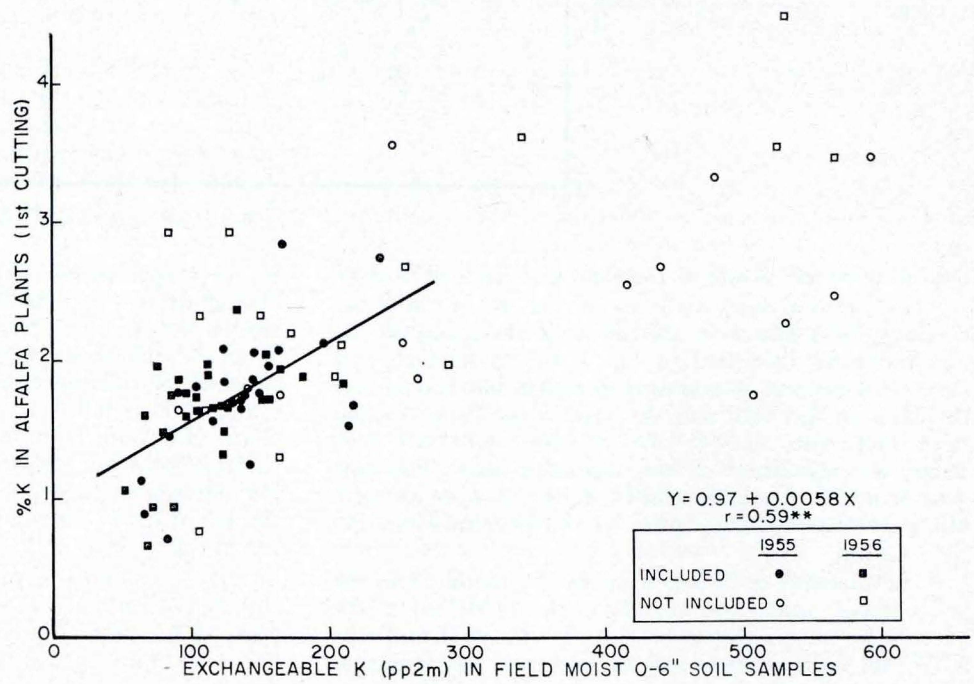

Fig. 8. Relation between percent K in alfalfa plants (first cutting) and exchangeable K in field-moist soil samples from the 0-6 inch layer. (Only solid points were included in the correlation studies.)

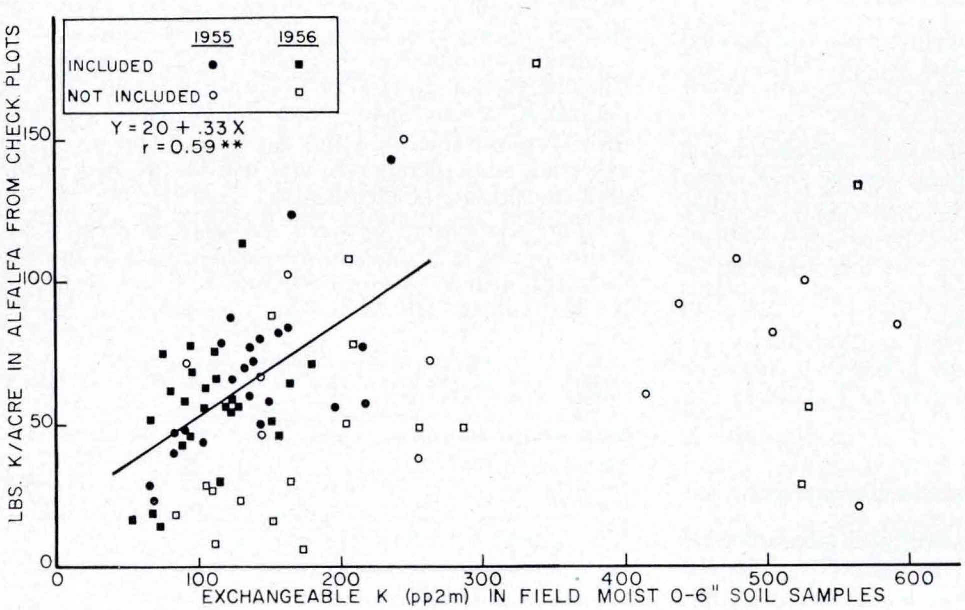

Fig. 9. Relation between pounds of K per acre in the alfalfa plants and the exchangeable K in field-moist soil samples from the 0-6 inch layer. (Only solid points were included in the correlation studies.)

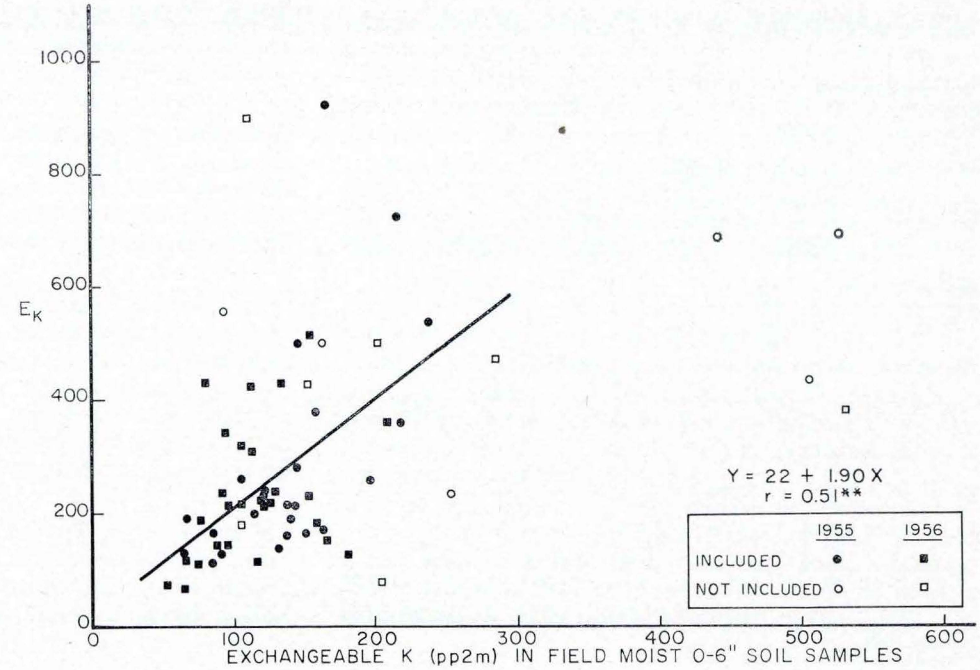

Fig. 10. Relation between E_k values calculated from K uptake by alfalfa in field experiments and exchangeable K in field-moist soil samples from the 0-6 inch layer. (Only solid points were included in the correlation studies.)

ing at 5°C. generally resulted in only small changes in exchangeable K from that observed in field-moist samples. As the degree of drying increased, the r^2 and R^2 values decreased. The coefficients of determination were consistently lowest for oven-dried samples. This agrees with the results obtained in greenhouse studies where exchangeable K in field-moist soil samples gave the best prediction of K availability to plants.

The r^2 values generally decreased with increasing depth in the soil. The r^2 values for 6-12 inch soil samples that were field moist or air dried at 5°C. were just as high as those for the 0-6 inch samples for percent K, however, and much higher for the E_k values. The coefficients of determination for the 12-18 inch layer of soil were in all cases much lower than for the 6-12 inch layer. Exchangeable K in layers below 18 inches was highly correlated with that in the 12-18 inch layer, and the coefficients of determination for these deeper layers were similar to those for the 12-18 inch sample. The coefficients obtained for all oven-dried subsoil samples were very low.

The inclusion in a multiple regression of exchangeable K values for all the layers sampled (0-6 inches to 30-36 inches) improved the correlations between exchangeable K in the soil and the indexes of K availability to plants over that obtained for samples from any one depth alone. Nevertheless, there was much less improvement for the dried soil samples than for the field-moist samples. In fact, very little improvement resulted from inclusion of exchangeable K for oven-dried soil samples from all soil layers over that obtained from the 0-6 inch layer alone. This effect could be expected since exchangeable K in field-moist samples appears to provide the better estimate of K availability to plants, and drying resulted in very large increases in exchangeable K in many of the subsoil samples.

Since the exchangeable K values for field-moist soil samples were most highly correlated with the estimates of K availability to plants, only field-moist exchangeable K values were used in a more detailed study of the K contributions of different soil depths to the plants. The regression equations for these relationships are shown in table 7. The figures directly below the regression coefficients are the standard errors associated with the respective coefficients. These standard errors provide an approximate method of assessing the significance of the regression coefficients. As a rough rule, a regression coefficient is significant at the 5-percent level if it exceeds twice its standard error.

Where the regression equations include all six soil layers, none of the regression coefficients for depths be-

TABLE 6. COEFFICIENTS OF DETERMINATION FOR REGRESSIONS RELATING INDEXES OF K AVAILABILITY TO PLANTS AND THE EXCHANGEABLE K IN SOIL SAMPLES FROM DIFFERENT LAYERS AND DETERMINED AT DIFFERENT MOISTURE CONTENTS.

Index of K availability to plants	Soil layer included[a]	Coefficient of determination (r^2 or R^2) for regression with exchangeable K determined on soil samples that were:			
		Field moist	Air dried (const. temp.)	Air dried (soil test)	Oven dried
%K	X_1	0.35**	0.37**	0.30**	0.20**
	X_2	0.36**	0.38**	0.18**	0.11*
	X_3	0.19**	0.27**	0.12*	0.10*
	X_1, X_2	0.46**	....	....	....
	X_1, X_2, X_3	0.46**	....	....	....
	$X_1, X_2, X_3, X_4, X_5, X_6$	0.47**	0.50**	0.37**	0.24*
Lbs. K/A	X_1	0.35**	0.31**	0.23**	0.14**
	X_2	0.23**	0.21**	0.07	0.06
	X_3	0.04	0.10*	0.04	0.05
	X_1, X_2	0.38**	....	....	....
	X_1, X_2, X_3	0.49**	....	....	....
	$X_1, X_2, X_3, X_4, X_5, X_6$	0.50**	0.44**	0.30**	0.20
E_k	X_1	0.26**	0.23**	0.29**	0.20**
	X_2	0.62**	0.32**	0.12*	0.06
	X_3	0.30**	0.17**	0.10*	0.05
	X_1, X_2	0.63**	....	....	....
	X_1, X_2, X_3	0.71**	....	....	....
	$X_1, X_2, X_3, X_4, X_5, X_6$	0.72**	0.45**	0.33**	0.24*

[a] X_1, X_2, X_3, X_4, X_5 and X_6 represent exchangeable K (pp2m) in soil samples from the 0-6, 6-12, 12-18, 18-24, 24-30 and 30-36 inch layers, respectively.
* Significant at the 5-percent level.
** Significant at the 1-percent level.

TABLE 7. REGRESSION EQUATIONS AND COEFFICIENTS OF DETERMINATION FOR SOME RELATIONSHIPS BETWEEN EXCHANGEABLE K IN FIELD-MOIST SOILS AND DIFFERENT INDEXES OF K AVAILABILITY TO ALFALFA PLANTS IN THE FIELD.

Regression equation[a]	Coefficient of determination (r^2 or R^2)
$\%K = 0.97 + 0.0058X_1$	0.35**
± 0.0011	
$\%K = 0.85 + 0.0037X_1 + 0.0053X_2$	0.46**
$\pm 0.0016 \quad \pm 0.0023$	
$\%K = 0.85 + 0.0034X_1 + 0.0078X_2 - 0.0026X_3$	0.46**
$\pm 0.0017 \quad \pm 0.0046 \quad \pm 0.0042$	
$\%K = 0.83 + 0.0037X_1 + 0.0077X_2 - 0.0012X_3 - 0.0026X_4 + 0.0081X_5 - 0.0074X_6$	0.47*
$\pm 0.0018 \quad \pm 0.0046 \quad \pm 0.0065 \quad \pm 0.0067 \quad \pm 0.0138 \quad \pm 0.0123$	
$\text{Lbs. } K/A = 20 + 0.33X_1$	0.35**
± 0.07	
$\text{Lbs. } K/A = 17 + 0.26X_1 + 0.18X_2$	0.38**
$\pm 0.09 \quad \pm 0.13$	
$\text{Lbs. } K/A = 19 + 0.20X_1 + 0.71X_2 - 0.56X_3$	0.49**
$\pm 0.10 \quad \pm 0.26 \quad \pm 0.24$	
$\text{Lbs. } K/A = 16 + 0.22X_1 + 0.68X_2 - 0.61X_3 - 0.05X_4 + 0.39X_5 - 0.24X_6$	0.50**
$\pm 0.11 \quad \pm 0.27 \quad \pm 0.37 \quad \pm 0.39 \quad \pm 0.79 \quad \pm 0.71$	
$E_k = 22 + 1.90X_1$	0.26**
± 0.46	
$E_k = -65 + 0.41X_1 + 3.79X_2$	0.63**
$\pm 0.62 \quad \pm 0.87$	
$E_k = -51 + 0.047X_1 + 6.87X_2 - 3.25X_3$	0.71**
$\pm 0.65 \quad \pm 1.74 \quad \pm 1.39$	
$E_k = -48 - 0.058X_1 + 6.88X_2 - 3.64X_3 + 0.65X_4 - 2.66X_5 + 2.72X_6$	0.72**
$\pm 0.70 \quad \pm 1.76 \quad \pm 2.46 \quad \pm 2.56 \quad \pm 5.27 \quad \pm 4.68$	

[a] X_1, X_2, X_3, X_4, X_5 and X_6 represent exchangeable K (pp2m) in soil samples from the 0-6, 6-12, 12-18, 18-24, 24-30 and 30-36 inch soil layers, respectively.
* Significant at the 5-percent level.
** Significant at the 1-percent level.

low 18 inches in any of the three equations approach significance at the 5-percent level.

Eliminating the lower three layers so the regression equations include only the top three soil layers reduces the coefficient of determination in each case by only 0.01 from that obtained by using all six depths. Where only the top three soil depths are used, the regression coefficients for the 12-18 inch layer are significant at the 5-percent level in the equations for pounds K/A and E_k, but not in the equation for percent K. It may be noted that the regression coefficient for the 12-18 inch layer is negative in all the equations. This does not appear to be realistic, and the reason for it is not obvious. The fact that exchangeable K values in the 6-12 and the 12-18 inch layers were highly correlated ($r = 0.88^{**}$) is probably involved. As would be expected from the significance of the regression coefficients, eliminating the 12-18 inch layer from the regression equations, leaving only the 0-6 and 6-12 inch layers, reduced the coefficients of determination for pounds K/A and E_k but not for percent K.

The regression equations for predicting percent K indicate that exchangeable K in both the 0-6 and 6-12 inch layers is important. The equation for pounds K/A indicates that exchangeable K in the 0-6 and 12-18 inch layers is of greatest importance. For predicting E_k values the exchangeable K in the 6-12 inch soil layer is of most importance, and that in the 12-18 inch layer is also significant, but the regression coefficient for the 0-6 inch layer is significant only where it is used alone.

From this it may be concluded that each 6-inch layer of soil to a depth of 18 inches made a significant contribution to the alfalfa plants and that knowledge of the exchangeable K in the soil to this depth can be used to improve the estimation of K availability to alfalfa plants growing in the field. It should not be concluded, however, that alfalfa plants do not obtain significant amounts of K from below the 18-inch depth in the soil. Exchangeable K contents of field-moist soil samples from below the 18-inch depth showed relatively small differences with depth and were highly correlated with exchangeable K in the 12-18 inch layer. Therefore, inclusion of the exchangeable K values for these depths would not improve the correlations obtained. Nonetheless, plants probably did obtain K from these depths.

In practice, the marked improvement in precision of estimation derived from the inclusion of measurements of exchangeable K on field-moist samples below the surface 6 inches might be obtained either directly or indirectly—directly by actually making the measurements or indirectly by estimation from the exchangeable K in the surface layer. Unpublished data of the Department of Agronomy, Iowa State University, indicate that the level of exchangeable K in the individual lower soil layers is reasonably constant within soil types. Once these levels are established for the different soil types, most of the improvement in precision attainable by measuring exchangeable K in the lower layers of soil can be attained without making actual measurements on any except the surface layer where exchangeable K will vary within soil types because of management and fertilization practices.

Including soil pH or the change in exchangeable K that occurred on oven drying the soil samples in the multiple regression equations, did not significantly increase the coefficients of determination.

SUMMARY AND CONCLUSIONS

During 1955 and 1956, 89 field experiments in which K fertilizer was applied at different rates for alfalfa were conducted in seven North Central states, Alaska and Ontario, Canada. The yield and K content of the alfalfa were determined. Soil samples from each field experiment were used in supplementary greenhouse and laboratory studies.

Regardless of the plant method used for estimating K availability or the depth of soil sampled, the index of plant availability of K was more highly correlated with K extracted from field-moist soil samples than from samples that were air dried at room temperature or oven dried.

Drying different surface soil samples resulted in increases, no change or decreases in exchangeable K. Fewer soils from the eastern part of the region showed large increases in exchangeable K as a result of drying. Changes in exchangeable K in surface soil samples because of drying seldom exceeded 100 pp2m, but in some soils this meant that the amount of K extracted was nearly doubled by drying.

Drying of subsoil samples resulted in increased exchangeable K in almost all samples, except some from sandy soils, and with some the increase from drying was almost tenfold. Therefore, it is imperative that analyses for exchangeable K in subsoils be made on undried samples.

Exchangeable K in field-moist subsoil samples was almost always considerably lower than in corresponding surface soil samples.

Knowledge of exchangeable K in the 6-12 and possibly the 12-18 inch layers in addition to that in the 0-6 inch layer can be used to improve the estimation of K availability to alfalfa plants growing in the field.

Percentages of K in the alfalfa from different cuttings were highly correlated, even though dry matter yields of the different cuttings were not.

Significant yield increases of alfalfa from K fertilization were obtained in only 15 of the 89 experiments, and the increases of the first cutting in these 15 experiments averaged only ¼ ton of hay per acre with no increases greater than ½ ton per acre.

The correlations between percent K, amount of K in the plants and percent recovery of added K in field alfalfa and greenhouse millet were not high, indicating that environmental conditions in the field have a marked effect on K uptake by plants in the field.

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APPENDIX

TABLE A-1. CHARACTERISTICS OF THE SOILS ON WHICH FIELD EXPERIMENTS WERE CONDUCTED.

						Laboratory analysis							
						Field moist		Air dried[a]		Air[b] dried	Oven dried	Soil test[b]	
State	Year	Expt.	County	Soil type	Sample depth (in.)	Exch. K pp2m	H_2O %	Exch. K pp2m	H_2O %	Exch. K pp2m	Exch. K pp2m	pH	P pp2m
Alaska	1956	1	Third Judicial District	Knik sil	0- 6	165	21	177	4	84	129	6.1	14
					6-12	132	20	114	5	74	127	6.0	10
					12-18	122	17	95	5	60	94	6.0	6
					18-24	222*	14	220*	4	94	136*	6.0	6
					24-30	32	2	50	2	32	52	6.6	6
					30-36	34	2	66	2	38	65	6.6	8
Illinois	1956	1	Montgomery	Oconee sil	0- 6	151*	20	186*	5	183*	216*	5.4	5
					6-12	110	20	152	5	177	191	5.4	2
					12-18	73	20	146	7	230	246	5.4	1
					18-24	77	20	163	9	329	318	5.4	1
					24-30	78	19	164	8	326	360	5.4	1
					30-36	80	17	170	8	310	372	5.6	1
Illinois	1956	2	Macoupin	Ebbert sil	0- 6	92	21	104	4	151	132	6.4	7
					6-12	68	19	101	3	179	189	6.1	3
					12-18	66	16	128	5	285	311	6.2	1
					18-24	79	19	150	7	302	389	6.3	1
					24-30	68	18	142	7	255	370	6.5	1
					30-36	53	17	116	7	215	316	6.7	1
Indiana	1955	1	Montgomery	Brookston sil	0- 6	150	24	160	6	136	205	6.4	10
					6-12	66	24	137	6	185	310	6.7	1
					12-18	62	20	145	8	208	403	6.4	1
					18-24	60	18	152	8	218	432	6.6	< 1
					24-30	62	15	146	7	197	393	6.7	< 1
					30-36	65	14	133	6	184	336	7.0	< 1
Indiana	1955	2	Montgomery	Miami sil (gritty)	0- 6	90	22	76	3	79	99	6.8	6
					6-12	64	19	83	4	99	101	6.7	3
					12-18	59	18	92	6	124	196	6.5	< 1
					18-24	60	18	123	8	186	274	6.3	< 1
					24-30	65	15	129	6	187	287	7.1	< 1
					30-36	53	13	99	5	140	181	7.5	< 1
Indiana	1955	3	Montgomery	Reesville sil	0- 6	84	19	72	4	91	115	6.3	3
					6-12	62	20	125	8	189	314	6.3	< 1
					12-18	63	19	142	8	216	415	6.6	< 1
					18-24	49	17	123	7	165	347	7.1	< 1
					24-30	42	19	106	6	125	297	7.7	< 1
					30-36	39	18	104	5	121	274	8.0	< 1
Indiana	1955	4	Montgomery	Brookston sil	0- 6	158	24	167	6	168	237	6.2	10
					6-12	104	26	157	9	189	334	6.5	7
					12-18	85	17	162	7	228	438	6.8	4
					18-24	79	15	151	7	217	446	7.3	1
					24-30	78	15	149	7	229	429	7.6	< 1
					30-36	73	14	152	7	231	465	7.6	< 1
Indiana	1955	5	Cass	Miami l	0- 6	123	12	123	2	129	119	6.4	3
					6-12	55	12	72	4	102	104	6.9	< 1
					12-18	48	12	84	4	135	172	6.6	< 1
					18-24	46	13	89	3	144	192	6.8	< 1
					24-30	46	11	89	4	145	195	7.4	< 1
					30-36	46	11	70	4	99	139	8.1	< 1
Indiana	1955	6	Cass	Brookston sil	0- 6	131	28	157	7	144	151	6.6	9
					6-12	69	20	95	7	130	211	6.7	3
					12-18	63	14	101	6	149	292	7.1	1
					18-24	62	12	121	6	181	328	7.5	< 1
					24-30	64	12	118*	6	157*	254*	7.7	< 1
					30-36	65	13	111*	5	151*	251*	7.7	< 1

TABLE A-1 (continued)

State	Year	Expt.	County	Soil type	Sample depth (in.)	Laboratory analyses: Field moist Exch. K pp2m	Field moist H_2O %	Air dried[a] Exch. K pp2m	Air dried[a] H_2O %	Air[b] dried Exch. K pp2m	Oven dried Exch. K pp2m	Soil test[b] pH	Soil test[b] P pp2m
Indiana	1955	7	Cass	Brookston sil	0- 6	117	18	122	5	106	106	6.5	9
					6-12	39	15	60	2	56	95	6.6	2
					12-18	32	12	86	2	94	169	7.0	1
					18-24	30	12	89	2	118	185	7.1	< 1
					24-30	23	12	73	4	84	142	7.7	< 1
					30-36	26	14	74	2	78	140	7.9	< 1
Indiana	1955	8	Cass	Miami l	0- 6	91	15	104	2	100	91	6.8	9
					6-12	47	13	62	2	62	81	7.1	1
					12-18	43	12	89	3	119	175	6.7	< 1
					18-24	43	13	113	4	132	223	6.8	< 1
					24-30	39	13	106	4	117	202	6.9	< 1
					30-36	42	12	100	3	129	183	7.1	< 1
Indiana	1956	1	Fulton	Crosby fsl	0- 6	95	10	103	4	91	82	6.5	13
					6-12	61	9	61	3	59	63	6.1	11
					12-18	46	8	54*	3	66*	63*	5.8	7
					18-24	47	10	73*	5	75*	90*	5.6	1
					24-30	72*	13	119	4	139	195	5.9	< 1
					30-36	67	15	116	3	124	191	6.6	< 1
Indiana	1956	2	Fulton	Brookston sil	0- 6	103	22	104	3	86	104	6.0	30
					6-12	52	20	67	3	58	70	5.8	14
					12-18	23	14	45	3	59	64	6.0	5
					18-24	28	13	69	2	98	105	5.9	4
					24-30	24	10	51	2	58	81	6.8	1
					30-36	33	10	60	2	73	88	7.4	2
Indiana	1956	3	Fulton	Coloma lfs	0- 6	111	5	116	2	114	98	6.5	28
					6-12	78	6	71	2	61	59	6.4	21
					12-18	53	6	59	1	55	47	6.2	14
					18-24	44	6	52	2	46	39	6.1	6
					24-30	40	5	38	2	41	33	6.0	3
					30-36	36	5	40	2	47	39	6.1	1
Indiana	1956	4	Fulton	Brookston sil	0- 6	131	14	135	2	125	123	7.0	13
					6-12	91	12	96	2	75	78	6.6	4
					12-18	38	9	39	2	41	52	6.8	1
					18-24	38	15	96	4	86	129	6.7	< 1
					24-30	43	15	98	3	109	151	7.2	< 1
					30-36	39	14	94	4	103	142	7.4	< 1
Indiana	1956	5	St. Joseph	Tracy lfs	0- 6	76	9	87	3	87	76	6.6	22
					6-12	83	9	85	3	83	82	6.2	23
					12-18	57	10	70	7	84	77	5.9	27
					18-24	41	9	69	4	93	85	6.4	17
					24-30	45	8	67	5	100	98	6.8	14
					30-36	37	5	47	3	77	70	6.7	13
Indiana	1956	6	St. Joseph	Tracy lfs	0- 6	90	6	105	3	112	86	6.6	37
					6-12	78	7	73	2	84	60	6.3	27
					12-18	60	7	56	2	55	45	6.3	18
					18-24	41	6	39	3	49	41	6.0	14
					24-30	35	5	34	2	40	36	6.1	11
					30-36	35	4	35	2	45	37	6.1	8
Indiana	1956	7	St. Joseph	Brookston sicl	0- 6	111	33	115	3	96	114	6.8	32
					6-12	76	32	89	5	87	90	6.8	24
					12-18	36	24	71	4	93	90	7.0	10
					18-24	26	20	65	3	112	114	7.6	3
					24-30	29	11	61	2	107	94	7.8	2
					30-36	22	12	44	3	69	70	8.0	2
Indiana	1956	8	St. Joseph	Tracy lfs	0- 6	104	10	104	5	125	95	5.8	20
					6-12	56	9	55	4	68	57	6.0	19
					12-18	50	9	54	2	79	61	5.7	20
					18-24	32	8	51	3	80	62	5.8	15
					24-30	39	7	56	2	83	71	5.9	15
					30-36	38	6	45	2	65	60	6.1	13
Iowa	1955	1	Washington	Clinton sil	0- 6	239	25	268	2	223	264	7.0	10
					6-12	115	13	135	4	180	259	6.5	14
					12-18	70	15	141	3	261	416	6.1	21
					18-24	68	18	163	6	364	536	5.6	27
					24-30	64	20	176	5	375	584	5.4	29
					30-36	67	20	179	6	372	572	5.3	35
Iowa	1955	2	Washington	Clinton sil	0- 6	122	23	153	3	170	232	7.5	3
					6-12	60	18	144	6	292	448	6.3	1
					12-18	51	20	150	6	361	489	5.7	6
					18-24	48	21	155	8	378	551	5.5	15
					24-30	42	23	151	7	362	530	5.5	28
					30-36	47	24	146	6	352	514	5.5	34
Iowa	1955	3	Story	Clarion sil	0- 6	143	16	156	3	163	212	7.3	3
					6-12	97	10	100	2	170	199	7.1	2
					12-18	61	10	74	3	153	205	7.3	1
					18-24	33	9	62	2	145	209	7.9	< 1
					24-30	30	9	60	2	132	190	7.9	< 1
					30-36	33	10	61	3	104	181	8.0	< 1
Iowa	1955	4	Story	Clarion sil	0- 6	138	18	152	1	154	208	6.9	3
					6-12	72	15	113	6	166	213	6.4	1
					12-18	52	14	96	6	166	216	6.3	< 1
					18-24	38	13	90	7	168	244	7.1	< 1
					24-30	31	12	78	4	151	234	7.6	< 1
					30-36	27	12	67	3	129	196	8.0	< 1

TABLE A-1 (continued)

State	Year	Expt.	County	Soil type	Sample depth (in.)	Laboratory analysis: Field moist Exch. K pp2m	Field moist H_2O %	Air dried[a] Exch. K pp2m	Air dried[a] H_2O %	Air[b] dried Exch. K pp2m	Oven dried Exch. K pp2m	Soil test[b] pH	Soil test[b] P pp2m
Iowa	1955	5	Marshall	Tama sil	0- 6	440	26	438	3	> 400	526	6.7	8
					6-12	104	22	159	6	308	462	6.3	3
					12-18	63	20	133	7	303	459	6.1	6
					18-24	55	20	130	7	294	466	6.1	12
					24-30	47	21	128	7	293	467	6.2	15
					30-36	46	22	129	6	313	452	6.3	14
Iowa	1955	6	Marshall	Tama sil	0- 6	219	27	252	5	251	319	7.3	5
					6-12	103	21	155	5	262	362	6.0	2
					12-18	84	21	151	7	281	398	6.0	1
					18-24	61	22	141	7	292	474	6.2	3
					24-30	52	22	132	6	295	501	6.3	4
					30-36	57	22	130	6	278	485	6.7	3
Iowa	1955	7	Dubuque	Fayette sil	0- 6	140	22	147	3	135	180	7.4	4
					6-12	46	22	119	5	237	368	6.2	10
					12-18	46	23	114	6	266	412	5.8	19
					18-24	48	23	106	6	272	425	5.7	26
					24-30	43	23	112	6	277	406	5.9	30
					30-36	44	23	109	6	285	431	5.7	30
Iowa	1955	8	Jackson	Fayette sil	0- 6	145	26	147	3	158	162	7.4	7
					6-12	60	18	83	4	157	224	6.2	6
					12-18	55	18	96	4	221	360	5.4	10
					18-24	55	19	109	5	251	416	5.3	16
					24-30	51	20	114	6	269	440	5.2	23
					30-36	57	22	119	6	265	438	5.3	31
Iowa	1955	9	Delaware	Carrington l	0- 6	139	32	138	5	149	153	6.9	2
					6-12	48	27	77	6	120	160	5.6	1
					12-18	45	24	80	6	152	199	5.5	< 1
					18-24	32	20	85	5	163	217	5.8	< 1
					24-30	32	19	89	4	162	241	6.1	< 1
					30-36	27	19	92	5	167	209	6.2	< 1
Iowa	1955	10	Delaware	Carrington sl	0- 6	164	18	170	4	150	171	7.0	4
					6-12	66	16	118	4	98	107	5.7	2
					12-18	58	16	116	4	110	116	5.4	1
					18-24	37	14	112	4	119	147	5.4	< 1
					24-30	30	14	136	4	128	203	5.3	< 1
					30-36	30	14	138	4	154	236	5.4	< 1
Iowa	1956	11	Jackson	Fayette sil	0- 6	159	21	184	4	211	205	5.9	5
					6-12	80	23	138	5	208	184	5.6	5
					12-18	60	23	126	5	240	244	5.2	1
					18-24	48	22	128	5	278	310	5.2	4
					24-30	45	23	133	6	290	256	5.1	4
					30-36	44	20	134	6	320	329	5.2	12
Iowa	1956	12	Jackson	Fayette sil (eroded)	0- 6	128	16	145	4	175	161	6.2	6
					6-12	60	19	108	4	228	214	5.9	3
					12-18	43	21	126	5	270	278	5.6	5
					18-24	46	20	128	6	306	303	5.6	6
					24-30	42	18	130	5	302	317	5.6	22
					30-36	40	18	128	6	284	324	5.6	23
Iowa	1956	13	Delaware	Carrington 1	0- 6	124	16	135	3	164	162	5.8	7
					6-12	64	20	93	5	146	124	5.7	2
					12-18	47	19	80	4	158	130	5.7	2
					18-24	30	16	79	5	176	174	5.8	1
					24-30	28	11	78	4	158	197	6.1	1
					30-36	28	9	72	3	164	196	6.2	1
Iowa	1956	14	Delaware	Carrington 1	0- 6	121	14	126	3	154	143	6.2	6
					6-12	69	17	91	4	142	124	5.9	4
					12-18	46	17	79	..	138	110	5.9	2
					18-24	28	14	68	3	144	145	5.8	1
					24-30	37	11	70	3	158	157	5.8	2
					30-36	28	13	73	3	162	152	6.0	2
Iowa	1956	15	Bremer	Floyd sil	0- 6	121	43	161	8	161	193	6.2	5
					6-12	72	23	130	10	212	290	6.7	2
					12-18	54	19	125	7	204	326	6.9	1
					18-24	38	14	110	4	192	316	7.2	1
					24-30	30	10	82	3	138	228	7.6	< 1
					30-36	30	11	80	5	132	204	7.7	< 1
Iowa	1956	16	Bremer	Clyde sil	0- 6	210	27	234	5	203	245	6.3	6
					6-12	88	22	121	8	150	171	6.0	3
					12-18	62	21	120	8	156	199	6.2	2
					18-24	54	19	124	9	198	288	6.5	1
					24-30	37	17	112	7	182	316	6.9	1
					30-36	38	11	86	4	166	274	7.4	1
Kansas	1955	1	Cherokee	Cherokee sil	0- 6	102	14	122	4	104	137	6.6	5
					6-12	94	19	74	6	108	94	5.6	2
					12-18	122	25	110	9	128	242	5.2	< 1
					18-24	112	18	154	10	232	328	4.9	< 1
					24-30	75	16	150	9	224	321	4.8	< 1
					30-36	66	16	142	8	216	277	4.8	< 1
Kansas	1955	2	Cherokee	Bates vfsl	0- 6	65	15	86	4	76	100	7.0	10
					6-12	32	14	63	1	46	88	5.7	< 1
					12-18	25	16	66	4	80	100	5.3	< 1
					18-24	38	16	80	4	118	150	5.6	< 1
					24-30	36	16	89	5	136	191	5.8	< 1
					30-36	47	15	105	6	180	230	6.0	< 1

TABLE A-1 (continued)

State	Year	Expt.	County	Soil type	Sample depth (in.)	Laboratory analysis: Field moist, Exch. K pp2m	Field moist, H_2O %	Air dried[a], Exch. K pp2m	Air dried[a], H_2O %	Air[b] dried, Exch. K pp2m	Oven dried, Exch. K pp2m	Soil test[b], pH	Soil test[b], P pp2m
Kansas	1955	3	Labette	Parsons sil	0- 6	145	12	185	5	188	264	5.6	20
					6-12	176	18	178	8	280	382	5.8	2
					12-18	178	20	186	10	394	454	6.2	< 1
					18-24	187	18	181	9	284	431	6.3	< 1
					24-30	100	17	194	10	246	405	6.4	< 1
					30-36	84	17	193	10	252	357	6.6	< 1
Kansas	1955	4	Neosho	Bates vfsl	0- 6	254	21	292	6	256	296	5.6	< 1
					6-12	312	22	344	5	296	357	5.8	< 1
					12-18	544	23	540	10	>400	494	6.0	< 1
					18-24	466	26	492	10	384	511	6.2	< 1
					24-30	247	25	294	11	260	404	6.4	< 1
					30-36	112	19	194	3	220	340	6.6	< 1
Kansas	1955	5	Franklin	Woodson sil	0- 6	262	20	292	6	248	368	6.6	8
					6-12	88	21	166	9	220	350	6.2	3
					12-18	110	20	206	9	356	507	6.4	1
					18-24	106	15	201	8	312	520	6.6	1
					24-30	99	12	188	7	336	488	7.1	< 1
					30-36	86	13	180	6	300	460	7.2	< 1
Kansas	1955	6	Riley	Hobbs-like sil (alluvial)	0- 6	565	11	589	4	>400	645	5.2	24
					6-12	347	15	398	5	364	487	5.4	11
					12-18	222	14	292	5	292	406	5.4	7
					18-24	194	17	295	9	308	432	5.7	6
					24-30	214	15	301	9	320	447	5.8	6
					30-36	219	10	294	5	328	478	6.0	7
Kansas	1955	7	Riley	Geary sicl	0- 6	675	11	681	7	>400	800	6.0	22
					6-12	340	14	381	7	>400	606	6.2	8
					12-18	150	12	232	7	308	486	6.7	1
					18-24	125	12	214	7	300	471	6.6	2
					24-30	138	11	216	6	300	475	6.8	1
					30-36	131	11	211	6	288	461	7.0	2
Kansas	1956	1	Riley	Hobbs-like sil (alluvial)	0- 6	522	23	615	4	>400	612	5.3	23
					6-12	262	23	328	4	>380	386	5.8	7
					12-18	224	24	318	5	320	392	5.8	6
					18-24	218	25	348	6	364	483	5.8	6
					24-30	228	20	355	4	>392	465	5.8	6
					30-36	222	16	367	5	>400	548	5.9	6
Kansas	1956	2	Riley	Geary sicl	0- 6	567	21	602	7	>400	639	5.8	25
					6-12	288	22	318	5	>400	534	5.7	10
					12-18	169	23	236	5	354	456	6.4	4
					18-24	142	22	222	6	342	446	6.9	2
					24-30	122	22	208	5	322	460	6.8	3
					30-36	121	21	199	5	329	476	7.0	2
Kansas	1956	3	Riley	Sarpy fsl	0- 6	531	18	602	4	>400	574	7.8	23
					6-12	365	17	463	3	>362	479	7.4	15
					12-18	227	17	293	5	294	378	7.3	6
					18-24	151	21	204	5	238	302	7.7	5
					24-30	127	12	162	1	194	244	8.0	4
					30-36	149	13	186	1	230	288	8.1	2
Kansas	1956	4	Cherokee	Cherokee sil	0- 6	82	18	90	3	123	110	5.7	1
					6-12	72	18	84	5	120	117	5.6	< 1
					12-18	85	26	118	10	154	216	5.3	1
					18-24	109	24	154	9	214	292	5.0	1
					24-30	155	19	195	9	245	314	5.0	< 1
					30-36	103	18	142	7	214	252	5.0	1
Kansas	1956	5	Neosho	Parsons sil	0- 6	106	21	110	3	151	142	6.6	2
					6-12	65	23	102	5	154	150	5.7	1
					12-18	90	22	144	6	170	198	6.4	1
					18-24	109	20	177	6	234	272	7.2	1
					24-30	136	23	206	8	254	311	7.8	1
					30-36	133	21	192	7	260	292	8.1	1
Kansas	1956	6	Labette	Parsons sil	0- 6	129	20	140	4	142	200	7.0	8
					6-12	83	20	121	5	170	219	5.5	1
					12-18	109	23	142	7	178	277	5.6	1
					18-24	116	20	168	8	228	323	5.7	1
					24-30	134	19	194	8	270	373	6.4	1
					30-36	181	16	232	8	286	419	7.0	1
Kansas	1956	7	Franklin	Woodson sil	0- 6	134	18	155	4	148	210	6.8	5
					6-12	88	20	144	7	221	279	6.2	2
					12-18	116	20	168	8	278	410	6.4	2
					18-24	138	21	202	9	322	480	6.6	2
					24-30	132	19	206	8	388	486	6.8	2
					30-36	136	17	188	8	334	502	7.1	2
Kansas	1956	8	Cherokee	Cherokee sil	0- 6	151	20	178	3	160	192	6.6	3
					6-12	68	22	140	5	170	224	5.6	1
					12-18	82	23	175	3	180	215	5.4	2
					18-24	111	27	195	9	228	290	5.8	2
					24-30	105	25	200	10	298	344	5.8	1
					30-36	128	24	228	12	298	345	6.5	1
Kansas	1956	9	Neosho	Parsons sil	0- 6	111	17	109	3	128	149	6.5	3
					6-12	69	19	86	4	132	134	5.4	2
					12-18	66	21	104	6	168	180	5.4	2
					18-24	74	19	120	7	190	200	5.7	1
					24-30	71	18	116	7	196	208	6.0	1
					30-36	62	17	96	6	170	183	6.6	< 1

TABLE A-1 (continued)

State	Year	Expt.	County	Soil type	Sample depth (in.)	Field moist: Exch. K pp2m	Field moist: H_2O %	Air dried[a]: Exch. K pp2m	Air dried[a]: H_2O %	Air[b] dried: Exch. K pp2m	Oven dried: Exch. K pp2m	Soil test[b]: pH	Soil test[b]: P pp2m
Kansas	1956	10	Neosho	Bates vfsl	0- 6	172	21	181	4	198	191	5.9	< 1
					6-12	112	18	130	6	158	165	5.5	1
					12-18	128	25	146	6	170	198	6.2	1
					18-24	127	26	188	10	218	294	6.5	1
					24-30	146	24	204	10	230	334	7.1	1
					30-36	130	23	186	9	210	313	7.6	< 1
Michigan	1955	1	Kalamazoo	Fox sl	0- 6	232	11	216	1	214	173	7.5	42
Michigan	1955	2	Ingham	Hillsdale sl	0- 6	199	18	193	2	166	138	7.2	5
					6-12	67	14	92	3	97	111	7.3	< 1
					12-18	68	15	91	4	110	148	6.9	< 1
					18-24	59	14	78	4	127	163	7.0	< 1
					24-30	60	15	89	4	121	159	7.8	< 1
					30-36	61	13	80	3	111	140	7.9	< 1
Michigan	1956	1	Rose Lake Wildlife Expt. Station	Bellefontaine sl	0- 6	151	15	167	5	132	120	5.9	10
					6-12	70	11	71	2	66	61	6.0	4
					12-18	52	10	75	3	97	95	5.6	10
					18-24	60	11	100	5	146	159	5.2	9
					24-30	65	10	108	3	166	154	5.1	10
					30-36	69	11	108	3	151	158	5.1	10
Michigan	1956	2	Kalamazoo	Fox sl	0- 6	180	13	168	3	169	166	6.2	13
					6-12	80	12	104	3	140	138	6.0	16
					12-18	72	10	98	3	150	142	5.4	14
					18-24	48	7	68	3	118	108	5.5	13
					24-30	35	8	57	5	82	62	5.5	9
					30-36	28	4	52	1	62	54	5.6	7
Michigan	1956	3	Ingham	Conover l	0- 6	80	15	81	3	68	86	6.6	3
					6-12	56	15	62	3	61	150	7.0	2
					12-18	54	15	102	2	138	188	7.1	< 1
					18-24	44	15	102	3	146	161	7.8	< 1
					24-30	42	14	80	3	126	132	8.1	< 1
					30-36	38	12	62	3	89	130	8.2	< 1
Michigan	1956	4	Clinton	Miami l	0- 6	209	17	204	4	161	174	5.8	2
					6-12	100	11	105	2	89	104	6.2	2
					12-18	67	12	86	2	104	132	6.7	< 1
					18-24	67	13	96	2	124	116	7.4	< 1
					24-30	59	12	86	3	101	116	7.9	< 1
					30-36	64	11	84	2	98	110	8.0	1
Michigan	1956	5	Jackson	Bellefontaine sl	0- 6	65	6	69	3	67	60	6.9	6
					6-12	52	7	46	2	39	39	7.0	10
					12-18	32	6	42	2	35	31	6.9	7
					18-24	26	7	40	2	32	36	6.8	5
					24-30	30	7	31	2	38	40	6.6	5
					30-36	30	5	34	3	43	42	6.6	4
Minnesota	1955	1	Steele	Nicollet cl	0- 6	217	25	191	5	197	250	7.4	21
					6-12	117	22	115	5	145	156	7.0	10
					12-18	60	21	71	5	161	228	6.6	11
					18-24	56	20	85	6	210	320	6.3	5
					24-30	61	20	93	6	234	344	7.1	3
					30-36	68	20	104	7	223	367	7.8	4
Minnesota	1955	2	Jackson	Clarion cl (variable sandy subsoil)	0- 6	507*	20	514*	5	> 400*	543*	6.5	5
					6-12	212*	22	308*	6	> 284*	352*	6.9	1
					12-18	119*	19	195*	6	270*	317*	6.6	< 1
					18-24	77	16	119	4	214	307	7.3	< 1
					24-30	69	17	117	4	188	302	7.9	< 1
					30-36	60	18	100	4	165	259	8.1	< 1
Minnesota	1955	3	Fillmore	Fayette sil	0- 6	162	24	177	4	179	197	6.9	7
					6-12	76	21	114	5	176	194	6.5	9
					12-18	62	19	124	6	200	299	6.1	13
					18-24	57	18	129	6	228	328	5.9	21
					24-30	53	20	133	5	230	346	5.8	24
					30-36	65	20	137	5	222	380	5.9	25
Minnesota	1955	4	Stevens	Aastad sil (variable subsoil)	0- 6	1,010*	29	1,058*	10	> 400*	1,061*	7.7	6
					6-12	673*	25	687*	6	> 400*	752*	7.8	3
					12-18	346*	20	366*	5	> 307*	562*	8.0	< 1
					18-24	139*	16	194	6	236	425*	8.2	< 1
					24-30	98	16	157	6	197	368	8.1	< 1
					30-36	99	16	163	6	197	351	8.1	< 1
Minnesota	1955	5	Crow Wing	Menahga sil	0- 6	166	6	165	2	200	154	6.5	51
					6-12	197	6	193	1	199	169	7.2	43
					12-18	180	6	166	1	174	128	6.7	36
					18-24	151	7	141	1	143	116	6.8	28
					24-30	128	6	119	1	128	102	6.7	21
					30-36	119	7	107	2	107	97	6.8	19
Minnesota	1955	6	Ottertail	Rothsay sicl	0- 6	529	29	551	11	> 400	647	7.4	5
					6-12	235	27	292	7	294	500	7.8	2
					12-18	100	21	170	6	256	471	8.1	< 1
					18-24	75	19	140	5	197	429	8.4	< 1
					24-30	55	20	109	5	183	336	8.4	< 1
					30-36	62	18	118	4	182	331	8.5	< 1
Minnesota	1955	7	Hubbard	Beltrami vfsl	0- 6	123	17	127	2	96	116	6.3	14
					6-12	63	15	59	4	65	68	6.4	14
					12-18	36	11	52	3	90	181	6.3	8
					18-24	37	11	69	3	128	270	6.8	5
					24-30	37	13	68	3	117	211	7.9	2
					30-36	51	12	69	3	102	246	8.2	1

TABLE A-1 (continued)

State	Year	Expt.	County	Soil type	Sample depth (in.)	Laboratory analysis: Field moist Exch. K pp2m	Field moist H_2O %	Air dried[a] Exch. K pp2m	Air dried[a] H_2O %	Air[b] dried Exch. K pp2m	Oven dried Exch. K pp2m	Soil test[b] pH	Soil test[b] P pp2m
Minnesota	1955	8	Polk No. 1	Fargo sic	0- 6	592	34	615	11	> 400	910	8.0	9
					6-12	298	27	382	10	389	632	8.2	4
					12-18	177	21	282	7	394	614	8.5	< 1
					18-24	167	20	287	10	394	582	8.6	< 1
					24-30	134	20	274	8	397	574	8.7	< 1
					30-36	141	19	269	8	392	566	8.6	< 1
Minnesota	1955	9	Polk No. 2	Bearden sicl	0- 6	480	29	492	10	> 400	755	8.1	18
					6-12	199	22	260	8	357	474	8.4	2
					12-18	116	20	184	8	290	375	8.4	< 1
					18-24	104	18	172	8	281	373	8.5	< 1
					24-30	127	18	194	10	295	411	8.5	< 1
					30-36	144	19	211	9	332	461	8.5	< 1
Minnesota	1956	1	Mower	Floyd cl	0- 6	107	21	123	6	177	177	7.0	10
					6-12	48	23	93	6	160	158	6.3	2
					12-18	41	19	92	6	206	218	5.9	1
					18-24	40	16	81	5	208	237	6.0	1
					24-30	34	17	67	4	152	204	6.4	1
					30-36	31	8	64	3	124	201	6.7	< 1
Minnesota	1956	2	Washington	Hubbard ls	0- 6	72	5	67	1	88	79	5.5	11
					6-12	35	7	49	1	68	58	5.9	5
					12-18	32	6	37	2	74	56	6.0	2
					18-24	30	4	34	2	74	52	6.0	2
					24-30	32	4	34	1	74	55	6.1	2
					30-36	30	4	32	1	82	64	6.2	2
Minnesota	1956	3	Anoka	Lino lfs	0- 6	87	7	86	1	87	79	6.6	24
					6-12	41	9	48	1	52	55	6.2	16
					12-18	34	9	34	1	46	42	6.4	13
					18-24	38	10	38	1	50	52	6.3	10
					24-30	43	13	45	3	70	74	6.2	9
					30-36	41	13	52	2	86	88	5.8	6
Minnesota	1956	4	Pine (1)	Hayden fsl	0- 6	121	16	115	2	100	118	6.7	6
					6-12	64	15	68	2	108	113	6.1	4
					12-18	41	16	88	4	272	270	5.6	2
					18-24	45	17	116	6	336	292	5.3	2
					24-30	58	16	110	7	328	332	5.2	6
					30-36	52	16	109	5	308	286	5.4	9
Minnesota	1956	5	Benton	Milaca fsl	0- 6	68	15	62	1	77	57	6.4	6
					6-12	32	12	30	2	48	40	6.2	2
					12-18	29	9	28	2	54	43	6.3	1
					18-24	24	10	30	2	68	46	6.1	1
					24-30	29	10	35	2	76	56	6.2	1
					30-36	31	10	34	3	72	53	6.2	1
Minnesota	1956	6	Pine (2)	Milaca fsl	0- 6	90	21	92	2	97	95	6.2	12
					6-12	32	13	40	2	44	36	5.7	2
					12-18	28	11	34	2	42	34	5.9	1
					18-24	44	11	42	1	48	40	6.3	< 1
					24-30	37	10	34	2	58	41	6.4	< 1
					30-36	34	10	38	2	74	58	6.8	1
Minnesota	1956	7	Pine (3)	Crown fsl	0- 6	98	24	102	3	82	101	5.7	45
					6-12	66	18	66	2	66	58	5.4	36
					12-18	30	17	33	3	44	29	5.2	26
					18-24	24	19	26	3	28	28	5.3	26
					24-30	26	17	30	4	64	28	5.3	42
					30-36	26	11	28	2	52	24	5.4	32
Nebraska	1955	1	Merrick	Thurman ls	0- 6	247	6	215	1	324	258	7.6	12
					6-12	156	7	134	1	204	161	6.0	2
					12-18	87	7	98	1	145	131	6.2	< 1
					18-24	72	7	80	1	122	99	6.6	< 1
					24-30	71	7	112	1	120	112	7.2	1
					30-36	89	9	134	1	126	134	6.8	1
Nebraska	1955	2	Dawson	Hall sil	0- 6	1,488	5	1,416	5	> 400	1,525	6.8	32
					6-12	992	5	990	5	> 400	1,050	6.7	17
					12-18	725	5	702	5	> 400	865	6.8	12
					18-24	712	5	719	5	> 400	908	7.2	10
					24-30	1,020	5	1,010	5	> 400	1,140	8.0	11
					30-36	1,358	5	1,374	5	> 400	1,462	8.3	9
Nebraska	1956	1	Cedar	Moody vfsl	0- 6	254	5	266	4	300	282	6.7	11
					6-12	164	6	168	2	218	214	7.2	3
					12-18	69	5	94	2	196	225	7.4	1
					18-24	64	6	96	3	190	220	7.3	1
					24-30	72	4	92	3	184	250	8.1	1
					30-36	59	4	84	2	160	218	8.3	< 1
Nebraska	1956	2	Stanton	Thurman ls	0- 6	340	2	328	1	377	341	7.5	22
					6-12	143	3	140	1	210	172	7.4	4
					12-18	145	3	156	1	196	170	7.0	2
					18-24	109	4	120	1	168	156	7.0	1
					24-30	77	3	89	1	148	142	6.9	1
					30-36	68	2	74	1	124	110	7.0	1
Ontario	1955	K-1	Wellington	Guelph l	0- 6	82	4	78	3	90	93	7.6	2
					6-12	67	4	59	3	73	83	7.7	1
					12-18	56	5	55	3	70	81	7.8	< 1
					18-24	48	4	54	3	61	68	8.0	< 1
					24-30	47	3	47	2	59	57	8.1	< 1
					30-36	47	2	43	2	67	62	8.1	< 1

TABLE A-1 (continued)

State	Year	Expt.	County	Soil type	Sample depth (in.)	Laboratory analyses: Field moist, Exch. K pp2m	Field moist, H_2O %	Air dried[a], Exch. K pp2m	Air dried[a], H_2O %	Air[b] dried, Exch. K pp2m	Oven dried, Exch. K pp2m	Soil test[b], pH	Soil test[b], P pp2m
Ontario	1955	K-2	Brant	Burford l	0- 6	142	4	142	2	130	128	7.2	9
					6-12	77	5	75	3	79	113	7.3	8
					12-18	83	6	82	3	96	127	7.4	8
					18-24	99	5	89	4	95	124	7.5	7
					24-30	102	5	98	4	112	131	7.8	4
					30-36	93	4	85	3	109	141	7.9	14
Ontario	1955	K-3	Lincoln	Haldimand c	0- 6	418	8	440	5	326	287	6.2	7
					6-12	172	19	233	6	244	346	6.3	< 1
					12-18	148	21	214	8	238	371	6.8	< 1
					18-24	160	21	214	7	243	337	7.6	< 1
					24-30	146	17	169	5	189	274	8.1	< 1
					30-36	133	17	160	6	193	261	8.2	< 1
Ontario	1955	K-4	Waterloo	Fox sl	0- 6	66	3	61	2	70	70	7.2	7
					6-12	40	2	34	2	45	47	7.6	4
					12-18	41	3	38	2	48	49	7.8	2
					18-24	37	3	34	3	46	59	8.0	2
					24-30	31	2	31	2	42	47	8.1	2
					30-36	26	2	38	2	36	42	8.2	1
Ontario	1956	K-1	Wellington	Guelph l	0- 6	94	11	112	2	93	108	7.4	4
					6-12	72	8	81	3	78	89	7.5	2
					12-18	62	7	74	3	84	95	7.8	1
					18-24	102	4	100	3	116	117	7.8	< 1
					24-30	82	5	72	3	96	108	7.9	< 1
					30-36	75	4	72	2	92	96	8.1	< 1
Ontario	1956	K-2	Waterloo	Fox sl	0- 6	52	4	64	3	62	64	7.3	4
					6-12	24	2	32	2	46	38	7.8	2
					12-18	26	1	28	1	44	38	7.9	1
					18-24	22	1	26	1	38	36	8.1	1
					24-30	18	1	20	1	31	26	8.2	1
					30-36	14	< 1	15	< 1	22	22	8.4	< 1
Ontario	1956	K-3	Waterloo	Dumfries l	0- 6	163	7	169	4	125	145	6.9	30
					6-12	66	15	99*	7	138*	128*	7.7	4
					12-18	58	12	94*	6	124*	118*	7.8	2
					18-24	34	6	36	2	50	48	8.0	2
					24-30	29	6	32	3	38	46	8.1	1
					30-36	21	5	24	4	30	35	8.0	< 1
Ontario	1956	K-4	Waterloo	Perth cl	0- 6	117	11	144	3	122	175	7.2	2
					6-12	96	11	124	5	132	192	7.6	1
					12-18	108	10	144	5	168	235	8.2	1
					18-24	84	9	120	3	138	196	8.3	1
					24-30	86	8	120	3	128	188	8.4	1
					30-36	89	8	120	3	122	175	8.4	< 1
Ontario	1956	K-5	Waterloo	Huron cl	0- 6	202	9	212	5	177	248	7.5	6
					6-12	131	10	156	4	170	251	8.0	1
					12-18	82	10	111	3	124	185	8.4	< 1
					18-24	84	9	110	2	118	182	8.4	1
					24-30	84	9	111	2	128	188	8.4	< 1
					30-36	86	10	111	2	130	179	8.4	1
Ontario	1956	K-6	Lincoln	Haldimand cl	0- 6	285*	23	325*	7	227	331	6.8	3
					6-12	239	18	286	8	210	323	7.2	1
					12-18	184	16	226	10	214	351	8.0	2
					18-24	125	16	199	6	187	262	8.2	< 1
					24-30	128	15	168	3	175	256	8.2	< 1
					30-36	138	15	178	6	184	262	8.3	< 1

[a] Air dried for 2 weeks at 5°C. and 40 percent relative humidity prior to analysis.
[b] Air dried for 2 weeks at room temperature. Analysis in Iowa State University Soil Testing Laboratory.
* Results extremely variable between replicates.

TABLE A-2. YIELD IN POUNDS OF DRY MATTER PER ACRE AND PERCENT POTASSIUM OF ALFALFA AS INFLUENCED BY APPLICATIONS OF POTASSIUM FERTILIZER.

State	Year	Expt.	Cutting	Determination	Pounds $K_{2}0$ applied per acre							
					0	20	40	60	80	120	240	360
Alaska	1956	1	1	Yield	2,280	3,400	2,560	2,160	2,300	2,200	....	....
				% K	1.30	1.21	1.24	1.39	1.46	1.32	....	....
Ill.	1956	1	1	Yield	2,860	2,930	2,780	2,880	2,790	2,810	....	....
				% K	1.77	1.78	2.01	1.95	2.10	2.22	....	....
			2	Yield	1,000	1,040	920	940	950	990	....	....
				% K	1.83	1.59	1.59	1.53	1.66	1.66	....	....
			3	Yield	1,090	1,130	1,010	1,010	1,050	920	....	....
				% K	1.95	1.81	2.34	2.25	2.43	2.43	....	....
Ill.	1956	2	1	Yield	2,590	2,820	2,810	2,940	2,760	2,840	....	....
				% K	1.78	1.78	1.93	1.95	2.04	2.01	....	....
			2	Yield	1,510	1,460	1,270	1,620	1,590	1,580	....	....
				% K	1.54	1.59	1.65	1.71	1.81	1.89	....	....
			3	Yield	1,630	1,610	1,280	1,610	1,600	1,650	....	....
				% K	1.59	1.59	1.68	1.69	1.71	1.72	....	....
Ind.	1955	1	1	Yield	3,230	3,160	3,380	3,330	3,650	3,280	3,440	3,560
				% K	1.79	1.88	2.25	2.23	2.34	2.73	2.56	2.89
			2	Yield	2,060	2,120	2,360	2,350	2,260	2,490	2,460	2,550
				% K	2.00	2.05	2.23	2.27	2.19	2.85	2.97	3.04
Ind.	1955	2	1	Yield	2,770	2,760	2,570	2,850	2,970	3,030	2,900	2,770
				% K	1.78	1.93	2.29	2.38	2.60	2.66	2.87	3.06
			2	Yield	2,780	2,710	2,760	2,920	2,960	3,050	2,910	2,910
				% K	2.00	2.13	2.02	2.53	2.51	2.54	2.90	3.04
Ind.	1955	3	1	Yield	3,360	3,520	3,740	3,840	3,560	3,600	3,700	3,600
				% K	1.44	1.64	1.92	1.69	2.11	2.68	2.36	2.69
			2	Yield	3,250	2,950	3,010	3,120	3,210	3,130	3,210	3,320
				% K	1.80	1.82	2.01	1.99	1.97	2.15	2.30	2.49
			3	Yield	1,690	2,140	1,980	2,220	2,120	2,210	2,280	2,240
				% K	0.97	1.11	1.21	1.28	1.33	1.53	1.66	1.87
Ind.	1955	4	1	Yield	4,090	4,150	3,980	4,060	4,030	4,120	4,000	3,790
				% K	1.99	2.26	2.36	2.53	2.38	2.69	2.82	3.00
			2	Yield	3,000	3,100	3,090	3,320	3,180	3,350	3,290	3,300
				% K	1.25	1.35	1.41	1.62	1.61	1.77	1.98	2.34
			3	Yield	2,520	2,360	2,420	2,520	2,420	2,400	2,450	2,700
				% K	1.43	1.47	1.61	1.70	1.73	1.70	1.85	2.30
Ind.	1955	5	1	Yield	3,650	3,760	4,000	4,170	3,720	3,900	4,130	3,750
				% K	1.82	1.89	2.19	2.07	2.35	2.69	2.76	2.93
			2	Yield	2,180	2,600	2,400	2,320	2,420	2,420	2,700	2,250
				% K	1.58	1.86	1.87	1.84	1.92	2.04	2.26	2.52
			3	Yield	1,050	1,290	1,170	1,210	1,220	1,350	1,390	1,210
				% K	1.50	1.62	1.61	1.57	1.70	1.76	1.93	1.97
Ind.	1955	6	1	Yield	4,100	4,180	4,490	4,480	4,360	4,810	4,620	4,940
				% K	1.70	1.64	1.93	2.32	2.28	2.40	2.59	2.79
			2	Yield	3,390	3,000	3,460	3,470	3,480	3,310	3,460	3,590
				% K	1.57	1.65	1.78	1.84	1.92	2.16	2.30	2.54
			3	Yield	1,800	1,720	2,060	1,980	1,890	2,230	1,880	1,840
				% K	1.49	1.58	1.47	1.58	1.67	1.79	1.94	2.08
Ind.	1955	7	1	Yield	4,990	5,450	5,040	5,500	5,450	5,490	5,720	5,910
				% K	1.59	1.98	2.04	2.14	2.17	2.37	2.63	2.74
			2	Yield	3,290	3,630	3,320	3,790	3,400	3,670	3,610	3,880
				% K	1.38	1.16	1.32	1.44	1.57	1.70	1.84	2.04
Ind.	1955	8	1	Yield	4,370	4,500	4,170	4,060	3,930	3,790	3,920	3,890
				% K	1.63	1.97	1.87	1.91	2.14	2.44	2.55	2.75
			2	Yield	3,400	3,590	3,580	3,270	3,680	3,250	3,490	3,560
				% K	1.43	1.63	1.72	1.80	1.81	2.00	2.21	2.30
Ind.	1956	1	1	Yield	4,260	4,140	4,290	4,350	4,470	4,490	....	....
				% K	1.60	1.65	1.72	1.97	2.01	2.32	....	....
Ind.	1956	2	1	Yield	3,860	3,680	3,840	3,820	3,750	3,920	....	....
				% K	1.62	1.63	1.65	1.75	2.07	2.37	....	....
Ind.	1956	3	1	Yield	3,860	3,900	3,850	4,100	3,990	4,100	....	....
				% K	1.98	1.83	2.11	2.13	2.14	2.61	....	....
Ind.	1956	4	1	Yield	4,730	4,770	4,770	4,870	4,730	4,770	....	....
				% K	2.38	2.16	2.26	2.44	2.73	2.67	....	....
Ind.	1956	5	1	Yield	3,820	3,640	4,090	4,040	3,990	4,050	....	....
				% K	1.95	1.95	2.25	2.35	2.52	2.79	....	....
Ind.	1956	6	1	Yield	3,030	3,010	3,150	3,300	2,950	3,170	....	....
				% K	1.86	2.04	2.28	2.43	2.50	2.83	....	....
Ind.	1956	7	1	Yield	3,540	3,470	3,090	3,280	3,230	2,890	....	....
				% K	1.90	1.92	2.47	2.23	2.64	2.76	....	....
Ind.	1956	8	1	Yield	3,250	3,080	3,020	3,460	3,250	3,320	....	....
				% K	1.74	1.92	2.25	....	2.40	2.25	....	....
Iowa	1955	1	1	Yield	5,240	5,140	5,300	5,570	5,250	5,030	5,350	5,340
				% K	2.75	2.85	2.92	2.94	3.08	3.14	3.10	3.37
			2	Yield	2,490	2,240	2,590	2,590	2,630	2,440	2,530	2,670
				% K	2.60	2.66	2.80	2.84	2.77	2.90	2.87	3.03
Iowa	1955	2	1	Yield	4,170	4,540	4,430	4,330	4,710	4,220	4,170	4,310
				% K	2.07	2.27	2.53	2.50	2.58	2.69	3.15	3.35
			2	Yield	3,640	3,980	3,790	3,420	3,800	3,920	3,820	4,300
				% K	1.67	1.71	1.66	1.80	1.82	2.00	2.36	2.41

TABLE A-2 (continued)

State	Year	Expt.	Cutting	Determination	Pounds K_2O applied per acre 0	20	40	60	80	120	240	360
Iowa	1955	3	1	Yield	3,700	3,260	3,460	3,610	3,440	3,780	3,530	3,530
				% K	1.80	1.77	1.82	1.91	1.85	2.11	2.09	2.28
			2	Yield	2,150	1,780	1,820	1,750	1,770	2,000	1,800	2,020
				% K	1.57	1.53	1.69	1.73	1.71	1.96	2.06	2.28
Iowa	1955	4	1	Yield	4,550	5,080	5,200	5,410	5,230	5,180	5,480	5,290
				% K	1.66	1.78	1.75	1.94	2.02	2.08	2.23	2.32
			2	Yield	2,010	1,910	1,840	1,880	1,880	2,010	2,080	2,120
				% K	1.64	1.66	1.76	1.80	1.74	1.95	2.14	2.31
Iowa	1955	5	1	Yield	3,420	3,480	3,620	3,670	3,860	3,940	3,820	3,680
				% K	2.68	2.74	2.67	2.69	2.70	2.82	2.87	2.90
			2	Yield	2,810	3,010	2,900	3,100	2,930	2,900	3,160	3,100
				% K	2.32	2.44	2.46	2.39	2.59	2.42	2.63	2.68
Iowa	1955	6	1	Yield	3,450	3,580	3,580	3,570	3,530	3,670	3,560	3,700
				% K	1.68	1.96	2.02	2.04	2.09	2.05	2.34	2.38
			2	Yield	3,110	3,360	3,320	3,330	3,460	3,220	3,420	3,510
				% K	1.93	1.93	1.96	2.07	2.14	2.12	2.41	2.36
Iowa	1955	7	1	Yield	4,030	4,130	4,060	4,420	4,490	4,380	4,330	4,440
				% K	1.79	1.88	1.91	2.22	2.18	2.29	2.76	2.80
			2	Yield	3,070	3,130	3,100	3,150	3,090	3,150	3,390	3,340
				% K	1.71	1.81	1.94	1.99	1.88	2.00	1.90	1.95
Iowa	1955	8	1	Yield	3,900	4,080	4,100	4,040	4,440	4,380	4,560	4,310
				% K	2.05	2.32	2.28	2.40	2.46	2.76	3.02	3.07
			2	Yield	2,200	2,430	2,610	2,530	2,660	2,710	2,720	2,670
				% K	2.05	2.24	2.20	2.16	2.21	2.70	2.70	3.13
Iowa	1955	9	1	Yield	3,510	3,860	3,670	3,920	3,930	4,250	4,500	4,280
				% K	1.70	1.93	2.00	2.33	2.34	2.81	3.61	3.84
			2	Yield	1,940	2,170	1,970	2,200	2,280	2,430	2,770	2,810
				% K	1.28	1.18	1.19	1.21	1.36	1.50	2.15	2.28
Iowa	1955	10	1	Yield	4,170	4,190	4,330	4,390	4,620	4,620	4,490	5,010
				% K	2.07	2.17	2.56	2.43	2.77	2.97	3.59	3.58
			2	Yield	2,540	2,600	2,590	2,590	2,800	2,750	2,880	2,930
				% K	1.77	1.65	1.71	1.69	1.74	2.03	2.58	2.60
Iowa	1956	11	1	Yield	2,690	2,760	3,140	3,120	3,120	3,170	....	....
				% K	1.72	1.84	2.03	2.06	2.06	2.22	....	....
Iowa	1956	12	1	Yield	3,340	3,420	3,510	3,320	3,340	3,500	....	....
				% K	1.68	1.82	1.78	2.11	2.32	2.47	....	....
Iowa	1956	13	1	Yield	3,450	3,520	3,350	3,530	3,640	3,970	....	....
				% K	1.68	1.74	1.98	2.01	2.07	2.21	....	....
Iowa	1956	14	1	Yield	3,780	3,850	3,810	3,220	4,170	3,240	....	....
				% K	1.48	1.66	1.83	2.00	1.96	2.26	....	....
Iowa	1956	16	1	Yield	4,280	4,260	4,150	4,040	4,480	4,600	....	....
				% K	1.81	1.89	1.88	1.96	2.20	2.34	....	....
Kan.	1955	1	1	Yield	2,440	2,050	2,280	2,240	2,520	2,090	2,300	2,280
				% K	1.80	1.80	2.03	2.16	2.13	2.15	2.42	2.56
				Yield	1,880	1,840	1,780	1,950	1,980	1,890	1,960	1,930
			2	% K	1.30	1.34	1.55	1.49	1.57	1.66	1.90	2.15
Kan.	1955	2	1	Yield	2,500	2,300	2,300	2,320	2,440	2,390	2,310	2,580
				% K	1.14	1.27	1.50	1.55	1.81	2.04	2.30	2.60
			2	Yield	3,120	2,810	3,210	3,490	2,910	2,960	3,700	3,480
				% K	1.17	1.13	1.40	1.57	1.53	2.00	2.52	2.78
Kan.	1955	3	1	Yield	2,460	2,750	2,850	2,930	2,630	3,050	3,040	2,780
				% K	1.87	2.04	1.94	1.92	2.14	2.18	2.21	2.41
Kan.	1955	4	1	Yield	1,750	1,970	1,790	2,000	1,970	1,770	2,030	1,830
				% K	2.13	1.98	2.96	2.67	2.32	2.55	2.65	2.67
			2	Yield	1,910	1,800	1,930	1,890	1,860	1,830	1,940	1,920
				% K	2.77	3.15	2.92	3.07	2.72	3.03	3.44	3.35
			3	Yield	1,650	1,710	1,650	1,600	1,570	1,610	1,410	1,580
				% K	2.13	2.51	2.78	2.67	2.23	2.51	3.05	2.63
Kan.	1955	5	1	Yield	3,920	4,260	4,100	3,890	3,590	3,740	3,640	3,710
				% K	1.84	2.00	1.92	1.94	1.88	2.10	2.30	2.21
			2	Yield	2,880	3,090	2,860	3,120	2,790	2,910	2,880	2,770
				% K	2.60	2.59	2.59	2.69	2.66	2.76	2.96	2.94
			3	Yield	980	990	970	1,130	840	760	960	1,090
				% K	1.94	2.00	2.00	1.99	1.98	2.05	2.07	2.12
Kan.	1955	6	1	Yield	810	940	880	870	860	720	840	840
				% K	2.48	2.44	2.43	2.61	2.47	2.46	2.45	2.55
			2	Yield	1,100	1,310	1,360	1,420	1,210	1,100	1,070	1,290
				% K	2.38	2.35	2.37	2.37	2.44	2.37	2.27	2.37
Kan.	1955	7	1	Yield	1,280	1,240	1,700	1,480	1,060	1,160	1,270	1,180
				% K	2.34	2.31	2.34	2.29	2.21	2.28	2.14	2.35
			2	Yield	1,380	1,510	1,060	990	1,290	1,420	1,290	1,380
				% K	2.23	2.16	2.27	2.21	2.23	2.21	2.10	2.27
Kan.	1956	1	1	Yield	800	680	480	540	620	....	....	....
				% K	3.57	3.51	3.42	3.42	3.39	....	....	....
			2	Yield	2,080	2,420	1,900	2,320	2,340	....	....	....
				% K	3.00	2.88	2.85	2.82	2.85	....	....	....
			3	Yield	1,640	1,620	1,440	1,920	1,900	....	....	....
				% K	3.26	3.24	3.36	3.36	3.30	....	....	....

TABLE A-2 (continued)

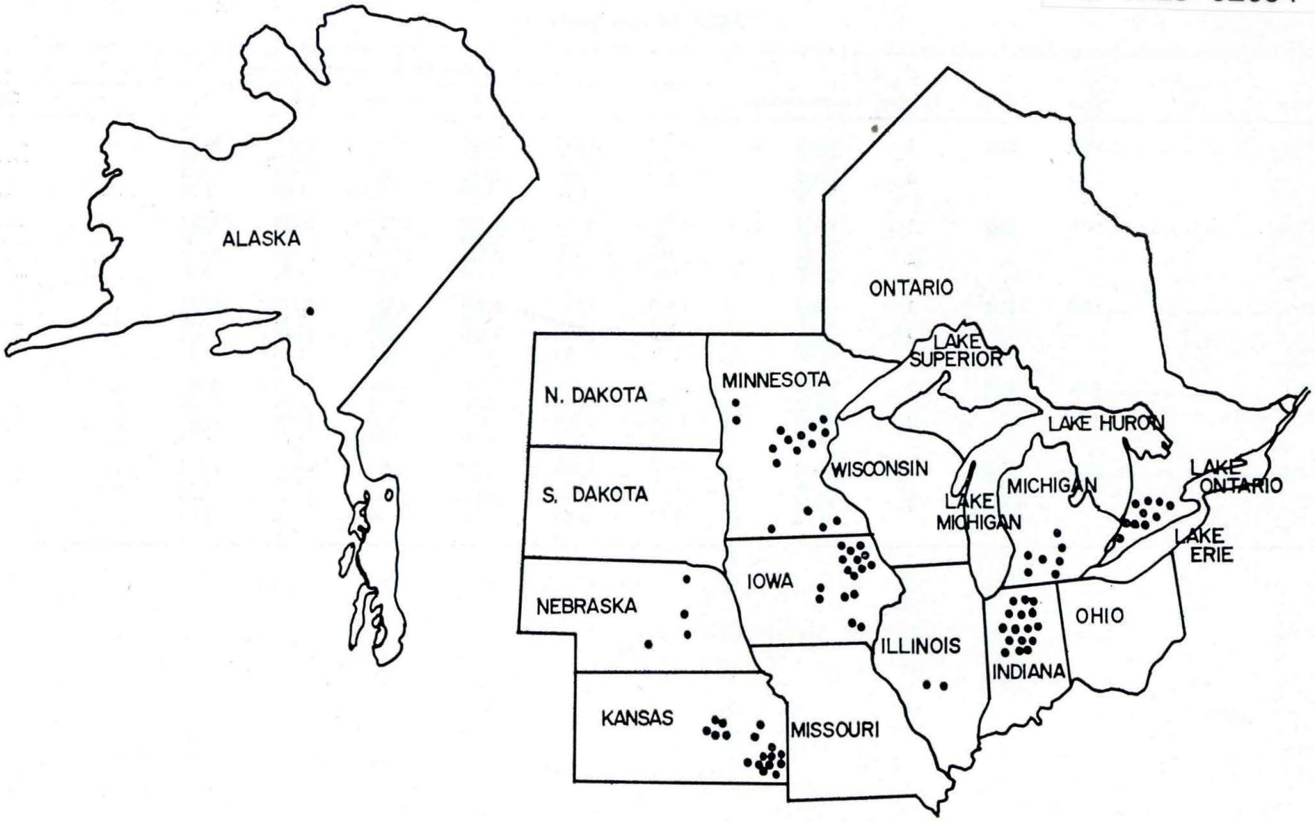
State	Year	Expt.	Cutting	Determination	Pounds K_2O applied per acre 0	20	40	60	80	120	240	360
Kan.	1956	2	1	Yield	3,840	4,200	3,000	4,120	3,6C0	....	....	....
				% K	3.48	3.72	3.52	3.66	3.39	....	....	....
			2	Yield	1,960	2,400	2,200	2,200	2,000	....	....	....
				% K	3.96	4.05	4.11	3.78	3.78	....	....	....
			3	Yield	2,140	2,440	2,420	2,300	2,320	....	....	....
				% K	3.94	4.12	3.96	3.96	4.02	....	....	....
			4	Yield	1,000	1,080	1,100	1,100	1,080	....	....	....
				% K	3.18	3.69	3.48	3.48	3.45	....	....	....
Kan.	1956	3	1	Yield	1,240	1,240	1,280	1,380	1,400	....	....	....
				% K	4.50	4.41	4.39	4.56	4.68	....	....	....
			2	Yield	3,260	3,900	3,600	3,560	3,880	....	....	....
				% K	5.11	5.04	5.22	5.01	5.16	....	....	....
			3	Yield	2,000	2,200	2,600	2,600	2,600	....	....	....
				% K	4.71	4.86	4.83	4.83	4.80	....	....	....
			4	Yield	1,700	2,0C0	2,200	2,000	2,200	....	....	....
				% K	4.95	5.04	5.16	4.86	5.04	....	....	....
			5	Yield	2,200	2,2C0	2,200	2,400	2,400	....	....	....
				% K	4.44	4.44	4.35	4.38	4.44	....	....	....
Kan.	1956	4	1	Yield	600	680	680	620	720	....	....	....
				% K	2.94	2.92	2.74	2.88	2.93	....	....	....
			2	Yield	1,140	1,260	1,160	1,020	1,020	....	....	....
				% K	2.55	2.58	2.67	2.50	2.64	....	....	....
Kan.	1956	5	1	Yield	1,260	1,380	1,340	1,240	1,400	....	....	....
				% K	2.32	2.37	2.34	2.34	2.28	....	....	....
			2	Yield	360	420	460	420	380	....	....	....
				% K	2.04	1.98	2.04	2.04	2.01	....	....	....
Kan.	1956	6	1	Yield	820	700	760	740	700	....	....	....
				% K	2.94	3.03	3.03	2.90	3.15	....	....	....
Kan.	1956	7	1	Yield	1,620	1,720	1,820	1,700	1,760	....	....	....
			2	Yield	1,380	1,480	1,520	1,480	1,720	....	....	....
				% K	2.55	2.42	2.55	2.70	2.61	....	....	....
			3	Yield	1,520	1,400	1,500	1,420	1,660	....	....	....
				% K	2.70	2.73	2.58	2.67	2.55	....	....	....
Kan.	1956	8	1	Yield	740	760	760	860	820	....	....	....
				% K	2.34	2.28	2.43	2.24	2.46	....	....	....
Kan.	1956	9	1	Yield	580	660	680	540	700	....	....	....
				% K	1.62	1.56	1.62	1.56	1.56	....	....	....
Kan.	1956	10	1	Yield	280	340	320	300	320	....	....	....
				% K	2.20	2.28	2.34	2.34	2.34	....	....	....
Mich.	1955	1	1	Yield	2,160	2,240	2,980	2,790	2,920	2,810	3,270	3,310
				% K (alfalfa)	1.93	2.20	2.20	2.22	2.24	2.46	2.60	2.54
				(red clover)	2.01	2.22	2.17	2.36	2.44	2.60	2.72	2.96
Mich.	1955	2	1	Yield	2,680	2,810	2,810	3,090	3,120	3,160	3,290	3,120
				% K	2.14	2.22	2.33	2.35	2.36	2.46	2.66	2.90
Mich.	1956	1	1	Yield	4,340	5,010	5,020	5,050	5,320	5,480	....	....
				% K (alfalfa)	2.03	2.28	2.03	2.35	2.34	2.55	....	....
				(brome)	2.16	2.13	2.13	2.18	2.21	2.59	....	....
			2	Yield	3,310	3,480	3,470	3,620	3,920	3,990	....	....
Mich.	1956	2	1	Yield	3,780	4,040	3,900	3,820	4,340	4,400	....	....
				% K	1.87	2.24	2.48	2.72	2.80	2.71	....	....
			2	Yield	800	800	960	950	1,080	1,290	....	....
Mich.	1956	3	1	Yield	4,240	4,320	4,560	4,780	4,580	4,950	....	....
				% K (alfalfa)	1.47	1.26	1.36	1.45	1.48	1.58	....	....
				(brome)	2.13	2.13	1.77	3.17	2.07	3.17	....	....
			2	Yield	1,540	1,720	2,110	2,110	2,1C0	2,590	....	....
Mich.	1956	4	1	Yield	5,100	5,640	5,160	5,420	6,340	5,810	....	....
				% K	2.13	1.98	3.22	3.39	3.30	3.49	....	....
			2	Yield	2,850	3,200	3,100	3,150	3,380	3,450	....	....
Mich.	1956	5	1	Yield	3,220	3,360	3,750	3,700	3,730	3,700	....	....
				% K	1.60	2.01	1.98	2.21	2.33	2.50	....	....
			2	Yield	1,650	1,700	1,880	1,860	2,050	2,340	....	....
Minn.	1955	1	1	Yield	5,020	5,080	5,280	4,580	4,680	5,220	5,380	5,000
				% K	1.54	1.54	1.47	1.76	1.84	2.27	2.64	2.76
			2	Yield	3,240	3,040	3,220	2,780	3,080	2,920	2,980	2,980
				% K	1.70	1.88	1.94	1.96	2.06	2.18	2.69	2.84
Minn.	1955	2	1	Yield	4,620	4,780	4,840	5,880	5,060	5,600	5,160	4,820
				% K	1.76	2.10	1.64	2.11	1.76	2.30	1.62	1.67
			2	Yield	1,660	1,680	1,820	2,000	1,840	1,560	1,560	1,700
				% K	2.16	2.38	2.01	2.27	2.20	2.22	1.98	2.16
Minn.	1955	3	1	Yield	5,880	4,760	4,760	5,240	5,140	6,240	5,480	5,000
				% K (alfalfa)	1.76	1.88	1.98	2.10	2.20	2.59	2.62	2.81
				(grass, etc.)	2.46	2.48	2.97	2.78	3.12	3.25	3.22	3.28
Minn.	1955	4	1	Yield	3,280	3,240	3,720	3,600	3,460	3,500	3,300	3,200
				% K	2.76	2.69	2.86	2.82	2.72	2.76	2.78	2.72
			2	Yield	2,700	2,640	2,640	2,680	2,680	2,540	2,600	2,580
				% K	3.14	3.25	3.26	3.34	3.31	3.22	3.18	3.18
Minn.	1955	5	1	Yield	4,420	4,620	4,780	4,740	4,620	4,780	4,480	4,660
				% K	2.81	2.78	2.76	2.84	2.91	2.84	2.97	2.91
			2	Yield	3,580	3,720	3,800	3,920	3,640	3,840	3,640	3,660

TABLE A-2 (continued)

State	Year	Expt.	Cutting	Determination	Pounds K_2O applied per acre: 0	20	40	60	80	120	240	360
Minn.	1955	6	1	Yield	4,440	4,500	4,940	4,660	5,000	5,300	5,020	4,860
				% K	2.26	2.28	2.20	2.33	2.24	2.33	1.61	1.85
			2	Yield	3,160	3,360	3,640	3,520	3,480	3,360	3,240	3,460
				% K	3.08	2.94	2.94	3.11	3.00	3.46	3.34	3.31
Minn.	1955	8	1	Yield	2,480	2,500	2,520	2,440	2,720	2,400	2,740	2,760
				% K	3.46	3.49	3.52	3.46	3.46	3.64	3.62	3.84
			2	Yield	2,680	2,760	2,720	2,500	2,580	2,800	2,520	2,600
				% K	2.97	3.37	3.36	3.22	3.18	3.22	3.18	3.38
Minn.	1955	9	1	Yield	3,240	3,560	3,180	3,420	3,360	3,420	3,540	3,460
				% K	3.34	3.52	3.34	3.37	3.43	3.52	3.70	3.61
			2	Yield	3,160	3,200	3,060	3,180	3,280	3,440	3,180	3,520
				% K	3.46	3.34	3.31	3.40	3.34	3.58	3.40	3.58
Minn.	1956	1	1	Yield	3,760	4,260	4,200	4,340	4,300	....	....	....
				% K	0.78	0.93	0.93	1.15	0.99	....	....	....
			2	Yield	1,500	1,740	1,960	1,900	2,040	....	....	....
				% K	1.32	1.36	1.39	1.62	1.63	....	....	....
Minn.	1956	2	1	Yield	1,460	1,460	1,560	1,600	1,640	....	....	....
				% K	0.93	1.09	1.27	1.32	1.53	....	....	....
			2	Yield	1,700	1,740	1,760	1,800	1,900	....	....	....
				% K	2.01	1.78	2.31	2.16	2.38	....	....	....
Minn.	1956	3	1	Yield	4,360	4,640	4,060	4,660	4,560	....	....	....
				% K	0.96	1.14	1.15	1.36	1.44	....	....	....
			2	Yield	1,700	1,860	1,740	1,900	1,760	....	....	....
				% K	2.32	2.10	1.93	2.32	....	....	....	....
Minn.	1956	4	1	Yield	4,160	4,060	4,400	4,340	4,240	....	....	....
				% K	1.32	1.32	1.68	1.57	1.72	....	....	....
			2	Yield	3,000	3,000	2,900	3,100	3,140	....	....	....
				% K	1.32	1.74	1.54	1.59	1.48	....	....	....
Minn.	1956	5	1	Yield	2,840	2,700	2,900	2,960	2,860	....	....	....
				% K	0.64	0.60	0.93	1.12	1.20	....	....	....
			2	Yield	2,640	2,740	2,760	2,860	2,740	....	....	....
				% K	0.90	1.08	1.21	1.35	1.57	....	....	....
Nebr.	1955	1	1	Yield	4,230	5,080	4,020	4,390	4,180	3,920	4,420	4,250
				% K	3.55	3.28	2.97	3.00	3.11	2.97	3.00	3.00
			2	Yield	1,530	1,650	1,470	1,790	1,470	1,540	1,580	1,570
				% K	2.80	2.88	2.88	2.90	3.04	2.91	2.92	2.84
			3	Yield	1,680	1,520	1,800	1,550	1,610	1,360	1,950	1,700
				% K	2.81	2.76	2.81	2.78	2.69	2.78	2.94	2.90
Nebr.	1955	2	1	Yield	4,240	4,250	4,280	4,220	4,180	4,210	4,260	4,290
				% K	3.52	3.52	3.58	3.61	3.58	3.55	3.52	2.97
			2	Yield	3,390	3,290	3,180	3,230	3,410	3,330	3,440	3,560
				% K	3.60	3.72	3.84	3.76	3.70	3.72	3.78	3.92
			3	Yield	4,180	4,120	4,240	4,170	4.050	4,220	4,110	4,280
				% K	3.66	3.66	3.66	3.68	3.80	3.44	3.62	3.50
Nebr.	1956	1	1	Yield	1,850	1,720	1,860	1,600	1,740	....	....	....
				% K	2.67	2.72	2.72	2.66	2.76	....	....	....
			2	Yield	2,220	2,100	2,380	2,100	2,230	....	....	....
				% K	3.93	3.81	3.84	4.05	3.27	....	....	....
			3	Yield	1,840	1,840	1,950	1,590	1,980	....	....	....
				% K	....	3.30	3.36	3.48	3.48	....	....	....
Nebr.	1956	2	1	Yield	4,890	5,250	5,100	4,980	5,050	....	....	....
				% K	3.60	3.78	3.78	3.91	3.75	....	....	....
			2	Yield	4,340	4,710	4,710	4,640	4,470	....	....	....
				% K	3.15	3.21	3.30	3.30	3.36	....	....	....
Ont.	1955	K-1	1	Yield (alfalfa)	2,090	1,860	2,090	2,210	2,690	2,350	2,390	2,160
				(red clover)	1,750	1,700	1,670	1,770	1,750	1,860	1,760	1,990
				% K (alfalfa)	0.73	0.78	0.92	1.06	1.20	1.50	2.05	2.43
				(red clover)	1.40	1.40	1.74	1.74	1.80	1.80	1.85	2.06
			2	Yield	350	370	330	360	360	290	340	320
				% K	0.62	0.65	0.72	0.81	0.96	1.03	1.27	1.33
Ont.	1955	K-2	1	Yield (alfalfa)	2,870	2,530	2,520	2,900	2,800	2,450	2,640	2,360
				(red clover)	990	1,160	1,400	800	1,140	1,130	940	1,430
				% K (alfalfa)	1.22	1.38	1.48	1.59	1.72	2.08	2.44	2.75
				(red clover)	1.50	1.73	1.84	1.90	1.98	2.10	2.69	2.86
			2	Yield	1,210	1,310	1,140	1,230	1,280	1,120	1,250	1,260
				% K	1.44	1.45	1.52	1.73	1.70	1.82	2.32	2.34
Ont.	1955	K-3	1	Yield (alfalfa)	460	320	560	440	580	770	730	770
				(red clover)	1,910	1,690	1,790	1,770	1,650	1,600	1,780	1,320
				% K (alfalfa)	2.56	2.50	2.33	2.56	2.59	2.72	2.91	2.46
				(red clover)	2.54	2.72	2.59	2.69	2.65	2.84	2.97	2.91
			2	Yield	1,940	1,820	2,070	1,750	1,870	2,180	2,100	2,050
				% K	2.81	2.98	3.04	3.13	3.18	2.98	3.40	3.34
Ont.	1955	K-4	1	Yield (alfalfa)	1,030	980	1,060	1,170	1,060	1,110	1,210	1,330
				(red clover)	1,400	1,380	1,430	1,330	1,500	1,590	1,590	1,380
				% K (alfalfa)	0.89	0.94	1.10	1.05	1.16	1.28	1.79	2.20
				(red clover)	1.08	1.15	1.35	1.34	1.43	1.54	2.00	2.24
			2	Yield	330	280	300	290	290	270	330	340
				% K	0.74	0.73	0.81	0.80	0.87	0.92	1.04	1.38
Ont.	1956	K-1	1	Yield (alfalfa)	2,330	1,980	2,400	2,450	2,510	2,440	....	....
				(clover, etc)	1,500	1,880	1,610	1,550	1,650	1,700	....	....
				% K (alfalfa)	1.77	1.95	2.25	1.74	2.79	3.00	....	....
				(clover, etc)	2.46	2.73	2.68	3.97	3.30	3.24	....	....
			2	Yield (alfalfa)	1,380	1,260	1,520	1,340	1,450	1,520	....	....
				(timothy, etc)	1,050	1,180	1,120	1,320	1,130	1,170	....	....
				% K (alfalfa)	1.36	1.38	1.45	1.67	1.78	2.25	....	....
				(timothy, etc)	2.07	2.25	2.35	2.34	2.75	2.94	....	....

TABLE A-2 (continued)

State	Year	Expt.	Cutting	Determination	Pounds K_2O applied per acre 0	20	40	60	80	120	240	360
Ont.	1956	K-2	1	Yield	1,650	1,920	2,120	1,930	2,160	2,070	....	....
				% K	1.05	1.59	1.51	1.74	2.01	2.46	....	....
			2	Yield	1,190	1,460	1,660	1,760	1,800	1,930	....	....
				% K	1.12	1.17	1.30	1.31	1.48	1.24	....	....
Ont.	1956	K-3	1	Yield	3,350	3,260	3,450	3,320	3,320	3,280	....	....
				% K	1.95	2.31	2.46	2.91	2.94	3.00	....	....
			2	Yield	2,360	2,330	2,500	2,550	2,460	2,570	....	....
				% K	1.62	1.76	1.90	1.38	1.52	1.49	....	....
Ont.	1956	K-4	1	Yield	1,820	2,060	2,030	2,030	2,110	1,850	....	....
				% K	1.65	1.77	1.98	2.22	2.46	2.55	....	....
			2	Yield	1,480	1,510	1,580	1,370	1,640	1,640	....	....
				% K	1.44	1.59	1.57	1.74	1.88	2.07	....	....
Ont.	1956	K-5	1	Yield	2,670	3,070	3,300	3,000	2,850	3,480	....	....
				% K	1.87	1.98	2.00	2.05	2.14	2.36	....	....
			2	Yield	1,130	1,100	1,130	1,220	1,160	1,200	....	....
				% K	1.74	1.72	1.80	1.84	1.92	2.09	....	....
Ont.	1956	K-6	1	Yield	2,440	2,360	2,380	2,310	2,640	2,500	....	....
				% K	1.99	2.07	2.11	2.14	2.18	2.42	....	....
			2	Yield	2,170	2,310	2,290	2,250	2,390	2,360	....	....
				% K	1.67	1.65	1.70	1.86	1.78	1.95	....	....



MAP: Dots indicate locations of field experiments.

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