Better Crops
WITH PLANT FOOD
SUMMER—1971
25 CENTS

Soybeans Use Much Plant Food

While they grow!

DRY MATTER PRODUCED & PLANT FOOD ABSORBED BY ACRE OF GROWING SOYBEANS (50 Bu/A YIELD)

	At 40 Days Lbs	80 Days Lbs	100 Days Lbs	120 Days Lbs	140 Days Total Lbs	
Dry Matter	266	4,763	5,472	8,223	9,111	
N	7.6	125	134	196	257	UPTAKE: 560 lbs
P_2O_5	1.1	21	24	36	48	
K_2O	6.1	105	112	150	187	
Ca	2.4	31	38	49	49	
Mg	0.6	11	10	16	19	

PERCENTAGE OF PLANT FOOD REQUIREMENT TAKEN UP BY SOYBEANS

	%	%	%	%	%
N	2.9	49	52	76	100
P_2O_5	2.3	44	51	76	100
K_2O	3.3	56	59	80	100
Ca	4.9	63	77	99	100
Mg	3.1	58	53	82	100

(Calculated from N. C. State University Data)

50 Bu/A Soybeans Absorb:

257 lbs/A
NITROGEN *

48 lbs
PHOSPHATE

187 lbs
POTASH

49 lbs
CALCIUM

19 lbs
MAGNESIUM

23 lbs
SULFUR

3 lbs

MANY THINGS influence a soybean crop. One of the big things is the plant food diet available in its soil.

Too many soybean crops "eat at the second table" on slim leftovers from a greedy corn crop.

We know corn takes up plenty of plant food while it grows. Soybeans can be just as greedy.

On page 16, BETTER CROPS features facts calculated from an important study by the N. C. Agricultural Experiment Station.

It shows the dry matter produced and plant food absorbed by an acre of growing soybeans—at different stages of growth.

This is a graphic story, revealing what a good crop demands of the soil—and what the soil demands of a good grower if he expects top-profit yields.

* Soybeans can get most of their N from the air. Amounts include requirements of both grain and stalks and will vary with soil type, fertility, variety, and season.

THE STORY OF PLANT FOOD UPTAKE BY SOYBEANS, starting on page 16, will be converted into a two-color folder . . . opening into an attractive 8½″ x 15″ brochure. It will be available in August . . . in large quantities . . . for use in meetings . . . mailings . . . and educational promotion throughout the coming year. The subject is timeless, but the target is always next season's crop.

It will feature not only yield and removal facts presented in this issue, but also a check list to MORE bushels per acre. Top growers know they can pick up EXTRA bushels through right seed selection . . . full-feed fertility . . . best planting time and rate . . . lower weed tax . . . right combine use at harvest . . . etc.

The Potash Institute's folder on CORN PLANT FOOD UPTAKE has gone by the hundreds of thousands. You might plan your distribution of this new SOYBEAN PLANT FOOD UPTAKE folder early.

Better Crops
WITH PLANT FOOD

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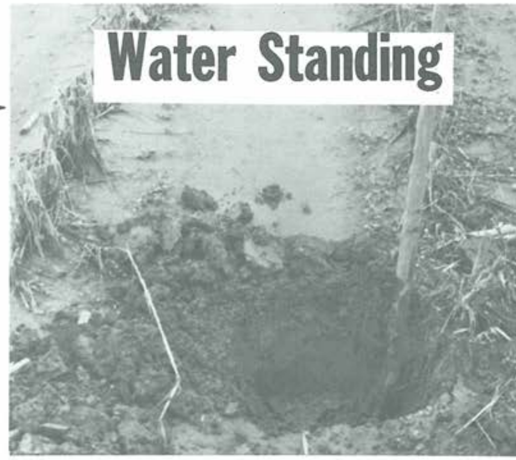


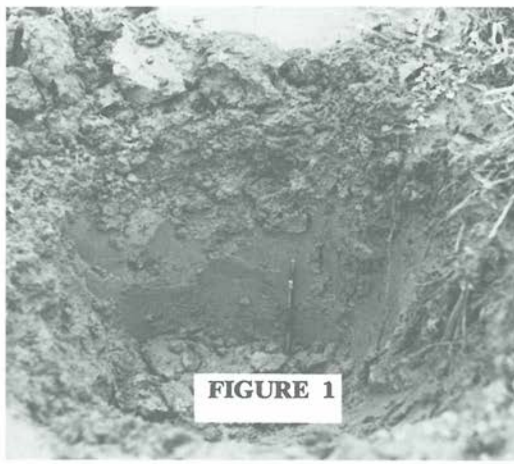


FIGURE 1—Repeated spring tillage compacts soil, leading to ponds, poor drainage and bad aeration. Water stands in furrows in April on land that should have already been planted. Digging into the soil showed no subsoil water table problem, but revealed compacted soil to about 12 inches. This holds up infiltration. Free drainage exists below the compacted layer.

FIGURE 2—What a contrast between a fall-prepared seedbed (left) ready to be planted early and spring-prepared seedbed (right) full of clods from wet soil. Fall seedbed eliminates need for additional land preparation. And winter freeze-thaw action mellows the soil into a fine friable seedbed.

ROLLIN C. GLENN
MISSISSIPPI STATE UNIVERSITY

FALL Soil Management

WHY HAS CORN ACREAGE declined in the South? Ten years ago Mississippi was a major corn-producing state, with over one million acres.

In 1970 only one-third of that acreage was planted. Rising production costs and consistently low yields have made corn unattractive.

Farmers say the crop is too risky. State yields average only 40 bushels per acre, where 300 bu has reportedly been demonstrated as possible.

Many factors lead to these low yields. **Spring soil management problems is one of them. Failure to plant early opens the flood gates to yield barriers.**

WET SOILS DELAY PLANTING. Spring in the South means frequent rain and cold wet soils.

Dry periods are too brief for both land preparation and seeding. Few farmers get corn land ready in time to capitalize on early planting advantages.

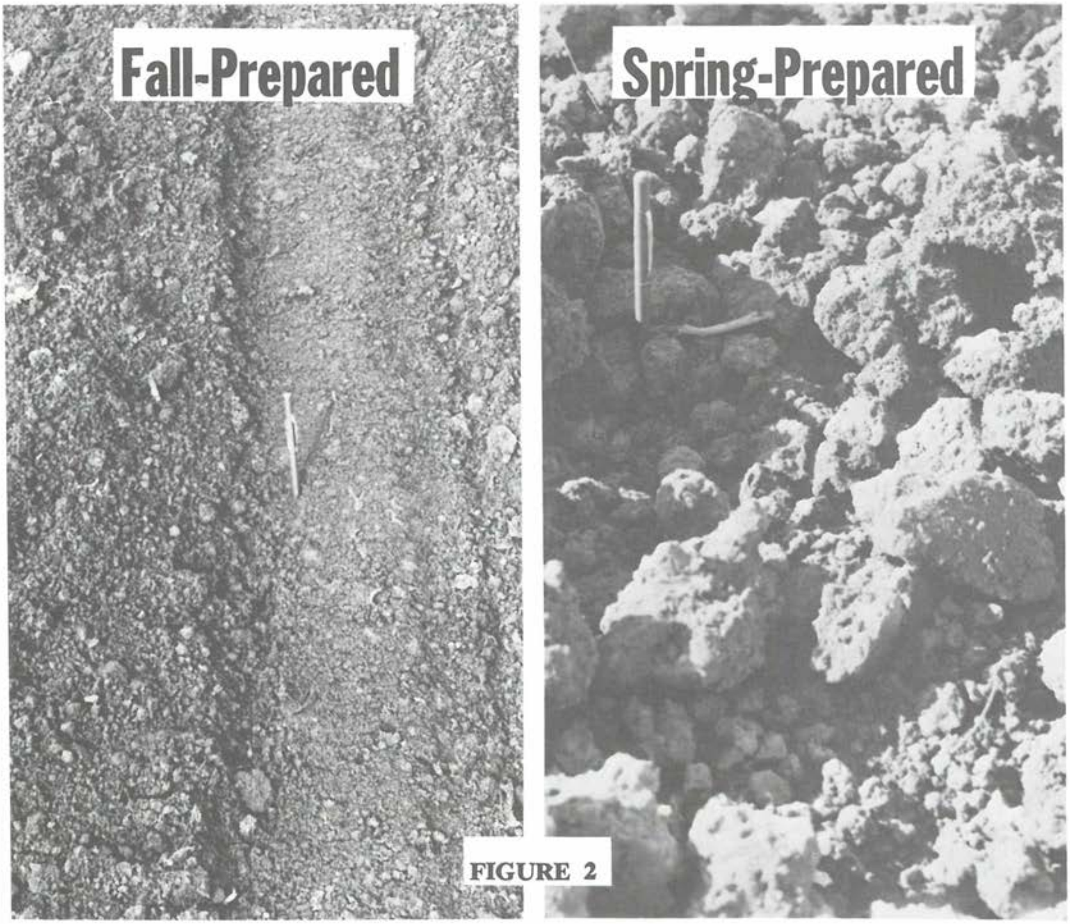


FIGURE 2

. . . does it pay down South?

Much can be said about spring land preparation for corn, and most of that is bad. Spring soils appear dry on top but down under they are plenty wet. Only the coarsest textured soils are dry enough to work early.

Wet soils are highly plastic and respond unfavorably to traffic or tillage. Heavy tractors and fertilizer spreaders deform and compact them to depths of 10 or 12 inches.

Compacted soil drains slowly. Water stands high on germinating seed and seedlings, depriving them of vital oxygen, cutting into stands and retarding growth.

Wet soils also gets hard and cloddy within a few hours after tillage. A pile of clods makes a poor seedbed.

FALL PREPARATION — plowing and seedbed work—may prove easier and cheaper than spring work for the southern farmer, especially where soils are medium or fine textured.

Table 1. Physical Properties of Marietta Soil Following Spring and Fall Soil Management.

	0–4 INCHES DEEP		6–10 INCHES DEEP	
	Bulk Density g/cm³	Hyd. Conduct. inches/hour	Bulk Density g/cm³	Hyd. Conduct. inches/hour
After spring plowing				
Rows	1.46	1.1	1.67	0.02
Furrows	1.78	0.0	1.71	0.01
After fall plowing				
Rows	1.21	8.2	1.38	2.04
Furrows	1.33	2.0	1.40	1.71

Soils are dry and firm enough in fall to support big machines. The soil is less cohesive or adhesive and works easy.

Midwest researchers have known for some time that fall plowing means important increases for their farmers. Will fall plowing also pay southern farmers?

RESEARCH SAYS YES. Management studies on a moderately well drained marietta heavy loam at State College Mississippi, show fall plowing and seedbed preparation can boost corn yields and advance planting dates two to four weeks.

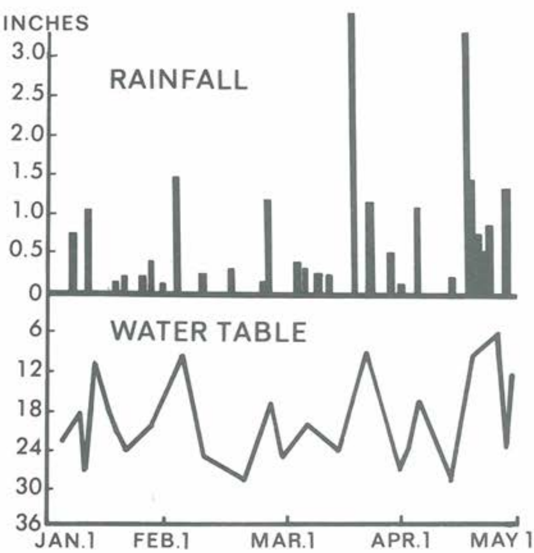


FIGURE 3—Quick rise of marietta water table after rains shows top soil infiltration and percolation is high following fall plowing.

The marietta soil is excellent corn land and responds well to fall management.

Figure 1 shows how **repeated spring land preparation** on marietta leads to poor drainage and poor aeration. Water is standing in furrows in April when the photograph was taken.

The land should have already been planted. Digging into the soil showed no subsoil water table problem, but revealed **a compact soil layer to about 12 inches.**

This layer is holding up infiltration. It must be thoroughly shattered if drainage is to improve. How can it be done? The quickest, surest way is **deep plowing** when the soil is dryer and firm.

Tables 1 and 2 show how beneficial fall plowing and seedbed preparation on the marietta soil can be.

Before 1970 only spring land preparation was practiced. Bulk densities had increased to around 1.7 g/cm³ and percolation rates were near zero.

In 1968, earliest seeding date for corn was May 20. Heavy rain the next day resulted in a stand failure.

In 1969, the crop was finally seeded on May 16. Plots fertilized with 225 lbs K and 200 lbs N produced yields above 100 bu per acre, but lodging following heavy corn borer infestation made harvesting difficult.

In late 1969, a fall soil management system was employed. The field was plowed 12 inches deep in early November to shatter compacted zones. Muriate of potash was applied at the rate of 225 lbs K per acre and disked in. Rows were bedded up for the winter.

By March, 1970 winter freeze-thaw ac-

Table 2. Corn Yields from Preplant and Layby Broadcast Nitrogen Following Spring Land Preparation for the 1969 Crop and Fall Preparation for the 1970 Crop.

SPRING APPLIED NITROGEN		FALL K	GRAIN YIELDS 15.5% MOISTURE	
Preplant lbs/acre	Layby lbs/acre	lbs/acre	1969 bu/acre	1970 bu/acre
200	0	225	67	124
0	200	225	104	135

tion had mellowed the soil into a fine friable seedbed, shown in **Figure 2.**

Table 1 shows how percolation in beds averaged 8 inches per hour, with 2 inches per hour in furrows. The bulk densities suggest good aeration.

Seedbeds were dry enough to plant corn on March 31 without further land preparation. Excellent stands were obtained and the plants grew vigorously.

Figure 3 shows improved drainage in the marietta soil following fall plowing. January through May water tables remained around 24 to 26 inches deep.

Significant rains produced a quick rise of the subsoil water table, indicating the water was getting through.

Furrows were clear of excess water within a few hours after rainfall. Later when water demands were high, roots easily penetrated to the available subsoil moisture. Grain yields soared to 140 bu per acre.

MORE YIELD FROM N. Poor drainage in early spring can severely reduce nitrogen efficiency. **Table 2** shows how preplant and layby nitrogen applications following spring soil management in 1969 compare with fall management in 1970 for corn on the marietta soil.

During both years nitrogen was broadcast at rates of 200 lbs actual N per acre. With spring soil management, grain yields from preplant N were only 65 percent of yields with layby N.

Following fall soil management, 1970 grain yields from both preplant and layby N were much higher than in 1969—but layby N again produced higher yields.

Fall Plowing ADVANTAGES

GETTING HEAVY WORK done in the fall has many big advantages for southern corn farmers.

1. **Soils can support heavy machinery. Compaction is minimized.**
2. **Winter freezes produce friable seedbeds that drain and dry quickly in spring for early planting.**
3. **Well aerated seedbeds warm up quick in spring—seeds germinate faster.**
4. **Early planting gets the crop out ahead of aggressive summer weeds—reduces or eliminates weed control costs.**
5. **Early corn makes more of its growth when evapo-transpiration is low and rainfall higher—water is saved for hot-dry months.**
6. **Roots penetrate the friable soil to tap valuable subsoil water.**
7. **Fertilizer efficiency is enhanced—especially nitrogen.**
8. **The crop can be harvested in September. Plenty of time remains to get winter crops in.**
9. **The early crop escapes severe insect and disease damage.**
10. **The crop can be harvested and sold when markets are good and prices still high. There is less need for farm storage.**

Better drainage increased nitrogen efficiency, but losses still occurred when nitrogen was applied too early. Delaying application until the soil was dryer and thoroughly warm was more profitable.

WHAT ABOUT EROSION problems with fall plowing? Wind erosion is not a problem on most southern soils, but water erosion in winter can be severe on bare sloping land.

Fall plowing is safe on nearly level fields. It should not be attempted on sloping land unless good conservation practices are employed.

FALL FERTILIZATION with P, K, and lime can be conveniently done around fall plowing time. Plow-down applications work well on soils that test high in P and K.

When liming, half the lime should be cut in before plowing and half after plowing.

WITH ADVANTAGES like these, southern farmers should carefully examine their soil management practices. Perhaps fall preparation can solve their spring lateness problems. **THE END**

Shooting At A Moving Target
. . . K soil test levels

Noble Usherwood Guatemala

A POTASSIUM SOIL TEST becomes relevant when it helps predict K fertilizer needs for a given crop on a given soil.

Many chemical tests for potassium are quite reproducible on a given soil under a given condition.

The problem may come when the same method is used among soil series and/or different environmental conditions.

CONSIDER MINERALS in the soil. Many soils RELEASE potassium upon drying and then FIX potassium upon rewetting and incubation.

Why? Consider the silicate clay mineral content of the soil—especially montmorillonite, vermiculite, and illite.

Montmorillonite will fix potassium upon drying.

Micaceous minerals and vermiculite can potentially fix potassium under moist soil conditions.

Illite has released potassium upon drying (3). Soils high in illite often exhibit high potassium soil test levels and still release extra exchangeable potassium upon drying.

Thus, the relative amounts of each clay mineral in a soil will exert a major influence upon the amount of release and fixation measured as a soil is dried and remoistened.

SAMPLING TIME is important. Soil test laboratories must operate year-round. They need a steady flow of samples.

Yet, many research workers have observed that extractable soil potassium is influenced by the time of year a sample is taken.

Illinois and West Virginia researchers simultaneously studied how season affects exchangeable potassium. **See Figure 1.**

The general availability curves are quite similar. What causes the rapid increase in exchangeable potassium? Scientists believe freezing and thawing (a drying and wetting action) may affect potassium release and fixation by clay minerals.

Chemical and biological activity, soil temperature, rainfall, crop removal and

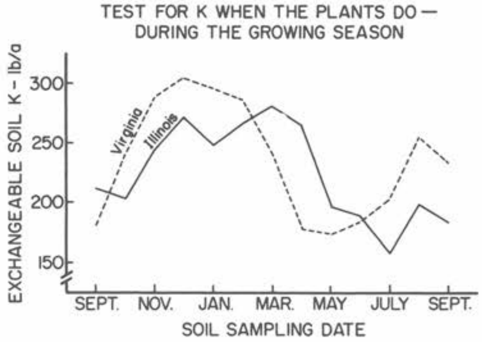


FIGURE 1

air humidity in the laboratory may also be involved.

The soil concentrations measured during late fall, winter or very early spring ran much higher than the values obtained during early growing season.

Yet, corn needs about 70 percent of its potassium during this "early growing season."

On some soils with borderline potassium levels, a soil test in late fall, winter or early spring could indicate adequate K level when deficiency actually exists.

"AIR DRYING" can boost soil K levels. Ohio found air dry soil samples releasing "extra exchangeable potassium" and boosting soil test levels. **See Figure 2.**

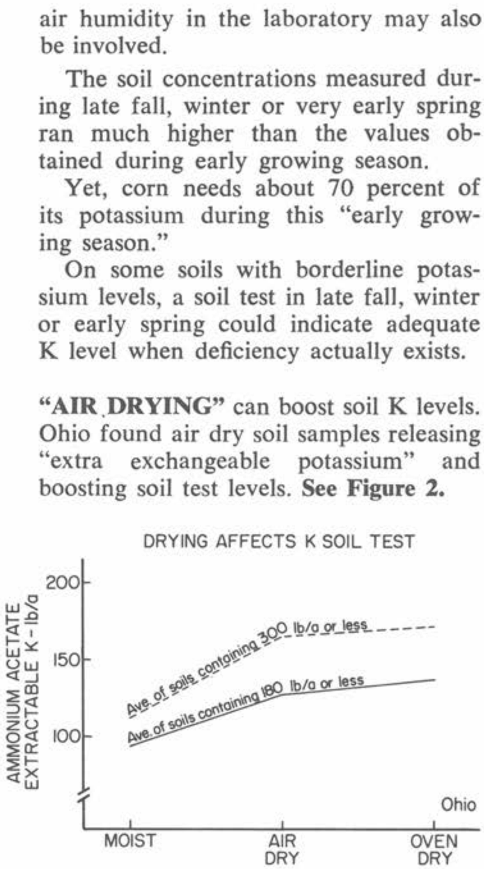


FIGURE 2

With further drying, exchangeable levels increase more—for both high and low testing soils. In the North Central Regional Potassium Studies, many Midwest soils exhibited this characteristic. **See Figure 3.**

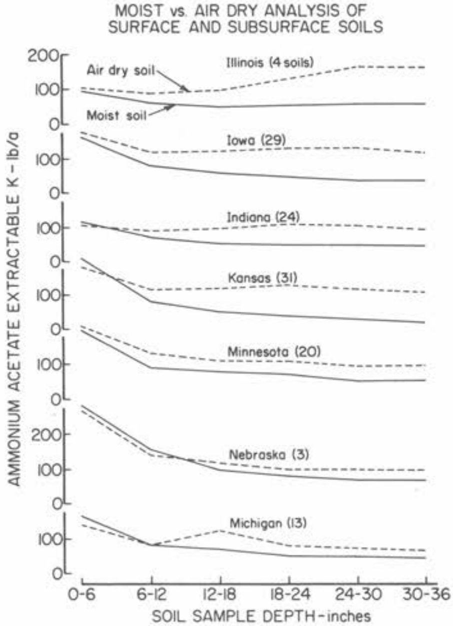


FIGURE 3

Note how the greatest effect from air drying generally occurred with subsoil samples.

CONTROL TEMPERATURE and humidity while air drying. What is the moisture content of an air dry soil? It depends on the soil, the temperature, and the humidity of air.

Samples "air dried" at 5°C and 40 percent relative humidity, varied from about 2 to 6 percent moisture.

The soil moisture content at which potassium release is initiated also seems to vary with the soil.

Some soils begin to release potassium when dried below about 7 percent moisture while others begin at about 3 percent. **See Figure 4.**

One might expect marked differences in exchangeable potassium with only small changes in soil moisture on some soils.

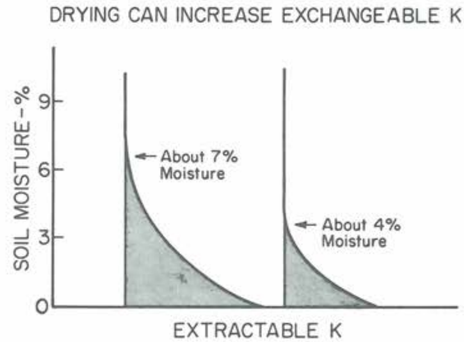


FIGURE 4

As soil humidity rose, extractable potassium declined in certain Kansas and Illinois soils. **See Figure 5.**

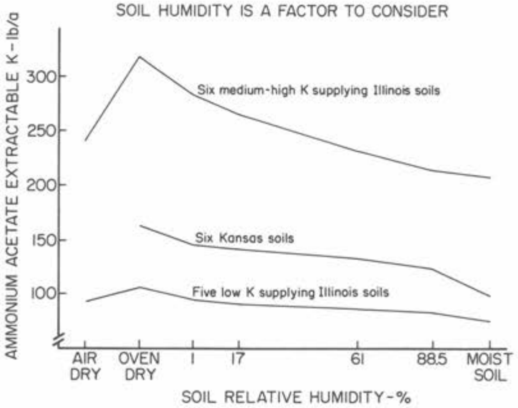


FIGURE 5

Once again, the extent of this effect seems closely related to specific soil characteristics.

Note how the six medium-to-high potassium supplying soils of northern Illinois released more K than the six Kansas soils or the fine low-K Illinois soils released as soil humidity declined.

During a growing season only the surface one to two inches of a field soil ever becomes aid dry.

Most of the plow layer maintains a relative humidity near 100 percent throughout the season.

Thus, a measure of soil potassium in moist soils should give more reliable and reproductive results. Iowa researchers have found this to be true.

IS MOIST SOIL ANALYSIS the solution? A few say yes, most say no.

Iowa changed to moist soil analysis in 1964. Illinois developed a system of soil test correction factors, shown here:

SEASONAL ADJUSTMENT IN K TEST—for Unfrozen Soil Samples After October 1 and Before May 1.

Subtract From Soil Test Results	Soils
30	Dark colored soils.
45	Light colored soils of central and northern Illinois.
45	On fine textured bottom land soils.
60	Low K soils of southern Illinois.

FURTHER EFFORTS are needed. Laboratories will continue to receive soil samples with various moisture levels—at all times of the year.

Research tells us misleading potassium soil test results are being obtained for some soils.

For example, air drying a number of Ohio soils boosted the potassium soil test by 25 to 100 lbs. per acre, depending on the soil type.

Similar results have happened elsewhere. We need to identify such soils, determine the magnitude of K release, and develop suitable corrective measures.

Greater use of soil mineralogy seems realistic.

Much of the work on moisture and exchangeable potassium was conducted nearly a decade ago—a time when production practices and yields were much lower than they are today.

Higher plant populations and improved management now put great stress on soil nutrients. With this added stress, sample drying might well have a more significant effect upon predicting plant response to potassium than in past years.

With today's technology, we must know and use the method of sampling and handling which provides the most reliable measure of plant available potassium.

(Literature sources for this article available on request.) **THE END**

18 years experience . .

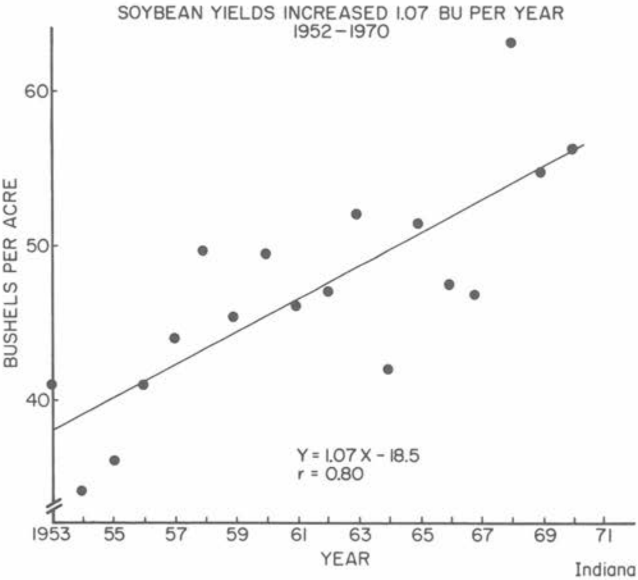


FIGURE 1
Soybean yields increased steadily on rotation fertility plots, Purdue Agronomy Farm from 1953 to 1970.

Soybeans DO Respond To Fertilizer In A Rotation

STANLEY A. BARBER **PURDUE UNIVERSITY**

A ROTATION-FERTILIZATION experiment was started in 1952 at the Purdue Agronomy Farm to study methods and rates of phosphorus and potassium fertilization of a crop rotation.

This report discusses soybean fertilization in a rotation and compares response of soybeans and corn to P and K applications.

The rotation was corn-soybeans-wheat-hay until 1962 when hay was dropped and corn was grown in its place.

There were 22 different P and K treatments with two replications of each crop grown every year. The fertilizer treatments consisted of combinations of row applications for corn and wheat with broadcast applications applied once in four years before corn.

INITIAL SOIL TEST levels were 20 lbs P/acre by the Bray P test and 90 lbs of exchangeable K.

On plots receiving no P since 1952, the test is now 11 lbs P per acre and on plots receiving no K since 1952 the K test is now 63 lbs K per acre.

The soil was a Raub silt loam and was limed in 1952 to bring the pH to a 6.5 to 6.8 range.

Soybeans were not directly fertilized. They were grown the second year after broadcast applications applied before corn and between row application on corn and row application on wheat.

One fourth of row-applied fertilizer per rotation was applied for corn and three-fourths was applied for wheat.

AT PURDUE AGRONOMY FARM

Table 1. Response of Soybeans to Phosphate

Broadcast per 4 Yr.	In Row*	1953–70 Av. Yield	1970 Yield
lbs. P_2O_5/acre		bu/acre	
0	0	39.2	49.7
0	10	42.0	52.1
0	25	45.6	54.9
0	50	45.4	54.5
200	0	47.3	54.5
100	25	46.4	54.0
400	0	47.1	56.0

*This amount on corn preceding soybeans, three times this rate on wheat.

Table 2. Returns from P-Fertilized Soybeans

P_2O_5* Applied	S. Test Bray P_1	Avg. Yield	Yield Increase	Net Return
lbs/A	lbs/A	bu/a	bu/A	$/A
0	7	39.2		
10	11	42.0	3.2	$ 8.00
25	18	45.6	6.4	**15.60**
50	25	46.3	7.1	15.53
100	61	47.1	7.9	13.73
110	63	45.5	6.3	8.50
125	78	46.1	6.9	9.00

*Avg./Yr. Soybeans $2.75/bu. P_2O_5 8¢/lb.

Table 3. Response of Soybeans to Potassium

K_2O Appl.	1953–1970 Av. Yield	1970 Yield
lbs/A/Yr	Bu/A	Bu/A
0	37.1	45.0
25	41.7	50.8
50	44.5	53.7
75	45.1	54.1
150	46.2	55.5

Table 4. Returns from K-Fertilized Soybeans

K_2O Appl.	S. Test K	Av. Yld.	Yld. Inc.	Nt. Return
lb/A/Yr	lb/A	bu/A	bu/A	$/A
0	63	37.1		
25	90	41.7	4.6	$11.40
50	84	44.5	7.4	17.85
75	97	45.1	8.0	**19.50**
150	160	46.2	9.1	17.50

Soybeans $2.75/bu., K_2O 5¢/lb.

Table 5. Soybean & Corn Response to P & K
(18-Yr. Avg.)

Fert. Appl. Per 4 Yr.	Soy-beans	Yield Increase	Corn	Yield Increase
lbs/A	bu/A	%	bu/A	%
0 P_2O_5	39.2	18	119.7	12
400 P_2O_5	46.2		134.4	
0 K_2O	37.1	25	103.8	29
600 K_2O	46.2		134.4	

Figure 1 shows the soybean yields at the highest fertility level for each year during the 1953-1970 period.

Gradual yield increase was probably due to several factors. Variety changes made were as follows: Hawkeye until 1955, Harosoy and Harosoy-63 until 1966, Amsoy in 1967 and 1968, and Beeson in 1969 and 1970.

Fertility build-up and growth of higher yielding crops in the rotation also probably caused an increase in soybean yields with time.

The increase averaged 1.07 bu. per year.

WHAT ABOUT RESPONSE TO P? Table 1 shows soybean response to phosphate applied broadcast for the preceding corn crop or applied in the row for corn.

The amounts in the row for corn are the average amounts per acre per year since three times this amount was used for wheat.

There was little response above 25 lbs P_2O_5 per acre per year. **Table 2** gives the economics of phosphate application. Since the soybeans are responding to the level applied rather than the method of application, the cost of all applications was charged at the same rate per lb of phosphate.

WHAT ABOUT RESPONSE TO K? Table 3 summarizes soybean response to potassium.

While increase occurred with higher rates, increases for additional potassium were small above 50 lbs K_2O.

But **Table 4** shows how the economics of potassium use indicate rates to 75 lbs K_2O per acre per year in the rotation would be profitable on this soil.

SOYBEANS AND CORN COMPARED. Since both corn and soybeans were grown in this rotation it is possible to compare their relative response to phosphate and potassium.

Table 5 indicates soybeans were slightly less responsive to potassium and slightly more responsive to phosphate than corn.

The percent response to P was 18%

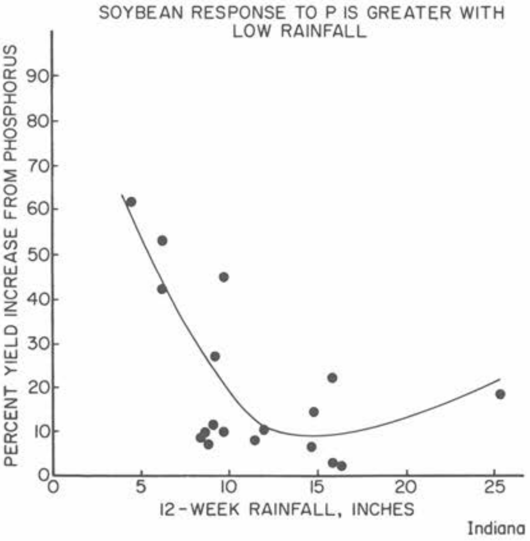


FIGURE 2—The less the rainfall for 12 weeks after planting the more the soybeans responded to added phosphate.

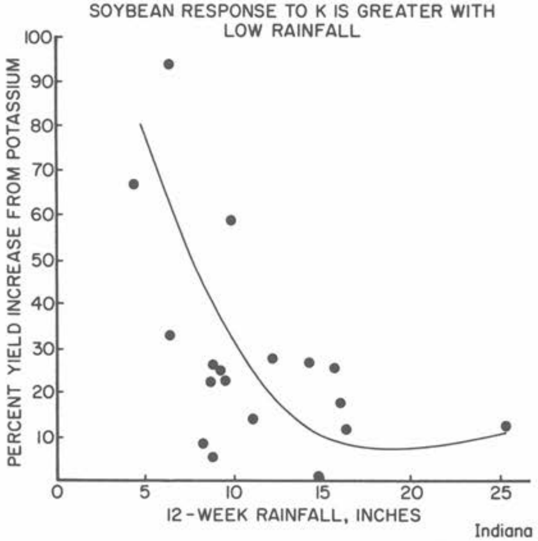


FIGURE 3—The less the rainfall for 12 weeks after planting the more the soybeans responded to added potassium.

for soybeans and 12% for corn. The percent response to K was 25% for soybeans and 29% for corn.

This refutes the oft-heard statement that soybeans don't respond to fertilizer like corn.

INFLUENCED BY WEATHER. Soybean yield response from applied phosphate or potassium varied from year to year. It was found related to the amount of rainfall occurring during the growing season.

Figure 2 shows the lower the rainfall the more soybeans responded to P. The rainfall figures covered the 12 weeks following planting date.

Figure 3 shows a much greater response to K fertilizer when rainfall was less. A season with adequate rainfall did not get much response to P or K. When the season was relatively dry, we got a large response to both added P and K fertilizer.

So, we cannot judge the need for fertilizer on the results for one season. We need to know the effect of weather. Moisture is very important to insure P-K movement from the soil to the plant root.

When rainfall is short, added P and K help to maintain yields. **THE END**

IS IT WORTH YOUR TIME?

. . . this little magazine

Let us know. We appreciate those who have written to stay on the mailing list. What about you? If you have time, let us know if this magazine is useful to you. Drop a line to Active Better Crops Reader, Potash Institute of North America, 1649 Tullie Circle, N. E. 30329.

HOW ABOUT COATING legume seed with lime? It may get legumes off to a good start under conditions not otherwise considered suitable for plant establishment.

Legume seeds may be coated with lime, high-phosphate clays, or even fertilizers containing micronutrients required only in small quantities.

This coating procedure, called pelleting, may help a farmer establish legumes rather quickly in acid soils.

Present general recommendations call for increasing the pH of acid soils to about 6.5 to get legumes, such as alfalfa, well established.

How About Coating Legume Seed With LIME?

SOUTHERN ILLINOIS UNIVERSITY
DONALD M. ELKINS

A legume of coming importance is crownvetch. It is used widely in some midwestern states, such as Illinois and Ohio, and in some eastern states especially Pennsylvania, for stabilizing road banks.

It requires about the same soil pH as alfalfa for rapid seedling establishment. Crownvetch has been used extensively by the author in studies at Southern Illinois University.

For many years, Australian researchers have pelleted seed with lime ($CaCO_3$) to help seedling establishment and nodulation in subterranean and crimson clovers on soils of low pH values.

They have found such legume species tolerant to soil acidity after the seedlings become well-established. Even alfalfa has been reported somewhat tolerant to acidity once it gets started.

Lime coating on the seed may neutralize excessive soil acidity in the immediate vicinity of the sprouting seed and developing legume seedling. It may also provide a favorable environment for bacteria activity that form nodules on roots of legume plants. This may insure nitrogen fixed directly from the air by the bacteria—nitrogen available to the host plant.

Such lime-coating might be used to make legume seedings on steep slopes, or for seeding large acreages of rough land, such as strip-mined spoils, areas impractical to lime in the usual manner.

Seeding rough land by air for pasture or ground cover to control erosion would be feasible by pelleting the seed with lime, inoculant, and perhaps a starter fertilizer.

The Department of Plant Industries at Southern Illinois University scarified seed of alfalfa, crownvetch, and subterranean clover to make the hard seed coat more permeable to water. We then pelleted it with powdered lime, using a 45 percent solution of gum arabic as a sticking agent.

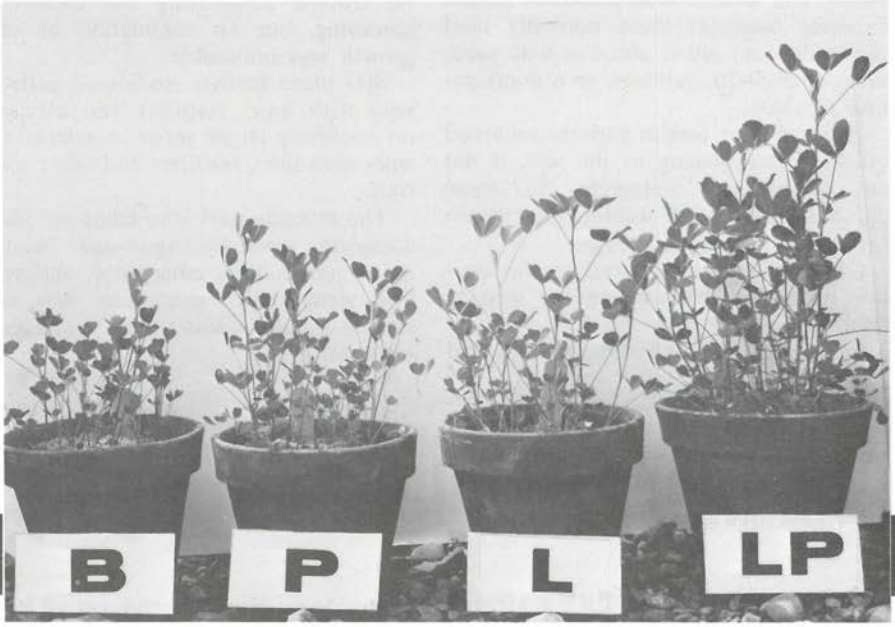
The dry peat-base inoculant was stirred into the gum arabic solution before coating the seed.

After treating the seed with the right amount of gum arabic, we added powdered lime to the seed, constantly stirring until all seed was coated with a thin layer of lime.

In other studies, high-phosphate clay obtained from phosphate-mined pits was used alone or in combination with lime for pelleting seed.

This pelleting operation was done by hand because of the small quantities of seed used. However, a cement mixer could be easily used to mix large batches of seed.

After pelleting, the seed was spread out to dry overnight before planting. Although this seed was planted within a few hours after pelleting, the pelleted seed could be stored quite well for



B—Non-pelleted seed on unlimed soil with pH 5.3

P—Pelleted seed on unlimed soil, pH 5.3

L—Non-pelleted seed on limed soil, pH 6.5

LP—pelleted seed on limed soil, pH 6.5

several weeks before planting, if desired.

In these studies, lime-pelleted seeds were planted in pots containing acid soil collected from a roadbank site, dried and screened before using.

The pH values of the soils collected ranged from 4.4 to 5.3. The same amount of soil and fertilizer and the same number of seeds were placed in each pot.

Four pots of each treatment were used in this series of experiments so the results obtained would be reliable.

Lime-pelleted and nonpelleted seed were planted in both limed and unlimed soil.

The number of seeds that sprouted and the vigor of the developing legume seedlings were measured carefully.

These studies indicated lime-pelleting of seeds is promising for some kinds of legumes seeded on acid soils.

None of the legumes grew well on soil with a pH level as low as 4.4 even when the seeds were lime-pelleted.

But on soil with an initial pH of 5.3, lime-pelleting stimulated seedling growth, either with or without added lime.

Crownvetch responded to pelleting better than alfalfa, but subterranean clover showed more response than either one.

Coating the seeds with a high-phosphate clay did not give any noticeable advantage.

Field studies are now being conducted on the SIU Experimental Farms to measure how lime pelleting influences establishment and growth of alfalfa, crownvetch, birdsfoot trefoil, and sericea lespedeza in an acid soil.

Completed pilot field studies with crownvetch and alfalfa indicate lime-pelleting shows promise under field conditions.

In other studies, seeds of corn, soybeans, and alfalfa were placed in gelatin capsules (such as those normally used for medicines) either alone or with sand, lime, or 5-20-20 fertilizer, or a combination of these.

Although the gelatin capsule collapsed quickly after placing in the soil, it did not completely disintegrate. So, these did not allow good seedling emergence for the smaller seeded crops.

Often water was trapped in the capsule with the seed, causing the seed to decay.

Large seeds of corn and soybeans had no trouble penetrating the capsule in sprouting, but no stimulation of early growth was noticeable.

SIU plans further studies on pelleting seed with lime, fertilizer and clay and on enclosing larger seeds in gelatin capsules with lime, fertilizer and other materials.

The ultimate goal is to come up with a complete seed package—one insuring more germination, emergence, and seedling vigor under conditions now considered unfavorable for establishing legumes.

THE END

Summer Trouble Shooting Tips

EVERY FIELD OF EVERY FARMER has problems. No field produces all it is capable of producing. This is why more and more farmers have come to believe in summer trouble shooting. This kit answers 22 questions frequently asked by top farmers.

1—Better parts of my corn field yield about 150 bushels . . . soybeans about 50 bushels. But the poorer parts barely half this. What can I do?
Get your dealer or other agricultural leader out in the field with you to see the problem. Take a spade to check for plowsole or sandy, hard subsoil. Check drainage. Is area drouthy? Compare soil and plant samples from poor and good areas. Plowsole, bad drainage, unsure fertility can usually be corrected.

2—I can't get my fertilizer dealer to look at my fields with me this summer. What would you do?
Change dealers!

3—I average about 135 bu. corn. Would like to get 160 bu. Can I?
You can always boost yield regardless of crop. Get your dealer or county agent to check your fields for problems this summer . . . and suggest what to correct, what to try. As you improve yields, you should gain more money—and more personal satisfaction.

4—If I plow 2 inches deeper this fall, do I need to apply more fertilizer and lime than for just 7 inches?
University of Kentucky experts say increase lime and fertilizer rates proportionately with depth of plowing. A soil test will help you decide how much.

5—Will Southern Corn Leaf Blight reduce my yields?

This depends on your seed and location. Let experts look. Your problems may not be all blight. In 1970, many farmers blamed blight for drouth, low fertility, pests, and other factors reducing yields.

6—Folks talk about the influence of fertilization on corn disease. Can fertilizer really reduce disease in my fields?

Fertilization won't prevent corn diseases. But balanced fertilization helps reduce plant stress so the crop can weather blights and other diseases better. On high-K soil in Illinois, extra potash increased yields 33 bu/A on corn badly infected with the 1970 Southern Corn Leaf Blight. Research has shown too little potash in relation to nitrogen gives lush growth which invites disease to enter the plant. Check your fields. Are some more diseased than others? It may be too little nutrients or an unbalanced supply.

7—I try to do everything right—fertilization, weed control, population, etc. But some fields beat others year after year. Why?

The only certain thing about soils and soil fertility is that they vary. Some fields have better production potential . . . deeper topsoil . . . better drainage . . . less drouthiness. Look under your corn crop. How deep can the roots grow?

8—If I see deficiencies, can I correct them this year?

That depends on crop . . . stage of growth . . . application method. Fight iron or manganese hunger in soybeans with foliar sprays on plants no more than 12 or 15 inches tall . . . nitrogen or potash hunger in corn with sidedress or application in irrigation system . . . potash hunger on alfalfa with application after it is cut . . . and potash hunger on soybeans with sidedress application.

9—When is the best time to topdress alfalfa?

After the *first* and *third* cuttings . . . with recommended rates of phosphorus, potash, sulphur, and boron. Topdressed nutrients and June rains help alfalfa recover rapidly and give top yields. Late summer topdressing takes advantage of fall rain . . . helps "winterize" the crop.

10—Will herbicides to control weeds eliminate the need for a mower in the pasture?

No, sir! Forage must be kept young and tender for best profits. Mowing helps get quality forage. Rotational grazing with high stocking rates per pasture insures better USE of forage. Use a mower to clip ungrazed spots or to make hay from ungrazed pastures in a rotational system. This is vital to pasture profits.

11—Can I ruin my pasture by close grazing?

Did you ever destroy your lawn by clipping at regular intervals of a week or

TURN TO PAGE 18

YOUR SOYBEAN PLANT produces about half its total dry matter in 80-90 days after planting.

Total plant weight is divided between vegetation (leaves, stems) and the seed and pods.

At lower yields (35 bushels*), 56% total weight was in vegetation, 44% in seed and pods.

* One bushel is 60 lbs.

At 50-bushel yields, total weight almost balanced between plant parts: 51% in seed and pods, 49% in vegetation.

At 80-bushel yields, 62% total weight was in seed and pods, only 38% in vegetation.

This increased seed and pod weight with rising yields was recorded by North Carolina Agricultural Experiment Station scientists E. J. Kamprath and J. B. Henderson.

They measured the dry matter produced and the plant foods absorbed during different stages of growth.

Over a 3-year period, they produced the following dry weights and yields per acre:

	1966 lbs	1967 lbs	1968 lbs
Plants	4,242	4,763	4,467
Pods, seeds	3,391	7,634	4,644
Total	7,633	12,397	9,111
Bu/acre	35	80	50

In 1968, the 50-bushel crop of soybeans took up a total of 257 lbs N, 48 lbs P_2O_5, 187 lbs K_2O, 49 lbs Ca, and 19 lbs Mg in the above ground portions.

Dry Matter and Nutrient Accumulation Rates—1967

	Lbs/A/Day—After Planting		
	40-60 days	60-100 days	100-110 days
Dry Matter	95	145	339
N	2.4	3.1	6.9
P_2O_5	.39	.62	.85
K_2O	2.9	1.6	4.9
Ca	.44	.85	2.1
Mg	.20	.29	.69

Know The Plant

DRY MATTER PRODUCED & P

	At 40 Days Lbs
Dry Matter	266
N	7.6
P_2O_5	1.1
K_2O	6.1
Ca	2.4
Mg	0.6

PERCENTAGE OF PLA

	%
N	2.9
P_2O_5	2.3
K_2O	3.3
Ca	4.9
Mg	3.1

Although greatest nutrient accumulation occurred during grain formation (the 100-110 day period), early season uptake is equally important.

The 40-80 day period in 1968 shows heavy uptake—**46% of the total N, 42% P_2O_5, 53% K_2O, 58% Ca, and 55% Mg.**

Uptake continues late in the life of the plant. In the 120-140 day period, the plant took up **24% of the N, 24% P_2O_5, 20% K_2O, 1% Ca, and 18% Mg.**

Food Your Soybeans TAKE UP

. . while they grow

ANT FOOD ABSORBED BY ACRE OF GROWING SOYBEANS (50 Bu/A YIELD)

80 Days Lbs	100 Days Lbs	120 Days Lbs	140 Days Total Lbs
4,763	5,472	8,223	9,111
125	134	196	257
21	24	36	48
105	112	150	187
31	38	49	49
11	10	16	19

UPTAKE: 560 lbs

IT FOOD REQUIREMENT TAKEN UP BY SOYBEANS

%	%	%	%
49	52	76	100
44	51	76	100
56	59	80	100
63	77	99	100
58	53	82	100

(Calculated from N. C. State University Data)

To insure high yields, your soil must be able to supply all the plant food a crop needs—when it needs it, where it needs it—during the WHOLE growing season.

Plant growth is a continuous process. Top profit yields demand FULL-season feeding—a sure diet all along the way.

High yields take up high levels of plant food. These soybean trials proved that point by taking up 430 lbs of nutrients from EACH ACRE the first year, 779 lbs the second year, and 560 lbs the third year. That's a lot of plant food:

	1966 35 bu.	1967 80 bu.	1968 50 bu.	Ave. 55 bu.
Uptake, lbs/A				
N	209	411	257	292
P_2O_5	32	78	48	53
K_2O	122	203	187	171
Ca	45	55	49	50
Mg	22	32	19	24

We must return those nutrients to the soil or take the consequences: low yields, poor quality, and little, if any, profit.

You can't go wrong taking out hidden hunger insurance. **THE END**

These tips can be ordered as kits of FERTILEGRAMS for distribution to farmers, advisers, and fertilizer outlets. The rate is 4¢ per kit. Order on next page.

FROM PAGE 15

less? Not hardly. Close grazing most species of permanent pasture grasses and clovers will not destroy them. Bermuda grasses, Dallas grass, and Bahia grasses do well with close grazing—2 to 4 inches—IF properly fertilized. Keep cool season grasses—fescue, rye grass, etc.—grazed short in winter.

12—What should I check my crops for in summer?

- *Nutrient hunger signs* . . . trouble spots. Mark the spot . . . tissue test there . . . take leaf samples and a soil sample from both problem AND healthy areas.
- *Leaf or stalk diseases* . . . in this southern leaf blight age.
- *Insects* . . . including root worms and corn borers . . . and *root nematodes.*
- *Stalks and stems* . . . cut to make sure tissue is healthy.

13—What can I do with my findings?

- *Buy and apply nutrients* to be ready for next year.
- *Spray fungicides* to fight controllable diseases on high value crops.
- *Seek varieties or hybrids* resistant to prevalent diseases for next season.
- *Spray insect pests* if at economic levels.
- *Line up good nematocide* for next year if nematodes are a problem.

14—Who can I talk to about problems?

Contact your area agronomists, pathologists, entomologists from extension, universities, industry. Also dealers with whom you deal regularly . . . also county extension directors who know your area and its problems.

15—Many of us double-crop in my area . . . following small grain with soybeans or harvesting a small grain silage crop followed by corn silage. How can we best fertilize this system?

Apply phosphorus and potassium before small grain seeding . . . ENOUGH for the second crop as well as the small grain. An EXTRA 50 lbs P_2O_5 and 100 lbs K_2O per acre will serve a second crop of soybeans . . . while corn silage demands more. Corn silage also needs nitrogen after the small grain is harvested. And a 1-3-1 started fertilizer helps get the second crop off to a fast start . . . shading the ground early to conserve moisture and fight weeds.

LOOKING FOR EDUCATIONAL AIDS? DISTRIBUTE FERTILEGRAMS

16—Last fall I put 500 lbs of 0-10-20-B on my alfalfa. Should I add some more this summer? The stand is still good.
Every ton of alfalfa you remove from your field takes 50 lbs of K_2O with it. Six tons or more may take even more. To maintain stand and high yield level, you must replace nutrients removed. That 500 lbs 0-10-20 is probably not half enough. You can apply more after any harvest.

17—How much fertilizer will a 10-ton Coastal Bermudagrass crop remove?
Such a big crop takes 570 lbs N, 150 lbs P_2O_5, 400 lbs K_2O, 50 lbs Mg and 80 lbs S from each acre.

18—Why do I usually end up with a low corn population?
Maybe your planter does not plant enough. Check it out this fall or winter. Maybe poor germination, insects, diseases, or cultivation damage is holding you back. Spring is a good time to check population when plants are small. But find out for sure what your population is this summer.

19—What can I do about the weed problem in my fields?
Make a weed map of your farm during the growing season . . . or just before harvest . . . showing kind and extent. Use this map next spring to fight the weeds in each field with the RIGHT herbicide and cultivation.

20—Corn lodging costs me $10 to $20 per acre most years. How can I fight it?
Know the causes of lodging: Too heavy plant population . . . late planting . . . corn rootworm . . . unbalanced fertility (too little potash) . . . late harvests . . . severe winds and rain.

21—I've been told not to graze pastures below 4 to 6 inches. What do you think?
If you fertilize well and rotate your grazing, you can graze below this height. Many waste feed by allowing it to grow too tall. Close grazing USES more of the forage. It also insures better quality feed as livestock eat more leaves and less stem.

22—Is it a good idea to avoid overstocking pastures? We always get summer drouth.
Why "plan on disaster?" Stocking the pasture with too few cattle costs you profits. The pasture gets too tall and wastes much feed. Water may run short . . . but inadequate plant food may limit your pasture more than low moisture.

Potassium Deficiency And Potassium-Sodium Relationships In Irrigated Alfalfa

Condensed From Pacific Northwest Fertilizer Conference Proceedings . . . From Original Report By A. I. Dow And D. W. James

ALFALFA FERTILITY TRIALS were conducted at 13 locations in Okanogan, Kittitas, and Walla Walla Counties in central Washington in 1968-69—each trial a randomized complete block experiment containing K as one variable.

Most of the results reported here are from two trials in Kittitas County, established in 1968 on Selah silt loam. Selah soils are developed in wind deposited material, shallow to caliche. The soil at the Busch location is calcareous at the surface with pH 7.8. The soil at the Katen location is non-calcareous at the surface with pH 7.2. Soils at both locations are less than two feet deep overlying lime-silica cemented hardpan (caliche).

Soil test index for K at Busch was 66 ppm, at Katen 100 ppm. In central Washington, K fertilization is recommended for alfalfa where soil test K is below 120 ppm. At each location, the soil has an exchange capacity of about 25 me/100g with 1.0 to 1.5 percent of the exchange capacity consisting of K and about the same amount of Na.

Fertilizer treatments were applied yearly in March. All plots containing K variables received adequate rates of other nutrients suspected of being needed. Plots were harvested with a 42-inch plot mower, usually about 1/10 bloom stage. Yields were calculated on the basis of 10% moisture. Tissue samples included upper ¾ of 30 stems (with leaves) per plot. Tissue samples received standard kits.

TABLES 1, 2, 3, 4 SHOW HOW LACK OF K application reduced yield and percent K in tissue and how deficiency symptoms showed up at both Kittitas locations—but more at the Busch location where soil K tested lower. At the less deficient Katen location, K hunger did not show until the second season in 1969.

Note how K levels in tissue were less than 2%, even where 400 lbs K/A were applied, except in first cutting samples from the Katen location. In general, K

Table 1. Relation between K Treatment and Yield of Alfalfa at the Busch Location (soil test K= 66 ppm).

K Treatment, lb/A			Yield of Alfalfa, T/A (10% moisture)				
No.	1968	1969	1968 Cutting		1969 Cutting		
			1	2	1	2	3
1	0	0	2.89	2.29°	3.63	2.37°	1.00°
3	200	0	—	—	3.60	2.94	1.33
6	200	400	3.05	2.63	4.02	2.93	1.42

° Indicates significant (.10) reduction from yield of treatment #6.

In These Washington Alfalfa Trials . . .

- Potash hunger signs generally appeared where tissue K was below 1.5% and yields dropped significantly where tissue K fell below 1.0%.
- Soil test levels reflected the K applied one and two years before sampling time—BUT soil test K increased surprisingly little from K application. Why? Because of crop removal and "reversion" of added K and/or exchangeable K to non-exchangeable sites in soil minerals.
- A 10 ton/A alfalfa yield, cut 4 or 5 times per season in bud stage and with 4% K in the tissue, could potentially remove well over 700 lbs K/A per year.
- The yield in K deficient plots showed a downward trend, with later cuttings consistently showing more K deficiency than the first cutting.
- Tissue tests showed K deficient plants containing much less K and much more Na, Ca, and Mg than normal plants.
- Two types of K hunger signs showed up: (1) Traditional specklings near leaf margins. (2) Marginal scorch at tips and edges of leaflets. With Na concentration higher in scorch than in speckling plants, is scorch caused by excessive Na concentrations that accumulate in leaflets when K is short?

deficiency symptoms showed up at tissue K levels below 1.5% and yields dropped significantly at tissue K levels below 1.0%.

Table 2. Relation between K Treatment and K in Alfalfa Tissue at the Busch Location (soil test K = 66 ppm).

K Treatments, lb/A			% K in Tissue and K Deficiency Symptoms									
No.	1968	1969	1968 Cutting				1969 Cutting					
			1		2		1		2		3	
			%K	Symptoms	%K	Symptoms	%K	Symptoms	%K	Symptoms	%K	Symptoms
1	0	0	1.14	Slight	.90	Severe	1.59	Slight	.88	Severe	.73	Severe
3	200	0	—	—	—	—	1.96	None	1.10	Slight	.94	Slight
6	200	400	1.70	None	1.26	None	1.87	None	1.87	None	1.62	None

Table 3. Relation between K Treatment and Yield of Alfalfa at the Katen Location (soil test K = 100 ppm)

K Treatment, lb/A			Yield of Alfalfa, T/A			
No.	1968	1969	1968 Cutting		1969 Cutting	
			1	2	1	2
1	0	0	4.25	2.44	3.97	2.18°
3	200	0	—	—	4.18	2.59
6	200	400	4.53	2.43	4.28	2.57

° Indicates significant (.10) yield reduction.

Table 4. Relation between K Treatment and K in Alfalfa Tissue at the Katen Location (soil test K = 100 ppm).

K Treatments, lb/A			% K in Tissue and K Deficiency Symptoms							
No.	1968	1969	1968 Cutting				1969 Cutting			
			1		2		1		2	
			%K	Symptoms	%K	Symptoms	%K	Symptoms	%K	Symptoms
1	0	0	1.85	None	1.43	Slight	1.34	Slight	0.98	Slight
3	200	0	—	—	—	—	1.58	None	1.14	Slight
6	200	400	2.17	None	1.83	None	2.59	None	1.71	None

Table 5. Soil Test K Levels Resulting from 1968–1969 K Treatments at Two Locations in the Kittitas Valley.

K Treatments, lb/A			1970 (April) Soil Test K, ppm	
No.	1968	1969	Busch	Katen
1	0	0	65	94
3	200	0	79	106
6	200	400	135	156
Av. 1968 soil test (before treatment)........			66	100

TABLE 5 SHOWS HOW K TREATMENTS during the two previous years apparently affected the soil test K level. Note how soil test K did not increase a great deal, even where 400 lbs K had been applied just a year before.

TABLE 6 COMPARES THE K REMOVED by the Busch crop to the K removed by two other crops. The very K deficient Busch plots (66 ppm) removed a surprising amount of K—154 lbs/A—though plots receiving K removed much more, of course. The McCaw trial, with high soil test K, showed the potential for K removal. Where K had been applied in this trial, the percent K in oven dry tissue was 3.99, coming partly from early cut (bud stage) at this location. The first cutting—only one harvested—removed 327 lbs K/A.

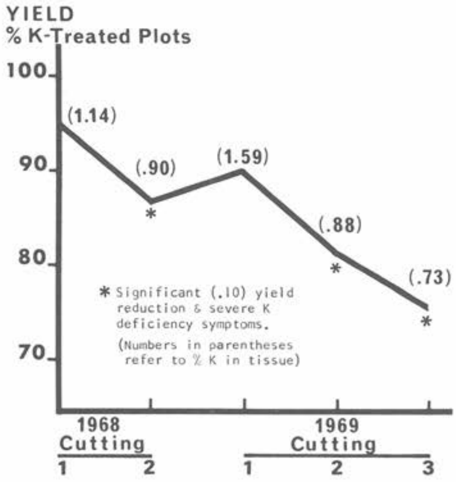
Table 6. K Removal in Alfalfa from Three Locations in 1969.

	Busch [1], 3 Cuttings		Dunckel [2], 3 Cuttings		McCaw [3], 1 Cutting	
	T/A	K removed	T/A	K removed	T/A	K removed
K applied	8.37	**275**	8.93	**422**	4.55	**327**
No. K	7.00	**155**	8.97	**378**	4.40	**296**

[1] Kittitas County; original soil test K = 66 ppm.
[2] Okanogan County; original soil test K = 215 ppm.
[3] Walla Walla County; original soil test K = 295 ppm.

TABLES 7 and 8 SHOW RELATION BETWEEN CATION concentration in alfalfa tissue from second cutting in 1969 and K treatments. The K deficient tissue, with greatly reduced K concentration, shows a marked increase in Ca, Mg, and Na concentration. When expressed in millequivalents, the Na to K ratio is about six times greater in K deficient than in K sufficient tissue. The K to

FIGURE 1 SHOWS YIELD TREND FROM K-DEFICIENT PLOTS relative to K sufficient plots for the two seasons at the Busch location. Although the general trend is definitely downward, the first cutting yield each year declined only slightly—and non-significantly at .10—and the alfalfa showed little or no visible deficiency. Note how the first cutting in 1969 seemed to "revive" somewhat, then continued its downward trend, below the second cutting in 1968. Severe stunting and K deficiency symptoms were evident in the K deficient plots on April 1, 1970—not observed in either spring, 1968-69.



Ca + Mg + Na ratio is about three times greater in K sufficient than in K deficient tissue, **Table** 8 shows.

Normally, K deficiency symptoms in alfalfa appear as a speckling starting at the leaf margin and developing toward the midrib as symptoms become more severe. These were observed in the plots—but another distinctly different symptom was observed on many plants. These symptoms consisted of necrotic areas along the leaf margins starting at the tip and proceeding along the edges back toward the leaflet base. Older leaves were more affected than young leaves.

Table 7. Relation between Cation Concentration (percent) in Alfalfa Tissue and K Treatments (1969 second cutting).

	K %	Na %	Ca %	Mg %
K added	1.87	.066	1.83	.22
No K added	.88	.200	2.38	.35

Table 8. Relation between Cation Concentration (me/g) in Alfalfa Tissue and K Treatments (1969 second cutting).

	K me/g	Na me/g	Ca me/g	Mg me/g	Sum me/g	Na/K	K / Ca + Mg + Na
K	.48	.028	.92	.18	1.61	.06	.50
No K	.23	.087	1.19	.29	1.80	.38	.16

TABLES 9 AND 10 SHOW TEST RESULTS OF SAMPLES taken from plants that were (1) normal, (2) K deficient with speckling symptoms, (3) K deficient with scorch symptoms. Note how much K goes down and the Na, Ca, and Mg concentration goes up in K deficient plants.

Table 9. Cation Concentration (percent) in Selected Normal and K Deficient Alfalfa Tissue.

Symptoms	K %	Na %	Ca %	Mg %
Normal	2.51	.10	1.83	.28
Speckling	.60	.35	2.64	.52
Scorch	.65	.62	2.24	.51

Table 10. Cation Concentration (me/g) in Selected Normal and K Deficient Alfalfa Tissue.

Symptoms	K me/g	Na me/g	Ca me/g	Mg me/g	Sum me/g	Na/K	K / Ca + Mg + Na
Normal	.64	.04	.91	.23	1.82	.06	.540
Speckling	.15	.15	1.32	.44	2.02	1.00	.078
Scorch	.17	.27	1.12	.42	1.98	1.59	.094

When expressed in milliequivalents, the Na to K ratio greatly increases in K deficient tissue—especially in tissue with scorch symptoms, shown in **Table 10.** The Na to K ratio is 16 times greater in speckling plants, 26 times greater in scorch plants than in normal plants. The K to Ca+Mg+Na ratio is much higher in normal than in deficient plants, with rather small difference between deficient plants of the two types of symptoms.

THE END

So you want to develop

S. N. POSTLETHWAIT

THE AUDIO-TUTORIAL APPROACH forces the instructor to evaluate his procedures and to reconsider his objectives in the development of a minicourse.

Many teachers depend on their earlier experience in teaching a subject to do and say the right things at the right time.

Many resist change, clinging to ideas that have outlived their usefulness and handicapping progress.

The following steps may help teachers develop a minicourse:

STEP 1. List as precisely as possible each achievement which you expect the student to accomplish.

Specify appropriate conditions and minimum acceptable performance. The list should include skills, concepts, vocabulary building, problem solving, creative activities, etc.

Write test questions concurrently with the writing of objectives.

STEP 2. Specify the students' entry behavior. Only by knowing where the student is, can you design a minicourse to carry him from his present performance level to mastery of the course.

STEP 3. List individually on cards all activities that might help accomplish the goals of the course.

These activities might include available media and teaching aids:

- **Paragraphs to be read from the text and periodicals.**
- **Exercises to be completed from a manual.**
- **Specimens to be observed or examined.**
- **Experiments to be completed.**
- **Study problems to be worked.**
- **Films to be viewed.**
- **Points to be emphasized on tape.**

Next edit the list of instructional activities and decide the method through which the goals can best be mastered.

STEP 4. Arrange the study activities in their proper sequence.

Consider carefully those items that can be used as a foundation for later ones and align each item in a properly programmed sequence.

Sometimes this can be done best on the planning board. With each activity on a separate card, the planning board enables one to visualize the entire study unit. The cards can be easily shifted about on the board to get the best sequence.

You have been working very closely with the material. What seems obvious to you may not be clear to someone else.

Ask your resource people to evaluate (1) subject-matter accuracy, (2) sequencing and teaching techniques, (3) quality and clarity of the programing instructions.

Perhaps others can suggest more creative and interesting approaches to parts of the minicourse.

STEP 7. Transcribe the preliminary audio tape and edit it critically.

This step should help you use precise words and avoid much redundancy that occurs in ordinary conversation.

a minicourse AN AUDIO-TUTORIAL ONE!

PURDUE UNIVERSITY

STEP 5. Assemble the instructional materials: Experimental equipment, text, study guide, visuals, films, etc.

Use these materials and your planning cards to make a trial tape—or make your first tape by "tutoring" a student helper through the program's activities.

If the student helper is an average student, his questions should help you determine what needs to be elaborated and revised or eliminated.

This approach also gives the tape a tutorial flavor, causing later students to feel like the instructor is talking directly to them.

STEP 6. Have the minicourse evaluated by another developer, colleague, or subject matter specialist.

STEP 8. Make the final tape—best from a manuscript which has been edited and typed in capital letters.

Emphasis marking, timing notations, and other taping suggestions may be entered at the discretion of the instructor.

STEP 9. Try the minicourse on students. Revise it until it does the job.

Much valuable feedback can be obtained by letting students go through the material and offer suggestions for improvement.

The most important criterion is **"Did the student master the objectives to an acceptable performance level?"**

The minicourse should be tried out and revised until it meets the above need. **THE END**

Can Fertilizers BALANCE OUT Disease?

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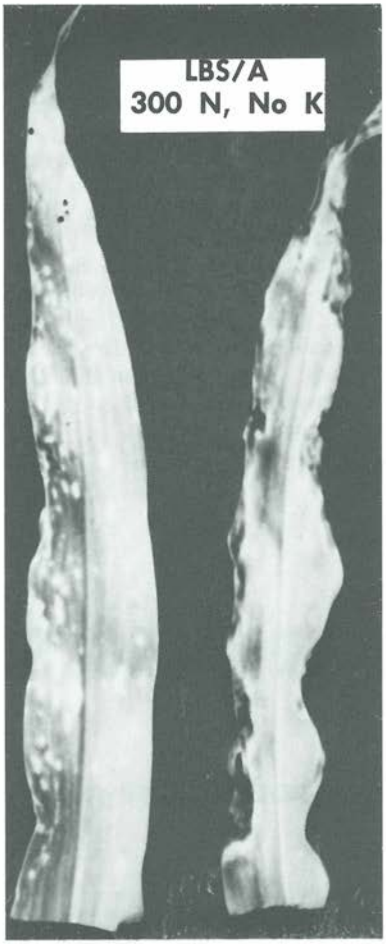


PLANT DISEASE DEMANDS just the right combination of virulent pathogen, susceptible host, and suitable environment—if it is to develop.

This is the first principle of plant pathology. Occasionally, a vector (carrying agent) is also needed to transmit the pathogen or casual agent.

Farmers and other commercial growers should consider how fertilizers influence the growing plant's relation to plant disease.

No farmer would use only fertilizers to control plant disease. But knowing the effect of fertilizers on host-pathogen interactions is important to the total crop production program.

New interest may develop in this area of plant pathology because science now knows more about when to apply fertilizers, how plants absorb and use them, and factors that control efficient, economical use.

Diseases can now be produced in large biotron chambers and carefully controlled Fertility conditions can be manipulated and studied as desired. This opens the way to new understanding of plant disease, its nature and hopefully its prevention.

LIVING ORGANISMS are generally divided into two classes, according to the way their nutrient needs are met:

1—Autotrophs — organisms that are self-feeding by photosynthesis (plants) or chemosynthesis (some bacteria).

2—Heterotrophs—organisms that depend on other sources for their food (animals and most plant pathogens).

Heterotrophic plant pathogens may be saprophytic and live off dead or decaying organic matter. Or they may be parasitic and receive their food from another living organism.

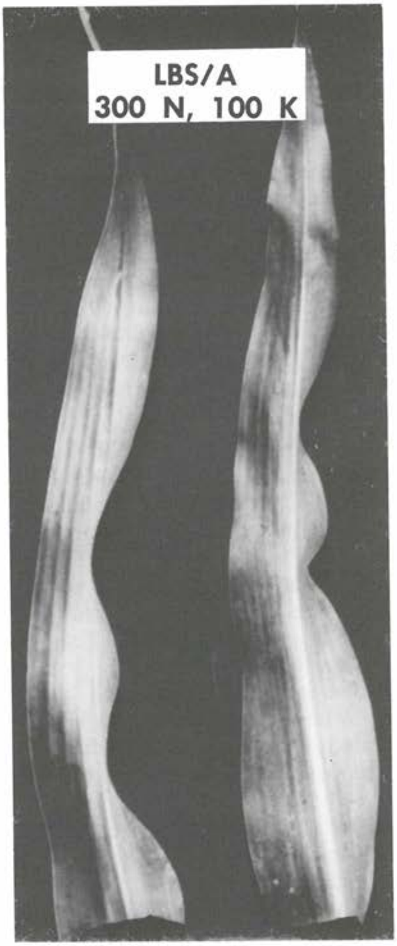


FIGURE 1—With only nitrogen, much corn leaf spot invaded this L. F. Welch field trial. The 100 lb K/A helped reduce infestation on a soil already testing 280 lb K/A from air-dry samples taken March 30. An IMBALANCE of nutrients, rather than absolute amounts of each nutrient, usually favors disease development.

Some organisms are soprophytic in some growth stages and parasitic in other stages.

Pathogenic organisms—those that cause disease—have very specific nutrient needs. Attempts to grow them in pure culture on synthetic media showed this. Reproductive bodies (spores) of certain fungi will not begin to grow (germinate) unless specific chemicals are provided by a particular plant exudate.

Other fungi will germinate in dilute sugar and amino acid solutions and can obtain their nutrients from a wide range of host plants.

Most crop plant pathogens grow actively during relatively short periods—stimulated by the presence of actively growing host tissue or seasonal changes in environmental conditions. Otherwise, they infect alternate hosts or exist in a dormant state in the soil or in crop debris between seasons.

Growth of infection hyphae from fungal spores or the initial division of bacteria occurs at the expense of stored reserves in these parasites. But the infection process soon puts demands on the host.

Most faculative parasites require only simple sugars and inorganic ions. Obligate parasites seem to require amino acids and vitamins as well, and the relationship is much more specialized.

It has been possible to produce mutant plant pathogens that cannot make certain metabolites on their own. These mutants will not cause disease unless the host plant supplies the required organic nutrient.

During the disease cycle, the parasite diverts nutrient substrates from the host to its own use. When senescence or death prevents the host from supplying these substrates, the saprophytic stage may predominate or the pathogen is transformed into a reproductive entity with spore production. More commonly, other dormant structures such as chlamydospores, sclerotia, pycnidia, or perithecia may form.

HOW DOES PLANT NUTRITION affect disease development? Many cases are familiar. Corn ear rots sometimes hit very fertile fields the worst.

Stewart's wilt of corn is aggravated by nitrate nitrogen. Stalk rots increase when plant potassium is low in relation to nitrogen and phosphorus.

Potassium is thought to help develop larger, more evenly distributed xylem vessels and so increase tolerance to vascular wilt diseases. **Figure 1** shows how 100 lb K/A helped reduce leaf spot infestation on corn.

Calcium may increase resistance to certain wilt fungi by stabilizing pectic wall substances, making them more resistant to enzymes that decompose cell walls.

Such examples suggest an important principle:

An IMBALANCE of nutrients, rather than the absolute amounts of each nutrient, usually favors disease development. Nutrient BALANCE is the key to fertility effect on host-pathogen interactions.

When a nutrient affects plant disease development, it does not act as a direct agent of control. It **augments** the natural resistance mechanisms of the plant.

In general, abundant nitrogen favors infection. Potassium increases resistance. Phosphorus varies in its effects on plant diseases caused by viruses, bacteria, or fungi.

NUTRIENTS HAVE COMPETITION in the soil. The soil environment is composed of and affected by many factors.

The physical factors include moisture, aeration, temperature, and mechanical properties.

The chemical factors include mineral composition, organic and inorganic elements, and soil acidity.

The predominance of any parasite or saprophyte and the condition of any plant growing in soil depend on the interaction of these factors—plus above-ground seasonal changes.

Soil microorganisms may survive in an active or inactive state, depending on soil conditions and, in some cases, availability of alternate hosts. Competition among soil organisms is a dynamic phenomenon. But it appears root infecting fungi are limited more by interference from saprophytic soil microorganisms than by physical conditions of the soil environment.

Microbial competition with plants for soil nutrients can be very serious in soils containing only low amounts of an element. On the other hand, certain mycorrhizal fungi enhance uptake of phosphate ions while other fungi and bacteria convert iron and sulfur to usable forms.

WHAT ABOUT DISEASE CONTROL? If nutrient needs of the host differ sharply from the pathogen, environmental conditions may favor either host or pathogen, but not both.

If host and pathogen have similar nutrient needs, you can expect limited cropping of the host unless additional control measures are available.

Efficient disease control uses one or more of the following principles: Avoidance, exclusion or quarantine, eradication, protection, resistance, and chemotherapy.

Avoidance can mean modifying the environment—giving the crop the best growing conditions you can by fertilizing adequately or according to need. Although plant vigor is not absolutely correlated with the absence of disease, timely fertilization at recommended rates will lead toward optimum yields.

More study of fertilizer impact on plant disease is needed. Many complex host-pathogen-environment interactions are waiting to be evaluated and understood. Such research holds much promise—for farmer and industry. **THE END**

J. A. Schilinger
University of Maryland

DESIGNING NEW SOYBEAN VARIETIES MORE RESPONSIVE TO K

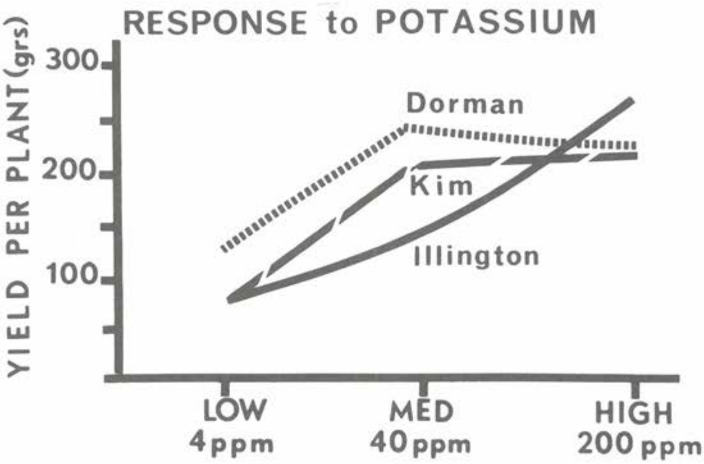


FIGURE 1—YIELD PER PLANT of three soybean genotypes under 3 levels of potassium in a nutrient culture study conducted under greenhouse conditions. (Gauch and Massey)

MOST RESEARCH REPORTS indicate no response to applied fertilizer by soybeans being grown on soils testing high P and K.

One of the major factors for this lack of fertility response may lie in the soybean itself.

Many factors within the soybean plant influence uptake, translocation, and utilization of P and K.

The processes of P and K utilization are controlled by genes and their interaction with the environment.

Our goal is to construct genetically soybean varieties that will be more efficient users of P and K and as a result produce greater yields than presently grown varieties under high fertility.

To reach this goal, we have evaluated nearly 1000 different soybean strains for their ability to produce extra yield when fertilizer is applied. Most of these strains are exotic forms of soybeans, originating from China, Manchuria, Japan, and Korea.

These strains were grown under the following four fertility systems.

NF—No fertilizer added 1967-1970. (Soil tests were low for K_20 in 1969 and 1970, but medium for P_20_5.)

HK—600 pounds K_20 added in 1967 and 1968 and 400 pounds K_20 added in 1969. (Soil tests were very high for K_20.)

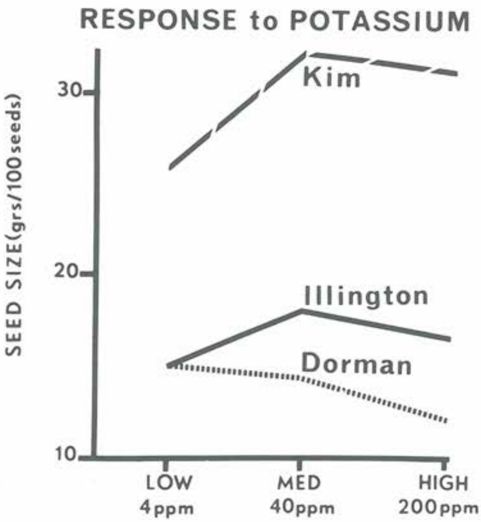
HP—400 pounds P_20_5 added in 1967, 1968, and 1969. (Soil tests were high in 1968, 1969, and 1970.)

PK—Same treatments as applied to K and P fertility systems above. (Soil tests were very high for K_20 and high for P_20_5.)

After three years of comparing yields of the 1000 strains under these four systems, 18 strains were selected that consistently gave significant response to K.

However, no consistent responders to P were found.

Table 1 shows the magnitude of yield response to K among 8 soybean strains. Note the lack of relative yield response



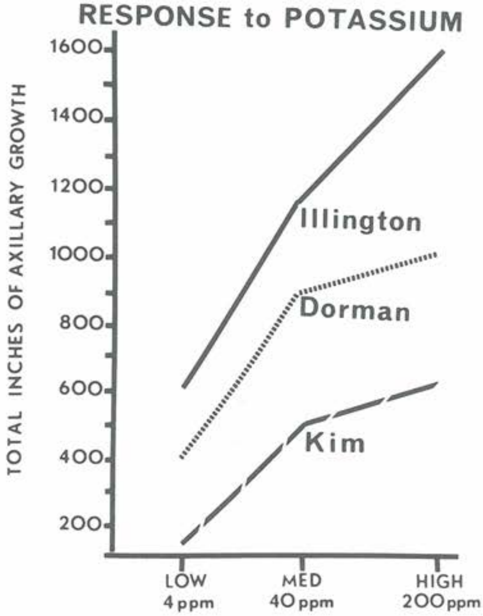


FIGURE 2—CHANGES IN SEED SIZE of three soybean genotypes under 3 levels of potassium in a nutrient culture study under greenhouse conditions. (Gauch and Massey)

FIGURE 3—AXILLARY GROWTH. Total length of axillary growth of three soybean genotypes under 3 levels of potassium in a nutrient culture study under greenhouse conditions. (Gauch and Massey)

in Lincoln and two progenies of Lincoln crosses, Cutler and Wayne. Apparently, the characteristic of poor response to K has been transmitted from Lincoln to Cutler and Wayne.

In contrast, however, are strains like Kim which gave a consistent yield response under K fertilization during three years of testing.

In another test conducted with nutrient solution in the greenhouse, 3 strains—Dorman, Kim and Illington—produced similar yields at the high K level **(Figure 1)** whereas at the low K level, Dorman, another relatively poor K responder, was the highest yielding strain.

Both Kim and Illington are not suited

Table 1. Relative Yield Response to K Among Soybean Strains Grown at the Wye Institute.

Variety	NF[1]	HK 1968	HK 1969	HK 1970	Average Relative Response to K
Kim	**100**	**170**	**156**	**209**	**178**
Hokkaido	100	183	137	121	147
31702	100	162	110	145	139
Boone	100	134	145	118	132
Illington	100	136	130	112	126
Cutler	100	—	102	103	102
Lincoln	100	98	108	93	100
Wayne	100	—	89	95	92

[1] NF—relative value of 100 used each year.

Table 2. Changes in Seed Size (grams/100 seed) Among 6 Soybean Genotypes When Grown Under High Concentration of K_2O at the Wye Institute.

Variety	Grams per 100 seed					
	1969			1970		
	NF	HK	% Change	NF	HK	% Change
Kim	**28.8**	**32.0**	**(11)**	**20.1**	**23.9**	**(19)**
PI 31702	**15.8**	**18.6**	**(11)**	**13.7**	**15.7**	**(15)**
Lincoln	16.7	17.1	(2)	13.4	13.0	(−3)
Wayne	18.3	17.4	(−5)	14.5	15.3	(6)
Dorman	12.9	12.7	(−2)	15.8	15.2	(−4)
Illington	19.0	19.4	(2)	15.7	14.3	(−9)

for today's high production standards for soybean varieties. Thus, they and most of the responding strains, are under a definite disadvantage in these tests, in that they have not been highly selected.

The mechanism for response to K varied among the strains. Kim and PI 31702, for instance, produced larger seeds when grown under high K. **(Table 2)** When evaluated under a controlled environment and exposed to three levels of K, Kim again produced larger seeds at the medium and high levels of K than at the low level **(Figure 2).**

This was significant considering the fact that Kim was also producing more pods and seeds at the same time it was increasing seed size.

The Dorman variety produced more seeds at the medium level of K, but produced smaller seed size **(Figure 2).**

Illington responded to K by producing more axillary branches and thus more pods per plant **(Figure 3).**

We are confident that the characteristic of responsiveness to K can be transferred to highly acceptable soybean varieties that will give soybean growers economic returns for dollars invested in fertilizer. **THE END**

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"JUST" a farmer . . . "JUST" a teacher

GEORGE SHUMAN was not a man of political or financial or educational prestige. He was "just" an Illinois farmer.

No eternal flame or marble shrine marks his grave in Woodford County. But today's generation owes George Shuman and his wife, Lucretia, a debt.

This Midwest couple embodies that handful of stalwarts who first trusted the early advice of America's agricultural colleges—sturdy folks strong enough to shed an open tear of pride as their first son received his college diploma 50 years ago.

For every Shuman there were 100 scoffers who would not listen to science in the early days—so stubborn many farm journals would not put a scientist's college connection under his byline.

Not George Shuman. He often lifted his son to his knee to read him pamphlets from Dean Davenport and Dr. Cyril Hopkins at the agricultural college. In 1907, he took his young boy to town to hear Dr. Hopkins.

There the great scientist used potted plants to show corn's greedy appetite for NPK—a dramatic stunt for 1907. A half century later George Shuman's son used the same tool to show villagers in India how much their crops craved NPK, especially on soils weary from 3,000 years of production.

That son, Frank, has now written a book he calls DRUM BEATS OF CHANGE. On the copy he sent us, this one-time vo-ag teacher, county agent, and USA soils missionary scribbled in one sentence the past and future of mankind:

"The final crop of any soil is PEOPLE and the SPIRIT of the people."

Frank Shuman's book is different—130 living anecdotes of human nature at work in America's breadbasket and among South Asia's teeming millions. But it is more than Illinois and India and Afghanistan. It is the story of mankind, in a sense.

The story of a boy whose father worked all night with an untamed filly to SHOW his son what patience and self-discipline can do . . . who fed two fine shotes different diets for 100 days to SHOW him what deficiency and balance mean . . . who used his new 1908 pocket knife to SHOW his son nodules on roots of a new wonder crop called alfalfa . . . who helped his son hand-hoe corn from Monday dawn to Saturday dark to SHOW him a tide of weeds brought in by a 3-week rain could not conquer the Shumans.

It is the story of a father who used his end of a 5-foot saw at post-cutting time to plant values in his young boy's mind: "Look on your neighbor to find his soul and not on his garment to detect a hole."

Simple, very square for today, but a principle that made George Shuman's son a successful and, more important, a happy man at work for people.

DRUM BEATS OF CHANGE tells what a young vo-ag teacher did when he found triangular hog rings clamped to the eyelids of chicken-eating sows at the home of a poor student with a stubborn father. What he did when an angry dairyman turned his shot gun on the county veterinarian come to test cattle for tuberculosis.

Frank Shuman pulls no punches—about the hurried dairyman rinsing his milk buckets in the green scum and filth of the horse tank so he could get to the Sanitary Milk Producers meeting in time.

Shuman helps the mature remember and the young understand what it felt like to wake up in 1932 and find corn bringing 10¢ a bushel and hogs 3¢ a pound, while town bankers waited for the mortgage.

He tells it in human terms, not in cold statistics—of family farms put under the auction hammer, of cunning speculators buying them up and getting shouted out of farmers' meetings when griping about "government in business."

The cunning did not like a man named Franklin Roosevelt. Mr. Shuman does not mention this president, but history does.

And Shuman explains why the Production Credit Association was created under FDR—in a day when the only farmers who could get credit were those who could prove they didn't need credit. Why Rural Electrification (REA) was created under FDR—in a day when "Electric Utilities refused to service farmers until they were threatened with a competitor whose arms were held up by the Federal Government."

Frank Shuman tells it like it was—how scores of farmers, long told they had enough "natural" potash for 2,000 years, were jarred when a potash demonstration more than doubled the corn yield on a leading farm.

Neighboring counties started hollering for potash trials, until a state-wide chant made K no longer a step child of the Illinois fertility system.

DRUM BEATS OF CHANGE is the story of a county agent whose mind was always open to change: To the Hopkins idea that we must put back all, not some, not most, but ALL the fertility our crop takes off . . . to the Bray idea that organic matter could be maintained with continuous corn, of all things, by plowing under stalks and residue and feeding (fertilizing) the bacteria that rot the stalks.

A popular practice today—but not the night Dr. Bray advised it in Frank Shuman's county nor the morning the newspaper editor called Shuman for "a statement."

It is the story of a man who did not fear . . . the story of one of God Almighty's natural-born teachers whose Maker apparently never freed him to pursue positions and wealth and power and the other phantoms between the two childhoods of man.

Instead this unfreed man found himself standing on India's Gangetic plain one afternoon in 1953 with two suitcases and three decades of enthusiasm from helping people help themselves.

And for another decade he gave southern Asians the best he had, in mind and heart, teaching them (and sometimes himself) much about soils and fertilizer and flies and roosters and love.

It is the story of a great teacher convincing peasants and professors alike that seeing is the best believing . . . that rigid standards should never stifle imagination . . . that the lowliest man can have a good idea and work his heart out for it when recognized . . . that no project should exclude women and children because the home is fundamental . . . that local leaders are the best promoters . . . that good teaching knows no classes or races and a good Extension man gets his hands dirty proudly so . . . that one thing well done is worth a dozen half done . . . that self-reliance beats government dole every time . . . that no villager is ever inferior and no university leader ever superior in the end.

It is the story of a man willing to befriend the people he helps—to celebrate their holidays, to play games with their children, to dance around student fires, to take their dousings in colored water, and to "baptize" them with his own water and fun.

A man breaking into song beside a miraculous fertilizer plot, soon joined by a young specialist harmonizing the people's national anthem in their own language as peasants stand deathly still to listen.

A man called a fool by a village mother-in-law returning later to say, "I have changed my mind . . . I did not understand . . . the field is beautiful!" And it was.

A man using less than $3,200 for his fertilizer and seed in one land where survey-happy committees had dumped $38 million into a valley that became a graveyard for huge tractors, plows, combines, and other machines—because the people were not FIRST taught efficient water use and fertilizer application.

A man declining a VIP dinner at the governor's mansion to get in a last visit with remote students using NPK pots and skits to act out the value of demonstration.

There is a mighty wholesomeness about this book.

This is what good men are, what they do and how they live and share and leave the earth richer than they found it.

This is what unselfishness means, a willingness to carry their know-how into foreign valleys flooded with millions of people speaking hundreds of dialects . . . to reach remote villages by worn-out jeep and bike and sometimes by foot . . . to teach with a bag of fertilizer and a bucket of seed . . . to pat a peasant shoulder for trying to show others it will work . . . and never to lose heart or hope.

This is human nature's finest hour. This is what man must not lose, if he is to survive.

I don't know how many George and Lucretia Shumans are being born on the earth this morning to raise future sons to become "just" simple teachers of men.

But I hope to God enough to keep saving man from himself.

This book can be purchased for $5.50 (includes mailing and tax). Write: Drum Beats Of Change, 1601 Ridge Road, Champaign, Illinois 61820.

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• • • your soybean plant produces about half its total dry matter in 80-90 days after planting?

• • • as yields increase, more of the total weight percentage shifts from vegetation to seed and pods.

• • • a 50-bushel soybean crop can contain 560 lbs plant food (N, P_2O_5, K_2O, Ca, Mg) in above-ground portions.

• • • though greatest nutrient accumulation occurs during grain formation, early season uptake can be heavy.

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