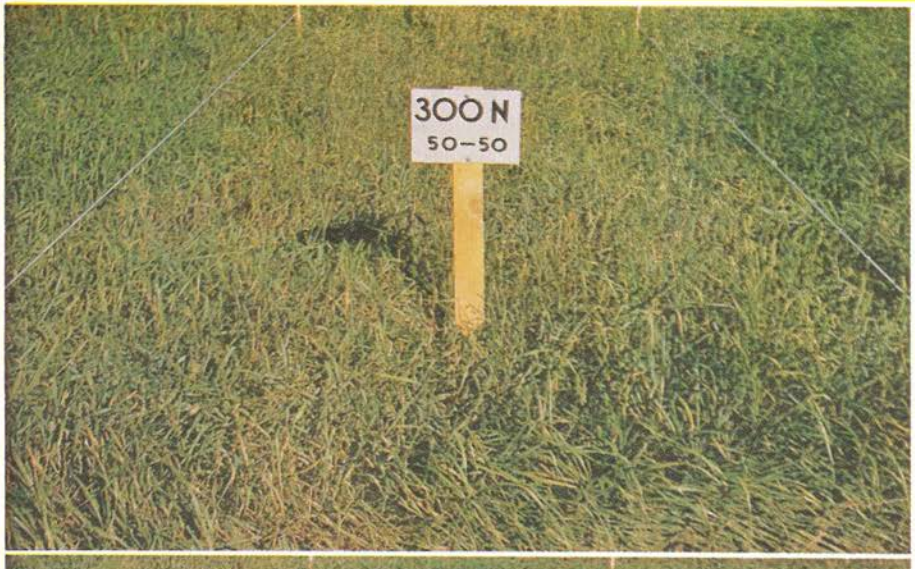
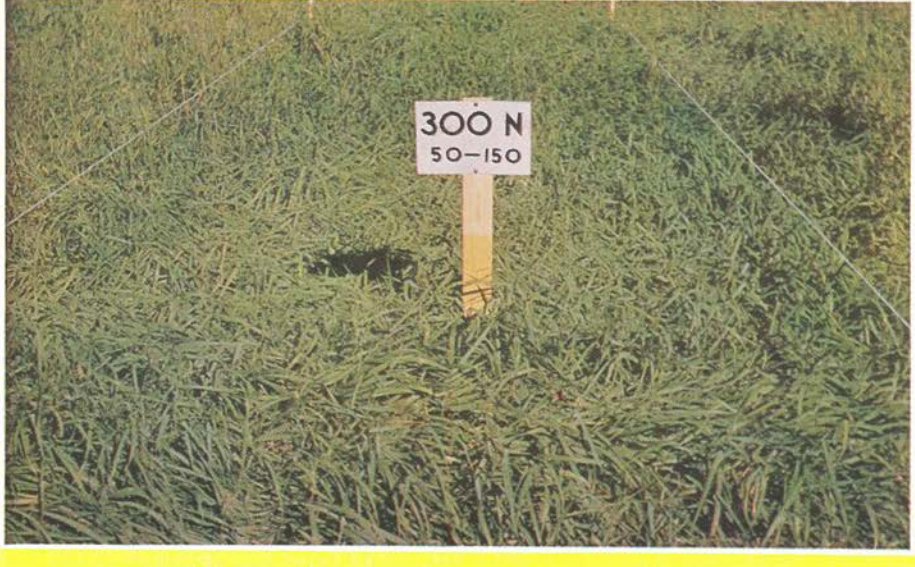
Better Crops WITH PLANT FOOD

November, 1958 10 Cents





HIGH NITROGEN UPS POTASH NEEDS OF GRASSES

ON THE COVER . . .

. . . We see convincing evidence that grasses which receive intensive nitrogen treatment can also demand high potash treatment.

The two plots shown here are from University of Maine experiments, led by Dr. Cecil S. Brown, well-known New England agronomist, who has been searching for an answer to why grass yields sometimes decline sharply after the first year or two, *in spite of continued high nitrogen usage.*

Maine tests have indicated potash starvation may be an important cause of these lowered yields.

While receiving 300 pounds of nitrogen, the timothy plot above (second cutting on Bangor soil in 1957) received only 50 pounds of phosphate and 50 pounds of potash per acre. Note the scorched, unthrifty look.

The plot below received *150 pounds potash* and 50 pounds of phosphate, in addition to the regular 300 pounds of nitrogen per acre. Note the green, thrifty look and full growth.

The low potash timothy above contained only 0.53% potash on a dry basis. The high potash plot below contained 1.34% potash content on a dry matter basis.

In their article, beginning on page 6, Cecil Brown and Paul Belyea of the University of Maine discuss how high nitrogen fertilization increases the potash needs of grasses.

They report that the more nitrogen they used on timothy the more potash the grass removed from the soil. When they met this need with 150 pounds potash per acre, their hay production increased *nearly one ton per acre.*

Better Crops WITH PLANT FOOD

The Whole Truth—Not Selected Truth

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Better Crops with PLANT FOOD

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Good fertilizer dealers are . . .

Community Builders

Jeff McDermid

(ELWOOD R. MCINTYRE)

"To meet today's rising production costs, greater intelligent use of fertilizers is one of the best tools the farmers can use to get more net income."

This advice from North Carolina State College reflects the role of our most successful purveyors of plant food—those who see beyond the tonnage piles and serve their home communities in countless ways not tied to profits alone.

"*See your dealer*" is a catchword in national fertilizer advertising. Broad-gauged dealers welcome "being seen." In fact, the best of them even get to the farmer with vital helps long before the ads reach his mailbox or TV screen. "See your dealer!" He'll make you see what a sound soil fertility program means to you and your neighbors, along with many other good farming tips and hints which pop out of the serviceman's customer kit.

Yet, to be sure, there are backward acres yonder where soils problems perplex and low yields disturb us. Here live too many farmers and fertilizer dealers who need to be "*shook up.*" The farmers neglect soil testing and use none or too scrimpy a fertilizer. Dealers in the doldrums look to the fertilizer manufacturers for some magic agricultural abracadabra—or for some foxy new ingredient to boost their business without much personal push or extra sales expense.

But let's forget these failures and hope for more capable dealers who

build prosperity via balanced crop feeding and keep alert to the welfare of the countryside as part of their own. They are teachers and demonstrators, sometimes as well-qualified to recommend and advise in a practical way as their friends, the state extension soils specialists.

Like that of his farmer customer, the dealer's profit is linked with the soil. So both are out *to make fertilizers pay.* And by the same token, plant food is relatively cheap. Since 1940, farm wages have risen 337 percent, farm machinery 133 percent, prices of all items used in production 141 percent, while fertilizer has risen *only 54 percent.*

The good dealer urges his customers to have soil tests run regularly. In Iowa, only about 25 percent of the farmers have their soils tested, and only 70 percent of these people fertilize to full strength advocated.

More than 4,500 soil tests were run last year in the laboratory of the Pfister Farm Store, Kearney, Nebraska, under B. T. Christensen, service director. Early in its life, the store laboratory began taking samples for customers. Charges are the same as at the University. Chris writes up most of the farm recommendations and sells his share of the fertilizers that result. Bank farm agents also take samples and send them to Chris for analysis. The store sells 5 tons of fertilizer for every soil test made. But despite its excellent advertising value, Chris says *the average dealer would do better not to take on any such wholesale business of testing.* He is an ex-chemist with a fertilizer concern and ought to know.

Mixing fertilizer formulas to meet specific needs and a consistent soil testing service builds up good will trade for the South Texas Fertilizer & Chemical Co., El Campo, Texas, where R. M. Hill is the manager. The store pays the cost of all tests, whether or not the prospect becomes a patron. Costs run from one dollar to $15, according to the number of samples. A nearby college runs the analyses and suggests the formulas. Then, Mr. Hill tells the farmer he'll sell him fertilizer outright, rent or sell him an applicator, or do a custom job for him. Through the custom job, the company mixes the goods from their stock at a flat per acre rate and uses their own men to run the distributor on the farm.

The good dealer uses check plots and keeps customer-cost studies and takes colored slides of the results to show groups and individuals.

Walters & Baker, Farm Service Company of Jeffersonville, Ohio, promotes liquid fertilizer sales by colored slides. They take photos of their applicating machines at work, as well as "with and without" pictures of crops. These slides are shown to visiting farmers. "We also use the slides at our fertilizer educational meetings, where we have from 50 to 400 farmers in attendance," says Mr. Baker. The firm conducts farm fertility tours and maintains a weed spraying service. With slight adaptations, the same trucks and tanks can be used for chemical weed control.

An electric soil augur used for faster work in winter months and a "gabfest" session where 200 farmers last winter consumed $200 worth of refreshments while hearing talks on starter placement and the economics of soil fertility—that's the feature of the Miller Seed and Supply Company, York, Nebraska. From tests made at a county laboratory, the part-

ners draw up a sampling map of each farm covered, keep all data on file, along with the record of the amount and grade bought by each customer. When the farmer drops in for a business chat, they take down his own record and make the recommendations for the season ahead. Being public spirited in a canny way, the firm donated 60 pounds of nitrogen per acre on 35 acres to improve the local park and golf course.

"Before you can sell fertilizer intelligently, you must know what it will do and be able to prove it by case histories. Then you can begin to talk turkey to the prospect so he will understand it." This is the word of Kenneth Stooky, Technical Farm Service and Supply Co., Markle, Indiana. His firm stresses the slogan, "For every dollar invested in anhydrous ammonia, the farmer usually gets back $3." They work this out on an actual financial basis based on their own case histories.

The good dealer *keeps local bankers sharpened up to the merits of fertilizer* and the soundness of loans made for this purpose.

Dr. C. L. Curlee, physician turned fertilizer dealer, makes prescriptions for weak soils and stands behind them with faith that they'll work. He tracked down some potash and trace elements deficient in central Texas soils. He then drew up his chart of special prescriptions to make good on those lacking minerals. He uses color prints to find out where the deficiencies exist. Meanwhile, he keeps in touch with local bankers continually and often addresses their meetings. To one group of bankers, Dr. Curlee offered to pay $1,000 to anyone who could show him a better net return on the investment than fertilizers pay. *The bet still stands.*

The good dealer is on the alert for new ideas to help in soil improvement efforts.

George Fallrath, Cokato, Minnesota, creamery manager, has a real practical idea that draws trade and renews the land thereabouts. He buys bulk goods from the mixer, stores the materials, and applies them at a nominal fee. He won't get involved in costly equipment. He contracts with a trucker who gets all the handling charges. The charge is 50 cents per acre for the spreading, $1.50 per ton for hauling the first 10 miles, and 25 cents per ton extra for every 5 miles beyond that. His bulk mixed goods deal draws many farmers who would have probably used little or no fertilizer otherwise.

The aforementioned firm at El Campo, Texas, finds it advisable to change, adjust, and fabricate a lot of attachments and equipment. They have fashioned a special combination mixer-distributor for use where the formula calls for both liquid and solid ingredients. In another improvised outfit they call "the dripulator," a tank is mounted on a cultivator and tubes are extended on both sides so that six rows can be fertilized at once. The company also sub-contracts airplane crop dusting and fertilizing for customers who want it.

Ingenuity, steadfast belief in what better soils mean to a rural area, and willingness to make sacrifices and cash investments for the good of the cause—these are hallmarks of the fertilizer business today in the capable hands of its representatives. More power to 'em from springtime to harvest! ◄◄◄

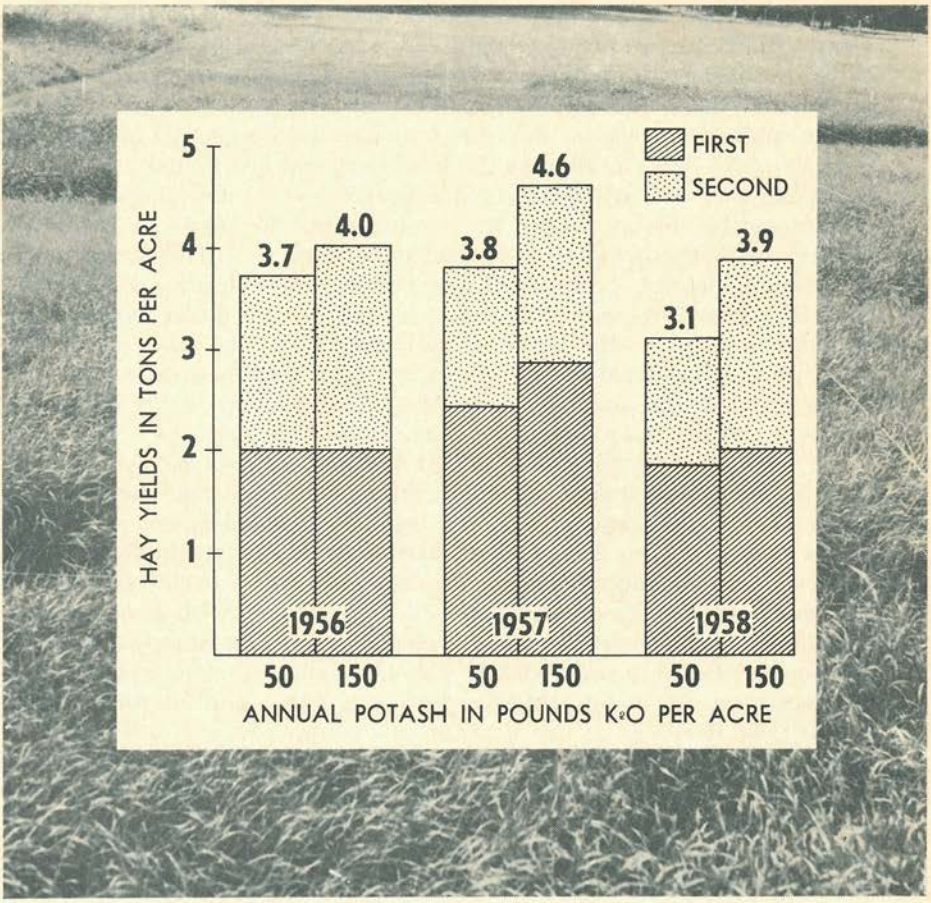

Figure 1—Potash fertilization became necessary when high nitrogen rates were used on timothy. In 1956, the 150-pound potash rates increased yields only in the second cutting. But continued high production from nitrogen in 1957 and 1958 increased the grass's demand for potash, until 150 pounds potash per acre boosted hay production *nearly a ton per acre*—0.8 ton, to be exact.

By Cecil S. Brown and Paul R. Belyea

New England dairymen have become more and more aware of what nitrogen fertilizer can do to their grass production.

Each year, more farmers are increasing their fertilizer usage on good grass fields from which high yields are desired. Better machinery and methods for early harvest, cheaper nitrogen fertilizer, and improved grass varieties have all contributed to the increasing stature of grass as an important basic crop.

Intensive fertilization of grasses is

N HIGH NITROGEN INCREASES

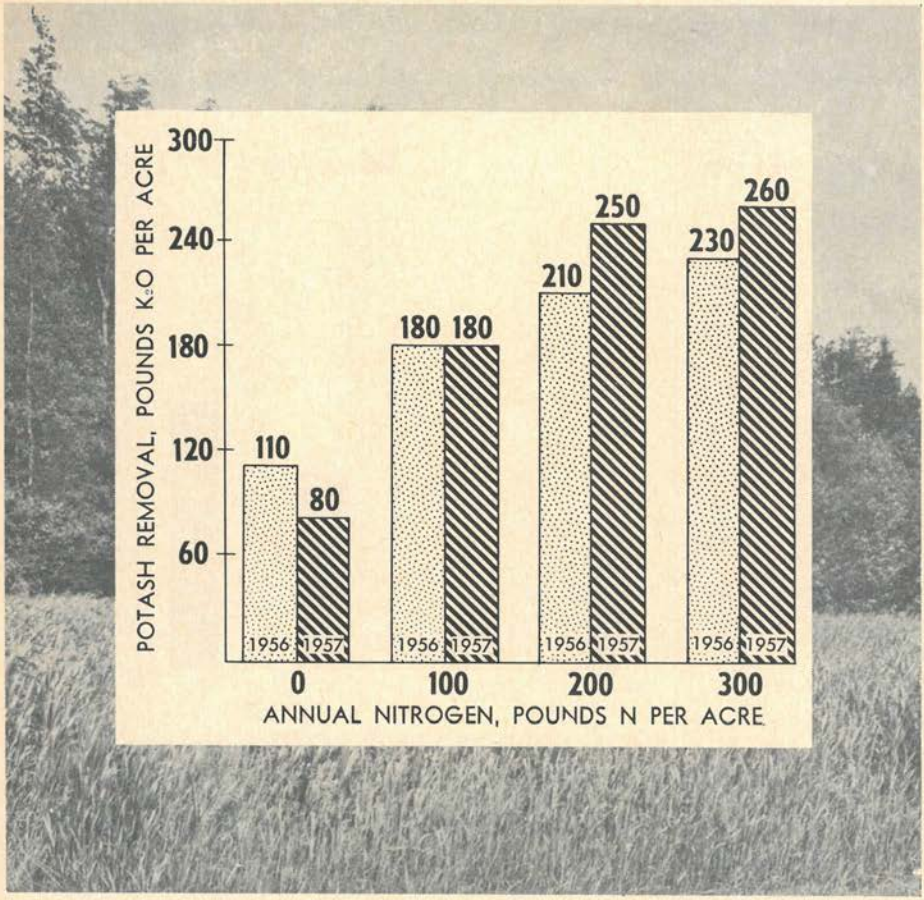

Figure 2—The more nitrogen they used on timothy the more potash the grass removed from the soil. Note how the timothy receiving 200 pounds nitrogen removed 100 to 150 pounds more potash annually than the low nitrogen plots. This is a good example of how high nitrogen rates increase annual potash demands of grasses.

Department of Agronomy **University of Maine**

becoming regarded by many as a practical means of extending the productive life of forage stands for a few years, following the loss of associated legumes.

We have observed that grass yields in New England may decline sharply after the first year or two, *in spite of continued high usage of nitrogen.* Field examinations and soil tests in Maine have indicated potash starvation may be an important cause of these lowered yields.

However, experimental proof of

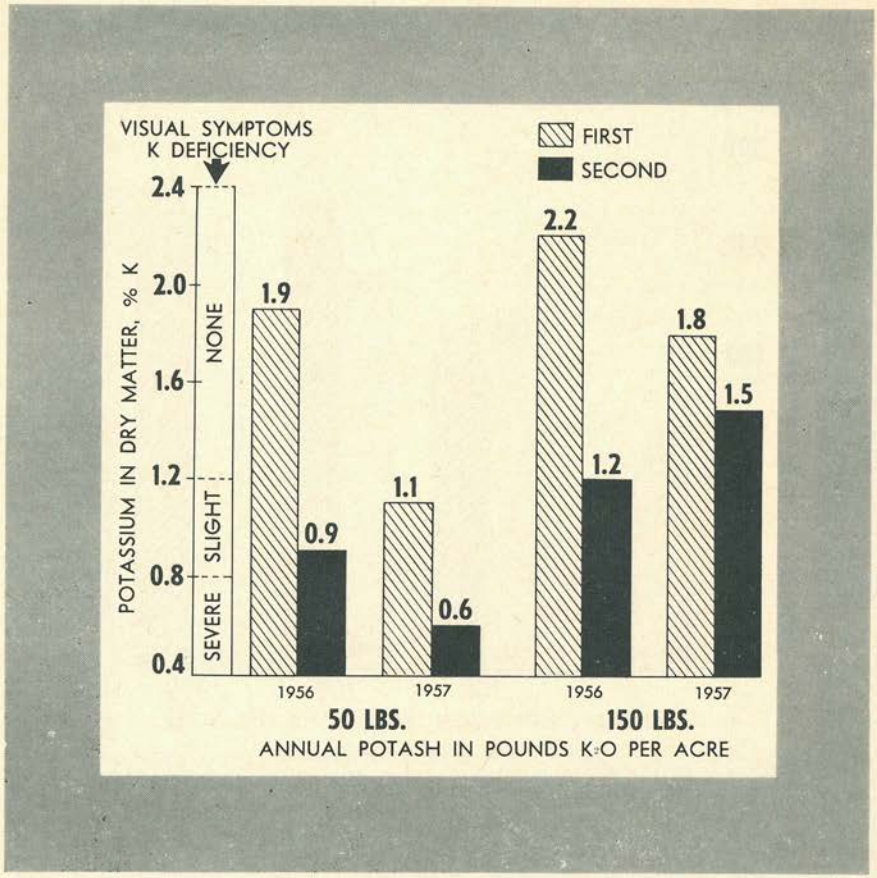

Figure 3—Here is striking evidence of high nitrogen timothy eating plenty of potash from the soil. This shows the amount of potash found in the first and second cuttings of high N timothy grown at two levels of potash fertilization. Note how the crop receiving only 50 pounds potash per acre dipped into slight and severe hunger signs after the first cutting in 1956. The crop receiving 150 pounds potash per acre managed to stay above visual hunger signs, though it dipped considerably in potash content on the second cutting of each year.

this likelihood has been lacking until field experiments were started in 1956 to determine the effect of nitrogen usage on the mineral requirements of timothy. Results from these experiments during the past three years indicate one fact—that grasses which receive intensive nitrogen treatment also demand high potash treatment.

The Experimental Plan

Field experiments were laid out in central Maine in the spring of 1956. We decided to use established timothy sods already in production in farm fields. Two sites were located, one on a well-drained Bangor silt loam and the other on a poorly-drained Monarda silt loam.

Both fields which had produced hay for about five years, had declined in clover content to a low of 10 to 20 percent. Rapid soil tests revealed pH values of 5.5, and *"very low" levels of available phosphorus and potash.*

Four levels of annual nitrogen fertilization were used throughout the study: *0, 100, 200,* and *300 pounds* actual nitrogen per acre. These were applied in two split applications of

ammonium nitrate—in early May and after the first cutting. Hay harvests were made in June and August of each year.

Four combinations of phosphorus and potash were topdressed annually on subplots of each nitrogen rate. The following treatments were used: (1) 50 pounds P_2O_5 + 50 pounds K_2O, (2) 50 P_2O_5 + 150 K_2O, (3) 150 P_2O_5 + 150 K_2O, (4) 150 P_2O_5 + 300 K_2O. *Superphosphate (20%) and muriate of potash were the fertilizer carriers used.*

The two soils were each adjusted to pH 6.1 through topdressed dolomitic limestone. Two tons of limestone were applied in May, 1956, and an additional ton in October of the same year. No additional limestone has been applied throughout the study.

Herbicides have been used annually to keep the plots free of legumes and broad-leafed weeds. Eliminating legumes is important, because it permits more direct evaluation of the fertilizer treatments on the yields and chemical composition of *timothy and associated grasses.*

It is important to note the two soils used in the experiment seem representative of the *low potash status* of many new England soils.

Soil samples of the Bangor soil, obtained adjacent to the field experiment, have been used in other studies on the potassium-supplying power of Maine soils. Preliminary results indicate that most of these soils have a potash status similar to that of the Bangor soil used. Several of the soils studied exist in many areas of New England.

Nitrogen Requirements Very High

Yield data obtained during three years of study in Maine clearly indicate that pure grass stands can produce over four tons of hay equivalent per acre, or about equal to the yields of well-managed legumes.

To do this, however, grasses must receive split applications of nitrogen totalling about *200 pounds nitrogen per acre annually.* Somewhat lower amounts of nitrogen may be needed during the first year or two while legume roots are decaying and releasing nitrogen to the grass sod. Somewhat higher levels of nitrogen fertilization may be required on the *sandier soils.*

Dr. Cecil S. Brown New Hampshire native, conducts extensive teaching and research in forage management at the University of Maine. He earned his B.S. from New Hampshire, his M.S. and Ph.D. from Cornell.

The effect of each 100-pound increment of nitrogen on the yields of timothy is shown in Table 1.

The first 100 pounds of nitrogen increased yields approximately *one and one-half tons* in each of the three years.

Yield increases from the second 100 pounds ranged from approximately one-half ton in 1956 to one and one-half tons in 1958. Release of nitrogen from clover and manure residues apparently explained the lower response in the first year.

The third 100 pounds had very little effect on yield in any of the three years studied and was clearly superfluous under the existing experimental conditions.

Mr. Paul R. Belyea former graduate assistant in agronomy at Maine, is now control chemist for the Maine Agricultural Experiment Station. He earned his B.S. and M.S. from the University of Maine.

Table 1. Yields of timothy hay (10% moisture) as affected by nitrogen rate (Bangor soil.)[1]

Annual Nitrogen	Hay, tons per acre		
	1956	1957	1958
0	2.2	2.0	1.0
100	3.4	3.4	2.5
200	4.0	4.6	3.9
300	4.2	4.8	4.1

[1] Topdressed with 50 pounds P_2O_5 and 150 pounds K_2O annually.

Phosphorus Requirements Moderate

Our results, so far, have caused us to conclude that phosphorus needs of intensively fertilized timothy can be satisfied by about 50 pounds of P_2O_5 per acre annually on many New England soils.

As shown in Table 2, increasing the rate to 150 pounds P_2O_5 per acre affected grass yields little on either of the two soils studied over a three-year period. The initial use of lime to adjust the soils to a more favorable pH range may have increased crop recovery of applied phosphorus.

Another way we know the 50-pound P_2O_5 rate in our tests is adequate is by analyzing the harvested timothy for phosphorus content. When the phosphorus application was increased to 150 pounds P_2O_5, the phosphorus content of the crop increased relatively little, as shown in Table 3.

Potash Requirements Moderately High

But potash is another matter. The annual potash requirements of high-nitrogen timothy have been considerably higher than the phosphorus needs of such timothy on both soils studied.

The low rate of 50 pounds K_2O has been adequate *only at the 0 and 100-pound nitrogen levels.* When the potash rate was increased to 150 pounds K_2O, yields for the 200- and 300-pound nitrogen rates increased greatly after the first year. When the potash rate was increased to 300 pounds K_2O annually, it had little effect. How nitrogen rates affected the response of timothy to potash is shown in Table 2.

Figure 1 gives a detailed picture of how potash fertilization affected the yield of timothy *receiving 200 pounds nitrogen.* In 1956, the 150-pound potash rates increased yields only in the *second cutting.* Continued high production from nitrogen usage in 1957 and 1958 *increased the potash requirements.* And when 150 pounds K_2O were used to meet these require-

Table 2. Yields of timothy hay (10% moisture) at two nitrogen levels as affected by phosphorus and potash rates (Bangor soil).

Annual P_2O_5–K_2O	Tons per acre at 100 and 200 lbs. nitrogen					
	1956		1957		1958	
	100	200	100	200	100	200
50–50	3.2	3.7	3.3	3.8	2.4	3.1
50–150	3.4	4.0	3.4	4.6	2.5	3.9
150–150	3.5	4.2	3.4	4.5	2.6	4.1
150–300	3.6	4.3	3.5	4.7	2.4	3.9
Increase at 150 lb. K_2O	0.2	0.3	0.1	0.8	0.1	0.8
Increase at 150 lb. P_2O_5	0.1	0.2	0.0	−0.1	0.1	0.2

ments, hay production rose 0.8 tons in each of the two years.

How nitrogen rates affect the uptake and removal of potash by timothy is shown in Figure 2, using data from the 300-pound K_2O rate on the Bangor soil. Timothy receiving 200 pounds nitrogen removed *100 to 150 pounds more potash* annually than the low nitrogen plots.

Potash Deficiency Symptoms

Potash deficiency symptoms in timothy were first observed in the *second cutting of the first year* on both soils. The deficiency was confined to the *200- and 300-pound nitrogen treatments* and occurred only on the low potash plots receiving 50 pounds K_2O in the spring.

In 1957, slight symptoms were observed in the first cuttings of these plots and severe symptoms in the second. The same was true in 1958, but in addition potash deficiency appeared for the first time in the 100-pound nitrogen plots.

Potash starvation in timothy appears as *a yellowing to browning of the dying tips and margins of the leaf blades.* The over-all effect is a scorched or burned appearance of the affected plots. If seen in a farm field, it might be incorrectly diagnosed as drouth or disease.

Timothy plants in the *high potash plots* maintained a *lush green color* throughout their entire leaf area. Moisture tests consistently show a greater succulence in these plants.

The relationship between the potassium content of timothy and the appearance of potash deficiency symptoms is shown in Figure 3.

Severe symptoms were associated with a potassium content *below about 0.8% K in the dry matter.*

Slight symptoms were observed *between 0.8 and 1.2% K.*

Significant depressions in yields usually occurred whenever the potassium content of the timothy had declined to *about 1.2% K.*

The abrupt potassium content drop in the second cuttings of the low potash plots is clearly shown in Figure 3. The use of 50 pounds K_2O in the spring was sufficient to keep plant potassium content above serious deficiency levels in the first cuts, but *did not carry over sufficiently to the second cuts to prevent deficiency.*

In contrast, 150 pounds K_2O—*split 100 pounds spring and 50 pounds after the first cut*—maintained an adequate potassium level in both the first and second cuttings.

Economic Significance

These and related experiments on grasses in Maine seem to point up

Table 3. Phosphorus content of high nitrogen timothy as affected by phosphorus rate.[1]

Cutting	Phosphorus content (% P) in timothy dry matter at 50 and 150 lbs. P_2O_5.			
	Bangor soil		Monarda soil	
	50	150	50	150
First, 1956	0.26	0.28	0.25	0.27
Second, 1956	0.19	0.21	0.22	0.27
First, 1957	0.20	0.24	0.20	0.24
Second, 1957	0.21	0.22	0.22	0.28

[1] Topdressed with 200 pounds nitrogen and 150 pounds K_2O annually.

certain ways fertilizers may be used to produce grasses on New England soils—intensively, successfully, economically. These pointers are:

(1) Timothy and similar grasses have a potential production capacity about equal to alfalfa on soils of good moisture retention. Four tons or higher per acre may be secured in two cuttings of well-fertilized grass hay grown on good loams or silt loams of at least moderate depth. Fertilized grasses grown on these better soils are affected less by drouth than we have previously assumed.

(2) Nitrogen requirements for near maximum yields of pure grass stands are *much higher than often recognized.* When clovers or other legumes are absent, about 200 pounds nitrogen a year are usually needed. Grasses managed for pasture may respond to even higher nitrogen levels.

(3) Intensive production from grasses requires *split applications of the annual nitrogen topdressing.* It is not practical to use a single massive application of nitrogen in the spring. Luxury consumption of nitrogen, lodging of the hay crop, difficulties in harvesting and curing can all occur when we fail to subdivide the annual nitrogen treatments.

(4) *High nitrogen fertilization increases the annual potash demands of grasses.* Failure to increase potash rates may reduce yields greatly just a year after the first intensive nitrogen usage.

(5) The potash requirement of many New England soils seems to be two or three times greater than the phosphorus requirement for topdressing high nitrogen grasses. Using equal amounts of P_2O_5 and K_2O on these soils, as currently practiced, does not appear economically sound. Fertilizers with higher potash content should be used to meet the minimum phosphorus and potash needs of high yielding grasses most economically.

Such findings should encourage more New England dairymen to examine their fertilizer ratios for grasses more carefully in the future. ◄◄◄

TOP-DRESS ALFALFA FIELDS

The average acre of alfalfa in Virginia and nearby states last year yielded a little over 2 tons of hay. Yet, the best fields produced double this amount. In most cases, plant food made the difference. Established stands of alfalfa ought to be top-dressed each year with 600 to 1,000 pounds per acre of borated 0-10-20, 0-14-14, or the equivalent in higher analysis material.

Unless alfalfa is top-dressed, yields will fall off and stands will soon die out. Less desirable plants will then come in. The best time to apply the fertilizer is in late winter before growth gets under way. If you are unable to get it on now, make the application immediately after the first cutting.

Southern Planter

FERTILE FACTS

VIA BROCHURES · REPRINTS · HANDBOOKS

The following article reprints on profitable soil and crop management are available on request. Please indicate the reprint code and the number you desire. The address is: American Potash Institute, 1102 16th Street, N. W., Washington 6, D. C.

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HIGH NITROGEN TREATMENT AFFECTS POTASH LEVEL OF PASTURE SOILS

THE current trend toward increasing application rates of nitrogen fertilizers on many crops is amply supported by research data. But in some instances, studies have not been conducted long enough on the same soil to determine the effect of continued high nitrogen treatment on *the nutrient balance in soils.*

Since increased crop yields remove from the soil more amounts of all plant nutrients, increased applications of one nutrient will ultimately deplete one or more of the other nutrient elements in the soil.

Such conditions have developed in several New Jersey studies where increased nitrogen rates have been applied to pasture and forage crops, *with potassium being the nutrient most fre-*

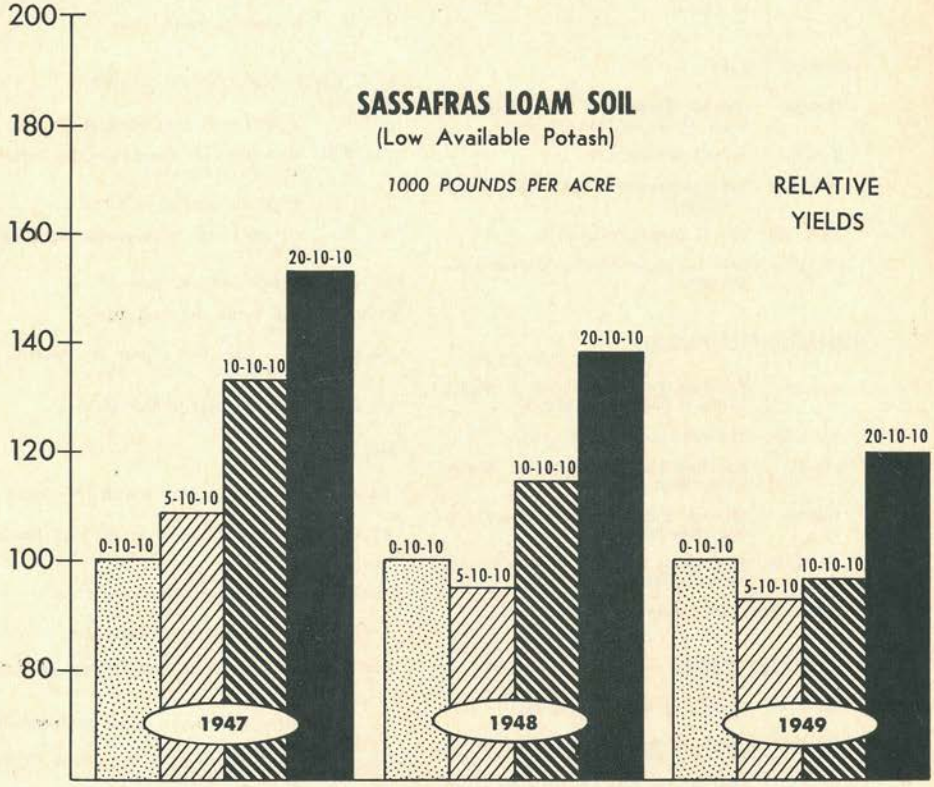


Figure 1—Here are the relative yield increases from applied nitrogen compared with 0-10-10 on two tested soils in New Jersey—Sassafras Loam and Chenango Fine Sandy Loam. Note how the two lower rates of nitrogen produced less forage on the Sassafras soil during the

By E. R. Purvis

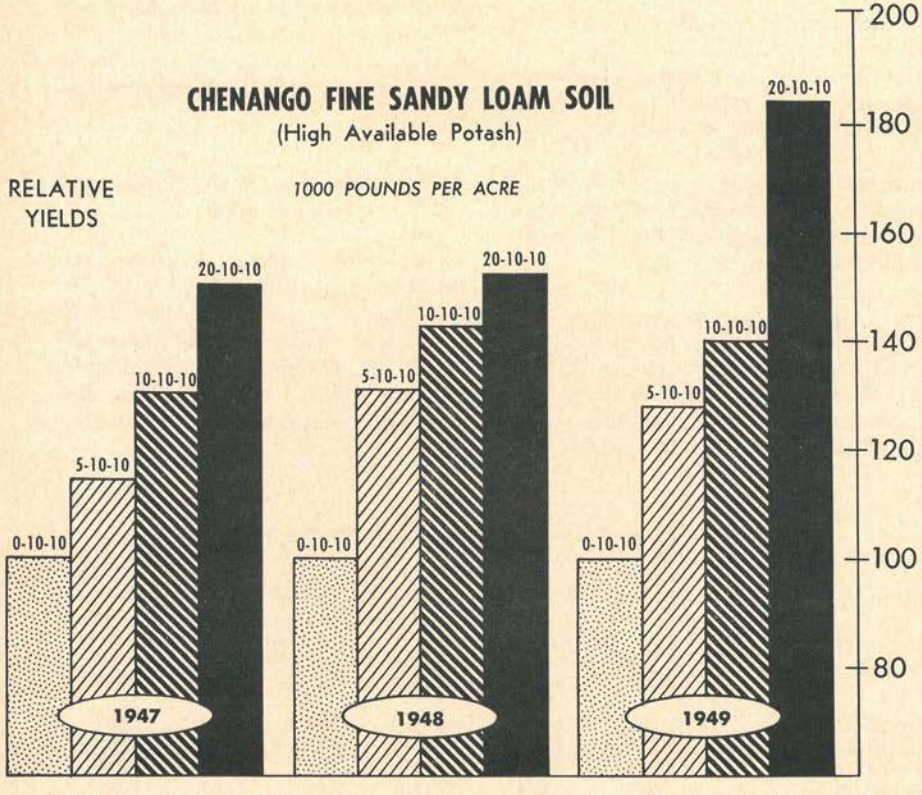
Soils Department **Rutgers University**

quently reduced to the deficient level.

Fertilizer Studies with Improved Pasture Stands

The data discussed here were obtained over a three-year period from field studies conducted at several locations in New Jersey on established pasture stands of *Ladino clover* and *orchardgrass*.

Though they were not designed for that purpose, two of the field trials illustrate the *importance of soil potash levels in determining the response of pasture crops to increased rates of nitrogen application.* As noted in Table 1, chemical characteristics of the soils on which the two tests were conducted were almost identical, with one exception—the Chenango soil contained almost three times as much



third year of the study than the no-nitrogen treatment. Note, also, that the highest nitrogen treatment on the Sassafras soil produced a 52 per cent increase in yield the first year and only a 19 per cent increase the last year—indicating a need for balanced fertilization.

Table 1. Chemical Characteristics of Soils

Soil Characteristics	Sassafras Loam Middlesex County	Chenango F. S. Loam Warren County
pH	6.5	5.8
% organic matter	4.0	4.1
Exchange Cap. (m.e. per 100 gms.)	13.7	13.7
Available P (lbs./A)*	60	62
Available K (lbs./A)*	65	172

* By electrodialysis.

exchangeable potassium as the Sassafras soil.

Treatments of 1000 pounds per acre of 0-10-10, 5-10-10, 10-10-10, and 20-10-10 were applied annually before growth started in the spring. Plots were harvested 4 times each year with a power mower, and the yield results are presented in Table 2.

Reduced yields during the 3rd year were due to drouth conditions, with the Chenango soil plots more seriously affected than the Sassafras soil plots. However, a study of these data show the relative yield increases due to nitrogen treatment decreased in a uniform pattern on the Sassafras loam soil, but increased on the Chenango fine sandy loam.

On Sassafras Loam Soil

This comparison is found in Figure 1, showing the relative yield increases from applied nitrogen compared with 0-10-10. Note how the two lower rates of nitrogen produced less forage on the Sassafras soil during the third year of the study than the no-nitrogen treatment, and that the highest nitrogen treatment produced a *52 per cent* increase in yield the *first year* and only a *19 per cent* increase the *last year.*

Potassium deficiency symptoms were widespread in the plots receiving high nitrogen treatment during the third year of the study and were present in plots receiving nitrogen at the lower rates.

On Chenango Fine Sandy Loam Soil

The highest nitrogen treatment on the Chenango soil produced a 45 per cent increase in yield over that of the no-nitrogen treatment in the first year, and an 81 per cent increase during the third year. No potassium deficiency signs appeared in any of the plots on this soil.

Table 2. Effect of Fertilizer Treatment Upon Pasture Yields.

Treatment*	Yields in pounds dry wt. per acre					
	Sassafras Loam			Chenango F. S. Loam		
	1947	1948	1949	1947	1948	1949
0–10–10	4642	5401	4949	4923	4570	2903
5–10–10	5031	5144	4496	5575	5963	3563
10–10–10	6086	6116	4855	6276	6268	3958
20–10–10	7081	7359	5983	7142	6789	5247

* Applied at rates of 1000 pounds per acre.

The studies show that the difference in response to applied nitrogen on the two soils resulted from *a variation in their levels of available potassium.*

The Chenango soil contained almost three times as much exchangeable potassium as the Sassafras soil at the beginning of the study, and also had a much higher potassium-supplying power, indicated by the relatively unchanged available potassium levels at the end of the trials.

How nitrogen treatment affects clover survival is shown in Table 4. These results are in line with conclusions by many investigators who find that applied nitrogen tends to reduce the growth of legumes in mixed stands. The fact that clover survival was no greater on the Chenango soil than on the Sassafras soil indicates the level of available potassium was not the controlling factor. The reduction in clover stand probably resulted from crowding and shading by the orchardgrass.

The field trials discussed here are but one of several instances encountered in New Jersey where potassium level has controlled response to increased nitrogen rates.

E. R. Purvis is Professor of Soils at Rutgers University. His primary interests are in the field of soil fertility. A native of South Carolina, he obtained his B.S. from Clemson College, his M.S. from the University of Florida, and his Ph.D. from Rutgers.

A summary study of the data obtained to date indicates that increased nitrogen rates on soils of low potassium-supplying power require increased potassium to maintain increased yields over a period of years. The Sassafras soil, discussed here, requires over *twice as much potassium as nitrogen* to maintain the proper balance between the two nutrients.

Splitting potash applications will reduce the above ratio somewhat by reducing luxury consumption of potassium, but it is questionable if the savings would justify the additional cost of application. ◄◄◄

Table 3. Available P and K Levels of Soils at End of Study

Treatment**	Sassafras Loam		Chenango F. S. Loam	
	P*	K*	P*	K*
	lbs./A	lbs./A	lbs./A	lbs./A
0–10–10	58	48	33	160
5–10–10	57	43	41	150
10–10–10	55	35	57	158
20–10–10	61	48	53	153

*By electrodialysis.
**Applied at rates of 1000 pounds per acre.

Table 4. Influence of Fertilizer Treatment on Survival of Clover

Treatment	Clover Survival*	
	Sassafras Loam	Chenango F. S. Loam
	%	%
0–10–10	49.8	25.7
5–10–10	6.1	4.5
10–10–10	2.9	1.9
20–10–10	1.2	Trace

*Data for % clover in 2nd harvest of 3rd year.

HOW SO FEW CAN

Planting soybeans in lister furrows on small grain stubble saves time and effort. South Carolina farmers are becoming increasingly interested in this and similar labor-saving and soil-conserving practices.

By T. S. Buie

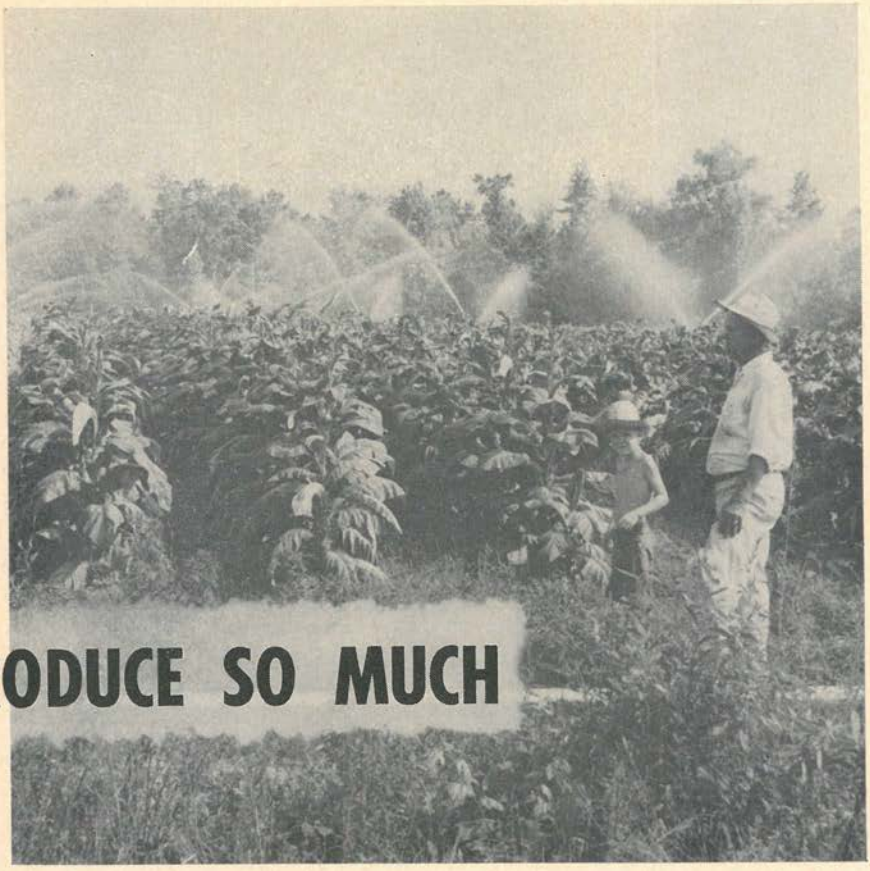
How fewer farmers can use less land each year and still produce more bushels of grain, more bales of cotton, and a greater volume of all the other crops needed to feed and clothe our constantly growing population is a mystery.

A mystery, that is, until we realize how methodically scientific knowledge is *replacing the labor of men and the use of land.*

South Carolina farmers are typical of those in other states. So, a look at recent developments in the Palmetto State will answer some of the why's and how's now going on throughout the nation.

In 1935, *386,000 agricultural workers* in South Carolina used *3,284,000 acres of land* to produce 744,000 bales of cotton, 22,825,000 bushels of corn, and 89,760,000 pounds of tobacco.

Just two decades later the change was almost unbelievable. Near the end of 1954, there were only *232,000 people* employed in agricultural production in the state. Yet, the next year this smaller number produced 572,000 bales of cotton, 27,440,000



PRODUCE SO MUCH

Columbia, S. C.

Good land, a productive variety of tobacco well-tended, proper fertilization and water when needed, combine to make a highly profitable crop. The per acre yield of tobacco on South Carolina farms has increased 3-fold in the past 30 years.

bushels of corn, and 197,200,000 pounds of tobacco on *only 1,826,000 acres of land.*

One-fourth more corn, over twice as much tobacco, and one-third less cotton on 55 *percent* of the acres used 20 years earlier—all by 40 per cent less workers!

Better Methods—Higher Yields

This increased production resulted from better methods—higher efficiency.

Farmers are using, with telling effect, the technical knowledge of soils and crops gained in the laboratories and field plots of the experiment stations.

They are adopting practices tried by pioneering farmers unafraid to test promising new crops and methods.

Specifically, our current high level of production has been caused by several interacting factors. Some of them are:

1. Better land use practices. This means crops fitted to the land—row crops only on level or gently sloping fields with the hillsides seeded to pasture or planted to pine trees.

Contented cows. And why shouldn't they be with nothing to do but convert succulent Coastal Bermuda grass into beef. This is a former cotton field which, properly fertilized and managed, is producing excellent pasture.

2. Sound soil and water conservation practices properly applied—the result of research and experience, technical assistance and, in numerous instances, cost-sharing.

3. Heavier applications of high analysis fertilizer—adapted to the specific needs of the soil used and the crop grown.

4. More efficient equipment—the modern plowman must have more power in his hands than that provided by a single slow-walking mule.

5. Improved crop varieties—to produce higher yields and meet the specific demands of the market.

6. Better cultural methods—which require less labor.

7. Proper disease, insect, and weed control—losses reduced.

8. Irrigation—as needed and practicable.

Changing Land Use Pattern

Let's take a look at how the land use pattern on South Carolina farms has changed in recent years.

Years ago a farmer had no choice in cash crops. It made little difference whether he was a one-horse farmer or a plantation owner operating 100 plows—*he looked to cotton for his money.*

Soil-building rotations, proper fertilization, and other modern farm practices combine to produce as much corn on one acre as was made on 5 or more only a few years ago.

Peach orchards fitted to the contour of Piedmont hillsides are a beautiful sight when in full bloom. And they represent a highly profitable use of the land, much of which was formerly planted to cotton.

But this is no longer true. Instead of averaging 50 per cent or more of the total farm income for the state, as it did only a few years ago, cotton is now the source of only about *one-fourth* of the wealth produced by our farmers each year.

Grass has virtually replaced cotton in many sections.

A big factor influencing this change is the soil capability information developed by Soil Conservation Service technicians. This specific knowledge —of what the soil in each field is like and what it needs—is now available to all farmers through their local soil conservation districts. The owners of nearly half the farm land in the state now use this information with good effect.

Fertilizer—An Important Factor

Fertilizer continues, as it has for many decades, to represent the *largest single cash outlay for crop production in our state.* Therefore, farmers look closely at what is in each bag—they want to get the most for the money they spend.

Light applications of low analyses

Southern farmers used to fight grass from daylight to dark every summer day; now they plant and fertilize it with profit. The owner of this 6-month-old field of Coastal Bermuda won first prize in the "First Year" Contest sponsored by the Edisto (S. C.) Soil Conservation District of which he is a cooperator.

The old days when Southern farmers were content with a half bale of cotton to the acre are no more. This cotton followed 4 years of fescue and ladino which "did something" to the land.

are a thing of the past. *Farmers are applying fertilizer of higher grade to all the crops they grow.*

In 1956-57 the average plant food content of all mixed fertilizer sold in South Carolina was *slightly over 23 percent.* Only 25 years earlier, it was *not much above 16 percent.*

This increase in plant food content is a tribute both to the research and educational agencies serving farmers and to the fertilizer industry. If high grade mixtures of good quality had not been available at reasonable cost, we would still be using the inferior products.

The ratio of plant food elements has changed as shown by the following figures from the Clemson College Fertilizer Inspection and Analysis Department:

Year	Nitrogen	P_2O_5	K_2O	Total
1907	2.71	8.91	3.29	14.91
1932	3.13	9.15	3.98	16.26
1957	4.01	9.75	9.33	23.09

This represents a 48 percent increase in nitrogen, not much change in phosphoric acid, and *nearly 3 times as much potash!*

Many of the acres previously planted to unprofitable crops of cotton and corn are now providing their owners with substantial returns from pulpwood and other woodland products. Meanwhile, the land is fully protected against soil and water losses.

This marked increase in the amount of potash used—most of which has occurred in the last 25 years—is due partly to the *large acreage of well-fertilized perennial legumes and grasses.* These heavy potash users now occupy many acres formerly planted to cotton and corn. *And heavier applications of potash have been found to pay on cotton and other crops as well.*

Better Equipment, Seed and Cultural Methods

When we note farm tractors in South Carolina increased from 1,304 in 1920 to 46,551 in 1955—while horses and mules were declining from 298,000 to 119,000—we see how much more power modern farm workers have to work with than their fathers had.

As hybrid corn gained popularity in the Corn Belt, there were questions over the possibility of developing adapted Southern strains. Well, our research workers and commercial seed breeders have come up with the answer. Most farmers throughout South Carolina and other Southern states now use adapted hybrids. And the rapidly increasing corn yield shows what this means to them.

While the shift to new varieties of other crops has not been as spectacular as with hybrid corn, currently available varieties of all field crops produce more than those of two or three decades ago.

Progress has been made in cultural methods as well.

Contour planting is common now, even in sections where the land is only gently sloping. Better land preparation is possible with the use of heavier equipment. Multiple-row planters and cultivators increase the efficiency of farm labor. Time spent chopping and hoeing cotton has been greatly reduced—entirely eliminated from many fields—by using chemicals which check grass and weeds. And controlling obnoxious weeds in pastures with spray is commonplace.

Mulch planting, while not generally practiced as yet, shows much promise. In this system, the farmer plants his row crops in lister furrows without other land preparation. Plant residues that may remain from previous crops are left on or near the surface of the ground.

Irrigation

While supplemental irrigation is not yet widespread in South Carolina, it is contributing to our changing agriculture. Farmers are beginning to realize that when they invest in fertilizer, seed, equipment, insecticides, etc., they cannot afford to take chances on a drought burning up the crop in midsummer.

More and more farmers each year are calling on research, technical-assistance and cost-sharing agencies for help in developing irrigation systems for their farms. Soil Conservation Service technicians have already designed and supervised construction of over 18,000 ponds on farms of soil conservation district cooperators in South Carolina. Most of these ponds are potential sources of irrigation water.

The trend toward supplemental irrigation will continue and increase.

What of the Future?

Each person on the farm today is producing for some 20 others. But we have no more reached the limit of economic crop and livestock production in South Carolina (and the other states) than we have reached the ultimate in electronics and space travel.

This changing agricultural pattern with its constantly increasing demands on fewer people and fewer acres presents a challenge. The challenge is not alone to those who live on the farm but includes all who provide the farmer with what he needs.

◄◄◄

POTASH HUNGER SIGNS

ON SOME ORCHARD CROPS

CROP	LEAF	TREE	FRUIT
ALMOND	Yellowish color. Brown scorch at tip and margins. Leaves fold upward. Reduced leaf size. Leaf curling at tip very noticeable on new growth.	Excessive leaf drop. Lack of foliage density gives bare appearance.	Reduced fruit set and yield.
APRICOT	Leaves fold upward, giving pointed appearance. Yellowish color. Irregular scorch proceeding from tip and margins until entire leaf is brown. New growth badly affected.	Stunted trees, excessively pruned because of the die-back.	Reduced yield and fruit size.
OLIVE	Leaves yellowish color. Brownish-gray scorch proceeding from tip of leaf.	Excessive leaf drop. Die-back of twigs and small branches.	Reduced yield and fruit size.
PEAR: BARTLETT	Leaves pale greenish-yellow color. Leaves curled upward with silver-brown scorch along edges.	Poor foliage density. Lack of new growth.	Reduced yield and fruit size. Premature ripening of some fruit.
PEAR: HARDY	Leaves pale greenish-yellow color. Leaves folded upward with irregular scorch along edges.	Poor foliage density. Lack of new growth.	Reduced yield and fruit size. Premature ripening of some fruits.
PEACH	Leaves yellowish-green color. Leaf edges very noticeably curled upward along entire length of leaf. Scorching along leaf edges. Dead areas fall out, leaving ragged edges.	Foliage density reduced. Die-back of branches results in stunted trees.	Yield and fruit size reduced.
PRUNE AND PLUM	Leaves yellow, many with brown scorch at tip and along edges. Scorch may involve entire leaf in some localities. Leaf size reduced.	Die-back of small and large branches commonly occurs. Poor foliage density. Excessive pruning of deadwood gives tree stunted appearance.	Yield and size reduced. Fruit takes on red color prematurely and may have "sunburn" spots.

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WHY

By M. E. McCollam
San Jose, California

INE ORCHARD SHOWS THE RESULTS OF PLANT FOOD AND GOOD CARE

ose of using fertilizer on fruit trees is increase the yield of good marketable

ccomplished if the fertilizer improves surface, and the vigor of fruit wood on ıny nutrient element applied to the affect the trees this way if the element n the soil, whether it is nitrogen, phos-ssium or any other element essential for pment.

ell-supplied with all of the essential s a good chance to be a productive good orchard practices are followed.

cannot be expected to cure *all* the or-ıts existing before its application.

ased trees are poor subjects for fertilizer

ı badly damaged root systems, caused poor drainage, or pest and disease at-so poor subjects.

"alkali" in the soil or excessive quanti-n or lime damages fruit trees so they effective use of fertilizers.

ors as these must be recognized and corrected, if possible, before greatest profit from fertilizers can be realized.

Nitrogen

For many years, fruit trees have responded to nitrogen applications. Nitrogen has been generally recommended throughout the West as an effective fertilizer in most orchard situations.

The answer often given to the question of which form of nitrogen to use in the orchard has been to use the cheapest form—*not the cheapest per ton,* of course, *but the cheapest per unit of nitrogen.* However, in addition to price consideration, certain other facts concerning the various materials must be kept in mind.

Long-continued use of ammonium sulfate may cause unfavorable soil acidity and water-penetration troubles. On the other hand, ammonia forms of nitrogen are less likely to leach through open soil than nitrate forms, reducing nitrogen loss.

Anhydrous ammonia and ammonia solutions are sold with application services, which appeal to many growers.

FEED FRUIT TREES—AND HOW

TOO LITTLE POTASH

TOO MUCH SODIUM

Although these apricot trees look very much the same, *leaf analysis* diagnosed the trouble as quite different—with the tree on the right suffering from *sodium* excess and the tree on the left suffering from *severe potash deficiency*.

Ammonium phosphate-sulfate, like some of the other materials also, has a content of two major plant nutrients —in this case 20 percent phosphoric acid as well as 16 percent nitrogen. The other nutrient elements may be of direct value on cover crops grown in the orchard to maintain good physical condition of the soil and to increase water penetration.

So with other nitrogen-bearing materials, they may have properties aside from price which add or detract from their value in certain situations.

If the amounts of commercial nitrogen recommended for deciduous orchards by various authorities were to be averaged and set down as a general recommendation, it would be a figure of *around one pound of nitrogen per tree* (*five lbs. sulfate of ammonia, three lbs. ammonium nitrate, or amounts of other materials according to N-content*).

There are many important deviations from this rate of nitrogen application, depending on various situations of soil, tree condition, size of trees, and the particular kind of fruit tree being grown.

To mention a few of these situations, mature apple trees or walnut trees may require *two pounds of nitrogen per tree or even more.* On some soils, replenishing nitrogen supply by cover-cropping may reduce commercial nitrogen requirements considerably.

Very old cherry trees may require *up to four pounds of nitrogen per tree.* In California, the tendency is to recommend a *minimum of nitrogen for the apricot,* and if the tree shows good growth and vigor, to omit nitrogen entirely at least until need becomes apparent.

According to a 1953 survey by Aldrich and Taylor, there appeared to

be no standard nitrogen fertilizer practice throughout California's citrus regions. About one-third of the citrus groves surveyed were being maintained in excellent condition on less than one and three-fourths pounds of nitrogen per tree, although two and one-half to five pounds of nitrogen per tree were common practice. This raised the question of how necessary higher nitrogen rates really were.

The most widely practiced method of applying nitrogen materials in the dry form to orchard soils is *scattering* or *broadcasting on the surface*. With this method, most of the fertilizer falls under the spread of the branches. This has proved an effective method of applying nitrogen in orchards.

Anhydrous ammonia and the liquid solutions of nitrogen are applied to the soils of deciduous orchards by drills that open up a series of furrows and spout these nitrogen materials directly into the soil. These nitrogen materials are well-suited for applying through irrigation systems. But this method is not usually suitable for deciduous fruits, since irrigation time and the best time for nitrogen application often do not coincide.

However, when an application of nitrogen is made after fruit setting, applying in the irrigation water may work out very well.

It is important to have a sufficient supply of nitrogen available to the tree for fruit setting and for the spring flush of new growth. Fertilizing is commonly done in *late winter* or *early spring*.

Nitrate forms of nitrogen should not be applied much before bloom on early blooming fruit crops, since there is danger of loss of nitrogen from the leaching action of rainfall. Less leaching loss is likely when ammonia forms of nitrogen are used, and these materials may be applied earlier.

In recent years, interest has developed in applying nitrogen, phosphorus, and potassium to plant leaves in the form of foliar sprays. While still most generally used as a soil application, the *urea* form of nitrogen has been used successfully on some fruit trees, particularly the apple, to accomplish nitrogen nutrition.

Thus far, however, it seems that repeated foliar sprays are necessary to get enough nitrogen into the tree and the main usefulness of the method is as a supplemental application following the main application to the soil.

Nearly 50 percent of the apple growers in the Northwest and in California, it has been estimated, are using nitrogen sprays on their trees. The material used commercially is urea. This contains 42 to 47 percent nitrogen, sprayed on the foliage in a concentration of 5 to 6 pounds of urea to 100 gallons of water.

Research is still going on with urea sprays on other deciduous fruits.

Peaches and sweet cherries apparently absorb urea through their leaves quite well, while pears and apricots do not. But foliage injury from urea sprays has occurred on peaches and sweet cherries, causing this type of nitrogen feeding not to be recommended for these fruits yet.

Urea sprays have been used successfully on citrus trees. But the urea must have a low content of biuret, not more than 0.25 percent, otherwise

M. E. McCollam, western manager of the American Potash Institute, is well known to the field of fruit tree nutrition. He is the long-time chairman of the Soil Improvement Committee of the California Fertilizer Association, a member of the Soil Science Society of America, the American Society of Horticultural Science, Western Society of Soil Science, and the National Joint Committee on Fertilizer Application. The city of San Jose, California, recently named one of its schools in his honor.

A GUIDE

TO PART OF PLANT AND TIMES TO TAKE IT FOR LEAF SAMPLING

CROP	PART OF PLANT TO SAMPLE	TIME OF SAMPLING
FRUITS AND NUTS		
APPLE	Matured leaves on spurs, or leaves near base of current year's growth	June 15 to July 15
APRICOT	Matured leaves on spurs, or leaves near base of current year's growth	June 1 to July 15
ALMOND	Matured leaves on spurs, or leaves near base of current year's growth	June 1 to July 15
PRUNE	Matured leaves on spurs, or leaves near base of current year's growth	June 15 to July 15
PLUM	Matured leaves on spurs, or leaves near base of current year's growth	June 15 to July 15
PEACH	Matured leaves near base of current year's growth	June 15 to July 30
PEAR	Matured leaves on spurs, or leaves near base of current year's growth	June 15 to July 15
OLIVE	Matured leaves from median position on last flush of growth	March or August
CITRUS FRUITS		
LEMON	Matured leaf from last flush of growth	May to July
ORANGE	Matured leaf behind a young fruit	July to October

"yellow tip" injury to the leaves will occur. Ten pounds urea to one hundred gallons water has been used successfully, with one pound of nitrogen applied as a foliar spray being equal in effect to two pounds as a soil application.

Phosphorus

Fruit trees are seldom deficient in phosphorus, appearing to get enough from the soil even though soil tests show very small amounts of available phosphorus.

A phosphorus fertilizer very often is used on the orchard cover crop, however, causing marked improvement of legume covers on many orchard soils.

Phosphorus deficiency has been recognized on citrus trees in southern California, with substantial improvement in trees and fruit yield resulting from heavy applications of phosphorus fertilizer.

Cases of phosphorus deficiency in all probability, will be found in deciduous orchards as our orchard lands become older.

Potassium

Studying nutritional problems of fruit trees through chemical analysis of leaves has uncovered many instances of low potassium levels in California orchards. This leaf analysis approach has confirmed potassium deficiency as abnormal symptoms hitherto not diagnosed on fruit trees.

Where there is severe potassium hunger, it takes a relatively large amount of potash per tree to get enough of the nutrient into the tree to cause the desired improvement.

Very satisfactory recovery has been accomplished on all of the orchard crops mentioned through *20 to 30 pounds sulfate of potash per tree (muriate of potash in some situations)*.

This one heavy application will usually supply enough potassium for five or more years, causing much more rapid improvement than smaller yearly applications.

The most effective application methods are to broadcast on top of the ground under the spread of the branches or in two or three furrows plowed out along the tree rows. These furrows should be located not too close to the trees nor much beyond the spread of the tree—and just deep enough to prevent the potash from being disturbed by later cultivation in the orchard.

It is usually suggested that the broadcast method be used on *lighter types of soil* and the furrow method on *clay and adobe types.*

The best time to apply potassium fertilizers is in the fall and winter months to overcome potassium deficiency. If delayed until spring, the full effect of the fertilizer usually will not be seen until the following year. *A considerable buildup of potassium is necessary in a deficient tree before improvement in leaf and fruit takes place.*

Micro-Nutrients

MANGANESE AND BORON.

These micro-nutrients may be deficient in certain fruit growing areas of California.

Both soil and spray methods of supplying them have been effective. Ten pounds of manganese sulfate per tree as a soil application has been effective on mature peach trees. Only one pound per tree would possibly be sufficient on light sandy soils with an acid reaction.

Foliar sprays of five to ten pounds manganese sulfate per 100 gallons of water are effective in supplying manganese to the trees.

Boron deficiency has been successfully overcome by applying one-half to one pound of borax per tree. (Other boron materials in proportion.)

Post-harvest foliage sprays of three pounds borax or one pound Polybor to one hundred gallons water can supply the necessary boron. (Other boron materials in proportion.)

IRON

A deficiency of iron causes fruit tree foliage to turn yellow, with only the leaf veins showing green. In severe

cases, even the green color of the veins fades out and brown dead spots appear on the leaf. The fruit is reduced in yield and quality. Sometimes called lime-induced chlorosis, this iron deficiency occurs in many localities in California and may affect many kinds of trees and plants.

Sprays of iron salts have been used on foliage, and iron sulfate has been applied to the soil in various ways and in fairly heavy amounts per tree. But results have usually been mediocre.

Injecting iron salts, such as iron citrate, into the trunk or large limbs of fruit trees has corrected the trouble. This method has been used commercially, especially by pear growers. This treatment, when properly applied, is effective for several years. But boring the holes in the trees, injecting the salt, and plugging the holes have been so laborious that any other less troublesome control would be very acceptable and welcomed.

IRON CHELATES

In recent years iron chelates have offered a new and more promising method of correction. Several of these new substances, which are now on the market, have been successfully used to correct iron deficiency on some fruit crops.

A chelate known as Chel 330 has been used successfully as a soil application, at the rate of one pound per

WHAT LEAF POTASSIUM READINGS MEAN ON SELECTED SAMPLES

CROP	SAFE LEVEL	RANGE FOR TRIAL K	DEFICIENCY SYMPTOMS K
FRUITS AND NUTS	(D.M. BASIS)	(D.M. BASIS)	(D.M. BASIS)
Apple	Above 1.00%	Below 1.00%	Below 0.50%
Apricot	Above 2.00%	Below 1.50%	Below 1.00%
Almond	Above 0.75%	Below 0.75%	Below 0.50%
Prune	Above 1.50%	Below 1.00%	Below 0.75%
Plum	Above 1.50%	Below 1.00%	Below 0.75%
Peach	Above 1.50%	Below 1.00%	Below 0.75%
Pear	Above 1.00%	Below 0.75%	Below 0.50%
Olive	Above 0.75%	Below 0.50%	Below 0.30%
CITRUS FRUITS			
Lemon	Above 0.90%	Below 0.90%	Below 0.35%
Orange	Above 0.90%	Below 0.90%	Below 0.35%

tree for each three inches of trunk diameter.

One pound of Chel 330 in one hundred gallons of water as a foliage spray has been effective repeated several times early in the growing season.

A material known as Greenz 26 has also been effective in correcting iron deficiency. The recommendations of the manufacturer follow:

> *8-10 pounds (Greenz 26) in 100 gallons water for apples, apricots, peaches, shipping pears and plums.*
> *10-15 pounds (Greenz 26) in one hundred gallons water for cherries, canning pears (Bartlett, Hardy), prunes, strawberries, walnuts.*
> *Spray early in growing season to avoid fruit staining. Usually two sprayings about two weeks apart is recommended.*

ZINC

This micro-nutrient is needed over widespread orchard areas in California. Zinc deficiency has been referred to as "mottle leaf" and "little leaf". Apple, peach, plum, prune, almond, and pear trees respond quite well to zinc sprays, usually made up at a strength of 25 pounds zinc sulfate per 100 gallons of water. This is used as a dormant spray.

On citrus trees, a foliage spray of 5 pounds zinc sulfate and 2½ pounds hydrated lime or soda ash per 100

ORCHARD CROPS SHOWING POTASH HUNGER IN CALIFORNIA—CROP AND LOCATION

CROP	LOCALITY
ALMOND	Sacramento Valley and San Joaquin Valley, Calif.
APRICOT	Santa Clara Valley, Calif.
OLIVE	Sierra Nevada foothills vicinity of Oroville, Calif.
PEAR	Sierra foothills, No. Calif. Santa Clara Valley, Calif.
PEACH	San Joaquin Valley, Calif.
PLUM	Sierra foothills, No. Calif.
PRUNE	No. Sacramento Valley, Calif. Santa Clara Valley, Calif.

gallons water is an effective corrective. Treatment is most effective when applied before the first flush of spring growth. It may be repeated often enough to prevent the appearance of the characteristic mottle-leaf symptoms.

Cherry and walnut trees with zinc deficiency have not been readily improved by zinc sulfate sprays. Driving several staggered rows of galvanized metal pieces into and around the trunks or large limbs of these trees has been a successful corrective.

On avocado trees, zinc deficiency has been successfully corrected by soil applications of zinc sulfate (metallic zinc content of 23%-28%) at any time of the year. Dosages recommended per tree are:

Age	*Dosage*
2 years	*1 pound*
5 "	*3 pounds*
7 years	*4 pounds*
10 "	*5 "*
15 "	*8 "*
20 "	*10 "*

Trees on sandy soil types respond more quickly than trees on heavier clay types of soil. A second application may be necessary in some cases for complete correction.

ZINC CHELATE

This is a relatively new material, but quite promising for correcting zinc deficiency on fruit trees. The material is used as a foliage spray at the strength of one pound per 100 gallons water. It is applied to the soil in the spring usually at the rate of two pounds per tree.

Recent work with zinc chelates on avocados has shown good correction of zinc deficiency with one pound of the zinc chelate per tree on six-year-old trees, *as a soil application.*

"... PLUS THE GOING RATE OF INTEREST"

Great as has been the growth of the use of fertilizers in recent years on American farms, feeling among the experts is that we have little more than opened the door a crack in this respect. More and better fertilizers are coming, they say, as well as much more efficient use of them. When, if ever, fertilizer's full potential is realized, chances are the transformation of agriculture will be of such proportions as to stagger the present-day mind. Here's what one visionary has to say:

Since 1941, fertilizer consumption, in terms of plant food content, has increased more than threefold. Fertilizer sales will be even higher in the future, however, and competition will be intense in regard to price, quality and service.

But the plant food industry has a growth potential as great as any industry today. Fertilizer, properly used, pays dividends that are almost unbelievable. Sooner or later, farmers will use fertilizer as businessmen use other factors of production. They will apply it up to the amount that the last increment returns its cost, plus the going rate of interest. Fertilizer use perhaps will be 6 to 10 times the piddling little 50 pounds now used on the average acre of crop and pasture land in the United States.

This would seem to answer those who fear that our population is outrunning our food production capacity. Let's hope our marketing know-how keeps step with our ability to produce.

The Corn Belt Farm Dailies.

Group of pears from high NPK plots

YIELD RESPONSES IN BARTLETT PEARS

By R. T. Riddell

Agricultural College **Guelph, Ontario**

I GROSS RESPONSE

In the Georgian Bay fruit-growing region of Ontario, most pear orchards have been abandoned or removed because of low yields.

The Tree Fruit Research Committee in Ontario began this project because field surveys of pear orchards in the Collingwood area found the remaining trees to be *normal and healthy in appearance despite low yield.*

They first thought the low yield might be due to the northern location of the orchards or to some cytologic instability that affected fruit set.

A 15-year-old Bartlett and Kieffer pear orchard, situated on one of the Smart Bros. Ltd., Collingwood farms was offered as a site for the projected experiments. This 16-acre orchard was located on a gentle northern slope about a half mile from Georgian Bay.

Pear tree from the high NPK plots

I GROSS RESPONSE

II MORPHOLOGIC VARIATIONS AFFECTING YIELD

III A COMMERCIAL APPLICATION

The orchard soil was a silty sand with *low native fertility, low organic matter, a pH ranging from 7.3 to 7.7,* and *a calcium base saturation ranging from 88% to 92%.*

Reports on general pear culture deal with areas having dissimilar soil or weather conditions. Since the varieties of pears growing in the Georgian Bay region did not follow the usual order of blossoming and apparently did not set a commercial crop of pears when the incidence of cross-pollination appeared adequate, they decided to reinvestigate factors influencing yield under the new environmental conditions.

Since fertilizers were effective in changing the soil conditions and increasing fruit-set, the researchers de-

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Where profit was highest when the *most* fertilizer was used.

cided to base the proposed experiments on differences in fertilizer composition and rates of application, changing orchard management practices as the need arose.

The plan of the project was designed to investigate the problem of low yield in three ways: (1) *The gross changes contributing directly to yield.* (2) *The minute changes which contribute indirectly to yield.* (3) *The commercial application of these findings.*

This report deals with the gross changes observed during the first five years.

Observations discussed here were derived largely from 32 plots of nine trees each. The fertilizer treatments were a high and a low application of NPK, NK, PK, and NP replicated four times.

The low rate for NPK was ten pounds of 10-10-10 per tree. Treatments that lacked one element had the remaining elements applied at the same rate they were in the low NPK treatment.

The high treatments were influenced by leaf analysis so that up to 1953, the high rate was 30 pounds 10-10-10 per tree. And by 1956, this had increased to 35 pounds 10-10-10 and 15 pounds sulfate of potash applied as a split application during the first week of May and June.

Mulching experiments were conducted on paired trees, with nine sets of trees constituting a plot. Treatments for this experiment were 100 pounds of waste excelsior with and without low NPK and 100 pounds of straw with and without the low rate.

These plots were replicated twice in the orchard. All of the check trees received the general orchard application of fertilizer which increased from three pounds of ammonium nitrate per tree in 1951 to three pounds of ammonium nitrate and five pounds of 60% muriate of potash by 1955.

The Agriculture Department used colonies of bees, pollen inserts, and compatible pollen to cause adequate cross-pollination and fruit-set.

After 1954, the great uniformity of fruit set between trees in a plot or between plots with the same treatment demonstrated the effectiveness of insuring adequate fruit-set in this way.

Results

Response of the trees to the applied fertilizer as indicated by leaf analysis varied from year to year. The 1955 drought caused a generally lower content of nitrogen and phosphorus and *a larger decrease in the content of potassium.*

Beyond this yearly variation, the differences in nutrient concentration in the leaves were small and variable, with only the checks being consistently lower.

The nitrogen level in PK treatments not receiving any nitrogen since 1951 was the same as the level in the plots receiving the highest nitrogen application.

Application of phosphorus did not change the level of leaf phosphorus. *This level seemed to be characteristic of the year and not the treatment.*

Since the leaf levels of potassium responded rapidly to potash up to a maximum 1.51% concentration, which is the highest concentration found in the individual tree analyses, the soil or the environment must check the further accumulation of potassium in the leaves.

Although lower than the experimental plots, the level of leaf nutrient

Where taste panels have shown a preference to canned pears from the *high NPK plots.*

Table I—Leaf analysis for the mulch plots.

Treatment	% dry wt. of nitrogen			% dry wt. of phosphorus			% dry wt. of potassium		
	1954	1955	1956	1954	1955	1956	1954	1955	1956
excelsior	1.59	1.50	1.55	.14	.16	.20	.71	.71	.58
excelsior & NPK	2.27	2.31	2.33	.15	.17	.19	1.09	.93	1.10
straw	1.83	2.03	2.17	.17	.18	.24	1.01	.97	1.22
straw & NPK	2.74	2.51	2.88	.17	.19	.23	1.17	1.02	1.48

in the check plots was the same as the general orchard level.

Response of the trees to mulch as reflected in leaf analysis (Table I) indicated that *excelsior alone had little effect* on the nutrient status of the tree in a five-year period.

Annual application of ten pounds 10-10-10 to the excelsior mulch gave the same response as the fertilizer alone. When straw was used as mulch, it had the same effect as the low NPK rate.

However, both straw and fertilizer raised the potassium level more effectively than the highest rate of complete fertilizer alone.

Pear yields from the different fertilizer plots are summarized in Table II.

The crop weight column gives the total weight of pears picked from the four replicated plots per treatment, a third of an acre. Increase in crop weight from 1955 to 1956 averaged one third, just as yield increase had averaged one-third the two previous years.

Divergence from this pattern noted in the high NPK and NK treatments was probably due to corrective pruning given the plots in early 1956.

In the previous harvest, 11% of all the fruit picked from the plots was

Table II—Summary of pear yields, 1955 and 1956.

Treatment	Crop wt. of 4 plots		% culled for size and defects		wt. of 2″ and up pears		Profit per acre over check	
	1955	1956	1955	1956	1955	1956	1955	1956
NP low	2521	3151	69	70	794	983	$35.26	$71.00
NP high	2154	3630	53	27	1019	2653	35.26	80.00
PK low	2983	6677	21	70	2345	2027	76.00	84.00
PK high	3301	5931	46	65	1772	2061	76.00	61.00
NK low	4311	5720	57	57	1864	2444	118.00	143.00
NK high	4925	3616	68	11	1555	3219	118.00	121.00
NPK low	4747	5689	50	42	2379	3296	220.00	264.00
NPK high	4983	5056	51	1	2451	4996	220.00	373.00
Check	2342	4254	78	66	732	1448	0	0

discarded because of limb-rubs and maggot emergence holes. The reduction in culls from these treatments in 1956 was believed due to this pruning.

Pears were graded to eliminate ones which were undersize or misshapen or showed limb-rubs, worm holes, or spray russetting.

The profit per acre was calculated on the following basis: the untreated parts of the orchard were considered just paying operating expenses, so the *check yields* were subtracted from the *plot yields* and the value of the balance was calculated with a selling price of five cents per pound.

Full cost of the fertilizer applied and extra cost of distributing it were subtracted from the net return and the balance represented *the profit derived from using the fertilizer.*

Discussion

Effect of the added fertilizer on the level of nutrients in the leaves was evident after the second application, varying only with growing conditions.

The PK plots, which had not received any nitrogen fertilizer for the past five years, had the same concentration of nitrogen in their leaves as plots which had received at least 30 lbs. of 10-10-10 per year for the past five years.

The level of phosphorus in the leaves had not responded to phosphorus fertilizers.

The response to potassium was much the same as to nitrogen, yet the concentration plateau was much lower with no individual tree having a potassium concentration higher than 1.51% dry weight.

Straw mulch alone proved more effective than the low rate of NPK in raising leaf potassium, although the amount of potash added was the same in both cases.

Straw plus low NPK gave as great a response as the highest rate of NPK application, although the actual amount of potassium applied was much smaller.

Profit from adding fertilizer was highest where the most fertilizer was used. *The high NPK plots returned $250.00 more than the high NK ones.*

The only difference in management was the addition of phosphorus to the first mentioned plots. Thus, we have a decided increase in profit from an element that has not appeared to change concentration in the leaf tissue.

Similarly the concentration of nitrogen in the leaves of the PK plots was the same in 1956 as that in the NPK plots, yet the nitrogen added to the latter plots has influenced the profit in a marked manner.

Thus, it appears that up to a certain level, *chemical leaf analysis would reflect the potential production of marketable fruit.*

Further additions of fertilizers, while not reflected in leaf analysis, were effective in increasing the marketable yield further.

II MORPHOLOGIC VARIATIONS AFFECTING YIELD

Pear yields from a tree depend on the *number* of fruit on the tree and on their *size.*

Size can be subdivided into the number of cells in the fruit and the size of the cells. The number of fruit on the tree is determined partly by the number of blooms produced and the number of blossoms which set fruit.

The analysis of yield can be largely proportioned among structures of the pear tree that can be measured, counted, chemically analyzed, or cultured artificially. Thus, potential and

Where high NPK plots returned $250 *more* than the high NK ones—emphasizing the need for *balanced* fertilization.

actual yields might be correlated to structure variations that form part of the pear tree.

During the two preliminary years of investigating the Bartlett variety, we determined measurable factors that contributed to fruit yield and seemed independent in their variation.

Yield attributes that could be measured were *size of fruit, number of fruit, number of blossoming spurs,* and *fruit-set.*

We also measured certain vegetative characteristics of the pear tree—such as *trunk circumference, spur diameter, leaf size, leaf thickness, number of leaves per spur, number of blossoms per spur, pollen germination,* and *chemical leaf analysis.*

We hoped that some of these characteristics by themselves or in combination would indicate potential yield.

Materials and Methods

Individual trees within the plots set out for the fertilizer and mulch trials were used for this part of the experiment.

On each tree, we selected four branches at chest height during the first bloom period in 1952. Starting at the tip of the selected branch, we counted 25 blossoming spurs and marked the limit by a metal tag. As the various measurements were continued from year to year, these same tagged branches were used.

Two aluminum brads driven into the trunk marked the position of the first and all subsequent measurements of trunk circumference.

Leaf analysis of the pear samples was performed according to the system adopted by the Soils Department at this Institution, which uses both *flame spectographic* and *colorimeter tests.*

Leaf samples from the individual branches were small, two leaves from either terminal growth, fruiting spur or non-fruiting spur constituting a sample.

Twice during the year, a companion over-all sample of 50 leaves per tree was taken to form a basis for evaluating the results from small branch samples.

When replications were considered, pear pollen germinated most consistently on a medium containing 0.75% agar, 10% sucrose, and 5 ppm boron.

Presence of boron seemed to insure *maximum germination* of the pollen despite small differences in distribution, water content, and thickness of the agar film.

Results

Pollen Germination. During 1951, the percent pollen germination for the orchard as a whole averaged 72% with individual trees varying from 54% to 82%. In the plots where nitrogen and phosphorus were applied, germination declined in two years to 49% using plain sugar agar. The addition of 5 ppm boron to the medium had a stimulating effect, with the germination rising to 66%.

Where potassium was also applied to the plots by the fourth year, germination percentage had risen to 94% with only a 5% variation on either side of the average.

During 1956, the pollen from these same plots averaged 96% germination. The trees under standard orchard management have averaged 68% during the 6-year period.

Spur diameter. When the smallest diameter of the current year's growth

Where *high yielding* trees withstood adverse conditions better than low yielding ones.

Table III—Change in trunk circumference. The circumference measurements are the total for 36 trees with the same treatment.

Treatment	Trunk Circumference 1954	Trunk Circumference 1956	Term. Growth 1956	% Increase trunk
Check	1097 cms.	1528 cms.	17 in.	39
NP low	952	1414	16	49
NP high	1008	1239	6	23
PK low	903	1306	21	45
PK high	1142	1364	7	20
NK low	1068	1485	14	39
NK high	1097	1158	4	6
NPK low	941	1469	31	56
NPK high	1120	1177	3	5

of a lateral spur was measured, it was found to vary from 0.3 cm. to 1.2 cm. When fruit-bearing and non-bearing spurs were separated into two groups, a diameter of 0.5 cm. was the critical size, with most of the fruit being borne on larger spurs.

Most leafy spurs were below this critical diameter and small size spurs which flowered rarely matured fruit. Spur diameter was increased by adding both nitrogen and potassium fertilizers.

Leaf size and thickness. Leaves developed by the highest producing trees in this experiment differed markedly in shape from the accepted standard for the Bartlett variety. These variant leaves were generally twice as long and twice as broad as leaves found in the check plots, and lacked the characteristic fold at the mid rib. These leaves also had a blunt apex.

We found leaf thickness depends on the position in which the leaf grew, so no sharp distinction could be made between the various treatments.

Number of blossoming spurs. The number of spurs that bloomed was influenced by the treatments.

In Table IV, the biennial habit of blooming can be seen in the NP and check treatments. In the check treatment, there was a general increase in the number of blossoming spurs, but in the alternate years the number was much lower. The low number for 1956 was due in part to the heavy set of fruit in 1955.

All treatments that lacked one fertilizer component showed the same trend as the NP treatment in Table IV. Again the biennial habit of blooming was present but to a lower extent. When complete fertilizer was used, *especially at the high rate,* the biennial habit was suppressed although the number of blossoming spurs increased in two year steps.

Number of leaves per spur. As long as the tree appeared normal, various treatments and varying size of crop had no effect on the number of leaves on the leafy or fruiting spurs. The narrow range in numbers indicated that leaf number was an inherent quality in Bartlett pears.

Number of bloom. The number of blossoms produced by a single flowering spur varied within narrow limits on the same tree, between trees of a single treatment, and between treatments.

The variations were too small and capricious to infer that variations in yield corresponded to any shift in the number of blossoms produced per spur.

Trunk circumference. Trunk circumference measurements at a selected location have been used to indicate the over-all growth of a tree from year to year. The reaction of these measurements to the fertilizer applications has indicated (Table III) that the lower levels of fertilizer applications have increased the over-all growth the most.

Table IV—Total number of blossoming spurs on the selected branches.

Treatment	1952	1953	1954	1955	1956
Check	1800	2914	1766	4147	1229
NP high	1800	3144	2881	5770	3015
NPK high	1800	2741	2739	6031	6661

But when trunk circumference is compared to the yield from these treatments (Table VI), we can see that growth was influenced by the size of the crop. *Treatments such as high NK or high NPK have consistently produced the largest yields and also the least over-all growth.*

The low producing treatments—such as low NP and low PK which have the greatest increase in trunk girth—have produced only a few of the large-sized pears. The check treatments have responded in like manner.

The low NPK treatment has successfully combined good growth and a reasonable crop of marketable pears.

Fruit-set. Location of the experimental orchard was such that prolonged bee flight during bloom was unusual. Prior to 1955, two beehives were used per acre trying to increase fruit-set, but they were inefficient (Table VII).

A method of insuring a high uniform level of fruit-set was first used in 1955 and again in 1956 and 1957 with success.

The highest percentage of fruit-set during 1956 and 1957 occurred on the PK plots. The high fruit-set was one of the factors influencing the high cull rate at harvest (Table VI).

A very heavy bloom in the NPK plots appeared to reduce the per cent fruit-set of these treatments. However, as experimental treatments were repeated from year to year, the per cent fruit-set has increased in the NPK treatments without a decrease in bloom density.

Number of Fruit. One factor influencing the number of fruit at harvest was the ability of the fruit to remain on the tree throughout the season and not be lost in the June and subsequent drops.

Although no living embryos were found in the fruit shed during the June drop, fruit containing one or two seeds were often lost subsequently. The high NPK and NK treatments, in particular, reduced the number of fruit lost in this manner. By 1956, no fruit that had not suffered external injury was found under these trees.

During the 1955 harvest, undersized fruit from all treatments were examined for seed count. When culled

Table VI—The effect of treatment on pear size, 1956.

Treatment	Total Crop in lbs.	Graded size in lbs.			% culled
		2-2¼″	2¼-2½″	2½″ and up	
Check	4254	638	572	238	66
NP low	3151	374	251	358	70
NP high	3630	1266	760	627	27
PK low	6677	1081	585	361	70
PK high	5931	1112	530	419	65
NK low	5720	1006	614	824	57
NK high	3616	1714	903	602	11
NPK low	5689	1439	819	1038	42
NPK high	5056	1968	1510	1518	1

for size, fruit from the high NPK treatment (Table V) showed undersized pears had less than one well-developed seed per pear. The smallest commercial size had the normal number of seeds.

Table V—Average number of seeds in 100 pears selected for size. 1⅞″ is the minimum size for cannery grade pears.

Treatment	Pear Size under 1⅞″		Pear Size 1⅞″–2⅛″	
	1955	1956	1955	1956
Check.....	4.7	4.6	4.4	5.2
NP high....	4.9	5.1	4.3	4.9
PK high....	5.5	3.4	4.6	4.1
NK high....	1.2	0.8	4.6	5.5
NPK high...	0.4	0	4.2	0.5

The number of seeds in fruit culled for small size from the high NK treatment also showed a reduced number of seeds. In the other treatments and the check, the fruit with a low number of seeds per fruit had been largely shed during the growing season.

In 1956, the effect of high NPK treatment was to allow the fruit that had been below commercial size in 1955 to develop into marketable pears. The few pears from this treatment that were culled for size did not have any mature seeds.

However, no strictly parthenocarpic fruit were observed to mature in this orchard. The other treatments again lost their fruit with the low number of seeds.

Fruit Size. In this study, pears with a minimum diameter of two inches were considered suitable for market. Total crop in Table VI refers to all the pears picked from the 36 trees in four plots. In 1956, two-thirds of the pears from the check plots were discarded (Table VI), due to small size. Also, the weight of the largest-sized pears was lowest in the check plots.

Total yields from the NP treatments were less than the check yields, a decline that has been noticeable since 1954. The low NP plots produced a high percentage (70%) of undersized pears, so the marketable yield was below check levels. The high NP treatments produced fewer pears culled for size and the marketable yield was above check levels.

The PK plots produced the highest total yields, but heavy culling for size markedly reduced the size of the commercially acceptable crop. Although the yields from the high NK and NPK plots were intermediate, the low weight of small pears gave these treatments high marketable yields. All the fruit discarded from the high NPK treatment had a defect other than small size.

Discussion

A frost occurred at the end of the bloom period in 1957, killing the young fruit and partially defoliating the trees so 1957 results are incomplete.

No single morphological character of a pear tree was found to be an infallible indicator of potential yield. But three attributes, when considered together, gave a basis for evaluating the yielding ability of individual trees or the orchard as a whole: (1) *Pollen germination,* (2) *spur diameter,* and (3) *leaf shape* were the attributes used in this evaluation.

Per cent pollen germination responded rapidly to applied fertilizer and definitely indicated when orchard management practices were detrimental to yield.

Spur diameter measurements have afforded a confirming estimate of yield potential.

Shoot and spur leaves from high producing trees have a larger size and are flat with a large, blunt apex.

The number of leaves or blossoms that developed on a spur was constant for the variety and was not changed by orchard management practices.

Leaf analysis was a useful tool *when the orchard was at a low level of vigor.* But it was of doubtful use

Table VII—Fruit-set (percent of blooming spurs which bore fruit).

Treatment	1954	1955	1956	1957
Check	11	29	51	47
NP	11	43	50	44
PK	9	41	72	63
NK	12	46	59	52
NPK	16	37	44	54

in planning the fertilizer program *when the yields were high.*

Fruit size, fruit number, and *fruit-set* were three measurable quantities directly affecting pear yields.

A uniformly high level of fruit-set was found to be necessary for maximum yields under orchard conditions. The use of pollen inserts greatly aided in meeting this need. Treatments containing only P and K produced the highest fruit-set, although a large number of fruit failed to develop to marketable size at maturity.

The largest direct effect on fruit number resulted from the June drop. In the parts of the orchard not under experimental control, this fruit shedding could reduce the number by 30 to 50%.

These fruits had no developing seeds, although they had been pollinated. The high NK and NPK treatments reduced the June and subsequent drops almost to zero.

Considerable research in development and experimental morphology is still needed before an estimate of factors influencing fruit size can be made.

In this study, however, fruit size has been influenced in two ways.

(1) *When potassium was low in the leaves, added nitrogen had no effect on fruit size.* (2) *When the level of potassium in the leaves was above one per cent, additions of nitrogen fertilizers increased the size of the fruit.*

At high fertilizer rates, when leaf analysis did not indicate the effect of added fertilizers, nitrogen, potassium, and phosphorus became equally important for the full potential of fruit size to be realized.

Omitting nitrogen, potassium, or phosphorus greatly increased the number of fruit culled for size (Table VI).

Throughout this study, the commercially important qualities concerned with storage, uniform ripening, and processing have been carefully checked by the owner of the orchard and other interested persons.

No adverse effects have been found and taste panels have shown *a preference to canned pears from the high NPK plots.*

III A COMMERCIAL APPLICATION

Bartlett pears have not been a popular fruit crop in the Georgian Bay fruit-growing district in Ontario for the past 15 years.

A survey of the remaining pear orchards showed that *low* and *variable yields* were the main reason that old orchards have been destroyed and few new ones planted.

It was found, however, that yield of Bartlett pears could be increased and the increase was *economically profitable.*

This report deals with the results when regular-sized orchard equipment was used.

Where the *increased vigor* of the trees suppressed fire blight infections.

Materials and Methods

One-third acre plots were laid out in the poorest yielding section of the experimental orchard.

One plot, called *the check orchard plot,* received a yearly application of fertilizer at the rate of *300 lbs. of ammonium nitrate and 600 lbs. of muriate of potash per acre.* This general practice was begun in 1953 by the owner.

A second plot, called *the test orchard plot,* received the same orchard management practices that had proved the most profitable in small plot experiments.

These practices, however, were modified by the owner to fit available machinery, money, time, and the talents of his employees.

Fertilizer was applied in April or May at the rate of *1500 pounds of 10-10-10 per acre.* Each tree had a mulch of five bales of weathered straw or hay that was renewed each year. Cross-pollination was insured by using pollen inserts. And corrective pruning over a four-year period greatly reduced limb-rub and worm-holes from the mature fruit. The grass sod in the orchard was mowed to a height of three inches as needed.

Table VIII—Leaf Analysis of Test and Check Orchards. Mid July averages.

Treatment	Percent Dry Weight		
	N	P	K
Test Orchard 1954	2.03	.18	.63
Test Orchard 1955	2.11	.16	.87
Test Orchard 1956	2.73	.23	1.50
Check Orchard 1954	1.53	.17	.63
Check Orchard 1955	1.31	.14	.49
Check Orchard 1956	1.58	.19	.57

Results and Discussion

The plots were established in 1953, but no marked response in yield was found until 1956. This three-year lag was found in all the experimental plots, where the main treatment was applications of fertilizer.

The level of nitrogen in the leaves increased during the first year of treatment. It also remained at least one-half per cent above the nitrogen level in the test orchard from the second year of treatment (Table VIII).

The phosphorus content of leaves from both the test and check orchards varied from year to year probably in response to environmental conditions.

Potassium began to increase in the leaves of the test orchard after the second application of fertilizer. Straw mulch helped increase the potassium content of the leaves to the highest level, 1.51%, recorded during these experiments.

The total yield and the marketable yield of pears from the check orchard varied from year to year (Table IX), but the percentage of fruit culled, mainly for small size, remained at a high level.

In the test orchard, the increase in marketable yield during 1954 (Table IX) was not large enough to pay the added cost of fertilizer, mulch, and picking.

By 1956, however, the response to the treatment was evident *and the profit was $340.00.*

A series of hard frosts in the next spring reduced the fruit yield. The

Where treatments of *high NK* or *high NPK* have consistently produced the largest pear yields and also the least over-all tree growth.

Table IX—Effect of Orchard Management practices on the yield from the Test and Check Orchards.

Treatment	Total Crop lbs./acre	Graded Crop lbs./acre	% culled	Profit over Check Orchard
Test Orchard 1954	3641	1894	48	— $38.00
Test Orchard 1955	4145	3120	27	$20.00
Test Orchard 1956	6224	4609	26	$340.00
Check Orchard 1954	2368	543	77	
Check Orchard 1955	1585	426	73	
Check Orchard 1956	4152	1434	65	

check orchard produced less than a bushel of pears from thirty-six trees while the test orchard produced *sixty-eight bushels.* This indicated that high yielding trees would withstand *adverse weather conditions better than the lower yielding ones.*

The orchard in which this study was made had a history of regular mild attacks of fire blight. *No proven infections by fire blight were found in the fertilizer test plots or the test orchard after 1953. Apparently the increased vigor of the trees had suppressed fire blight infections.*

The test orchard, however, showed an increased build-up of pear psylla and apple maggot. An increased number of sprays were needed to keep these insects under control. ◄◄◄

BORON CONTENT VARIES WITH SEASON FOR ALFALFA

Boron content of alfalfa was lowest in July and August and highest in May and September, according to F. B. Stewart and J. H. Axley of the University of Maryland. They found that it varied as much as 300 percent in a single crop year.

This variation may be due in part to the amount and distribution of boron in the soil, the soil moisture supply, or the rate and stage of growth.

It is difficult to tell with tissue tests if the alfalfa has sufficient boron for the entire growing season, except in cases of pronounced deficiency or where there is a large excess of the element. Only the top 1½ inches of the plant should be used in tissue testing.

REVIEWS

November 1958

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ABSTRACTS

The American Potash Institute issues a regular abstracts service, summarizing important findings on the role of potash in good soil management and balanced soil fertility. These abstracts, issued 6 times a year, are available on request to professional agricultural workers of the U.S. and Canada. The summaries below illustrate the style in which the abstracts are prepared. For this free service, write: Abstracts, 1102 16th St., N. W., Washington 6, D. C.

Tobacco—Chloride Improves Quality of Both Dark and Burley

Chlorine in tobacco. Ky. Ann. Rept. 1928, p. 16.

The best grades of burley tobacco contained 30% more chlorine than the poor grades of this variety. The best grades of dark tobacco contained 20% more chlorine than the poor grades of this variety. The averages for all good grades of burley and dark tobaccos show 29% more chlorine than the poor grades of these varieties. The average chlorine content in all grades of dark tobacco was 209% more than in the corresponding grades of burley tobacco. The sulfate content in different grades of dark tobacco appears to be about 10% larger than in the corresponding grades of burley tobacco.

Peaches—Chloride Hastened Date of Maturity

Hayward, H. E., Long, E. M., and Uhvits, R.

Effect of chloride and sulfate salts on the growth and development of the Elberta peach on Shalil and Lovell rootstocks. U. S. D. A. Tech. Bul. 922. 1946.

Chloride accelerated the opening of flower buds and shortened the period of flowering. Harvesting was 2 to 7 days earlier.

Corn—Relative Placement NPK Important in P Absorption

Robertson, W. K., Smith, P. M., Ohlrogge, A. J., and Kinch, D. M.

P utilization by corn as affected by placement and N and K fertilization. Soil Sci. 77:219-226. 1954.

N with P and K increased height of corn plants. It tended to increase P in plant from fertilizer and recovery of P up to waist-high stage. K with N and P tended to increase plant height and tended to decrease P uptake. P placed below seed level was not used as early as P placed at seed level.

It costs more now to amuse a child than it used to cost to educate his father.

H. L. Mencken: "Ah, that the eugenists would breed a woman as capable of laughter as the girl of twenty, and as adept at knowing when not to laugh as a woman of thirty-five."

Samuel Johnson: "Were it not for imagination, Sir, a man would be as happy in the arms of a chambermaid as of a Duchess."

Golf is the game that turned the cows out of the pasture and let the bull in.

Joe: "I feel ten years younger after I shave."

Mrs. Joe: "Why don't you try shaving before you go to bed?"

"I'm a bit worried about my wife," a man told his friend. "She was talking in her sleep and saying: 'No, Frank; no, Frank!' "

"Well, what are you worried about?" demanded the friend. "She said 'No,' didn't she?"

"Brethren, don' yo' all know it's wrong to shoot crap?" said the preacher as he accidentally ran into a group of his flock in action.

"Yas, parson," admitted one participant sadly, "and believe me, ah's sho' paying fo' mah sins."

At fifteen she uses adjectives; at thirty she uses verbs; at fifty she uses adverbs, verbs, nouns, pronouns, adjectives, prepositions, interjections, and gobs and gobs of conjunctions, interpersed with tiny twitters. Finally, at eighty, she runs down and listens. —*Typo Graphic.*

"Dad, why is a man not allowed to have more than one wife?"

"My son, when you are older you will realize that the law protects those who are incapable of protecting themselves."

A tactful girl is one who makes a slow boy believe he is a fast worker.

Said the mountaineer: "I shore wish I had my wife back."

Friend: "Where is she?"

Mountaineer: "I sold her for a jug of mountain dew."

Friend: "I reckon you're beginning to miss her."

Mountaineer: "Nope, I'm thirsty again."

YOU DON'T SAY?! Think you're indispensable? Just stick your finger in a glass of water and see what a big hole you make.

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To help more farmers recognize potash hunger signs in their crops when they see them, the American Potash Institute has developed a color film strip on signs of potassium deficiency in plants. Assembled in cooperation with many national and state agencies, the strip was prepared for use by agricultural advisors in classroom work, agricultural meetings, convention sessions, etc. It presents typical potash deficiency symptoms in field crops, vegetables, fruits, forage crops, and ornamentals. It is a single frame 35 mm strip, with 22 pictures and script, featuring such common potash hunger signs as poor growth, leaf scorch, poor root development, weak and lodged plants, poor seed and fruit quality.

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