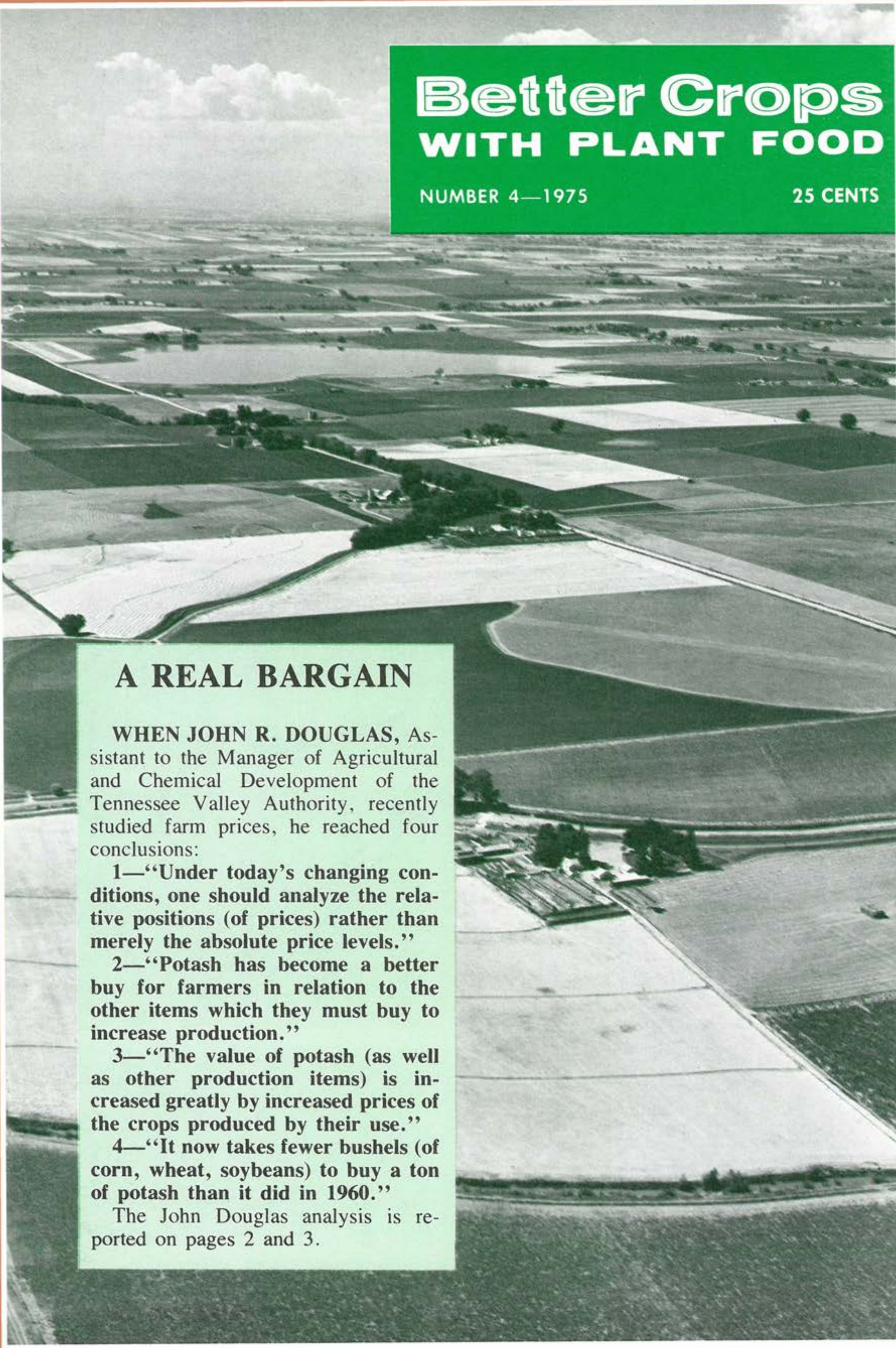
Better Crops WITH PLANT FOOD

NUMBER 4—1975 25 CENTS



A REAL BARGAIN

WHEN JOHN R. DOUGLAS, Assistant to the Manager of Agricultural and Chemical Development of the Tennessee Valley Authority, recently studied farm prices, he reached four conclusions:

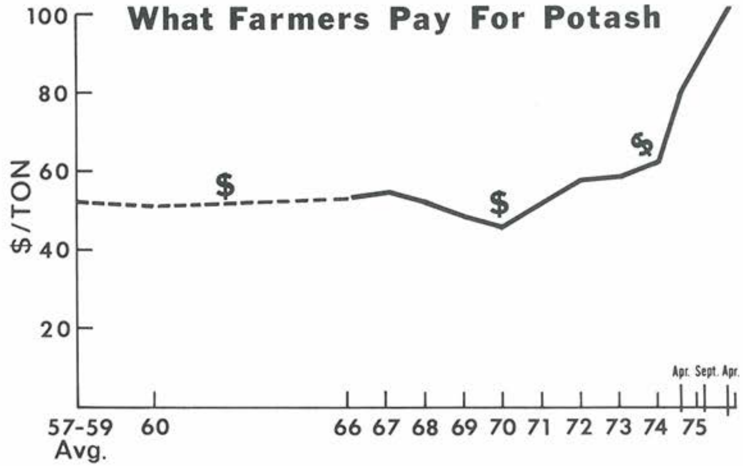
1—"Under today's changing conditions, one should analyze the relative positions (of prices) rather than merely the absolute price levels."

2—"Potash has become a better buy for farmers in relation to the other items which they must buy to increase production."

3—"The value of potash (as well as other production items) is increased greatly by increased prices of the crops produced by their use."

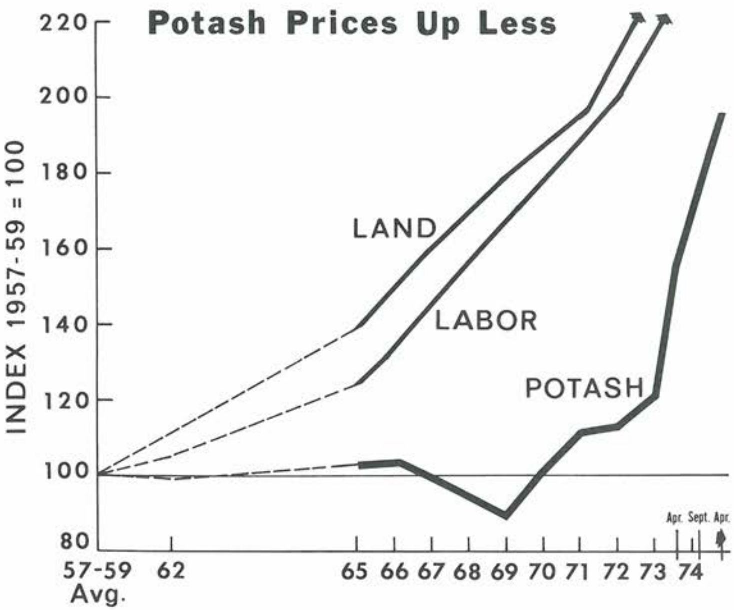
4—"It now takes fewer bushels (of corn, wheat, soybeans) to buy a ton of potash than it did in 1960."

The John Douglas analysis is reported on pages 2 and 3.



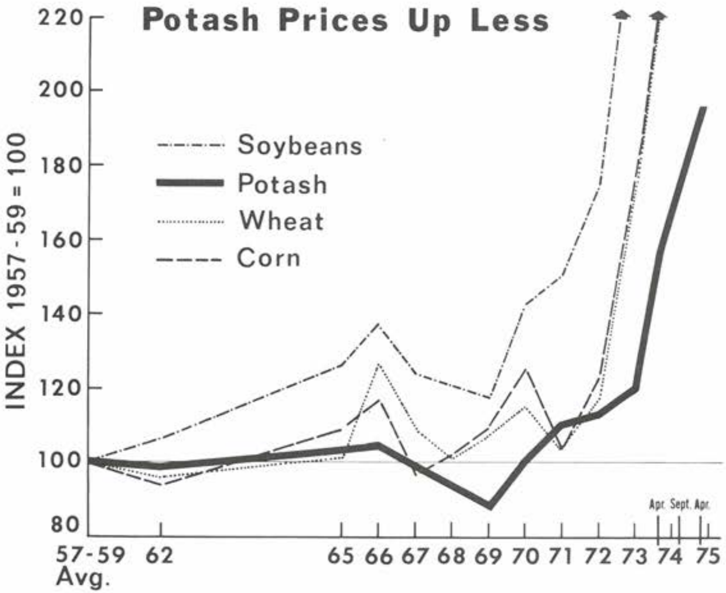
Potash Prices Have Gone Up. . .

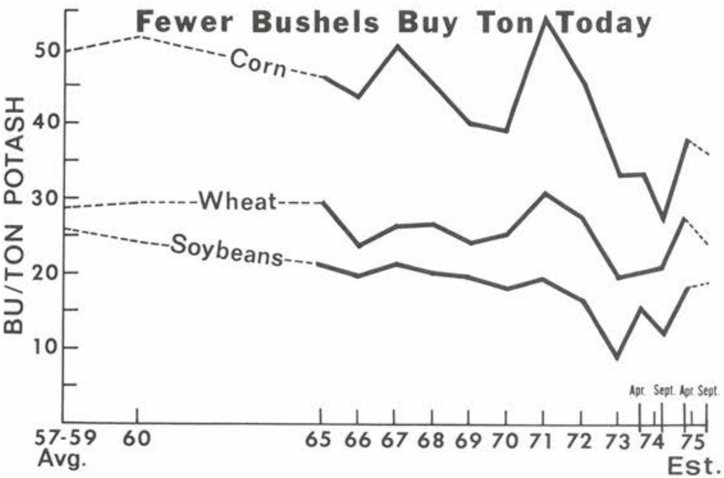
WHY DOES A TON OF POTASH cost the farmer more today than in the past 20 years . . . $102 average last April (1975) compared to $60 a ton at the farm in the 50's and 60's? Three factors stand out: (1) General inflation—higher taxes, freight rates, wages, and all other costs. (2) Potash prices remaining almost static during the 50's and 60's. (3) Oversupply in late 60's depressing prices to an all-time low. Under such changing conditions, RELATIVE PRICE LEVELS make potash a real bargain.



Less Than Most Farm Items

EVEN WITH THEIR 1974-75 SURGES, potash prices have remained lower than most other items used by farmers. Look at land prices. More than double from the late 50's to 1973. And wages, what the farmer must pay for labor. Also more than double over the same period. And they CONTINUE UP, seemingly without brakes. Nearly all other items farmers use show the same trend. When we place potash on this inflationary rocket, it becomes the best buy on the scale.





Less Than Most Crop Prices

CROP PRICES WENT UP BEFORE potash prices. And much *more*. On many crops that receive most of the potash. Let's look at three between *1971* and late *1974*. *CORN:* Tripling from $1.08 to more than $3 bu. It still hangs around $3. *WHEAT:* More than doubling from less than $2 to well over $4 bu. It still hangs close to $4. *SOYBEANS:* More than doubling from about $3 to over $7 bu. And in September 1975, they brought over $5 bu. Such soaring crop prices increase the value of potash and other inputs that produce top-profit yields.

So . . . It Takes Fewer Bushels To Buy A Ton of Potash Today

THE RELATIVE VALUE OF POTASH comes alive when you figure how much corn or wheat or soybeans it takes to buy a ton of potash. *CORN:* Through 1972, between 40 to 50 bu. to buy 1 ton. In 1973, 74, and 75, less than 40 bu. to buy a ton, even at highest potash prices. *WHEAT:* Less bushels to buy a ton today than 1960. *SOYBEANS:* About 18 bu. to buy a ton in April 1975, but 25 bu. during the 1957-59 base period. This will not hold for all crops. But for major potash-using crops, farmers will find a real bargain in potash.

Better Crops
WITH PLANT FOOD

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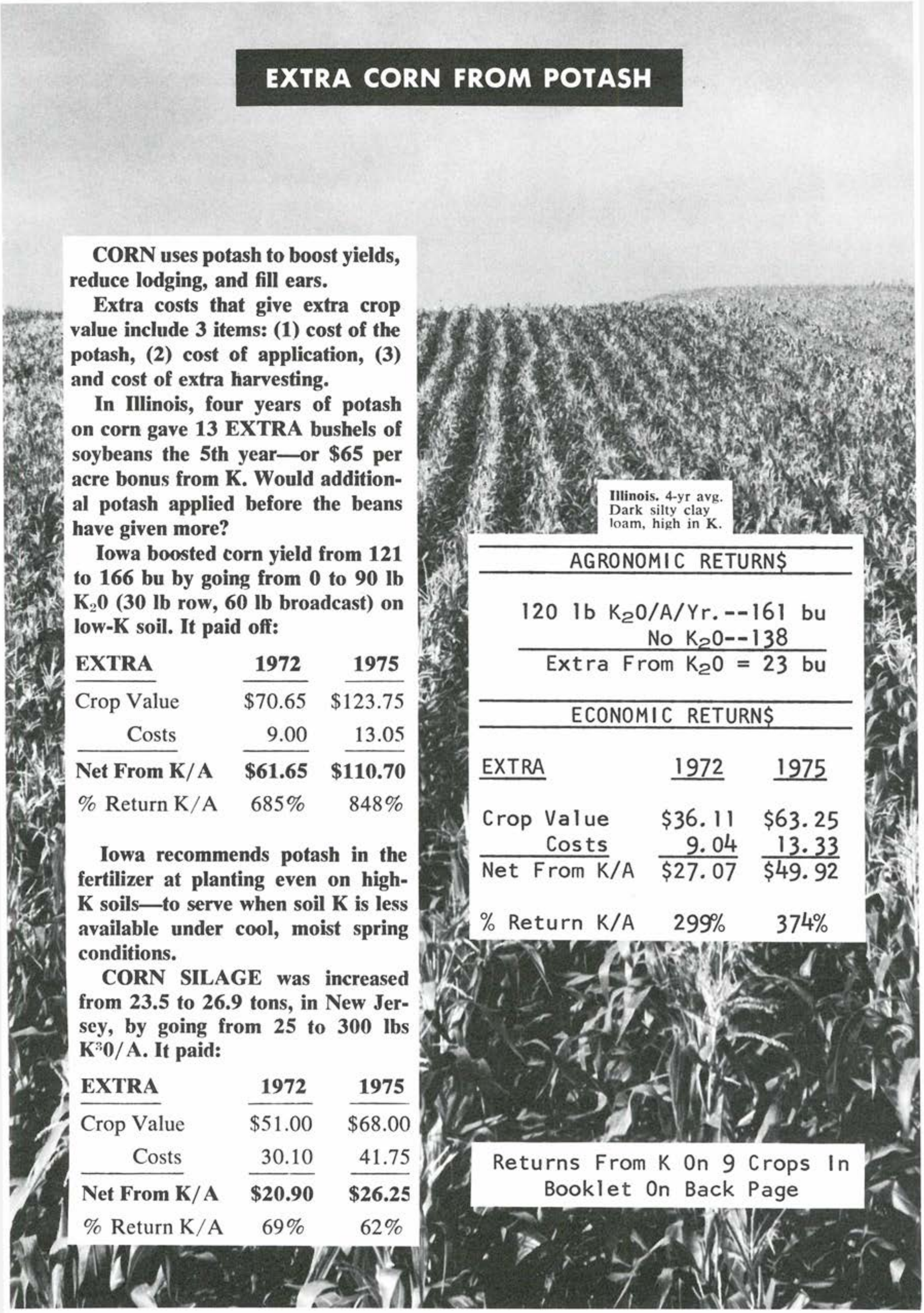
EXTRA CORN FROM POTASH



CORN uses potash to boost yields, reduce lodging, and fill ears.

Extra costs that give extra crop value include 3 items: (1) cost of the potash, (2) cost of application, (3) and cost of extra harvesting.

In Illinois, four years of potash on corn gave 13 EXTRA bushels of soybeans the 5th year—or $65 per acre bonus from K. Would additional potash applied before the beans have given more?

Iowa boosted corn yield from 121 to 166 bu by going from 0 to 90 lb K_20 (30 lb row, 60 lb broadcast) on low-K soil. It paid off:

EXTRA	**1972**	**1975**
Crop Value	$70.65	$123.75
Costs	9.00	13.05
Net From K/A	**$61.65**	**$110.70**
% Return K/A	685%	848%

Iowa recommends potash in the fertilizer at planting even on high-K soils—to serve when soil K is less available under cool, moist spring conditions.

CORN SILAGE was increased from 23.5 to 26.9 tons, in New Jersey, by going from 25 to 300 lbs K^30/A. It paid:

EXTRA	**1972**	**1975**
Crop Value	$51.00	$68.00
Costs	30.10	41.75
Net From K/A	**$20.90**	**$26.25**
% Return K/A	69%	62%

Illinois. 4-yr avg. Dark silty clay loam, high in K.

AGRONOMIC RETURN$

120 lb K_2O/A/Yr.--161 bu
No K_2O--138
Extra From K_2O = 23 bu

ECONOMIC RETURN$

EXTRA	1972	1975
Crop Value	$36.11	$63.25
Costs	9.04	13.33
Net From K/A	$27.07	$49.92
% Return K/A	299%	374%

Returns From K On 9 Crops In Booklet On Back Page

Reduce Lodging with POTASSIUM

3rd IN STRESS SERIES

NOBLE R. USHERWOOD
ATLANTA, GEORGIA

WHEN STALKS BEGIN to bend and break, profits begin to bend and break—in many ways.

Through premature slowdown in grain-fill . . . decline in yield . . . increase in harvest time, labor, and machine wear . . . and greater weather gamble with each additional day of harvest.

So, lodging means more than higher grain losses. It means more work for less profit.

SEVERAL CONDITIONS accompany lodging. Let's look at some:

1—Nitrogen fertilization. Top grain production demands it. But lodging often goes with it. Recent studies show it pays to delay nitrification—to keep the ammonium from becoming nitrate as long as possible. **Table 1** shows this helps reduce lodging in corn. **Table 2** shows stalk rot from Diplodia or Pyth-

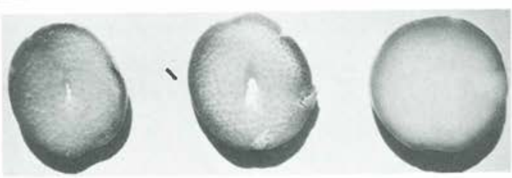


FIGURE 1—With added K (160+70+133), a solid, healthy stalk develops, shown from Wisconsin plots taken Sept. 20.

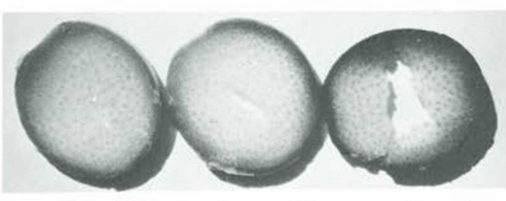


FIGURE 2—Without added K, stalk tissue steadily breaks down under NK (160 lb N+70 lb P). Soil tested 132 lb Exch. K medium.

ium disease increasing under **nitrate** **(NO_3)** but stalk rot from Fusarium increasing under ammonium (NH_4). This simply says no one form of nitrogen discourages or encourages all diseases associated with lodging.

Many factors influence this relation of N form to lodging: Host preference. Previous cropping history. Nitrogen rate and stability. Residual nitrogen. Time of application. Soil microflora present. Ammonium/nitrate ratio. Or the existing disease complex.

2—Potassium deficiency. Many studies have tied potassium hunger to plant lodging—through stalk deterioration and disease infestation.

Modern farming—higher nitrogen rates and greater plant populations to get the best possible yields—can create potash deficiency fast. When adequate potash is applied, lodging often declines.

Take Tennessee work, for example. When potassium was applied to corn plots receiving 120 lb N/A, yields increased 18 bu/A and lodging decreased 11%, from a costly 20% down to 9%. Potassium cut lodging losses in half.

Illinois experienced the same influence. When a soil testing 280 lb K/A received 120 lbs K_2O/A each year for 4 years, it averaged 16 bushels MORE CORN per acre yearly and suffered less lodging 3 out of the 4 years. Potassium cut lodging losses in half the last 2 years, a notable fact the last year when Southern Corn Leaf Blight swept the Midwest. **Table 3** documents this.

And in **Table 4,** Wisconsin documents the help potassium (K) gives balanced (NPK) fertilization. With K on the NPK team, stalks and roots lodged only 11% and plants produced 85% brace roots above ground. Without K, the crop suffered 78% total lodging and developed just 42% brace roots above ground. Potassium doubled the brace root system.

Kansas decreased severe grain sorghum lodging in 2 locations, moderate lodging in 3 locations with potassium fertilization. **Table 5** documents this. Some of the fluctuations in lodging severity may be traced to climatic conditions.

Why does potassium reduce lodging so well? In Iowa tests, it improved stalk diameter and strength. In Tennessee, it improved rind thickness and stalk crushing strength and reduced the number of dead stalks at harvest. **Table 6** documents this.

In Wisconsin tests, corn stalks suffering potassium deficiency deteriorated internally much faster than stalks receiving adequate K. **Figures 1 and 2** show this premature breakdown, of parenchyma tissue, progressing more rapidly as the plant approached maturity. The microscope showed no disease invasion. So, potassium deficiency appears to be the problem.

3—Differences in varieties. Grain sorghum, corn, and wheat varieties differ widely in lodging susceptibility. All 73 varieties of Kansas grain sorghum differed in deterioration of the stalk base at harvest. The Tennessee corn lodged when the stalk pith near the stalk base disintegrated. Of the 70 hybrids tested, some lodged before grain fill, some after fill, and some relatively little.

Why such differences in hybrids? The parenchyma tissue and the pith tissue deteriorate faster from certain deficiencies in some hybrids than in others, perhaps.

Figure 3 shows the advance of parenchyma cell breakdown is delayed more by potassium than by the chloride treatment in all 3 hybrids. We also know genetically different corn lines contain different levels of organic nitrogen and sugar in their pith tissue—and the sugar content declines differently in different lines.

TABLE 1. Effect of delayed nitrification on corn yield and lodging.

Treatment	Grain Yield	Lodging
120# N/acre	100 bu/acre	39%
200 "	126 "	35
120 " *	140 bu/acre	13%
200 " *	157 "	14

*With nitrification inhibitor.

Table 2. Effect of inorganic forms of nitrogen on plant diseases.

Crop	Disease	Form of Nitrogen NO_3	NH_4
CORN	Stalk rot (Diplodia)	**Increase**	**Decrease**
	Stalk rot (Fusarium)	D	I
	Root rot (Pythium)	I	D
	Northern leaf blight (Helminthosporium)	D	I
SOYBEANS	Root rot (Aphanomyces)	D	I
	Cyst nematode (Heterodera)	I	D
WHEAT	Root rot (Fusarium)	D	I
	Take all (Ophiobolus)	I	D
COTTON	Root rot (Phymatotrichum) ..	I	D
	Wilt (Fusarium)	D	I

Table 3. Effect of annual application of potassium on yields and lodging of corn.

YEAR	YIELD (Bushels/acre)		LODGING (%)	
	Control	**120 lb K_2O/Ac**	**Control**	**120# K_2O**
1967	148	164	56	60
1968	148	165	30	25
1969	151	167	30	16
1970	104	120	52	27

Table 4. Effect of nitrogen, phosphorus and potassium on field corn, lodging and brace root development.

Treatment (lb/a)			Lodging (%)			Brace Roots
N	**P**	**K**	**Root**	**Stalk**	**Total**	**Above Ground (%)**
160	0	0	24	14	38	42
160	0	133	3	0	3	79
160	70	0	50	28	78	42
160	**70**	**133**	**10**	**1**	**11**	**85**

Table 5. Effect of potassium on yield and lodging of grain sorghum.

K_2O Lb/A	ALLEN CO.—1971		LABETTE CO.—1972		CHEROKEE CO.—1973	
	Lodging %	Grain Yield bu/acre	Lodging %	Grain Yield bu/acre	Stalk Deterioration %	Grain Yield bu/acre
0	88	95	78	64	22	52
40	71	105	—	—	20	61
80	45	108	55	71	26	72
160	16	107	50	75	16	76
320	2	106	48	82	4	83

Table 6. Influence of potassium on stalk quality.

K_2O lbs/acre	Rind Thickness cm $\times 10^3$	Crushing Strength (Kg)	Dead Stalks Harvest (%)
0	91	254	77
60	97	349	64
120	100	374	55

4—Planting Date. This can affect lodging potential. Early planted corn hybrids are often shorter—with sturdier stalks, less insect damage, more favorable response to nitrogen, and greater yield potential.

For example, European corn borer damaged 39% more of the crop planted May 26 than April 14 in Kansas trials. **Table 7** documents a similar trend in Missouri. Insect damage not only weakens plant structure, but also creates an expressway for stalk rot pathogens to enter the plant.

5—Plant Population. It must use the sun's energy for fullest possible yields. Plant populations differ widely because hybrids differ widely in size, shape, and genetic potential.

A high plant population will generally have taller plants with smaller stalk diameter and higher lodging potential. Nebraska workers found stalk diameter 15 to 20% greater at 16,000 than at 32,000 corn plants per acre. Lodging tends to increase with plant population. **Table 8** documents this in Nebraska and Kentucky.

6—Chloride Involvement. The

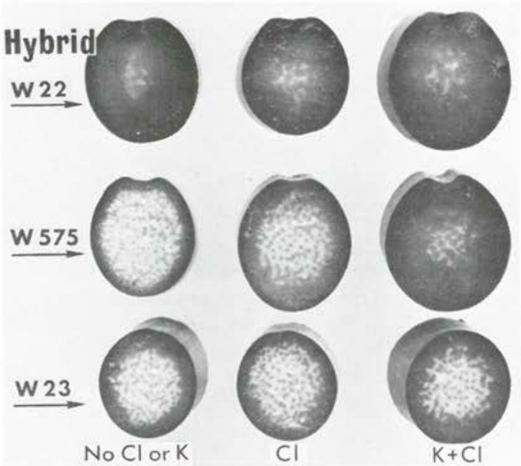


FIGURE 3—Pith condition of 2nd internodes in 3 corn lines 19 weeks after planting shows cell breakdown is delayed more by potassium than by chloride treatment in all 3 hybrids.

Table 7. Relation between planting date and corn borer infestation.

Planting Date (corn)	European Corn Borer (Tunnels per 10 plants)
APRIL 1	24
APRIL 20	27
MAY 10	44
JUNE 1	61
JUNE 20	69

*Nine year average of four maturity dates.

Table 8. Effect of plant population on corn lodging.

Plant Population Per Acre	NEBRASKA	Lodging
16,000		18%
24,000		29
32,000		45
	KENTUCKY (2 yr av. of 40 hybrids)	
	Lexington	Princeton
18,000	8.7%	10.2%
22-24,000	18.9	20.3

Table 9. Influence of chloride from ammonium and potassium sources on corn lodging and yield.

	Yield	Lodging
No K or Cl	5.5t/ha	64%
NH_4Cl	—	64
KCl	**7.2**	**16**

Table 10. Effect of nitrogen and potassium on malting barley yield.

Broadcast N Lb/A	Row K—Lb/A 0	12.5	25
		Bu. Barley	
0	35.6	35.0	39.9
30	40.6	47.1	44.0
60	44.6	47.7	47.0

N. Dakota

chloride ion has been considered to suppress disease because it inhibits or delays nitrate nitrogen uptake by the plant. Yet, sweetcorn studies show nitrate nitrogen did not affect disease control. **Table 2** showed the relation of nitrate nitrogen to disease varies widely with crop and disease.

Table 9 documents two effects on lodging—KCl vs. chloride ion alone. It confirms less lodging is due primarily to potassium and not chloride.

7—Carbohydrate Concentration. Some suggest the corn stalk's pith tissue degenerates because sugar level declines. Such degeneration, of course, increases susceptibility to stalk rot and lodging.

Detailed studies have shown KCl influences carbohydrate concentration in 3 ways: (1) Increases total sugar content of pith tissue for about 15 weeks after planting. (2) Decreases the reducing sugar concentration. (3) Increases the total organic nitrogen level of the second internode pith tissue.

HOW MUCH K IS NEEDED to balance nitrogen and reduce lodging? That depends on the rate of nitrogen, soil traits, and environmental influences.

In North Dakota and Manitoba the application of 25 lbs/acre of K to a soil very high in exchangeable K reduced lodging of malting barley, increased plant response to applied nitrogen and boosted grain production (See Table 10).

Both **Figure 4** and **Table 11** show how corn continued to respond to increased nitrogen as long as potassium rates kept up with nutritional needs.

FOR BEST HARVESTS, keep an eye on:

(1) Best variety for local conditions. (2) Early planting for head start on insects and disease and most efficient

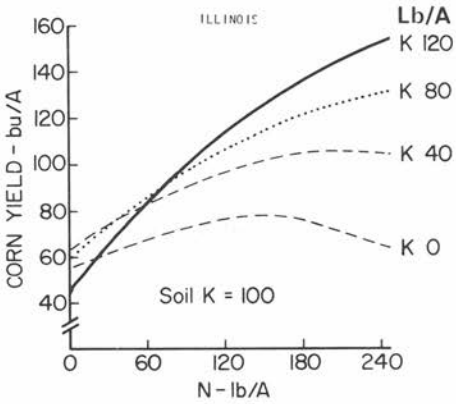


FIGURE 4—Corn continued to respond to increased nitrogen as long as potassium rates kept up with nutritional needs.

fertilizer use. (3) Plant population for most efficient light use and best yield potential. (4) Balanced fertility for best yields and lodging resistance. (5) Good disease, insect, and weed controls. (6) Crop rotation consciousness to make sure grain crops following potash-greedy forage crops have enough potassium.

COSTS OF PRODUCING crops will continue to rise regardless of their market value. So, the farmer must get more results from EACH ACRE OF WORK.

Table 12 documents this. Boosting corn yield from 94 to 122 bushels per acre did two things: Cut costs 20¢ per bushel and gave 28 more bushels from each acre to market.

LODGING COSTS THE FARMER. For example, let's slow the ground speed of a 4-row (30-inch) combine just a half mile per hour to gather lodging stalks. What happens? We get "behind" 6 acres a day or nearly 20% of our harvest capacity. On 600 acres of corn, this can cost 5 days of harvest and 20% more labor, equipment use, and weather risk.

Table 11. Effect of nitrogen and potassium on corn yield and stalk breakage.

K_2O Applied (Lbs/A)	Nitrogen Applied (Lbs/A) 0	80	160
	Yield (bu/A)		
0	48	33	38
80	73	116	119
160	59	122	129
	Stalk Breakage (%)		
0	9	57	59
80	4	3	8
160	4	4	4

Table 12. Relation between corn yield and costs of producing, harvesting and marketing the crop.

Yield Bu/A	Cost Per Bushel Growing	Harvesting	Marketing	Total
94	$1.06	$0.21	$0.37	$1.64
122	0.92	0.17	0.35	1.44

Lodging may never be completely conquered. But it can often be turned from a major menace into a minor loss by being more potash-conscious. **The End**

DO YOU KNOW . . .

. . . if this magazine's current series on **STRESS** can be used by your school or company or state? For mailings, meeting handouts, teaching and talks, radio and press use—scientific facts to face stresses, not promotion gimmicks.

If you are interested in such a booklet, see commitment form on page 16.

POTASH

$60 MILLION POTENTIAL FOR FARMERS

BETTER THAN 600% RETURN ON THE INVESTMENT

EARL SKOGLEY
MONTANA STATE UNIVERSITY

MONTANA GROWERS are applying less than 4% of the potash (under 3,500 tons in 1974) that their crops could use effectively and economically.

The producers could be receiving $60 million MORE income from proper potash use—or $6.50 from each $1 invested in potash, research results indicate.

These figures came from combining the results of many field experiments with cropping and crop price statistics throughout the state.

Most Montana growers use a "zero potash" fertilizer. This seems logical when most of the state's soils test "high K." But research results are piling up to indicate Montana crops DO NOT get the potash they need for top yields.

During the past 15 years, many experiments have been conducted with potash fertilizers at the Montana Experiment Station, its Research Centers, and on farms all over the state. These experiments represent enough soils and cropping conditions to give a reliable sample of the whole state.

TABLE 1 ESTIMATES potential potash fertilizer use for major crops. To estimate acres responsive to potash (K_2O), we multiplied planted acreage of each crop by its frequency of response to K_2O. To get potash fertilizer use potential, we multiplied the responsive acres by the average recommended rate of K_2O, remembering muriate of potash (KCl) contains 60 to 62% K_2O.

If muriate of potash costs about $100 a ton, our results show Montana growers could profitably invest $9.3 million a year in potash. A big investment at first glance—but a *paying* one when you calculate the potential return of $6.50 from each $1 spent on potash or 650% gross return.

TABLE 2 ESTIMATES potential farm income increase from proper potash use. To estimate this potential increase, we first multiplied average yield increase from recommended potash by the number of acres responsive to potash. This value was then multiplied by the price of product. All 10 crops added up to a whopping $60 million MORE income potential for Montana's farm population.

Such added income, of course, always enlarges as it changes hands through the economy. So, this potential becomes even greater for the state's general economy.

We realize there are some assumptions in this analysis which, if proven incorrect, will alter results.

1. For example, we use 1973 crop prices. Some of these prices were somewhat better in 1973 than they are today.

2. For example, we believe research data collected over the past 15 years can tell us reliably how often and how much a crop will respond to potash fertilization.

But even if errors, price fluctuations,

TABLE 1 – POTENTIAL POTASH FERTILIZER USE FOR SEVERAL IMPORTANT CROPS.

CROP	1973 Planted Acreage[1]	Frequency of Response to K_2O[2]	Ave. Rec. Rate of K_2O[2]	Potash Fertilizer Use Potential
	State Total	%	lb K_2O/A	Tons K_2O/yr
Winter Wheat	2,200,000	50	24	13,200
Barley	2,100,000	42	24	10,584
Spring Wheat	1,850,000	26	24	5,772
Durum	185,000	25	24	554
Oats	510,000	25	24	1,530
Alfalfa (hay & seed)	1,250,000	50	60	18,750
Other Hay	540,000	25	36	414
Oats	510,000	25	48	3,240
Corn	92,000	25	36	414
Sugar Beets	45,900	50	96	1,102
Potatoes	7,000	72	120	302
		Total	55,862 T of K_2O = 93,103 T muriate of potash (60% K_2O)	55,862

[1]From Montana Agricultural Statistics, Vo. XV. County Statistics, 1972 & 1973. Montana Department of Agriculture and Statistical Reporting Service, Helena, Montana, Dec., 1974.

[2]From results of field trials over 15 years under a wide range of conditions.

TABLE 2 – POTENTIAL FARM INCOME INCREASE FROM PROPER K USE.

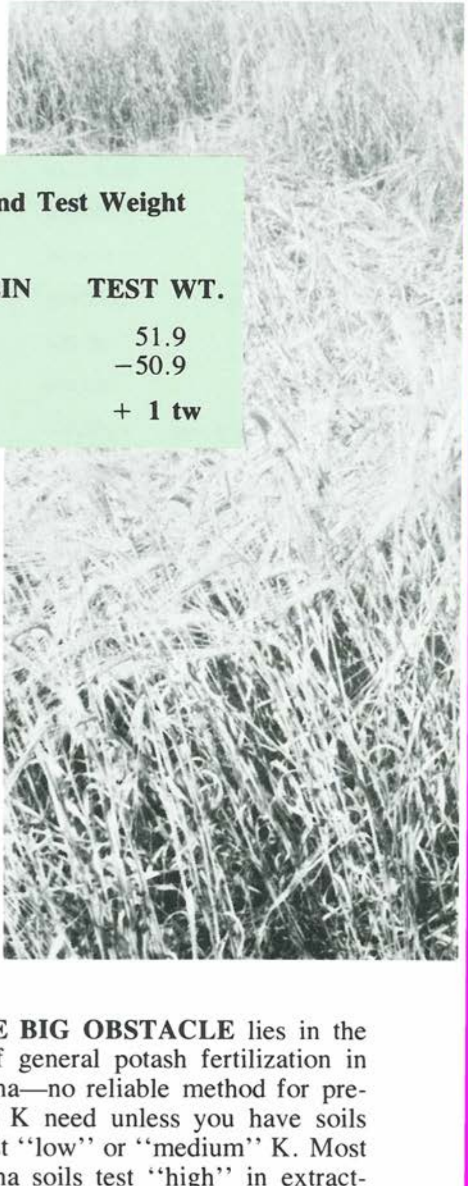
CROP	Acreage Responsive To K_2O In State 1/	Av. Increase From Rec. K_2O Rate 2/	Price of Product 3/	Potential Increase In Income
Winter Wheat	1,100,000	3.9 bu/A	$ 4.30/bu	$18,447,000
Barley	882,000	3.7 bu/A	2.20/bu	7,179,480
Spring Wheat	481,000	4.2 bu/A	4.15/bu	8,383,830
Durum	46,250	4.0 bu/A	5.65/bu	1,045,250
Oats	127,500	4.0 bu/A	1.20/bu	612,000
Alfalfa Hay	610,000	0.5 T/A	60.00/T	18,300,000
Other Hay	135,000	0.5 T/A	55.00/T	3,712,500
Corn	23,000	2.0 T/A (Silage)	14.00/T	644,000
Sugar Beets	22,950	225 lb Sugar/A	.13/lb	671,290
Potatoes	5,040	25 Cwt/A	10.80/Cwt	1,360,800
			Total	$60,356,150

[1]Calculated from data of Table 1. [2]From results of field trials during past 15 years. [3]1973 Agricultural Statistics or estimates from available information.

or other situation changes cut this \$6.50 return in half, \$3 for \$1 invested still makes potash a good buy.

Barley Produces More Bushels, Protein, and Test Weight With Potash: 40-50-*100*

FERTILIZER	BU/A	GR. PROTEIN	TEST WT.
40-50-100	70.4	12.3%	51.9
40-50-0	−64.8	−11.5	−50.9
Net From K/A	**+ 5.6 bu**	**+ 0.8%**	**+ 1 tw**



One agronomic fact of life must be remembered: If nitrogen (N) or phosphate (P_2O_5) are **inadequate,** don't expect results from potash fertilization to be as good as those in Tables 1 and 2. Research has proved Montana crop yields could be increased very significantly if all farmers applied recommended N and P_2O_5—meaning a multimillion dollar increase in farm income. Then, with proper NPK balance, the net return could reach much more than the estimated \$60 million from potash fertilization.

WHEN WE ADD the influence of potash on crop quality, we justify its use even more. For example:

1. In 49 malting barley experiments since 1962, adding 30-40 lb K_2O/A increased plump kernels more than 5% in 80% of the trials.

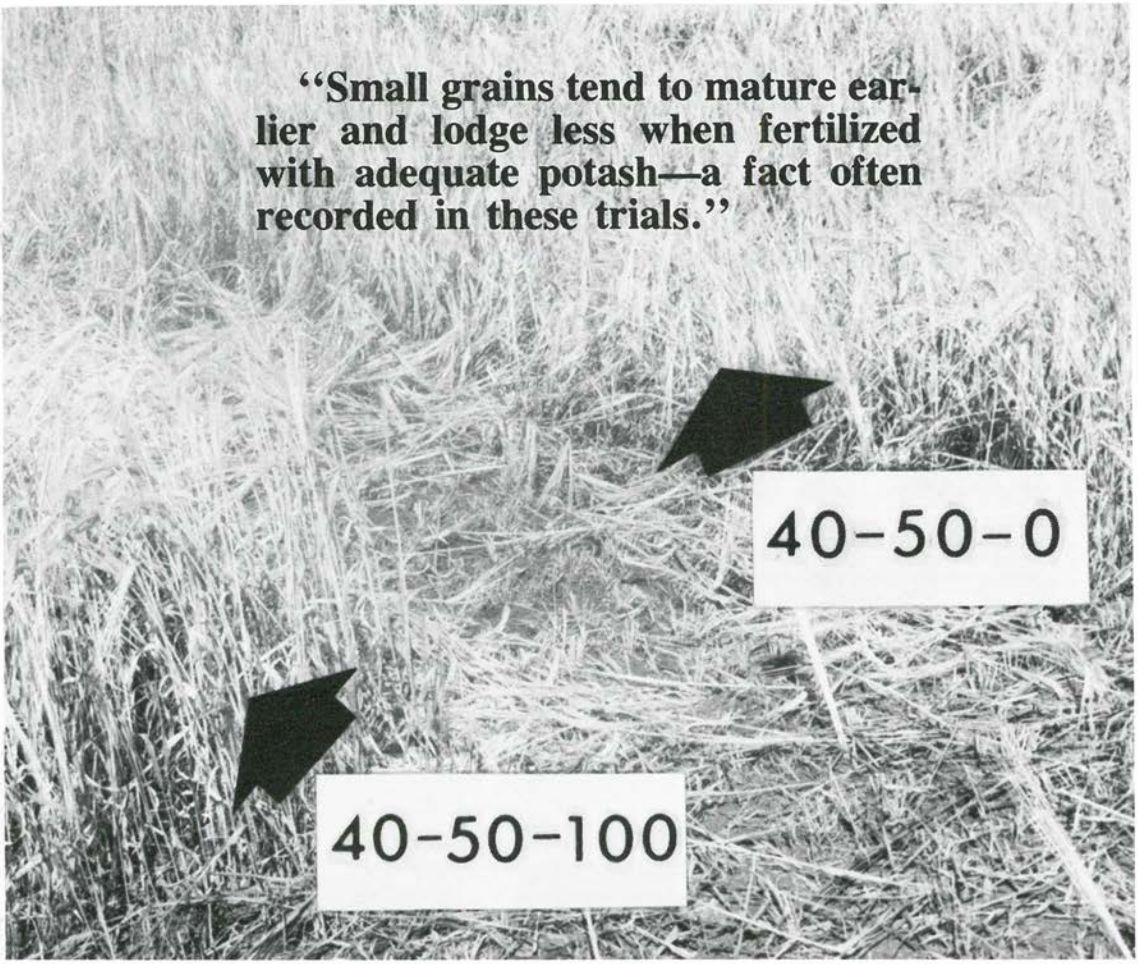
2. Extra potato yields from added potash fertilizers are due almost always to an increase in No. 1 potatoes. Potash improves potato quality.

3. Small grains tend to mature earlier and lodge less when fertilized with adequate potash—a fact often recorded in these trials.

4—Current studies indicate potash fertilization helps reduce disease problems in small grains and legumes.

ONE BIG OBSTACLE lies in the way of general potash fertilization in Montana—no reliable method for predicting K need unless you have soils that test "low" or "medium" K. Most Montana soils test "high" in extractable K. Yet, added potash fertilizer has boosted yields significantly regardless of high soil test K level, and in all areas of the state.

So, our problem seems clear. To pinpoint all soil and cropping conditions that will respond to potash fertilizers. The results may do wonders for our yields—and our economy.



Most Montana soils may test "high" in K—but climate, soil temperature, and moisture greatly influence (1) how AVAILABLE K is at any time of the growing season and (2) how RAPIDLY the fast-growing crop can get the K during critical need periods, as in early spring.

A reliable soil test and K recommendation program may depend on our ability to predict climatic and associated soil variables.

A GROWER CAN TAKE certain steps to decide whether he should use potash fertilizers:

1. If your current soil test shows "low" or "medium" K, adding potash will probably boost yields as long as N and P_2O_5 are adequate.

2. Consider the crop you are growing. Potatoes, sugar beets, and other crops that translocate and store big amounts of carbohydrates need more K than small grains do. K hunger any time in the season could badly cripple these crop yields. Routine potash fertilization of sugar beets and potatoes may be a wise practice.

3. Crops needing rapid growth in early spring may suffer potash hunger when the cold soil releases too little K for the slowly functioning chilly roots. Such crops (winter wheat, alfalfa, grasses, and very early seeded spring crops) need plenty of K fast at this time. You can expect greater, more consistent response to potash fertilizers from these than from later-seeded crops.

4. Try potash fertilizer for 2 or 3 years on a limited basis. Broadcast in fall or spring 25 to 120 lb K_2O/A, depending on crop, soil, and climatic conditions. Be sure to include adequate N and P_2O_5 in your fertility program. Harvest the potash (NPK) areas separately and compare those yields with yields from NP areas. Compare more than one year—BECAUSE weather variations greatly influence the crop's response to potash fertilizers.

Adequate potash in our soils is not our main problem. AVAILABILITY of this potash at critical growth periods is the problem. It is sometimes unavailable when needed most by our costly crops. That's why potash fertilizers may become a big booster of our farm economy in the future.

It's only human for hard-working growers to seek their share of the $60 million yield potential from potash fertilizers in Montana. **The End**

GROWING INTEREST

If you want us to convert our series on **STRESS** into a booklet, please make commitment below. **DO NOT** send payment now. Just state quantity you agree to purchase. If demand warrants, the booklet can be available in June, 1976.

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BIFOCALS

S.W. Martin

WE RECEIVE many coupons selling books on how to edit and write. To get reader impact, I believe the experts call it.

I stand in awe of such because I have no formal education, in the modern sense. Indeed so little reading and writing, in the modern sense, that I stand in shock at reader responses to this little column. From 32 states.

Teachers, corporation officials, university deans and scientists, coeds, fertilizer salesmen, wives, editors, county agents, even a cartoonist of a major newspaper. Some asking to share the column with legislators. Some in graduation speeches and civic talks. Some in press and radio work.

Since the simple stuff started appearing, interesting invitations have come in. To join special writers' associations, to "apply" for a spot in a who-is-who book. I decline, not ungratefully, but simply because I'm not qualified. And because my nature insists there is only one Who, really.

And we butchered Him on a cross when He tried to teach us how to love the potential in our neighbor's soul, not judge the cost of his clothes.

You can forgive my personal approach to the column today when I explain the news that prompted it. I refer to the trend toward "experts" in technical know-how who are robots with the language God gave us.

Indeed, worse than robots. Just check with your state uni-

Uhhhhhhh . . .

versity or your favorite neighborhood college. My news report happened to cite three great state universities. About 80% of the freshmen with serious writing problems at one. About 60% of sophomore journalism students (journalism, mind you) flunking required English usage at another. Graduate schools calling their applicants technically proficient but functionally ignorant.

What scares me is the raging inability to write a clear, expository theme. That implies the inability to have a thought and express it convincingly to your fellowman. Could this lead in one of two directions?

DIRECTION ONE—A generation of technically proficient experts shuffling from weatherized labs into dark little auditoriums to stare at colored graphs and numbers projected on a beaded screen. Mumbling some numbers and a few vague phrases linking the numbers. Expressing little of the wonders and promises beyond that pitifully dark room.

DIRECTION TWO—A generation of functionally frustrated characters wandering around using technically proficient weapons to terrorize the few human beings left who can express ideas with some degree of eloquence inside or outside "their field."

We've got to get busy and start educating our youngsters in the fundamentals again. Without a command of language, how can they think? Thoughts demand words. When their language is a mystery to them, their world will be a mystery to them, beyond their little island of proficiency.

A news item recently grabbed me. In Communist Poland, it alleged, a guy with a guitar, a good voice, and some old, old ballads out of their religious past is singing those WORDS to sellout concerts. Their forms of folk music, perhaps.

Whatever it is, they are flocking to hear him. Apparently hungry for eloquent words. That lift. That ring. That cause the soul to rise up and sing.

Ever had a friend enthusiastically hand you a brochure from an organization he supports? One of those glossy, charty, costly, color-flooded booklets of pictures and graphs with a few columns of leukemia called narrative? Read it and then ask him what it said. What it SAID.

Listen to the uhhhhhhh come out. It impressed his eye, NOT his mind. He didn't read it. A little 'possum that frequents our garbageteria is a specialist at lugging such gloss into an island of azaleas on his way home with his dessert.

May God help us if today's school libraries called "Media Centers" carry our children down the path of uhhhhhhh.

People have asked why I don't send this column to the daily press. It is very hard work. But if I should ever do it, I will dedicate it to one mission: Urging parents to inspire their youngsters EARLY with moving words. The origin of all thought and communication.

Words that sing. That lift. That explain. That teach and motivate and irritate and sell. Words that describe more vividly, more movingly than any camera can ever do. And more colorfully. Words that bring tears, then laughter, then boundless joy down to the very taproot of the soul.

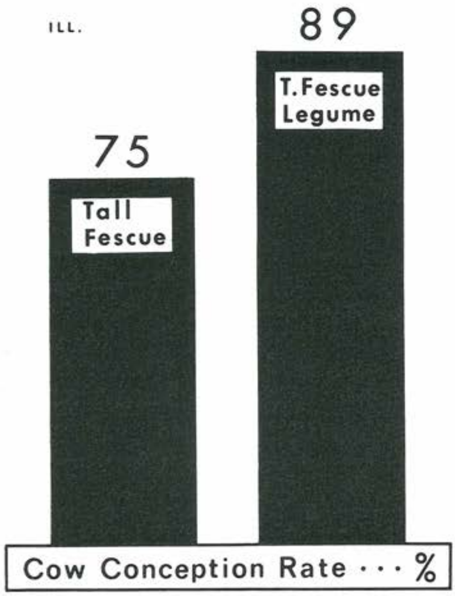
Not big, ponderous words. But clean, clear words. We have spent many years building our tower of technical Babel, from the days of humanly pompous barristers to the days of inhumanly pompous computers.

We have made the writing of a will or the correlating of economic slumps sound like a mystery solvable only by Gabriel's mentally select. No wonder we were so ready by the 20th century for "visual aids" projecting waxy colors and blocky words that say as little as possible with as much flare as possible.

Great organizations taking their blessed know-how to the earth's unfortunates soon learn that the most important tool they have are words. Phrases that move and convince and clear the way, sometimes for waxy charts and mumbling men.

Thankfully, Nobel winner Norman Ernest Borlaug has never been a mumbler with eager peasants in wheat fields. Every time the press quotes him, eloquence rolls from his words.

God knows what He's doing, all right, when He places certain men in certain places at certain times. And the first thing he gives them is the right WORD—not uhhhhhhh.



Legumes Improve ANIMAL PERFORMANCE On Fescue Pastures

F. C. HINDS, G. F. CMARIK, and
G. E. McKIBBEN
UNIVERSITY OF ILLINOIS

IN ILLINOIS RESEARCH

MUCH OF SOUTHERN Illinois is ideally suited for grazing beef cattle. The natural advantages of a long grazing season and a favorable rainfall distribution are enhanced by the general use of high-producing forage.

Probably the most common forage grass in the area is tall fescue. It is persistent, has a high tolerance to various levels of soil fertility, and is adaptable to various management systems.

Tall fescue produces large amounts of high-quality feed both early and late in the grazing season. Unless it is properly managed, however, the plant material available during the middle of the season is of rather low quality. This drop in quality is characteristic of all cool-season grasses, but it usually occurs earlier in the year in fescue than in other grasses.

The change in quality is directly related to the growth stage of the fescue plants in the pasture. Although influenced slightly by fertility, the stage of growth is largely dependent on day length and on environmental temperature.

QUALITY CHANGES FAST. In the spring, the soil usually contains enough reserve moisture and nutrients to permit rapid production of dry matter. As soon as the temperature warms up enough, fescue growth rapidly accelerates.

At first—during the vegetative stage in early April—forage quality is high. However, as days lengthen, the rapid growth of the fescue quickens the pace of the normal change in plant composition. As a result, quality plummets, dropping from about 70 percent digestible dry matter in April to 40 percent or less digestible in late May or early June, when the plants reach the seed stage.

Because cool-season grasses are dormant during the warmer part of the growing season (June-August), digestibility of the forage does not improve, and may even decline further, until the end of summer. At that time fescue and other cool-season grasses emerge from their dormancy and begin a new period

HIGHER

⬇

Weaning Weight

⬇

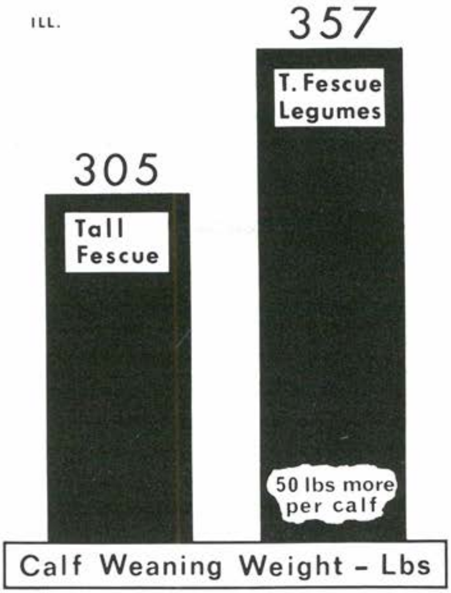
Calf Grade

⬇

Conception Rate

⬇

LEGUMES



of vegetative growth. Since day length is declining and environmental temperature is dropping, the plants remain vegetative through the fall. Plant material is thus of much higher quality then in the summer, although the quantity of forage produced is not high.

ENERGY IS LOW. As the percentage of digestible dry matter goes down, the levels of most nutrients also decline. Except for rare cases, however, the most critical drop is in digestible energy. In several years' grazing studies with cool-season grasses at the Dixon Springs Agricultural Center, it was found that supplemental energy improves animal performance more than do supplemental vitamins, minerals, or protein.

Unfortunately, the forage is low in digestible energy at just the time when the spring-calving cow has especially high energy needs. It can thus be easily seen that, unless the quality of mid-season fescue pastures is improved, both the weaning weights of calves and the conception rates of cows will be reduced.

IMPROVING THE QUALITY of mid-season fescue pastures can be approached in at least three ways:

1—Management of the stands can be aimed at having the plants in a vegetative stage of growth between May and August. This will require careful management of animals as well as clipping of the pastures.

2—Legumes can be incorporated into the fescue pasture. By providing high-quality material for grazing from May to September, legumes would compensate for low quality of the fescue in midseason.

3—Management and legumes can be combined to improve pasture quality.

In a recent three-year study at Dixon Springs, two management systems were used on 15-acre fescue and legume-fescue pastures. The legumes were a mixture of alfalfa, red clover, and lespedeza. Experimental treatments were replicated.

In the first management system, the

pastures were continuously grazed from mid-April to late October. In the second (split management) system, half, or 7.5 acres, of the pasture was grazed for the same period while the other half was grazed only after hay was harvested as round bales in early June.

Stocking rate varied from 1 to 1¼ acres per cow. During the three years, a total of 39 cows and their calves were grazed on each 15-acre pasture. One mature bull was turned into each pasture during the breeding season (May through July).

At roundup in early November, the cows were checked for pregnancy, and the calves' weaning weights and grades were obtained. None of the calves had received creep feed.

LEGUMES BOOST PERFORMANCE. As shown in the table, including legumes in a fescue stand increased calf weaning weight, grade of calves at weaning time, and conception rate of cows.

System of management had only a minor and inconsistent influence on cattle on the legume-fescue pastures. However, on the fescue pastures, continuous grazing resulted in a higher level of performance than did split management. This result was not anticipated, but it occurred consistently in each of the three years. Probably the continuous grazing kept the fescue plants in a more vegetative stage of growth than normal.

In the split management system, which required harvesting of hay, the legume-fescue pasture did not produce enough forage for grazing during the latter part of the season. As a result, the cattle consumed almost all of the harvested hay. Cattle on the fescue pasture used little, if any, of the harvested forage. This suggests that, although legume-fescue pastures produce no more or even less dry matter than the fescue pastures, the legume-fescue dry matter has greater nutritive value, which is accompanied by increased forage intake.

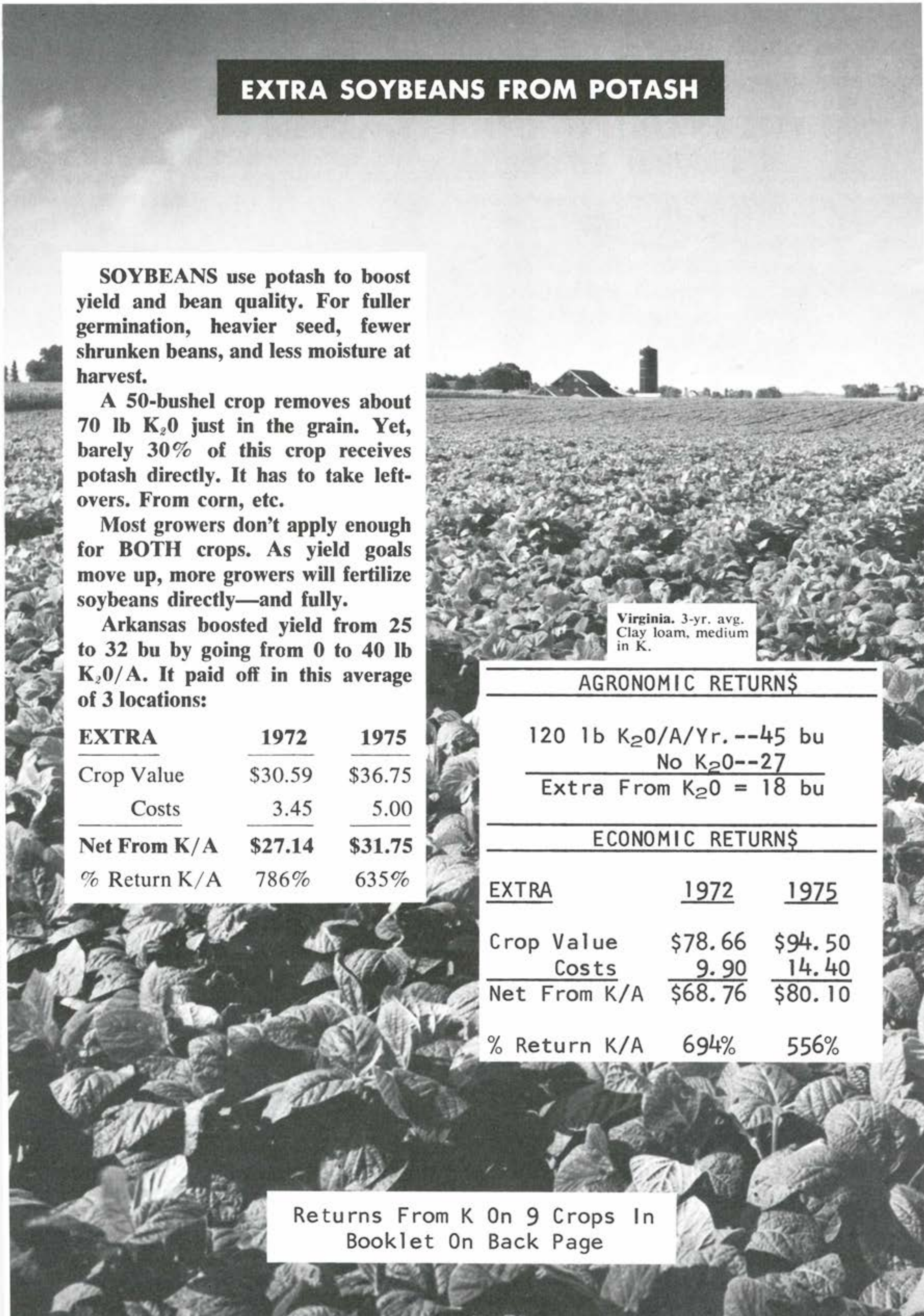
The calves produced by cows grazing fescue not only weighed less and graded lower than the other calves, but also had the characteristic appearance of a "fescue-calf." A fescue-calf will generally be lighter than it looks, will have a rough hair coat, and will be slightly less alert than a normal calf.

NEED FOR LEGUMES is indicated. The sizable differences in performance between cows and calves on the fescue pastures and those on the legume-fescue pastures clearly indicates that cow-calf operators need to incorporate legumes into their fescue stands if maximum performance is desired.

It is likely that the superior performance of cattle on the legume-fescue pasture is related to the greater amount of digestible energy provided by the legumes in mid-season. The differences in cow conception rates suggest that the fescue pasture does not provide enough energy during the breeding season. A more general lack of energy, which may not be related to any specific time, is indicated by the differences in calves' weaning weight and grade.

Further studies now being conducted are designed to determine whether performance can be improved on fescue pasture by using supplemental sources of energy. **The End.**

EXTRA SOYBEANS FROM POTASH



SOYBEANS use potash to boost yield and bean quality. For fuller germination, heavier seed, fewer shrunken beans, and less moisture at harvest.

A 50-bushel crop removes about 70 lb K_2O just in the grain. Yet, barely 30% of this crop receives potash directly. It has to take left-overs. From corn, etc.

Most growers don't apply enough for BOTH crops. As yield goals move up, more growers will fertilize soybeans directly—and fully.

Arkansas boosted yield from 25 to 32 bu by going from 0 to 40 lb K_2O/A. It paid off in this average of 3 locations:

EXTRA	1972	1975
Crop Value	$30.59	$36.75
Costs	3.45	5.00
Net From K/A	**$27.14**	**$31.75**
% Return K/A	786%	635%

Virginia. 3-yr. avg. Clay loam, medium in K.

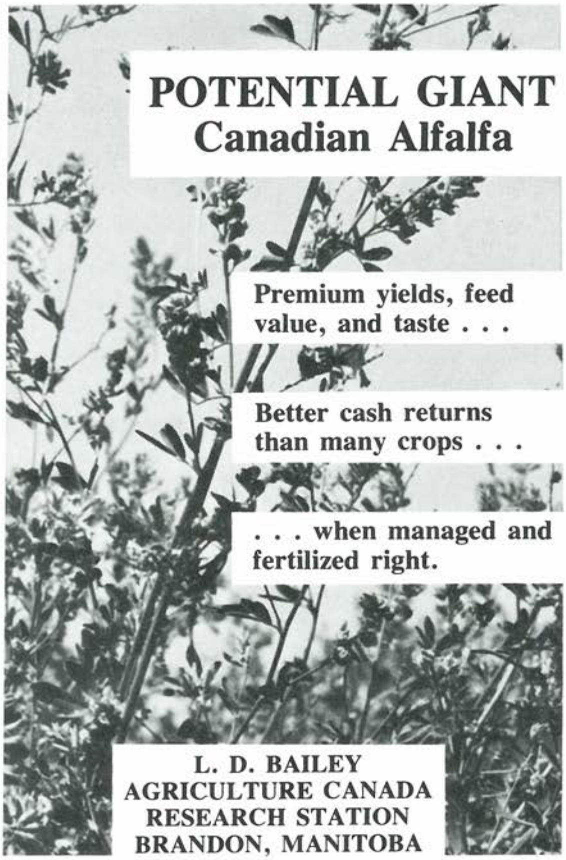
AGRONOMIC RETURN$

120 lb K_2O/A/Yr.--45 bu
No K_2O--27
Extra From K_2O = 18 bu

ECONOMIC RETURN$

EXTRA	1972	1975
Crop Value	$78.66	$94.50
Costs	9.90	14.40
Net From K/A	$68.76	$80.10
% Return K/A	694%	556%

Returns From K On 9 Crops In Booklet On Back Page



POTENTIAL GIANT
Canadian Alfalfa

Premium yields, feed value, and taste . . .

Better cash returns than many crops . . .

. . . when managed and fertilized right.

L. D. BAILEY
AGRICULTURE CANADA
RESEARCH STATION
BRANDON, MANITOBA

WHEN A GREAT NATION uses 13.5 million acres to produce only 26 million tons of hay per year, the future can only point UPWARD.

Why does Canada average less than 2 tons of hay per acre? It's the same old forage story of poor management for the hay crop.

The grower doesn't know the latest techniques for top production. Or he believes such forages as alfalfa "build up the soil."

Alfalfa CAN help soil structure. It CAN give superior yield, protein, and net energy. It CAN attract the tastes of livestock better than other forages. It CAN bring superior return on money.

But to do this, it must be managed right. Good management at the Brandon Research Station in Canada produced 5 tons or more without irrigation, even in dryland conditions of Manitoba Province.

Let's look at the management package:

SOIL TYPE. Alfalfa can be grown on all western Canadian soils except poorly drained areas or sandy soils too low in moisture. If the sands have high water tables or high rainfall and adequate fertility, alfalfa will produce about what it does on finer textured soils.

Alfalfa tolerates saline soils moderately (conductivity of 4 to 8 millimhos per cm) in its early stages. But once established, the crop tolerates salts much better—IF its fertility needs are met. Alfalfa needs lime on soils with a pH below 6.5. Most Manitoba soils have 7.0 pH or better.

VARIETIES. You can get them for different climates and purposes in western Canada—such as, creeping for pasture, upright for hay.

Good stands are vital. They start with a firm seedbed free from clods to insure uniform seeding depth (much less than 1 inch) and close contact of seed with soil moisture.

Early spring seeding (May 1-30) usually gives better stands in Manitoba than late summer seeding (Aug. 15-30). With enough moisture and fertility, the May-seeded crop can be harvested in August. The fertilizer should be banded with the seed or broadcast before seeding to avoid germination damage. No companion crop should be included when seeding alfalfa.

PLANT NUTRITION. In Manitoba and other Canadian areas where only two cuts are possible, the grower should aim for 4 to 5 tons per acre. This demands a well-balanced fertilizer program.

For 6 years, the Brandon Research Station studied alfalfa's response to phosphorus, potassium, and sulfur at 7 locations.

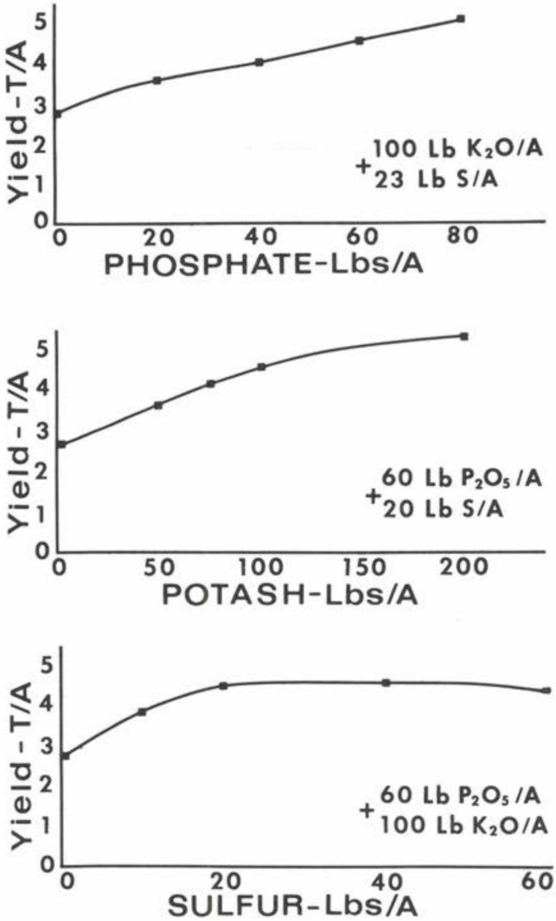
The three charts show annual P-K-S fertilization increasing alfalfa yields. This happened (1) when phosphate was applied to soil testing below 17 lbs phosphorus per acre (bicarbonate extractable) in the top foot of soil, (2) when potassium was **broadcast** on soil testing below 620 lbs exchangeable potassium per acre in the top foot, (3) when sulfur was applied to soil testing less than 15 lbs SO_4-S in the top 6 inches of soil.

Alfalfa uses about as much sulphur as it does phosphate. So, any soil test program should check sulphur needs of soil and crop to maintain high yields and quality.

Since alfalfa fixes its own nitrogen from the air, the roots should be checked periodically for nodules. Large nodules that are bright pink when cut open mean the plant is getting its nitrogen.

Old alfalfa stands with very low plant population have responded to low nitrogen rates. But continuous N applications reduced the stand.

Fertilization Boosts Alfalfa



NUTRIENT CONTENT shows what balanced fertilization means to yield and quality. In **Table 1**, fertilization increased first-cut yields 39%, second cut 122%, and total yields 66%.

Although micronutrients did not boost yields significantly, spray or soil applications helped alfalfa take up more of the other nutrients—for example, more nitrogen when it received some copper and molybdenum.

Table 2 shows the tremendous nutrient drain a 66% increase in alfalfa yields can put on the soil. At the 4.5 ton yield, **each ton** of alfalfa contained 10 lbs P_2O_5, 60 lbs K_2O, and almost 5 lbs S. Total nitrogen accumulation more than doubled.

HARVEST TIME is vital. Alfalfa gives its highest feed value when cut at 1/10 bloom. Delaying until full bloom can cause problems:

(1) A woody forage. (2) More leaf loss during curing and haying. (3) Less food value and mineral content, shown in Table 3. (4) Slow regrowth in dry

TABLE 1. Yield and chemical composition of alfalfa harvested over a 6-year period (average of 7 locations).

Treatments	Cuts	Yield T/A	Percent N	P	K	S	ppm Cu	Mo
Check	1st Cut	1.8	2.80	0.20	2.10	0.18	6	3.1
Check	2nd Cut	0.9	2.05	0.17	1.95	0.15	6	3.3
Fertilized*	1st Cut	2.5	3.50	0.25	2.50	0.25	8	3.6
Fertilized*	2nd Cut	2.0	3.25	0.20	2.45	0.20	8	3.6

* Plots received annually as a spring broadcast application 60 lbs. P_2O_5/ac, 100 lbs. K_20/acre and 20 lbs. S/acre.

July and August, moving second cut into September when grain harvest often prevents it.

Note in **Table 3** that delaying harvest until full bloom **did not** increase total yields under dryland conditions.

ALFALFA STAND LIFE depends greatly on soil fertility or fertilization program. Plants receiving no potash on soils testing less than 225 lbs K/A suffered winterkill. Their K content generally ran 1% or less. Plants receiving no phosphate and sulphur on soils testing less than 9 lbs P/acre and 5 lbs SO_4-S/acre also suffered winterkill. Their P or S content ran 0.15% or less.

To guarantee top yields, quality, and stand life of 12 to 15 years, the alfalfa plant should contain more than 3.0% N, 0.20% P, 2.0% K, and 0.20% S.

TABLE 2. Nutrient Uptake (6 yr. av., 7 locations)

Treatment	Cuts	N	P_2O_5 (lb./a)	K_2O	S
Check	1st Cut	102	17	77	6
	2nd Cut	38	7	36	3
Total		140	24	113	9
Fertilized*	1st Cut	176	29	151	13
	2nd Cut	131	18	119	8
Total		307	47	270	21

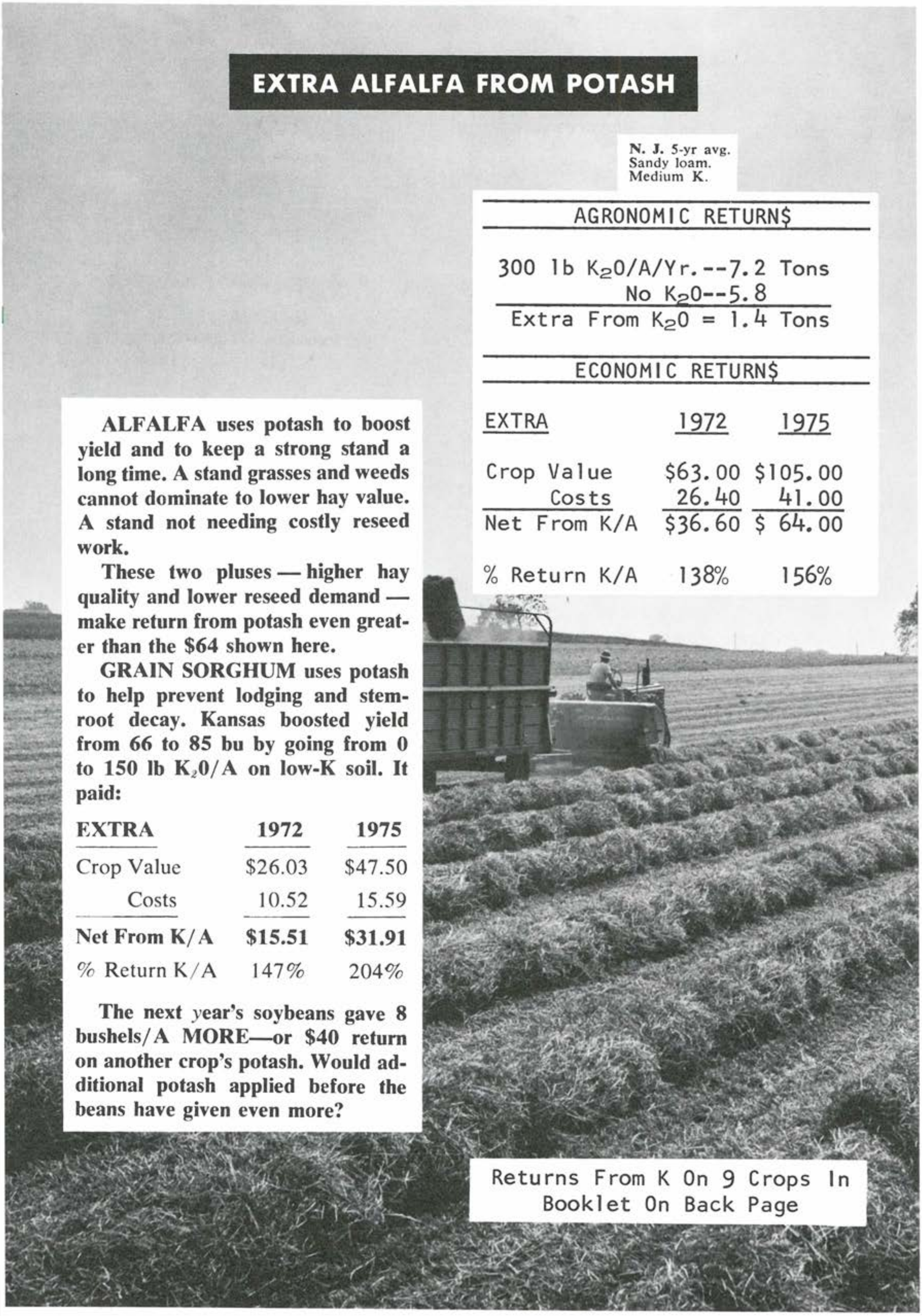
*0 + 60 + 100 + 20S annually

Such content occurred by maintaining more than 20 lb P and 600 lb K per acre available in the top foot of soil, more than 18 lb SO_4-S/A available in the top 6 inches of soil. **The End.**

TABLE 3. Change in chemical composition of alfalfa with delay in harvest (6 years average from 7 locations).

Harvest* Stages	Cuts	Yields T/A	Percent N	P	K	S
1/10 Bloom	1st Cut	2.5	3.50	0.25	2.50	0.25
Full Bloom	1st Cut	2.5	2.15	0.17	2.08	0.16
1/10 Bloom	2nd Cut	2.0	3.25	0.20	2.45	0.20
Full Bloom	2nd Cut	2.0	2.08	0.15	1.85	0.14

* Both plots received the same fertilizer treatment (Table 1).



EXTRA ALFALFA FROM POTASH

N. J. 5-yr avg.
Sandy loam.
Medium K.

AGRONOMIC RETURN$

300 lb K_2O/A/Yr.--7.2 Tons
No K_2O--5.8
Extra From K_2O = 1.4 Tons

ECONOMIC RETURN$

EXTRA	1972	1975
Crop Value	\$63.00	\$105.00
Costs	26.40	41.00
Net From K/A	\$36.60	\$ 64.00
% Return K/A	138%	156%

ALFALFA uses potash to boost yield and to keep a strong stand a long time. A stand grasses and weeds cannot dominate to lower hay value. A stand not needing costly reseed work.

These two pluses — higher hay quality and lower reseed demand — make return from potash even greater than the \$64 shown here.

GRAIN SORGHUM uses potash to help prevent lodging and stem-root decay. Kansas boosted yield from 66 to 85 bu by going from 0 to 150 lb K_2O/A on low-K soil. It paid:

EXTRA	1972	1975
Crop Value	\$26.03	\$47.50
Costs	10.52	15.59
Net From K/A	**\$15.51**	**\$31.91**
% Return K/A	147%	204%

The next year's soybeans gave 8 bushels/A MORE—or \$40 return on another crop's potash. Would additional potash applied before the beans have given even more?

Returns From K On 9 Crops In Booklet On Back Page

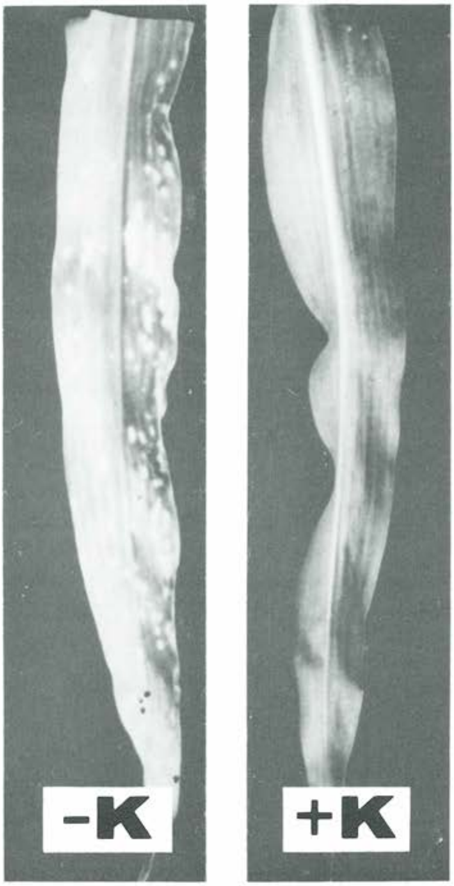


FIGURE 1—Holcus Leaf spot infection on corn in Illinois was reduced when 300 lb N/A was balanced with 100 lb K/A (120 lb K_2O/A).

4th IN STRESS SERIES

Reduce Disease with POTASSIUM

W. K. GRIFFITH
HERNDON, VIRGINIA

CROP DISEASES can gnaw the profits out of what could have been a good crop yield and quality.

What happens when a seemingly healthy crop becomes ridden with disease? First, it must be weakened by some stress. This weakness hangs out a welcome sign to all disease pathogens in the neighborhood. So, if we can keep the stresses down, we can keep the diseases down.

Plants face many possible stresses: Low or unbalanced fertility. Low moisture supply. Soil compaction. Poor soil drainage. Unadapted varieties. Insect infestation. Etc.

STRESS FROM LOW POTASSIUM has been linked to many diseases. Dr. George McNew put it this way in the USDA Yearbook on PLANT DISEASES:

"More plant diseases have been retarded by the use of potash fertilizers than any other substance, perhaps because, potassium is so essential for catalyzing cell activities."

Potassium is not a direct agent of disease control. But eliminating disorders caused by low-K levels strengthens natural resistant mechanisms in the plant.

Let's analyze a "crop disorder-crop disease" cycle in corn that grows on potash-deficient soil:

First—Leaf necrosis on margins, shallow roots, few brace roots, pith breakdown and premature stalk dying.

Second—Poor, sluggish flow of water, minerals, and food to and from the leaves and roots.

Third—Soon carbohydrates begin to build up in the leaves. Unable to translocate and produce needed metabolites.

Fourth—Metals, such as iron, manganese, and aluminum begin to clog nodal tissue and disrupt their work for leaves and roots.

Fifth—As leaf, stem and root tissue grow weaker, lurking fungi. bacteria, and virus welcome the chance to attack the plant.

Sixth—Leaf spot, leaf blight, stalk rot, and root rot ailments finally hit the plant, reducing both metabolism and yields.

The "crop disorder-crop disease" cycle is now complete—and we can look for unfilled ears and chaffy kernels, lodging stalks, and much less quality corn.

This corn example features clear-cut losses. Most losses are overlooked or blamed on some other plant stress because **some** potassium was used. That's the problem. "SOME." Maybe enough to keep crop disorders and disease attacks rather mild. Maybe enough to hide K hunger. But not enough for **top yields** in today's costly farming.

RESEARCH RESULTS ON MANY crops strongly endorse the USDA Yearbook's statement about potassium retarding disease:

1—ON CORN. When New York added 200 lb K_2O/A, the 7 hybrids suffered 20% less stalk rot and produced 12 bushels MORE per acre.

In Pennsylvania, corn hybrids that took up the most K in leaf tissue developed the least Northern leaf blight symptoms, shown below:

Leaf K	Blight Rating
1.85%	3.58
1.96	2.56
2.34	**1.97**

(Higher the rating, greater the blight.)

Unbalanced nutrition is an open invitation to crop diseases. It is the **imbalance** of nutrients rather than absolute amounts of each nutrient that encourages diseases. Potassium, for example, is vital for balancing nitrogen usage.

CROP DISORDERS CAUSED by POTASSIUM DEFICIENCY*

ON ALL CROPS: Slower Germination. Thinner Cell Walls. Non-Protein Nitrogen Accumulation. Parenchyma Tissue Breakdown. Early Tissue Aging. Aborted Blossoms. Wilting (Reduced Turgor). Smaller, Fewer, And Poorly Distributed Xylem Vessels. Smaller, Fewer And Less Active Stomata. Smaller And Shorter Roots. Lower Leaf To Stem Ratio. Unused Sugar Accumulation In Leaves. Leaf Necrosis, Scorch And Chlorosis. Slower New Cell Production.

ON SPECIFIC CROPS

CORN: Lodging. Chaffy Grain. Unfilled Ears. Delayed Silking. Fewer Brace Roots. Premature Stalk Dying. Nodal Contamination. Metal Accumulation In Nodes.

SOYBEANS: Shorter Plants. Fewer Nodules. Smaller Nodules. Shriveled Seed. Leaf Drop. Aborted Blossoms.

FORAGES: Smaller Plants. Slower Regrowth. Smaller Crowns. Leaf & Stem Lesions. Heaving. Winterkill. Leaf Drop.

FRUIT: Leaf Curl. Poor Fruit Color. Smaller Fruit. Creased Fruit. Split Fruit. Reduced Firmness. Stem Dieback. Winterkill. Poor Storage Quality. Reduced Shelf Life.

SMALL GRAIN: Shriveled Seed. Unfilled Spikelets. Lodging. Leaf & Stem Lesions.

VEGETABLES: Uneven Ripening (Tomato). Internal Blackening (Potato). Poor Storage Quality. Leaf & Stem Lesions. Internal Breakdown (Cabbage).

***Many of these disorders are considered nonparasitic diseases. They all weaken the crop—an open invitation to the entry and spread of parasitic diseases. Even though a parasitic disease does not develop, these disorders can play economic havoc with yield and quality.**

TABLE 1—The highest potassium level was still increasing corn yields when corn was under stress from Southern Leaf Blight. (1970)

Annual K Rate	K Soil Test** After 3rd Yr.	Yield—3-Yr. Avg. 1967-69	Yield With Southern Leaf Blight (1970)
0 Lb/A	280 Lb/A	149 Bu/A	104 Bu/A
100	322	172	126
200	**363**	**177**	**130**
400*	421	171	137

*This rate was applied only the first two years of the study.
**Tests run on air-dried samples taken 3/30/70.

TABLE 2—Effect of potash on Odgen soybeans—North Carolina*

K_2O	Yield	Shrunken, Shriveled, Moldy or Discolored Seed	Weight Per 100 Seeds
0 Lb/A	7 Bu/A	37%	11.2 gm
120	27	3	14.5

*P applied to both plots—Low K soil.

TABLE 3—Fertilizer improved soybean quality. (Ind.)

	Yield	Oct. 3 H_2O	Damaged or Purple Blotched Seed	Germination
No Fertilizer	20.2 Bu/A	58.6%	17.3%	82%
400 lb/A 0-10-20	32.9	12.3	2.9	93

TABLE 4—Gray-moldy soybean seed decreased as K increased. (Del.)

KCl or K_2SO_4 Added/Cylinder	Potassium Applied* KCl	K_2SO_4	Diseased Seed Delmar	Wayne	Ave.
0 gm	0	0	87%	62%	75%
2	92	70	65	58	62
10	462	518	21	33	27
30 + 10 sidedress	1850	2074	13	14	13

*No significant differences found for two K sources.

Illinois proved this when they reduced Holcus leaf spot infection on corn by balancing 300 lb N/A with 120 lb K_2O/A. And on a soil already testing 280 lb K/A. The right NK balance increased yields an average of 23 bu/A over a 4-year period.

Table 1 shows how potassium reduced stress from Southern leaf blight when the blight infected a 1970 Illinois research area. The highest yield of 137 bu/A came on soil that had been built up to 421 lb K/A.

2—ON SOYBEANS. Many varieties can fall victim to pod and stem blight, caused by a fungus known as Diaporthe sojae. One of the clearest symptoms is the gray, moldy seed at harvest.

The disease may strike roots, stems, conducting tissue, or the leaves. One target seems to be the photosynthesis factory—to disrupt the production of photosynthates, interrupt their trip to developing seed, and reduce their conversion into storage products within the seed.

Tables 2, 3, and 4 show how potassium helped soybeans resist disease on the way to good quality. **In North Carolina:** 34% less shrunken, moldy, discolored beans and 29% greater seed weight. **In Indiana:** 11% faster germination, 46% less moisture buildup, and 14% less damaged seed. **In Delaware:** 50 to 60% less gray-moldy seed.

3—ON FORAGES. Potassium is a big key to HIGH yielding, HIGH quality, LONG living alfalfa stands. **Tables 5 and 6** document this. Look at that 8-ton yield/A in the 5th year in **Table 6.** Why? Because the alfalfa received 300 lbs K_2O/A yearly on soils that release about 125 lbs K_2O each year. With no annual potash applications, the stands were almost gone by the 5th year.

Low alfalfa persistence can often be traced to low K fertilization. This leads to more heaving and winterkill, more crown rot and other diseases.

Adequate potassium does wonders with the root system to build a strongly resistant plant. A plant with bigger, deeper roots and more roots per square foot. With larger, more evenly distributed xylem vessels to move vital metabolites to and from the upper plant.

These larger xylem vessels help alfalfa resist such vascular diseases as bacterial wilt and root knot nematode

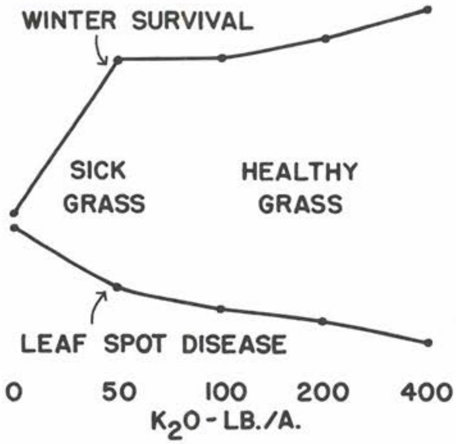


FIGURE 2—As more potash (K_2O) was applied to Midland Bermudagrass, leaf spot disease decreased and winter survival increased.

that can enter and constrict the vessels of low-K alfalfa.

Potassium speeds up alfalfa regrowth—meaning less unfavorable weather for crowns, more reserve carbohydrates from faster leaf accumulation, and less competition from weeds and grasses. **Table 7** shows how K boosts regrowth.

Severe leaf spot can infect both Coastal and Midland bermudagrass when they receive too little potassium fertilizer. **In Alabama,** Coastal fertilized with 200 lb N/A averaged 147.5 spots per leaf without K, only 13.5 spots with K. **In Maryland,** Midland experienced less leaf spot disease and more winter survival as K_2O applications increased. **Figure 2** documents this.

4—ON FRUIT. Potassium corrected Black Leaf in Concord grapes in Washington and reduced Apple leaf spot in France. **Table 8** documents K's aid to grapes. When 840 lb K_2SO_4/A was placed 4 inches deep in the irriga-

Table 5—How K Fertilization affected 9-yr. avg. alfalfa yields and stand in the 3rd and 9th year. (N.J.)

K_2O (Year)	Hay Yield (9-Yr. Avg.)	Stand 3rd. Yr.	Stand 9th Yr.
0 Lb/A	2.07 Ton/A	17%	0%
100	3.92	34	18
200	4.52	55	49
400	**4.95**	**66**	**70**

TABLE 6—Yield, percent K, K removal from 4 cuttings alfalfa in 5th harvest year from 300 lb/A K_2O rate. (N.J.)

Cuts	Hay Yield	% K	K Removal
1	2.35 T/A	2.5%	124 Lb/A
2	2.10	2.4	107
3	2.03	2.3	98
4	1.52	2.25	72
Totals	**8.00**		**401**

TABLE 7—How K fertilization affected yield & K content of 18-day alfalfa regrowth. (Va.)

K_2O	Dry Matter/Day	K/Total Herbage
0 Lb/A	41 Lbs	1.49%
120	59	1.92
200	68	2.45
400	**71**	**3.91**

Results are the average of two growth periods.

TABLE 8—Level of potassium in grape leaf blades & petioles and intensity of black leaf disease. (Wash.)

Disease Intensity Visual Rating	Potassium Lf. Blade	Potassium Petioles
Severe Black Leaf	0.28%	0.28%
Slight Black Leaf	0.62	1.25
Normal Vines	**0.70**	**3.50**

TABLE 9—Potassium decreased tomato graywall incidence. (Fla.)

K_2O Rate	Nitrogen	Graywall
100 Lb/A	100 Lb/A	29%
200	100	19
400	**100**	**11**

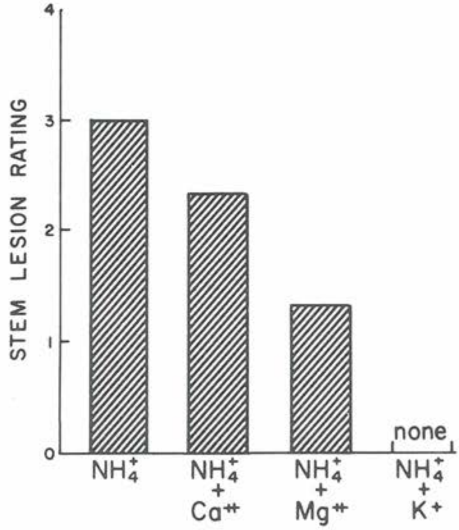
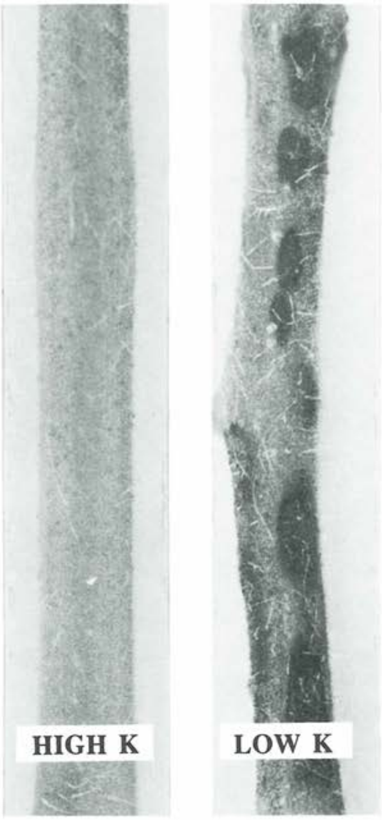


FIGURE 3—Potassium prevented tomato stem lesions, above and below. Without added K, ammonium compounds accumulated and lesions came.



tion rill, leaf K increased the first year and Black Leaf disappeared the second year.

French scientists found a correlation between the number of Apple leaf spots and N/K ratio—the wider the ratio the greater the disease. Potassium applications did the most to reduce infection.

5—VEGETABLES. Tomato plants receiving low potassium and high ammonium N (NH_4) developed stem lesions in Massachusetts. **Figure 3** shows this. Some suspect NH_4 might have caused a cationic imbalance in the tomato plant. Potassium was the best cation, by far, in overcoming this imbalance.

Without added K, ammonium and possible other toxic N compounds accumulated and lesions occurred. Potassium helps utilize NH_4 into protein or other non-toxic storage compounds.

Two other tomato diseases show how important potassium is in reducing disease effects. **Table 9** documents K's sharp reduction of graywall in Florida. And recent New York research shows tomato lines bred to resist blotchy ripening take up more K than susceptible lines.

Potassium greatly reduces black tissue in cabbage heads. **Table 10** documents this New York work with 4 K_2O rates on 3 cabbage varieties.

6—SMALL GRAINS. These crops, especially wheat and rice, are vital to world food supplies.

As nitrogen rates increase to insure more food, potassium is needed to keep small grains in healthy balance.

With low N rates, brown spot on rice showed 40% with no K, only 10% with high K. With high N, the spot showed 74% with no K, only 25% with high K. Leaf blight on rice went from 65% under no K down to 36% under high K.

CROP DISEASES ASSOCIATED with POTASSIUM DEFICIENCY

CORN: Bacterial Leaf Blight. Holcus Leaf Blight. Stalk Rot. Chocolate Spot. Leaf Spot. Root Rot.

SOYBEANS: Purple Stain. Diaporthe Sojae (Moldy Seed). Leaf Spot.

FORAGES: Bacterial Wilt. Leaf Spot. Fusarium Wilt. Crown Rot.

FRUIT: Dwarf Virus (Mulberry). Brown Rot (Apricot). Black Leaf (Grapes). Leaf Spot (Several). Powdery Mildew (Several).

VEGETABLES: Leaf Blight (Potato). Rizoctonia Rot (Potato). Hollow Heart (Potato). Stem End Rot (Potato). Blotchy Ripening (Tomato). Tobacco Mosaic (Tomato). Graywall (Tomato). Black Spot (Potato). Black Rot (Cabbage). Yellows (Cabbage). Stem Rot (Brussels Sprouts). Root Rot (Peas). Cercospora Blight (Carrot). Sclerotinia (Carrot, Onion). Leaf Roll Virus (Vines). Powdery Mildew (Several). Damping-Off (Beets).

SMALL GRAIN: White Blotch (Barley). Yellow Dwarf Virus (Barley). Helminthosporium Teres (Barley). Leaf Rust (Several). Powdery Mildew (Wheat). Bacterial Leaf Blight (Rice). Stem Rot (Rice). Brown Spot (Rice). Blast (Rice). Leaf Spot (Several).

TABLE 10—K affected development of internal black tissue. (N.Y.)

K_2O Rate	Whole Heads With Internal Black Tissue
0 Lb/A	45%
36	27
144	7
576	**0**

All plots received 300 lb/A concentrated superphosphate & 200 lb/A nitrogen.

Many reports from around the world show potassium reducing leaf rust, mildew, lodging and winterkill on wheat—so vital to millions. **The End**

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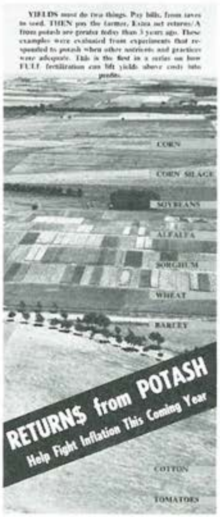

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