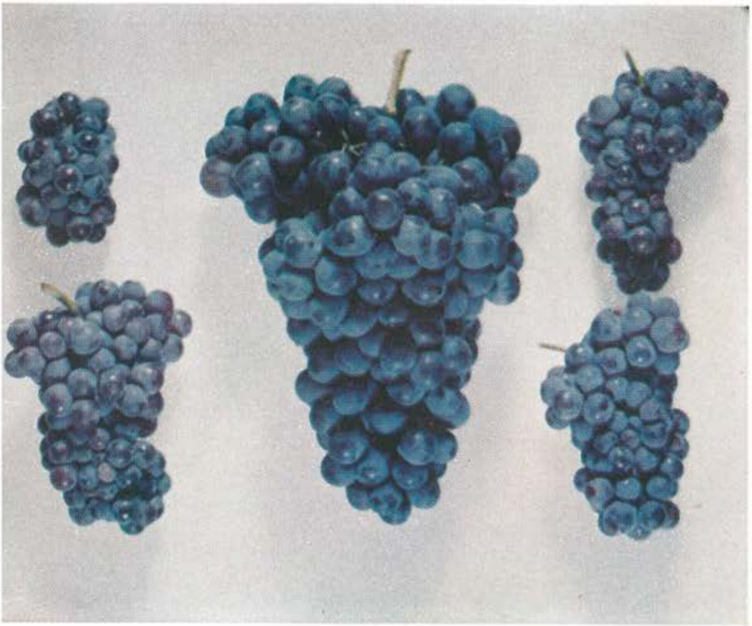
Do Not Remove

Last copy

Better Crops WITH PLANT FOOD

May-June, 1961

20 Cents



IN THIS FRUIT

POTASH WAS THE DIFFERENCE

IN THIS FOLIAGE

Better Crops WITH PLANT FOOD

The Whole Truth—Not Selected Truth
$1.00 for 6 Issues, 20¢ Per Copy

Vol. XLV Washington, D. C. No. 3

Santford Martin, Editor
Selma Bushman, Assistant Editor
Barbara Martin, Circulation

Published bimonthly by
The American Potash Institute Inc.
1102 16th Street, N.W.
Washington 6, D. C.

CONTENTS

ON THE COVER

. . . potash hunger is reducing vine growth and grape yields in numerous vineyards of the nation.

A good example are these fruit clusters and leaves taken from potash-starved vines and from normal vines of a Grenache vineyard in California in 1958.

Potash-hungry grapevines mean "small, tight clusters of small, unevenly ripened berries," as Cook and Carlson of California express it in their article starting on page 2.

Leaf symptoms of K hunger begin to appear in early summer on midcane leaves, the California scientists explain, "as a diffuse, light chlorosis (blanching of the leaves), first noticeable and most intense around the margin." This chlorosis moves into the interveinal areas, gradually decreasing as it approaches leaf veins.

Before necrosis (death of leaf tissue) occurs, the chlorotic leaf areas may turn bronze, red, or yellow, according to variety. Marginal burning and curling of the burned leaf edges follow chlorosis.

Adequate potash means large, lustrous, dark green leaves.

California experience has shown potash deficiency is corrected better by infrequent massive doses—1,000 to more than 2,000 lbs. per acre—than by much smaller rates at annual intervals.

Member Companies
AMERICAN POTASH & CHEMICAL CORPORATION • DUVAL SULPHUR & POTASH COMPANY
POTASH COMPANY OF AMERICA • SOUTHWEST POTASH CORPORATION
UNITED STATES BORAX & CHEMICAL CORPORATION

DO YOU FOLLOW UP?

ARE you looking for ways to improve your soil testing program? Do farmers in your area give as much thought as they should to their management practices?

How much information do you really have on the actual success your recommendations *based on soil tests* really bring the farmer?

Sometimes lime and fertilizer don't get a fair chance, as President W. L. Nelson of the Soil Science Society of America recently put it, because of poor calibration or other management practices.

To encourage follow-up in his area, Midwest Agronomist R. D. Munson of the Potash Institute, recently developed a soil test lime-fertilizer recommendation follow-up card. The suggestion seems to be a good one to think about, perhaps to modify for local needs. Here it is:

CORN

FOLLOW-UP CARD

SOIL TEST LIME-FERTILIZER RECOMMENDATION

Dear (County Agent)

(Fertilizer Dealer)

I followed the soil test-lime recommendation completely..........; Partially..........

I followed the soil test fertilizer recommendation completely..........; Partially..........

Method of fertilizer application included: broadcast-plow-down.........., broadcast-disc.........., split-boot.........., sideband.........., sidedressing.......... .

Minimum tillage used—yes.........., no.......... . Checked..........

Final plant stand was .... per acre; corn drilled.........., Power-checked..........

Used .... (Hybrid) .... (No.); controlled weeds by .... (cultivation) and/or .... (chemical).

Insect control: corn borer .... (yes or no)—soil insects .... (yes or no). Insecticide: ....

Rainfall was above ave.........., ave.........., below ave.......... .

Results from the fertilizer used were: Excellent.........., Good.........., Fair.........., Poor.......... .

I believe the reason for these results was ....

....

I am interested in discussing my fertilization program with you .... (yes or no)

Sincerely yours,

Name..........

Address..........

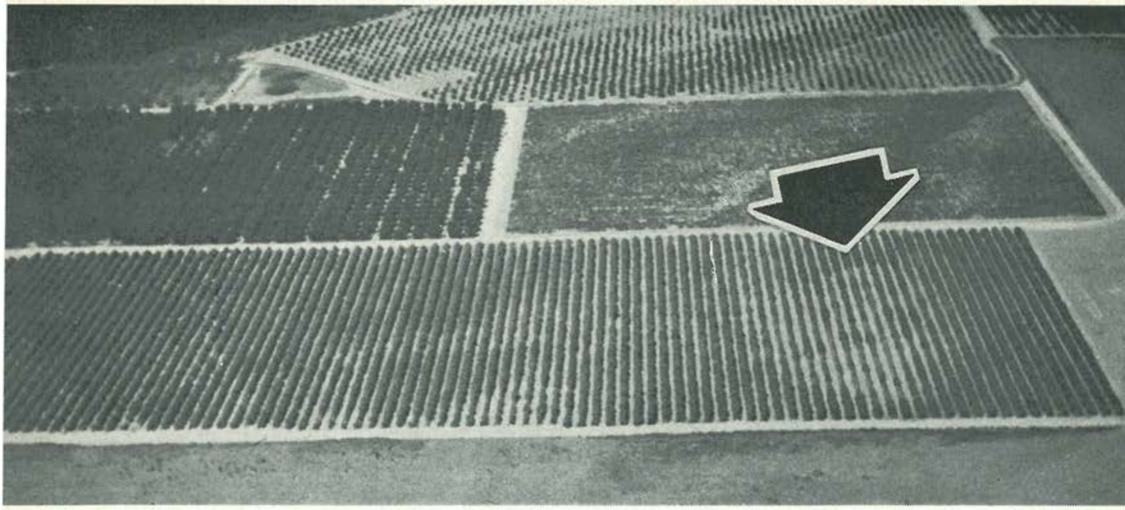


Figure 1—From the air, the K-deficient area of this 20-acre Grenache vineyard stood out like a sore thumb in 1958. The area had been scraped to fill in the low part of the vineyard at right end, now occupied by about 8 rows of very uniform, high-crop grapes. When potash trials were conducted in the deficient area, the 5-vine plots showed good response to K.

CALIFORNIA VINEYARDS RESPOND TO POTASH

Where infrequent massive doses of potash—1,000 to more than 2,000 lbs. per acre—correct potash hunger better than smaller rates annually.

IN California trials, Albert Ulrich obtained a yield response from potash in one vineyard, but not in the other.

Although the two vineyards were widely separated, of different varieties, and on different soil types, they were selected for treatment because they were similar in available potassium content.

Ulrich concluded that the soil level of either replaceable or Neubauer potassium was not a reliable basis for predicting vineyard response to potash applications, particularly when complicated by numerous varieties and soil types.

Ulrich found that the difference between fertilized and control vines was much greater in potassium content of petioles (leafstalks) than in potassium content of the corresponding blades. In the vineyard that gave significant yield increases, late-summer petioles averaged 0.26% K from unfertilized plots and 0.70% K from potash-treated plots. In the no-response vineyard, the respective levels were 0.45% and 0.48%.

REMARKABLE YIELD INCREASES FROM POTASH

Nearly 3 times more fruit yearly from fertilized vines.

***40* lbs. per year per vine average increase . . . equal to a crop increase of 9 tons per acre.**

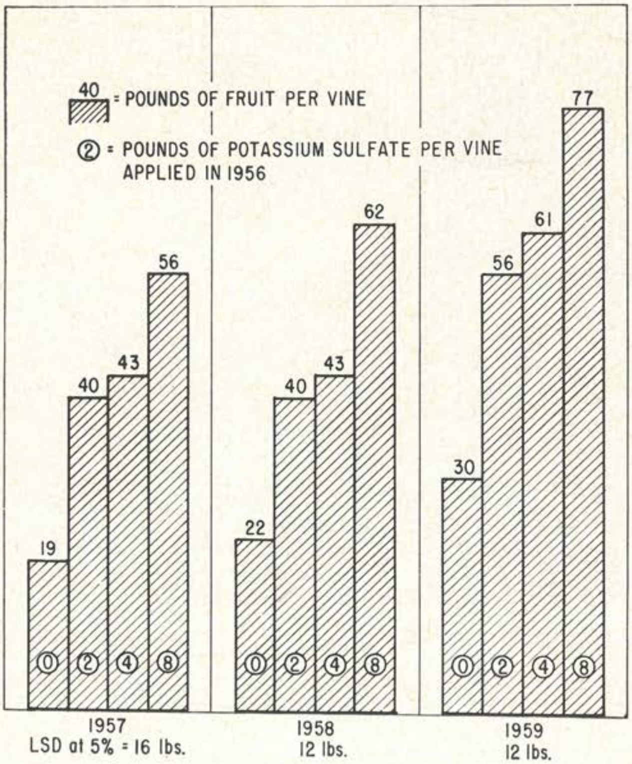


Figure 2—Potash-hungry Grenache grapevines—at 8 x 12 ft. spacing—gave these responses to 2, 4, and 8 lbs. potash per vine in 1956 treatments.

. . . when needed

By James A. Cook and C. Verner Carlson

University of California

In a state with some 450,000 acres of vineyards that produced 2,715,000 tons of grapes worth $131,761,000 in 1960.

There have been no other reported yield responses to potash in the 450,000 acres of grapes in California.

Studying the relative effects of N vs. NPK, W. O. Williams chose vineyard sites more or less at random throughout the state. Twenty-seven comparisons failed to show any vineyard in which yields or fruit quality were improved more by use of NPK than by N alone.

Petiole samples were collected in September, 1948, from many of Williams' fertilizer trials. Although average K level for control plots was below 0.50% in eight of these vineyards, only two showed appreciable uptake of applied potash. Of these two, the first—Beaulieu's Semillon vineyard in Napa Valley (from which the data in Table 1 were obtained)—had received approximately 400 lbs. K_2O


ADEQUATE POTASH INADEQUATE POTASH

Figure 3—This sharp vine contrast, shown at 1955 harvest, resulted from 25 lbs. of potash on the foreground vine in 1952.

per acre, placed 10″ deep, each year for four years. September petioles from the N plots averaged 0.25% K, from the NPK plots 1.17%.

But—total yield records for a 5-year period showed only 7% *more fruit* from the plots that had received approximately 1,600 lbs. K_2O during that period. The second vineyard, fertilized similarly for 5 years, showed petiole K values of 0.27% for N and 0.62% for NPK plots. Yet, over a 6-year period, total yields *favored the NPK plots by only 2%!*

Factors Preventing K Response

Assuming that vineyards with potassium levels like those found by Ulrich (0.15% to 0.31% in harvest-time petioles) are potassium-deficient, several factors may prevent or hide yield responses.

Lack of uptake by the vines may be a basic reason. Five of Williams' trial vineyards showed potassium levels below 0.50% in September petioles from the NPK plots, although *they had annually received deeply placed, high potash rates for several years.* Many California soils lock up (or inactivate) potassium, so that rates considered very heavy in other areas may be too light to be effective on California soils.

Tree-fruit studies, now supported by trials with grapes, have shown that *response is better from truly massive doses at intervals of three or four years than from annual rates of 200 to 300 pounds of K_2O per acre.*

Several workers have reported how rainfall or lack of it has influenced symptom expression, yield response, and foliage potassium levels, especially in areas subject to drought.

Visual symptoms of potassium deficiency and associated low tissue levels in California vineyards may be expected wherever root activity is se-

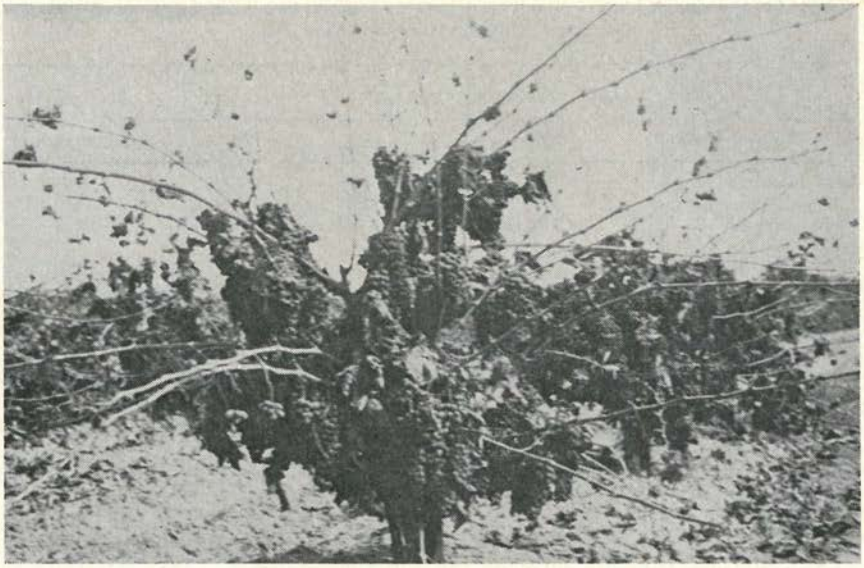


Figure 4—Both potash hunger and heavy cropping caused this result on a Carignane vine, pictured at early harvest time.

riously reduced by any of several causes.

For example:

(1) We have found harvest-time leaves showing severe deficiency symptoms and 0.10% to 0.20% K levels in vineyards on heavy, very dense clay soils subject to poor drainage.

(2) Vines often show potassium deficiency symptoms in localized areas infested by such root pests as nematodes or phylloxera, though not obvious elsewhere in the particular vineyard.

K Hunger May Dot An Area

Such conditions may often restrict potassium deficiency to small areas within a given vineyard. Foliage potassium levels and crop yield may vary widely in and near these locations. Also, annual differences in general crop level will affect the level of foliage potassium.

Table 1 is typical of many of Williams' trials. Such extreme variations in potassium content, accompanied by wide ranges in crop yield both among plots and between years, demand many replications to show important yield differences between treatments.

True response to potash treatment in a small deficient area might be lost in the statistical analysis of an entire trial area, most of which might not need potash at all.

Such difficulties, due partly to his semi-survey manner of selecting typical vineyards of an area for his trials, may help explain the lack of measurable yield responses Williams received from potash applications. Several of his trial plots undoubtedly contained small potash-deficient areas, though he reported no measurable crop increase from potash applications on 27 fertilized vineyards.

His over-all results did provide one valuable conclusion: that potassium deficiency is not widespread enough in California vineyards to warrant indiscriminate applications of potash where need is not indicated.

What is a good basis for potash de-

TABLE 1—Annual variation in petiole potassium levels and variation among replicate plots. Beaulieu's Semillon vineyard.

	Petiole K in percent dry wt.			Av. crop on control vines
Sampling Date	Control	N	NPK	(lbs. per vine)
1947 Aug. 26	0.70	1.00	1.66	5.7
range	(.3–1.2)	(.3–2.1)	(.7–2.9)	
1948 Sept. 21	0.46	0.25	1.17	17.8
range	(.2–.7)	(.1–.4)	(.7–2.0)	
1949 Aug. 18	0.59	0.41	1.27	10.4
range	(.3–1.3)	(.2–1.1)	(.9–2.1)	

ficiency in grapes? Although Ulrich suggested low potassium content in midsummer petioles as an indicator, his data are not extensive enough to be an unqualified basis for 15 to 20 important varieties planted on all possible soil types with a wide range in temperature and rainfall conditions.

Ulrich noted that marginal leaf scorch was present at midsummer and harvest time on unfertilized vines in the vineyard that showed yield increase from potash treatment. Likewise, reports from other grape-growing areas of the world indicate that Vinifera varieties respond positively to K fertilization when vines show deficiency symptoms.

So, let us look at some conditions under which potassium deficiency may be suspected in California vineyards and some results obtained when using only visual symptoms to determine potash need.

Potash Hunger On Grapes

Leaf symptoms of potassum deficiency begin to appear in early summer, on midcane leaves, as a diffuse, light chlorosis (blanching of the leaves), first noticeable and most intense around the margin. As the chlorosis develops, it moves into the interveinal areas, with gradual decrease as it approaches the leaf veins.

Before necrosis (death of leaf tissue) occurs, the chlorotic leaf areas may turn bronze, red, or yellow, according to variety. Marginal burning and curling of the burned leaf edges follow chlorosis.

With time, leaves above and below the midcane position become affected, until most of the leaves may show some symptoms by harvest time. Leaf fall is premature, especially with vines carrying a heavy crop, and can be so early and complete that fruit fails to ripen. These symptoms are illustrated on the cover and in Figures 3 and 4.

In advanced deficiency stages, leaf symptoms appear before bloom and affect all leaves at about the same time. Shoot growth is severely stunted, coming mainly from latent buds on old wood in the head of the vine, with buds on younger wood failing to grow at all. Potassium-deficient vines carry small, tight clusters of small, unevenly ripened berries. See cover.

"True Low-Soil-Potash"

Omund Lilleland and J. G. Brown showed a remarkably high correlation between soil depth and replaceable potassium in California soils. Of 100 soils studied, 94 had less K in the fourth foot than in the first, and 72 of the 100 had only half as much or less in the fourth foot as in the surface soil. Yet most of these soils are alluvial in origin, exhibiting no noticeable profile differences in texture.

Although many of the San Joaquin Valley soils were originally almost level or gently undulating, necessary irrigation has caused extensive land leveling in localized areas, often displacing surface soil to a depth of several feet. These scraped areas, usually less than one acre in size, occur widely in the irrigated vineyards of the San Joaquin Valley. Vines planted on them are subjected to a true low-soil-potash level.

In almost all cases visual deficiency symptoms occur, especially when other factors associated with potash deficiency are present—such as sandy or shallow soil, nematodes, or excessive cropping.

Amazing Potash Response

We have secured striking response from potash applications in two such areas. Both were within otherwise normal vineyards on loamy sandy soil, both had vines with symptoms of varying severity—mild at the periphery of the area and so severe in the center that some vines had died and had been replaced.

In Potash Trial One . . .

The first of the two trials was with Carignane vines, planted at 8 x 10-foot spacing. To insure uptake, we applied 15 and 25 pounds per vine of potassium sulfate as surface applications in October, 1952.

. . . Unusual vine improvement

In spite of such heavy treatments, no response was visible in 1953. *But when examined in late summer, 1954, an amazing improvement was apparent from both application rates.* See Fig. 3 for treated and untreated vines immediately after harvest in 1955. Although yields were not obtained in this trial, various foliage samples were collected for comparative analysis, Table 2.

TABLE 2—Analyses of various foliage tissue samples from potassium-deficient Carignane vineyard, Merced County, California. (Values by flame photometer procedure)

Date sampled	Description of samples	Percent dry wt. basis K	Ca	Mg
6/ 7/55	Petioles—Normal vines	1.82	1.4	.8
6/ 7/55	Petioles—Symptom vines	0.30	2.4	1.0
6/ 7/55	Shoot tips*—Normal vines	1.92	0.5	0.4
6/ 7/55	Shoot tips—Symptom vines	0.46	1.4	0.4
7/14/55	Leaf blades—Treated vines	0.64	1.5	0.6
7/14/55	Leaf blades—Symptom vines	0.30	0.8	0.6
7/14/55	Shoot tips—Treated vines	0.72	1.0	0.5
7/14/55	Shoot tips—Symptom vines	0.33	1.0	0.8
9/1/55	Petioles—Normal vines—good area	0.46	2.9	1.3
9/1/55	Petioles—Treated vines—bad area	0.38	2.9	2.1
9/1/55	Petioles—Symptom vines—bad area	0.12	1.5	2.8
9/1/55	Leaf blades—Normal vines—good area	0.38	2.4	0.6
9/1/55	Leaf blades—Treated vines—bad area	0.30	2.4	1.0
9/1/55	Leaf blades—Symptom vines—bad area	0.22	1.9	1.1
9/1/55	Shoot tips—Normal vines—good area	0.40	2.2	0.7
9/1/55	Shoot tips—Treated vines—bad area	0.42	2.7	0.4
9/1/55	Shoot tips—Symptom vines	0.19	1.5	1.0

*6-inch tips of representative shoots. Leaves taken from midcane position.

. . . Petiole analyses best so far

In Table 2, we see how the relative difference between potassium levels of normal and deficient *leaf blades* might be useful at *midsummer* (*7/14*), but at harvest time these differences are much smaller. In contrast, *petiole* analyses show much greater total and relative differences at *all times* between normal and deficient vines.

Data are now being collected to see whether shoot-tip analyses might be a better reference than petiole analyses for detecting hidden potassium needs of grapevines.

In Potash Trial Two . . .

A more carefully evaluated potash trial was conducted concurrently by the authors in an area reserved for the study (see Figure 1) in a block of 20-year-old-rooted Grenache vines. Individual vines were carefully rated for deficiency symptoms in October, 1955. Twenty uniform plots of five vines each were selected and marked for four treatment rates replicated in five randomized blocks.

Potassium sulfate (51% K_2O) at 0, 2, 4, and 8 lbs. per vine was applied in February, 1956 in 6-8″ deep furrows, about 24″ from the vines. The grower's usual nitrogen program of 600 lbs. ammonium sulfate per acre in split application was continued. Response to potash was measured *visually,* by *tissue analyses,* and by *yield records.*

Throughout the 4-year period, the extremely potash-deficient check vines showed severe symptoms: foliage symptoms appeared before bloomtime and total shoot-growth for the year ranged from 1 to 3 ft. in length, while normal vines ranged from 3 to 6 ft.

. . . Marked growth differences

Table 3 shows the visual changes in the treated vines and the rates at which they took place. The vines receiving 2 and 4 lbs. potash recovered more slowly, were never completely normal in total growth (or crop amount as seen later), and were depleted of added potash before vines receiving the 8 lb. treatment. The highest-rate vines, after complete recovery in the second year, showed no appreciable need for supplementary potash through 1959.

. . . Remarkable yield differences

Differences in fruit yields were as great as growth differences, and in the same relative order. Yield data were not obtained in 1956, since very little crop response was observed the first season. Fig. 2, a graph of results for the remaining 3 years, shows the remarkable yield response to the potash treatment. Vines receiving the 8 lb. potash rate produced almost three times as much fruit each year as the unfertilized check vines—*a three-year total of 195 pounds compared with 71, or an average increase of 40 pounds per year per vine, a crop increase equivalent to 9 tons per acre!*

. . . Sharp quality improvement

There was not only a great increase in *quantity* of fruit produced, but also a sharp improvement in fruit *quality* (by both appearance and laboratory analysis).

Quality analyses were made in 1958 and again 1959 on fruit from the check and 8 lb. treatment plots. One 50 lbs. sample was composited from each of the two series by grabbing clusters at random from the harvested fruit of the five replications.

Representative clusters of these two comparisons in 1958 are shown on the cover. The great difference in size of cluster and individual berries was consistent. The only care used in selecting the large cluster was to choose one of typical shape for the variety. Total number of clusters was a factor in crop response, ***but by far the greatest factor in the yield increase was larger cluster and berry size.***

TABLE 3—VISUAL RESPONSE OF GRENACHE GRAPEVINES TO SINGLE POTASH APPLICATIONS MADE IN FEBRUARY, 1956. FOLIAGE SYMPTOMS AND SHOOT GROWTH

Rate of K_2SO_4 Per Vine		7/26/1956	6/19/1957	10/1/1958 (harvest time)	5/21/1959 (bloom time)	9/25/1959 (harvest time)
2 lb.	Foliage	Variable chlorosis and scorch.	Almost normal.	Slight to moderate symptoms.	Uniform mild chlorosis.	Moderate chlorosis scorch and defoliation.
	Growth	No change.	80 to 90% normal.	60 to 90% normal.	60 to 90% normal.	50 to 75% normal.
4 lb.	Foliage	Almost normal, (not so green as with 8 lb. rate.)	Almost normal.	Mild to none.	Occasional mild chlorosis.	Mild to moderate chlorosis, scorch & defoliation.
	Growth	No change.	90% normal.	80 to 90% normal.	80 to 90% normal.	60 to 80% normal.
8 lb.	Foliage	Normal green.	Normal.	Rare, mild chlorosis.	Normal.	Normal.
	Growth	Only slight improvement.	Normal.	Normal.	Normal.	Normal.

TABLE 4. Fruit quality measurements on representative samples picked at the same time from potassium-deficient (check) and heavily fertilized plots.

		Fresh Fruit				Wine
Year	Treatment	ppm K	% Sugar	% Acid	Grade*	% Alcohol
1958	Check	796	23.3	.40	No. 6	13.2
	8 lb K_2SO_4	926	25.7	.52	No. 2	15.2
1959	Check	20	20.1	.50	No. 5	12.4
	8 lb K_2SO_4		20.8	.55	No. 5	12.4

* Based on sugar to acid ratio. No. 1 is best, No. 6 is lowest that is marketable.

. . . With higher sugar and acid levels

The fruit samples were crushed and sugar, total acid, and potassium levels determined on the juice. The juice was then processed into wine and the alcohol content measured. The results are shown in Table 4.

The 1958 high-potash fruit rated higher in all comparisons. Both sugar and acid were at higher levels, resulting in a better-quality, industry-recognized grade, with higher alcohol content of the wine confirming the sugar difference found in the juice.

Overcropping Evils

Although the 1959 fruit composition of the two comparisons was very similar, why the difference between the two years? The evidence points toward a general overcropping effect —caused by a fruit load above vine capacity—at all four potash levels in 1959.

Since most vinifera grape varieties are extremely fruitful, annual pruning is necessary to bring vine growth and crop load into a compromise balance by removing potential, but excess, crop.

The successful grower tries to prune for a maximum crop of acceptable fruit quality that can be produced without injuring the vine. Often the load limit is exceeded, resulting in lower fruit sugar content and poor vine growth. Such heavy cropping also lowers the potassium level of leaf tissue.

In 1959, when vines at all four potash levels produced 30 to 40 percent more fruit than the average 1957 and 1958 yields, overload results showed up in many ways.

The unfertilized (lowest K) vines dropped in fruit sugar content—from 23.3% in 1958 to 20.1% in 1959. Although fruit quality was not measured for the intermediate potash levels, vine growth was reduced and potassium deficiency symptoms developed. At the highest potash level, vine growth seemed normal but fruit sugar content declined—from 25.7% in 1958 to 20.8% in 1959—as with unfertilized vines.

In terms of pounds of sugar produced per vine, the check plots showed an increase in 1959—from 5.1 in 1958 to 6.0 in 1959—while the highest-K vines showed slight decrease—from 10.8 to 10.0. Thus, although no visible potash hunger was evident at the high treatment rate, the decreased total sugar may indicate a beginning need for potassium more obvious in plots receiving lower rates.

It would have been interesting to prolong the trial to see if visible symptoms might develop the next year in the highest-K plots. After the 1959 harvest, however, the grower applied 4 lbs. potassium sulfate per vine over the entire experimental area. Because of results discussed here, the grower plans to repeat this application rate every 3 or 4 years as a routine maintenance program.

Summary

Numerous field trials indicate potassium deficiency is not extensive enough to warrant general fertilization of California's nearly one-half million acres of vineyards.

Soil analysis for exchangeable potassium does not seem to be a reliable indication of potash need. Potassium content of foliage tissues, especially leaf petioles, offers much promise as a guide to potassium status, although current data are too limited for general use.

Until conclusive, calibrative correlation can be developed between tissue potassium levels and yield responses, heavy potassium sulfate treatments necessary for uptake by California grapevines should be restricted to localized areas that show visual deficiency. Such areas are individually small (seldom over an acre) but quite frequent in vineyards of the San Joaquin Valley.

Experience has shown potassium deficiency in California is corrected better by infrequent massive doses—1,000 to more than 2,000 pounds of potassium sulfate per acre—than by much smaller rates at annual intervals.

THE END

NEW ALFALFA MOVIE

with 2 Shorts

Color
Sound

Time Lapse Growth Scenes

Order From Potash Institute

STILL QUEEN

■ ALFALFA IS AS OLD as written records of man, but as modern as tomorrow in any feeding program.

It has been called the "queen" of the forage crops. It well deserves the title. Alfalfa ranks at the top in yield of quality protein, vitamins, especially A and D, and minerals.

Alfalfa is unexcelled as roughage for all kinds of livestock. It is unbeatable for beef cattle, tops for all ages and classes of beef animals.

In recent trials at the Irrigation Experiment Station at Prosser, Wash., yearlings fattened on alfalfa hay and corn-and-cob made excellent gains without a protein supplement.

Average daily gains of over 2.5 pounds were made for a 150-day feeding period. These cattle were marketed at about 950 pounds, grading U. S. Choice.

Alfalfa hay was fed at the rate of one pound of hay to two pounds of corn-and-cob meal. Average daily feed consumption at full feed was about 10 pounds of hay and 19 pounds of corn-and-cob meal.

For fattening cattle with limited amounts of grains the best results will usually be obtained if only alfalfa is fed the first half of the feeding period.

For breeding animals and stockers, alfalfa hay serves exceptionally well as the only wintering feed. This is a good practice if hay prices are low compared with other feeds. Mature beef cows will consume about 25 to 30 pounds of hay per day.

A closing note on feeding alfalfa hay. Your extra efforts this summer to make the best hay you can will pay off in the feedlot this winter. Those bales of bright green hay with the leaves still there are worth much more than the stemmy bleached hay we see around too many feed yards.

It is not surprising that alfalfa has earned the title "Queen of the Forages." No other forage can list all these uses and advantages.

► 1. It can be grown alone, or in combination with grasses, as a high quality hay crop.

► 2. It is adapted to either long or short rotations.

► 3. It is widely used in combination with grasses for rotation pastures.

► 4. It is grown alone for dehydrated products.

► 5. It is unsurpassed for green chop.

► 6. It is an excellent green manure crop preceding corn.

► 7. It withstands drought better than any other legumes.

► 8. Its seedlings are vigorous and easily established.

► 9. It adds a generous amount of nitrogen to the soil.

► 10. The yields of alfalfa alone or with grasses are higher than other legumes under normal growing conditions.

► 11. Nutritionally, alfalfa is the livestock farmers' most nearly perfect feed package.

American Livestock Journal

GOOD MANAGEMENT DIVIDENDS

IN CANADA . . .

The Ontario Beef Pasture Improvement Committee leased five farms with a total area of 500 acres. Fertilization was compared with fertilization plus reseeding with grass-legume mixture. Reseeding plus fertilization was clearly superior to fertilization alone.

	Beef per acre 5-year ave. lbs.	Increased annual net return over check Dollars per acre
Check	**79.7**	
Fertilizer	**119.2**	**$ 4.77**
Fertilizer+reseeding	**167.2**	**19.43**

IN KENTUCKY . . .

Experiments on fescue sod have shown the benefits of fertilizing and reseeding.

Not renovated	**4840 lbs. of dry matter per acre**
Pasture renovated	**6895 " " "**

Kentucky authorities strongly emphasize the need for grass-legume pastures and state that renovation will pay high dividends to livestock farmers.

Midwest Office, Potash Institute

WEATHER AFFECTS

By A. C. Caldwell and Dwight Hovland

University of Minnesota

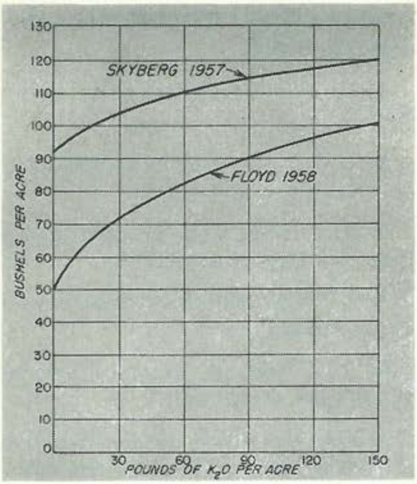


Figure 1—How potash affected corn yield on Skyberg silt loam in 1957 and Floyd silt loam in 1958, Dodge County, Minn.

AVAILABLE potassium as indicated by soil test is the best measure we have yet devised to predict what crop response to applied potassium might be. But sometimes our predictions are not correct—and we don't always know why.

Some indications of *why* showed up in experimental corn fields where we measured response to applied K in 1957 and 1958.

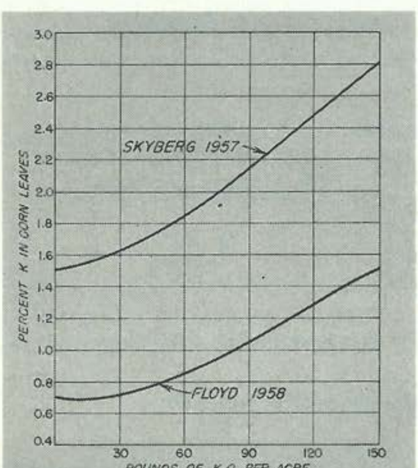


Figure 2—How potash affected K content of corn leaves at pollinating time.

Rates of K_2O varying from 0 to 150 pounds were applied broadcast to corn on a Skyberg silt loam in 1957 and a Floyd silt loam in 1958 near Rochester, Minn. No starter fertilizer was applied, but 80 lbs. of N and 120 lbs of P_2O_5 per acre were broadcast.

These soils are somewhat alike texturally and both rather poorly drained. The Floyd soil is darker in the surface, having formed under grass. The Skyberg soil was developed under forest vegetation which had been invaded by grasses.

Exchangeable (or so-called "available") potassium contents of these soils down to 3 ft. are shown in Table 1. Both *field moist* and *oven dry* determinations were made. Large differences between these values was not an unusual finding. What should be noted is the rather similar amounts of available potassium, with a slight edge in favor of the Floyd soil. Based on the general soil characteristics and available potassium values, we would expect about the same response to potassium fertilizers.

But the response was not the same.

Potash Observations

Figure 1 shows very large yield increases (52 bu.) from potassium ap-

TABLE 1.—Exchangeable potassium in the soils before fertilizer application.

Depth of soil sample	Skyberg silt loam 1957		Floyd silt loam 1958	
	Field moist soil	Oven dry soil Exch. K, pp2m	Field moist soil	Oven dry soil
0–6″	85	140	119	199
6–12″	47	160	45	204
12–18″	40	246	52	244
18–24″	42	195	36	244
24–30″	51	170	34	246
30–36″	57	193	26	177

plied to the Floyd soil (1958) and moderate increases (27 bu.) on the Skyberg (1957). Increases on both soils were very profitable.

CORN RESPONSE TO K

Showing how one soil gave a 52 bu. increase after a cold wet spring, while a reasonably similar soil gave only a 27 bu. increase in a season of well distributed rainfall.

In Figure 2, we see the potassium levels in corn leaves from these fields at pollinating time. There was much more potassium in the corn on the Skyberg soil, twice as much or more in corresponding plot treatments. The potassium content information supports the belief that yield differences were due to potassium availabilty in the soil. The following data showing the relationship between yield and % K in the corn leaf on these two potassium deficient soils is very interesting:

	Skyberg	Floyd
Yield—0 K_2O	93 bu.	49 bu.
K in corn leaves	1.5 %	0.7%
Bu. of corn per 0.1% leaf K	6.2 bu.	7.0 bu.

Also the curves showing how potassium rates affected moisture content of corn are interesting (Figure 3). Adequate potassium supply in the soil

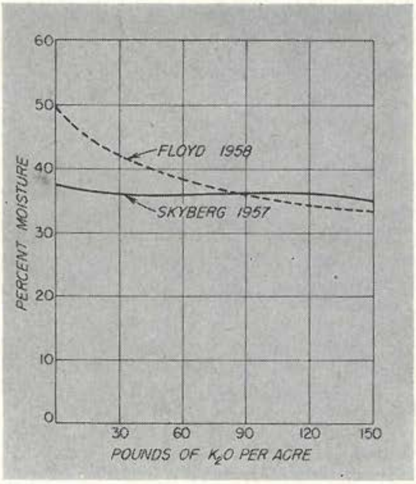


Figure 3—How potash affected moisture content of corn grain at harvesting time.

resulted in drier corn at harvest time.

Why was the response to potassium on these soils so different when the apparent *available* potassium was quite similar? We know that some of the factors affecting yields include *precipitation, temperature, sunshine, soil moisture, insects, diseases, varieties, stand,* etc.

Although these experiments were conducted as much alike as possible, certain weather factors could not be controlled. Some of the weather statistics, we believe, help explain the different responses to potassium.

Weather Observations

Weather observations were available from a station about 20 miles from the experimental fields. Temperatures, precipitation, and moisture deficit are shown in Table 2. The moisture deficit is the amount by which the calculated "actual" and the calculated potential evapotranspiration differ—that is, the inches of water the soil contains below that amount it would hold if it were at the field capacity. Although these are calculated figures, they indicate the amount of water in the soil available for plant growth.

Note that the June temperatures particularly were lower in 1958 than in 1957 and thus less favorable for growth.

There was heavy rain in early June (4.68 inches), which fell on an imperfectly drained Floyd soil with already twice as much water in it as the Skyberg soil in 1957. A cold, wet soil is very often a *potassium deficient* soil. Early work by Lawton and later work by Hammond and others at Iowa have shown the importance of aeration in potassium uptake.

So the combination of cold weather, heavy rain, and poor drainage in 1958 provided the right set of circumstances to make potassium availability critical. Despite the similarity in exchangeable potassium indicated by soil tests on the two soils, added potassium on the Floyd soil provided K at a very critical time, contributing to the much larger increases in yield.

Typical potash deficient plants were observed on the non-fertilized plots even when they were only a foot high, giving further evidence of extreme potash hunger.

In the January-February, 1960 *Better Crops,* Barber says, "In very

Table 2.—Some meteorological observations for the corn growing seasons of 1957 and 1958 at Rochester, Minnesota.

Interval	Average Temperature (°F) 1957	1958	Total Precipitation (inches) 1957	1958	Moisture Deficit[1] (inches) 1957	1958
May 16-31	55.4	58.8	3.12	2.03	0	0.06
June 1-15	64.9	58.8 (cold)	1.36	4.68 (wet)		
16-30	67.1	62.2	2.80	0.88	0	0
July 1-15	74.8	66.6	2.26	0.84		
16-31	75.6	67.4	3.55	0.37	0.04	0.97
August 1-15	70.7	72.8	3.09	1.43		
16-31	67.4	63.4	1.56	1.10	0.02	1.25
September 1-15	62.2	61.9	0.52	1.44		
16-30	55.8	58.7	0.92	1.63	0.34	0.16
October 1-15	52.9	56.5	0.69	0.42		
	Average 64.7	62.7	Total 19.87	14.82	Average 0.08	0.49

[1] The difference between "actual" and potential evapotranspiration calculated by Thornthwaite's method.

dry and very wet years, soil potassium is less available, causing large responses to potassium application."

Another look at the precipitation figures shows how well-spaced and adequate rainfall was on the Skyberg soil in 1957, and how low in late June and July on the Floyd soil. Perhaps there was additional response to potassium on the Floyd soil because of the less than favorable precipitation pattern.

Our best single guide for predicting crop response to fertilization is still the soil test. But it is not infallible, as we well know. When we fail to get the correlation we would like, experience, weather data, observation and research information will usually provide the answers.

Evidence is accumulating that proper fertilization, in this case with potash, helps overcome the hazards of unfavorable weather.

THE END

CUT WATER NEED BY FERTILIZING

University of Kentucky research shows that it takes about four times as much water to produce a bushel of corn without fertilizer than when fertilizer is used.

In the Kentucky tests, a properly fertilized corn crop yielded 79 bushels an acre, compared with only 18 bushels for unfertilized corn.

But the fertilized corn used only 16 inches of water a season and the unfertilized 14 inches, which figures out to 5,600 gallons of water per bushel for the 79-bushel crop, and 21,000 gallons per bushel for the unfertilized corn.

The Kentucky researchers explain that the roots of fertilized corn go deeper and use more subsoil water. Also, a higher stalk population in the fertilized field slows down air speed and reduces evaporation per stalk.

USDA Farm Paper Letter

MAKING SOYBEANS PAY

RECENT research by the Arkansas Agricultural Experiment Station indicates that fertilization of soybeans can be very profitable.

Responses of from 2 to 10 bushels per acre increase in research plots have been primarily obtained on terrace soils testing low to very low in phosphate and potash. Farmers over the state have reported yields as high or even higher than this.

Mr. Beryl Adams of Clay County reported that applying fertilizer equivalent to an 0-36-36, according to soil test, resulted in 6½ bushels per acre increase, as compared with no fertilizer. D. B. Woodard of Craighead County reported that he received an 18-bushel per acre increase from an application of fertilizer equivalent to an 0-36-36 as compared with no fertilizer.

You may need to apply only phosphate or only potash, or you may need both. Following other well-fertilized crops, soybeans may not need fertilizer. On some fields lime may be needed more than fertilizer. This emphasizes the importance of soil tests.

Placement is very important in getting the fertilizer used efficiently by soybean plants. Two good methods are either to apply the fertilizer in the band and bed on it, placing the fertilizer about 4 inches below the planted seed, or to band the fertilizer 2 to 3 inches to the side of the row and 2 to 3 inches below the seed.

In most cases soybeans do not need nitrogen fertilizer. They take the nitrogen requirements from the air when properly inoculated. On very low organic matter soils or following small grain, a small amount of nitrogen may help plants off to a good start.

Current Trends in Agronomy, Arkansas Extension Service

Soil test for P as related to percentage of maximum yield (Ill.)

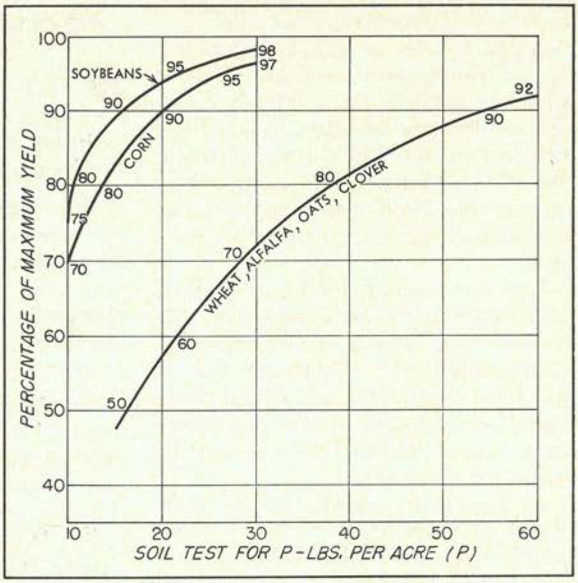


Figure 1—Crops vary in their need for P. For example, with a 20 lb. P test the percentage of the maximum yield is 57, 90, and 94% for wheat, corn, and soybeans as shown here.

WHERE ARE YOU ON THIS YIELD CURVE

YOU CAN PREDICT FERTILIZER NEEDS WITH SOIL TESTS

By R. H. Bray
Department of Agronomy University of Illinois

TESTING soils with chemical tests to estimate fertilizer needs is now a widespread practice in the United States, as well as other countries. Testing methods vary widely in objectives and chemical nature. Many tests are based on an idea of Dyer, who in 1894 suggested the use of citric acid to measure *the availability of soil phosphorus.* As late as 1948 Peech claimed the extracting solution must simulate the ability of plant roots to obtain different nutrient elements for normal growth.

To simulate plant feeding with a single chemical extractant is impossible, of course, since different crops have different requirements. Also, different planting rates of the same crop would require a different test for each planting rate and pattern.

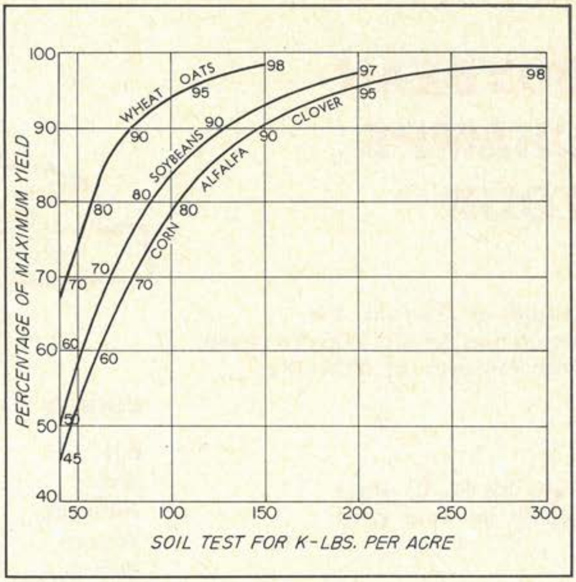
Perhaps all one can expect of a soil test is that it will measure the *amount* of an available form.

Keep the Factors Constant

To correlate a soil test with percentage yield and fertilizer require-

Soil test for K as related to percentage of maximum yield (Ill.)

Figure 2—Crops also vary in their need for K. For example, with a 100 lb. K test the percentage of the maximum yield is 78, 83, and 94% for corn, soybeans, and wheat as shown here.



. . . AND ON THIS YIELD CURVE

A soils scientist who pioneered in soil testing for both P and K speaks out . . .

. . . on the importance of the percentage sufficiency concept.

. . . on correlating P and K tests with fertilizer needs.

. . . on equations for correlating P and K tests.

. . . on the difference in approach and estimate of N needs.

ments, you must keep constant the factors that help determine the requirements. These factors are:

1 The kind of crop (corn, wheat, etc.).

2 The planting pattern and rate of planting.

3 The form of the nutrients in the soil and the fertilizer.

4 The distribution pattern of these forms in the soil in relation to the planting rate and pattern.

For practical reasons, soil available forms are considered to be rather evenly distributed unless it is known they are not. Since fertilizer is applied in many different ways, each application method requires its own special correlation with the other factors, hence its own c value.

The relationships between soil tests for P and K and percentage of maximum yield are shown in Figures 1 and 2.

Continued on page 25

AFTER WINNING 50-BUSHEL CLUB CONTEST

SOYBEAN CHAMPS TOUR

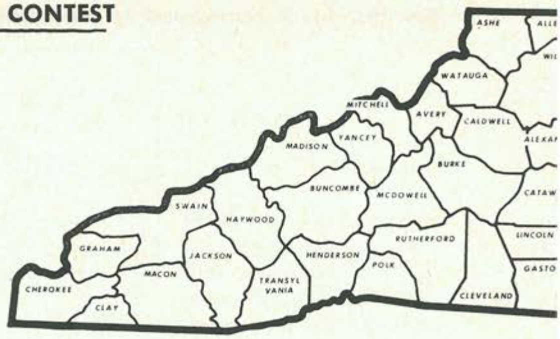
Cargill at Norfolk, Va. Production in Del-Mar-Va Area And Research at Beltsville.

From an N. C. State Report by Tom Byrd

LINDSEY HAMPTON and his son, Newton, (shown below), are the first winners in North Carolina's new 50-Bushel Soybean Club.

The Hamptons, from Coinjock in Currituck County, produced an average of 51.68 bushels per acre on three acres, according to George Spain, extension soybean specialist at North Carolina State College and chairman of the 50-Bushel Club.

Lindsey (left) and Newton Hampton of Currituck County, N. C.



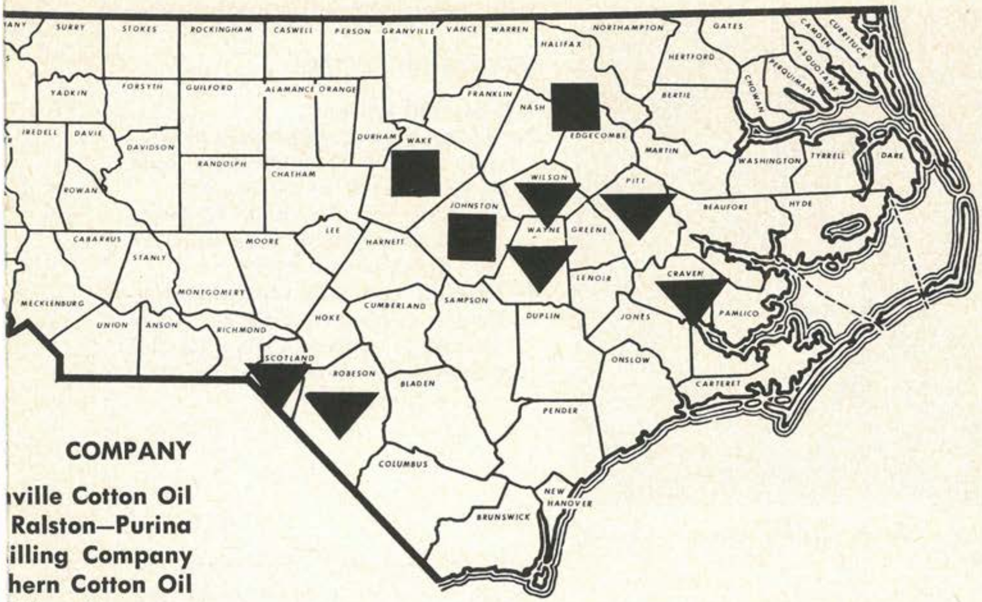
COUNTY	
Pitt	Far
Wake	
Johnston	Gurley
Wayne	Sou
Wilson	Wilson
Scotland-Hoke	
Robeson	
Craven	New
Nash-Edgecombe	Plc

"Competition for the Hamptons was rough," Spain explained. "Lister Jones of Northampton County produced 51.30 bushels an acre from two acres to become another winner in the 50-Bushel Club."

These first two winners will be guests of the American Potash Institute on a tour of soybean processing and handling facilities in Norfolk, from there to review the Del-Mar-Va

RECIPE FOR CHAMPIONS:

1—Sandy loam soil well drained and kept at
2—Limed so pH was about 6—best level for s
3—Phosphate and potash very high . . . org
4—Planted Hill soybeans on May 15 in 42-i rotation.
5—Weeds controlled by one rotary hoe trea plowing.
6—500 lbs. of 3-9-18 to corn that preceded s



COMPANY

ıville Cotton Oil
Ralston—Purina
illing Company
hern Cotton Oil
Cotton Company
A Raeford Firm
A Maxton Firm
Bern Cotton Oil
ıters Cotton Oil

N. C. SOYBEAN PROCESSING CENTERS COMPOSE GROWING INDUSTRY

■ **Solvent Extraction**

▼ **Hydraulic Press or Expeller**

area to show the Tar Heel farmers firsthand what good farmers are doing elsewhere, concluding with a review of the extensive research work at Beltsville, Md. The champs will be accompanied on the trip by their county agents, L. A. Powell of Currituck and B. H. Harrell of Northampton.

The 50-Bushel Soybean Club, now taking its place beside North Carolina's 100-Bushel Corn Club, Two-Bale Cotton Club, Two-Ton Peanut Club, and 300-Bushel Sweet Potato Club, was organized last year as an educational program for farmers interested in producing soybeans more efficiently.

high fertility level.
ıybeans.
nic matter 2.7 per cent.
ch rows . . . after corn, his usual
nent and 3 cultivations . . . deep
ıybeans left good level for beans.

Hampton produced the top yield on sandy loam soil that is well drained and kept at a high fertility state. Soil tests indicated the soil had been limed so the pH was about 6—the best level for soybeans.

Phosphate and potash were very high. Calcium and manganese were high. Organic matter content was 2.7 per cent.

Hampton planted Hill soybeans on May 15 in 42-inch rows. He planted his soybeans after corn, his usual rotation. Weeds were controlled by one rotary hoe treatment and three cultivations.

"I always break my land deep,"

Lister Jones, Northampton County, N. C.

RUNNER-UP RECIPE:

1—Soil well drained.
2—Added lime and fertilizer to peanuts on field for two years prior to planting it in soybeans.
3—Applied 150 lbs. of 0-10-20 to beans at planting time because soil test showed need.
4—Planted Lee and Jackson soybeans to reduce risk of single variety . . . planted May 13 and cultivated 4 times.

Hampton explained, "because I find that I get best yields by breaking it this way and keeping fertility high."

Hampton applied 500 lbs. of 3-9-18 per acre to the corn that preceded his soybeans. This left potash and other nutrients at such a level that no direct fertilizer was needed for the soybeans.

"It is not surprising that Mr. Jones produced a high yield under similar conditions," Spain said. His soil was well drained, and he had added lime and fertilizer to peanuts on the field for two years prior to planting it in soybeans.

He also applied 150 lbs. of 0-10-20 per acre directly to the soybeans at planting time, because a soil test indicated fertilizer need.

Jones planted Lee and Jackson soybeans, which he felt helped reduce the risk of a single variety. The soybeans were planted May 13 and cultivated four times.

"I find the most efficient soybean growers in this area are farmers who plant on good soils and provide just as good management for their soybeans as they do for their other market crops," Jones said. He is also an advocate of deep plowing in his soil preparation.

Coy Roberson of Williamston also grew a bumper crop in his efforts to break the 50-bushel barrier. And he almost made it. He harvested an average of 49.23 bushels from two acres.

Joel Sutton of Kinston grew 45 bushels per acre. "Mr. Sutton had his soil tested early and is out to make 50 bushels in 1961," Spain said.

Other high yielders in 1960 were Marsh Doxey, Aydlett, 44.5 bushels; James Ferebee, Shawboro, 40 bushels; Lewis Sawyer, Gregory, 40 bushels; and Jack Rich, Turkey, 34.6 bushels.

"Several other farmers completed all requirements for the 50-Bushel Club," Spain said, "but ran into a big obstacle in the form of Hurricane Donna."

Spain said a special "well done" is due L. E. Yelverton of Eureka for his 60.44-bushel yield in the Wayne County contest. "Winners in the 50-Bushel Club had already been announced, following the deadline for applications, before we heard about Mr. Yelverton's yield," Spain explained.

THE END

FREE REPRINTS

UP TO 100 COPIES FREE. ADDITIONAL COPIES AT ACTUAL COST TO US.

	Serial Number	Number Desired
Make Agronomy Your Career	A-1-58	______
Three Periods of Southern Agriculture	D-1-58	______
Looking At Potash Deficiency & Carbohydrate Metabolism	E-1-58	______
Balanced Soil Fertility Less Plant Pests and Disease	H-2-58	______
Looking At Your Soil In A Test Tube	I-2-58	______
Potassium Content and Forage Yield As Affected by Fertilization	K-3-58	______
Successful Crop Production Depends On K	T-6-58	______
Balanced Fertilization	V-6-58	______
High Potash Rates Boost Watermelon Yields	W-8-58	______
Effects of Fertilizer Practices On Marketable Potatoes	X-8-58	______
Farm Ponds	Y-8-58	______
How So Few Can Produce So Much	GG-11-58	______
Fertilizers Boost Bell Peppers	C-1-59	______
Fertility Needs of Crimson Clover Grown With and Without Coastal Bermudagrass	G-8-59	______
Growing Alfalfa Successfully	B-5-60	______
Understanding Soil Testing	D-10-60	______
Soil Test—A Gimmick or an Effective Tool for Profitable Farming	E-10-60	______
Soil Testing On The Move	G-10-60	______

HANDBOOKS

6¢ Per Copy Up to 25 Copies Free Official
$5 Per 100 Advisors and Fertilizer Firms

	Serial Number	Number Desired
You Can Grow A Good Garden	E-4-59	______
You Can Grow A Good Lawn	F-4-59	______

Also See Coupons on Back Cover

COLOR FOLDERS

1¢ Per Copy Up to 100 Copies Free Official
$1 Per 100 Advisors and Fertilizer Firms

	Serial Number	Number Desired
Potash Helps Yields Go Up	B-59	______
Hidden Hunger in Crops	C-59	______
Plant Food Your Corn Absorbs	D-59	______
Fertilizer Placement	E-59	______
Proper Fertilization Pays on Grasses & Legumes	F-60	______

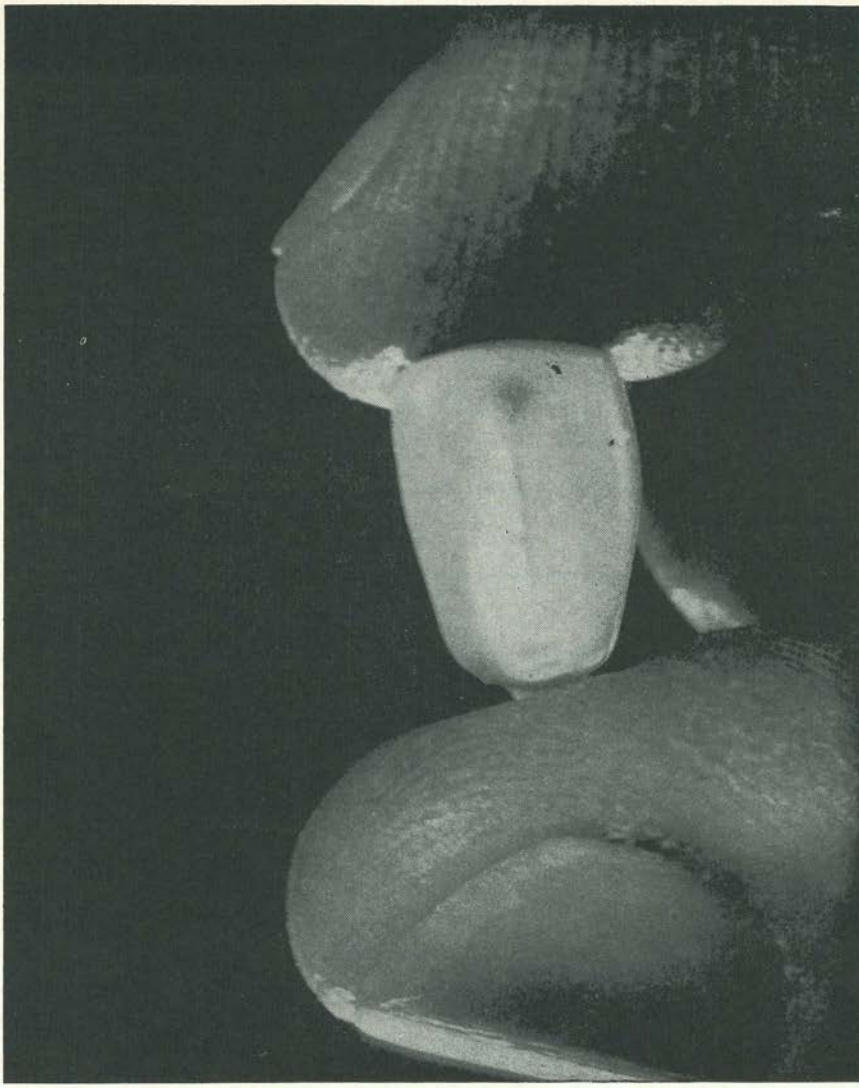
I enclose $__________ for items requested in excess of free offer.

Name______________________________ **City**______________

Address____________________________ **State**______________

Signed____

Department B.C. American Potash Institute 1102 16th St., N.W. Washington 6, D.C.



Bray—Continued From Page 19

Percentage Sufficiency Principle

According to the law of the limiting nutrient, one amount of nitrogen (a mobile nutrient) can be adequate for only one yield of a given size and composition, while one amount of P or K (relatively immobile nutrients) can be adequate for widely varying yields. A given level of adsorbed phosphorus or of exchangeable potassium can be just as adequate for a 60-bushel yield as for a 100-bushel yield. Hence P and K needs are related directly to percentage yield but not to yield size. Table 1 gives an example.

Of course, more P and K will be needed to maintain the level in the soil producing the higher yield because of the larger amounts of nutrients removed.

Fertilizer requirements for P and K can be accurately calculated in advance, given the soil test values and c_1 and c values. To predict so-called adequate amounts of P and K for a certain number of bushels increase is to ignore the fact that next year's yield possibility is entirely unpredictable. *But next year's percentage sufficiency values and fertilizer requirements for P and K are predictable for given rates of planting and planting patterns,* if a few simple field experiments have been conducted to obtain data for establishing the c_1 and c values in the equation $\log (A-y) = \log A - c_1 b - cx$.

Here A is the yield possibility, the 100 percent yield either as *percent*, or in *bushels* per acre, or whatever unit is used—and y is the yield or percentage value obtained when b amounts of the nutrient are present and x amounts of the fertilizers are added.

Correlating P and K Tests With Fertilizer Needs

Fertilizer experiments designed to measure the efficiency of the soil and fertilizer forms of P and K are not only highly practical, since they give us the c values required for soil test correlations, but they are also the easiest to carry out. They require only a field low in the nutrient and a single year's work using a replicated rate experiment. A second year on the same field, of course, could measure the residual value of the added fertilizer. In general, the long time experimental fields throughout the country are providing little or no data for soil test correlations.

Today's farmers depend more on soil tests than ever before. Crop removals and fertilizer additions have changed the fertility situation on every farm. The native fertility has either increased or decreased, depending on practices. No longer can we depend

Table 1

Response of Corn to P or K—1956–59

Limed Plots, Brownstown, Illinois

Comparison	Yield—bu/A	% of maximum yield
	Response to phosphorus	
O and P_2	37 and 43	87
N_2 and N_2P_2	39 and 44	89
N_2K_2 and $N_2K_2P_2$	65 and 72	90
	Response to potassium	
O and K_2	37 and 62	60
N_2 and N_2K_2	39 and 65	60
N_2P_2 and $N_2P_2K_2$	44 and 72	61

on the soil type to indicate fertility requirements, although it can be used as a productivity or yield unit and helps in estimating nitrogen needs.

The soil test value is a record of the status of the soil at the time the fertilizer is to be used. It includes native forms and also residual accumulation from previous fertilization.

Fertilizer experiments not designed for soil test correlation or involve this as only one objective have no permanent value. They tell what happened that year but not why it happened or where it will happen again.

Equations Used In Correlating P and K Tests

The original Mitscherlich-Baule equation Log (A-y) = A-c (b+x) cannot be used for soil test correlations for P and K in this form, since it says that the efficiency of the soil form (b) is the same as the efficiency of the fertilizer form (x). This is not the case.

To overcome this handicap, the writer modified the equation to read log (A-y) = log A-c_1b-cx where c_1 is the "efficiency factor" for b, *the soil form,* and c is the efficiency factor for x, *the fertilizer form.* These values of c and c_1 will vary with the kind of crop, the planting pattern, rate of planting, form of nutrient, and distribution pattern of the nutrient in relation to planting pattern.

Field experiments in Iowa and Illinois have given the following yield equations:

P_2O_5 hill dropped for corn: log (A-y) = log A-0.05lb-0.032x where b is the P_1 test value in lbs. P/acre and x is the lbs. per acre P_2O_5. (Based on Iowa data)

P_2O_5 broadcast for corn: log (A-y) = log A-0.05lb.-0.02x.

K_2O broadcast for corn: log (A-y) = log A-0.0054b-0.0086x where b is lbs. per acre of exchangeable K and x is the lbs. per acre K_2O applied.

P_2O_5 drilled in the row for wheat: log (A-y) = log A-0.0184b-0.0178x.

P_2O_5 broadcast for wheat: log (A-y) = log A-0.0184b-0.0088x.

P_2O_5 broadcast, disced, and plowed for soybeans: log (A-y) = log A-0.05b-0.01x.

The above c values make it possible to calculate the P_2O_5 or K_2O fertilizer requirements for achieving any desired approach to the 100 percent yield level. For example, broadcast P_2O_5 for wheat is relatively less efficient than drilled. One could approach the 98% yield level with reasonable amounts of P_2O_5, 75 lbs. for a 20 lb. P_1 test when drilled, while when broadcast the amount would be 320 lbs. for about a 90 percent yield.

Approach To N Needs

The ultimate available soil form of nitrogen is nitrate nitrogen, a highly soluble and mobile soil form. Nitrogen does not follow the Mitscherlich-Baule percentage sufficiency concept as do P and K. Instead it follows Liebig's law of the limiting nutrient, because it can be almost quantitatively removed by plant roots. Hence, it is practically 100 percent available and one net amount is good for only one yield of a given composition. This has been verified by nitrogen studies in the field, using corn as the test crop. The term "net" is here used to eliminate losses such as leaching or volatilization.

This difference in approach for nitrogen as compared to phosphorus or potassium is due to: (1) *the nitrate goes* to the plant roots, (2) *the roots must explore* for exchangeable K, adsorbed P, and other exchangeable or adsorbed nutrient forms.

In contrast to water-grown plants, the extensive root hair system of soil grown plants must have developed in response to a need for organs to explore large areas of the soil for the relatively immobile forms.

In a pure sand, where all nutrients are soluble (and thus mobile) because there is no clay to adsorb them, the law of the limiting nutrient applies to all nutrients and a given amount is adequate for only one yield of a given composition. A large root hair system would not be necessary. Thus such nutrients as P or K follow the percentage sufficiency concept *only as long as they are relatively immobile.*

Estimating N Requirements

While added P and K build up the available soil forms and have a high residual value when ample amounts are added, nitrate nitrogen as such does not. However, crop residues containing protein nitrogen do contribute to next year's crop.

The need for nitrogen depends on the size and the nitrogen composition of the crop. This will be the "net" need. For example, the usual 100-bushel corn crop will contain, in stalk and grain, around 150 lbs. of nitrogen, with a net need of around 150 lbs. (here the root content is not included). The net need will be around 1.5 lbs. per bushel (stalk and grain) and in a 125-bushel season will be around 190 lbs. of N.

The net need is not the fertilizer requirement. All soils release nitrate nitrogen, the amount depending on the organic matter content and the crop residues returned. Originally in Illinois on land without legumes or commercial nitrogen, around 50 lbs. of nitrogen were being released and taken up by the corn crop. This produced about 50 bushels containing a pound of nitrogen per bushel, and the corn was highly deficient in nitrogen.

Illinois on the average produces 60 to 70 bushels of corn. This means that a nitrogen-deficient program is being practiced. Actually Corn Belt soils are capable of producing 100 or more bushels of corn in an average season.

Discussion

A simple replicated field study of varying application rates of a given nutrient, having all other nutrients adequate, will give the data required for soil test correlations *if the soil test is a measure of the available soil form rather than one which is supposed to measure the availability of the soil form.*

The long-time experimental fields were not designed to be of much help in soil test correlations. *The most useful areas for correlation are fields which have not been treated and are highly deficient in one or more nutrients.* Once correlations are obtained the yield equation can serve many purposes.

For example, the writer received some data giving the response of wheat to different rates of P_2O_5 drilled with the wheat. The rates went high enough to give a yield curve and project to the 100 percent yield. Soil tests were not included in the data. Since b, the test value, was the only value not known in equation log $(A-y_0) = \log A - c_1 b$ where y_0 is the check plot yield, b can be calculated.

The calculation gave b as 23 pounds of phosphorus by the P_1 test method. Later the check plots were sampled and 4 tests were found to average 23.3 pounds. Without rates of P_2O_5 high enough to permit plotting the yield curve to its approximate A level, b could not have been calculated.

This illustrates that *any term in the equation can be calculated.* The values of A, y, b, or x are calculable *if three out of the four are known.* The percentage yield values can also be calculated and are used more extensively than the actual yield values.

Percentage yield values *can be calculated in advance of planting* because they do not depend on the actual yield level, only on the factors in yield discussed above. This is the reason for the term "percentage sufficiency concept" as applied to the Mitscherlich-Baule formulation of the yield equations. On the other hand nitrogen, following Liebig's law of the limiting nutrient, varies in need with the yield level.

THE END

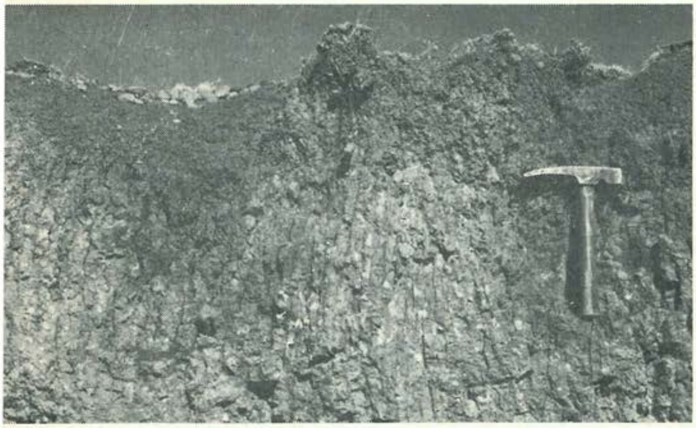
WHAT IT IS . . .

A LAYER of soil—varying greatly in depth, color, and texture—covers the world somewhat like the cracked and broken husk covers a ripe walnut.

Composed of minerals, organic matter, water, and air, this soil provides anchorage for the roots of higher plants and mineral nutrients required for their growth.

The soil is sometimes called the Breast of Mother Nature, because all living things on earth (including people) are directly or indirectly dependent on it for nourishment.

Physical and chemical forces operate continuously against the surface of the earth to form new soil and to change the old. These actions began when the world was first created and still continue today.



THE SOIL

"Most processes that form and alter soils work so slowly that . . . many people, unaware of the changes, make the mistake of regarding soils as masses of inert, lifeless dirt."

By
Erwin J. Benne

A Child of the Sun

Since our world is made of the same stuff as the sun, it is undoubtedly a child of the sun. According to one probable theory, the earth was born billions of years ago when a runaway star passed close by the sun and tore from her glowing body streamers of incandescent fluids, which, when deserted far out in space by their kidnaper, coalesced into huge spherical masses to bring into being the world and her sister planets.

What we now call the world, then a mass of molten rock with a luminous atmosphere of hot vapors and gases, was left spinning around the sun 93,000,000 miles away.

As it slowly cooled, its outer surface gradually solidified, causing tremendous forces to go into action.

From Mountains to Valleys

In some places, the stony crust was heaved upward by surging fluids beneath it—and mountains arose. In other places, it sank unevenly downward, creating basins, crevices, and valleys. Volcanoes erupted like huge blast furnaces, spewing out gases, white-hot molten lava, ashes, and rock fragments ranging from dust particles to large chunks.

Large rock fragments fell nearby, and the lava flowed over the adjoining areas until it solidified. But the fine dust and ashes rose in great clouds, eventually settling all over the surface of the earth.

Lightning struck exposed rocks and shattered them to rubble. Water vapor condensed to liquid. Rains fell. And torrents of water rushed down the mountains, forming streams and rivers and converting basins and depressions into lakes and oceans.

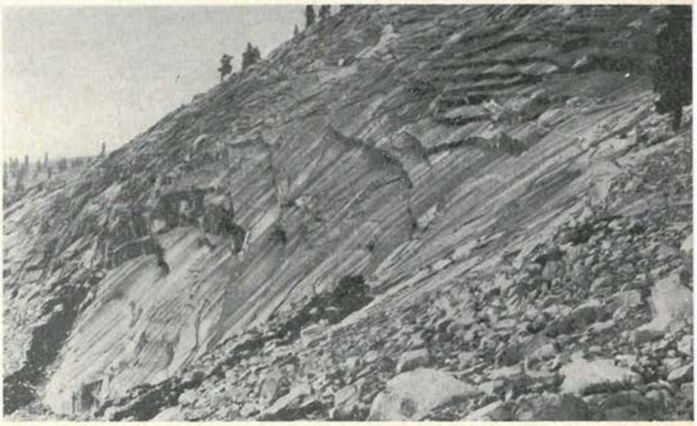
Rocks—the Target

Then, as now, severe temperature changes caused large rocks to crack when the outside suddenly became much hotter or much colder than the inside. Water collected in holes and crevices in the rocks, and when it froze it broke them or caused pieces to scale off their sides. Pebbles were ground together and made still smaller by moving water. Winds transferred small particles from place to place and eroded exposed rocks by blasting them with fine sand.

During successive geologic periods, glaciers (or great ice sheets) moved ponderously over large areas of the aging world. Rocks embedded in the lower surface of the moving ice scraped along on those beneath, grinding some of both to powder. When the ice melted, these fine materials remained in place or were transported to other locations by water and wind.

While this was happening in some parts of the world, in other places liquid water, rocked by winds and tides in lakes, seas, and oceans, reduced fragments from their stony basins to the pebbly sands of their shores.

"BREAST OF MOTHER NATURE"

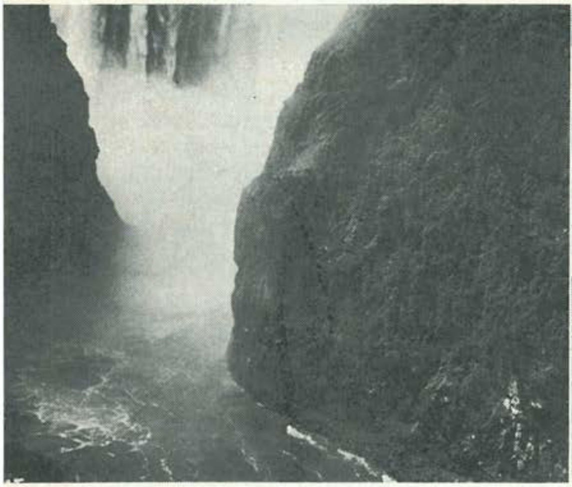


"Weathering acts slowly but continuously and goes on at present just as it has for countless centuries in the past . . . with some rocks yielding to weathering more quickly than others."

Michigan State University

Physical+Chemical=Weathering

These physical forces acting against the earth's crust for millions of centuries have caused it to be covered with a mantle of rocky fragments that form the parent materials from which the mineral portion of the soil was, and still is, derived. Together with these physical actions, chemical forces attacked exposed rocky fragments and



ALTERED BY MOVING WATERS . . . AND DRIVING WINDS

changed them into substances more simple in composition.

The collective effects of these physical and chemical forces against rocks is called weathering. Weathering acts slowly but continuously and goes on at present just as it has for countless centuries in the past.

At first thought weathering might appear destructive, but it is indispensable in forming soil and releasing plant foods from rocks. Some rocks yield to weathering more rapidly than others. For example, limestone and sandstone disintegrate more rapidly than granite.

And Life Appeared

But mineral particles alone do not make a soil. Somehow, somewhere, sometime in the past, the simple elements contained in the weathered rocks, plus water and the vital elements of carbon and nitrogen, were organized into protoplasm—and life appeared on the earth.

Eventually the green pigment called chlorophyll formed in certain granules of the newly-created protoplasm, giving them the ability to capture energy from sunlight and to store it in compounds like sugar and starch, synthesized from water and carbon dioxide. These compounds provided a food and energy supply for living things that did not contain chlorophyll, making possible an animal kingdom as well as a plant kingdom.

Since life began on earth, large numbers of living things, fantastically different in size and shape, have lived and died. When they died, their remains crumbled down among the rocky fragments covering the world and provided food for many kinds of organisms to grow there.

This addition of organic matter to the disintegrated mineral materials, together with the air and water contained in them, completed the soil. In many areas of the world, bulky accumulations of dead plant materials have completely filled lakes and other water basins and formed peat and muck soils, consisting largely of organic matter in various stages of decomposition.

Men Harness Soil Life

Compared to the total age of the world, men have been on earth for a


. . BY VOLCANO ACTIONS . . . AND BEATING SURF

relatively short period. But they (especially civilized men) have greatly influenced the recent history of the soil.

By cutting forests, damming streams, draining swamps, terracing hillsides, and raising cultivated crops at the expense of native vegetation, men have changed the course and rate of natural processes, which if left unaltered would have exerted much different effects on the soil. By using fertilizers to supplement the natural productivity of the soil, they have greatly increased the growth and yields of crops of their own choosing.

Most processes that form and alter soils work so slowly that marked variations in the character of the soils in a given area may not be noticeable during a human life time. So it is not surprising that many people, unaware of the changes, make the mistake of regarding soils as masses of inert, lifeless dirt.

Nothing could be more wrong, since fertile soils literally teem with life. Millions of microorganisms—*bacteria, fungi, algae, actinomyces, nematodes,* and *protozoa*—inhabit them, and living roots from countless numbers and varieties of higher plants penetrate them to compete for mineral nutrients there. Soils are also the home of many higher forms of animal life, including worms, insects, rodents, reptiles, and even birds.

Prosperity or Poverty Via the Soil

In different areas of the world, soils are slowly but definitely changed by the climatic environments to which they are subjected. Any observant person should notice marked differences in the soil as he travels from place to place in the United States and the world.

He should observe not only physical differences in the soils themselves, but also in the manner in which they are used agriculturally. It should be apparent *how closely agricultural prosperity or poverty is linked to the character of the soil.*

With a fuller understanding of the soil and its history, travel in rural areas becomes more interesting. An alert traveller can read many fascinating stories relating to soil formation from pictures portrayed on landscapes instead of canvases.

On the Canvas Called Earth

Deep canyons and gorges hewn out of solid rock by streams and waterfalls tell of the slow but continuous erosive effects moving water has on the earth's crust. Waves breaking against rocks on the shores of lakes and oceans, pebbles and fine sand on beaches in other areas—all these are clear signs of how water action can disintegrate stones.

Whirling dust clouds and shifting sand on dunes and deserts remind the traveller of what winds have done to help form soils. Craters of extinct volcanoes, and in some areas active ones, show how volcanoes have contributed lavas from the bowels of the earth to form mineral bases for soils in many parts of the world.

Stony rubble at the ends and sides of mountain glaciers, moving inexorably toward a sea, proclaims the silent power of these ice rivers and the part their forerunners have had in providing the world with its rocky mantle.

Pine trees clinging tightly to a meager layer of soil on mountain rocks—while swamps abound with water lilies, cattails, sedges and many other aquatic plants—present contrasting contributions of living things to the genesis of soil. Delta soils show the traveller that soil materials are not always destroyed by erosive forces but are often transported to other locations and formed into new soils there.

Finally the sight of forest-covered mountain sides, of luxuriant corn and vegetable crops in fertile valleys, of grains and grasses waving in prairie breezes should fill the traveller with wonder and gratitude for the bounties furnished by soil.

Vital to Every Man

In life's scheme of things, soil is vitally important to every person on earth. Since men came into existence, they have depended on it for their food and for many shelter and clothing materials. While we live, we are nourished and sheltered by the fruits of the soil. When we die, our remains become a part of it.

Eventually the elements that now compose our bodies will become a part of new living things, enabling us to live again in the beauty of the flowers and grasses of the fields.

Truly—"God moves in mysterious ways his wonders to perform."

THE END

PROMISING CROP

SOYBEANS look like a promising new crop for Oregon, in low altitude, high temperature areas of the eastern and southern parts of the state, according to Oregon State Agricultural scientists.

Best bets for soybean production will be the Snake River Valley, Hermiston area, and Rogue River Valley, Norman R. Goetze, OSU extension farm crops specialist, reports.

Prospects for soybean marketing in Eastern Oregon also look good, with the probable building of a soybean processing plant at Quincy, Wash. A plant of the type planned at Quincy needs around 30,000 acres of soybeans to process, Goetze pointed out, which means it should provide a market for at least some soybeans grown in Oregon.

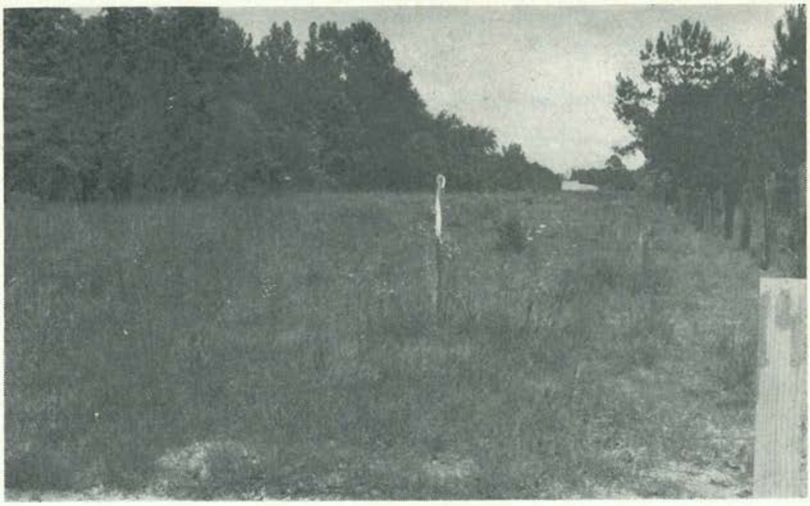
Research conducted at the OSU agricultural experiment station has shown the Willamette Valley is too cool for good soybean production, reported Henry H. Rampton, USDA research agronomist at OSU. Soybean varieties that mature in 90 days in the Midwest take from 120 to 130 days to mature in the Willamette Valley, he said.

This longer growing season tends to lower yields, pushing harvest time for soybeans into the valley's rainy season, Rampton explained. His conclusions are based on research carried on cooperatively by the experiment station and USDA agronomists since 1919.

Present research efforts are being concentrated at the Malheur branch experiment station near Ontario, under the direction of E. N. Hoffman, superintendent, and Luther A. Fitch, farm crops scientist. New varieties of soybeans, time of planting, rate of seeding, and irrigation practices are being checked.

Results to date show a definite promise for soybean production in adapted areas of the state, but several problems remain to be ironed out before commercial production of soybeans can be recommended on a large scale, the scientists advise.

Oregon News Service



Gas line right of way 3 years after it was burned, fertilized, and seeded.

FERTILIZED TOP WILDLIFE FOOD

By Dale H. Arner **Soil**

PROPER development and management of utility line rights of way through wooded areas will provide game birds and animals with excellent cover and nutritious food and utility companies with greatly reduced maintenance costs.

In Alabama alone there are over 240,000 acres in power, telephone, and gas line rights of way. The major acreage is located in woodlands. In the past, these areas have been largely unused and keeping them free of brush and trees has been expensive.

Through 12 years of research in Alabama and Maryland, techniques have been developed for converting these unproductive areas to valuable wildlife lands. The most effective methods are:

1. Clearing stumps and brush with a bulldozer, liming, fertilizing, and seeding.
2. Maintaining the seeded right of way with such equipment as a spring shank cultivator, or controlled burning with refertilizing and reseeding (where needed).

Bulldozer, Fertilizer, and Seed

Nine miles of right of way (107 acres) through mountain forest land in western Maryland were cleared and seeded with a grass-legume mixture in the spring of 1948. At the

Gas line right of way 3 years after it was seeded—but never burned nor fertilized.

UNFERTILIZED

... LOW UPKEEP COSTS ... VIA FERTILIZER-MANAGEMENT OF UTILITY RIGHTS-OF-WAY

Conservation Service **Selma, Alabama**

end of three years, studies showed that only 9 percent of the right of way was covered by objectionable woody plants, and within seven years only 20 percent required treatment to control woody vegetation.

The areas requiring treatment were renovated with a spring shank cultivator and limed, fertilized, and reseeded at a cost of $29.00 per acre. The original cost of bulldozing and seeding was $45.50 per acre. *Thus, the maximum cost for maintenance and clearing was $74.50 per acre, and the minimum cost was $45.50 per acre*. Of this amount the Potomac Edison Utility Company paid *$40.00 per acre* (the cost of bulldozing) and the Maryland Game and Inland Fish Commission paid the remaining portion, $34.50.

Previous estimated costs for brush eradication by spraying with herbicides on this right of way ranged between $80.00 and $90.00 per acre for two spray applications normally

FERTILIZED

Power line right of way that was fertilized and seeded with partridge pea—but was not burned.

required to control woody vegetation over a seven-year period.

Clipped areas in the fall of the year showed that the bulldozed-seeded right of way produced over 2,000 pounds (green weight) of nutritious grasses and legumes per acre. In contrast, the dominant vegetation on sprayed rights of way was broomsedge and bracken fern, useless as a winter food for deer, turkey, or quail.

Fire, Fertilizer, and Seed

In Alabama, experimental work was done with fire, fertilizer, and seed to control woody vegetation and provide wildlife food. Controlled burning was conducted over a three-year period on soils common to the Piedmont, Upper Coastal Plain, and the Lower Coastal Plain soil provinces in Alabama.

Fertilizer and seed of Kobe lespedeza, partridge pea, Florida beggarweed, and Sericea lespedeza were sowed directly on the burned area without any land preparation. Vegetational analyses conducted annually

UNFERTILIZED

Power line right of way that was burned and seeded with partridge pea—but received no fertilizer.

at the end of each growing season revealed the following:

1. Fertilization was necessary in all areas for establishing the seeded species in both burned and unburned plots.
2. Fertilized plots had more native quail food plants than unfertilized plots.
3. On these plots with a good herbaceous ground cover, burning significantly reduced woody vegetation.

Information obtained from this study indicates burning to control woody vegetation would be necessary every third year. At present day costs, controlled burning (two burns) plus fertilizer and seed should not exceed $30.00 per acre for a six-year period—or $5.00 per acre per year.

By selecting the proper technique and sharing the costs, conservation agencies, utility companies, and landowners can reduce maintenance costs to the utility company, while providing nutritious wildlife food and cover. Such areas can contribute greatly to improved hunting in the Southeast.

THE END

Tall gladioli like these at Castle Hayne, N. C., come from proper fertilization.

NUTRIENT needs of gladioli vary considerably from one area to another, scientific experiments have shown.

McClelland (1950), working at Beltsville, Maryland, concluded that gladioli need very little fertilizer for flower production from blooming size corms. Sufficient nutrients for good growth appeared to be present in the corms and in the soils with which he was working. He suggested applying superphosphate to cover crops that precede gladioli, and applying nitrogen (if needed) as a sidedressing at flowering time.

Other workers in northern states have also reported that relatively little chemical fertilizer is needed.

GLADS LIKE THEIR PLANT FOOD

Especially Potash On Sandy Loam Soils

From nearly 800 acres in Eastern Carolina, quality glads are shipped to market each year.

High Potash User

In Florida, where soils are sandy, low in organic matter, and subject to leaching from heavy rains, tests showed gladioli demanding from 1000 to 2400 lbs. complete fertilizer per acre, plus minor elements such as boron, iron, zinc, and manganese.

Magie and Cowperthwaite (1954) reported that in addition to a basic

Table 1.—How gladioli flower spikes (Snow Princess variety) responded to different fertilizer treatments.

		Numbers of flower spikes in 3 height classes			
No.	Treatment([1])	40″ or less	40″–44″	44″ or taller	Totals
1	Check	248	172	42	462
2	5–10–10, 500# S.D.([2])	242	160	62	464
3	Potassium sulphate (or other K sources), 105# S.D.	228	204	77	509
4	Sodium nitrate, 120# S.D.	312	151	17	480
5	Cottonseed meal, 300# S.D.	288	115	28	431
6	25# Mn and 25# Fe	303	142	23	468
			L.S.D. at .05 level		46

([1]) All plots received an application of 500 pounds of 5–10–10 in the row prior to planting. All fertilizer rates are in pounds per acre.
([2]) S.D. = Sidedressing.

By J. M. Jenkins, Jr. North Carolina State College

application of 400 to 800 lbs. 4-8-8 or 4-8-12, growers should apply 300 to 400 lbs. every two or three weeks after planting—amounting to three or four applications for a total of from 1700 to 2400 lbs. complete fertilizer per acre.

The Florida workers also recommended 150 to 250 lbs. of potash per acre sidedressed when spikes first appear above the leaves. They have found that *the gladiolus plant utilizes large quantities of potassium while the spike is elongating.*

Growers in North Carolina's coastal areas normally use around 1000 lbs. 5-10-10 per acre for gladioli. Many sidedress with sodium nitrate at time of spiking. Soils in this area are sandy, containing from 1.5 to 4.0 percent organic matter.

1960 Tests Confirm K Value

Experiments conducted during the past six years at the Horticultural Crops Research Station near Castle Hayne, N.C., indicate gladioli need around 500 lbs. 5-10-10 per acre applied in the row. In 1960 a number of fertilizer treatments based on previous experiments were tested on a sandy loam soil containing 1.0 percent organic matter. Soil tests showed: (1) high in available phosphorus, (2) very low in available potassium and nitrogen, (3) a pH reading of 6.1.

To control nematodes, the soil was fumigated with 4.5 gallons of Dowfume 85W per acre well before planting time. The variety used was Snow Princess. Table I gives the flower yields in three height classes from some of the fertilizer treatments tested. (All plots received an in-the-row application of 500 lbs. 5-10-10 per acre before planting.)

The table shows that a sidedressing of 500 lbs. 5-10-10 per acre gave no yield increase over the check. Data taken at the end of the growing season showed no increases in the size or number of corms as a result of this treatment.

The potassium (Treatment 3) gave increases in total yields as well as in number of taller spikes, 40" or taller. *This was the only treatment resulting in significant increases over the check.*

Applications of mineral nitrogen, organic nitrogen, or manganese and iron gave no increases in spike heights or numbers. No difference in spike quality was observed. The cottonseed meal sidedressing gave significantly lower yields than the equivalent sidedressing of mineral nitrogen from sodium nitrate.

Discussion

Results obtained in the 1960 series confirm test results of previous years. No increases in yields of flowers or corms were obtained from the use of more than 500 lbs. 5-10-10 per acre.

Although soil fumigation was expected to kill nematodes that might damage feeder roots and prevent plants from making full use of heavier fertilizer application, it had no observable effect in the 1960 test.

Lack of response to nitrogen sidedressing was unexpected since most commercial growers sidedress with nitrogen to produce taller spikes. *In these tests, potassium produced the highest percentage of tall spikes and the greatest yields. This response to potassium by gladioli has been reported in Florida and is confirmed by the tests reported here.*

Lack of response to iron and manganese indicated these elements were already available in sufficient amounts to supply plant needs. Subsequent crops may reduce available iron and manganese to a point where gladioli will respond to such applications. Responses to these elements have been obtained on some farms in the area.

Conclusions

On average sandy loam soils, gladioli should receive an in-the-row application of 500 lbs. 5-10-10 per acre before the corms are planted. This mixture may be supplemented with minor elements, such as iron or manganese, where soil tests indicate the need.

When the plants first start to send up flower spikes, they should be sidedressed with at least 50 lbs. available potassium per acre.

On very light sandy loam soils, it may be advisable to sidedress with both potassium and nitrogen since considerable leaching occurs during wet seasons. However, nitrogen sidedressings have not given increased flower production in tests at this station.

THE END

"About all I can say for the United States Senate up on the hill is that it opens with a prayer, and closes with an investigation."—Will Rogers

---

One wife to another: "Don't worry if your husband flirts. My dog chases autos but he wouldn't know what to do if he ever caught up with one."

Obstinacy and vehemence in opinion are the surest proofs of stupidity.

The stuffed-shirt businessman came home from work one day more puffed up than ever. "I've just been made a vice president of our firm," he boasted to his wife.

Thoroughly annoyed with him, considering all his previous boasts, she snapped: "So? Vice presidents are a dime a dozen. The grocery market where I shop, for example, has so many vice presidents it even has one in charge of prunes."

The husband pretended to ignore his wife's remark, but it sorely bothered him. The next morning after he reached his office he decided to call the store to see if she was telling the truth.

He asked the switchboard operator for the vice president in charge of prunes.

"Packaged or bulk?" asked the operator.

They were most anxious not to be recognized as newlyweds so before they went in to the hotel to register, they took off the last of the rice and the bride took off her corsage. Then sure that no one would know they had been married just that morning, the groom said casually to the desk-clerk: "I'd like a double bed with a room, please."

"How did you get that black eye?"

"I was calling on my girl friend last night, and we were in her parlor, dancing, while the radio was playing, and her old man came in and the old so and so is deaf."

The newly appointed justice was not familiar with the code, and when a bootlegger appeared before him to plead guilty he was at a loss to know what to assess him. He called up the old justice.

"I've got a bootlegger here. What shall I give him?

"Don't give him over four dollars. I never do."

At a baseball game a young woman asked her escort: "Why does that man behind the hitter wear such a big bib?" He explained to her that it was to keep the catcher's shirt from getting all mussed up when the ball knocked his teeth out.

Intelligence is like a river—the deeper it is, the less noise it makes.

A NEW HANDBOOK FOR TEACHING ADVISORY USE, AND SALES SERVICE

10¢ per copy
$10 per 100

Up to 10 Copies Free Official Advisors and Fertilizer Firms

Name ____________________

Position ____________________

Address ____________________

For quantities above stated free policy:

$________ attached

Bill me $________

Department B.C. American Potash Institute 1102 16th St., N.W. Washington 6, D.C.

Better Crops WITH PLANT FOOD

IF NOT DELIVERED, return to

AMERICAN POTASH INSTITUTE, INC.
1102—16th St., N. W., Washington 6, D. C.

RETURN POSTAGE GUARANTEED

Bulk Rate
U. S. POSTAGE
PAID
Washington, D. C.
Permit No. 2283