BETTER CROPS with plant food

SPRING 1979 25 CENTS

The Potash and Phosphate Institute staff recently toured high-yield research projects and farms in the mid-West.

Editors: Bill Agerton & Santford Martin
Assistant Editor: Selma Bushman

Vol. LXIII **Spring 1979**

BETTER CROPS (USPS 396850) is published quarterly by the Potash and Phosphate Institute. Subscription price is \$1.00 per year or 25c per copy. Controlled Circulation Postage Paid at Atlanta, GA. **Postmaster:** Send address changes to Potash & Phosphate Institute, 2801 Buford Hwy., N.E., Suite 401, Atlanta, GA 30329.

Contents

Cover picture by Bill Agerton

Plant Food Utilization for MAXIMUM ECONOMIC YIELD

YOU HEAR MORE TODAY ABOUT "MAXIMUM ECONOMIC YIELDS" for almost every crop. But how much plant food do crops need to produce these high yields? The Potash and Phosphate Institute has compiled data for various yield levels from research and laboratory analyses at numerous locations.

It is difficult to answer that question, but there are several factors that will affect the amount of plant food utilized by specific crops. These factors include: (1) variety or hybrid, (2) moisture availability, (3) temperature, (4) soil type, (5) nutrient levels and their balance in the soil, (6) final plant population, (7) tillage practices, (8) weed, insect and disease control, (9) previous cropping and (10) other factors of varying significance.

THOSE GROWTH FACTORS THAT AFFECT YIELD become the most important to management. For example, variety or hybrid selection can bring about a small variation in nutrient content which would be far less important than heavy crop losses due to uncontrolled insect or disease problems. Thus, management must integrate all growth factors into a system of favorable interactions to obtain a desired production level.

As research and farmer yields increase, plant food utilization (PFU) guidelines must be periodically revised to remain useful. This is the fourth revision since 1940 by the PPI staff.

These data are not generally from any one experiment but are collected from several sources where yield levels were close to yield levels selected for PFU data. Though not an absolute value, these data are highly reliable for indicating the amount of plant food taken up by each crop at given yield levels. You can also calculate from these data a reasonable uptake figure for lower or higher yields.

HIGH YIELDS REQUIRE ADEQUATE FERTILITY PLUS. Soil fertility is just one part of soil productivity and the high-yield management system. In this "dynamic system" of management, all the growth factors interact and are dependent on each other individually and in combinaton to complete the high-yield equation. The following list includes information you must have as a top manager for maximum economic yields:

- The productive capabilities of the soil
- The high-yielding varieties or hybrids
- The proper seeding rate and plant population
- The optimum planting date
- The best insect, weed and disease control measures
- The best tillage practices
- The best rotation and/or land use, and
- THE AMOUNT OF PLANT FOOD REQUIRED for the crop

YOU MUST, AS A TOP MANAGER, UNDERSTAND THE DEPENDENCE OF GROWTH FACTORS on each other if you want to be successful. You can achieve your goal of MAXIMUM ECONOMIC YIELDS only when you manage all interacting factors in the dynamic system of crop production.

PFU figures shown are given in pounds per acre of N (nitrogen), P_2O_5 (phosphate), K_2O (potash), Mg (magnesium) and S (sulfur) found in the harvested portion of the crop and, where applicable, in the unharvested aboveground residue. Nutrients remaining in the root system have not been determined, but the figures provided are an excellent guide for total nutrients taken up during the growing season.

PLANT FOOD UTILIZATION
(UPTAKE by plant parts and total at harvest)

CROP	YIELD—PLANT PART	N	P_2O_5	K_2O	Mg	S
		Pounds per acre				
GRAIN CROPS						
BARLEY	100 bu grain	110	40	35	8	10
	Straw	40	15	115	9	10
	Total	150	55	150	17	20
BUCKWHEAT	30 bu grain	30	15	10	—	5
	Straw	12	5	25	—	3
	Total	42	20	35	—	8
CORN	200 bu grain	150	87	57	18	15
	Stover	116	27	209	47	18
	Total	266	114	266	65	33
OATS	100 bu grain	80	25	20	5	8
	Straw	35	15	125	15	11
	Total	115	40	145	20	19
RICE	7,000 lb grain	77	46	28	8	5
	Straw	35	14	120	6	7
	Total	112	60	148	14	12
SORGHUM	8,000 lbs grain	120	60	30	14	22
	Stover	130	30	170	30	16
	Total	250	90	200	44	38
WHEAT	80 bu grain	96	44	27	12	5
	Straw	42	10	135	12	15
	Total	138	54	162	24	20
OIL CROPS						
COTTON	1,500 lb lint	94	38	44	11	7
	Stalks, etc.	86	25	82	24	23
	Total	180	63	126	35	30
FLAX	20 bu grain	40	17	15	—	3
	Straw	14	5	30	—	3
	Total	54	22	45	—	6
PEANUTS	4,000 lb nuts	140	22	35	5	10
	Vines	100	17	150	20	11
	Total	240	39	185	25	21
PULPWOOD (slash pine)	40 cords	150	30	80	20	—
	Bark, branches, foliage	190	7	60	30	—
	Total	340	37	140	50	—

PLANT FOOD UTILIZATION
(UPTAKE by plant parts and total at harvest)

CROP	YIELD—PLANT PART	N	P_2O_5	K_2O	Mg	S
		Pounds per acre				
OIL CROPS (Cont.)						
RAPESEED (Canola)	35 bu grain	66	32	16	—	12
	Straw	39	14	67	—	9
	Total	105	46	83	—	21
SOYBEANS	60 bu grain	240	48	84	17	12
	Stover	84	16	58	10	13
	Total	324	64	142	27	25
SUNFLOWER	3,500 lb grain	125	60	39	12	6
	Stover	51	10	89	30	10
	Total	176	70	128	42	16
SILAGE CROPS						
CORN SILAGE	32 tons	266	114	266	65	33
FORAGE SORGHUM	8 tons	198	67	286	35	18
OAT SILAGE	8 tons	110	30	235	20	15
SORGHUM-SUDAN	8 tons	319	122	467	47	—
FORAGE CROPS						
ALFALFA	10 tons	600	120	600	53	51
BIG BLUESTEM	3 tons	63	61	105	12	—
BIRDSFOOT TREFOIL	4 tons	192	84	272	32	—
BROMEGRASS	5 tons	220	65	315	10	20
CLOVER-GRASS	6 tons	300	90	360	30	30
GUINEAGRASS	11.5 tons	288	101	436	99	46
HYBRID BERMUDAGRASS	10 tons	500	140	420	50	50
INDIANGRASS	3 tons	60	51	72	9	—
LESPEDEZA	3 tons	150	50	150	25	20
LITTLE BLUESTEM	3 tons	66	51	87	12	—
NAPIERGRASS	12.5 tons	303	147	605	63	75
ORCHARD GRASS	6 tons	300	100	375	25	35
PANGOLA GRASS	11.8 tons	299	108	430	67	46
PARAGRASS	12 tons	308	98	460	79	41
PENSACOLA BAHIAGRASS	7 tons	303	87	242	35	27
RYEGRASS	5 tons	215	85	240	40	—
SWITCHGRASS	3 tons	69	60	114	15	—
TALL FESCUE	3.5 tons	135	65	185	13	—
TIMOTHY	4 tons	150	55	250	10	16

PLANT FOOD UTILIZATION
(UPTAKE by plant parts and total at harvest)

CROP	YIELD—PLANT PART	Pounds per acre				
		N	P_2O_5	K_2O	Mg	S
TURF GRASS						
BENTGRASS	2.5 tons	260	66	146	13	10
BERMUDAGRASS	4 tons	225	40	160	20	15
BLUEGRASS	3 tons	200	55	180	20	25
FRUITS						
APPLES	250 cwt	20	8	50	2	—
	Leaves, stems, etc	80	38	130	22	—
	Total	100	46	180	24	—
GRAPES	12 ton fruit	66	23	120	10	—
	Vines	36	12	36	8	—
	Total	102	35	156	18	—
ORANGES	540 cwt	90	23	162	10	7
	Leaves, stems, etc	175	32	168	28	21
	Total	265	55	330	38	28
PEACHES	600 bu	35	10	65	12	—
	Leaves, stems, etc	60	30	55	10	—
	Total	95	40	120	22	—
VEGETABLES						
BELL PEPPERS	180 cwt	72	21	88	7	—
	Vines	65	31	129	36	—
	Total	137	52	217	43	—
CABBAGE	700 cwt	140	35	128	9	64
	Stem & leaf	130	28	121	27	—
	Total	270	63	249	36	64
CANTALOUPES	175 cwt	39	16	81	6	—
	Vines	26	5	36	6	—
	Total	65	21	117	12	—
CELERY	75 tons tops	255	130	680	—	—
	Roots	25	35	70	—	—
	Total	280	165	750	—	—
CUCUMBERS	10 tons fruit	40	14	66	4	—
	Vines	50	14	108	21	—
	Total	90	28	174	25	—
LETTUCE	400 cwt	90	30	185	—	—
ONIONS	600 cwt	180	80	160	18	37
PEAS	25 cwt with pod	92	24	31	6	6
	Vines	72	11	74	12	4
	Total	164	35	105	18	10
POTATOES	500 cwt	173	73	281	14	15
	Vines	96	17	265	36	7
	Total	269	90	546	50	22

PLANT FOOD UTILIZATION
(UPTAKE by plant parts and total at harvest)

CROP	YIELD—PLANT PART	N	P_2O_5	K_2O	Mg	S
		Pounds per acre				
VEGETABLES (Cont.)						
SNAP BEANS	4 tons	70	21	77	8	—
	Vines	68	12	86	9	—
	Total	138	33	163	17	—
SWEET CORN	90 cwt with husk	80	22	52	6	5
	Stover	60	25	84	14	6
	Total	140	47	136	20	11
SWEET POTATOES	300 cwt	73	39	169	8	—
	Vines	83	30	144	10	—
	Total	156	69	313	18	—
TABLE BEETS	500 cwt	170	30	210	30	13
	Tops	190	13	370	74	28
	Total	360	43	580	104	41
TOMATOES	600 cwt	100	23	216	8	21
	Vines	80	25	120	20	20
	Total	180	48	336	28	41
TROPICAL CROPS						
BANANAS	1200 plants	400	400	1500	156	—
COCOA	900 lb beans	18	7	11	2	—
	Husks, stems, leaves, etc	398	101	722	117	—
	Total	416	108	733	119	—
COCONUTS	12,000 nuts	96	31	206	13	8
OIL PALM	220 cwt/A	65	25	99	19	—
	Fronds, stems, etc	107	49	169	36	—
	Total	172	74	268	55	—
PINEAPPLE	357 cwt	153	125	596	64	14
SUGAR CANE	100 tons	160	90	335	40	54
	Trash, etc.	200	66	275	60	32
	Total	360	156	610	100	86
OTHER CROPS						
RUBBER	2,020 lb	17	10	17	4	—
	Leaves, stems, etc	58	27	93	13	—
	Total	75	37	110	17	—
SUGAR BEETS	30 tons	125	15	250	27	10
	Tops	130	25	300	53	35
	Total	255	40	550	80	45
TOBACCO (Flue-cured)	3,000 lb leaves	85	15	155	15	12
	Stalks, etc.	41	11	102	9	7
	Total	126	26	257	24	19
TOBACCO (Burley)	4,000 lb leaves	147	13	148	20	17
	Stalks, etc.	143	24	173	13	7
	Total	290	37	321	33	24

*Legumes can get most of their nitrogen from the air

LONG versus SHORT TERM COSTS of Building Up P & K For High Yields

L. F. WELCH
University of Illinois

MANY STATES now use the build-up and maintenance concept in making fertilizer suggestions.

The idea is to add enough P and K to build up the basic fertility level of the soil plus enough to replace the P and K removed in the harvested portion of the crop.

Build-up may be programmed to occur over a period of 1 to 4 years—that is, 1 to 4 applications of build-up fertilizer.

If the soil tests are low, the costs of build-up plus maintenance may be so high that the grower may hesitate to apply the suggested high fertilizer rates. The grower may grow more reluctant if he assigns the build-up costs to only the crop grown immediately after the fertilizer application than if the cost is spread over several crops or years.

No grower assigns the total cost of a new combine to only the first crop harvested with it. The same principle applies when assigning the cost of build-up fertilizer applications.

Also, the grower is more likely to follow the very high rate you suggested if you explain that once the build-up phase is completed, the rate will then be reduced to provide only maintenance fertilizer shown in TABLE 1.

MANY GROWERS already amortize P and K costs over a 2-year period. This would be when fertilizer is applied only one year during a two-year period.

For example, Illinois growers often add P and K to a corn-soybean system only for the year corn is grown. But they know the cost is rightly assigned to both corn and soybeans. They know this in their mind, although it may not be so partitioned on their income tax forms.

If more than crop removal is being added, it is not generally thought right to assign all P and K costs to the immediate crop. Nitrogen costs are usually assigned just to the immediate crop.

A factor influencing the time over which P and K costs should be spread is whether the grower leases or owns the land.

A ONE-TIME PROCESS is what build-up application is thought to be, although it may occur over 1 to 4 (or more) years.

Maintenance fertilizer will be applied more frequently and continuously. So, amounts of fertilizer needed for maintenance will determine long-time fertilizer rates.

Fertility build-up level, that level beyond which a yield increase to added fertilizer is unlikely, causes much discussion.

Since build-up is a one-time process, I suggest the differences in cost, from moderate differences in suggested build-

Table 1. An example to illustrate how P and K costs differ during the build-up period and afterwards. Initial P test of 10 and K of 100 with yield goal of 250 bushels of corn per acre.

Fertilizer applied for	Pounds per acre per year	
	P_2O_5	K_2O
First two years		
Build-up	168	200
Maintenance	107	70
Total	275	270
Cost/Year	$49.50	$27.00
Third and following years		
Build-up	0	0
Maintenance	107	70
Total	107	70
Cost/Year	$19.26	$7.00

up levels, become almost inconsequential when considered over the appropriate long-term basis.

Examples to illustrate this point follow here. They tell a strong story.

COSTS ARE SMALL. Suppose opinions differed on whether proper build-up level should be a P_1 test of 40 to 50 lb/A.

How much difference in cost is there between the two alternatives?

To increase P_1 level 1 lb/A requires 9 lb P_2O_5/A. So 90 more lb/A would be required to build the P_1 test from 40 to 50 lb/A.

At 18¢/lb, the cost of 90 lb P_2O_5 is $16.20/A.

This would be a sizeable cost to attribute to a single crop, but it becomes a modest $1.08/A per year if assessed over a 15-year period. It may be appropriate to consider an even longer time.

What is the diqerence in cost between a 300 and 350 lb K/A soil test level? It takes 200 lb K_2O/A to build K soil test from 300 to 350 lb/A at a cost of $20.00 per acre, or $1.33/A over a 15-year period.

For both P and K, this would be less than 1 bushel of corn/A.

When considered on a long-term basis, the cost of different build-up levels of soil fertility differ less than one would estimate if judged by the amount of heated discussion in the past.

It is not good economic sense to add large amounts of unneeded fertilizer. But, it is even more unwise to suffer economic loss from too little fertilizer use.

BENEFITS ARE LARGE. A little more maintenance fertilizer will be required if the higher P_1 and K build-up soil test levels produce higher crop yields.

I have yet to hear a grower complain about the extra fertilizer required for maintenance because of high crop yields.

Even though wide differences in crop and fertilizer prices are used, the most profitable fertilizer rate invariably turns out to be one that helps push yields near the top of the response curve.

More and more researchers and growers are getting a firmer grasp of the limiting factors concept in crop growth.

They realize some growth factors are difficult to control and others relatively easy to control. They appreciate an abundant supply of nutrients is one factor relatively easy to maintain.

We know inadequate nutrition is too costly to afford.

High, profitable yields are impossible without good fertility. This knowledge is becoming more commonplace, fortunately. But too many of us still fall short of being good stewards of soil fertility. **The End.**

Tissue Tests for SOYBEANS

CLYDE E. EVANS
Auburn University

W. R. THOMPSON, JR.
Starkville, Mississippi

FOR 6 YEARS, we have compared what tissue test kits tell us with soybean yields and soil test values.

And we have concluded these quick tests indicate plant condition fairly well, especially during bloom stage of growth. Testing too early or too late was not as reliable as bloom stage. This report features only 1971 results, since they represent the trends of all years.

TEST PROCEDURE. The vial test for phosphorus (P) and the paper spot test for potassium (K) were used.

The test was made on the enlarged stem end section called pulvinis of petioles from the top mature leaves.

BLACK BELT SUBSTATION (Central Alabama). This experiment was located on Vaiden clay with very low soil test P — only 2 pounds per acre. Phosphorus was applied on some blocks in 1968, followed by annual P rates from 1969-1972, shown in Table 1. The high P rates increased soil test P to **medium.**

Plant tissue test levels were directly related to yields. Plants testing "high P" yielded 44 bushels per acre . . . "medium P" 3 to 8 bushels less . . . "low P" 11 to 23 bushels less. This experiment showed that fertilizer P applied to a very deficient soil can more than double soybean yields — from 21 bushels up to 44 bushels.

GULF COAST SUBSTATION (Southern Alabama). This experiment was located on a Malbis fine sandy loam that was newly cleared from forest in 1966. It had never been fertilized. Soil test P was **very low** and K was **medium.**

The highest P rate yielded 49 bushels and plant tissue tested "high P", as shown in Table 2. The second highest P rate yielded 37 bushels and plant tissue tested "low" or "medium P." Without P fertilizer, yields declined to only 8 bushels and plant tissue tested "very low P."

Potassium fertilizer increased yields 15 bushels — from 34 to 49 bushels. But the tissue test for K was not a good indicator of relative yield levels. Either the spots did not have the spread in concentrations needed to indicate deficient levels or the plant part tested (the pulvinis) was not the best plant part for the K test.

SAND MOUNTAIN SUBSTATION (Northern Alabama). This experiment was located on a Hartsells fine sandy loam. This soil had a wide range of soil test P from a previous long term experiment shown in Table 3.

Top soybean yields were produced where soil test P was **upper medium** or **high** and no P was applied. On soil testing **medium,** the tissue tested "high P" and yield reached 50 bushels. Yield declined 5 bushels when the tissue tested "medium P," but a whopping 26 bushels when it tested "low P."

"HIGH" PLANT P AND K NEEDED. In each of these experiments, top soybean yields occurred when plant tissue tested "high P" during bloom stage. Tissue testing "medium" or "low P" indicated a P deficiency and reduced yields.

Although the K test was not highly correlated to yield and soil test values, in no case was maximum yield attained without "high K" in the plant tissue.

The End.

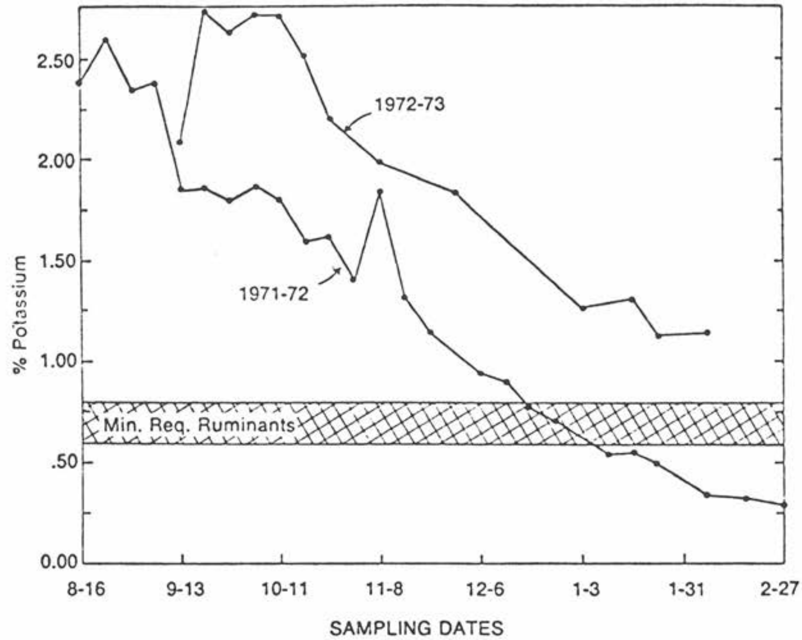


FIGURE 1

Trends In Potassium Concentration Of Autumn-Stockpiled TALL FESCUE

A. G. Matches, University of Missouri & W. R. Ocumpaugh, University of Florida

Forage of autumn-stockpiled tall fescue **(Festuca arundinacea, Schreb.)** may become deficient in potassium (K) as a livestock feed during January and February. For ruminants, diets that contain less than 0.6 to 0.8% K are considered deficient in K (National Research Council, National Academy of Science, 1970).

In research conducted by the U.S. Department of Agriculture and the University of Missouri, tall fescue growth was stockpiled (accumulated) from a 10 August harvest in each of two years (Ocumpaugh & Matches, 1977).

In the stockpiled forage, concentration of K declined an average of 0.1 percentage unit per week from October through February. During one winter, K concentration declined from an August high of over 2.5% to below minimum dietary levels by early January and to 0.26% K by 27 February (Fig. 1).

Dry matter digestibility (IVDMD) of stockpiled herbage also declined during the winter. The digestibility remained fairly constant (63-68% IVDMD) from September until freezing temperatures became common in November. Following these freezes, digestibility declined an average of 1.0 percentage unit IVDMD per week and was very low (40% IVDMD) in February.

Low digestibility plus a deficiency of K becomes especially important if stockpiled tall fescue is the only winter diet of cattle. Potassium deficiency may depress appetite and reduce voluntary intake of feed (Devlin et al. 1969; Pfander and Rubio, 1972).

Cattle producers should be aware of this possibility when animals winter graze stockpiled tall fescue. The feeding of potassium-deficient forage may be avoided by grazing the stockpiled growth in early winter before K declines to deficient levels. Supplemental feeding of cattle with a good quality grass or legume hay may be desirable in late winter if the stockpiled tall fescue has no green growth remaining and has begun to decompose. **The End**

POTASSIUM Reduces Dry Weather & Late Harvest RISKS

J. W. JOHNSON
Ohio State University

Table 1. Soil and management information

Soil: Crosby silt loam
Soil tests (Spring 1976, before treatments)
pH 6.9
P_1-40 lb P/A
K-162 lb K/A
CEC-11 meq/100 g
Fertilizer treatments
N 240 lb/A preplant
P_2O_5 50 lb /A preplant
K_2O 0 to 200 lb/A preplant
Zn 50 lb/A $ZnSO_4$ plowdown

WEATHER CAN complicate the life of a corn farmer in many ways.

One is late rains delaying fall harvest. The longer the delay the greater the risk of lodging and yield loss due to poor stalk quality.

Another is too little rain which can reduce yields due to lowered nutrient uptake.

This study measured corn response to K when harvesting was done both at early and late dates in the fall. Machine harvested plots showed no yield response to K in 1976, but in 1977 there was up to a **51 bu/A increase.**

CORN YIELDS. In 1976 the weather cooperated at Ohio's Western Research Center.

Rains were adequate and well timed. The crop year rainfall (October to September) was 32.2 inches. **Table 2** shows the excellent yields.

This was the first year of the study, and the corn was able to get enough K from residual soil supplies. There was no response to added K.

The 1977 season was cool and dry. The crop year rainfall was 23.7 inches, 8.5 inches less and not as well distributed as in 1976.

Lack of water restricted root growth, particularly in the nutrient-rich, but

Table 2. Effect of K_2O and harvest date on corn grain yields

K_2O	1976		1977	
	Harvest date		Harvest date	
lb/A	Oct 30	Dec 9	Sept 30	Dec 21
	bu/A			
0	165	160	93	69
50	164	161	129	97
100	168	165	136	106
150	164	163	129	104
200	163	162	137	120

Approved for publication as Journal article No. 93-79 of the Ohio Agricultural Research and Development Center, Wooster, Ohio 44691.

dry surface soil. K moves to plant roots by diffusion through soil water. Without enough water, K uptake was reduced and the plants suffered from K deficiency at the lower rates of added K. Yield response to K was big in 1977.

EAR LEAF K. Leaf content of K showed the benefit of added K.

Table 3 shows leaf content of K in 1976 and 1977. In both years added K boosted the leaf K, but in 1977 the differences were most striking.

Table 3. Effect of K_2O on the K content of corn ear leaves.

K_2O lb/A	1976	1977
	—% K ear leaf —	
0	1.60	0.70
50	1.65	1.11
100	1.73	1.38
150	1.91	1.47
200	1.65	1.43

Even at the higher K rates of 1977, the leaf K never approached optimum levels (around 1.7% K), although leaf K was significantly increased. The corn simply was not getting enough K in 1977.

HARVEST DATE. Severe lodging in 1977 was the reason for the large yield difference between harvest dates. At late harvest date in 1977, around 80% of the corn was lodged while in 1976 only 15% lodged (more on lodging later).

The higher rates of added K reduced the lodging severity and reduced losses from machine harvesting. **Figure 1** shows how K took some of the risk out

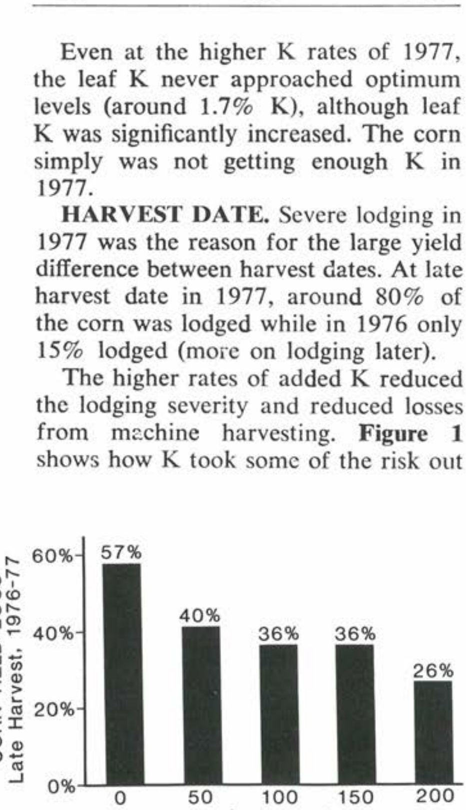


FIGURE 1

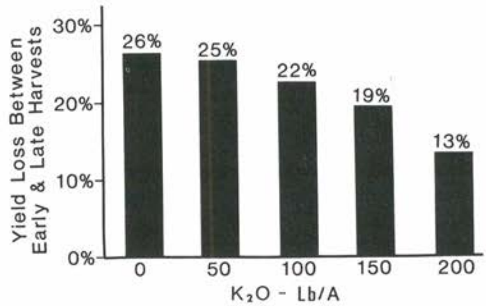


FIGURE 2

of harvesting late. Machine losses were cut in half (13% from 26%) by the highest K rate.

COMPARE 1976 AND 1977. Added K also reduced the yield differences between years. Although the average yield dropped from 164 bu/A in 1976 to 112 bu/A in 1977, the drop was less at the higher K rates.

Figure 2 shows what happened at late harvest in 1977—corn receiving no K yielded 57% less, while corn receiving 200 lb K_2O yielded only 26% less than the 1976 corn.

TAK—TOTAL AVAILABLE K. To predict how much K_2O needs to be added to a soil of a known K level, corn response was plotted against total available K (TAK). TAK is soil test K(lb K/A) plus ½ of the K_2O added (lbs K_2O/A) and estimates how much the soil test **K** is raised by adding a certain amount of **K_2O**. In the average Ohio soil one pound of K_2O will raise the soil test K by ½ pound. But individual soils differ widely in their K fixing capacity which makes the estimate subject to large errors.

The advantage of using TAK is that it helps to compensate for differences in soil test levels between research plots. A TAK value was determined for each plot by adding ½ of the K_2O applied to the soil test K. Corn response was then plotted against TAK using regression techniques.

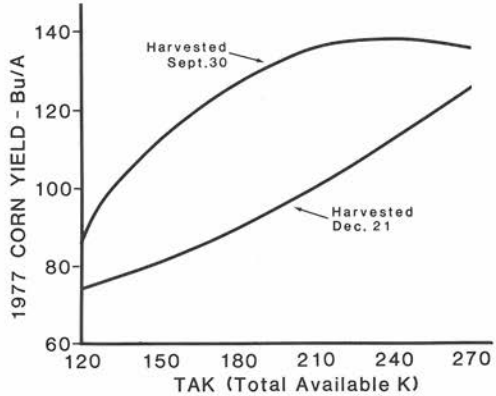


FIGURE 3

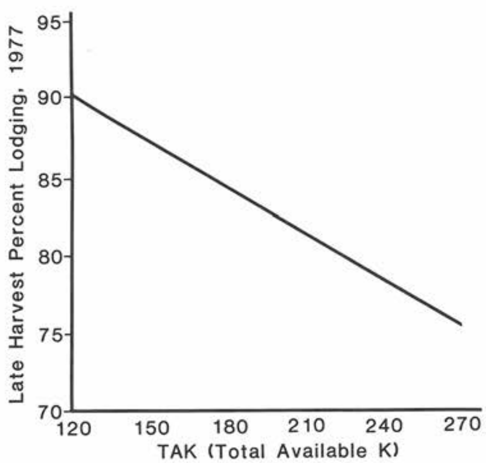


FIGURE 4

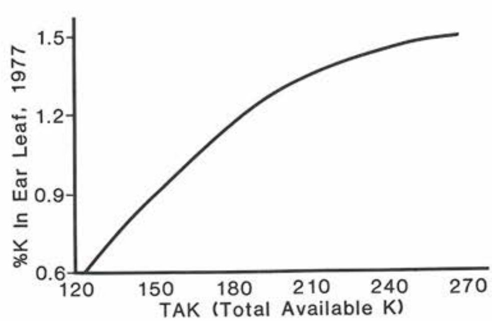


FIGURE 5

TAK AND CORN YIELD. Corn yields in 1977 are plotted against TAK (Total Available K) in **Figure 3.**

At early harvest, the optimum TAK value was about 220. At late harvest, yields continued to increase throughout the range of TAK studied.

TAK AND LODGING. Percent lodging was also reduced throughout the entire TAK range. **Figure 4** shows lodging was 90% at a TAK of 120 and was **75%, and still falling, at a TAK of 270.** By increasing the K available to the plant stalk quality was improved, resulting in significantly less lodging and higher yields.

TAK AND EAR LEAF K. Figure 5 shows ear leaf K increased over the entire TAK range in 1977. The percent K never reached the level considered sufficient (1.7% K).

WAS HIGHEST K RATE HIGH ENOUGH IN 1977? At the late harvest date in 1977, corn yields were continuing to increase at the highest K rate of 200 lb K_2O/A and at the highest TAK value of 270.

Percent lodging was still decreasing and ear leaf K still increasing at a TAK value of 270. This suggests that during the dry year of 1977 **additional K above 200 lbs K_2O/A would have given still further growth response.**

CONCLUSIONS.

1. Adequate amounts of K can help reduce the risk of late harvest by improving stalk quality.

2. Differences in corn yields between a year of adequate rainfall and a dry year were reduced with added K.

3. The optimum rate of K_2O in 1977 was 100 lb per acre at the early harvest and 200 lb per acre, or higher, at the late harvest.

4. At the late harvest in 1977, corn yields continued to increase throughout the entire range of TAK (Total Available K).

NITRATE MONITORING
To Help Improve Nitrogen Fertilizer Efficiency On Cotton

RICHARD MAPLES & WOODY N. MILEY
University of Arkansas

NITRATE MONITORING is a system used to regulate N input by the needs of a particular cotton group.

It has been used on irrigated cotton in the Western U. S. for years. Its suitability for cotton in the southern rain belt was generally unknown, until we began our work in the 70's.

Back then both farms and research plots showed available N was progressively accumulating in many of our best cotton-producing soils.

A survey compared nitrate levels in normal fields to those that had produced excessive stalk growth. Normal fields generally contained 10 to 25 lbs nitrate-N in the upper 18 inches. Those with excessive stalk growth or delayed maturity contained 40 to 60 lbs—or more—per acre.

Yield data from some N rate studies also showed no response to any N rate the first year. In others, applied N seriously depressed yields. The problem became more intense from south to north, corresponding roughly to a shortening of the cotton growing season.

The first step in developing a nitrate-N monitoring service program for Arkansas cotton farmers was to find preplant N rates that got top yields and prevented accumulation of nitrate-N in soil, at the same time.

Table 1 shows the influence of various nitrogen rates over five-year yields.

EACH YEAR, 1973-75, yields leveled off at the 50 to 75 lb N/A rates. This indicated that more than 75 lb N/A was surplus.

Surplus N caused no problem until

Table 1. Five-Year Yields of Seed Cotton Per Acre as Influenced by Various Nitrogen Rates Applied on Loring-Calloway Silt Loam, Cotton Branch Experiment Station, Marianna, Arkansas.

N RATE (LB/A)	POUNDS OF SEED COTTON PER ACRE				
	1973	1974	1975	1976	1977
0	2,094	1,937	1,976	1,604	1,429
25	2,292	2,109	2,626	2,105	2,042
50	2,443	2,208	2,982	2,290	2,246
75	2,358	2,246	3,004	2,289	2,256
100	2,311	2,232	2,961	2,030	2,272
125	2,349	2,239	2,903	1,819	2,351
150	2,455	2,365	2,921	1,888	2,226

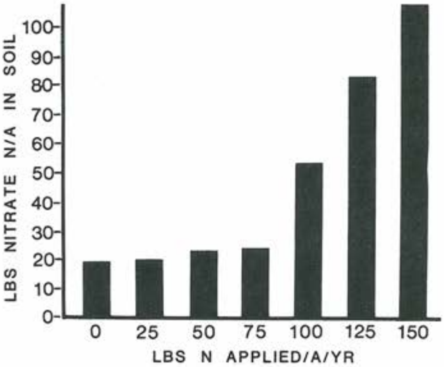


FIGURE 1

1976. Then a cool late season depressed yields at all N rates above 75 lb/A. The plots were irrigated each year as needed. Phosphate and potash were applied according to soil tests.

In March of 1975, after 3 years of annual treatment soil in each plot was sampled 36 inches deep and tested for nitrates. **Figure 1** gives results.

In plots receiving 75 lbs N/A (or less), nitrate-N remained about the same. This indicated equilibrium between fertilizer application and crop removal. Above 75 lbs, N shifted the equilibrium upward.

COTTON PETIOLES were sampled weekly during fruiting period and analyzed for nitrate-N and readily soluble phosphorus.

These data were correlated with yields from various N rates. Each year, nitrate-N in the petiole was higher with increasing N rate. It decreased in all cases as the season progressed.

Yields leveled off with the 50 to 75 lb N/A rates. This means the values for petiole N obtained with these rates represent practical sufficiency levels.

Such results from selected soil types provided the base for the model in **Figure 2.** We use this model in our service program.

Petiole N and P are used together as barometers of unused N and P in the plant vascular system. When N decreases or increases, P tends to do the same. A change in P can lag behind a change in N.

Figure 3 shows the best time to study the relationship of the two elements in the physiology of the cotton plant is through the 5th week of blooming. After that 5th week, other factors tend to mask the relationship although different seasonal conditions can cause this to vary.

OUR SERVICE PROGRAM takes 9 weekly petiole samples, beginning the week before the first bloom. The County Extension offices distribute kits for sampling.

The samples and information cards are mailed to the Soil Testing Laboratory in preaddressed envelopes the day they are taken. At the lab, they are dried over-night and analyzed the following day. Results are fed into a computer program and recommendations mailed to the grower. Turnaround time is 3 to 5 days.

When excessive nitrogen is detected, we recommend foliar boron to try to increase translocation of carbohydrates and nitrogen and to stimulate fruiting.

When nitrogen is deficient, we recommend 15 to 20 lbs N/A applied until the third week of blooming. After blooming, we recommend 5 to 10 lb N/A applied as foliar application. It depends on dilution—4 to 5 lbs in 10 gallons, 7 to 8 lbs in 15 gallons, or 9 to 10 lbs in 20 gallons of water or insecticide solution per acre.

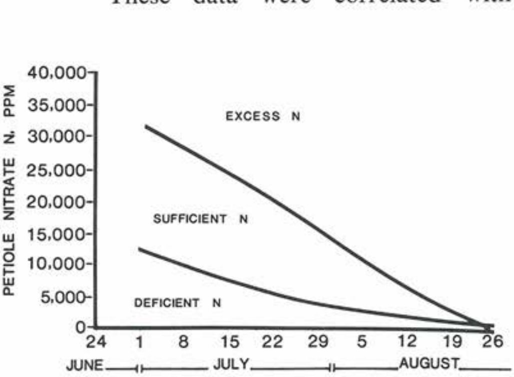


FIGURE 2

A NITRATE MONITORING system is much harder to apply in the mid-South than in the West, apparently. Our unpredictable weather and low percent of irrigated fields cause this.

Each year we learn more about interpreting and applying petiole test results. In 1977, 300 cotton producers monitored 57,000 acres. Most of these were repeated in 1978. Participation in the service program increased by about 50% in 1978.

Wise use of the system helps maximize yields in favorable seasons and decreases risks of delayed maturity, boll rot, and yield failure in unfavorable seasons.

The system serves best in a good overall management program. **The End**

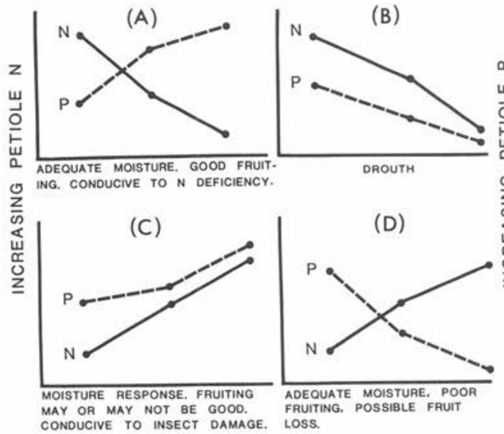


FIGURE 3

Multiple Cropping Needs MORE FERTILITY

BOB DARST
STILLWATER, OKLAHOMA

WHAT IS MULTIPLE CROPPING? It is the growing of two or more crops on the same acre in a single year—an intensive production system. It demands detailed management.

There are many advantages. Some of them include:

- **Increased profit potential from two or more crops grown on the same acreage each year.**
- **More production without bringing new acres into production.**
- **More efficient use of moisture, sunlight, equipment, labor and other inputs.**

One of the most important keys to the success of a multiple cropping system is an adequate soil fertility program.

SOIL FERTILITY REQUIREMENTS are high. A common danger is the tendency to under fertilize this system.

Fertility should receive special attention, because two or more crops—not one—are being grown on the same land. A double crop of barley and soybeans demands much of the soil.

		Removal, Lbs/A			
Crop	Yield, Bu/A	N	P_2O_5	K_2O	Mg
Barley*	113	140	53	94	6.4
Soybeans**	39	143	26	46	4.5
Total of both crops		283	79	140	10.9

*Includes straw removal of 3,278 Lbs/A.

**Soybeans get most of their N from the air.

TO PAGE 20

How to Produce 10 Tons of Alfalfa

DARRELL A. MILLER
University of Illinois

ALFALFA is our highest yielding perennial forage legume grown in the U. S.

Cattlemen are asking why grow alfalfa in Illinois when I can produce 150 bu corn. The answer is very simple: For the protein and energy in alfalfa.

In protein, 10 tons of alfalfa equals 3,600 lbs of protein or 715 bu of corn or 150 bu of soybeans.

In energy, 10 tons of alfalfa equals 14,100 lbs of TDN or 315 bu of corn or 10.5 ton corn silage.

Another simple comparison is found in 100 lbs of alfalfa hay. In protein and energy, 100 lbs of alfalfa hay is equal to 33 lbs of corn plus 22 lbs of SBOM.

When converted to dollars and cents, alfalfa is a very valuable crop. So it deserves proper establishment and management to produce top production. How can we produce 10 tons of alfalfa? Here are some steps:

1. Select a well drained field. A former corn field is best for establishing a new alfalfa seeding. The reason is no water soluble chemical is released from the corn that inhibits alfalfa germination. Old alfalfa fields possess the chemicals for about one year.

2. Lime the field to a pH of 6.8 to 7.0 at least 6 months before establishment.

3. Apply enough P for a P_1 test of 45 and enough K for a soil test of 400.

4. Prepare a fine, firm seedbed.

5. Select a high yielding, disease resistant cultivar that is adapted to your area of the state.

6. Seed in early April for southern ⅔ of Illinois and from April 10 to 15 for northern ⅓ of Illinois. One can seed up to mid-May with little problems. After May 15, grassy weeds become a problem and less chance for adequate rainfall.

7. Seed at least 18 lbs of inoculated seed per acre. Use a roller type seeder which compacts the soil and seed so that there is excellent soil-seed contact.

8. Control weeds. If one can seed before April 15 in southern ⅔ of Illinois or April 25 in northern ⅓ of Illinois, herbicide preplant is probably not needed. If seeded later or a known grassy weed problem exists, then a preplant herbicide may be needed. Broadleaf weed control can be controlled by applying 2, 4-DB about one month after seeding or when weeds are 2-3 inches tall.

9. Control leaf hoppers. If seeded around April 30, spray for leaf hopper about one month after seeding and within 3 to 5 days after each harvest.

10. Take the first harvest at late bud stage and each 30 to 35 days thereafter.

11. Cutting height should be as close to the soil as possible. This insures uniform regrowth.

12. Take the last harvest in the fall 35 days before the average killing frost date.

13. After a killing frost, 24° or below, take the last harvest. Leave a 3 to 5 inch stubble which helps insulate the crown, helps gather snow, and helps penetrate ice sheets.

14. Maintain fertility by annually applying the amount of P and K removed by harvest. For every ton removed from the field, 12 to 15 lbs of P_2O_5 is removed and 60 lbs of K_2O is removed. This generally amounts to 150-200 lbs of P_2O_5 and 600 lbs of K_2O for a 10-ton

yield. Split applications after the first and fourth harvest. Also apply 2 to 3 lbs of actual boron per year.

15. Following the year of establishment, take the first harvest at late bud or first flower stage. Take the last harvest 30-35 days before average killing frost date. Divide the remaining portion of the season into a cutting schedule every 30-35 days.

16. Control insects. Spray for weevil control if needed prior to first harvest or possible second growth. Spray for leaf hopper control after each harvest within 5 days. The End

Factors Influencing K Availability And Need Other Than Exchangeable K Test Level

POTASH RECOMMENDATIONS for your crop and soil are now far more accurate because of new information and ways of measuring K levels from soil tests.

Scientists used the exchangeable K level in the soil for many years to help them estimate the recommended rate of potash. But, they never gave up their research in the laboratory, the greenhouse and the field. The following 15 measurements or factors are the results that help to "zero in" for maximum accuracy.

1. **Cation exchange capacity (CEC)**—In general, the higher the CEC, the greater the amount of K needed in the soil.

2. **Fixation**—Fixation capacity of the soil influences the pounds of applied K_2O needed to change the soil test by one pound.

3. **Subsoil K**—The level of K in the subsoil affects the amount of K the crop needs in the plow layer.

4. **Calcareous soils or liming**—Calcium competes with K for entry into the plant.

5. **Moisture level**—The K level requirement increases with unusually wet or dry conditions in the soil.

6. **Temperature**—Cool soils restrict uptake of K and increase the need for added K.

7. **Compaction**—K uptake is reduced by soil resistance to root expansion, decreased movement of nutrients in the soil and poor aeration. These are problems caused by compaction.

8. **Tillage**—The soil may be more compact and cooler with no-till. This will increase the need for added K in drier, northern areas.

9. **Ammonium-Nitrogen**—NH_4^+ may compete with K for entry into the plant. NH_4^+-fed plants may require a higher K level in the plant, and NH_4^+ may block release of K from some clays.

10. **High N**—N-K balance is important. As N is increased, greater amounts of K are removed with the higher yield. Too, there is a shift in organic and amino acids with a buildup of non-protein nitrogen.

11. **Yield level**—Many states vary the recommended amount of K depending

on yield goal.

12. **Rotation**—Production costs can be reduced by adding enough K for one crop to satisfy K needs for that and the next crop. Applying K once for double-cropped corn and soybeans or wheat and soybeans are examples.

13. **Forage**—High amounts of K are removed with silage, hay or other above ground harvested crops. The amounts of N and K are about equal in high yielding non-legume crops.

14. **Diseases**—Applying adequate K can reduce certain leaf diseases, stalk rots, and pod and stem blights.

15. **Quality**—Quality and value of the crop are influenced by K level—examples: tomatoes, soybeans, cotton tobacco and barley. Applied K can improve quality and value.

The key is to provide amounts of K that will assure a high rate of K delivery to the plant during rapid growth periods and adequate rates during stress. Thus, the key is to provide total plant K needs.

Maximum economic yields and other factors have to be considered in making K recommendations even though soil scientists begin with exchangeable K. The K level in the soil does not directly affect its responsiveness to K. **The End**

FROM PAGE 17

Other multiple crops, such as wheat and soybeans or small grain and corn, also remove high rates of nutrients.

An 8-ton small grain and 20-ton corn silage double crop will remove more than 360 lbs of N and 360 lbs of K_2O. Just to maintain soil K levels will require 320 lbs K_2O per acre applied each year.

ADEQUATE FERTILIZATION is essential to maintain soil fertility. Soybeans can be found in many multiple cropping systems. Since they tend to respond to carryover fertility as well as applied fertilizers, they are often overlooked.

This can be a serious mistake in management judgment. If fertilizer rates are not high enough to feed the soybeans as well as other crops in the rotation, soil fertility levels will drop rapidly.

The following data show how much P_2O_5 and K_2O various yield levels removed over a period of five years. Without adequate fertilizer, the soil can be robbed of its ability to produce satisfactory yields.

Soybeans Bu/A/Yr	Removal after 5 years P_2O_5 (Lb/A)	K_2O (Lb/A)
20	80	140
30	120	210
40	160	280
50	200	350

Corn and small grains were double cropped for four years, each crop being removed as silage. Three fertility schemes were used.

Final yields reflected the importance of applying adequate fertility to meet the needs of both crops in the system.

N	P_2O_5	K_2O	Silage yield—T/A 35% D.M.—4 yr. avg.	
	Lb/A		Corn	Small grain
250	180	250	18.4	6.9
150	110	150	13.3	5.0
150	110	150*	17.7	5.8

*K_2O applied half in the fall, half in the spring.

Note that potash efficiency in this study was improved by splitting the applications between fall and spring.

Soil tests taken before the study began were compared to tests made after the study was completed.

Phosphorus levels increased substantially at the high fertility rate, but went up only slightly at the lower rate.

Potassium levels remained about the same at the 250 lb rate, but dropped at the lower rate.

N	P_2O_5 Lb/A	K_2O	Soil test after 4 years P	Soil test after 4 years K
250	180	250	203	304
150	110	150	130	229
150	110	150*	119	271

(Initial tests: P—108; K—298)

*K_2O applied half in the fall, half in the spring.

WHEN CAN P AND K be applied? If the soil is built to medium or high test levels, double or even quadruple P_2O_5 rates every two to four years and double K_2O rates every two years give yields equal to annual applications.

Heavy P_2O_5 and K_2O applications are practical on most soils, except very sandy ones. It is practical to apply high P_2O_5 and K_2O rates in a multiple cropping system. Purdue recommends up to 180 lbs P_2O_5/A and 220 lbs K_2O/A for 45+ bushel wheat and 30 to 40-bushel soybeans.

Soil Test	P_2O_5 Lb/A	K_2O Lb/A
Very low	180	220
Low	140	170
Medium	100	110
High	60	70
Very high	20	0

USE ENOUGH N, LIME, and other nutrients. Though soybeans can get most of their N from the air, nonlegumes in a multiple cropping system will need adequate N applied to meet their needs.

In a study with ryegrass followed by millet, additional N on the millet boosted total yield sharply, shown in Figure 1. Adequate P_2O_5 and K_2O were applied for both crops.

To improve fertilizer efficiency, soils should be limed to a pH of 6.0 or higher. Liming improves availability of nutrients such as Mo, Mg, Ca and P.

Nitrogen on Double Crop of Ryegrass & Millet

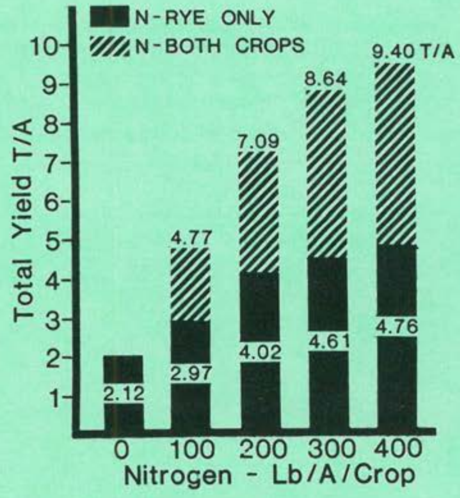


FIGURE 1

Lime along with P and K also improves nodulation and nitrogen fixation by legumes. This is very important in critical dry periods during summer months.

AS HIGHER YIELDS are taken from the soil, other nutrients such as sulphur and the micronutrients may become limiting.

Many soil and plant testing laboratories run analyses to determine whether or not such nutrients may be limiting production.

There is no substitute for careful field observation to help spot potential trouble.

Adequate fertility does more than boost yields. It makes the crop healthier and better able to resist attacks from diseases and insects. More able to compete with weeds for light, water, and air. More able to withstand dry spells, vital to drought-sensitive crops such as soybeans.

And adequate fertility helps speed maturity which is so important in a multiple cropping system. **The End.**

THE FERTILIZER INDUSTRY lost a colorful character when Harvey "Skin" Mann died this spring in a community he loved and often boosted in tones similar to proud Texans, Hyde County, North Carolina.

He dwelled on this earth, growing up, living, learning, loving, laboring for 80 years.

Dr. Mann was the second president of the American Potash Institute (now Potash & Phosphate Institute) that has published this magazine since 1935.

He was a man of style. In the vernacular of the old vaudevillians, he had class. He also had sharp instincts about the difference between ordinary and extraordinary men.

Harvey Blount Mann clearly symbolized the agricultural scientist produced by America's land-grant universities during the first third of this century: Sound but insistently practical, suspicious of much rhetoric but dedicated to clarity, searching for scientific results the farmer could use to improve his lot.

Mann was never the basic or fundamental scientist. Theory held him only briefly. He grew impatient if the light of practical application didn't soon shine through.

Yet, he early did original work through North Carolina's Agricultural Experiment Station: On more concentrated fertilizers, on the influence of mineral supplements, on the relation of fertilizer placement to crop stand, growth, and production.

But they were not tests for tests sake. They were aimed toward profitable fertility practices for the farmer.

J. J. Skinner, a legend among USDA soils scientists, influenced Mann's scientific career. After Mann developed the paper he was invited to deliver at an Oxford University conference, he turned to Skinner for advice on it. He often turned to Skinner.

The former Research Coordinator of USDA, Dr. R. Y. Winters, once credited Dr. Mann's controlled studies on peanut fertilization with "changing the practice of supplying lime to North Carolina peanuts."

Dr. Winters also described Mann's "promotion of plant nutritional research in agricultural colleges" (while Southern Manager of the Potash Institute) as "generous and discreet, in strict accordance with fertilizer recommendations of the State Experiment Stations and U. S. Department of Agriculture."

Winters' most important point, especially to a scientist in industry, was the conclusion that "Mann maintained the respect and confidence of State and Federal officials alike."

Most young scientists entering agricultural industry today accept the mutual respect between themselves and Experiment Station scientists without question. It wasn't always that easy.

Not too many years ago, University scientists sometimes suspected industry of promoting more plant nutrients than needed or where not needed.

In turn, specialists in industry felt university scientists worked in an ivory tower too removed from everyday-farmer problems.

One fertilizer manufacturer advertised for a field representative like this: "Wanted, competent field representative, but no college graduate."

Industry felt "laboratory dwellers" were loafers—wrongly, of course.

Feeling ran so high at one point that some industry groups talked about "suing" certain institutions for what they thought were unwarranted claims against certain plant foods. Talk is all that happened, of course.

Not long after joining the Institute in 1936, Dr. Mann ran head-on into the early attitude of official agriculture.

He had hardly removed his hat to visit with Dr. Frapps at Texas A&M when the veteran scientist said: "Well, Mann, I'm sorry to see you've succumbed to the lure of commercial work. I thought you had a bright future in official agriculture."

He implied he thought Mann had sold his birthright, an insinuation that hung heavy on the new potash scientist as he drove back to Atlanta.

Before he left N. C. State, Mann's superiors offered him a year's leave of absence to try the job. If it didn't work out, he could return to his old post.

The Frapps comment made him think long about that leave—for about six months, until he saw enough of the Institute at work to ask his former boss to cancel the leave.

He had learned what the famed chemistry writer, Edwin Slosson, meant when he said "statements issued by the potash industry were found so accurate by government specialists" that they used them as part of their recommendations.

Although Skin Mann was listed in many Who's Whos, he was a character of disarming candor who delivered his views in country-cured language dressed in country club suits.

He insisted he went to N. C. State College because he "thought it would be a lot easier than UNC and I had visions of returning to 'Hoide' (Hyde) County to become a big shot farmer riding around on a fine horse overseeing my farms. But farm prices were rock bottom."

So he accepted N. C. State's offer to become a soils specialist carrying two degrees from there and one from Cornell.

His route to that Cornell degree was another one of his candid tales. He literally earned that Ph.D. in one year, but not before being sent on by Maryland and Rutgers after they told him he was in too big a rush and didn't have the right attitude.

He laid the whole story of turndowns before his Cornell advisor, Prof. Bizzell. Bizzell heard him, stared at him a long time, doodled something on a pad, and said if Mann could do it in a year it would be a miracle.

He did it. And left Cornell with only his dissertation to complete.

One of the best examples of Mann's candor and independence occurred the first time he met the founding president of the Institute, Dr. J. W. Turrentine.

Turrentine called Mann from Washington in 1936 and said he wanted to "come down to N. C. State and talk about a matter of mutual interest."

Mann said fine. But after he hung up, he remembered he had planned a deer hunting trip for the week-end Turrentine mentioned. He was to go with a close friend, Frank Poole, then an N.C. State plant pathologist and later president of Clemson College.

He weighed the deer against the potash. The deer won. He wrote Dr. Turrentine a thank-you note for the call and his regrets for having a previous engagement he overlooked on the phone.

The deer ran well in the sandhills that weekend. And Harvey Mann had virtually forgotten the Washington call when a little man with a sharp eye stood in the door of his N. C. State office the next Wednesday.

The stranger didn't waste words: "I am Dr. Turrentine of the Potash Institute and I wondered if you are interested in joining our southern staff."

Mann, who would have made a great model for some shoe manufacturer, didn't shift his feet from his desk or his seat from his chair. He replied simply, "No, suh, I'm not interested. But have a seat, Dr. Turrentine."

The world-known potash chemist sat down. He was at home talking potash because he had revolutionized the potash industry by inventing a process for vacuum cooling and crystallizing potash salts.

Suddenly, in the middle of their conversation, he quoted a starting salary to Mann.

Skin Mann's feet whirled off the desk, barely missing Dr. Turrentine's head, as he said, "I'll take that job!"

Later Dr. Mann explained, "I took it because he would pay me much better than a university. To say I took it out of some sense of challenge or duty would be hypocrisy for me. And I knew his tremendous reputation for objectivity."

In his 27 years of objectivity with the Institute, Skin Mann witnessed many progressive changes.

- He saw average mixed fertilizer contain almost 120% more potash the day he retired than the day he came with the Institute.
- He saw soil and plant testing shed early accusations of "witchcraft" to become an accepted science, greatly through the support of Institute research grants.
- He saw fertilizer placement methods improve to use more concentrated fertilizers.
- He saw plant food removal much more widely taught, after Institute educational materials spread the word.
- He saw his Institute invest thousands of dollars into research grants at agricultural institutions in 40 states and Canada.
- He saw scores of promising graduate students able to prepare for important careers in science and industry through Institute grants.
- He saw official agriculture invite his Institute to help sponsor thousands of field demonstrations, covering everything from high-N treated pastures removing huge amounts of potash to proper fertility balance preventing "down corn."

• He saw agricultural leaders request nearly 11,000,000 copies of 1,140 different article-reprints written by official specialists for the Institute magazine.

• He saw agricultural leaders request 1,000 slide sets annually (average) from 7 educational sets, 350,000 wall posters, and more than 2,500,000 regional Potash Newsletters.

• He saw many of his staff invited to serve on policy-making committees and even elected to top posts in state and national societies advancing the cause of agriculture.

• He saw six member companies permit the agronomic truth about their product to be searched out through his Institute.

• He saw this agronomic truth help increase potash usage almost 800% in his 27 years with industry.

Agronomy was almost a religion with Skin Mann. To him, agronomy was the science of survival.

He always supported anything that would gain better recognition and understanding of agronomy. For agronomy! Not for himself.

When the American Society of Agronomy hung one of their highest awards on him at the sunset of his career, I had visions of a major release to major media.

He killed it. I asked if he thought an ASA award wasn't worth publicizing.

The highest honor, he agreed. But not when his name was involved. He did not like publicity—for himself or for his Institute, except through agronomic results.

This attitude summarized the Mann called Skin, as I saw him.

COTTON NEEDS phosphate and potash to produce profitable yields. A Georgia test showed 315 pounds of nitrogen, phosphate and potash was absorbed by the crop to produce 2,000 pounds of seed cotton.

The plant takes up N and K rapidly. P is taken up more slowly until the early square stage. From then to maturity, the plant takes up 89 percent of P absorbed. Soils must have good, full season fertility to supply plant food needs throughout the growing season.

Nutrient content decreases as the plant matures. However, K remains high in the developing cotton boll, especially the bur. High K content may be associated with a favorable water content in the boll.

The bur continues to accumulate K sometimes reaching 5.5 percent concentration at maturity. Burs contain about one-third (37 percent) of the K in the plant at maturity.

P+K Fertilization

W. R. THOMPSON, JR.
Starkville, Mississippi

P is accumulated slowly in the developing cotton plant, but accumulates more rapidly as the plant begins to square. The seed takes up 52 to 62 percent of the total P and about 50 percent of the N. Following are the daily uptake rates of NPK in July.

N 1.30 - 1.76 lbs./A
P 0.15 - 0.31 lbs./A
K 1.85 - 2.97 lbs./A
(California data)

Fertilization of cotton will increase yields, particularly when the soil is deficient in essential nutrients. "Within normal fertilization practices, one may conclude that the use of fertilizer to increase yield will not place much, if

FIGURE 1

Response of cotton to fertilization — fine sandy loam soil near Morton in Cochran County. Soil test: P — very low — 11 pounds P_2O_5 per acre. (Texas)

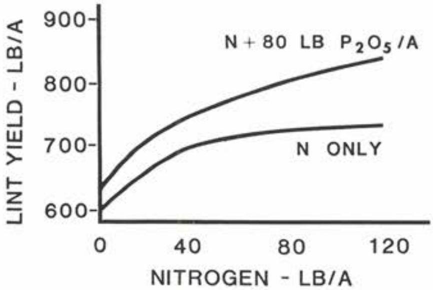


TABLE 1. Plant Food Taken Up by Cotton at Different Stages of Production

Stage of Maturity	Nutrients					
	N		P_2O_5		K_2O	
	lbs.	%	lbs.	%	lbs.	%
Planting to Seedling	10	8	2	3	7	6
Seedling to Early Square	20	14	5	8	30	25
Early Square to Early Boll	56	42	23	38	46	38
Early Boll to Maturity	48	36	31	51	37	31
Totals	134	100	61	100	120	100

Georgia

= More+ Better=Profits!

TABLE 2. Nutrient Content in Cotton at Different Stages of Growth

Stage of Growth	Nutrient Concentration in Dry Matter			
	N	P	K	Mg
	%	%	%	%
Seedling	3.60	0.33	3.29	1.30
Early Square	3.40	0.28	2.49	0.65
Early Boll	2.42	0.24	2.13	0.62
Maturity	1.56	0.17	1.01	0.58

Cecil sandy loam — Georgia

TABLE 3. Effects of P on Yields in First Harvest on Medium and High P Soils

Seed Cotton Yield	P_2O_5 Application Rate in lbs./A		
	0	30	60
HIGH P			
1st Pick lbs./A	1,402	1,555	1,638
Percent of Crop	67.3	71.4	75.3
Total Yield lbs./A	2,083	2,178	2,174
MEDIUM P			
1st Pick lbs./A	987	1,205	1,398
Percent of Crop	44.7	51.1	60.5
Total Yield lbs./A	2,209	2,358	2,308

P level determined by soil test (silt loam soil) — Arkansas

TABLE 4. Effects of K on Quality of Cotton Yield

K_2O Rate lbs./A	Bolls per pound	Micronaire	Fiber Strength g/grex	Fiber Length UHM/inch
0	110	3.70	1.49	1.07
75	80	4.80	1.56	1.11
150	74	4.28	1.57	1.11
300	74	4.23	1.47	1.10

Alabama

TABLE 5. 1971 Seed Cotton Yields

Initial Plowdown K_2O	Annual K_2O rate lbs./A 0	25	50
0 lbs./A			
Yield, pounds per acre	1,140	1,911	2,133
Percent lint	36.7	38.2	38.3
Micronaire	2.6	3.5	3.1
100 lbs./A			
Yield, pounds per acre	1,856	2,543	2,785
Percent lint	38.3	39.4	39.1
Micronaire	2.9	3.6	3.5
200 lbs./A			
Yield, pounds per acre	2,199	2,956	2,949
Percent lint	39.1	39.3	39.1
Micronaire	3.4	4.1	4.7

Missouri

TABLE 6. Production Costs at Different Yield Levels

Yield	Production Costs (cents/pound)
400 lbs.	68¢
550 lbs.	53¢
700 lbs.	43¢

TABLE 7. Effect of Fertilization on Cotton Yields in Tennessee

Fertilizer Rates (lbs./A) N	P_2O_5	K_2O	Seed Cotton Yield lbs./A
0	0	0	791
100	0	0	584
100	24	24	1,005
100	48	48	1,214
100	96	96	1,500

Soil test: P—low; K—low

any, penalty on early harvest and may actually increase even the first pick." (Luckhardt and Ensminger in "Changing Patterns in Fertilizer Use," 1968)

P increased the amount of fruit set during the early fruiting period and resulted in increased yields at first harvest, especially when soils were deficient or low in the nutrient.

In addition to yield, fertilization can improve quality of the cotton harvested. Thus, profits will be even greater. Tests in Alabama showed that plants not receiving K fertilizer were completely defoliated by September 1. K applied to the plant increased boll size, fiber quality and micronaire (mike).

K increased cotton yields, percent

TABLE 8. Effect of N, P, and K on Cotton Yields in Louisiana

Fertilizer Rates (lbs./A)			Seed Cotton Yield	
N	P_2O_5	K_2O	lbs./A	% 1st Pick
0	0	0	1,232	89
32	64	64	1,985	77
64	64	64	1,920	73
64	32	64	1,800	70
64	0	64	1,232	67
64	64	32	1,676	74
64	64	0	1,283	82

Loring silt loam

TABLE 9. Effect of P on Cotton Yields in Alabama

P_2O_5 Rate lbs./A	Seed Cotton Yields lbs./A
0	1,520
20	1,640
40	1,670
60	1,750
100	1,750

TABLE 10. Response of Cotton to Potash in Arkansas

K_2O Rate lbs./A	Plant Concentration of K, %	Seed Cotton Yield lbs./A
0	0.99	1,897
30	1.05	2,083
60	1.15	2,257
90	1.16	2,323

Soil test: K—medium

TABLE 11. Response of Cotton to Potash in the Mississippi Delta

K_2O Rate lbs./A	Lint Yield lbs./A
0	832
60	934

Soil test: K—Low to high (Average on 7 sites)

lint and improved micronaire in a Missouri test.

Fertilizer is the most economical input used to increase yields. As yields increase, cost per pound to produce lint decreases.

A farmer getting 60 cents per pound at the market would lose 8 cents per pound with a 400 pound per acre yield and would make 7 cents per pound with a 550 pound yield. Therefore, high yields are a must for maximizing profits.

Applications of a balanced fertilizer can increase yields and that will increase profits. Data from several southern states indicated the value of good fertility programs.

TABLE 12. Costs and Returns for Fertilization of Cotton

State	Soil	Soil Test	Lint Yield Increase lbs./A	Cost of Treatment $/A	Net Value of Increase $/A	Return %
POTASH						
MS	silt loam	L	114	$14.52	$ 53.88	371
MS	silt loam	M	51	9.48	21.12	223
TN	silt loam	M	104	11.02	51.38	466
AR	silt loam	M	137	16.36	65.84	402
LA	silt loam	VL	242	25.12	120.08	478
AL	fine sandy loam	L	475	47.60	237.40	499
MO	sandy loam	L	399	36.40	203.00	558
PHOSPHATE						
TN	silt loam	L	239	33.52	109.88	328
LA	silt loam	L	216	22.40	107.20	478
AL	fine sandy loam	L	84	16.48	33.92	206
AL	fine sandy loam	H	114	18.72	49.68	265
AR	fine sandy loam	M	193	20.10	95.70	476
TX	clay loam	VL	220	24.00	108.00	450
TX	fine sandy loam	VL	130	23.00	78.00	239

An Alabama test showed that P needs must be satisfied to maximize yields. These results were produced using varying rates of P with applications of 100 pounds of N and 100 pounds of K_2O per acre per year. Results are average yields for 8 locations over 8 test years.

In Texas, response to applications of nitrogen was greater when P was applied. There was no response to N applied at greater than 40 pounds per acre when P was omitted. However, when P was added, significant yield increases were obtained at all N application rates.

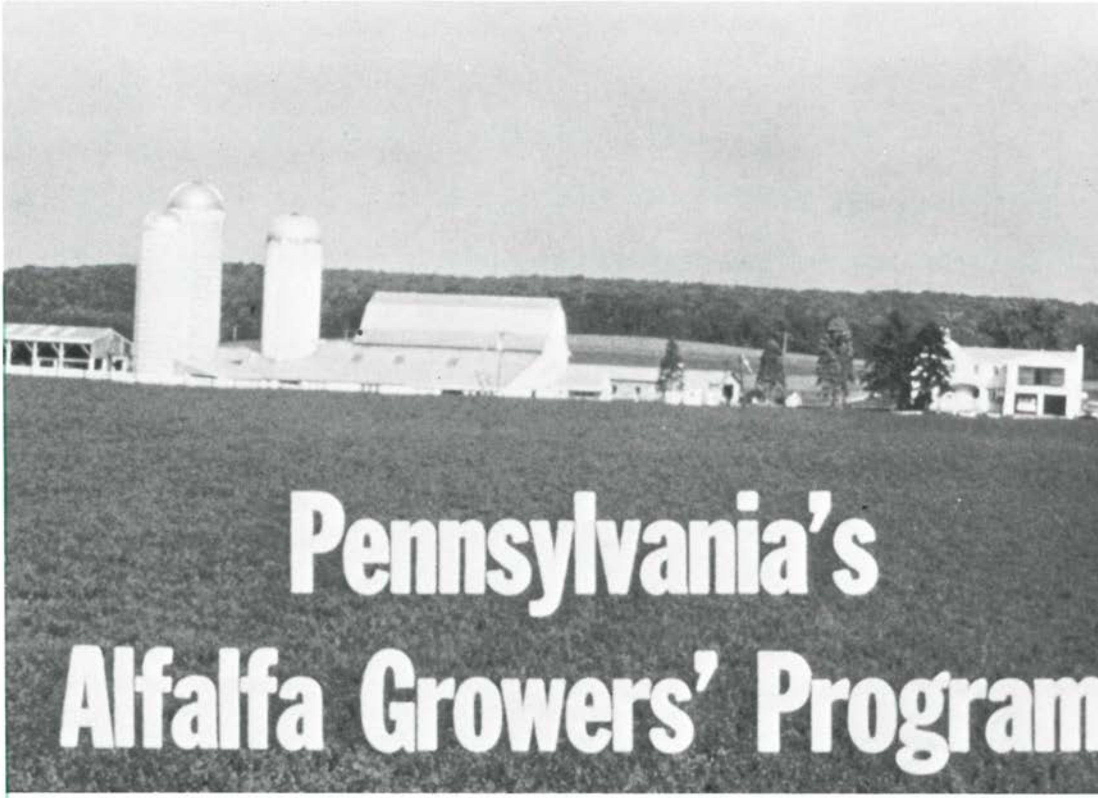
Research in Arkansas and Mississippi indicated that cotton responds well to potash, even on the fertile Mississippi Delta soils.

WHAT ABOUT COSTS AND RETURNS? It costs about $300-400 to produce an acre of cotton. Figuring 100 pounds of N, 80 pounds of P_2O_5, and 80 pounds of K_2O per acre at a cost of $35, this makes the cost of fertilizer only about 8 to 12 percent of total cash costs.

The first 50 to 60 pounds of increased lint yield would pay fertilizer costs with cotton selling at 60 cents per pound.

Sound economical? Fertilizer cost is a small slice of the pie of production costs in the cotton budget. Yet, tests show fertilizer applications to yield good returns on your investment dollar.

While banks, savings and loan associations and other investments yield about 5 to 10 percent return, fertilizer can yield from 200 to 500 percent for cash invested. **The End**



Pennsylvania's Alfalfa Growers' Program

JOHN E. BAYLOR, W. K. WATERS, L. E. LANYON
Pennsylvania State University

ALFALFA is the most important forage legume in Pennsylvania.

In 1978, some 840,000 acres were harvested for hay or silage—BUT the 2.8 ton average yield falls far below our great state's potential.

Several years ago, progressive young Pennsylvania alfalfa growers started asking, "What is the real yield potential of alfalfa in Pennsylvania? And how can we reach it?"

We decided to find out, with the help of these and other top growers.

So, in 1977, after two years of field study, we launched a statewide competitive Alfalfa Growers' Program.

The purpose? To measure just how much alfalfa hay, protein, and energy an acre of Pennsylvania land will produce. To learn more about nutrient uptake under farm conditions. To develop more reliable on-the-farm data on alfalfa production costs.

In 1977, 37 growers completed all requirements. In 1978, 52 growers completed all the steps.

MEASURING YIELDS was done by taking six random 1/1,000 acre samples from the swath of a selected 5-acre block using a special measuring device designed for the Pennsylvania Forage and Grassland Council.

Yields are measured by taking 1/1000 acre samples from 7, 9 or 12 foot swath, using this special measuring device.

Composite moisture samples were taken for each harvest and were in turn used for quality determinations. Quality data included crude protein, ADF, TDN, and a complete mineral analysis. Per acre yields of hay equivalent, protein, and TDN were calculated as was nutrient removal for all major elements. Cost of production data was collected for both years.

HAY YIELDS topped 8 tons/A in 1977. They ranged from 3.3 to 8.1 tons/A for the 37 participants. They averaged 5.5 tons in 1977.

In 1978, yields ranged from 3.0 to 8.7 tons. And, again, the 52 growers averaged 5.5 tons.

Pennsylvania's top grower in 1977, Harold Gaymen, a Franklin County Dairyman, produced an estimated 8.1 tons of alfalfa hay equivalent; 3,133 pounds of protein; and nearly 9,300 pounds of TDN per acre.

In 1978 our top grower, I. Hershey Bare, a Dairyman from Lebanon County, produced an estimated 8.7 tons of alfalfa hay equivalent; 3,268 pounds of protein; and over 9,700 pounds of TDN per acre.

Four other participants in 1977 and six other participants in 1978 had per acre hay equivalent yields of seven or more tons.

HIGH NUTRIENT REMOVAL goes with high yields. In 1977, P_2O_5 removal was in line with established values, 70 to 80 lbs per acre, with a top removal of 105 lbs.

In 1978, P_2O_5 removal ranged from 46-112 lbs per acre, with an average of 78 lbs removed.

Potash removal varied with yield both years: Averaging 347 lb/A in 1977, with a range of 150 to 500 lb/A. Averaging 367 lb/A in 1978, with a range of 174 to 629 lb/A.

The alfalfa removed 67 lb/ton average last year, with one high yielding form removing 78 lb/ton.

TOP PRODUCTION demands top management. High yields don't just happen. A brief review of the 10 top growers in 1978 shows why.

1. The top 10 averaged 7.3 tons hay, 1.42 tons crude protein, and 4.07 tons TDN per acre.

2. They used six different varieties, all known to be high yielding in the state.

3. The top 10 are located on well-drained soils known to be well suited to alfalfa, with 9 out of the 10 fields on limestone soils.

4. They limed and fertilized for establishment and for maintenance according to soil tests — and high applications of manure in the crop before alfalfa were the rule.

5. The top 10 made four cuttings in 1978. Three stored all harvests as silage. Eight stored one or more cuts in the silo.

First cut came at prebud to bud stage in late May to early June. Average interval between cuts was 36 days between 1 and 2, 39 days between 2 and 3, and 45 days between 3 and 4 cuts.

6. The top 10 all sprayed for insects, mainly leafhoppers, at least once during the year. Seven of the growers sprayed two or more times. Insect control was a big key to high yields.

COSTS IN SUMMARY. Production costs for 30 of the 1977 participants were also summarized.

Briefly, the total annual cost of growing and harvesting alfalfa in 1977 was \$173 per acre, just a dollar more than the per acre costs in the 1977 5-Acre Corn Club.

Machine costs, fertilizer, the land charge, and labor accounted for 86% of the total cost. The average annual per acre fertilizer bill on these farms was \$33.93, nearly 20% of the total cost.

Original establishment costs totaled nearly \$103 per acre. When prorated over the estimated stand life (4.8 years) the annual establishment cost totaled \$21 per acre.

The average labor requirement for growing, harvesting, and storing the alfalfa crop was about 7.3 hours per acre, or about 1.5 hours per ton harvested, considerably less than the 11 to 14 hours per acre estimated from earlier studies.

To help offset some of the costs of our Program, an entry fee of \$50 was paid by each participant with many growers sponsored or co-sponsored by a local seedsman or fertilizer dealer.

IN SUMMARY, we're pleased with what we've learned to date. We've encountered some problems with field sampling and weighing. And our data indicates we need more information on desirable plant nutrient levels, including micronutrients.

Low yields obtained over the past two years were generally from soils considered marginal for alfalfa, or where rainfall during the growing season was limited.

For the 1979 Program rain gauges have been set up at each location in an effort to better correlate yields with soil and moisture conditions. **The End**

Over 1,200 readers have replied so far to our survey on this journal. We are very grateful to those who advised us. If you have the last issue handy (Winter 1978-79), check the question form on Page 12 and let us know your opinions. We will welcome whatever advice you have.

EDUCATIONAL AIDS
FOR FALL-WINTER FERTILIZATION

SEND US:

	Quantity	Amount
Folders—15¢ ea. (MC 10¢)*		
Know Plant Food Your Soybeans Take Up	______	______
Higher Yields from Fertilization Mean Less Cost/Bu	______	______
Why Fall-Winter Is Best P-K Buildup Time	______	______
Booklets—20¢ ea. (MC 15¢)*		
Potassium for Agriculture	______	______
Phosphorus for Agriculture	______	______
Wall Charts—20¢ ea. (MC 15¢)*		
Every Season Fertilization	______	______
Soybeans Get Hungry, Too	______	______
Slide Set—$15 Per Set (MC $10)*		
Facts Point To Fall Winter Fertilization—(37 sl.)	______	______

Payment Enclosed $______________. (No shipping charges.)

Bill us __________. (Add shipping charge to invoice.)

*Member Cost. This price extended to member companies of the Potash & Phosphate Institute, to colleges, universities and government agencies.

Name______________________ Address______________________

City______________________ State__________ Zip__________

Organization______________________________________

Potash & Phosphate Institute, 2801 Buford Hwy., N.E., Suite 401, Atlanta, GA 30329

Better Crops
WITH PLANT FOOD

Potash & Phosphate Institute

2801 Buford Hwy., N.E., Suite 401, Atlanta, GA 30329

Controlled circulation postage paid at Atlanta, GA