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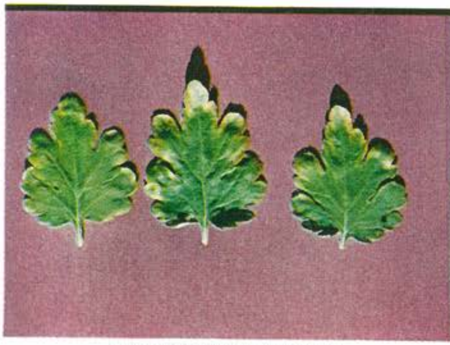

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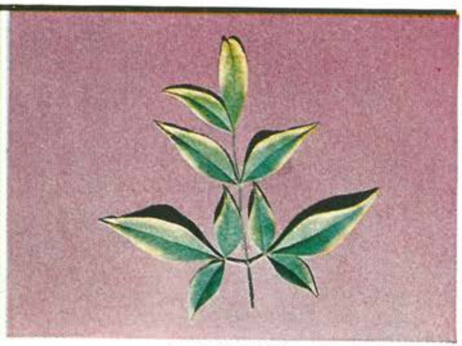

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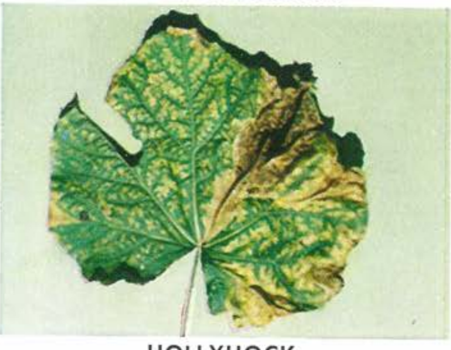

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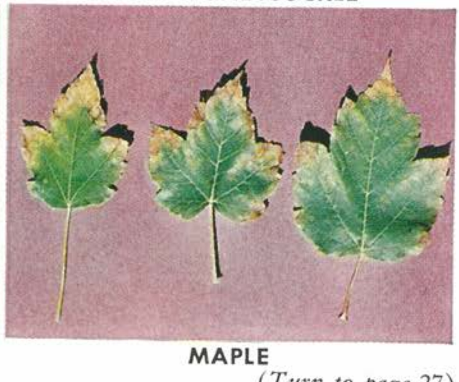

MAPLE

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Better Crops with PLANT FOOD

The Whole Truth—Not Selected Truth

R. H. STINCHFIELD, *Editor*

Editorial Office: **1102 16th Street, N. W., Washington 6, D. C.**

VOLUME XL NO. 6

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It's Nice to Remember . . .

Long-gone Summers

Jeff McDermid

(ELWOOD R. MCINTYRE)

DISTRACTED and distraught as many of us are from the noise nuisance of our era (even in remote suburbia) and fed up on the cult of convenience and conformity, it's sort of nice to nibble at the tag-ends of long-gone summers. Main drawback to this innocent daydreaming is that our memories only hold brief flashes of incidents and situations. We have piled too many heaps of discarded hopes and ambitions upon the castoff events of our youth. Sometimes we wonder why we enjoyed the experiences that memory grants us but fleeting glimpses of, mired as we are in an age when the luxuries of the past are the absolute essentials of today.

Surely, the family of modest or meager means, such as we belonged to, is at a greater disadvantage now than back there when folks led simpler lives and required so relatively little to make them genuinely happy and lastingly content. But regardless of the economics, the mechanics, and the physics that have swept us to undreamt of levels, we are all just human beings still, more or less inclined to cling to habits of retrospective imagery. In due time, this up-and-coming generation will also indulge in its reviewing of long-lost summers. At least, they will when they suddenly discover that a goodly portion of their busy lives has slipped into the pages of history.

Those remote summers of the nineties and early nineteen hundreds behaved weatherwise much as do ours today. Droughts and floods alternated. Plants grew or languished. Topsoils yielded their virgin values easily. Too often they moved on the swift currents of dashing rains to sedimentary deltas faraway. Lightning blazed across purple clouds. Thunder reverberated over the hills. Stuffy waves of humidity and sticky prostration interfered with the zest for labor and nights of rest. Old-timers even then said that the seasons were rapidly changing and that it was either hotter or colder than it had been before the Civil War.

What change there has been, as we consider nature in the summertime, is that modern men refuse to sit idly by and accept all the effects of weather vagaries. Through science and sound soil management they have really "done something about it" in answer to the humorist's statement that you couldn't.

IN the late nineties and early nineteen hundreds those old veterans of the late war doted on reunions of their regiments. My first train ride marked one of those eventful occasions. My home town was only 20 miles distant from the quiet little farm trading post where the remnants of the old Thirty-Second Volunteer Infantry met on that hot summer day. I boarded the yellow wooden cars with my Father and a dozen or so "cumrads" who also belonged to that doughty regiment. This was all duck soup for me, as I was almost a mascot to the G. A. R. post at home and marched in their parades on Decoration Day—usually a scorcher in promise of June humidity just around the corner of the calendar.

So every field and crossroad held my attention as the little five-car train wobbled and scuttled along the weaving rails through the sun-drenched countryside. These were scenes I had never laid eyes on.

Floral arches were suspended from the second stories of the Main Street stores. The speakers' stand of heavy planks, all garlanded with evergreen boughs and Old Glory bunting, stood at the edge of town near Perkins' pasture. There were even a smell and a taste of something unusual and thrilling for such a sleepy little hamlet, as we sauntered along the boardwalks where I looked at men and boys and buildings the like of which I had never seen before. The village concert band and another that we brought along were all ripe and ready to toot it out between cool steins of local lager. As we "detrained" on the rough oak depot platform, the village post's fife and drum corps shrilled and thumped us a rousing greeting.

That same summer, or perhaps the next one, we had a too brief vacation visit from my "generous" brother, who had gone to find a clerking job in a town quite a long ways from home. Young, fair-haired, and smiling, he took me in tow and treated me to a magical medicine show on the square, a lawn "sociable" where home-made yellow ice cream was sold by the churchwomen, and lastly, a marvelous shopping tour. Then I discovered how rich and powerful he was. He bought me a brand new suit of clothes and my first pair of patent leather shoes. It took no extensive investigation to tell him that my wardrobe was not surfeited with sartorial elegance.

As I always went barefoot all summer long, it was now possible for me to burst forth in September with my glossy, sharp-toed kicks, to be followed later in the fall with the entire gift ensemble. Through the haze of countless summers, I can still see that kindly brother (now aged but unbroken) sitting with me in my string hammock on an August-scorched lawn, deftly rolling his own from a small cloth packet of "Bull Durham." I sincerely hope that the youngsters who receive such generous attention today retain for life the good will and happy remembrance such deeds inspire.

ON a summer Sunday my memory seems to center on several typical scenes and impressions. These include long, undistinguished sermons, a solo by a rather scared chum of mine who all too soon lost his cherubic voice, and peppermint lozenges, hard pews, and forests of waving palm-leaf fans.

Finding Father asleep in the string hammock, with his shoes off and necktie loosened, I laid myself down on the burnt grass in the speckled shade of the oaks. There I watched the slow motion and shifting shapes of cottony clouds, with my dog Major snapping at flies and trying to snooze with one eye open.

Audile echoes stay with me still, calling back some of those old services. Down through the years, and including the later ones in which my own family worshipped, two stirring titles ring through my mind. They are "Onward Christian Soldiers" and "Leaning on the Everlasting Arm." I feel sort of sorry for anyone who has not had, or will not eventually possess, that inner lift that stays by a fellow fetched up to

give the spiritual preference over the material. Just thinking back to the ones I sang them with makes me remember the poignant words of McKinley's favorite hymn: "Then we shall see those angel faces smile, of friends we have loved long since but lost awhile."

No long-gone summer memory would be complete unless the mental picture comes clear once more regarding those regular July trips taken by Mother and me to see some old friends of hers. They lived in a Sleepy Hollow kind of hamlet situated on the shady bank of the Wisconsin River. From her tales told me of the long ago (or thus it seemed), these women were remarkable persons. The aged grandma of the clan was pretty far gone from the heydey times when Mother knew her best. She had slaved to keep the family together after losing her husband. One older girl was married and the two others engaged in that familiar custom job of rag-carpet weaving. The only son was shiftless and had only one recognizable "talent"—that of being able to outdo Baron Munchausen in fanciful yarns.

Because Grandma had acquired and retained allegiance to the comfort of a clay pipe and black tobacco, Mother always tucked into our luggage a generous package of Adams' Standard. (I myself could testify to the hefty effect of this concoction from bouts taken with it *sub rosa.*) She also took along some candy for the only grandchild on the premises—a gawky young sprout about 14 with pigtails, who "shined up" to visiting boys, including myself.

WE hitched up old Pike and started out about 5 a.m. It was cool and refreshing. We first drove through the sleeping town of my youth and came to the old, covered wagon bridge which spanned the wide and usually peaceful river. The wooden affair was about a quarter of a mile long. On both sides of the double driveway were blotched and faded signs. These related mainly to the agricultural economy of the region. Merchants advertised seeds, feeds, harness, groceries, patent medicines, and farm machinery.

Once over this causeway, we came to the first of a series of confusing crossroads. That old slang term "dirty work at the crossroads" fitted them well. Which way do we turn for Merrimac? Out I hopped to ask of the nearest person in barnyard or hayfield. This dilemma repeated itself time and time again in the 25 miles we had to go. Looking back, I can visualize the nuisance of this common ignorance of routes. Today firm steel signs and markers point unerringly toward the right highway one must take to reach his final destination.

When it came high noon, we halted near some spring or country well. I got out and watered the horse, and perhaps followed that with a nosebag of bran mash or oats. We sat in the buggy (a phaeton style affair) and

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Fig. 1. The natural beauty of a sugar beet field captured by the Spreckels Sugar Company's master photographer, Austin Armer, Woodland, California.

Plant Analysis as a Guide to Fertilization of Crops

By Albert Ulrich

Department of Soils and Plant Nutrition, University of California, Berkeley, California

BASICALLY the idea of fertilizing a crop is rather simple. All that needs to be done is to add as a fertilizer the amount of material to make up the difference between the nutrients needed by the crop and those supplied by the soil. Thus, if we wish to make crops grow better, we have to estimate the amount of a nutrient required by the plant for unrestricted growth and the amount supplied by the soil. The difference, if any, is to be added to the crop as a fertilizer.

While the ideas behind fertilization are relatively easy to understand, the exact quantities to be applied are not easily determinable. In some respects the estimation of the amount of fertilizer needed by a grower is quite analogous to the estimation of a year's supply of fertilizer to be sold by a fertilizer company. The amount needed by a company would depend upon the growers' demands for fertilizers and the ability of the manufacturers to supply these needs. If the company is permitted to make only one guess at the beginning of each season as to the amount of fertilizer to be demanded and produced, the company would be in the same position as the grower who has to guess as to the amount of fertilizer to apply to his crops.

The grower, like the fertilizer company, is dealing with a dynamic system, the outcome of which, in terms of crop production, is dependent upon a multitude of factors that must be manipulated in such a manner as not to restrict plant growth. Since the system influencing plant growth cannot be defined, except in broad terms, the amount of growth to be made by the plant and the supply of nutrients to be delivered from the soil cannot be estimated precisely. Success in this direction, if it is to be obtained at all, will depend upon accurate long-range weather forecasts which can then serve as a basis for estimating the nutrient requirements of the crop and the amounts of nutrients to be released by the soil for plant growth.

Soil and Plant Tests

Over the years, soil and plant scientists have developed and used many tests for estimating the nutrient requirements of crops. Of these, the field trial or field experiment is perhaps the oldest method developed for evaluating a new cultural practice. Even today, the field trial is considered to have the last word before adopting a new idea for enhancing crop production. However, there is the challenge of other methods that have their appeal in lower costs, the possibility of taking less time, and the hope of having a wider applicability. Of the many objections raised against the field trial, perhaps the most important is the fact that the results apply only to that spot for which the results have been obtained and for only that year or years for which the experiments were conducted.

To meet the need for broader methods of estimating the fertilizer requirements of crops, two general types of tests have been developed, namely, soil tests and plant tests. Soil tests, either by chemical or biological means, estimate the concentration of a soil nutrient available to the plant for growth. These concentrations can be made useful for estimating the fertilizer requirements of crops by recognizing that the nutrient concentrations of the soil may require special interpretation in accordance with the kind of crop, the soil, and climate of the area. Plant tests, or more specifically, quantitative chemical analyses made of a plant or plant part, give an integrated value of all the factors that have influenced the nutrient composition of the plant to the time of sampling. By comparing the nutrient concentrations found within the plant with previously established critical nutrient levels, the nutrient status of the plant may be ascertained. Plants above the critical nutrient concentration may be considered adequately supplied with that nutrient, whereas plants at or below the critical nutrient concentration are deficient with respect to that nutrient. The longer a deficiency persists, and the earlier in the growth cycle the deficiency occurs, the greater the likelihood of a response upon the addition of the nutrient to the crop. In making these interpretations, it is significant to note that the importance of plant analysis to plant nutrition rests upon the fact that the nutrient concentration found within the plant directly reflects the ability of the plant to acquire nutrients from the soil in the environment in which the plant grows. This is a matter that cannot be safely predicted from soil analysis alone, since soil analyses are unrelated to the plant-growth factors of climate and to the kind of plant grown.

When a farmer asks, "Shall I fertilize my cornfield?" he is in reality asking a series of questions. If we answer his question in the affirmative, his next question is apt to be, "What kind of material shall I use?" As soon as this question is answered, he will follow it by "How much?" and by "When and how should the fertilizer be applied to the soil?" After the farmer has made his first fertilizer application he will want to know when it should be applied again; this season, next year, or after several years, or at all? Obviously, there is no simple test that will give an answer to all of these questions. However, it is possible to show, by using plant analysis, that the effects of fertilizer practices can be followed closely and adjustments made to fit the needs of the crop as it grows in the field year after year.

Plant Tests

In using plant analysis as a guide to fertilizing crops, a foundation for using plant analysis must be carefully laid. Each crop and each nutrient is a special problem unto itself, but once the basis for evaluating the nutrient status of a crop has been established the same system can be used over a wide range of soils and climatic conditions with a reasonable assurance of success. For example, the same critical nutrient concentration for nitrogen and for phosphorus has been found to hold in California for sugar beets grown in fields ranging from the Imperial Valley to the Sacramento and San Joaquin Valleys, as well as along the coast. This has been found to be true not only for one year but for a period of nearly 10 years.

The central idea behind the use of plant analysis is that an element essential for the growth of a plant is contained within the plant and that it must be present at a concentration that is sufficient for plant growth. The exact concentration at which a plant becomes deficient in a nutrient will depend upon the function or functions that element performs within the plant. If we knew the exact function of a nutrient, then we would know the concentration or concentrations necessary for the maintenance of growth and de-

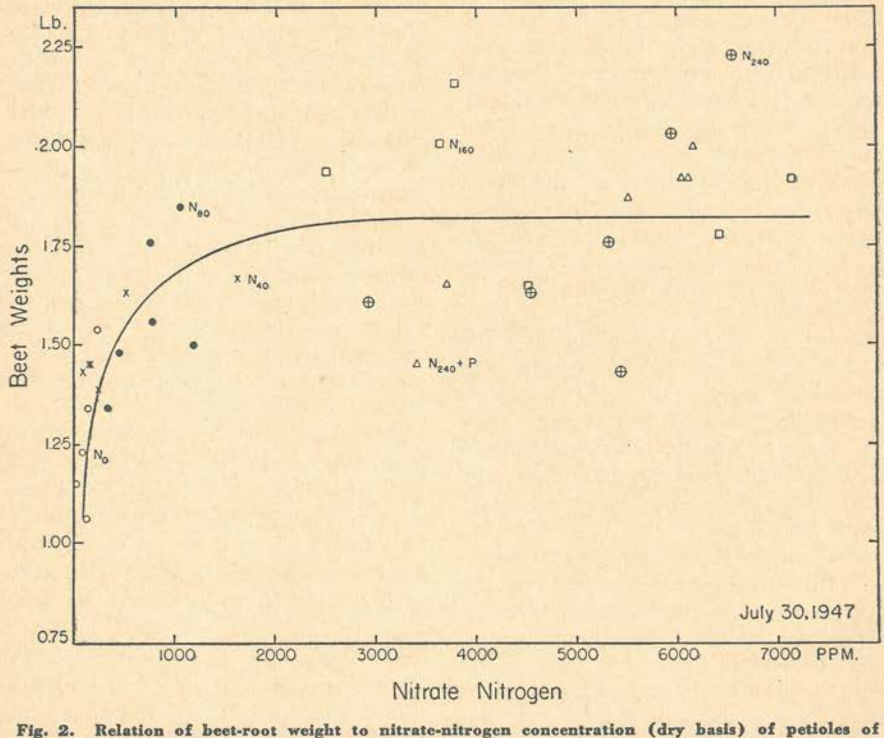

Fig. 2. Relation of beet-root weight to nitrate-nitrogen concentration (dry basis) of petioles of recently "matured" leaves sampled July 30, 1947. When the petioles of these plants contained less than 1,000 ppm. of nitrate-nitrogen, the beet roots weighed less than those above this value. The symbol N, including the subscripts, indicates the pounds of nitrogen per acre applied as ammonium nitrate, and P equals 200 pounds of P_2O_5 per acre applied as treble superphosphate. (Ulrich, Soil Science, 69: 291-309, 1950. Fig. 6.)

velopment of the plant. Ideally, this concentration should be determined on a cell basis or, at most, on a tissue basis for cells with the same function. Since the function in terms of chemical and physiological reactions is not known specifically for any nutrient element necessary for the growth of the plant, this problem must be solved, for the present, by empirical means. In practice this consists of selecting leaves or parts of leaves, or stems or parts of stems, for analysis. The form of the nutrient determined depends upon the element involved. In some instances it is the total concentration of the element within the plant part and in others it is the soluble or insoluble form of the nutrient, or at times some specific compound, as for example, nitrate for the element nitrogen and phosphate soluble in 2% acetic acid for phosphorus.

Plant Nutrient Calibrations

A typical calibration curve is depicted in Figure 2. This was obtained by plotting nitrate-nitrogen in the petioles of recently matured leaves of sugar beet plants on the horizontal axis and the corresponding root weight on the vertical axis. The points plotted are from a field experiment involving a series of nitrogen treatments. The petiole and beet-root samples were collected on July 30, 1947. On this date the nitrate-nitrogen values for the petioles from the untreated beets were exceedingly low and did not differ greatly from each other. The beet-root weights, however, did differ from each other considerably and were related to the amount of nitrogen the plants took from the soil earlier in the growing season. When nitrogen was applied to the plots at the rate of 40 lbs. per

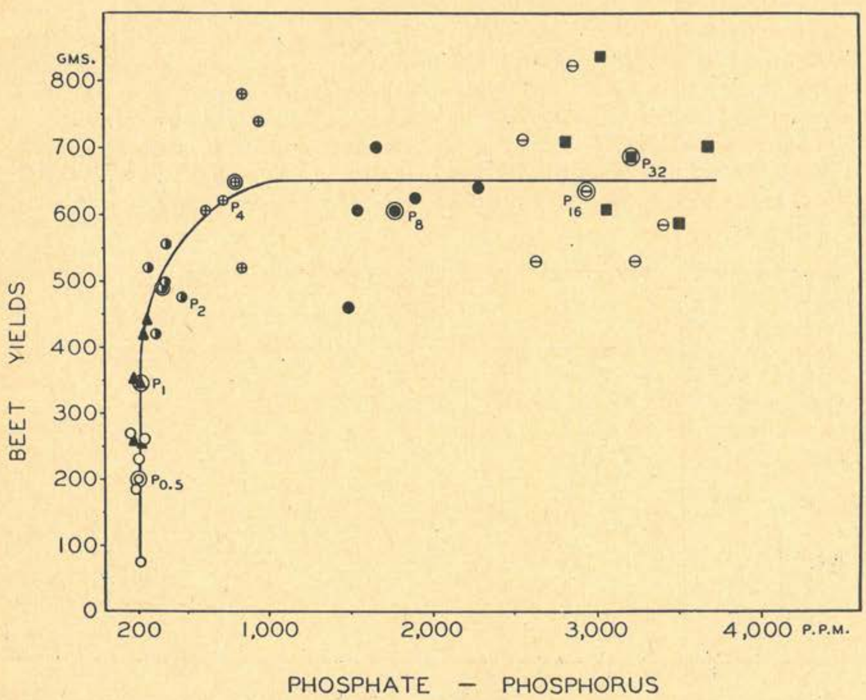

Fig. 3. Relation of beet-root weights (fresh basis) to the concentration of phosphate phosphorus (dry basis) in petioles of recently "matured" leaves. P_1 = 1.00 grams P_2O_5 (2.27 grams treble superphosphate) per pot. This is equivalent to 100 pounds P_2O_5 per acre. The points circled represent average values for a treatment. (Ulrich, Proc. 5th General Meeting, American Society of Sugar Beet Technologists, pp. 364-377, 1948. Fig. 2.)

acre, the nitrate concentrations of the petioles from three of the six plots failed to increase significantly even though the yields increased appreciably, again indicating a shortage of nitrogen in relation to beet growth. The nitrate values and the yields increased simultaneously for three plots in the 40-lb. application. For the 80-lb. application, the nitrate values and yields again increased simultaneously, and finally for the 160- and 240-lb. applications the nitrate values of the petioles increased tremendously but the beet-root weights remained unaffected.

A similar calibration curve is given in Figure 3 for phosphorus for sugar beets. The curve was obtained by conducting a pot experiment with a very low phosphate soil, namely Aiken clay loam. Recently matured leaves were found to reflect the phosphorus status of the beet plant satisfactorily. The petioles of these leaves appeared to give a sharper transition point than the leaf blades and the phosphate-phosphorus soluble in 2% acetic acid was better than the analysis for total phosphorus in either the petiole or blade tissues.

Figure 4 depicts a typical potassium yield curve obtained for sugar beets grown in culture solutions supplied with increasing amounts of potassium. The critical potassium concentration, estimated from petioles or blades of recently matured leaves, is approximately 1.0% potassium on the dry basis. This value holds for blades regardless of the sodium status of the plant and for petioles only when the sodium concentrations are 1.5% or above. When the sodium concentrations of the petioles are less than 1.5% the potassium concentrations increase gradually from 0.2% to 1.6% (Fig. 5A). The blades of these leaves at the same time have a rather narrow range of potassium values, 0.33 to 0.55% (Fig. 5B). Thus, in areas where sodium is apt to be low, the analysis of blades from recently matured leaves is preferable to petiole analysis as a means of estimating the potassium status of sugar beet fields.

The calibration curves (Fig. 2, 3, and 4) may be divided into a series of zones of which the portion of the curve above the critical concentration is frequently referred to as the zone of adequacy or of luxury consumption. The nutrient concentration at the point of decreased growth (approximately

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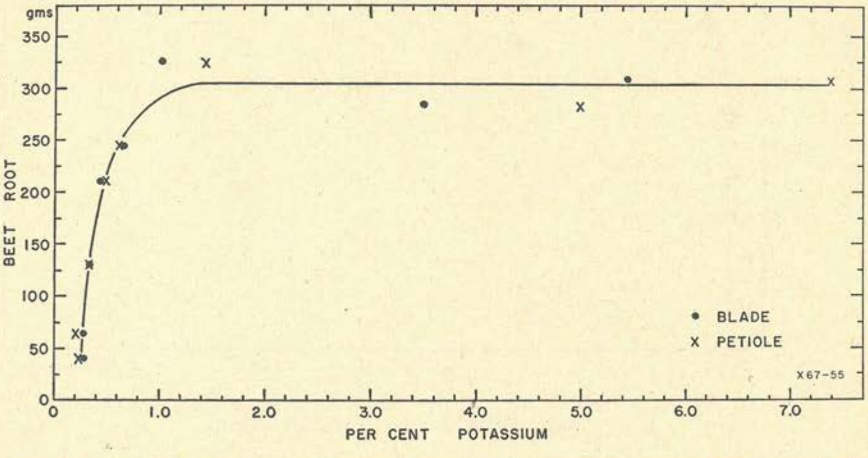

Fig. 4. Relation of beet-root weights (fresh basis) to the potassium concentration (dry basis) of petioles and blades of recently "matured" leaves of plants that have been supplied with increasing amounts of potassium and a constant but adequate amount of sodium. Each point is an average of five replications.

The Place of Fertilizer in Building Land Productivity

By E. T. York, Jr.

Washington, D. C.

THE contributions of commercial fertilizer to the agriculture and overall economy of this country represent a remarkable story. The chemical fertilizer industry is but approximately 100 years old. Furthermore, it has been only during the last century that the knowledge and appreciation of the role of fertilizers in plant nutrition have developed. During this period, tremendous progress has been made in fertilizer technology and in the development of information relative to the proper use of fertilizers for the most efficient production of crops.

Since 1940, fertilizer consumption has approximately tripled in the United States. Closely paralleling this increase in fertilizer usage has been a very significant increase in yields of all major crops. Since the late 30's, for example, corn yields have increased about 45%, cotton 70%, and tobacco 75%. Although the development of improved varieties, better disease and insect control, and the use of improved management practices generally have contributed significantly to these higher yields, it is doubtful if any other single practice has had as great an effect as has the increased use of fertilizers.

In 1950 the U. S. Department of Agriculture estimated that 25% of the total crop yields in the United States could be attributed to the use of fertilizers. There is much evidence that in the humid sections of the country fertilizers contribute substantially more to crop production. In a recent experiment in one of the Southern States for example, corn receiving no fertilizer during a 10-year period averaged 5.5 bushels per acre while that adequately fertilized averaged 89.0 bushels. In this case, approximately 93% of the total yield could be attributed directly to fertilizers.

Increasing Farm Income

The immediate effects of fertilizers upon soil productivity are well recognized. Perhaps of greater significance, particularly in this period of surplus farm commodities, is the role which fertilizers may play in increasing farm income by lowering the unit cost of producing crops. Experiments in Missouri have shown that unfertilized corn yielding 35 bushels per acre costs 84 cents per bushel to produce. On the other hand, corn fertilized according to soil test recommendations yielded 80 bushels and costs only 58 cents per bushel to grow. Regardless of the selling price of corn, the farmer could increase his profits 26 cents per bushel by following recommended fertilization practices.

Similar data from North Carolina also show that through recommended fertilization, the cost of producing a bushel of corn is greatly lowered. The North Carolina agronomists conclude: "In producing a given quantity of corn, the net return to the farmers would be much greater with high yield levels on fewer acres than with low yields on a greater number of acres." It was estimated that the net profit to North Carolina farmers from corn could be increased more than four times through the adoption of recommended fertilization and other improved practices even though the acreage was adjusted to produce the same amount of corn currently being grown.

All of the state experiment stations have collected similar information which, when subjected to an economic analysis, shows that fertilizer properly applied almost always reduces the unit cost of production and can contribute to increased farm income without necessarily increasing the total production of a given commodity.

Building Fertility

This nation is vitally concerned with the conservation of the soil and the maintenance of this soil in a highly productive state. For many years there has been much talk of how soils in this country were being depleted and ruined through intensive cropping. Certainly, there are ample data to show that particularly in the Northeast and Midwest, organic matter levels have declined considerably as a result of cropping practices. Furthermore, farmers in the South have long been accused of ruining their soils by following rotations involving only row crops.

To a certain extent, perhaps this criticism is justified. However, it need not be so. More and more evidence is accumulating to indicate that soil productivity may actually be increased under intensive cropping through the proper use of lime and fertilizer.

Over the years many have thought of virgin soil as the ultimate in terms of high productivity. This is far from the case, particularly in the humid regions of the South where high temperatures limit the build-up of organic matter and heavy rainfall accelerates the weathering of soil minerals and the leaching of soluble constituents from the soil. Analyses of soils from a field in one of the Southeastern States which had been planted to well-fertilized row crops for several years revealed available phosphorus levels which were some six times as great and available potash levels twice as great as those in the virgin soil in an adjacent area. Furthermore, when crops were planted on these two areas without additional fertilization, the virgin soil yielded only one third as much as the field which had been cropped previously.

At Mississippi State College, well-fertilized corn yielding 100 bushels produced over 2 tons more stover per acre than unfertilized corn yielding only 26 bushels. Dr. C. D. Hoover, Head of the Agronomy Department at Mississippi State, concluded: "This increased amount of crop residues is a by-product of good soil management, including adequate fertilization, and may offer the best possibilities for annually replenishing the organic matter reserves of Southern soils."

Further evidence of the effect of fertilizers in building soil productivity is found in work from West Virginia. Agronomists there found that after receiving fertilizer annually for 15 years, a soil contained nearly 50% more organic matter in the plowed layer than was contained in an unfertilized plot alongside—notwithstanding the fact that all the crops were harvested and hauled away. The West Virginia agronomists explain this phenomenal effect in the fact that the yields on the fertilized plots were nearly three times those of the unfertilized plots and the amount of roots and crop residues turned under was likewise much greater. They conclude: "Organic matter is a by-product of good farming. It does not have to be applied to the soil. It can be produced on and in the soil by the use of mineral fertilizers."

Reducing Erosion

In addition to building fertility of soils, fertilizer may also contribute to improved soil productivity by helping to reduce erosion and the loss of topsoil where nutrient levels are the highest. The late Dr. Robert Salter, for-

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The Use of Minor Elements for Organic Soils

By Robert E. Lucas

Department of Soil Science, Michigan State University, East Lansing, Michigan

ORGANIC soils, commonly called peats or mucks, are often low in minerals. This is especially true for deposits that are deep and where the water source that covers the deposits is low in minerals. Minor elements that may be deficient for plant growth under these conditions are manganese, boron, copper, and zinc. The total content of iron may be low, but that in available form is usually adequate.

The use of minor elements should be considered as good insurance against the possibility of a deficiency. High-value crops, particularly, should have minor element fertilization if conditions indicate a possible need. This helps to insure efficient returns from the major nutrients, nitrogen, phosphorus and potassium.

Minor elements can be absorbed through the leaves of plants. Where equipment is available, minor elements may be applied as a spray. Cost of material used is greatly reduced. If compatible, the minor elements can be mixed in a fungicide or insecticide spray. Suggested minor element rates as sprays are:

1. Two to five pounds per acre of water-soluble manganese sulfate.
2. One to three pounds per acre of basic copper sulfate.
3. One to two pounds per acre of zinc sulfate or neutral zinc.
4. One half to two pounds per acre of borax.

Growers often find it handier and cheaper to apply minor elements directly to the soil, however, because of convenience and the saving in labor and equipment.

Manganese

Manganese deficiency is likely to occur on alkaline or near alkaline mucks. The development of severe deficiency symptoms in plants is greatest in cool, wet soils. The deficiency can be corrected by the application of manganese salts or by the addition of sulfur so as to acidify the soil. Manganese salts are more effective and cheapest when immediate results are desired. Sulfur, on the other hand, is more economical when the effects are considered over a

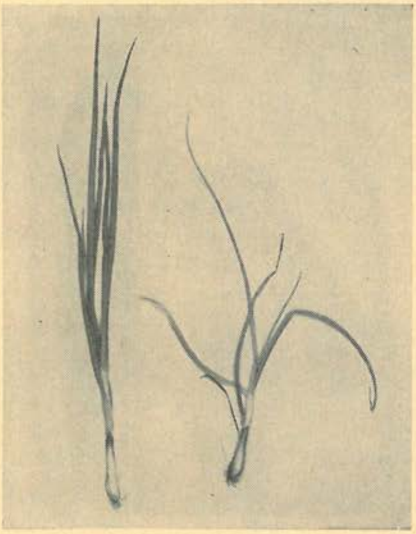

Fig. 1. Normal and manganese-deficient onion leaves.

period of years. Because of high costs, sulfur is not advisable for soils containing considerable free calcium carbonate (marl). Of the manganese salts, manganese sulfate has been most commonly used. Tests with broadcast applications of manganese carriers at the Michigan Muck Experimental Farm show that manganous oxide is about 20% less effective than the sulfate. The oxide or similar materials, however, may come into more use in fertilizers because of less caking.

Total soil manganese means very little in determining the amount available to plants. An adequate level of exchangeable manganese is at least 3 ppm. (determined on field moist sample). Most rapid soil-test methods now employed are not sensitive enough to measure critical deficiency levels, however.

For a number of years a pH above 6.5 has been used as the point for recommending manganese fertilizers for muck soils. Recent experiments and field observations have shown that one can expect a deficiency on soils with pH as low as 6.0. Very acid soils that have been limed usually show a greater need for manganese fertilization than do soils naturally high in lime.

Crops listed in Table I are grouped according to the degree of response to manganese fertilization. Such a listing could have serious limitations as varieties of a given crop can show large differences in response. For example, in one field experiment the Mandarin soybean yielded 16 bushels per acre without manganese fertilization and 37 bushels with manganese. The Norchief soybean variety, on the other hand, showed no response to manganese.

TABLE I.—CROP RESPONSE TO MANGANESE FERTILIZATION.

None to low	Medium	High
Alfalfa	Barley	Beans
Asparagus	Carrots	Lettuce
Cabbage	Celery	Oats
Cauliflower	Clover	Onions
Cucumbers	Corn	Peas
Parsnips	Table beets	Potatoes
Peppermint	Tomatoes	Radishes
Rye	Spearmint	Spinach
	Sugar beets	Sudan grass
	Most grasses	Soybeans
		Wheat

The amount of manganese suggested for crops as affected by pH is shown in Table II. Soil fixation can be extremely great. Recovery is particularly low when the fertilizer is broadcast on calcareous soils. To increase the recovery it is advisable to place some of the manganese fertilizer in bands near the seed. Broadcast applications may require amounts greater than those suggested in Table II. Manganese must be applied yearly as there is often no carryover in the available form.

TABLE II.—MANGANESE NEEDED FOR MUCK SOILS — ELEMENTAL BASIS * (POUNDS PER ACRE).

Crop response	Soil pH		
	6.0–6.6	6.7–7.2	7.3–8.0
High......	10	20	40
Medium...	5	10	20
Low.......	0	5	10

* To convert elemental manganese to manganese sulfate, multiply by 4.0.

Boron

The need for boron fertilization on muck soils depends greatly on the crop grown (see Table III). Fertilizer containing much boron should not be banded near the seed. It is generally applied broadcast or drilled in before seeding. Certain crops are easily injured by borax. At times, growers have used left-over fertilizers containing borax for such sensitive crops as corn, barley, and beans. This invariably resulted in injury.

TABLE III.—CROP RESPONSE TO BORON FERTILIZATION.

None	Low	Medium	High
Beans Small grain Onions Mint Soybeans Sudan grass Peas	Corn Potatoes Clover Carrots Asparagus	Broccoli Kale Parsnips Radishes Lettuce Cabbage	Alfalfa Cauliflower Celery Spinach Table beets Sugar beets Turnips Rutabagas

The availability of boron in the soil is affected by the lime content. For this reason, the amounts suggested in Table IV are greater on high-lime soils. In estimating boron needs, one can expect some residual effect for the succeeding crop. However, this will not cause injury to sensitive crops if recommended rates are applied. It may be necessary to use quantities greater than those suggested in Table IV for table beets, celery, and cauliflower.

TABLE IV.—BORON RECOMMENDATIONS FOR MUCK SOILS—ELEMENTAL BASIS* (POUNDS PER ACRE).

Crop response	Soil pH	
	5.0–6.4	6.5–8.0
High	3	5
Medium	1	3
Low	0	1

* To convert from boron to borax, multiply figures by 9.0.

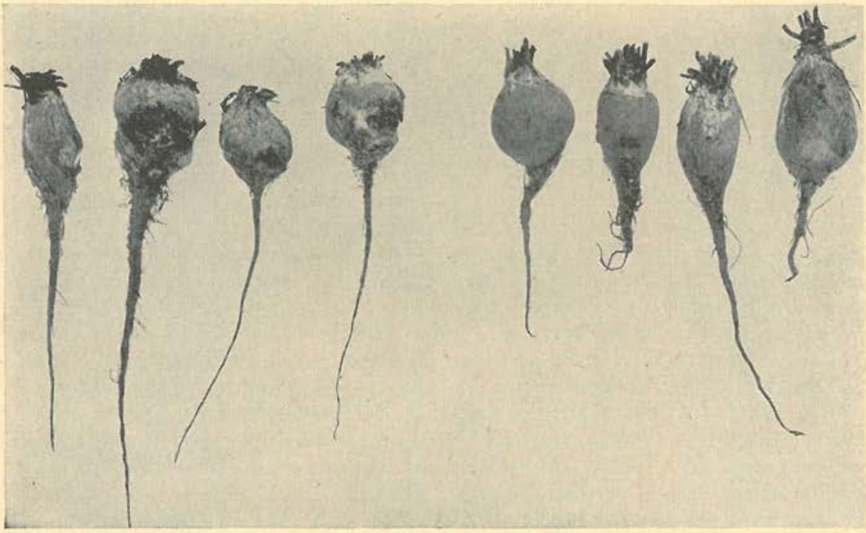

Fig. 2. The beets on the left show canker, while those on the right received borax, which controlled the canker.

Copper

The need for copper is closely related to total copper in the soil. Swedish research workers report that grains growing on peat containing over 15 ppm. copper are not likely to respond to copper fertilization. Findings at Michigan State University indicate somewhat higher values are needed. The copper content of undeveloped acid soils in Michigan is about 10 ppm. Acid soils are usually lower in copper than those naturally high in lime. No doubt, environmental factors related to the amount of lime in water covering peat deposits also influence the dissolved or suspended copper compounds. For this reason, the recommendations shown in Table VI are less on naturally high-lime soils. Liming acid soils, however, will not decrease the need for copper. The burning of the topsoil or organic matter decomposition resulting from drainage will tend to increase the copper content in the surface soil.

TABLE V.—CROP RESPONSE TO COPPER FERTILIZATION.

None to low	Medium	High
Asparagus	Barley	Alfalfa
Beans	Brome grass	Canary grass
Peas	Cabbage	Carrots
Peppermint	Celery	Dill
Rye	Clover	Endive
Spearmint	Corn	Lettuce
Soybeans	Parsnips	Oats
	Potatoes	Okra
	Radishes	Onions
	Sugar beets	Spinach
	Tomatoes	Sudan grass
	Turnips	Table beets
		Wheat

The copper carriers used for fertilizers are either copper sulfate or copper oxide. Copper applied to soils is not easily leached nor is removal by the crop much of a factor. No further copper fertilization is needed if a total of 20 pounds per acre has been applied to low or medium responsive crops and 40 pounds for high responsive crops.

TABLE VI.—COPPER RECOMMENDATIONS FOR MUCK SOILS—ELEMENTAL BASIS* (POUNDS PER ACRE).

Crop response	Native soil pH		
	5.4 or less	5.5–6.4	6.5 or higher
High......	12	8	4
Medium...	8	4	0
Low.......	4	0	0

* To convert elemental copper to copper sulfate multiply by 3.9.

However, additional copper will be needed if soil erosion is serious or the field is plowed deeply. The 20 or 40 pounds applied in one broadcast application will not cause injury to crops. In many instances, the copper level in the soil is ample because of repeated applications of copper dusts or sprays. Crops listed in Table V show the degree of response to copper fertilization.

Minor Element Labeling

Because of the difference in soil and crop requirements, it is not advisable to meet minor element needs by some general mixture. Such a single special fertilizer may contain useless elements, toxic quantities of some element such as zinc and borax, or lack adequate amounts for crops of high requirement. On the other hand, making special fertilizer mixtures containing minor elements to meet the grower's request complicates manufacturing and labeling problems.

When manufacturers add minor elements to prepared fertilizer grades, they run into a caking problem. If a number of special mixtures are requested, it then requires a large number of curing bins. Recent advances in granulation and the use of certain minerals such as copper oxide instead of copper sulfate have helped to avoid caking.

The addition of minor elements to a fertilizer for special mixtures dilutes the content of the major plant nutrients.

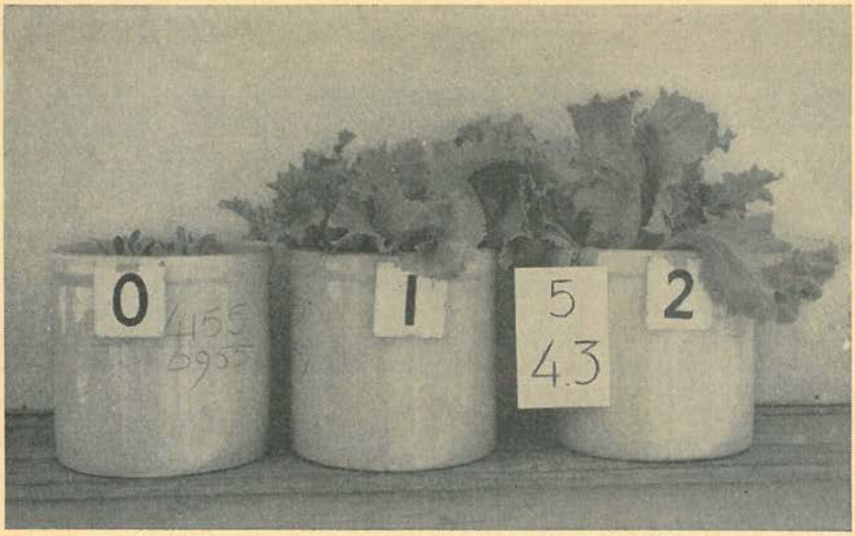

Fig. 3. Effect of copper on head lettuce grown on an acid peat limed to pH 6.0. 0 = no copper; 1 = copper oxide, 6 lbs. of copper per acre; and 2 = copper sulfate, 6 lbs. of copper per acre. (Photo by W. Van Eck)

Most states require that the manufacturer change the label and tag to correct for the dilution. In some cases, the manufacturers can change from one licensed grade to a lower grade having the same fertilizer ratio. For example, borax can be added to 0-10-30. The new mixture then can be labeled 0-9-27 containing boron. This example does not work out so simply for some other grades. The problem becomes greater when two or more minor elements are added. As state laws require that the major fertilizer nutrient percentages be based on the final mixture, it will not be easy for a farmer to buy minor elements in amounts and combinations that he may desire.

Regulations now in force in Michigan permit the addition of minor elements or approved pesticides to any fertilizer grade which has been licensed. Such a law allows flexibility in ordering fertilizer. If caking is not a problem, immediate delivery of the special fertilizer can be made.

The amount of minor elements permitted in fertilizer in Michigan is limited to a selection of two or three analyses for each one. This selection is specified by the Director of Agriculture and the Director of the Agricultural Experiment Station. It helps prevent orders for an endless number of combinations. The analyses that have been permitted will meet the fertilizer requirement for most crops. At present, the quantities that can be used in the final mixture are:

boron—0.25, 0.5, or 1.0%
copper—0.5, 1.0, or 2%
manganese—1.0, 2.0, or 5%
zinc—0.5 or 1.0%

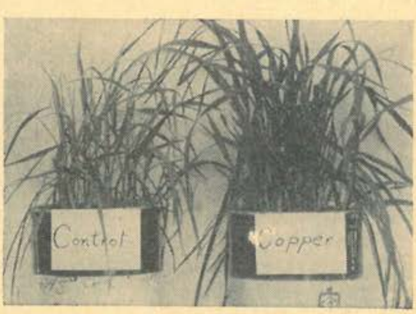

Fig. 4. Response of oats to copper fertilization. Left no copper; right, with copper.

Even though minor element additions are limited to the above listing, the possible fertilizer combinations are great. If minor or secondary elements are added to a licensed fertilizer grade, the seller must have attached on the fertilizer sack a label or tag bearing a legible statement showing (1) pounds per ton of the licensed N—P_2O_5—K_2O fertilizer grade, (2) pounds per ton of the additional plant nutrient compounds, (3) guaranteed elemental per cent of the added plant nutrient. Such a label could appear as follows:

for the dilution effect of the added minor elements. The charges on the minor elements are then added. In price listing, the manufacturers usually show the cost for one per cent of each of the minor elements.

In the author's opinion, the method used in Michigan is satisfactory labeling. The growers understand the formulation and can get what they want. Fertilizer manufacturers like the arrangement because it is easier to handle requests for special fertilizer mixtures. In estimating the amount of minor ele-

This package contains a mixture of the following per ton:

1,790 lbs.	5–10–20	
	Nitrogen (N)	—Min. 5.0%
	Available phosphoric acid (P_2O_5)	—Min. 10%
	Potash (soluble K_2O)	—Min. 20%
160 lbs.	Manganese sulfate	—Equiv. 2% Mn in mixture
50 lbs.	Borax	—Equiv. 0.25% boron in mixture

In determining the cost of the fertilizer, the major plant-nutrient costs are reduced proportionally to correct

ment required in a mixed fertilizer, one would follow the recommendations shown in Table VII.

TABLE VII.—PERCENTAGE OF MINOR ELEMENT REQUIRED IN MIXED FERTILIZER AS RELATED TO THE AMOUNT OF FERTILIZER APPLIED AND MINOR ELEMENT NEEDED.

Fertilizer application pounds/acre	Pounds per acre of minor element desired									
	Manganese				Copper			Boron		
	5	10	20	40	4	8	12	1	3	5
100	5%	*	*	*	*	*	*	1%	*	*
200	2%	5%	*	*	2%	*	*	½%	1%	*
400	1%	2%	5%	*	1%	2%	*	¼%	½%	1%
600	1%	2%	5%	*	1%	1%	2%	¼%	½%	1%
800	**	1%	2%	5%	½%	1%	2%	¼%	¼%	½%
1,000	**	1%	2%	5%	½%	1%	1%	**	¼%	½%
1,250	**	1%	2%	5%	**	½%	1%	**	¼%	½%
1,500	**	**	1%	2%	**	½%	1%	**	**	¼%
2,000	**	**	1%	2%	**	½%	½%	**	**	¼%

* Amount required greater than that possible in mixed fertilizers by Michigan law. Farmers should make home-mix or apply straight minor element materials.

** Farmers can use some fertilizer without minor element, or in the case of manganese and copper, use the minimum percentage in all the applied fertilizer.

Fig. 1. Interest in Bahia grass is evidenced by this group of Soil Conservation District Commissioners on a tour in south Mississippi. Being shown is part of a 75-acre Bahia grass pasture on the farm of Abe Payne in Forrest County.

Bahia Grass Gains Favor in Mississippi

By H. S. Saucier

Management Agronomist, Soil Conservation Service, Meridian, Mississippi

BAHIA is making grassland farming a reality in south Mississippi. Ten years ago a large part of this section of the State was generally known as a land of scrub oaks and range cattle. Today you can see evidence that the native range grasses are being rapidly replaced with luscious, green Bahia grass.

Bahia is playing an important role in this change from range condition to improved pastures for soil conservation and livestock production. For example, in 1945 there were only about 15,000 acres of improved pastures in 10 south Mississippi counties. In 1955, there were an estimated 137,000 acres of improved pasture in these same 10 counties. The amazing part of this development is the fact that nearly 75,000 of the 137,000 acres of pasture were in Bahia grass.

It is estimated that during this period of grassland development there were about 122,000 acres of perennial grasses planted, of which 75,000 acres were planted to Bahia grass and only about 47,000 acres planted to all other adapted perennial grasses. The popularity and preference of Bahia by farmers in this section are evident by the fact that the total of acres in this grass alone is ex-

Fig. 2. A typical herd of purebred beef cattle on a Bahia grass pasture in Mississippi. This photograph shows part of the E. C. Simmon farm near Hattiesburg, Mississippi.

pected to exceed 100,000 in 1956.

To establish Bahia grass, farmers have found it pays to prepare a good seedbed before planting. There are generally two seasons of the year when most Bahia is planted. One is the fall and the other is early spring. If Bahia is planted in September, October, or November, it is mixed with an adapted winter legume. Farmers use from one to two tons of agricultural lime per acre. In addition to lime, 600 to 800 pounds of 20% superphosphate and 200 pounds of muriate of potash per acre are applied and worked into the soil before seeding. Nitrogen is usually applied as a topdressing in the spring and summer.

In order to maintain a good Bahia and winter legume combination, it is necessary to repeat the lime application every five to seven years as needed. An annual application of 600 pounds of superphosphate or its equivalent and 150 pounds of muriate of potash is necessary for most soil conditions in this section. Some farmers have found an application of nitrogen in late summer helps maintain the grass in better condition. The legume, if properly managed, will furnish some nitrogen for the grass in summer.

Why has this grass become so acceptable to farmers? L. A. Knott, Chairman of the Forrest County Soil Conservation District, made a statement that pretty well answers that question. Mr. Knott said, "Bahia grass gives more grazing over a longer period of time during the year than any grass I know." He went on to say, "It took the past four years of dry weather here to really prove just how good Bahia grass really is."

Soil Conservation Service technicians and other agricultural workers say farmers report Bahia grass is the best summer perennial grass ever planted in this section of the State. They say it provides good ground cover for soil erosion control and good grazing for livestock. It has been found to grow well on a wide range of soil types.

Reports from Soil Conservation District Commissioners throughout the southern part of the State give a definite indication of just how well farmers are taking to Bahia grass. Their reports also show that most of the acreage

(Turn to page 39)

Soil Testing in Oklahoma

By Robert O. Woodward

Agronomy Department, Oklahoma A and M College, Stillwater, Oklahoma

FARMERS in Oklahoma have had more than 380,000 soil samples tested in their own laboratories since 1949. This was possible through the State soil-testing program based on locally owned and operated laboratories.

In December 1949, the first local laboratory was established in an effort to meet the steadily increasing need for specific information in regard to soil improvement and fertilizer practices. Contributions varying from $1 to $100 from local farmers and farm organizations were collected to offset the initial expense of supplies and installation. A small charge has been made for each sample tested to maintain supplies and meet other expenses incident to regular operation. A committee of farmers was organized as the county soil-testing laboratory committee to establish policies and act on other matters pertaining to the laboratory operation. The county agent served on the committee as recorder and was responsible for managing the laboratory and maintaining accurate soil tests. He was also responsible for making fertilizer recommendations on the basis of the results of the chemical soil analysis and other factors, and giving counsel to farmers on their soil management problems.

Immediately following the first laboratory, similar organizations were formed in other counties throughout the State, and 57 laboratories were in operation by the end of 1950. At the present time 75 of the 77 counties have laboratories. The farmers in the two counties without laboratories have access to this service through the adjoining county.

The county soil-testing laboratory is not complicated. It is flexible enough to permit the county agent to enter the laboratory and accurately test soil after only a few minutes orientation following some of his other routine activities. It occupies a space of approximately 160 square feet for tables, shelves, storage, and working area and requires electricity, running water, and a sink. The initial cost for equipment and supplies is approximately $500. Installation costs vary according to local conditions and other factors, but generally are about $300. The location in the county will be determined by available space, but oftentimes will be found in the corner of a large office or in a former storage room—any place where

Fig. 1. County Agent Bob Lamar discusses the results of the soil analysis with the farmer while standing in the laboratory.

Fig. 2. County Agent Bill Blakemore checks final results of a soil analysis.

water, lights, and ventilation can be found.

Soils are tested for organic matter content, available phosphorus, potassium, acidity (lime need), excess calcium, and soil pH. These tests are generally sufficient to inventory the soil for those plant-food elements that can be replaced by available commercial fertilizers. The procedures used are considered adequate for making these determinations and are approved by the State experiment station prior to being adapted to the county laboratory. The organic matter test is colorimetric and measures total organic matter—from this determination the active organic matter is approximated and available nitrogen predicted. Sodium nitrate, sodium cobalti-di-nitrite, and isopropyl alcohol are used in producing the color for determining the available potassium. The inorganic phosphorus soluble in weak sulphuric acid is colorimetrically determined through the use of ammonium molybdate and stannous oxalate. The lime requirement is determined by the modified Comber test. Soil pH is measured with a bromcresol purple indicator. Excessive calcium is detected by using a weak hydrochloric acid solution.

A chemical soil test is of little value unless the sample has been taken properly. The sample must be representative of the area to be tested, consequently an intensive program is constantly in use in an effort to get the farmer to draw accurate samples. Surface samples taken to plow depth are generally adequate for the average crop; however, on crops that will occupy the land several years and have deep rooting habits (alfalfa and sweet clover for example), a subsoil sample to a depth of more than 10 inches is necessary.

Fertilizer recommendations are made on the basis of the chemical soil analysis and several other factors having a direct relationship to the field in question. The principal basic factors now being used to determine the kind and amount of fertilizer, and the best methods of application are:

1. Characteristics of the soil type and its production capacity.
2. Crop to be grown and probabilities for crop yield.

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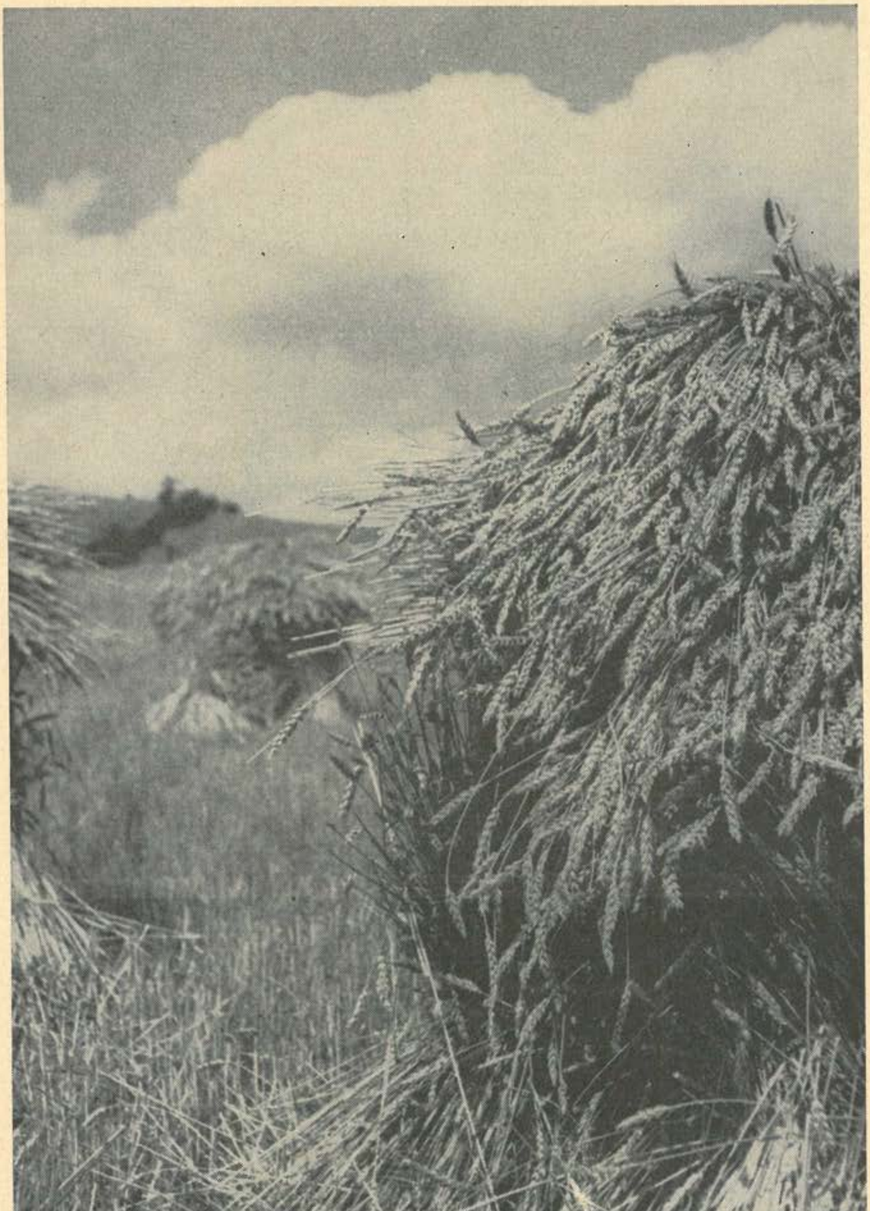
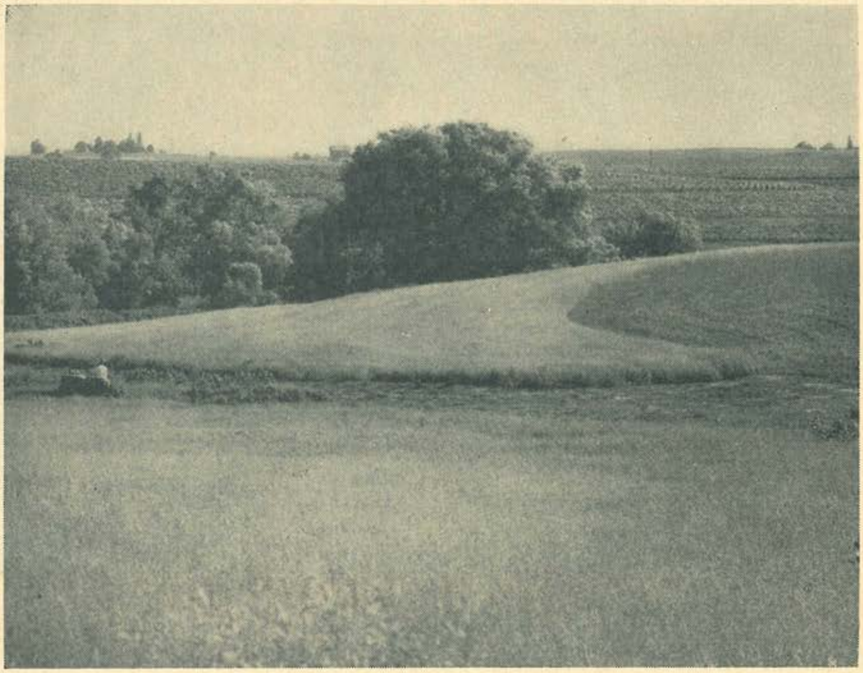
PICTORIAL

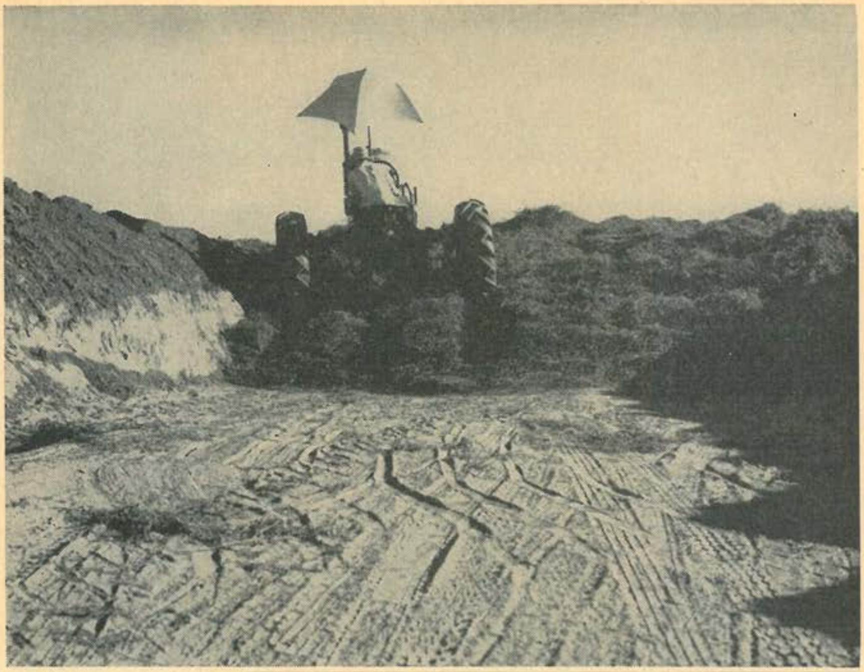


Signs of a Bounteous Harvest

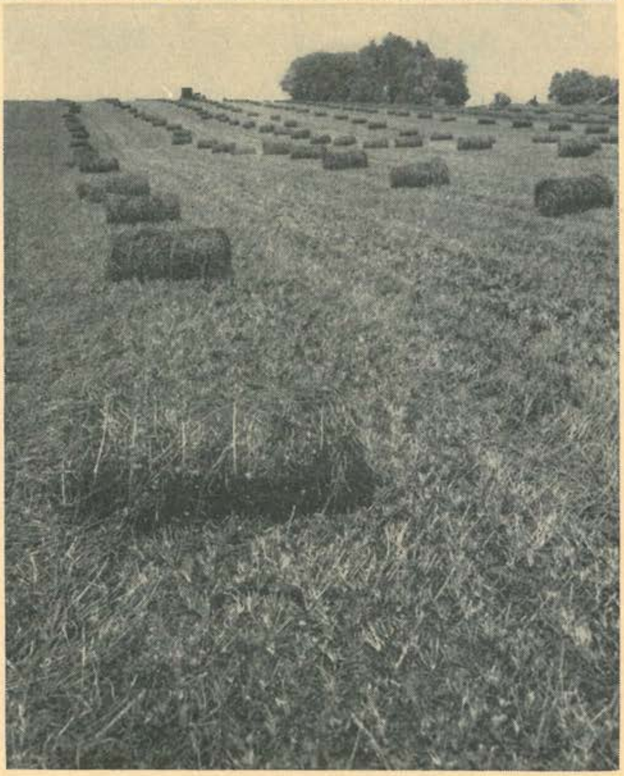
Left: Unloading chopped hay at a barn on a farm in Iowa.

Below: Mowing draws and waterways in strip-cropped oats.





Above: Packing legumes in trench silo for long grass silage.



Right: Round bales of hay in a hayfield in northeastern Iowa.

After the Chores Are Done!

The Editors Talk

Our Cover Picture

To most home-owners and amateur gardeners discolored and unhealthy-looking foliage is an indication of lack of moisture, or possibly disease or insect damage. Too few are familiar enough with plant-food requirements to recognize the starvation symptoms which plainly reveal the soil's deficiency in one of the essential nutritive elements. In the cover illustration of this issue we are pleased, therefore, to present signs of potash starvation on some of the common ornamentals. In general, similar symptoms on other shrubs and flowers would indicate deficiency of this same necessary plant food.

The cover illustration shows a good range of stages of typical potash starvation on broad leaf plants. At first there is likely to be a faint yellowing on the margins of the leaves, as shown in the chrysanthemum, nandina, and maple. This chlorosis occurs first on the lower leaves and gradually spreads inwards between the veins until a very marked chlorosis of the entire leaf is noticed, as in the dogwood and honeysuckle. This will continue until curling of the leaf takes place, followed by browning and death, as seen in the hollyhock leaf.

In the book "Fertilizers for Greenhouse and Garden Crops" by Laurie and Edmond it is stated that a close relationship exists between potash and the formation of starches, sugars, and similar compounds and their transference from one part of the plant to another. It is credited with making stems less brittle and succulent, with delaying maturity, with intensification of color, and with increasing root development. Together with other elements, it is essential in the formation of protoplasm, and has been found in some cases to be of help in increasing disease resistance of plants (streak of sweet peas, mildew on roses). The effect of potassium compounds is more localized than that of phosphates, therefore potash starvation may be detected more readily. The color of the leaves becomes dull and yellowish, the stem is weaker, and the plant's efficiency in making starch is lost. Such plants are the first to succumb to diseases.

Laurie and Chadwick in their book "Commercial Flower Forcing" state that potassium has much to do with the general vigor of the plant. It exerts a balancing influence, and is said to increase resistance to certain diseases. "Potassium is essential to the nitrate changes which occur in the plant. Because of its solubility it is translocated readily from the older to the newer tissues. Root formation is also dependent upon sufficiency of potassium. Due to its affinity for soil particles, leaching does not readily take place."

Because of economic pressure, much more work has been done on the fertilization of vegetable and field crops than on ornamentals. The latter, however, have not been entirely neglected and numerous articles and bulletins have been published as a result of investigations with flowers and shrubs. Several books assembling this information in a form to be easily consulted are available.

Certainly there is great satisfaction in having healthy and vigorous plantings around the home for the appreciation of passers-by as well as friends and neighbors. And obviously, because of the greater number of people who will observe it, good plant husbandry in urban and home surroundings attracts more attention than it does in the field. Therefore, every addition to what already is known about the fertilization and management of ornamentals will be welcomed.

Soil Is a Factory for Plant Growth

Before some 300 persons assembled for the Fourth Annual California Fertilizer Conference at Riverside on April 16, Emil Truog, Emeritus Professor of Soils, University of Wisconsin, stated that our best soils provide a well-nigh perfect medium for the growth of crop plants. He pointed out that soil is not an unorganized and static body of material, but is, in fact, a highly and specially organized dynamic system.

"If now, the every-day processes of a soil, that is, those of immediate practical concern, are examined by means of chemical and other tests, it will be found that the soil solution is continually reacting with the solid particles so that certain constituents go into solution and others go out of solution by precipitation or absorption by the solid particles. Not only will it be found that the soil solution is in continual reaction with the solid phase, but also that it exhibits movement, going downward by gravity when there is an excess at the surface, and upward and horizontally by capillarity when it is removed at or near the surface by evaporation and growing plants. And, finally, if a crumb of soil is examined with a microscope, it will be found to consist of a living community in which myriads of bacteria, fungi, and other organisms are carrying on their relentless life activities, and producing products and conditions which may be favorable or unfavorable to crop production, depending largely on type of soil management practices.

"For the continued satisfactory production of crops in practical agriculture," Professor Truog stated, "soils in their day-to-day processes must provide for the following:

1. Storage of water and its gradual delivery to crops and removal of excess.
2. Storage of plant nutrients and their gradual delivery to growing crops as required.
3. Aeration for the plant roots and soil microbes.
4. Prevention of formation of injurious conditions and accumulation of toxic concentrations of salts and other substances.
5. Anchorage for roots so the crop may stand upright and resist removal.
6. Resistance to self-destruction by leaching, wind and water erosion, and prodigal crop production.
7. Replacement of losses, due to unavoidable erosion and leaching, through additions provided via rock weathering and plant residues."

Professor Truog looks upon a soil as a factory, humming with activity and having a large storage capacity. When lime, manure, and fertilizer are supplied to this factory, certain chemical reactions, biological processes, and physical movements take place therein which make possible this transformation and storage of the nutrient elements added, and their delivery in suitable forms to the growing plant as needed. "It is the task of the farmer to control the physical, chemical, and biological soil processes in such a manner as to provide the most favorable conditions for the crops to be grown," he says. "To do this in the most satisfactory and profitable manner with various types of soils requires fundamental knowledge concerning soils so as to make possible both a scientific and practical approach to the problem."

Season Average Prices Received by Farmers for Specified Commodities *

Crop Year	Cotton Cents per lb. Aug.-July	Tobacco Cents per lb.	Potatoes Cents per bu. July-June	Sweet Potatoes Cents per bu. July-June	Corn Cents per bu. Oct.-Sept.	Wheat Cents per bu. July-June	Hay [1] Dollars per ton July-June	Cottonseed Dollars per ton July-June	Truck Crops ....
Av. Aug. 1909–July 1914....	12.4	10.0	69.7	87.8	64.2	88.4	11.87	22.55	....
1930..........	9.5	12.8	91.2	108.1	59.8	67.1	11.06	22.04	....
1931..........	5.7	8.2	46.0	72.6	32.0	39.0	8.69	8.97	....
1932..........	6.5	10.5	38.0	54.2	31.9	28.2	6.20	10.33	....
1933..........	10.2	13.0	82.4	69.4	52.2	74.4	8.09	12.88	....
1934..........	12.4	21.3	44.6	79.8	81.5	84.8	13.20	33.00	....
1935..........	11.1	18.4	59.3	70.3	65.5	83.2	7.52	30.54	....
1936..........	12.4	23.6	114.2	92.9	104.4	102.5	11.20	33.36	....
1937..........	8.4	20.4	52.9	78.0	51.8	96.2	8.74	19.51	....
1938..........	8.6	19.6	55.7	69.8	48.6	56.2	6.78	21.79	....
1939..........	9.1	15.4	69.7	73.4	56.8	69.1	7.94	21.17	....
1940..........	9.9	16.0	54.1	85.4	61.8	68.2	7.59	21.73	....
1941..........	17.0	26.4	80.8	92.2	75.1	94.4	9.70	47.65	....
1942..........	19.0	36.9	117.0	118.0	91.7	110.0	10.80	45.61	....
1943..........	19.9	40.5	131.0	206.0	112.0	136.0	14.80	52.10	....
1944..........	20.7	42.0	150.0	190.0	109.0	141.0	16.50	52.70	....
1945..........	22.5	36.6	143.0	204.0	127.0	150.0	15.10	51.10	....
1946..........	32.6	38.2	124.0	218.0	156.0	191.0	16.70	72.00	....
1947..........	31.9	38.0	162.0	217.0	216.0	229.0	17.60	85.90	....
1948..........	30.4	48.2	155.0	222.0	129.0	200.0	18.45	67.20	....
1949..........	28.6	45.9	128.0	214.0	124.0	188.0	16.50	43.40	....
1950..........	40.1	51.7	91.7	173.0	153.0	200.0	16.70	86.50	....
1951..........	37.9	51.1	163.0	304.0	166.0	211.0	19.50	69.30	....
1952..........	34.6	49.9	198.0	338.0	153.0	209.0	19.95	69.60	....
1953..........	32.3	52.2	78.1	244.0	148.0	204.0	17.45	52.60	....
1954..........	33.6	51.4	123.0	216.0	143.0	214.0	17.35	60.30	....
1955									
June........	31.43	39.5	121.0	392.0	140.0	206.0	16.35	52.00	....
July.........	32.11	38.0	88.0	279.0	140.0	197.0	15.25	54.00	....
August......	32.74	50.6	75.2	179.0	130.0	190.0	15.25	50.10	....
September...	33.77	51.5	71.3	142.0	124.0	192.0	15.55	43.70	....
October......	32.83	55.0	72.3	144.0	114.0	194.0	15.75	43.50	....
November...	32.42	52.5	82.9	168.0	109.0	194.0	16.05	44.30	....
December....	31.19	57.2	80.7	203.0	115.0	195.0	16.55	45.00	....
1956									
January.....	30.67	51.3	99.4	199.0	116.0	195.0	16.55	45.50	....
February....	31.00	35.4	114.0	198.0	118.0	195.0	16.45	46.20	....
March.......	31.64	....	134.0	209.0	120.0	197.0	16.15	46.80	....
April........	32.50	....	172.0	217.0	132.0	203.0	16.25	46.90	....
May........	31.96	54.0	219.0	231.0	139.0	200.0	16.15	47.30	....

Index Numbers (Aug. 1909—July 1914 = 100)

Crop Year	Cotton	Tobacco	Potatoes	Sweet Potatoes	Corn	Wheat	Hay	Cottonseed	Truck Crops
1930..........	77	128	131	123	93	76	93	98	128
1931..........	46	82	66	83	50	44	73	40	107
1932..........	52	105	55	62	50	43	52	46	100
1933..........	82	130	118	79	81	84	68	57	90
1934..........	100	213	64	91	127	96	111	146	94
1935..........	90	184	85	80	102	94	63	135	116
1936..........	100	236	164	106	163	116	94	148	108
1937..........	68	204	76	89	81	109	74	87	114
1938..........	69	196	80	79	76	64	57	97	96
1939..........	73	154	100	84	88	78	67	94	98
1940..........	80	160	78	97	96	77	64	96	122
1941..........	137	264	116	105	117	107	82	211	138
1942..........	153	369	168	134	143	124	91	202	178
1943..........	160	405	188	235	174	154	125	231	270
1944..........	167	420	214	216	170	160	139	234	236
1945..........	181	366	205	232	198	170	127	227	240
1946..........	263	382	178	248	212	209	141	319	217
1947..........	257	380	232	248	336	259	148	381	262
1948..........	245	482	222	253	201	226	155	298	253
1949..........	231	459	184	244	193	213	139	192	232
1950..........	323	517	132	197	238	226	141	384	211
1951..........	306	512	233	346	259	239	164	307	269
1952..........	279	499	284	385	238	236	168	309	274
1953..........	260	522	112	278	231	231	147	233	240
1954..........	270	514	176	246	223	242	146	267	228
1955									
June........	253	395	174	435	218	233	138	231	230
July.........	259	380	126	318	218	223	128	239	223
August......	264	506	108	204	202	215	128	222	211
September...	272	515	102	162	193	217	131	194	230
October......	265	550	104	164	178	219	133	193	223
November...	261	525	119	191	170	219	135	196	231
December....	252	572	118	231	179	221	139	200	231
1956									
January.....	247	513	143	227	181	221	139	202	244
February....	250	354	164	226	184	221	139	205	244
March.......	255	...	192	238	187	223	136	208	214
April........	262	...	247	247	206	230	137	208	202
May........	258	540	314	263	217	226	136	210	239

Wholesale Prices of Phosphates and Potash * *

	Superphosphate, Baltimore, per unit	Florida land, pebble, 68% f.o.b. mines, bulk, per ton	Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton	Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports [2]	Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports [2]	Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports [2]	Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports [2]
1910–14	$0.536	$3.61	$4.88	$0.714	$0.953	$24.18	$0.657
1930	.542	3.18	5.50	.681	.973	26.92	.618
1931	.485	3.18	5.50	.681	.973	26.92	.618
1932	.458	3.18	5.50	.681	.963	26.90	.618
1933	.434	3.11	5.50	.662	.864	25.10	.601
1934	.487	3.14	5.67	.486	.751	22.49	.483
1935	.492	3.30	5.69	.415	.684	21.44	.444
1936	.476	1.85	5.50	.464	.708	22.94	.505
1937	.510	1.85	5.50	.508	.757	24.70	.556
1938	.492	1.85	5.50	.523	.774	15.17	.572
1939	.478	1.90	5.50	.521	.751	24.52	.570
1940	.516	1.90	5.50	.517	.730	24.75	.573
1941	.547	1.94	5.64	.522	.780	25.55	.367
1942	.600	2.13	6.29	.522	.810	25.74	.205
1943	.631	2.00	5.93	.522	.786	25.35	.195
1944	.645	2.10	6.10	.522	.777	25.35	.195
1945	.650	2.20	6.23	.522	.777	25.35	.195
1946	.671	2.41	6.50	.508	.769	24.70	.190
1947	.746	3.05	6.60	.432	.706	18.93	.195
1948	.764	4.27	6.60	.397	.681	14.14	.195
1949	.770	3.88	6.22	.397	.703	14.14	.195
1950	.763	3.83	5.47	.371	.716	14.33	.195
1951	.813	3.98	5.47	.401	.780	15.25	.200
1952	.849	3.98	5.47	.401	.793	15.25	.200
1953	.878	....	....	.410	.793	15.25	.200
1954	.895	....	....	.405	.791	15.27	.200
1955							
June	.895	....	....	.360	.720	13.45	.175
July	.895	....	....	.380	.735	14.00	.193
August	.895	....	....	.380	.735	14.00	.193
September	.895	....	....	.380	.735	14.00	.193
October	.895	....	....	.380	.735	14.00	.193
November	.895	....	....	.380	.735	14.00	.193
December	.895	....	....	.380	.735	14.00	.193
1956							
January	.895	....	....	.380	.735	14.00	.193
February	.895	....	....	.380	.735	14.00	.193
March	.895	....	....	.380	.735	14.00	.193
April	.895	....	....	.380	.735	14.00	.193
May	.895	....	....	.380	.735	14.00	.193

Index Numbers (1910-14 = 100)

	Superphosphate	Florida land pebble	Tennessee phosphate rock	Muriate of potash	Sulphate of potash	Sulphate of potash magnesia	Manure salts
1930	101	88	113	95	102	111	94
1931	90	88	113	95	102	111	94
1932	85	88	113	95	101	111	94
1933	81	86	113	93	91	104	91
1934	91	87	110	68	79	93	74
1935	92	91	117	58	72	89	68
1936	89	51	113	65	74	95	77
1937	95	51	113	71	79	102	85
1938	92	51	113	73	81	104	87
1939	89	53	113	73	79	101	87
1940	96	53	113	72	77	102	87
1941	102	54	110	73	82	106	87
1942	112	59	129	73	85	106	84
1943	117	55	121	73	82	105	83
1944	120	58	125	73	82	105	83
1945	121	61	128	73	82	105	83
1946	125	67	133	71	81	102	82
1947	139	84	135	70	74	78	83
1948	143	118	135	67	72	58	83
1949	144	108	128	67	74	58	83
1950	142	106	112	68	75	59	83
1951	152	110	112	72	82	63	83
1952	158	110	112	72	83	63	83
1953	164	...	...	73	83	63	83
1954	167	...	...	72	83	63	83
1955							
June	167	...	...	66	76	56	80
July	167	...	...	69	77	58	82
August	167	...	...	69	77	58	82
September	167	...	...	69	77	58	82
October	167	...	...	69	77	58	82
November	167	...	...	69	77	58	82
December	167	...	...	69	77	58	82
1956							
January	167	...	...	69	77	58	82
February	167	...	...	69	77	58	82
March	167	...	...	69	77	58	82
April	167	...	...	69	77	58	82
May	167	...	...	69	77	58	82

Wholesale Prices of Ammoniates **

	Nitrate of soda bulk per unit N	Sulphate of ammonia bulk per unit N	Cottonseed meal S. E. Mills per unit N	Fish, scrap, dried 11–12% ammonia, 15% bone phosphate, f.o.b. factory bulk per unit N	Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N	High grade ground blood, 16–17 % ammonia, Chicago, bulk, per unit N
1910–14	$2.68	$2.85	$3.50	$3.53	$3.37	$3.52
1930	2.47	1.81	4.78	4.96	3.79	4.58
1931	2.34	1.46	3.10	3.95	2.11	2.46
1932	1.87	1.04	2.18	2.18	1.21	1.36
1933	1.52	1.12	2.95	2.86	2.06	2.46
1934	1.52	1.20	4.46	3.15	2.67	3.27
1935	1.47	1.15	4.59	3.10	3.06	3.65
1936	1.53	1.23	4.17	3.42	3.58	4.25
1937	1.63	1.32	4.91	4.66	4.04	4.80
1938	1.69	1.38	3.69	3.76	3.15	3.53
1939	1.69	1.35	4.02	4.41	3.87	3.90
1940	1.69	1.36	4.64	4.36	3.33	3.39
1941	1.69	1.41	5.50	5.32	3.76	4.43
1942	1.74	1.41	6.11	5.77	5.04	6.76
1943	1.75	1.42	6.30	5.77	4.86	6.62
1944	1.75	1.42	7.68	5.77	4.86	6.71
1945	1.75	1.42	7.81	5.77	4.86	6.71
1946	1.97	1.44	11.04	7.38	6.60	9.33
1947	2.50	1.60	12.72	10.66	12.63	10.46
1948	2.86	2.03	12.94	10.59	10.84	9.85
1949	3.15	2.29	10.11	13.18	10.73	10.62
1950	3.00	1.95	11.01	11.70	10.21	9.36
1951	3.16	1.97	13.20	10.92	10.18	10.09
1952	3.34	2.09	13.95	11.27	9.72	9.16
1953	3.26	2.27	11.04	11.19	7.39	7.09
1954	3.07	2.20	11.50	11.63	9.72	9.85
1955						
June	2.98	2.02	9.91	11.55	6.23	5.92
July	2.98	2.02	10.01	9.43	6.68	7.14
August	2.98	2.07	9.88	11.12	7.04	6.86
September	2.98	2.05	9.30	11.60	6.75	6.53
October	2.98	2.07	9.17	13.01	7.47	7.16
November	2.98	2.07	8.71	13.10	6.14	6.23
December	2.98	2.12	9.21	12.93	5.66	6.00
1956						
January	2.98	2.12	9.43	12.75	5.58	5.58
February	2.98	2.12	8.69	12.15	5.77	5.69
March	2.98	2.12	8.30	11.89	5.92	5.92
April	2.98	2.12	8.31	11.66	5.77	5.71
May	2.98	1.70	8.67	11.80	6.60	6.37
Index Numbers (1910-14 = 100)						
1930	92	64	137	141	112	130
1931	88	51	89	112	63	70
1932	71	36	62	62	36	39
1933	59	39	84	81	97	71
1934	59	42	127	89	79	93
1935	57	40	131	88	91	104
1936	59	43	119	97	106	131
1937	61	46	140	132	120	122
1938	63	48	105	106	93	100
1939	63	47	115	125	115	111
1940	63	48	133	124	99	96
1941	63	49	157	151	112	126
1942	65	49	175	163	150	192
1943	65	50	180	163	144	189
1944	65	50	219	163	144	191
1945	65	50	223	163	144	191
1946	74	51	315	209	196	265
1947	93	56	363	302	374	297
1948	107	71	370	300	322	280
1949	117	80	289	373	318	302
1950	112	68	315	331	303	266
1951	118	69	377	310	302	287
1952	125	74	399	319	288	260
1953	122	80	315	317	219	201
1954	114	77	329	330	288	280
1955						
June	111	71	283	327	185	168
July	111	71	286	267	198	203
August	111	73	282	315	209	195
September	111	72	266	329	200	186
October	111	73	262	369	222	203
November	111	73	249	371	182	177
December	111	74	263	366	168	170
1956						
January	111	74	269	361	166	159
February	111	74	248	344	171	162
March	111	74	237	337	176	168
April	111	74	237	330	171	162
May	111	60	248	334	196	181

Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and All Commodities

	Farm prices*	Prices paid by farmers for commodities bought*	Wholesale prices of all commodities†	Fertilizer material‡	Chemical ammoniates	Organic ammoniates	Superphosphate	Potash**
1930	125	140	126	105	72	131	101	99
1931	87	119	107	83	62	83	90	99
1932	65	102	95	71	46	48	85	99
1933	70	104	96	70	45	71	81	95
1934	90	118	109	72	47	90	91	72
1935	109	123	117	70	45	97	92	63
1936	114	123	118	73	47	107	89	69
1937	122	130	126	81	50	129	95	75
1938	97	122	115	78	52	101	92	77
1939	95	121	112	79	51	119	89	77
1940	100	122	115	80	52	114	96	77
1941	124	130	127	86	56	130	120	77
1942	159	149	144	93	57	161	112	77
1943	193	165	151	94	57	160	117	77
1944	197	174	152	96	57	174	120	76
1945	207	180	154	97	57	175	121	76
1946	236	197	177	107	62	240	125	75
1947	276	231	222	130	74	362	139	72
1948	287	250	241	134	89	314	143	70
1949	250	240	226	137	99	319	144	70
1950	258	246	232	132	89	314	142	72
1951	302	271	258	139	93	331	152	76
1952	288	273	251	144	98	333	158	76
1953	258	262	247	139	100	269	164	77
1954	249	264	248	142	95	311	167	76
1955								
June	243	263	248	131	90	242	167	70
July	237	262	248	131	90	240	167	72
August	233	260	248	133	91	252	167	72
September	235	259	250	132	91	244	167	72
October	230	261	250	134	91	259	167	72
November	225	259	250	131	91	235	167	72
December	223	259	250	131	92	232	167	72
1956								
January	226	259	252	131	92	232	167	72
February	226	259	252	130	92	225	167	72
March	228	261	254	130	92	222	167	72
April	235	261	257	130	92	219	167	72
May	242	264	257	130	85	236	167	72

* U. S. D. A. figures, revised January 1950. Beginning January 1946 farm prices and index numbers of specific farm products revised from a calendar year to a crop-year basis. Truck crops index adjusted to the 1924 level of the all-commodity index.

† Department of Labor index converted to 1910-14 base.

‡ The Index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management, Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] Beginning July 1949, baled hay prices reduced by $4.75 a ton to be comparable to loose hay prices previously quoted.

[2] Potash salts quoted F.O.B. mines; manure salts since June 1941; other carriers since June 1947.

**** Where range of prices for fertilizer material is quoted, average figure is used. The weighted average of prices actually paid for potash is lower than the annual average because since 1926 over 90% of the potash used in agriculture has been contracted for during the discount period.**

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

"Field Evaluation Studies of Rock and Superphosphate," Agr. Exp. Sta., Univ. of Ark., Fayetteville, Ark., Mimeo. Series 41, Feb. 1956, E. O. McLean.

"Summary of Fertilizer Usage in Kentucky," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., May 1956.

"Fertilizer Recommendations for Tomatoes in Maryland," Agr. Ext. Serv., Univ. of Md., College Park, Md., Ft. Sh. 2, Rev. May 1955, F. C. Stark.

"Fertilization of Grain Sorghum in Curry County," Agr. Exp. Sta., N. Mex. A. & M. College, State College, N. Mex., Res. Rpt. 2, June 1955, M. R. Pack and D. E. Buchanan.

"Fertilization of Cotton on Soil Unusually High in Organic Matter," Agr. Exp. Sta., N. Mex. A. & M. College, State College, N. Mex., Res. Rpt. 3, June 1955, M. R. Pack.

"Boron Deficiencies for Alfalfa in Ohio," Agr. Exp. Sta., Wooster, Ohio, Res. Cir. 33, May 1956, J. M. Stackhouse, P. F. Pratt, and G. W. Volk.

"Distribution of Fertilizer in Oklahoma Counties by Grades and Material for the Period January 1, 1956 to April 1, 1956," State Dept. of Agr., Oklahoma City, Okla.

"A Method of Economic Analysis Applied to Nitrogen Fertilizer Rate Experiments on Irrigated Corn," USDA, Wash., D. C., Tech. Bul. 1141, May 1956, J. L. Paschal and B. L. French.

Soils

"Menard County Land-Use Program," Agr. Ext. Serv., Univ. of Ill., Urbana, Ill., ES 1672, March 1956, D. M. Hall and L. W. Chalcraft.

"Conservation on Rented Land in the Midwest," Agr. Exp. Sta., Kans. State College, Manhattan, Kans., No. Cen. Reg. Pub. 69, Feb. 1956, W. H. Pine, et al.

"Relation of Soil pH in Salt Solutions to Exchangeable Sodium Percentages," Agr. Exp. Sta., N. Mex. A. & M. College, State College, N. Mex., Res. Rpt. 5, Nov. 1955, C. W. Chang, H. E. Dregne, and H. I. Nightingale.

"Field Irrigation of Tobacco," Agr. Ext. Serv., N. C. State College, Raleigh, N. C., Ext. Cir. 388, Nov. 1955.

"Our Soil and It's Care," Agr. Ext. Serv., Okla. A. & M. College, Stillwater, Okla., Cir. 638.

"Reconnaissance Soil Survey of Potter County, South Dakota," Agr. Exp. Sta., S. Dak. State College, Brookings, S. Dak., Bul. 449, May 1955, W. I. Watkins, G. J. Buntley, F. C. Westin, and F. E. Shubeck.

"A Soil Science Career for You in SCS," USDA, Wash., D. C., Misc. Pub. 716, May 1956.

"Soil Survey, Allegany County, New York," USDA, Wash., D. C., Series 1942, No. 12.

Crops

"Peach Varieties for Alabama," Agr. Exp. Sta., Ala. Polytechnic Institute, Auburn, Ala., Lflt. 48, March 1956, T. B. Hagler and W. A. Johnson.

"Comparative Yields of Early- and Late-Harvested Corn," Agr. Exp. Sta., Ala. Polytechnic Institute, Auburn, Ala., Prog. Rpt. Series 63, March 1956, J. L. Butt and J. O. Helms.

"Factors Affecting Production and Quality of Apples," Agr. Exp. Sta., Univ. of Ark., Fayetteville, Ark., Bul. 560, Jan. 1956, J. R. Cooper.

"Experimental Farm, Lennoxville, Quebec, Progress Report 1947-1952," Exp. Farms Serv., Dept. of Agr., Ottawa, Ont., Can., Feb. 1956.

"Dominion Experimental Farm, Swift Current, Saskatchewan, Progress Report 1948-1954," Exp. Farms Serv., Dept. of Agr., Ottawa, Ont., Can., March 1956.

"Soil Research Laboratory, Swift Current, Saskatchewan, Progress Report 1948-1954," Exp. Farms Serv., Dept. of Agr., Ottawa, Ont., Can., March 1956.

"Descriptive Notes on Herbaceous Perennials for Canadian Gardens," Dept. of Agr., Ottawa, Ont., Can., Pub. 968, Jan. 1956, R. W. Oliver.

"Growing Herbaceous Perennials," Dept. of Agr., Ottawa, Ont., Can., Pub. 970, Jan. 1956, R. W. Oliver.

"Growing Pickling Cucumbers in the Lower Mainland of B. C.," Dept. of Agr., Exp. Farm, Agassiz, B. C., Can., Cir. 404, Rev. Jan. 1955, J. A. Freeman.

"Sorghum Varieties for Colorado," Agr. Exp. Sta., Colo. A. & M. College, Fort Collins, Colo.,

Bul. 494-S, April 1956, W. H. Leonard, J. F. Brandon, and H. Fauber.

"Horticultural Trials with Bush Snap Bean Varieties, Strains, and Breeding Lines, 1954-55 Season," Fla. Everglades Exp. Sta., Belle Glade, Fla., Everglades Sta. Mimeo. Rpt, 56-1, July 1955, E. A. Wolf.

"Results of Research on Field Corn and Popcorn in the Everglades Area—1955," Fla. Everglades Exp. Sta., Belle Glade, Fla., Everglades Sta. Mimeo. Rpt. 56-2, July 1955, V. E. Green, Jr.

"Horticultural Trials with Sweet Corn Hybrids, Spring 1955," Fla. Everglades Exp. Sta., Belle Glade, Fla., Everglades Sta. Mimeo. Rpt. 56-5, Sept. 1955, E. A. Wolf.

"Holly Production in Georgia," Agr. Ext. Serv., Univ. of Ga., Athens, Ga., Cir. 395, Sept. 1955, R. A. Bowden.

"Christmas Tree Production in Georgia," Agr. Ext. Serv., Univ. of Ga., Athens, Ga., Cir. 398, Oct. 1955, R. A. Bowden.

"1955 Rose Variety Trials at Athens, Georgia," Agr. Exp. Sta., Univ. of Ga., Athens, Ga., Mimeo. Series N. S. 14, Nov. 1955, F. E. Johnstone, Jr., G. E. Smith, L. C. Curtis, and R. A. Bowden.

"Results of Research in 1954," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., Ann. Rpt. 67.

"Crops and Soils Departmental Annual Report for 1955," Agr. Exp. Sta., La. State Univ., Baton Rouge, La.

"Research: Background for Efficient Agriculture, Sixty-Eighth Annual Report, 1954-1955," Agr. Exp. Sta., Univ. of Md., College Park, Md., Bul. A-83, March 1956.

"Maryland Tobacco Varieties," Agr. Ext. Serv., Univ. of Md., College Park, Md., Ft. Sh. 119, Feb. 1956, O. E. Street and J. H. Hoyert.

"Sixty-Second Annual Report of the Agricultural Experiment Station, University of Minnesota, July 1, 1954 to June 30, 1955," Agr. Exp. Sta., Univ. of Minn., St. Paul, Minn., Dec. 1955.

"Mississippi Crowder—a New Cowpea," Agr. Exp. Sta., Miss. State College, State College, Miss., Inf. Sh. 519, Dec. 1955, W. W. Hare.

"Annual Report of the Missouri Agricultural Experiment Station, 1952-53," Agr. Exp. Sta., Univ. of Mo., Columbia, Mo., Bul. 643, Jan. 1955.

Influence of Light and Nutrition on Color and Growth of Redcedar Seedlings," Agr. Exp. Sta., Univ. of Mo., Columbia, Mo., Res. Bul. 587, June 1955, R. E. McDermott and P. W. Fletcher.

"Balanced Farming Helped Cut Costs in 1955," Agr. Ext. Serv., Univ. of Mo., Columbia, Mo., Cir. 663, Feb. 1956.

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Plant Analysis As A Guide . . .

(From page 10*)*

1,000 ppm. NO_3-N for nitrogen, 750 ppm. PO_4-P for phosphorus, and 1.0% K for potassium) is often referred to as the critical concentration. Below the critical concentration is the transition zone or zone of poverty adjustment and finally a zone of starvation. Here

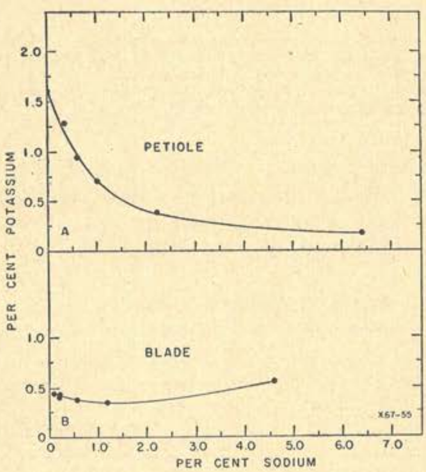

Fig. 5A. Relation of potassium to sodium concentrations (dry basis) in petioles of potassium-deficient (scorched) sugar beet leaves. Note that the potassium concentrations of the petioles decrease greatly (1.61 to 0.19%) as the sodium concentrations increase. Sodium as well as potassium should be determined when petioles are used to estimate the potassium status of sugar beet plants.

Fig. 5B. Relation of potassium to sodium in blades of potassium-deficient (scorched) sugar beet leaves. Note that the potassium values of the blades (0.33% to 0.55%) are affected only slightly by sodium even when sodium concentrations are as low as 0.20% or as high as 4.52%. Therefore, it is not necessary to analyze blades for sodium in order to estimate correctly the potassium status of sugar beet plants.

the petiole nitrate, phosphate, and potassium values are relatively constant, but the beet-root weights differ in accordance with the nitrogen, phosphorus, or potassium available to the beets.

In developing plant analysis as a technique to evaluate the nutrient status of a crop, it is important to find that part of the plant and that form of nutrient that will give a sharp transition zone between the zones of adequacy and deficiency. The situation is analogous to the selection of an indicator in a chemical titration. The more swiftly the indicator changes color at the end point the more clearly may the end point of the titration be determined by the analytical chemist.

Plant Nutrient Inventory

Once we have the calibration curves for nitrate, phosphate, potassium, and other nutrients, how do we use these values in fertilizing crops more effectively and efficiently? This objective may be attained rather conveniently by plotting the nutrient concentrations of a field-grown crop with respect to time and referring the values found to the critical nutrient concentration as determined in the calibration curve. The results of a typical inventory for nitrate-nitrogen in field-grown beets are given in Figure 6. The critical concentration of 1,000 ppm. of nitrate-nitrogen on the dry basis for petioles of recently matured leaves has been indicated in this Figure. The beets were planted April 5, 1952, and the first date of

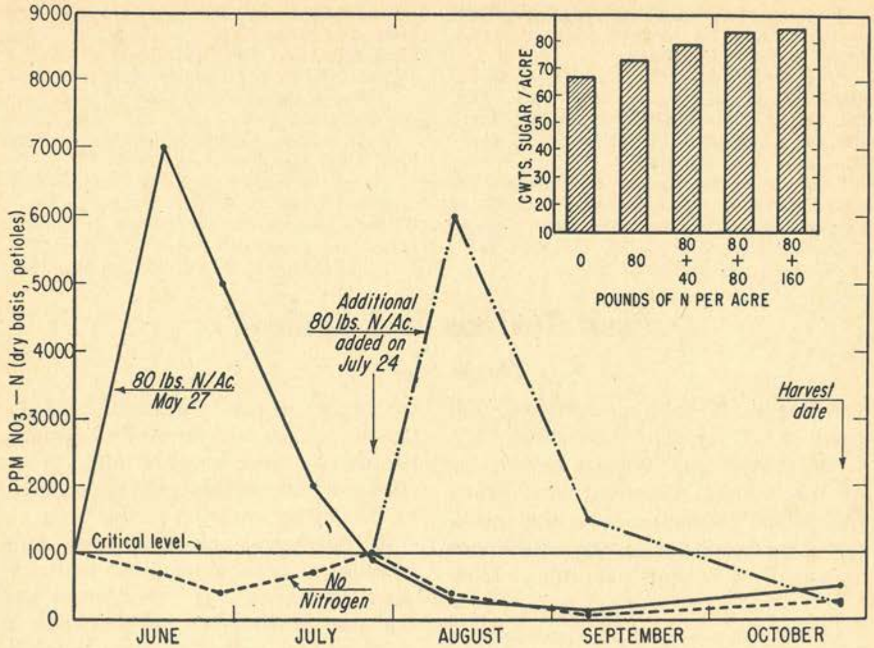

Fig. 6. Effects of fertilization on the nitrate-nitrogen content of sugar-beet petioles. Davis, California, 1952. The first petiole samples were taken on May 31, 1952. This was four days after fertilization but before water had been applied to the beets. The second set of petiole samples was taken after the beets had been irrigated. (Ulrich, Ririe, and Hills, "The Application of Petiole Analysis to Sugar Beet Fertilization," mimeographed circular, 1953. Fig. 1.)

petiole sampling was May 31, 1952. On this date the beets were already at the critical concentration for nitrate-nitrogen, and a nitrogen application was indicated. Phosphorus and potassium on this, and all other sampling dates, were well above the critical concentrations, and accordingly the appli-

TABLE I.—HARVEST RESULTS. DAVIS, CALIFORNIA, 1952.

Lbs. of N, P_2O_5, or K_2O per acre		Ton beets per acre	% sugar	cwts. sugar per acre	Increase in dollar return per acre[2]
May 27[1]	July 24				
0	0	21.1	15.9	66.8	....
80N	0	23.6	15.5	72.8	$11.50
80N	40N	25.9	15.1	78.2	28.25
80N	80N	28.5	14.7	84.0	44.25
80N	160N	30.4	14.0	84.8	38.00
$200P_2O_5$, 80N	160N	29.7	13.6	80.6	....
$200P_5O_5$, $200K_2O$ and 80N	160N	28.4	14.1	80.2	....
Significant.........	(19:1)	2.3	0.7	10.0	....
difference..........	(99:1)	3.1	0.9	13.4	....

[1] Applied shortly after thinning.
[2] Represents net gain over return from beets receiving no nitrogen. (Ulrich, Ririe, and Hills, "The application of petiole analysis to sugar beet fertilization," mimeographed circular, 1953, Table II.)

cation of the elements was not indicated.* After applying 80 lbs. of nitrogen per acre, the petiole nitrate-nitrogen values rose sharply and then dropped back to the critical concentration at the end of July. During this time the untreated beets remained below the critical value and were still below the critical value when the beets were harvested on October 23, 1952. The second application of nitrogen was made on July 24 at the rate of 80 lbs. per acre, and shortly thereafter the nitrate values were again high. The comparable plots with only one 80-lb. application of nitrogen per acre remained below the critical nitrate-nitrogen concentration for the rest of the season. The yields are given in Table I.

Answering Questions

Thus, by taking petiole samples at regular intervals, we have indeed answered to a large extent the question, or rather questions, asked by the beet grower. From the analyses it has been possible to learn what kind of fertilizer to apply, N, P, or K; when it should be applied; approximately how much to add; and finally, how often. This is not all that can be done for sugar beets through petiole analysis; it is also possible to determine the time of harvesting the crop so as to get the maximum production of sugar. When there is a choice of fields to be harvested, those fields that have been deficient in nitrogen the longest should be harvested first. Those fields still high in nitrogen should be left unharvested until the beets become deficient in nitrogen or until other considerations make it necessary to harvest the crop. By delaying the harvest of beets high in nitrogen, the crop continues to grow, and thereby beet-root weights increase. If through growth the beets deplete their nitrogen supply, they have a better opportunity to increase in sucrose content, since nitrogen-deficient beets are, as a rule, much higher in sucrose content than those high in nitrogen.

Quenching "Fires"

Plant analysis may be used also to put out "fires" or, more literally, to meet nutrient emergencies that have arisen in the field. An example of what can be done by teamwork between the laboratory and the agronomists in the field took place last year in one of the counties of California. There the Farm Adviser was requested by a beet grower to look at a field of beets that was yellow in spite of the fact that the crop had been fertilized recently with ammonium nitrate. Leaf samples of yellow beets and of green beets were taken to the laboratory for chemical analysis by the Extension Specialist in Soils and by a representative of the Department of Plant Nutrition, University of California. Incidentally, the only green beets in the field were those in a small area where rabbit manure had been spread in the field by the beet grower. The question to be answered: What did the rabbit manure supply to the soil that the rest of the field didn't get? The petiole samples were analyzed for NO_3, phosphate, and potassium, and the values for both samples were found to be well above the critical concentrations for these nutrients (Table III). Thus, the yellowing was not caused by a shortage of these nutrients. This might have ended the matter except for a suggestion from the Extension Specialist in Agronomy. He recalled kodachrome slides taken in that general area some years earlier showing yellow beets and green beets adjacent to each other. The yellowing of the beets had been corrected by the addition of gypsum to the soil. Accordingly, he suggested that the sam-

* As a part of the experiment, however, phosphorus and potassium in combination with 240 lbs. of nitrogen per acre were added to other plots. The conclusions drawn from the petiole analyses were confirmed when the beets were harvested, Table I.

TABLE II.—SUGAR-BEET LEAF ANALYSES, WESSNER FARM, BUTTE CO., JULY 7, 1953

Growth of sugar beets	Leaf analyses (dry basis)			
	(petioles)			(blades)
	NO_3–N (ppm.)	PO_4–P (ppm.)	K (%)	SO_4–S (ppm.)
Vigorous	2,520	2,120	3.15	1,880
Poor	9,000	2,900	3.80	155

ples be analyzed for sulfate as well. Fortunately, leaf blades as well as petioles had been collected, and the big differences in sulfate content of the leaves were found mainly in the blades (Table II).

On the basis of these findings, the Farm Adviser put out strip plots testing the conclusions that had been drawn from the results of the chemical analysis of the leaves. He observed shortly thereafter that there was a clear-cut response from the addition of ammonium sulfate, while from the addition of ammonium nitrate alone and gypsum alone the beets were no better than those in the untreated area. The chemical analyses of the petioles showed that in the meantime the beets in the untreated and gypsum-treated plots had become deficient in nitrogen, and this accounted for the lack of response of the beets in the gypsum plot even though the sulfate content of the petioles and blades had been increased tremendously. The beets in the ammonium-nitrate-treated plot were still yellow and were still low in sulfate even though the nitrate content of the petioles was kept high. Only in the $(NH_4)_2SO_4$-treated plot, where the beets were high both in nitrate and sulfate, had the yellowing been corrected. These relationships may be seen in Table III. A sequel to this episode is that during 1954 all but a few growers in the county used ammonium sulfate as a source of nitrogen, and it was only in those fields without sulfate that the yellowing again appeared.

TABLE III.—SUGAR-BEET LEAF ANALYSES, WESSNER FARM, BUTTE CO., AUGUST 11, 1953

Material	Treatments[1] lbs. per acre		Leaf analyses (dry basis)	
	N	S	ppm. NO_3–N (petioles)	ppm. SO_4–S (blades)
(Check)	0	0	640	750
Am. nitrate	200	0	7,600	295
Gypsum	0	484	580	13,600
Am. sulfate	200	242	1,350	11,000

[1] Applied by Morton D. Morse, Farm Adviser, Butte County, California, to single 4-row strips, July 20, 1953.

Bahia Grass Gains Favor . . .

(From page 20)

Fig. 3. L. D. Foles, Rt. 5, Hattiesburg, produced 500 bales of hay and 1,800 pounds of seed from 6 acres of Bahia grass on his farm in Forrest County.

has been planted in the past five years. Five years ago many counties in this section did not have any plantings. Today there are thousands of acres of Bahia in these counties. It has made it economically feasible to have improved pasture on many acres of land that heretofore have been questionable.

What will be the place of Bahia grass in our future grassland program? Time alone can give a definite answer to this question. But if the records of the past few years can be taken as an indication of things to come, then when you talk about summer pasture in this section you will be talking about Bahia grass.

I believe W. E. Lott, Chairman of the Jones County Soil Conservation District, gave a typical farmer reaction to Bahia grass when I asked him what he thought about it. Mr. Lott said, "I have 160 acres of pasture on my place. I have 100 acres of this in Bahia. I wish I had all my pasture land in it. It's the best grass I ever planted on my farm."

Farmers in central and in north Mississippi are now beginning to get acquainted with Bahia. There were several hundred acres planted in the upstate area. Indications now are this grass will be well suited to most of the soil throughout Mississippi.

Soil Testing in Oklahoma

(From page 22)

3. Previous cropping, fertilization, and management practices of the particular field.
4. Capabilities and limitations of the individual farmer in terms of capital, equipment, farming system, and experience.

As the soil sample is presented to the laboratory, the farmer fills out an information sheet giving details on his farming operation, past field history pertaining to crops and fertilizers, and intended use of the field. From this information, the chemical soil analysis, and the county agent's knowledge of the soil, the recommendation for a given amount of a particular fertilizer is made for the given area and crop to be planted. The recommendation also suggests specific soil management practices where applicable.

As a result of the State-wide soil testing program, a well-organized educational program on soil management and fertilizer use is possible. The use of commercial fertilizer is on the increase in Oklahoma (104,000 tons in 1948-49—171,000 tons in 1951-52), a large portion of which can be attributed to assistance given through the soil testing program. A carefully calculated estimate has indicated a need for more than 800,000 tons of plant food per year to no more than replace that which is hauled away from the farm in the form of crops and other farm products. With a soil-testing laboratory in each county, sufficient quantities of fertilizer available through local mixing plants, and a sound soil management program solicited by the majority of Oklahoma farmers, this goal should be realized within the next few years.

The Place of Fertilizer . . .

(From page 12)

mer Chief of the Soil Conservation Service, had this to say about the role of fertilizers in conserving soil: "Maintaining higher fertility levels and more vigorous plant growth constitutes one of the main steps in preventing loss of soils by erosion." Evidence of this is found in work in Illinois where soils which were made productive through the use of lime and fertilizer soaked up rain much faster than low-yielding, unfertilized soils. These studies indicated that land which was unfertilized during a 30-year period absorbed only .09 inches of rainfall in an hour, while adjoining land receiving good fertility practices during this period took up almost three times as much.

Emil Truog, Emeritus Professor of Soils at the University of Wisconsin, suggests six ways in which increased soil fertility may help facilitate soil conservation:[1]

"(1) High soil fertility produces a heavier plant growth that protects soil from washing and blowing.

(2) The heavy plant growth uses more water from the soil, thus allowing the soil to absorb more of the rainfall—thereby reducing soil and water losses by runoff.

(3) Fertile soil is in a better physical condition to take in water from rainfall—thus cutting the amount that runs off.

(4) Higher soil fertility increases crop yields on the more level fields, thus reducing the need for growing row crops on sloping fields—where soil erosion takes a heavy toll.

(5) By improving the fertility of our soils, we make it possible to grow needed quantities of the common agricultural crops on fewer acres, thus releasing more land for forestry, wild life, and recreation.

(6) The increased yields from soils of high fertility provide the farmer with money for installing terraces, waterways, and gully controls, and other conserving practices."

[1] What's New in Crops and Soils, February 1950.

Reclaiming Deteriorated Soil

Erosion and harvested crops are removing nutrients from the soil much faster than they are being replaced through fertilizers. Results of a study made by the Soil Conservation Service indicate that the replacement of plant nutrients in fertilizers and manures for the United States as a whole amounts to only 16% of the nitrogen removed by harvested crops and erosion, 20.3% of the phosphorus, and 2.1% of the potash. Despite such evidence of shortage in maintaining levels of plant nutrients in the soil, it is comforting to know that fertilizers can serve very effectively in reclaiming lands which have deteriorated from erosion and poor management.

Recent work from Illinois illustrates how effective fertilizers may be in rapidly rejuvenating a soil which had not been fertilized for more than 80 years and had been planted continuously to corn all this time. Certain treatments were established on plots at the University of Illinois in 1876 and were continued until last year. In 1955 these plots were split and adequate fertilizer and lime applied to one half of the plots in an effort to determine how rapidly they might recover from past intensive cropping and lack of fertilization. Last year yields on the fertilized plots were 86 bushels—approximately 150% higher than on the unfertilized plots and about four times as high as the 80-year average for the plots unfertilized and planted to continuous corn. Corn on the plots fertilized with lime, phosphorus, and manure "as needed" and planted to a rotation of corn, oats, and a legume during the previous 80 years yielded 100 bushels.

A significant fact about this experiment is that the soil was able to recover in such a short time from the long abuse of continuous cropping and absence of fertilization. The first year that lime and fertilizer were applied, this soil was able to produce yields that were almost 90% as great as the maximum yields obtained on the plots receiving good management (rotation and fertility) over the entire 80-year period.

An experiment in Ohio further demonstrates the effectiveness of fertilizers in reclaiming land where the topsoil had been completely removed to simulate intensive erosion. In this study, research workers using mechanical means completely removed the surface eight inches of soil, leaving exposed subsoil which was extremely low in organic matter and certain nutrients. Lime, fertilizer, and manure were added and a four-year rotation of corn and wheat followed by two years of alfalfa was established. Three years after the surface soil had been removed, the first-year alfalfa yielded 83% as much as the alfalfa growing on the normal soil which had received similar fertility treatments. Five years after the topsoil had been removed, corn following one cycle of the rotation yielded 86.1 bushels.

Experiments such as those in Illinois and Ohio illustrate quite vividly the effectiveness of proper use of fertilizers and lime in helping to overcome in a relatively short time the effects of poor management leading to the deterioration of soils.

Summary

Some of the major contributions which fertilizers are making to the productivity of soils, and ultimately to the over-all agricultural economy, can be summarized as follows:

(1) Fertilizers have enabled farmers to increase greatly crop yields, facilitating more efficient production and increased net returns.

(2) By facilitating higher, more efficient production, fertilizers have contributed much to the over-all economy and general prosperity of the American people.

(3) Through proper fertilization, the

fertility and ultimate productivity of soils may be increased, even under intensive cropping.

(4) Proper fertilization helps to protect land from erosion and to reclaim land which has deteriorated as a result of past erosion and poor management.

The late President Franklin Roosevelt once said, "The history of every nation is eventually written in the way in which it cares for its soil." Certainly, fertilizers are contributing much to the protection and maintenance of soil—the greatest of all natural resources.

Cover Your Garden

COVER your garden this fall for better crops next year, Eugene Wittmeyer, Ohio State University Extension Horticulturist advises gardeners. He says a cover crop will add organic matter to the soil, increase its water-holding capacity, and make it easier to work.

Seed 1 to 2 pounds of ryegrass, or 3 to 4 pounds of rye per 1,000 square feet. These cover crops may be seeded between the rows after the last cultivation. Ryegrass should be seeded by September 15 in central Ohio, while rye may be seeded later. The sooner it is sown the better cover it will give.

Wittmeyer says 10 to 15 pounds of a complete fertilizer like 4-12-8, 4-16-18, or 5-10-10 per 1,000 square feet will give heavier cover. The fertilizer should be applied before seeding of the cover crop.

Long-gone Summers

(From page 5)

munched on sandwiches and hunks of fruit pie, washed down with lemonade from a preserve jar. Then on we went, only about 12 miles from home, through somnolent, fragrant, brush-lined lanes. We seldom met other travelers on weekdays when farm folks were occupied afield. In late July, grain harvest was booming. We had an alarming thing to think about. We might meet the belching, rattling traction engine. The threshing crew had frequent moves to make, and we hardly ever escaped the consequences of a frightened nag. Thereupon it was my duty to hand Mother the reins while I went and held the halter strap as we met and passed the snorting monster.

Just before we came to Merrimac and restful communion, Mother would direct me to drive a mile off the main road to visit a little weedy country cemetery. Here among the long-neglected graves and the sighing pines, she would locate the one of a small sister who had died in that long ago when the settlement was new and raw and young ones were prone to leave this world before their time. She usually stopped to gather some coarse wild blossoms to put upon the small mound, while the robins sang and the chipmunks chattered at our intrusion in a spot of rest and rural oblivion.

The dignity of becoming a brother-in-law and an uncle was accorded to me in one gorgeous summer, in double-quick time. It made a lasting impression on a teenager. The newlywed was the afore-mentioned brother, and he wrote us that our home was to be first on the honeymoon agenda. Father hunted up his stiff derby hat, wore his boiled white Sunday shirt, and Mother pressed his pants. Then he brushed off the buggy seats, curried off old Pike, and headed solemnly to the depot fully two hours before train time. Why through all these years do I keep a vivid mental picture of Father, sitting so stiff and straight, trying hard to look important and jolly-welcome at the same time? Why did I dislike to see those turtledoves cooing and smooching after he brought them home? Why did I resolve then and there never to be as foolish myself?

MY unexpectedly becoming an uncle was the result of my sister's marriage to a capable school principal in a rural town. Soon after the baby came, she toted her down to see her next of kin. I used to poke at the baby and grin foolishly, bring it grubby bouquets from the cow-pasture arboretum, and loudly brag to all my pals that being an uncle was no easy degree to acquire. No doubt I felt the thing more forcibly because all my own uncles were graybeards, and I had come to believe that there existed some minimum age limit to a chap's filling such a responsible and looked-up-to job. The only occasion that beats it for inward pride happened after I had walked through the silence of a June night to learn that the greatest of life's attainments had blessed me with fatherhood.

That old silvery lake over there in the hollow was put there to tempt boys with chores to do and errands to run. I've seen some of the world's finest waters since, but nothing like the pull behind the dazzle of those native wavelets. Earl and I had an old rowboat somebody donated. We used to dig angleworms for bait and buy some line and sinkers and a few hooks. Then we pushed the old scow from shore and heave-ho'd for the best fishing grounds. Mostly we got sunfish and perch, sometimes a few bass. At other times we sneaked along the shore armed with flat board flails to get some frogs. After such harvests we built a roaring bonfire where we did our frying and lip-smacking over tender white muscle. Then, let it be known at this distant day, we often hid in the thick bushes above the lake to learn more about anatomy when the girls went in bathing. All I can say now about this diversion of ours is that, like the byword of the cartoonist, we were simply "born too soon." Ignorance of anatomy nowadays excuses nobody, unless he be stone blind.

There was a steep railway embankment near our homes. Earl and I decided to turn it to practical use. We dug into the bottom of the bank about six feet, got some old boards to cover the hole, put old canvas on the cave bottom and lugged in a soap box in which to keep our treasures. We traded dime novels and pretended that secret perusal of them was expected of us. I never heard either of my folks berate the effect of Diamond Dick or Liberty Boys on the culture of the rising generation. But with us there had to be a feeling of hazard and sin within us to make that old, damp railway dugout a happy reality.

WHERE can you beat the innate enthusiasm and devotion manifest by upper teenagers during carefree high school days? Almost free of all inhibitions, they meet each morning with the zest and ardor that only our community educational system and its many-sided privileges can bring. Just as the balm of spring enters into the pulsating growth of summer, they finish the term and face a new one. So it is quite natural that we remember the chums of those thrilling times and the triumphs we shared as brief actors on the classroom scene.

When they chose me to give the junior response to the seniors on the front platform, I took the assignment with serious attention. Using old five-cent tablets, I scribbled out ideas from classmates concerning the sharpest barbs and insults aimed at certain bigwigs among the graduates. In a week the script was ready for teacher review and rehearsal. Finally, we sat in an alcove decorated with lavender and white class colors. I waited in shivering anxiety for the summons to go up front. My strength to proceed was the knowledge that Mother and her friends were in the crowd, and I couldn't let them down. You would scarcely believe it, yet I recall the opening salute I gave them, corny as it was:

"Most potent, grave, and reverend seniors, our worthy and approved good masters, our class of 1907 has the temerity to address you." When I got back to my seat, the cutest lass in our class held up to me a sweet nosegay of roses in appreciation of my utter nonsense. When our class marched to the rostrum the next year to get our diplomas, somebody else made the sage remarks and prophesies. That year I had a minor part in the class play—you guessed it—"Charley's Aunt."

YES, there are many departed summers to bring us back to life's early pleasures. But as a trace of Scot lurks in me, I can point with special interest to the financial outlay attendant on treating your best girl on those starlit evenings so long ago. Our movie fee was 10 cents each at the corner nickelodeon. Our twin dishes of chocolate nut sundaes cost 15 cents each; and if you then felt momentarily rich, an open-sided streetcar ride out and back could be had for 40 cents all told.

No parking worries, no expense for gas and oil, no dollar theater tickets, and no elaborate midnight lunches. We who had those simpler advantages possess just as tender memories of joyful companionship as anyone might envy.

All that mars our contemplation of long-gone summers is the sense that something has gone from the sunshine and something is lost from the earth. One by one, those fond companions fade into the mists of the precious past —and all that is left is a breath, and a song and a dream.

Brooklynite: "What did you do in civilian life?"

Buddy: "Worked in Des Moines."

Brooklynite: "Coal or iron?"

* * *

They walked along the beach, holding hands and laughing like two unsophisticated children. Suddenly she turned to him and held out her arms. He drew her close to him, kissed her with all the first fires of passion. No one would have guessed they were married.

They weren't.

* * *

A visitor to a very famous Scottish golf course had an exalted opinion of his ability as a golfer. On his first round he succeeded in burying his ball in every bunker, gully, and burn on or near the links. "Really," he exclaimed to his caddy, "this is the most exasperating course I have ever played."

"But how can ye say that, sir?" the caddy questioned with typical Scottish candor. "Ye havnae even been on it so far."

* * *

The meanest man in the world was the ventriloquist who threw his voice under the old maid's bed.

* * *

Bobby's manners were gradually going to the dogs, despite his father's many attempts to reform. "Bobby, will you have some toast?" said his father one breakfast-time. "No," said Bobby. "No what, my boy?" "No toast."

One of the more hopeful presidential aspirants recently visited the Ozark Mountains and was gratified when one of the residents inquired, "Say, mister, ain't I seen you somewhere?" Modestly he replied, "Quite possibly you have seen my picture; it has been in the papers now and then." "I knowed it, I knowed it," the native ejaculated. Then he added, curiously, "What was it you was cured of, mister?"

* * *

In their bathing suits, many girls remind you of a bad photo. They're under-developed and over-exposed.

* * *

It is true that both men and women are wearing the same kind of jeans, but the over-all effect is different.

* * *

Bragging about his uncle's promotion, a small boy said, "The longer he stays in the Army the ranker he gets!"

* * *

A motorist travelling through the backwoods of Kentucky pulled up at a general store to ask one of the natives sitting on a tilted chair out front, the way to Louisville.

"Wal," says the hillbilly, "You keep on the way your a goin' until you come to a . . . naw, that ain't right. Lessee . . . you go back this here road till you git past . . . naw, that ain't right neither." The hillbilly scratched his head reflectively a few moments more. "Gol dang it, mister . . . you cain't git to Louisville from here."

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