POTASSIUM IN OKLAHOMA SOILS:

And Crop Response to Potash Fertilizer

OKLAHOMA AGRICULTURAL EXPERIMENT STATION
Oklahoma A.& M. College, Stillwater
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Bulletin No. B-346   March, 1950

Do Oklahoma Soils Need Potash?

Station soils scientists analyzed 6,379 soil samples, representing every county in Oklahoma, to find areas where the potassium content might be low enough to reduce crop yields. They also analyzed samples representing 85 different soil types, and 28 pairs of samples from virgin soils and adjacent areas of cultivated land.

Eighteen percent of the samples were very low in exchangeable potassium, the form which can be absorbed by plant roots. Most of the "very low" samples came from eastern Oklahoma (see map, back cover.)

Cropping has not yet seriously reduced the potassium content of the cultivated soils studied which contained an adequate supply of this element in their virgin condition.

The soils scientists also compared the exchangeable potassium content of various soils with the results of potash fertilizer experiments on those soils. This gave an indication of the variation among crops in response to potash fertilizers. The results are summarized on pages 15 to 16.

Further research is needed to obtain a detailed picture of potash fertilizer needs throughout the State, but this preliminary report indicates where potassium deficiency is most likely to be found. It also presents some suggestions on how to use potash fertilizer where chemical tests of the soil show that it is needed.

THE COVER: K is the chemical abbreviation for potassium. The last figure in a fertilizer grade gives the percentage of potash present. (Potash is the oxide of potassium.) For potassium-deficient soils, a 5-10-5 or a 5-10-10 grade is frequently recommended.

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Potassium in Oklahoma Soils:
and
Crop Response to Potash Fertilizer

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Potassium is one of fourteen or more chemical elements needed for the normal growth of plants.

Earlier fertilizer experiments in central and eastern Oklahoma showed that some of the land in that area does not have enough potassium to produce maximum crop yields. Further evidence that some of the soils in this area are low in potassium is given by the severe potassium deficiency symptoms sometimes seen on the leaves of corn, cotton, and legumes.

This bulletin reports a study made to obtain more precise information on the location of low-potash soils in Oklahoma, and the degree of the deficiency in various areas. The study also included a comparison between degree of potassium deficiency and the probable increase in yield which might reasonably be expected from applications of potash fertilizer.

This study of potassium is another step in the Station's soils research program, which has already made some progress in determining the needs of Oklahoma soils for nitrogen and phosphorus.

POTASSIUM CONTENT OF OKLAHOMA SOILS

Exchangeable Potassium, by Areas

Most of the potassium absorbed by plant roots comes from the soil's supply of exchangeable potassium. The potassium in exchangeable form is only a small part of the soil's total supply. A soil may contain as much as 40,000 pounds of total potassium in the zone of root development with only 100 to 300 pounds being in exchangeable form and available for easy absorption by plant roots.

Counties.—Table I and Figure 1 (Table I, Page 6; Figure 1, back cover) show that potassium deficiency is an important problem in several eastern Oklahoma counties. These data are based on analyses of 6,379 samples of air-dry surface soil.*** More than 18 percent of the samples were very low in exchangeable potassium. On such soils, more potash than is present in the average mixed fertilizer used in Oklahoma is needed to produce a maximum yield of many field crops. (The potassium requirements of various crops are discussed on pages 15 to 16.

In general, soils in western Oklahoma contain more exchangeable potassium than do those in the central and eastern parts of the State.

* The author is especially indebted to Lloyd Mitchell and Barbara Thompson for analytical data collected in connection with this study.

** The Experiment Station research project on which this report is based was supported by a grant from the American Potash Institute for the three-year period 1947-1949.

*** Each soil was extracted with 2 parts of neutral normal ammonium acetate at 70° C. for one-half hour and the potassium in the filtrate determined with a Perkin-Elmer flame photometer. The exchangeable potassium content of soils decreases slightly on drying.

TABLE I.—Exchangeable Potassium in 6,379 Samples of Oklahoma Soils, by Counties.

County	No. of Samples	Exchangeable Potassium Content, by Groups*				Percent of Samples in "Very Low" Group
		Very Low (0 to 50 p.p.m.)	Low (51 to 100 p.p.m.)	Medium (101 to 150 p.p.m.)	High (151 or more p.p.m.)	
Adair	86	52	19	10	5	60.4
Alfalfa	63	7	17	10	29	11.1
Atoka	48	31	17	0	0	64.6
Beaver	13	3	1	2	7	2.3
Beckham	98	23	41	12	22	23.4
Blaine	60	4	23	18	15	6.6
Bryan	189	19	88	47	35	10.0
Caddo	149	5	58	44	42	3.3
Canadian	64	3	15	17	29	4.7
Carter	16	6	5	2	3	37.5
Cherokee	85	20	30	25	10	23.5
Choctaw	142	52	58	18	14	36.6
Cimarron	21	0	1	1	19	0
Cleveland	18	1	5	5	7	5.5
Coal	42	8	19	7	8	19
Comanche	77	1	26	21	29	1.3
Cotton	29	2	11	11	5	6.9
Craig	44	5	25	7	7	11.3
Creek	126	15	75	22	14	11.2
Custer	71	0	9	25	37	0
Delaware	222	20	107	48	47	9
Dewey	24	3	9	7	5	12.5
Ellis	31	4	6	7	14	12.9
Garfield	165	5	43	52	65	3.0
Garvin	17	1	1	8	7	5.8
Grady	106	7	42	24	33	6.6
Grant	39	2	4	8	25	5.1
Greer	23	4	7	4	8	17.3
Harmon	27	2	5	6	14	7.3
Harper	25	0	3	7	15	0
Haskell	217	64	101	25	27	29.4
Hughes	87	31	45	5	6	35.6
Jackson	42	2	9	4	27	4.8
Jefferson	17	0	8	7	2	0
Johnston	11	3	3	4	1	27.3
Kay	65	3	3	18	41	4.6
Kingfisher	48	6	9	19	14	12.5
Kiowa	76	1	4	18	53	1.3
Latimer	24	8	9	3	4	33.3
LeFlore	182	54	79	23	26	29.7

p.p.m. = parts per million. This classification is tentative and subject to revision as additional information is obtained on crop response to potassium fertilization under Oklahoma conditions

TABLE 1, Continued.

County	No. of Samples	Exchangeable Potassium Content, by Groups* Very Low (0 to 50 p. p. m.)	Low (51 to 100 p. p. m.)	Medium (101 to 150 p. p. m.)	High (151 or more p. p. m.)	Percent of Samples in "Very Low" Group
Lincoln	44	8	22	6	8	18.2
Logan	34	2	22	7	3	5.9
Love	46	6	9	19	12	13.1
McClain	51	3	13	26	9	5.9
McCurtain	179	32	98	20	29	17.8
McIntosh	101	41	44	11	5	40.5
Major	49	2	17	13	17	4.1
Marshall	15	0	5	6	4	0
Mayes	165	45	73	17	30	27.3
Murray	22	2	9	5	6	8.1
Muskogee	351	102	143	56	50	29
Noble	23	0	7	10	6	0
Nowata	77	10	39	14	14	13
Okfuskee	82	9	53	12	8	11
Oklahoma	159	9	45	47	58	5.7
Okmulgee	221	60	105	39	17	27.2
Osage	61	3	20	20	18	4.9
Ottawa	73	20	30	11	12	27.3
Pawnee	69	3	23	26	17	4.4
Payne	139	15	63	29	32	10.8
Pittsburg	216	73	96	31	16	33.8
Pontotoc	20	5	5	6	4	25
Pottawatomie	70	20	35	10	5	28.6
Pushmataha	120	59	53	6	2	49.2
Roger Mills	30	2	10	8	10	6.6
Rogers	105	48	47	7	3	45.7
Seminole	69	33	27	4	5	47.8
Sequoyah	150	11	75	37	27	7.3
Stephens	28	1	8	7	12	3.6
Texas	29	0	0	2	27	0
Tillman	100	1	26	28	45	1.0
Tulsa	226	21	81	55	69	9.3
Wagoner	168	32	80	31	25	19.0
Washington	15	0	3	1	11	0.0
Washita	77	7	22	18	30	9.1
Woods	42	6	8	11	17	14.3
Woodward	56	0	11	28	17	0.0
Percentage in group		18.3	38.8	20.1	22.8	

* p. p. m. = parts per million. This classification is tentative and subject to revision as additional information is obtained on crop response to potassium fertilization under Oklahoma conditions.

Geologic Areas.—Two geologic areas were discovered to be very deficient in exchangeable potassium. One of these is near the central part of the Eastern Prairie section of Oklahoma. It includes soils occurring on sediments deposited in the upper part of the Cherokee geological formation, and also a large part of the soils developed on the Boggy shale. The Cherokee area begins near the Kansas line in the northern part of Craig county and extends southward across parts of Mayes, Rogers, and Wagoner counties. The Boggy shale occurs in Muskogee, McIntosh and Haskell counties, and the northern part of Pittsburg county.

The second area is the Trinity sand. A high percentage of the surface soils developed on this formation are very low in exchangeable potassium. The Trinity formation extends westward from the Arkansas line north of Idabel in McCurtain county, crossing the southern part of Pushmataha county, the northern part of Choctaw county, the southern part of Atoka county, and the southeastern part of Johnston county. Soils in the western part of this area are not as low in exchangeable potassium as those further east, because of lower annual rainfall.

Many low-potash soils were obtained from the northern part of Adair county; and a small area of sandy land in the vicinity of Elk City in Beckham county was also very deficient in potassium. More field study will be needed before the boundaries of other low-potash areas can be identified accurately.

Total and Exchangeable Potassium, by Soil Types

Table II shows both total and exchangeable potassium content of samples from 85 important Oklahoma soil types. These types represent 54 series from 20 different counties. The lowest amount of total potassium found in any of the samples was 4,000 pounds per acre (to plow depth, 6⅔ inches). This was in the Ochlockonee very fine sandy loam, a bottomland soil from Choctaw county. The highest quantity, 42,200 pounds, occurred in Weymouth very fine sandy loam, an upland soil from Washita county. Total potassium for other soil types can be computed from the percentage figures given in Table II, using 2,000,000 pounds as the weight of an acre of soil to plow depth.

Four soil series which are commonly deficient in total and exchangeable potassium are the Parsons and Bates soils in the Eastern Prairie section, and the Bowie and Norfolk series in the southeastern part of the State. Alluvium originating from these soils may also be low in exchangeable potassium.

Soil types high in total potassium but low in exchangeable potassium are explained in most cases by the rate at which potassium moves from the nonexchangeable to the exchangeable form in these soil types, and by the low clay content of these soils.

Relation to Soil Origin and Development

Acidity.—Table II shows the pH* as well as the total and exchangeable potassium of the samples representing important soil types. There was no indication that soil acidity was associated with a potassium deficiency.** In fact, soils which contain free calcium carbonate (finely pulverized limestone) often

* The pH (hydrogen ion concentration) scale is a measurement of soil reaction (acidity or alkalinity). The pH of a neutral soil lies between 6.7 and 7.3. Soils with a pH of 5.5 to 4.9 are classed as strongly acid, and those with a pH above 8.5 as moderately to strongly alkaline.

** Only a few of the soils studied were strongly acid, but there is no reason to believe that the results would have been changed if a larger number of strongly acid soils had been analyzed.

TABLE II.—Total and Exchangeable Potassium in Important Oklahoma Soil Types.

County and Soil Type	pH	Total Potassium (Percent)	Exchangeable Potassium (Parts Per Million)*
Alfalfa			
Enterprise fine sand, dune phase	7.9	1.88	46
Grant very fine sandy loam	7.8	1.67	325
Pratt loamy fine sand	7.4	1.80	57
Pond Creek silt loam	7.1	1.63	365
Pratt fine sandy loam	6.9	1.23	136
Nash very fine sandy loam	7.7	1.43	238
Reinach very fine sandy loam	8.4	1.56	288
Atoka			
Bowie loamy fine sand	5.6	.22	27
Carter			
Conway fine sandy loam	6.9	.52	97
Hanceville fine sandy loam	6.6	.31	46
Choctaw			
Kirvin fine sandy loam	6.2	.45	104
Norfolk fine sandy loam	6.5	.27	36
Durant silt loam	5.8	.34	43
Kaufman clay	6.8	1.48	367
Bowie very fine sandy loam	7.0	.41	50
Ochlockonee very fine sandy loam	6.9	.20	57
Cleveland			
Stephensville fine sand loam	6.3	.31	39
Minco fine sandy loam	7.0	1.16	117
Reinach silt loam	7.9	1.36	132
Vanoss silt loam	7.2	1.38	283
Chickasha very fine sandy loam	5.8	.65	78
Craig			
Parsons silt loam	5.7	.69	63
Bates silt loam	5.1	.76	108
Okoee silt loam	6.6	.75	161
Summit silt clay loam	5.4	.96	164
Grant			
Grant very fine sandy loam	6.5	1.70	208
Oswego silt loam	6.1	1.52	165
Renfrow silt loam	6.5	1.33	306
Reinach very fine sandy loam	7.0	1.56	128
Derby fine sandy loam	6.0	1.53	85
LeFlore			
Talihina stony silt loam	5.7	.84	127
Pottsville stony loam	7.3	.53	63
Conway very fine sandy loam	8.5	.51	67
Lonoke silty clay loam	7.0	1.75	255
McIntosh			
Yahola very fine sandy loam	8.3	.92	85
Brewer clay	7.3	1.78	475
Bates fine sandy loam	6.5	.68	63

* A majority of these soils were collected from virgin areas, consequently the exchangeable potassium content may be slightly higher than in similar samples from adjacent cultivated fields.

(Table continued on next page.)

TABLE II, Continued.

County and Soil Type	pH	Total Potassium (Percent)	Exchangeable Potassium (Parts Per Million)*
Teller fine sandy loam rolling Wh.	8.1	1.01	63
Stidham fine sand	6.8	.84	57
Mayes			
Verdigris very fine sandy loam	7.4	.55	184
Lebanon silt loam	4.9	.67	53
Parsons silt loam	5.4	.59	93
Bates very fine sandy loam	5.6	.50	85
Murray			
Osage clay loam	7.5	1.42	165
Dougherty very fine sandy loam	7.6	1.04	153
Okfuskee			
Brewer silt clay loam	6.9	1.71	184
McLain silt loam	6.2	1.21	228
Chickasha very fine sandy loam	6.0	.57	63
Mason very fine sandy loam	6.3	.51	125
Linker very fine sandy loam	6.4	.69	113
Vanoss very fine sandy loam	5.9	1.26	78
Payne			
Kirkland silt loam	5.2	1.16	128
Stidham fine sandy loam	6.0	1.22	132
Vanoss very fine sandy loam	5.3	1.44	165
Pittsburg			
Teller fine sandy loam	7.3	1.00	50
Conway fine sandy loam	5.6	.51	63
Pope very fine sandy loam	7.7	.42	53
Conway fine sand	7.7	.81	67
Bates very fine sandy loam	6.1	.69	60
Pontotoc			
Hanceville fine sandy loam	7.1	.45	117
Durant very fine sandy loam	6.9	.52	75
Verdigris clay loam	7.2	1.21	179
Newtonia silt loam	6.1	1.42	233
Rogers			
Bates silt loam	5.6	.63	50
Tulsa			
Parsons silt loam	5.8	.89	82
Summit silt clay loam	5.9	1.18	104
Verdigris very fine sandy loam	6.5	1.52	93
Lonoke very fine sandy loam	6.4	1.62	125
Washita			
Dill fine sand loam	7.5	1.49	175
Cobb fine sandy loam	6.0	1.69	271
Weymouth very fine sandy loam	7.1	2.11	198
Tillman silt loam	6.9	2.03	325
St. Paul silt loam	7.1	1.57	300
Vernon silt loam	8.0	1.87	255

* A majority of these soils were collected from virgin areas, consequently the exchangeable potassium content may be slightly higher than in similar samples from adjacent cultivated fields.

TABLE II, Continued.

County and Soil Type	pH	Total Potassium (Percent)	Exchangebale Potassium (Parts Per Million)*
Woods			
Abilene very fine sandy loam	6.6	1.77	153
Carwile very fine sandy loam	6.2	1.57	208
Grant very fine sandy loam	7.4	1.37	393
Dacoma clay loam	6.6	1.43	429
Pond Creek silt loam	7.0	1.65	458
Potter fine sandy loam	7.0	1.50	145
Woodward			
St. Paul very fine sandy loam	8.0	1.66	357
Quinlan very fine sandy loam	8.2	1.49	104
Pratt fine sandy loam	7.5	1.47	288
Pratt loamy fine sand	6.9	1.51	117
Miles loamy fine sand	7.4	1.08	78
Average	----	1.11	154

* A majority of these soils were collected from virgin acreas, consequently the exchangeable potassium content may be slightly higher than in similar samples from adjacent cultivated fields.

contain a lower quantity of exchangeable potassium than soils which are neutral in reaction.

Nevertheless, *potash fertilizer is more likely to be needed on an acid soil than on a neutral soil which is equally low in exchangeable potassium.*

Recent research in Illinois* indicates that fixed potassium is rapidly changed into exchangeable potassium, available to plants, in a calcareous soil.

Texture.—Most of the soils which were very low in exchangeable potassium were sandy soils with acid, sandy subsoils. In neutral or slightly acid soils, the content of exchangeable potassium increased as the proportion of clay increased.

Medium- and fine-textured soils usually contain more exchangeable potassium than sandy soils for two reasons:

(1) In eastern Oklahoma, where leaching by rainfall is a factor in soil development, leaching is most rapid on sandy soils; and

(2) The type of clay mineral present in the average Oklahoma soil (montmorillonite), has a high base exchange capacity and holds practically all of the exchangeable potassium.**

Soil Material.—The wide variation in total potassium content shown in Table II is due to the character of the sediments on which the different soil types developed. Soils which were formed on unweathered sediment coming from a granitic area are high in total potassium, because of the presence of potash feldspar. Soils which were formed on sandstone which has been highly weathered and therefore composed principally of quartz grains, or on sandy material that has been sorted by running water and most of the silt and clay removed, may be very low in total potassium. Soils which have developed on

* DeTurk, Wood, and Bray, *Soil Science*, 55:1-12 (1943).

** Another type of clay mineral (kaolin) has a low base exchange capacity. Presence of this type of clay might possibly account for the low exchangeable potassium content of many highly weathered soils in eastern and southeastern Oklahoma. However, very little information is available on the kaolin content of Oklahoma soils, therefore this question cannot be answered until further information is obtained.

weathered limestone normally contain an adequate supply of total potassium where grass was the original vegetative cover, because clay which was present in the limestone as an impurity accumulates in the soil as the limestone is dissolved by weathering. Even under forested conditions, soils on weathered limestone are usually higher in exchangeable potassium than those on weathered shales and sandstones under a similar climatic environment.

Alluvial soils, as one would expect, vary in potassium content according to the potassium content of the area from which they originated. Alluvium originating from a deeply leached upland where Bowie or Norfolk soils are found is likely to be low in exchangeable potassium. On the other hand, although most of the upland soils in McIntosh county are quite deficient in exchangeable potassium, bottomland soils in that area which have developed on sediments carried from western Oklahoma are very high in total and exchangeable potassium. A similar condition occurs in other counties in the eastern part of the State. Good examples of such soils are the Brewer soils along the North Canadian river in McIntosh county and the Lonoke soils along the Arkansas river in LeFlore county.

Age.—Gray colored prairie soils on gently sloping to nearly level land, such as the Parsons soils, have been affected by leaching for a long period of time and are more likely to be deficient in potassium than brown soils, such as the Summit and Labette soils, on adjacent areas of more sloping topography even though the potassium content is reasonably high in the subsoils of both areas.

Effect of Cropping

The data in Table III indicate that up to the present time removal of crops from the soils tested has not seriously reduced the exchangeable potassium content which was originally present in a sufficient quantity for the growth of crops having a high potassium requirement. One sample in each of the 28 pairs represented in the table was taken from an area of virgin soil. The other sample in the pair was taken from an adjacent area of the same soil which had been cropped from 30 to 50 years. In most of the comparisons, there was very little difference in total potassium. None of the soils was deficient in exchangeable potassium, therefore such decrease as has occurred would have little if any effect on crop production. Where a virgin soil was low in exchangeable potassium, continued cropping would be expected to gradually change it into a very low group where response from potash fertilizer would occur.

CROP RESPONSE TO POTASSIUM FERTILIZATION

General Conditions Affecting Response

Whether use of a potash fertilizer will increase crop yield depends not only on the quantity of exchangeable potassium in the soil, but also on other conditions. These other conditions include:

Soil Type.—As pointed out above (page 8,) the rate at which soil potassium will change from a non-exchangeable form to a form which can be used by plants varies considerably between soil types. Therefore the response of crops to potash fertilization may be different on two soils which are equally low in exchangeable potassium content as measured by chemical procedures but which differ in their inherent capacities

TABLE III.—A Comparison of Total and Exchangeable Potassium in Virgin and Cultivated Soils in Oklahoma.

County and Soil Type	Total Potassium (Percent)		Exchangeable Potassium (p.p.m.)*	
	Virgin	Cropped	Virgin	Cropped
Caddo				
Pond Creek silt loam	1.44	1.67	242.8	392.5
Carter				
Durant clay loam	.96	.96	152.5	100.3
Garfield				
Grant very fine sandy loam	1.59	1.36	277.0	237.5
Kirkland silt loam	1.72	1.65	293.8	249.6
Oswego silt loam	1.78	1.72	255.0	157.0
Pond Creek silt loam	1.62	1.62	318.8	222.5
Renfrow silt loam	1.09	1.05	270.5	174.5
Vernon very fine sandy loam	.59	.63	260.3	113.0
Greer				
Hollister silt loam	1.61	1.62	357.0	407.3
Tillman silt loam	1.86	1.74	450.5	499.0
Kay				
Labette silty clay loam	1.51	1.47	225.0	233.0
Kiowa				
Tillman clay loam				
Major				
Foard very fine sandy loam	1.48	1.64	212.5	183.5
Grant very fine sandy loam	1.57	1.53	212.5	157.0
Pratt loamy fine sand	1.56	1.78	169.8	112.5
Mayes				
Labette silt loam				
Murray				
Denton clay loam (deep phase)	1.58	1.65	183.5	183.5
Newtonia very fine sandy loam	1.34	1.55	227.5	161.0
Noble				
Canadian fine sandy loam	1.69	1.90	208.6	132.0
Carson loam	1.45	1.46	314.0	264.6
Labette silty clay loam	1.36	1.34	255.0	132.3
Labette silt loam	1.45	1.46	255.0	282.5
Norge silt loam	1.57	1.43	306.0	171.0
Otoe clay	1.32	1.32	277.0	272.0
Summit clay	1.74	1.62	442.0	330.0
Vanoss silt loam	1.65	1.67	300.0	164.0
Nowata				
Summit silt loam	1.09	1.09	277.0	108.0
Average of Pairs	1.46	1.47	269.7	217.6

* Parts per million.

to replace the potassium on the surface of the clay minerals as it is removed by plant roots.

Plant's Ability to Obtain Potassium.—Some plants can feed on relatively insoluble forms of soil potassium, such as feldspar. Cowpeas and oats are good examples (see page 15).

Rate of Plant Growth.—Crops which grow and mature during the spring or fall are more likely to respond to potash fertilization than those which grow during the summer months when dry weather is more likely to reduce the rate of growth.

Relation Between Successive Crops.—The greatest loss of soil potash occurs when forage crops or peanuts are grown and the hay is removed from the field. Therefore, when a crop needing much potash is planted following the removal of a big yield of forage, or peanuts, the fertilizer should contain more potash than would be needed otherwise.

Average Annual Rainfall.—Potash fertilizer is not likely to be needed under dryland farming conditions in western Oklahoma because of the relatively large quantity of exchangeable potassium in the soils of this area. Wheat and sorghums are important crops in the subhumid part of the State, and neither of these crops has a very high potassium requirement. Furthermore, wheat is grown most extensively on medium- to fine-textured soils which are neutral in reaction; and, as noted above (page 11,) such soils usually contain plenty of exchangeable potassium. Cotton and sorghums are planted on the sandier lands. The high yields obtained during favorable seasons, and the absence of potash deficiency symptoms on the leaves, would indicate that potassium is not a serious limiting factor in the development of cotton or grain sorghums in this area.

As average rainfall increases, more leaching occurs, especially on sandy soils; and the exchangeable potassium is usually low in acid, sandy soils because of the low total potassium content and low clay content of these soils. Also, the acreage of many crops having a higher potassium requirement is greater in areas where there is more rainfall. This adds to the likelihood that potash fertilizer may be needed to maintain or increase the yield of these crops when planted on soils low in exchangeable potassium.

Probable Yield.—The relation between the amount of exchangeable potassium in a soil and the yield increase which can be obtained by applying a potash fertilizer depends to a great extent on the probable yield as determined by seasonal rainfall and the availability of other plant food elements in the soil. If the moisture and other plant food elements are sufficient to produce a 60-bushel yield of corn, but the soil contains only enough exchangeable potassium for a 30-bushel yield, only 30 bushels of corn will be produced unless a potash fertilizer is applied. Under those conditions, proper use of a potash fertilizer could produce a 60-bushel yield. If rainfall or other plant food elements are only enough for a 30-bushel yield, the yield will remain 30 bushels even if sufficient potash to produce a 60-bushel yield is applied.

Method of Fertilization.—A mixed fertilizer containing a high percentage of potash and applied at high rates per acre may injure seed germination if not properly placed in the soil. The fertilizer should be applied in such a way that a high concentration of soluble salts does not come in contact with the seed, or the young roots near the seed.

Injury to germination is less likely to occur with potassium sulfate than with potassium chloride. The calcium sulfate formed when potassium sulfate is added to a soil is much less soluble and is less harmful to seed germination than the calcium chloride which appears in the soil water when potassium chloride is applied alone or in a fertilizer mixture.

Potassium Response Of Specific Crops

Chemical analysis of a soil sample will tell how much potassium the soil contains in a form useable by plants.* The report will show a certain number of parts per million of exchangeable potassium ("available" or "replaceable" potassium). The next question is: "Does this mean that application of potash fertilizer will or will not increase crop production?" The answer to that question, as pointed out above (page 12,) depends to some extent on other conditions.

The Oklahoma Station in 1932 made a comparison between the exchangeable potassium content of Oklahoma soils and the crop response to potash used in fertilizer tests.** It was concluded that, in general: Soils containing less than 60 parts per million of exchangeable potassium would give a good crop response to potash fertilizer; soils with 60 to 79 parts per million would respond in many cases; and response would be doubtful on soils having 80 to 99 parts per million.

More recent data indicate that some consideration must be given to the crop to be planted, since some crops will respond to potash fertilization on soils which contain a sufficient supply of exchangeable potassium to produce maximum yields of other crops. This information is summarized in the following paragraphs:

Alfalfa.—Increase in yield from potash fertilization can be expected where the exchangeable potassium is 150 parts per million or below.

Big Hop Clover.—Big Hop clover and lespedeza are good examples of crops which have a low potassium requirement and therefore can grow on soils very low in exchangeable potassium.

Corn.—If the probable yield is low, 50 parts per million of exchangeable potassium is adequate. Where probable yield is high, response will be obtained if the exchangeable potassium is less than 100 parts per million.

Cotton.—When the exchangeable potassium in a soil is less than 50 parts per million, response from potash fertilizer is high. (Cotton rust usually appears on leaves of unfertilized plants grown on soils containing less than 50 parts per million of exchangeable potassium.) Response will be moderate when the exchangeable potassium is 50 to 100 parts per million, slight from 100 to 150 parts per million, and none above 150 parts per million.

Cowpeas.—Cowpeas contain a high percentage of potassium. However, they are able to take potassium from soil minerals containing this element in a relatively unavailable form; therefore they will make good growth on soils where other crops having a high potassium requirement, such as alfalfa, will make a poor growth, or fail.

Lespedeza.—Same as Big Hop clover.

Oats.—If the probable yield is low, 40 parts per million of exchangeable potassium is adequate. If the probable yield is high, response from potash fertilizer will be obtained when the exchangeable potassium is less than 75 parts per million.

Sorghums.—No experimental data are available, but observation indicates that the potassium response of sorghums

* The exchangeable potassium in a soil usually will be lower immediately after a crop is harvested as compared with samples taken several weeks or months after plant roots have stopped taking potassium from the exchangeable supply in the soil.

** H. F. Murphy, *Journal of the American Society of Agronomy,* 26:34-37 (1934).

is similar to that of oats.

Soybeans.—If the probable yield is high, potash fertilizer is needed to get maximum yields when exchangeable potassium is less than 100 parts per million. Where soybean forage is removed, the rate of potash fertilization should be higher than where only the seed is harvested and the rest of the plant plowed under.

Sweet Clover.—Same as oats.

Vegetable Crops.—Hartwell* of Rhode Island reports that vegetable crops have the following potassium requirements:

High: Beet, cucumber, lettuce, onion, parsnip, and squash.

Intermediate: Carrot, potato, and tomato.

Low: Bean, cabbage, and turnip.

Wheat.—If the probable yield is low, 50 parts per million of exchangeable potassium is adequate. If the probable yield is high, soils containing less than 100 parts per million of exchangeable potassium need potash fertilizer to produce maximum yields.

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* *Journal of the American Society of Agronomy,* 13:353-359 (1922).

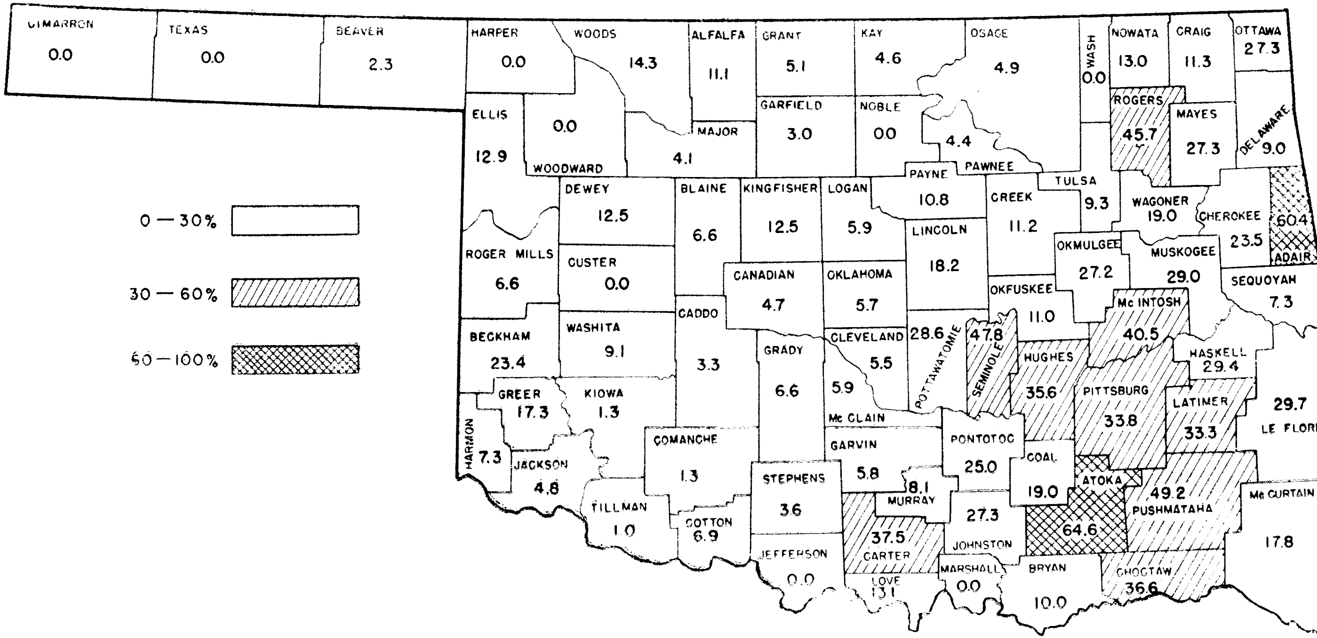

Fig. 1.—Where Oklahoma Soils Are Likely to Be Very Low in Potassium.

The figure in each county is the percentage of the soil samples from that county which contained less than 50 parts per million of potassium. In areas where soil moisture and other plant nutrients are adequate, such soils need potash fertilizer to produce maximum yields of alfalfa, cotton, and corn. The amount of potash needed is greater than usually applied in the average mixed fertilizer.