THESIS

AVAILABLE POTASSIUM IN COLORADO SOILS

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Karl R. Stockinger

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY KARL R. STOCKINGER

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Robert Gardner
In Charge of Thesis

APPROVED Alvin Kezer
Head of Department

Recommendation concurred in

Committee on Final Examination	Committee on Graduate Work
Robert Gardner	Alvin Kezer
W E Clyde	Geo. T. Avery
David W. Robertson	
Robert S. Whitney	

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AVAILABLE POTASSIUM IN COLORADO SOILS

Introduction

Potassium is a common constituent of commercial fertilizers and is one of the three most frequently limiting nutrient elements in the soil. Whether or not there is any extensive deficiency of available potassium in the soils of Colorado is a question now attracting the attention of both fertilizer dealers and farmers.

There is some experimental as well as theoretical evidence that the soils of the State are relatively well supplied with potassium in a form readily available to plants but the evidence is not sufficient to serve as a basis for fertilizer practices. It is therefore necessary that further study be made of the problem. This is particularly true at the present time because the consumption of mixed fertilizers carrying potash is rapidly increasing. About 1500 tons of mixed fertilizers (20) were sold in Colorado from July 1, 1938, to June 30, 1939. The lack of information regarding the areas where potash is needed and the extent of the need in the state has made it impossible to plan an economical fertilizer program. With the hope of getting an estimate of the percentage of Colorado irrigated soils which are deficient in available potassium, the location of the areas and the approximate average plant-available supply in the soils of the state, a study of these questions was begun in 1939. This thesis is a report of progress on the problem.

Because of the extensive area of soils and the complexity of the problem, the solution obtained by this study is obviously approximate and tentative. The study has been limited to the irrigated areas because fertility is believed to be a minor factor under the conditions of extreme moisture shortage on the dry land.

Historical

Very little work has been done on the availability of the potassium in the soils in the semi-arid region of western United States. Headden (4, 5, 6, 7) in reporting results of experiments conducted in Colorado prior to 1930, stated that a carbonic acid solution attacked orthoclase feldspar and liberated large quantities of potassium. He was able to pick out pieces of orthoclase feldspar in the coarser fractions of the soil and concluded that the soils in Colorado are largely made up of feldspar. He also found that the amount of water soluble potassium in the soil was correlated with the amount of carbon dioxide the crop was able to produce. Alfalfa produces the largest amount of carbon dioxide and though it requires a large amount of potassium for growth it doubled the amount of water soluble potassium in the soil as compared to fallow land. From these results it appears that the legumes in the rotation make potassium of the soil more available to subsequent crops. These results also indicate that alfalfa and clover are not likely to suffer from potash deficiency in Colorado soils.

In an earlier bulletin Headden (8) reports having applied potassium at the rate of 200 pounds to the acre to a wheat plot. The wheat produced on the plot had a high percentage of yellowberry. This effect was attributed to the nitrogen and potassium being out of balance due to the high potassium content of the soil.

In the period from 1921 to 1928 Hurst and Skuderna (9) carried on some fertilizer studies with sugar beets in the Arkansas Valley. They conducted a number of field trials throughout the Valley, using Schreiner's triangle method (9) for determining the fertilizer ratio which would give the best results. The data which they obtained were not subjected to statistical analysis. They inspected the data and arrived at the conclusion that the soils responded to treatment with phosphorus and nitrogen but not to potassium. The experiment was not replicated at any one location but the same treatments were used at different locations. This fact makes it possible to apply statistical methods to the data. The data, when set up in the form of randomized blocks, gave a significant F value. However, a homogeneity test (22) showed that the data were not homogeneous and therefore the generalized standard error could not be used to determine which was the best treatment. In order to find which elements were causing the response to the fertilizer, the separate standard errors of means of the treatments with and without potassium were computed by the author of this thesis. The significance of the difference was determined by means of the standard error of the difference derived from the separate standard errors. Applying this type of analysis to all of the data it was found that potassium depressed the yields somewhat but not significantly, nitrogen increased the yields but not significantly, while phosphorus caused a significant increase in yield. Also, the nitrogen and phosphorus treatments were significantly better than the nitrogen and potassium treatments. The percent sugar was not significantly affected by any treatment. Although these results would appear to indicate that potassium was not deficient in these soils, the experiment was designed in such a way that it could not be shown whether the nitrogen, phosphorus and potassium treatments were better than the nitrogen and phosphorus treatments. Potassium might have given a response with nitrogen and phosphorus by becoming a limiting factor only when the fertility levels of these other factors were increased.

Using the LaMotte test on one hundred seventy three soils from the Arkansas and San Luis Valleys, Uhlrich (21) found only 2% of the samples deficient in potassium if the 130 pounds per acre used by Lynes (12) is used as the sufficiency level (See Appendix Table 2). One hundred thirty pounds per acre by the LaMotte method apparently corresponds closely to 30 milligrams per 100 grams by the Neubauer test.

Similar results have been obtained in other states of the semi-arid region of the United States. McGeorge (15) determined the amount of available potassium on a number of calcareous soils of Arizona.

Although the amount of water soluble potassium present in these soils was very low, the Neubauer values were all high. Apparently the calcium carbonate in the soil repressed the hydrolysis of the potassium compounds but did not affect its availability to plants. The amount of available potassium in the subsoil was much less than that in the surface soil. He also found that the Neubauer values for calcareous soils were higher than those for non-calcareous soils containing the same amount of replaceable potassium.

According to a report of the Idaho Experimental Station (10), most of the soils of that state are high in available potassium as determined in the laboratory. The soils are desert soils, similar to the ones found on the western Slope of Colorado.

In northern Illinois there are some calcareous soils known as "alkali spots" which are very unproductive. Sears (18) found that the potassium of the soil was anavailable to plants. Increases in yield of corn due to the addition of potassium chloride to these soils amounted to as much as 54 bushels in one case and 40 in another.

Haley (2) using buckwheat in pot culture, found that the presence of calcium carbonate made potassium of orthoclase more available to the plants.

Harris (3) found that the addition of lime to Delaware soils increased the availability of potassium in some soils but in other soils the availability was decreased. Apparently the effect of lime on the availability of potassium is dependent on the type of soil.

MacIntire (13,14) found in lysimeter studies that lime decreased the solubility of potassium. This is in agreement with McGeorge's observation of calcareous soils.

In spite of the apparent exception in Illinois, the general concensus of opinion is that the presence of lime in the soil decreases the solubility of the potassium but increases the availability to plants. This does not necessarily hold true for all soils but appears to be especially true of calcareous soils. The literature tends to indicate that potassium is not likely to be deficient in calcareous soils similar to those generally found in Colorado irrigated sections.

Experimental Methods And Materials.

A detailed survey of the potash condition in all the irrigated soils is at present prohibitive because of the expense involved. It was therefore necessary in this study to limit the observations to sample farms which are assumed to be representative of the major irrigated areas. In planning the method of studying these sample farms two possible methods presented themselves - the method of fertilizer trials on the farms and a laboratory study of samples from the farms. The first of these methods was eliminated because of the greater expense, leaving the laboratory method as the only alternative.

The acceptance of the laboratory method presupposes that suitable laboratory procedures are available or can be devised. The situation regarding laboratory methods leaves much to be desired though methods are available which are capable of yielding valuable information. Of the laboratory tests for available potassium, the rye seedling method devised by Neubauer was selected as the most accurate and was used as the basic procedure but has been supplemented by some of the more rapid tests during the progress of the work.

The Neubauer Method

The Neubauer method has been used extensively in Germany where it has been found to give reliable indications of the need for potash fertilizers. The method has also been used in some parts of America, and to a limited extent in Colorado. However, there is some doubt as to whether or not the same Neubauer values used in Germany can be applied to the alkaline calcareous soils of Colorado. For that reason a part of the problem, which is left for later study, is to evaluate the method for Colorado conditions.

The Neubauer method, as modified by Rivaz (17) has been followed in general with some further modifications. A description of the method as it is now being used follows: Either Rosen or Cornell 45 Rye seed has been used to produce the seedlings. The seed is carefully selected and divided into lots of 100. The weight of seed is maintained at 3.5 grams or more per hundred seeds. Each lot of seeds is carefully weighed to two places and dusted with Semesan Bel. The seed treatment controls smut and fungus growth. The plants are grown in 10 cm. by 10 cm. glass refrigerator dishes. One hundred grams of soil mixed with fifty grams of quartz sand are placed in each of these dishes and covered with a layer of 175 grams of sand. Seventy grams of water are then added. After standing overnight, one hundred holes are punched in the sand with a marker made by driving one hundred nails in a square block. The seeds are placed in the holes and covered with 75 grams of sand. The plants are allowed to grow 17 days in a constant temperature room maintained at

20° C$\pm 2^\circ$C. Figure 1 shows the growing plants and a corner of the constant temperature room. The weight of each dish is checked on alternate days and the dishes are made up to weight with distilled water to take care of evaporation losses. Blanks with 100 grams of sand instead of soil are grown as checks on the amount of potassium in the seed and reagents. At the end of the period of growth the seedlings are harvested. The sand, soil and seedlings are removed from the jars and the seedlings counted for germination. (A count of at least 90 is considered essential for good results). The tops are then cut off and the soil is carefully washed from the roots with tap water. A screen tray with 2 mm. circular openings is placed on the sink to catch any roots, seed coats, or ungerminated seeds which may become detached from the root mass. All of the soil and sand is thoroughly washed from the mass of roots. This is very important as any soil not removed may contain potassium and cause high results. The seedlings are allowed to air dry for two days or more. They are then placed in large crucibles and ignited in a furnace for three hours at a controlled temperature of 1050° F. The temperature must not be allowed to become higher or the potassium will be volatilized leading to low result. After cooling, the crucibles

Figure 1. Photographs showing some of the equipment used in the potash tests.

Upper Left - Rye seedlings ready for harvest.
Middle - Furnace and pyrometer used in igniting rye samples.
Lower - Equipment used in leaching samples of replaceable potassium.

Upper right - A corner of the constant temperature room where the rye seedlings are grown.

are taken from the furnace and the contents carefully slaked with water. Five ml. of 5 N HCl are added to each crucible and evaporated to dryness on a 220 volt hot plate plugged into a 110 volt circuit. This serves to put all of the potash into solution and also to dehydrate the silica. The contents of each crucible is taken up with water and 2 ml. of 5 N HCl. After again warming on the hot plate, the entire contents are transferred to a 100 ml. volumetric flask. The flask is made up to volume and filtered through a dry 12.5 cm. No. 2 Whatman filter paper to remove the insoluble residue. Ten ml. of this solution are then made up to fifty ml. and a five ml. aliquot of this is analyzed for potassium by the cobalti-nitrite method of Brown, Robinson and Browning. (1) (See Appendix) This aliquot is equal to 1 gram of soil. The potassium found is corrected for the potassium in the seed by subtracting the amount corresponding to a similar weight of seed found in the blank sample. The results are reported as mg. K_2O per 100 gms. of soil.

Replaceable and Water Soluble Potassium

A short cut method for replaceable and water soluble potassium was devised to obtain a procedure more rapid than the Neubauer method for routine work.

The procedure is as follows: Ten grams of soil are leached in a Gooch crucible with 250 ml. of 0.01N Ba Cl_2 solution (PH 6.3) from an inverted volumetric flask which maintains a constant level of the solution (2 to 3 mm. above the soil) This is illustrated in Figure 1. A piece of filter paper holds the soil in the crucible. The leachate is collected in a 400 cc beaker, 5 ml. of 0.5N H_2SO_4 are added to precipitate the barium ion and the solution is evaporated to dryness. The residue is transferred to a 50 cc volumetric flask, made up to volume with distilled water, and a 5 cc aliquot is analyzed for potassium by the method of Brown, Robinson and Browning. (1). The results are reported in mg. K_2O per 100 grams of soil in order to be comparable with the Neubauer method.

Barium chloride was selected because the barium ion is one of the strongest replacing agents and also is very easy to remove from the solution. In small amounts barium does not interfere with the determination of potassium by the cobaltinitrite method. Barium chloride has several advantages over ammonium acetate. Since it is a stronger replacing agent it is possible to use a much more dilute solution and the labor of removing the ammonium ion is eliminated. The method of extraction is continuous with little labor involved in the process. The extraction can be started in the evening and is usually completed by morning.

Other Methods

A number of samples have been tested by the Morgan (16) and LaMotte "quick test" methods (11). The use of these tests has been mainly to get an estimate of their agreement with the Neubauer result.

Method Of Soil Sampling

A tile spade was used in collecting the soil samples and a composite of four or five locations was made in sampling each field. Two depths were taken, the top six inches and the second foot. The second six inches were not used because this depth included the transition zone between the A and B horizon.

Recording Data

The method of recording data is shown on page 15 which shows a duplicate of a sheet in the permanent record book.

Experimental Results.

One hundred and seventy six fields were sampled making a total of three hundred and forty two samples including surface and subsoil depths. Of these one hundred seventy six fields have been tested

Date ..Dec..15,1939 Field No........
Sample.No..G86A Depth.0-6". Acres..20.

Sec....16.. (Show location ....
T.......5.. in section) . .
R......64.. . .
.x.....

Owner's Name.......Howard.Bienks....
Tenant's Name .....Merton.Gross.....
Post Office.........................
Factory District ..Greeley..........
Slope: Steep... Medium... Flat.x. Rolling...
Drainage: Good.x. Fair... Poor...
Crop: 1939.Beans; 1937....Beets..
1938.Grain; 1936..Alfalfa..
Manure:..1939.x..; 19.....1937.x. 19....
Phosphate: 19... 19... 1937..x. 19......
Does field respond to phosphate? ...No.
Yields: Very good... Good ... Fair.x. Poor...
Water: Ample.x.; Short....; Very short.....

Sampled by: .....Fred.D..Law......

Analyses

Neubauer...............................K_2O 20.4mg/100
Morgan ....K 100#A.6 in
Replaceable...........................K_2O 23 mg/100gm
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Notes

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by the Neubauer method, one hundred two by the base replacement method and seventy five by Morgan's sodium acetate procedure. In addition to these tests the Holly Sugar Company cooperated by testing nineteen fields by the LaMotte method and these results are included.

Results of The Neubauer Tests

The results of the Neubauer and base replacement tests are shown in Table 1, Figures 2 and 3, and Appendix Table 1. Figure 2 shows graphically the frequency distribution of the samples studied and the Neubauer range in which all the samples fell. Table 1 shows the average Neubauer and replaceable values and the percent of the Neubauer values below 30 mg. per 100 grams of soil. It is generally conceded that few crops will show potash deficiency at values above 30 milligrams (19), and for that reason this figure has been chosen as a dividing line to separate those soils which appear to have plenty of potash from those which may be deficient. Only 4.0 percent of the surface soil and 18.6 percent of the subsoil fell below this line as is shown by the tables and the graph. It is interesting to note that the subsoil and surface soil frequency distribution curves are very similar except that the subsoil values are somewhat lower.

K_2O

Table 1 Available Potassium In Colorado Soils.

Location	No. Samples		Neubauer** mgm		Replaceable** mgm		%Neubauer below 30 mgm	
	A*	B*	A	B	A	B	A	B
Northeastern Colorado	64	58	47.6	39.2	48.8	29.9	6	22
Western Slope	27	27	49.1	33.4	40.3	20.1	3.7	14.8
Sheridan, Wyo.	7	7	52.4	41.1	37.7	18.1	0.0	14.0
Arkansas Valley	55	56	46.7	37.9	50.1	45.1	3.6	17.8
San Luis Valley	22	19	53.4	47.0			0.0	10.5
All Samples	175	167	48.4	39.6	46.8	29.0	4.0	18.6

*A refers to the surface soil, 0-6 inches, and B to the subsoil, 12-24 inches.

**Average values in mgm K_2O per 100 gram soil.

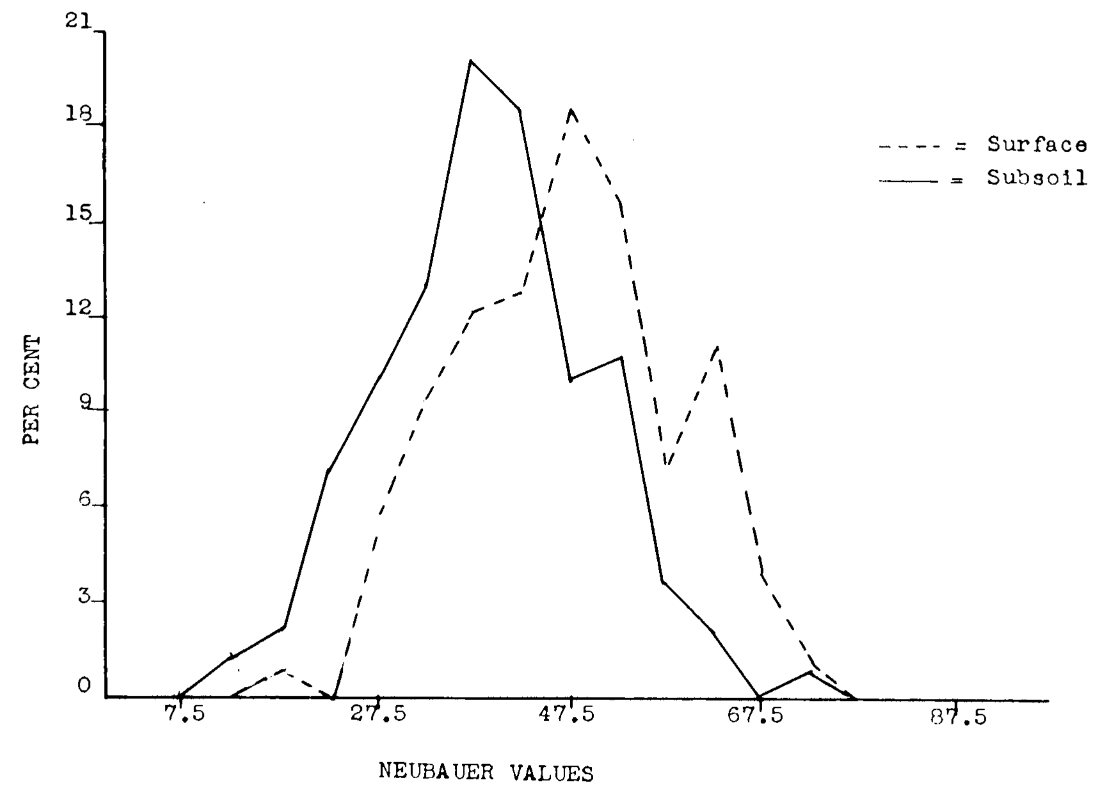

Figure 2. Frequency distribution curves showing the percentage of soils falling in various ranges of Neubauer values. The points on the curves are the class centers of groups of 5 milligrams each.

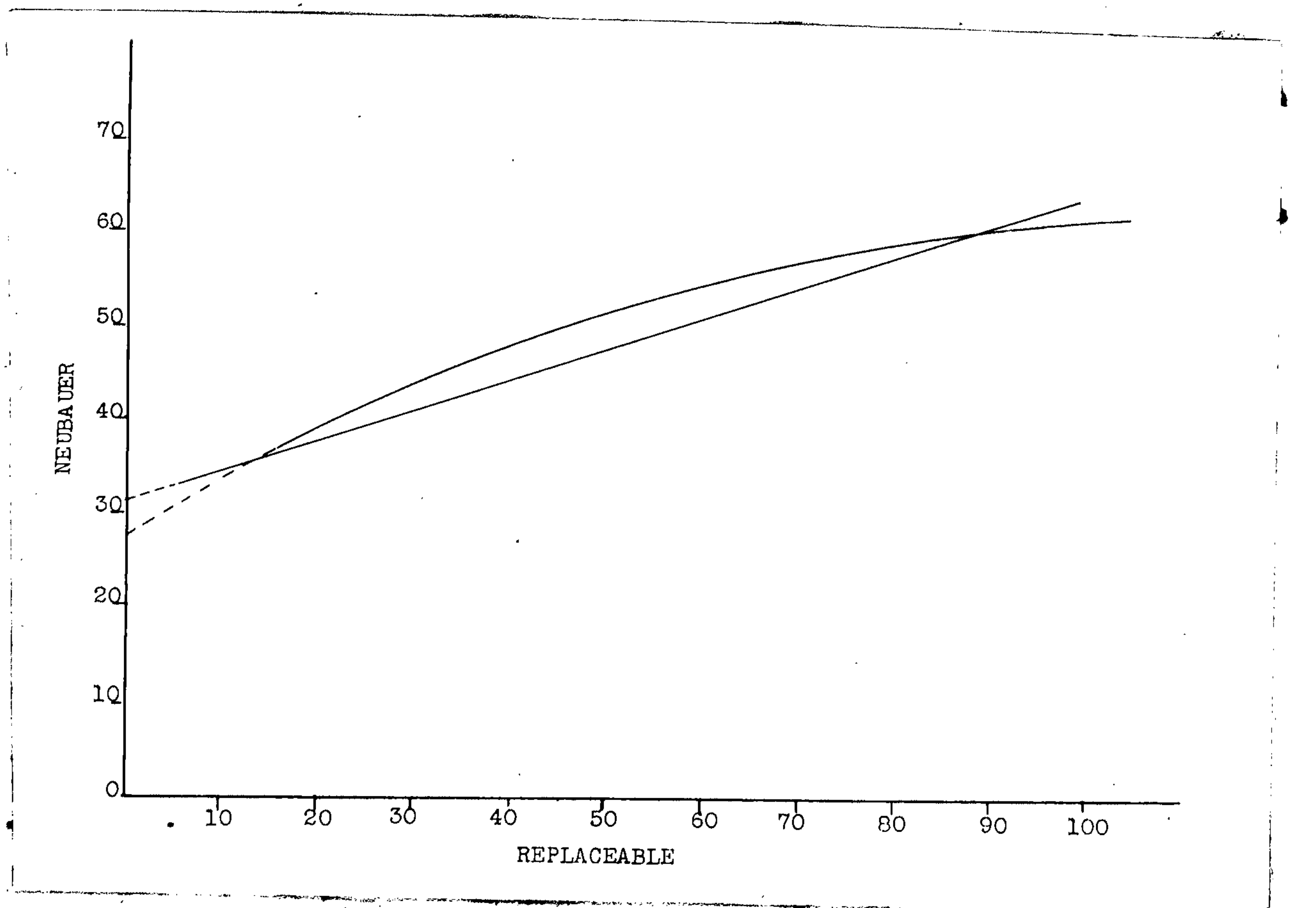

Figure 3. The best fit curve by the method of least squares showing the relation of results obtained by the Neubauer and base replacement methods. The straight line represents the subsoil values and the curved line the values from the surface soils.

The lowest Neubauer value for a top soil was 20 milligrams per 100 grams. Most of the soils which have a top soil with a low value are just on the dividing line between sufficiency and deficiency when 30 mg. per 100 grams is used as the criterion. It would be very desirable to use some field trials on some of the soils which are low in potassium in order to correlate the Neubauer test with field response. Because the project was begun only very recently, there has not been time to do this.

The subsoils on the whole are lower in available potash than the top soils. The lowest value obtained for a subsoil sample was 12 mg. per 100 grams. Also the number of samples below the level of sufficiency is much greater in the subsoil group. It would appear from these results that perhaps spots in fields which have been eroded, or have had the top soil removed in leveling the field, may be deficient in potash and may respond to potash fertilization.

Chemical Extraction Methods For Available Potash.

A number of chemical extraction methods are in use for the determination of available potash. These can be divided into two classes, those which extract the potash from the soil by successive leachings by a solution containing a base which will replace the potassium absorbed by the clay and those which produce an equilibrium solution with the soil and some solvent.

The former of these is commonly referred to as the base exchange method and the latter includes the so called "quick test". Either of these procedures is much less laborious than the Neubauer test and would therefore be preferable if sufficiently accurate. For that reason, a comparison of these procedures and the Neubauer method was made. One hundred two surface soils and ninety-five subsoils were tested by both the base exchange and Neubauer method. The best fit curves showing the relation of the results by the Neubauer method and the results by base exchange method were calculated by the method of least squares. These curves are shown in Figure 2. In the case of the surface soil the quadratic curve was found to be significantly better than the linear. The equation found for the surface soil was $Y = 28.07 + .506X - .00267X^2$ where Y is the Neubauer and X the replaceable variable. Calculating the predicted values corresponding to the observed values for Y from the equation and correlating them with the observed values gave a correlation coefficient, R, of 0.57. The quadratic was not significantly better than the linear curve for the subsoil. The correlation coefficient, r, for this curve was 0.44. The results are shown graphically in Figure 3. The equation for the subsoil curve was found to be $Y = .258X + 31.8$. While no results as low as zero were found by either method, some comparatively low results were found by the base exchange method and it appears that the curves can be extrapolated to near zero exchangeable potash without serious error. Extrapolation to 0 would give 28.07 mgm. Neubauer potash for the surface soil and 31.8 for the subsoil. If any reliance can be placed on the curves in the range as low as zero replaceable potash, a very significant deduction regarding replaceable potash and probably other solution extracts as methods of estimating potash deficiency can be drawn from the curves. This deduction is that in Colorado soils values low as zero by any of the common solution extraction methods may not indicate a deficiency since they correspond to a sufficient Neubauer level. This reasoning is justified from the fact that the removal of potassium from the soil by base exchange methods is more complete than removal in the equilibrium solutions and base exchange methods therefore tend to give higher value. Therefore, if sufficient available potassium by the

Neubauer method is indicated at zero replaceable potash the same should hold true for the other extraction methods except where a solution is used which is sufficiently active to decompose the potash minerals.

A comparison of the Neubauer, the Morgan and the LaMotte methods is shown in Table 2 for 19 Colorado and Wyoming soils*. The results by the LaMotte and Neubauer methods give a correlation coefficient of .8 but there is not a significant correlation between the Morgan method and either of the others. The number of samples, however, are not sufficient for an accurate comparison.

The significance of the regression curves and correlation coefficient were calculated from a co-variance analysis and the F test. The 5 percent point was used as the level of significance. The F values found for the surface and subsoil curves in Figure 3 were 25.3 and 32.0 respectively. Values of 3.1 and 3.9 were required for significance. The F value for the correlation coefficients between the Neubauer and La-Motte tests was 60.8 and between the Neubauer and Mor-gan tests 3.3. The value required for significance in the latter calculations is 4.1.

* The Morgan and LaMotte tests were made by The Holly Sugar Company and were furnished by Mr. Frank Lynes, Agronomist for that company.

Table 2. Available Potassium By The Neubauer, Morgan and LaMotte Methods.

The potassium is expressed in percent of respective sufficient criteria: LaMotte 130# per acre, Morgan 200# per acre, and Neubauer 29 mg. per 100 grams of soil.

Sample No.	Depth	LaMotte	Morgan	Neubauer
56A	8	200	300	184
56B	16	169	150	152
57A	8	153	75	148
57B	16	108	50	99
58A	8	269	300	238
58B	16	153	50	151
59A	8	139	100	160
59B	16	131	50	122
60A	8	131	100	163
60B	16	162	50	137
61A	8	162	300	218
61B	16	153	75	176
65A	8	108	75	144
65B	16	131	25	101
66A	8	146	300	134
66B	16	92	75	143
67A	8	153	300	147
67B	16	153	300	142
68A	8	139	300	139
68B	16	92	100	121
69A	8	185	300	158
69B	16	116	100	120
70A	8	170	100	169
70B	16	116	50	136
71A	8	185	100	143
71B	16	100	50	99
72A	8	153	75	148
72B	16	100	50	108

Sample No.	Depth	LaMotte	Morgan	Neubauer
73A	8	153	300	144
73B	16	108	100	111
74A	8	139	150	136
74B	16	100	75	110
75A	8	250	300	217
75B	16	139	300	169
76A	8	146	300	150
76B	16	100	75	134
77A	8	139	100	130
77B	16	116	50	106

* From a table prepared by Frank Lynes of the Holly Sugar Company. The Neubauer determinations were made in this laboratory and the LaMotte and Morgan tests by The Holly Sugar Company.

Summary And Conclusions.

In 1939 a study was begun to determine the available potassium in the soils of the major irrigated areas of Colorado. The following methods were used in the study:

1. The Neubauer rye seedling method
2. The base exchange method
3. Morgan's quick test
4. The LaMotte quick test

During the study 175 surface soils and 167 subsoil samples were tested by the Neubauer method, 102 surface soils and 95 subsoils by the base exchange method, 73 surface soils and 71 subsoil by the Morgan method, and 19 surface soils and 19 subsoil by the LaMotte method.

The results of these tests show that when 30 milligrams of K_2O per 100 grams of soil by the Neubauer test is used as the dividing line between sufficient and deficient soils only 4 percent of the surface soils and 19 percent of the subsoils are classed as deficient in available potash. Those falling below the 30 milligram point were only slightly lower and can therefore be classed as only slightly deficient. The average value for all soils tested was 48.4 milligrams for the surface soils and 39.6 for the subsoils. These values by the standards previously established in other parts of the United States and Germany are comparatively high. However, any conclusions regarding the percentage of deficient soils in the state are subject to revision if it is found that the 30 milligram levels are not the best value to be used as a criterion for an estimate of sufficiency.

In order to fix a sufficiency level for the base exchange procedure, it was necessary to plat a curve showing the Neubauer method corresponding to values determined by the base exchange method and use the Neubauer value as a basis for evaluating the base exchange method. On the best fit curve the 30 milligram dividing line fell at near zero replaceable potash, indicating that very low replaceable values should be chosen as the dividing line unless the 30 milligram Neubauer level is too low for Colorado soils. The correlation coefficient for the two methods was .57 for the surface soils and .44 for the subsoils. With the few samples studied, a correlation coefficient of .8 was found between the Neubauer and LaMotte methods. No significant correlation was found between the Neubauer and Morgan method but the pairs of samples were too few to justify any conclusions from the results in the last two correlations.

APPENDIX

Brown, Robinson and Browning Method For Determination of Small Amounts of Potassium. Ind. Eng. Chem., Anal. Ed. 10 652-4 (1938)

REAGENTS

"Precipitating Reagent. Mix together 46.2 grams of sodium cobaltinitrite, 18.9 grams of sodium acetate, 120.0 ml of distilled water, and 18.0 ml. of glacial acetic acid. Prepare this solution 48 hours before using. Keep stoppered and in a cold, dark place. Before using, centrifuge to remove and precipitate.

"Ethyl Alcohol. 95 and 70 per cent by volume.

"Ceric Sulfate. Dissolve about 9 grams of anhydrous ceric sulfate in 500 ml. of distilled water to which have been added 30 ml. of concentrated sulfuric acid. Make up to 1 liter. This solution which is approximately 0.02 N, may be standardized with sodium oxalate.

"Ferrous Ammonium Sulfate. Dissolve 8 grams of $FeSO_4(NH_4)_2SO_4.6H_2O$ in 500 ml. of distilled water to which have been added 10 ml. of concentrated sulfuric acid and make up to 1 liter.

"Sulfuric Acid. Concentrated sulfuric acid diluted 1 to 1.

"Indicator. 0.025 M o-phenanthroline ferrous complex.

PROCEDURE

"To 1.5 ml. of 95 per cent ethyl alcohol in a 15-ml. centrifuge tube add a 5-ml. aliquot of the potassium solution. Mix thoroughly. Add dropwise, with continuous shaking, 2.0 ml. of the precipitating reagent. Allow to stand for at least an hour at about of from 20° to 25° C. Centrifuge for about 10 minutes at about 2000 r. p. m., so that the precipitate is firmly packed in the bottom of the tube. Pour off the supernatant liquid and allow the tube to drain for about 5 minutes. Wash the precipitate with 5 ml. of 70 per cent alcohol, breaking up the bulk of the precipitate by forcing the wash solution in a fine stream from a pipet. Centrifuge for 5 minutes and drain as before. Dry the precipitate for 0.5 hour at 80° to 85° C. to remove all the alcohol.

"Add 5 ml. of the ceric sulfate reagent and 1 ml of 1 to 1 sulfuric acid. Heat in a water bath at 90° to 100° C. until all the precipitate is oxidized, as indicated by its disappearance (usually within about 5 minutes). Maintain an excess of ceric sulfate throughout the reaction (5 ml. of 0.02 N ceric sulfate are sufficient for precipitates containing no more than 0.5 mg. of potassium.) Cool to room temperature and titrate the excess ceric sulfate with ferrous ammonium sulfate, using one drop of o-phenanthroline ferrous complex as indicator. The end point is very sharp, the color of the solution changing from pale blue to red.

"Calculation. Milligrams of K = ml. of $Ce(SO_4)_2$ used in oxidation of the precipitate x normality of $Ce(SO_4)_2$ x 6.52.*

*7.86 for K_2O

(K_2O)

Appendix Table 1. Available Potassium By The Neubauer, Replaceable And Morgan Methods.

Northeastern Colorado

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan Lbs. per Acre
*4A	Ft. Collins loam	13 7N 69W	26	31	0
4B			25	20	150
5A	Ft. Collins loam	13 7N 69W	33	35	0
5B			30	21	0
6A	Ft. Collins loam	14 7N 69W	67	60	150
6B			59	32	50
11A	Ft. Collins loam	14 7N 69W	57	51	200
11B			48	32	50
12A	Ft. Collins loam	14 7N 69W	61	78	150
12B			40	20	0
19A	Weld fine sandy loam	27 7N 67W	39	26	150
20A	Weld fine sandy loam	7 7N 67W	52	38	100
21A	Weld fine sandy loam	24 7N 67W	33	31	50

*A refers to top six inches of soil and B is second foot of soil.

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan Lbs.per acre
22A	Weld fine sandy loam	26 7N 67W	28	28	0
22B			21	18	0
23A	Larimer fine sandy loam	13 6N 67W	28	19	0
23B			17	13	0
24A	Weld fine sandy loam	North of Ault	34	26	0
24B			19	13	0
25A	Weld fine sandy loam	25 7N 67W	43	39	0
25B			23	15	0
26A	Weld fine sandy loam	27 7N 67W	38	32	0
26B			12	10	0
27A	Terry silty clay loam	21 8N 69W	37	46	0
27B			28	30	0
28A	Terry fine sandy loam	12 8N 68W	52	60	300
28B			44	30	50
29A	Terry silty clay loam	22 6N 69W	55	63	200
29B			28	39	0
30A	Terry silty clay loam	3 5N 69W	55	58	50
30B			60	67	100

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
31A	Terry loam	34 6N 68W	62	77	200
31B			65	104	150
32A	Cass clay loam	28 8N 69W	47	33	50
32B			31	11	0
33A	Weld fine sandy loam	13 8N 68W	49	42	0
33B			33	18	0
34A	Cass fine sandy loam	28 9N 68W	72	74	200
34B			45	26	50
35A	Weld loam	28 8N 68W	70	58	200
35B			56	32	50
36A	Weld fine sandy loam	16 7N 68W	48	34	150
36B			34	17	0
37A	Cass clay loam	7 7N 68W	54	34	0
37B			38	14	50
38A	Weld loam	31 5N 68W	52	35	0
38B			29	17	0
39A	Ft.Collins clay loam	21 3N 69W	61	53	300
39B			75	26	150

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs. per acre
40A	Ft. Collins loam	23 4N 69W	61	49	300
40B			58	25	50
41A	Larimer fine sandy loam	23 7N 67W	55	50	600
41B			53	31	150
42A	Larimer fine sandy loam	17 9N 68W	52	40	300
42B			64	34	200
43A	Berthoud loam	16 4N 69W	41	26	50
43B			35	17	50
44A	Larimer loam	35 3N 70W	50	37	150
44B			48	21	50
45A	Berthoud loam	33 3N 70W	38	22	50
45B			39	23	0
46A	Ft.Collins clay loam	11 5N 68W	62	41	150
46B			38	12	0
47A	Larimer loam	35 7N 69W	48	15	0
47B			40	11	0
48A	Ft.Collins loam	15 5N 68W	73	68	600
48B			50	26	150
49A	Ft.Collins clay loam	32 7N 68W	62	60	600
49B			42	11	0

No.	Soil Type	Location Sec. T. R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
50A	Neville fine sandy loam	31 8N 69W	57	64	600
50B			31	12	0
51A	Neville fine sandy loam	26 6N 70W	45	30	200
51B			36	20	100
52A	Neville fine sandy loam	11 5N 70W	42	38	400
52B			38	15	0
53A	Leporte loam	18 5N 69W	51	25	0
53B			21	5	0
63A	Bridgeport silt loam	17 7N 53W	72	135	600
63B			56	55	600
78A	Neville fine sandy loam	Near Spring Canyon	33	24	
78B			27		
79A	Loam	Near Parshall, Colorado	39		
82A	Loam	22 10N 51W	60	75	
82B	Clay loam		51	75	
83A	Loam	5 10N 50W	47	52	
83B	Loam		38	49	

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100	Morgan lbs.per acre
84A	Clay	26 9N 52W	47	49	
85A	Clay loam	21 7N 53W	53	96	
85B	Clay loam		43	44	
86A	Clay loam	11 4N 56W	40	84	
86B	Clay		48	83	
87A	Clay	11 5S 4W	50	74	
87B	Sandy clay		38	39	
88A	Gilcrest gravelly sandy loam	34 8N 65W	47	54	
88B			29	27	
89A	Gilcrest gravelly sandy loam	16 5N 64W	20	23	
89B			22	17	
90A	Kuner silty clay loam	1 4N 64W	41	16	
90B			33	15	
91A	Gilcrest gravelly sandy loam	30 4N 66W	45	30	
91B			40	16	
92A	Gilcrest gravelly sandy loam	28 5N 65W	30	15	
92B			32	17	
93A	Terry fine sandy loam	12 5N 66W	32		
93B			22		

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
94A	Weld fine sandy loam	11 5N 64W	46	58	
94B			42	40	
95A	Valentine loamy fine sand	4 4N 64W	33		
95B			36		
96A	Clay loam	7 10N 48W	51	74	
96B	Clay loam		53	65	
97A	Loam	16 11N 47W	45	71	
97B	Loam		44	61	
98A	Loam	30 12N 44W	49	125	
98B	Loam		51	73	
114A	Silt loam	Near Bellvue	52		
118A	Clay loam	16 3N 60W	42		
118B	Clay		45		
119A	Clay loam	20 5N 54W	50		
119B	Clay		45		
133A	Clay	19 1N 68W	31		
133B	Clay		26		

Western Slope

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
7A	Clay Loam	Near Orchard Mesa	64	57	200
7B	Clay		27		0
8A	Clay	Near Vineland	61	65	50
8B	Clay		52	25	0
9A	Clay	Near Palisade	57	35	200
9B	Clay		42	25	50
10A	Sandy Loam	Near Vineland	63	57	150
10B	Sandy Loam		54	35	150
13A	Clay	Near Orchard Mesa	56	58	200
13B	Clay		40	19	50
14A	Sandy Loam	Near Palisade	56	52	200
14B	Sandy Loam		38	20	50
15A	Clay Loam	Near Vineland	49	42	150
15B	Clay Loam		43	25	100
16A	Clay Loam	Near Orchard Mesa	68	62	500
16B	Clay Loam		44	25	50
17A	Clay Loam	Near Palisade	65	59	500
17B	Clay Loam		55	32	200
54A	Clay loam	Near Austin	34		150
54B	Clay		36		0

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs. per acre
55A	Clay loam	Near Austin	66		200
55B	Clay		52		50
64A	Clay loam	13 15S 96W	58	22	150
64B	Clay loam		48	12	200
65A	Silty clay loam	15 14S 92W	42	35	150
65B	Silty clay		29	22	50
66A	Silt loam	21 1N 1W	39	22	200
66B	Very fine sandy loam		42	13	100
67A	Sandy clay loam	7 50N 10W	42	38	600
67B	Clay loam		41	31	200
68A	Clay loam	26 49N 9W	40	40	500
68B	Silty clay loam		35	20	50
69A	Loam	5 49N 10W	46	40	300
69B	Clay loam		35	21	100
70A	Silt loam	18 47N 8W	48	21	200
70B	Silty clay loam		39	9	50
71A	Silt loam	28 1S 1E	42	26	50
71B	Silty clay loam		29	9	50
72A	Silty clay loam	14 14S 92W	43	23	50
72B	Silty clay loam		31	8	0

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
73A	Loam	18 50N 10W	42	26	0
73B	Clay loam		32	17	0
74A	Clay loam	33 1N 1W	40	16	50
74B	Clay loam		32	7	0
75A	Loam	22 48N 9W	63	78	600
75B	Loam		49	35	300
76A	Silty clay loam	24 1S 1W	43	32	50
76B	Silty clay		39	18	150
77A	Silty clay loam	2 2N 2W	38	32	50
77B	Clay loam		31	18	50
80A	Loam	Near Woody Creek	28		
80B	Loam		22		
81A	Silt loam	Near Pagosa	33		
81B	Silty clay loam	Springs	21		
		Sheridan, Wyoming			
56A	Big Horn Clay	20 56N 84W	52	35	300
56B			44	20	150
57A	Big Horn clay	20 56N 84W	43	15	150
57B			29	9	50

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
58A	Big Horn clay	21 56N 84W	68	69	600
58B			44	21	600
59A	Big Horn clay	16 55N 85W	46	33	200
59B			36	18	50
60A	Big Horn clay	20 56N 84W	47	25	150
60B			40	21	0
61A	Bridgeport loam	30 56N 83W	63	43	600
61B			51	23	150
62A	Big Horn clay	29 56N 84W	48	30	200
62B			44	15	100
		Arkansas Valley			
18B	Fine sandy loam	From Baca County	37	28	200
99A	Silty clay loam	South of	40	73	
99B	Clay	Colorado Springs	38	41	
100A	Sandy loam	South of	33	59	
100B	Sandy loam	Colorado Springs	34	44	
101A	Silty clay loam	East of	44	77	
101B	Clay	Fountain	40	33	

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
102A	Clay	South of Fountain	43	53	
102B	Clay		46		
103A	Clay	North of Pueblo	61	45	
103B	Clay		50	68	
104A	Rocky Ford fine	3 21S 64W	40	69	
104B	sandy loam		37	52	
105A	Rocky Ford loam	5 21S 63W	51	29	
105B			34	47	
106A	Rocky Ford loam	11 21S 63W	32	25	
106B			32	55	
107A	Rocky Ford loam	9 21S 62W	35	31	
107B			33	66	
108A	Billings clay	32 20S 62W	41	34	
108B			37	67	
109 A	Billings clay	5 21S 61W	45	44	
109B			37		
110A	Rocky Ford fine	4 22S 60W	36	42	
110B	sandy loam		24	29	
111A	Ordway clay	24 21S 56W	46	56	
111B			42	34	

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
112A	Ordway clay loam	14 21S 56W	46	61	
112B			25	41	
113A	Ordway clay loam	3 21S 56W	44	53	
113B			32	26	
121A	Ordway clay loam	2 21S 56W	42		
121B			32		
122A	Ordway clay	4 21S 56W	40		
122B			20		
123A	Ordway clay	19 21S 56W	43		
123B			38		
124A	Las Animas silty	26 23S 56W	49		
124B	clay loam		38		
125A	Laurel fine sandy loam	23 23S 56W	47		
125B			33		
126A	Rocky Ford clay loam	29 23S 56W	51		
126B			19		
127A	Apishapa silty clay loam	4 24S 56W	44		
127B			19		
128A	Apishapa silty clay loam	34 23S 56W	43		
128B			32		

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
129A	Rocky Ford clay loam	34 23S 56W	57		
129B			49		
130A	Rocky Ford clay loam	27 23S 56W	51		
130B			30		
131A	Minnequa clay loam	28 23S 56W	54		
131B			29		
132A	Fort Lyons clay loam	20 23S 54W	65		
132B			36		
134A	Las Animas Clay	36 23S 55W	37		
134B			31		
135A	Las Animas silty clay loam	15 22S 59W	34		
135B			28		
136A	Rocky Ford loam	22 22S 59W	31		
136B			15		
137A	Rocky Ford clay loam	32 22S 57W	28		
137B			16		
138A	Rocky Ford clay loam	10 23S 57W	26		
138B			28		
139A	Rocky Ford loam	13 23S 57W	52		
139B			46		

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
140A	Rocky Ford loam	12 23S 57W	52		
140B			37		
141A	Las Animas clay	27 22S 46W	37		
141B	loam		35		
142A	Manvel silt loam	3 23S 44W	46		
142B			49		
143A	Prowers fine sandy loam		52		
143B		23 23S 44W	48		
144A	Las Animas clay	22 22S 46W	50		
144B	loam		52		
145A	Prowers loam	18 22S 46W	46		
145B			48		
146A	Prowers loamy fine	3 23S 45W	46		
146B	sand		42		
147A	Las Animas silty	27 22S 45W	53		
147B	clay loam		50		
148A	Fort Lyons clay	31 22S 52W	39		
148B	loam		36		
149A	Rocky Ford silty	31 22S 52W	50		
149B	clay loam		51		

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
150A	Minnequa clay loam	33 32S 53W	53		
150B	Clay loam		39		
151A	Clay loam	5 33S 63W	46		
151B	Clay loam		44		
152A	Clay loam	7 32S 62W	54		
152B	Clay loam		29		
153A	Clay loam	5 32S 62W	61		
153B	Clay loam		53		
154A	Silty clay loam	5 32S 62W	56		
154B	Clay loam		50		
155A	Clay	36 31S 63W	56		
155B	Clay		52		
156A	Clay	36 31S 63W	62		
156B	Clay		64		
157A	Clay	9 34S 61W	52		
157B	Clay		44		
158A	Clay	9 32S 62W	54		
158B	Clay		45		
159A	Clay	25 32S 62W	58		
159B	Clay		41		

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
160A	Clay loam	10 34S 62W	61		
160B	Clay		55		
161A	Clay	3 34S 52W	54		
161B			44		
		San Luis Valley			
120A	Sandy loam	Experiment farm	32		
120B	Sandy loam	near Alamosa	34		
162A	Loam	Near La Veta	39		
162B	Clay loam		38		
163A	Clay loam	Near La Veta	55		
163B	Clay loam		46		
164A	Sandy loam	19 38N 11E	48		
164B	Loamy sand		46		
165A	Sandy loam	11 38N 10E	54		
165B	Sandy loam		49		
166A	Loamy sand	1 39N 10E	56		
166B	Loamy sand		49		
167A	Sandy loam	7 29N 9E	39		
167B	Loamy sand		46		
168A	Loamy sand	18 39N 99W	60		
168B	Loamy sand		45		

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs. per acre
169A	Sandy loam	18 29N 9E	52		
169B	Sandy loam		54		
170A	Sandy loam	18 39N 9E	55		
171A	Loam	18 37N 9E	70		
171B	Clay loam		53		
172A	Sandy loam	35 37N 9E	57		
172B	Sandy loam		57		
173A	Loam	7 36N 10E	64		
173B	Loam		55		
174A	Loam	Near Monte Vista	58		
174B	Clay loam		49		
175A	Clay loam	Near Monte Vista	56		
175B	Clay loam		51		
176A	Clay loam	Near Monte Vista	46		
177A	Clay loam	Near Monte Vista	63		
177B	Clay loam		55		
178A	Loam	Near Monte Vista	70		
178B	Clay loam		68		

No.	Soil Type	Location Sec. T.R.	Neubauer mgm/100g	Replaceable mgm/100g	Morgan lbs.per acre
179A	Loam	Near Monte Vista	70		
180A	Loam	Near Monte Vista	58		
181A	Silt loam	14 35S 7E	37		
181B	Silt loam		27		
182A	Silt loam	11 35S 7E	37		
182B	Silt loam		24		

Appendix Table 2. LaMotte Potassium Tests on American Crystal Sugar Company Soils.

San Luis Valley District

Soil No.	K - Pounds per Acre					Average
1A	220	180				200
1B	140	160				150
2A	200	200				200
2B	350	240	210			266
3A	190	170				180
3B	150	150				150
4A	180	150				165
4B	220	145	180	150		173
5A	325	210	220			251
5B	220	140	220			193
6A	160	300	160			206
6B	210	200				205
7A	160	170				165
7B	350	170	170			230
8A	260	350	180	260	160	242
8B	170	220	350	170		227
9A	200	325	220			248
9B	300	400	160	145	260	253
10A	170	400	220	260		262
10B	145	180				162
11A	190	260	150			200
11B	300	300				300
12A	160	140				150
12B	220	145	160			175
13A	150	160				155
13B	300	160	300			253
14A	180	180				180
14B	175	180				177

Soil No.	K - Pounds per Acre				Average
15A	220	160	190		190
15B	170	220	170		186
16A	180	160	160		166
16B	160	180	200		180
17A	180	180			180
17B	220	210			215
18A	155	180			167
18B	180	140			160
19A	210	220			215
19B	200	260			230
20A	280	180	150		203
20B	220	220			220
21A	220	140	190		183
21B	180	180			180
22A	160	140			150
22B	180	130			155
23A	180	180	180		180
23B	260	150	140		183
24A	130	180			155
24B	210	180			195
25A	160	180			170
25B	150	110			130
26A	375	200	145	210	232
26B	240	190			215
27A	180	150			165
27B	400	160	160		240
28A	160	150			155
28B	180	160			170
29A	170	155			162
29B	200	180			190
30A	150	260	350	150	227
30B	160	160			160

Soil No.	K - Pounds per Acre				Average
31A	165	170			167
31B	170	220	125	160	168
32A	300	240			270
32B	180	210			195
	Upper Arkansas				
33A	180	130	220		176
33B	140	160			150
34A	220	220	260		233
34B	160	140	280	160	185
35A	160	140			150
35B	200	160			180
36A	140	220	200		186
36B	220	260			240
37A	200	180	300	170	212
37B	170	160	260	220	202
38A	325	190	210		241
38B	300	220			260
39A	170	180			175
39B	375	330			352
40A	240	210			225
40B	300	260			280
41A	220	325	220		255
41B	220	200			210
42A	160	350	260		256
42B	150	220	220		196
43A	260	260			260
43B	250	200			225
44A	240	200			220
44B	190	150			170
45A	300	300	270		290
45B	210	240	210		220
46A	260	200			230
46B	300	140	260		200

Pueblo

Soil No.	K - Pounds per Acre					Average
47A	180	220				200
47B	180	180				180
48A	180	160				170
48B	130	140				135
49A	140	210				175
49B	190	220				205
50A	180	260				220
50B	180	220				200
51A	150	140				145
51B	160	130				145
52A	180	180				180
52B	140	160				150
53A	190	170	220			173
53B	170	165	160			247
54A	190	220				205
54B	190	140				165
55A	160	160				160
55B	210	140	160			170
56A	190	140	220	160		177
56B	220	160	135			171
57A	300	140	330			256
57B	220	160	220			200
58A	220	210				215
58B	180	180				180
59A	130	220	300	160		225
59B	220					220
60A	170					170
60B	180	185				182
61A	160	260	350	170		235
61B	170	200				185
62A	220	160	300	145	350	235
62B	160					160

Soil No.	K - Pounds per Acre					Average
63A	190	260				225
63B	125	110				117
64A	165	260	375	125	350	255
64B	180	145				162
65A	145	210	350			235
65B	160	170				165
		Rocky Ford				
66A	140	180				160
66B	160	200				180
67A	180	200	210			196
67B	170	220	210			200
68A	160	260	140			186
68B	190	130	220	220		190
69A	220	300				260
69B	190	130	145			155
70A	240	400	135	120	220	223
70B	180	160				170
71A	210	165	140			171
71B	140	160				150
72A	260	175	180			205
72B	260	190	180			210
73A	180	260	220			220
73B	260	200				230
74A	260	150	260			223
74B	220	160	210			196
75A	170	155				162
75B	210	220				215
76A	140	180				160
76B	280	260				270
77A	170	145				157
77B	325	135	180			213
78A	240	220				230
78B	200	170				185

Soil No.	K - Pounds per Acre					Average
79A	260	140	220			206
79B	170	220				195
80A	210	155	190			185
80B	200	240				220
81A	190	180				185
81B	310	160	180			216
82A	280	160	160			200
82B	160	150				155
		Las Animas				
83A	190	140				165
83B	230	300				265
84A	170	220				195
84B	170	210				190
85A	180	135	175			163
85B	150	135				142
86A	145	180				162
86B	180	140				160
87A	160	125	135			140
87B	120	165	110			131
88A	180	150				165
88B	215	165	150			176
89A	325	150	260	135	220	218
89B	190	165				177
90A	220	180				200
90B	180	190				185
91A	200	160				180
91B	185	170				177
92A	130	180	120			143
92B	220	135	180	150		171
93A	190	160				175
93B	200	140	140			160
94A	140	150				145
94B	120	260	150			176

Soil No.	K - Pounds per Acre				Average
95A	200	180			190
95B	110	220	160		163
96A	140	180			160
96B	125	180	140		148
97A	180	220			200
97B	150	140			145
98A	220	170			195
98B	145	140			142
99A	140	160			150
99B	160	135			147
100A	200	210			205
100B	150	160			155
		Lamar			
101A	160	130			145
101B	135	140			137
102A	160	160			160
102B	190	160		1	175
103A	150	145			147
103B	140	200	170		170
104A	170	150			160
104B	140	170			155
105A	135	120			127
105B	125	140			132
106A	150	150			150
106B	260	140	140		180
107A	160	210			185
107B	140	160			150
108A	115	150	180		148
108B	130	140			135
109A	190	140	120		150
109B	240	160	120		173

Soil No.	K - Pounds per Acre			Average
110A	200	165		182
110B	180	160		170
111A	160	135		147
111B	150	200		175
112A	140	190		165
112B	160	135		147
113A	325	300		312
113B	220	160	140	173
114A	220	280		250
114B	260	200		230
115A	260	240		250
115B	240	160	210	203
116A	220	220		220
116B	200	200		200
117A	170	220		195
117B	220	130	140	163
118A	170	150		160
118B	190	150		170
119A	160	160		160
119B	140	160		150
120A	210	180		195
120B	170	160		165
121A	210	160		185
121B	130	110		120
122A	120	180	260	186
122B	150	300	260	236
123A	120	220	220	186
123B	200	240	260	233
124A	165	220		192
124B	220	170		195
125A	180	375	260	271
125B	160	220	190	190

Soil No.	K - Pounds per Acre				Average
126A	160	220	240		206
126B	220	260			240
127A	155	180			167
127B	160	150			155
128A	130	140			135
128B	210	135	300	260	226
129A	175	180			177
129B	180	160			170
130A	150	190			170
130B	150	125			137
131A	125	120			122
131B	140	120			130
132A	175	135			155
132B	160	160			160
133A	140	140			140
133B	130	140			135
134A	170	180			175
134B	160	190			175
135A	140	140			140
135B	100	120			110
136A	160	180			170
136B	140	160			150
137A	160	180			170
137B	160	200			180
138A	160	260	260		226
138B	180	190			185
139A	150	180			165
139B	180	180			180

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Soil No.	K - Pounds per Acre			Average
8204	180	125		152
8206	220	140	175	178
8198	240	300		270
8189	180	180		180
8194	180	260		220
8190	215	260		237
8201	220	220		220
8202	180	170		175
8182	185	180		182
8186	160	180		170
8197	220	350	260	276
8199	180	180		180
8191	160	160		160
8193	105	110		107
8187	200	260		230
8188	160	210		185
8192	200	220		210
8185	200	260		230
8184	220	260		240
8183	180	140		160
8230	220	180		200
8228	160	180		170
8227	170	210		190
8223	180	180		180
8234	180	180		180
8232	150	145		147
8235	210	160		185
8222	325	180	260	255
8224	180	160		170

Soil No.	K - Pounds per Acre			Average
1829	260	280		270
8231	160	260	180	200
8220	260	240		250
8236	200	180		190
8213	300	190	220	226
8212	180	220		200
8214	220	210		215
8215	300	190	160	216
8216	240	260		250
8217	180	230		205
8218	220	180		200
8219	130	180		155
8205	325	110	200	211
8208	200	155		177
8209	220	215		217
8207	160	130		145
8200	160	180		170
8221	240	160	160	186
8238	160	220		190
8239	150	220		185
8106	180	220		200
8130	185	190		187
8071	160	210		185
8094	300	240		270
8226	260	140	220	206
8195	150	260	180	196
8241	180	125		152
8095	180	260		220
8107	160	350	180	230
8180	170	220		195

Soil No.	K - Pounds per Acre			Average
8083	180	220		200
	180	160		170
8105	260	240		250
8102	170	280	180	210
8103	170	180		175
8104	220	140	180	180

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