Better Crops WITH PLANT FOOD

Number 1—1969

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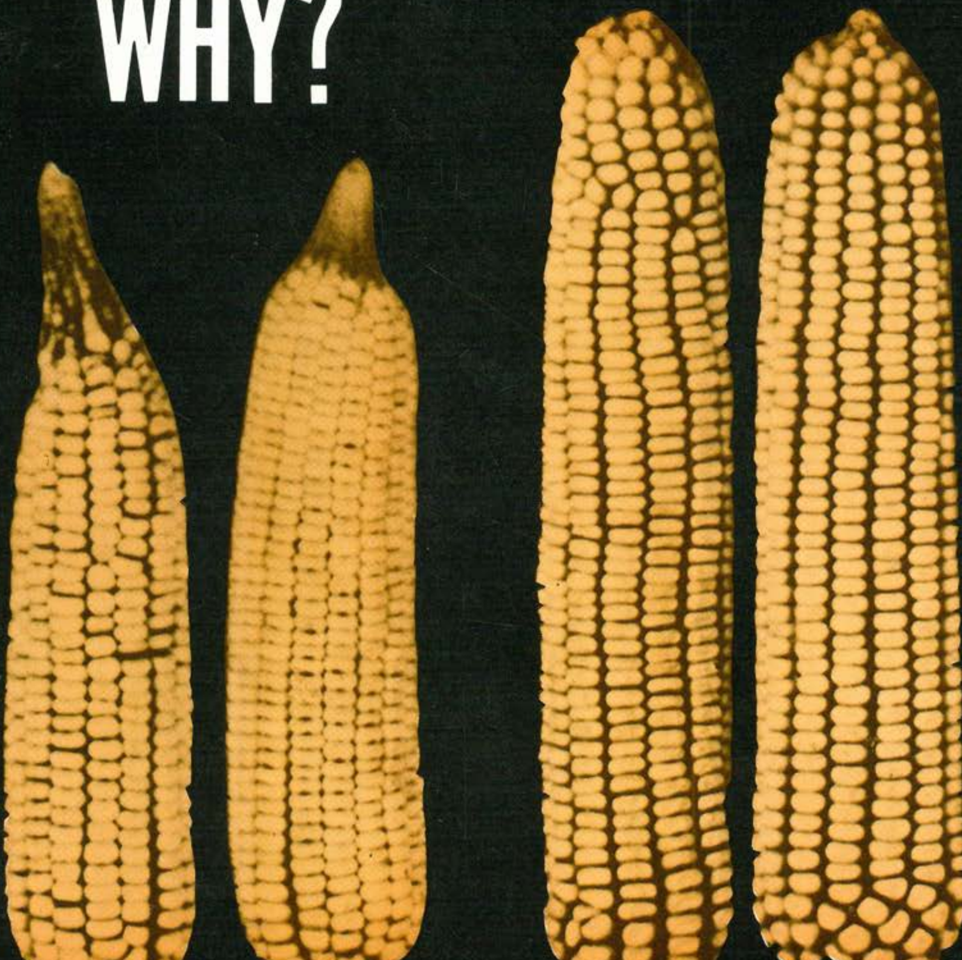

This Grower Didn't Give His Nitrogen Enough Potassium Muscle

This Grower Gave His Nitrogen Plenty Of Potassium Muscle

MAKE YOUR K MUSCLE O.K.

Now Going The Rounds

Now Going The Rounds

GUIDE FOR EVALUATING EMPLOYEE PERFORMANCE

Performance Factor	Far Exceeds Job Requirement	Exceeds Job Requirement	Meets Job Requirement	Needs Some Improvement	Does Not Meet Minimum Requirement
Quality	Leaps tall buildings with a single bound.	Must take a running start to leap tall buildings.	Can leap over short buildings only.	Crashes into buildings when attempting to jump over them.	Cannot recognize buildings at a glance.
Timeliness	Is faster than a speeding bullet.	Fast as a speeding bullet.	Not quite as fast as a speeding bullet.	Would you believe a slow bullet?	Wounds self when attempting to shoot.
Initiative	Is stronger than a locomotive.	Is stronger than a bull elephant.	Is stronger than a bull.	Shoots the bull.	Smells like a bull.
Adaptability	Walks on water consistently.	Walks on water in emergencies.	Washes with water.	Drinks water.	Passes water in emergencies.
Communications	Talks with God.	Talks with the Angels.	Talks with himself.	Argues with himself.	Loses these arguments.

Better Crops
WITH PLANT FOOD

The Whole Truth—Not Selected Truth

Published Quarterly by
The American Potash Institute Inc.

1649 Tullie Circle, N.E.
Atlanta, Georgia 30329

Santford Martin, Editor
Selma Bushman, Assistant Editor
Barbara Martin, Circulation

Vol. LIII No. 1 1969

$1.00 per year, 25¢ Per Copy

Controlled circulation postage
paid at Washington, D. C.

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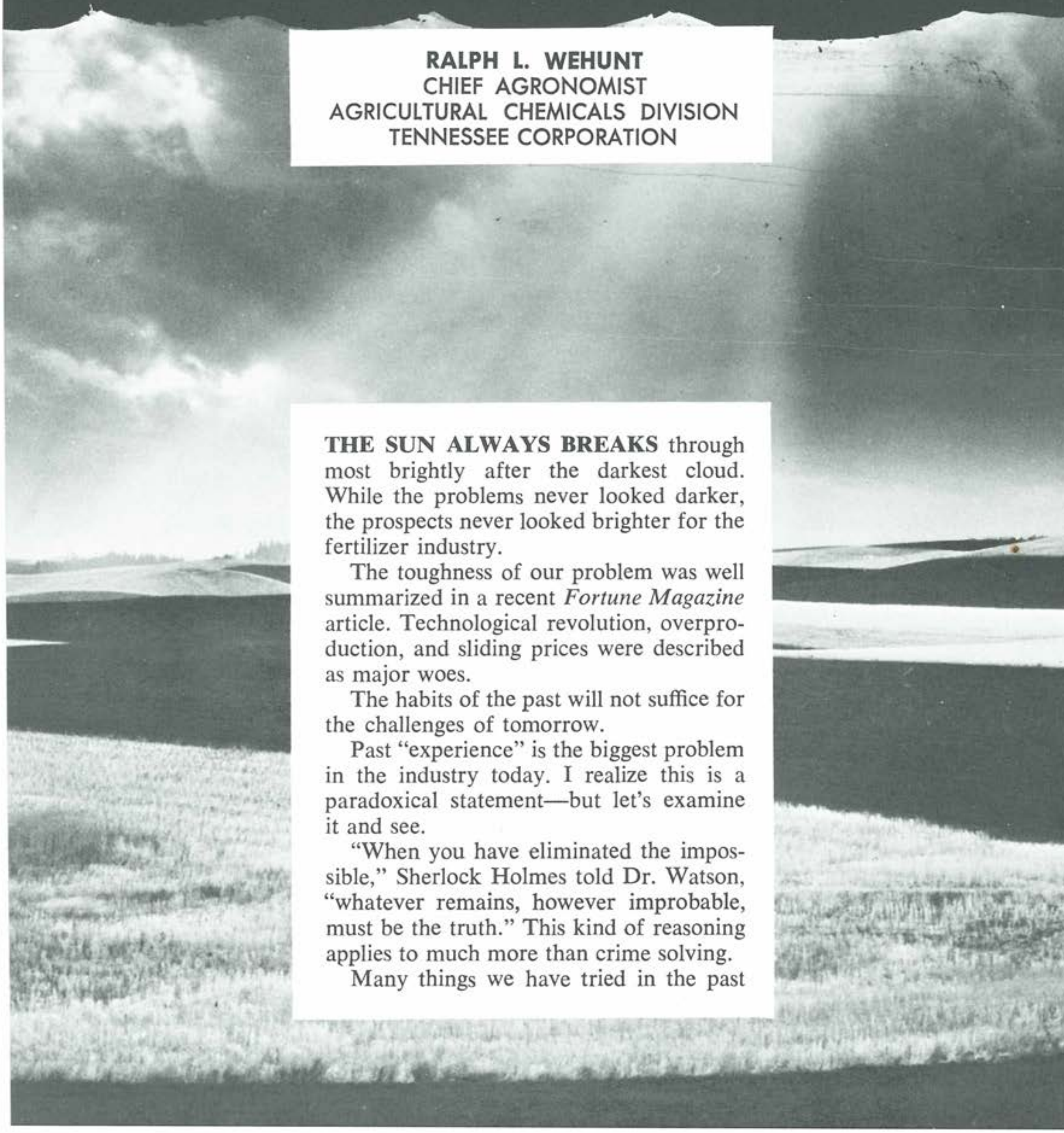


RALPH L. WEHUNT
CHIEF AGRONOMIST
AGRICULTURAL CHEMICALS DIVISION
TENNESSEE CORPORATION

THE SUN ALWAYS BREAKS through most brightly after the darkest cloud. While the problems never looked darker, the prospects never looked brighter for the fertilizer industry.

The toughness of our problem was well summarized in a recent *Fortune Magazine* article. Technological revolution, overproduction, and sliding prices were described as major woes.

The habits of the past will not suffice for the challenges of tomorrow.

Past "experience" is the biggest problem in the industry today. I realize this is a paradoxical statement—but let's examine it and see.

"When you have eliminated the impossible," Sherlock Holmes told Dr. Watson, "whatever remains, however improbable, must be the truth." This kind of reasoning applies to much more than crime solving.

Many things we have tried in the past

have been impossible of success. The old marketing concept—where production is the hub, the means is selling and promotion, and the end is profit through sales volume—has led a fine industry into a mess.

But, so far, we do not want to pay the price for making the farmer the hub, integrated marketing the means, and profit still the end—*but through customer satisfaction!*

Let's face it. This approach would eliminate our production-minded philosophy. Integrated marketing would cause some local distributors to give up their "proven" way of doing business.

We do not want to pay the price for upgrading our employees to better serve the farmer, which would mean spending on education for intellectual growth.

But, in the end, the price of retaining our old habits will be incalculably higher.

In my opinion, the fertilizer industry can no longer be a passive response system, operating entirely out of past knowledge, adapting to forecasted demands of its environment. It must become a dynamic, creative enterprise of people working together to develop new possibilities.

"FACTS" HAVE GOT US DOWN. No other large industry has let "facts" mislead it as much as the fertilizer industry has in recent years. Corporate planners were dazzled by what seemed to be obvious need for huge quantities of fertilizer.

So, in the past five years, U.S. companies spent more than $4 billion to build fertilizer mines and plants, to erect complex transportation and distribution networks, and to assemble wholesale and retail outlets. In this process, they forgot to do some basic market research. They did not see the big gap between what people need and what they can afford.

Production facts can be misleading when not related to market facts. Most of our analysis continues on the surface. We are enslaved by the "nuts-and-bolts" character of our business.

We are enslaved by the routine of daily affairs. Always moving "forward," usually in a circle, right back to the place we started—where the HUB is production,

SERVICE WORTH SELLING!

". . . PERHAPS the time has come when companies should take a completely candid look at service costs and explore the possibility of selling these more costly services.

"Just as a good customer is willing to pay a somewhat higher price for fertilizer to a company which gives good services we feel that the farmers of the future will be willing to pay for more of the services which they feel they need but might resent paying for them in the price of their products if they decide they do not need the so-called 'free' services.

"What I am saying is that there are some services which are an essential part of the product and product use and others which are not. These two classes should be correctly identified and the supporting services which are not really part of the product should be offered on a commercial basis.

"Some potential future services such as whole farm programming, tissue analyses, soil nitrate levels, etc., have not been worked out well —perhaps not yet well enough to adopt on a widespread basis. I would suggest that fertilizer marketing directors consider supporting the applied research needed to make these services a reality.

"Part of this research should be in the company shop, but a large part would be more efficiently done in cooperation with universities. Agricultural colleges need industry financial and political support to get the resources to do the job efficiently and on time."

From address by John Pesek, Head of the Agronomy Department, Iowa State, at American Society of Agronomy.

the MEANS is selling and the END is profit through sales volume.

Our tendency to avoid more enlightened understanding of marketing is natural. We contend "deep" things are sophisticated things, when the mark of real depth is its simplicity. We say, "This scientific approach to farming is too deep for me—I can't grasp it."

We are deceiving ourselves. It's not because it is too deep, but because it's too uncomfortable! Many so-called "experienced" people in our industry shy away from "the scientific approach," because it is easier and more comfortable to move material to the farmer the way they have always "sold" him.

The marketing concept that makes the customer the hub of the action, integrated marketing the means, and profit still the end, but through customer satisfaction, is more sophisticated. That's true. But it is ALSO more simple when organized right.

In the long run, such marketing approach will pay both the farmer and the fertilizer industry much more profits.

How do we approach the market this way? **Marketing, essentially, is a people business.** It involves imponderables—and dilemmas. So, we are really dealing with human behavior rather than fundamental economics. Our marketing procedures and progress depend greatly on how people act and react and our ability to follow this behavior.

The economics must be sound, of course, but economics is not enough.

To develop successful programs, we must abandon our intellectual defense—and go to more personal levels. It's easier to deal with budgets and production schedules than with people. But marketing and educational programs must cater to that paradox called man.

"Processed" information failed to show that underdeveloped countries CANNOT change from subsistance farming to a North American style of high capital-high fertilizer agriculture without major cultural and psychological adjustment.

Our real need is less reverence for "pure facts" and more understanding of the human being receiving those facts.

THE MARKET IS FOLKS. As an agronomist most of my experience has been devoted to organizing people in massive educational programs. With this background, I relate to the people side of marketing.

Marketing has long been the neglected stepchild of this industry. While the industry can boast of exciting new production —1,000 tons per day ammonia plants and new phosphoric acid processes—what marketing innovations can it cite?

Tired old methods are usually used over and over.

Unlike production innovations, coming through systematic and carefully coddled research, marketing innovations have come unsolicited, unplanned, and often as accidental by-products of some product development project.

Bulk blending is a good example of an unsolicited marketing endeavor.

During the past five years, when $4 billion was spent by the industry, how many man-hours were devoted to production and distribution innovations, how many to marketing innovations? The comparison might well shock us.

Because marketing so intimately involves human beings, its very nature is fundamentally different from the nature of the production problem. Marketing demands a different temperament than production needs.

Production follows a logical line of reasoning that works best in factual situations. Marketing people must follow their instincts and intuitions.

In companies where this fact is not appreciated, the situation usually leads to poor, unprofitable sales, large pile-ups of materials, and high administrative costs such as we now have in many phases of the fertilizer industry. Extensive Harvard research reported this.

MARKETING IS DYNAMIC. The change is so continuous and so widespread that it makes every plan virtually out-of-date before it is launched. The four walls of a plant may house a manufacturing problem, but scarcely can they confine a marketing problem.

Machines, materials, and skilled men are the usual elements of a production problem. But the uncertain attitude of distant retailers and customers dominates most marketing opportunities. Unless the retailer's and customer's habits, motives, and feelings are considered, the best production plans are limited.

When I was in public work before joining industry, I had the opportunity to visit many fertilizer companies. And I was continually impressed—or, more accurately, appalled—by the tendency of planners to simplify, to reduce to rules, to rush human changes, and to run out with programs before anyone understood what goals they were running toward.

Systematic thinking—yes. Efforts to analyze a problem—yes. But to attempt to apply to marketing what has worked in production—an emphatic no! You simply cannot make hundreds of human beings respond like well-meshed gears in our newest, finest production equipment.

Why has the fertilizer industry so underrated its marketing opportunities?

There are many reasons. Until recent years, the industry concentrated full attention on production and largely let the state agricultural extension services promote the use of its products. So we largely ignored the human side of the problem, except working with local dealers.

Such lack of contact with farmers—the industry's ultimate target for success—encouraged selling, not marketing. Being a more sophisticated and complex process, marketing was generally ignored.

Modern management experts say the difference between marketing and selling is more than semantic. Selling focuses on the needs of the seller, marketing on the needs of the buyer.

But building an effective customer-oriented company involves far more than good intentions or promotional tricks: Developing a sound marketing approach requires as much "design and development," as much knowledge, work and money as designing a good production system.

OUR GREATEST NEED is the capacity to see the marketing development approach as a WHOLE. It's not easy. It can create tensions and friction from questions raised. It can overturn deeply entrenched habits.

But eventually it builds understanding and agreement, as you begin to go more strategic and less operational—as one plan, one strategy, one master schedule dominates, subordinating and superimposing all others.

In other words, marketing becomes a team of coordinated forces that make things happen such as training, advertising, demonstrations, exhibits, and organized farm calls.

Very careful attention must be paid to planning the knowledge phase of marketing, such as agronomics. Sad to say, most of us have been brought up as functional doers. The transition from doer to planner is not easy. So we continue to have vague notions of direction, heavy preoccupation with day-to-day "doing" and gross neglect of goal setting and making specific plans to achieve goals.

OUR FUTURE DEPENDS on end-use technologists. As the fertilizer industry switches from production to marketing—from things to people—a major task will be finding the right people.

Modern agriculture will demand a technical "know-how" of almost undreamed of dimensions. The changes are moving today faster than we realize.

Future services will go far beyond fancy slogans and catchy gimmicks, beyond soil testing and custom spreading.

In the future, production knowledge—money-making services to help farmers shoot for yields that will put them in the top 10% of growers in their area—will be as important as the product. Since this is so, we will, like medical doctors, have to charge farmers for certain services. Research shows they are willing to pay for those services they need.

Will the industry meet this challenge? If so, it will have to give much greater attention to the end-use technology of its products. Also, it will have to give end-use technologists—agronomists, horticulturists and plant physiologists—significant rank and authority in the policy and decision-making setup of the industry. Unless this is done, the fertilizer industry will soon be largely makers and haulers of fertilizers at a bidder's price.

The end-use knowledge people will then be working for large farmers, farm management organizations, and farm consultant groups of their own, in addition to the many opportunities in public service. In other words, in one way or another, the future of this industry today lies more significantly in the hands of end-use technologists than ever before in its history.

This question is one of the most fundamental facing the industry. Will it form its own end-uses forces within the industry or will it be at the mercy of end-use forces outside of the industry? Battle lines are already beginning to form with the trend to corporate farming and the formation of more and more farm management-consultant groups.

Even if the industry gives "more-than-lip-service" to the end-use technology question, it still faces an uphill battle. Industry's past history of fast starts and equally fast finishes with agronomy programs has created an unfavorable image among end-use technologists.

Also, there is a great demand for end-use technologists in many areas—jobs are plentiful for good men! The demand far outstrips the supply in training, and pay in public service today is generally as high or higher than in industry.

These problems are not unsolvable. In fact, our industry has a real opportunity to obtain and keep young men now. But like other industries, it cannot do it too readily under present working conditions. This means some basic questions must be asked and answered truthfully.

WHAT MOTIVATES end-use technologists? Recent research has shown that, while not insensitive to money, this is not a prime motivating factor. The main influence is the work itself, the substance of the job.

Dr. Harry Livinson, clinical psychologist and head of Menninger Foundation Division of Industrial Mental Health, says his extensive work with young executives and scientists shows several important factors.

These young men say:

1—"Give me more responsibility, do not supervise me so much."

2—"Involve me more and give me more responsibility for what's going on."

3—"I want to be really in on things, don't conceal your feelings from me."

The toughest part of our problem is to convince ourselves that these young people have something important to say to us. But listen we must—if we want them in our industry. The campus grapevine is an effective communication system. If we have a meaningful program, fine; but if we don't, students will talk us down.

THE KEY FACTOR to obtaining and keeping end-use technologists is challenging work. To those with advanced training, this work must be stimulating and creative. Since every knowledge worker makes decisions of economic importance, he must know what performance and results are needed.

In turn, the knowledge worker must be "excited." He cannot be too closely supervised. He must largely direct, manage, and motivate himself. And that he will not do unless he can see how his knowledge and work contribute to the whole business. With this understanding he will work long, and to him, happy hours.

No industry has more challenge to offer graduates than the fertilizer industry. Our mission is highly stimulating. And by changing some of our structure and strategy, I believe we will obtain and keep the "end-use" personnel we must have for success. I have seen end-use technologists come and go—some for good reasons—but I have never seen one go because of too much challenging and interesting work.

Our opportunity is to get our present and future employees absorbed in cutting the mustard, and provide them with plenty of mustard to cut in a business that's worth belonging to.

After all, all business has is people, and if we can find better ways to develop the human potential, we will make a profit in this industry. Because of this important fact, we will, in the future, be thinking about how productive an organization is in psychic terms as well as in economic terms. An individual, as an individual, is the sole source of strength and meaning for an organization. An organization can grow only as he grows.

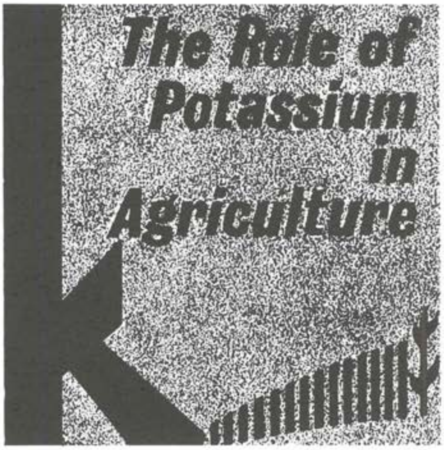
IN SUMMARY, this industry, despite its present difficulties, has opportunities now and even more in the future. We must pay more attention to the human side of the "facts," organize more productive marketing skills and bring end-use technologists in to both decision-making and market-development programs.

Ralph Waldo Emerson might well have been thinking of our challenge in the industry when he wrote:

"If there is any period one would desire to be born in, is it not the age of revolution, when the old and the new stand side by side and admit of being compared; when the energies of all men are searched by fear and hope; when the historic glories of the old can be compensated by the rich possibilities of the new era?

"The time, like all times, is a very good one if we but know what to do with it."

THE END



LIFE WOULD CEASE without it—human life, animal life, plant life. No one can read the new book, *The Role of Potassium in Agriculture,* without realizing what a vital mission this element has in today's agriculture.

Published by the American Society of Agronomy, Crop Science Society of America, and the Soil Science Society of America, the book can safely be called the world's most complete discussion of potassium today.

In 536 pages . . . through 100 tables and 145 line sketches and photos—27 authors carry the reader into the bowels of the earth and to surface salt flats to explain how potassium is recovered and what our reserve supply looks like.

They show how this element works in the soil, how plants absorb it, and how it interacts with other ions.

They report the role it plays in plant photosynthesis and respiration and how it affects

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Potash made the difference to the NPK team (150N, 100 P_2O_5, 240 K_2O kg/ha) in this trial.

Potash Gives Sweet Potatoes

CONDENSED FROM A.C.T. HO REPORT

SWEET POTATO is one of the most important corps in Taiwan. Its planted acreage is only second to rice. C. Y. Sheng's work has revealed that fertilizer application is one of the important factors in attaining the highest yield per unit area.

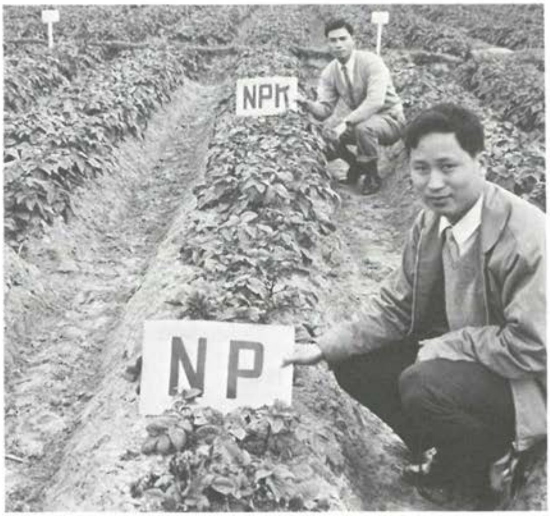
In past experiments optimum nitrogen rates increased root yield, while excess N promoted formation of tops but decreased root yield. Phosphoric acid has not affected yields so far. But potash has proved very effective in increasing root yields.

The trials reported here sought to find the most profitable potash rate for some soils in Taiwan's main sweet potato producing area, Tainan.

METHOD—These experiments were carried out in four localities: Kwantien and Paiho in 1962/63 and Hsinshih and Kweijen in 1963/64.

Table 1: Analytical data of soil samples

Locality	Soil	Texture	pH	Organic matter (%)	C.E.C. (me/100g)	Exch. K (ppm)	Non-exch. K (ppm)	Bray 2 Available P (ppm)
Kwantien	topsoil	L.	6.1	0.82	9.91	52	327	9.4
	subsoil	L.	6.9	0.72	10.82	53	331	9.4
Paiho	topsoil	S.L.	5.2	1.16	7.02	47	108	7.0
	subsoil	S.L.	6.4	0.76	4.35	63	129	3.9
Hsinshih	topsoil	L.	6.1	0.96	4.53	35	245	19.0
	subsoil	L.	6.7	0.71	5.47	25	255	20.5
Kweijen	topsoil	L.	5.9	1.36	9.10	66	294	7.6
	subsoil	L.	6.6	0.99	8.60	52	384	7.0



. . . where best potash rates boosted root yield from 12 to 27%, all with high statistical significance, except one locality.

. . . where net profits of NT$800-3,200 per hectare were obtained from added potash.

A Big Lift! IN TAIWAN

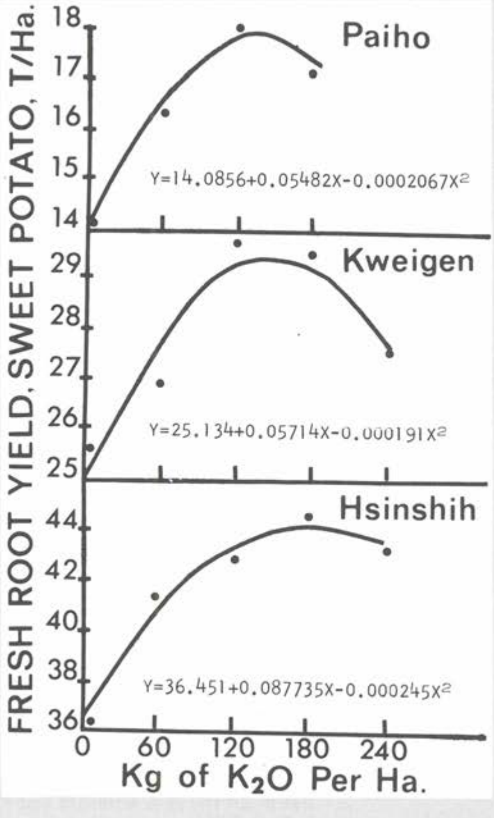
In 1962/63, 4 levels of K_2O were used: 0, 60, 120 and 180 kg/ha, laid out in a randomized block design with 6 replications. Rates of N and P_2O_5 were fixed at 60 and 50 kg/ha, respectively.

The size of the plots was 6.25m x 10m = 62.5m², with 125 plants in 5 beds. The distances between beds and between plants were 1.25 and 0.4m, respectively. The border beds were not excluded in the yield recording.

In 1963/64, 5 K_2O treatments were used: 0, 60, 120, 180 and 240 kg/ha, laid out in a randomized block design with 6 replications in Hsinshih and 5 replications in Kweijen. Rates of N and P_2O_5 were fixed at the previous year's levels: 60 and 50 kg/ha, respectively.

The size of the plots was 4m x 9m = 36m² with 120 plants in beds in Hsinshih and 4m x 11.4m = 45.6m² with 152 plants in 4 beds in Kweijen. The distances between beds and between plants were 1 and 0.3m, respectively. Border beds were not used for the yield calculation.

The fertilizers consisted of potassium chloride (60% K_2O), calcium superphos-



Yields rise with rising potash use.

Table: 2 Yields of Fresh leaf and vine

Locality	K_2O (kg/ha)	yield (ton/ha)	differences				L.S.D.	Indices
Kwantien	0	14.10	−0.73	−0.45	−0.13			100
	60	13.97	−0.60	−0.32				99
	120	13.65	−0.28				N.S.	97
	180	13.37						95
Paiho	0							
	60							
	120							
	180							
Hsinshih	0	16.28	0.98	0.37	2.50	0.79		100
	60	17.07	0.19	−0.42	1.71			105
	120	18.78	−1.52	−2.13			N.S.	115
	180	16.65	0.16					102
	240	17.26						106
Kweijen	0	20.26	0.06	0.00	0.11	−0.42		100
	60	19.84	0.48	0.42	0.53			98
	120	20.37	−0.05	−0.11			N.S.	101
	180	20.26	0.06					100
	240	20.32						100

phate (18% P_2O_5), urea (46% N in 1963/64) and ammonium sulfate (21% N in 1962/63).

Half of N and K and all of P fertilizers were applied in bands at the time of planting. The remaining N and K were topdressed one month after planting.

Tainung No. 31 was selected as indicator variety. Table 1 shows how the soils of each field tested before planting.

RESULTS—In the 1962-63 experiments, sweet potato was damaged seriously by frost, which resulted in a rather poor root yield. In 1963-64 experiments, the root yield in Hsinshih was higher than in Kwei-

Table 3: Yields of Fresh Root and Net Profits from Potash Application

Locality	K_2O kg/ha	(ton/ha)	Differences				L.S.D.	Indices	Net profit NT$
Kwantien	0	14.56	1.81	1.75	1.27			100	—
	60	15.83	0.54	0.48			N.S.	109	716
	120	16.31	0.06					112	800
	180	16.37						112	548
Paiho	0	14.91	2.97**	3.80**	2.14*			100	—
	60	16.33	0.83	1.16			1% 2.74	115	1,412
	120	17.99	−0.83				5% 1.98	127	2,440
	180	17.16						121	1,476
Hsinshih	0	36.30	7.08**	8.19**	6.66**	5.00**		100	—
	60	41.30	2.08	3.19	1.66		1% 6.43	114	2,340
	120	42.96	0.42	1.53			5% 4.72	118	2,730
	180	44.49	−1.11					123	3,195
	240	43.38						120	2,200
Kweijen	0	25.53	2.10**	3.94**	4.26**	1.37*		100	—
	60	26.90	0.73	2.57**	2.89**		1% 1.58	105	385
	120	29.79	−2.16**	−0.32			5% 1.14	117	1,530
	180	29.47	−1.84*					115	1,070
	240	27.63						108	−150

Note: 1. Net profit (NT$) in Kwantien and Paiho=(Increment due to K) × NT$800—(No. of kg of K_2O) × NT$5

2. Net profit (NT$) in Hsinshih and Kweijen=(Increment due to K) × NT$500—(No. of kg of K_2O) × NT$5

jen due to irrigation during the early growing period. Tables 2 and 3 list the yields of fresh leaf, vine and root, and net profits from potash application. And Figure 1 shows applied potash raising root yields up to certain levels.

CONCLUSIONS

1—Leaf and vine yield did not respond significantly to potash.

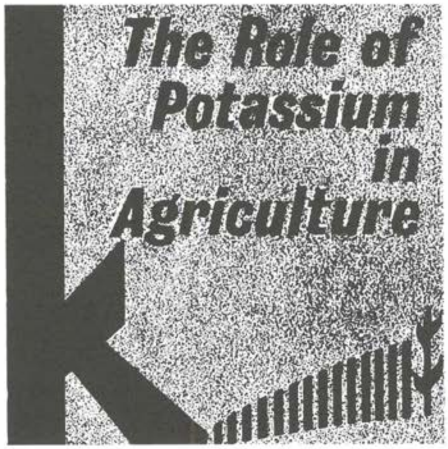
2—The best potash rate boosted root yield from 12 to 27%, all with high statistical significance except in Kwantien.

3—Net profits of NT$800-3,200 per hectare were obtained from added potash. Current recommendations—180 kg/ha of K_2O for Hsinshih and 120 kg/ha of K_2O for Kwantien, Paiho, and Kweijen—are based on these profits.

4—Potash applications above 120-180 kg/ha of K_2O adversely affected root yield. Further research is needed to learn whether the chlorine ion is related to this.

5—Root yield response to applied K seemed to correlate with soil non-exchangeable K but not with soil exchangeable K. But it should be noted the Hsinshih soil containing the lowest amount of exchangeable K required the highest potash rate.

THE END



the plant's carbohydrate metabolism and translocation.

They discuss how it affects the plant's enzyme systems and the organic acid and non-protein nitrogen content of plant tissue.

They document its role in building nutrition, disease resistance, and quality in all kinds of crops: tropical and forage crops, tree crops, vegetables, soybeans, and corn.

And they feature its role in human and animal nutrition.

We recommend this book for all agricultural leaders involved in raising the food and fiber crops of the world. We also recommend it for progressive growers. It will update everyone's working facts. The publisher's chapter breakdown shows the vast scope of the book:

1—Potassium Reserves In The World, Samuel S. Adams—Mineral sources; world reserves by regions and countries; methods of recovery; supply and demand.

2—Potassium Fertilizer Technology, E. C. Kapusta—World potash industry; raw materials and retrieval: mining, extraction of K brines; fertilizer production of several K varieties; shipping.

3—Preparation of Finished Fertilizers Containing Potassium, R. D. Young—K materials used: granular, slurry-type, bulk blends, and fluid fertilizers; potassium in nitrate and meta-phosphate.

4—Agronomic Evaluation of Potassium Polyphosphates and Potassium-Calcium Pyrophosphates As Sources Of Potassium, O. P. Engelstad—Chemical characteristics; plant products; germination effects; crop response; soil alterations; recovery of added K; conclusions.

5—Mineralogy of Soil Potassium, C. I. Rich—Soil minerals and K reactions; release of soil K by weathering and drying; fixation; K selectivity of mica vermiculites.

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N-K TEAMWORK GIVES

Condensed from Florida State Horticultural Society Proceedings reprint, "Effects Of Nitrogen And Potassium Fertilization On Persian Limes On Lakeland Fine Sand." By T. W. Young and R. C. J. Koo, University of Florida.

MATURE PERSIAN lime trees on Lakeland fine sand were fertilized for three crop years with three levels each of nitrogen and potassium in factorial combinations.

Yields increased with an increase in either nitrogen or potassium up to the maximum levels, with highest yield where both elements were used at maximum levels.

Juice content, soluble solids and acid increased with increased nitrogen fertilization. Increased potassium resulted in some increase in acid. Foliage color and density improved with increasing nitrogen fertilization.

Calcium and magnesium levels in leaves decreased as potassium fertilization increased, but the decrease was not sufficient to cause deficiency symptoms.

AT THE BEGINNING of this experiment in October 1963, the trees were approximately 10 years old. They were on rough lemon root and planted at 20 x 30 feet. The soil was Lakeland fine sand.

The soil pH was maintained between 6.0 and 6.7, with extractable calcium around 600 pounds per acre six inches and magnesium around 75 pounds with annual applications of dolomite.

The grove was equipped with solidset, low volume, overhead irrigation. Adequate moisture was maintained, as far as could be determined by tree condition.

Although serious cold did not occur in this grove during the trial period, the irrigation system was used a few times for cold protection. There was no cold damage to trees, bloom or fruit.

Lime bark disease, with perhaps some blotch, was found throughout the experimental block. Trees used for differential fertilizer treatments in the experiment, however, were as free of the trouble as could be ascertained by normal inspection. The trees also varied in size.

In laying out the plots, a selective randomization was used to have trees of relatively uniform size and vigor among the plots.

THREE LEVELS EACH of nitrogen and potash were used in factorial combination, with other fertilizer elements held constant. The four-tree plots were replicated four times in randomized blocks and completely buffered on all sides.

The total nitrogen rates for the crop year were 1.5 (N_1), 3.2 (N_2), and 4.9 (N_3) pounds per tree. Potash rates were 1.4 (K_1), 3.1 (K_2), and 4.7 (K_3) pounds, with each tree receiving phosphorus and magnesium at 0.34 pound P_2O_5 and 0.54 pound of MgO.

The low nitrogen and potash rates, together with phosphorus and magnesium, were applied in a mixed fertilizer by distributor over the entire area.

The intermediate and high nitrogen—potash rates were applied as supplements with ammonium nitrate and muriate of potash spread from tree to tree by hand. These applications were made in fall, winter and spring at rates to supply the three levels each of nitrogen and potash in approximately equal amounts each time.

The initial experimental fertilization was in October 1963 and the final one in October 1966. Thus, three full crop years, with harvests from midspring through late winter, were included well within these treatment limits.

SIX PICKINGS were made on the plots each year. Yields were obtained for individual plots to the nearest one-tenth of a field box (1.25 bu.).

Fruit quality studies were made in 1964, 1965, 1966 and 1967 on fruit samples taken in late spring or early summer. Leaf analyses were made in 1964, 1965 and 1966 on spring-flush leaves collected in early fall.

LIME YIELDS BIG BOOST

The high rates produced an average of 2.8 boxes more (per tree) per year than the low rates, at a cost of only 20¢ a box for the extra fertilizer . . . and the point of diminishing returns for N & K was not exceeded.

A visual rating of general tree condition, based on foliage color and density, was made in December 1966. In rating, chlorosis or sparse foliage obviously caused by lime bark disease or blotch was discounted.

Two observations were made on each tree—one on the east side in the morning and one on the west side in the afternoon, when light was most favorable from each direction.

By late summer of 1966, several trees in the plots were out of production from lime bark disease. Several others were starting to decline noticeably from the trouble.

There was no relationship between the decline and experimental treatments. Because of increase in rate of the decline, harvest data were not taken after the 1966 crop year, and the experiment was concluded with collection of fruit samples in May 1967.

TABLE 1 SUMMARIZES yields for the three years. There was a definite trend towards increased yield with increased nitrogen and potassium fertilization in 1964 and 1965, but variations among plots under the same treatment were great and the effects were not significant. These variations decreased with time, apparently being reduced by the treatment effects.

By the third year (1966) the increase in yield with an increase in nitrogen and potassium was highly significant.

TABLE 2 SHOWS the main effects of the treatments on fruit quality. The fruits taken for quality study were all 1⅝ inches or larger in diameter, in accordance with established size standards, averaging about 2 inches in diameter in all treatments.

Peel thickness increased significantly with increased nitrogen fertilization in 1966, but decreased in 1967. Potassium had no effect on peel thickness.

Percentage juice by weight was taken in 1964, 1965, 1966 and 1967. However, the industry-approved standard of maturity is based on percentage juice by volume, and this value also was obtained in 1966 and 1967.

The relationship between average percentage juice on weight and on volume basis was rather constant at a ratio of around 50:47. As nitrogen fertilization increased, there was a significant increase in percentage juice, by weight and by volume, in 1966 and 1967. Soluble solids and acid both increased with increased nitrogen fertilization.

The significant effect of potassium on internal quality was an increase in acid with increased potassium fertilization in one out of the four years.

TABLE 3 SHOWS the main effects of the treatments on chemical composition of leaves. The nitrogen content of leaves increased with increased nitrogen fertilization, which in turn reduced phosphorus and potassium contents.

Table 1. Main effect means of nitrogen and potassium fertilization on yield of Persian limes.

Treatment	Yield in 1.25 bushel field boxes		
	1964	1965	1966
N_1	5.18	7.66	9.22
N_2	5.20	8.03	10.17
N_3	5.55	8.54	11.45
F[a]	N.S.	N.S.	**
K_1	4.87	7.64	9.41
K_2	5.55	8.11	10.12
K_3	5.50	8.47	11.32
F[a]	N.S.	N.S.	**

[a] N.S. differences between means not significant.
** F significant at 1%.

Table 2. Main effect means of nitrogen and potassium fertilization on external and internal quality of Persian limes.

Treatment	[b] Diam. fruit (in.)	[a] Weight grams/ fruit	[b] Peel thickness (mm)	% Juice		[a] % Soluble solids	[a] % Acid
				[a] wt.	[b] vol.		
N_1	2.00	75	2.95	43.7	40.7	8.74	5.79
N_2	2.00	77	2.93	44.5	42.3	8.90	5.85
N_3	1.99	76	3.07	45.3	43.1	8.98	5.87
F[c]	N.S.	N.S.	**2/2[d]	*1/4 **1/4	*1/2 **1/2	**2/4	*2/4
K_1	1.99	76	2.99	44.7	41.8	8.87	5.83
K_2	2.00	75	2.99	44.5	42.0	8.90	5.84
K_3	2.02	77	2.98	44.5	42.3	8.94	5.84
F[c]	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	**1/4

[a] data for 1964, 1965, 1966, and 1967.
[b] data for 1966 and 1967.
[c] N.S. differences between means not significant.
*F significant at 5%.
**F significant at 1%.
[d] significant 2 years out of 2, etc.

There was no measurable effect on leaf calcium or magnesium. Increasing potassium fertilization had no effect on leaf nitrogen or phosphorus, but significantly increased leaf potassium and decreased both calcium and magnesium contents.

Nitrogen fertilization improved color of the leaves and density of the foliage. Potassium had no effect on leaf color.

While the difference was not statistically significant, **there was a slight trend towards heavier foliation with increased potassium fertilization.**

SINCE THERE WAS a consistent increase in yield with an increase in both nitrogen and potassium fertilization, up to the maximum used in this experiment, it is evident that the point of diminishing returns for either element was not exceeded.

For the 1966 crop, the maximum rate of both nitrogen and potash for the year amounted to slightly over 0.4 pound each per 1.25 bushel box of fruit harvested. This is as much or more than is recommended for a 2.2 bushel box of oranges or grapefruit.

On an acre basis, 250 lbs. per year for both nitrogen and potash is the maximum recommended for citrus in general. The maximum annual rate of nitrogen and potash in this experiment each amounted to about 380 lbs. per acre.

Therefore, nitrogen and potassium requirements for maximum yield of limes on deep sandy soil is quite high, compared to citrus generally.

The general condition of the trees improved with increasing nitrogen. A leaf nitrogen level of somewhat over 2.5% gave the darkest green and most dense foliage.

Although absorption of magnesium and calcium declined with increasing potassium fertilization, the effect was not sufficient to cause deficiency symptoms. In fact, the condition of trees receiving high potassium fertilization, which gave a leaf potassium content of 1.54%, appeared slightly better than those at the low rate with leaf potassium at 1.14%.

ANOTHER BONUS resulting from increased nitrogen and potassium fertilization, primarily from nitrogen, was improvement in internal fruit quality. Juice, soluble solids and acid all increased with increased nitrogen. Increasing potassium also gave some increase in acid.

This increase in juice is quite important because at the low nitrogen and potassium rates the percentage juice did not average up to the 42% by volume standard required for fresh fruit. Soluble solids are

Table 3. Main effect means of nitrogen and potassium fertilization on leaf analyses and tree condition of Persian limes.

Treatment	Chemical composition of spring-flush leaves collected in late summer (average for 1964, 1965 and 1966) — Percent Dry Weight					[b] Tree Condition rating—1966	
	N	P	K	Ca	Mg	Foliage color	Foliage density
N_1	2.25	0.168	1.44	3.38	0.495	4.83	4.79
N_2	2.48	0.163	1.40	3.25	0.504	6.67	6.62
N_3	2.59	0.153	1.28	3.42	0.515	7.25	7.04
F[a]	**	*	**	N.S.	N.S.	**	**
K_1	2.44	0.159	1.14	3.58	0.542	6.04	5.92
K_2	2.48	0.167	1.43	3.26	0.501	6.46	6.25
K_3	2.43	0.159	1.54	3.21	0.472	6.25	6.29
F[a]	N.S.	N.S.	**	*	**	N.S.	N.S.

[a] N.S. differences between means not significant.
*F significant at 5%.
**F significant at 1%.
[b] tree condition rating 1 to 10 = poor to good.

not highly important in limes, but, the juice and acid percentages are, the acid expecially for fruit to be processed for "concentrate."

Based on yield, leaf analysis and tree condition, trees receiving the maximum nitrogen and potassium rates in this experiment were not over fertilized, even though application rates were considerably above those found ample for oranges and grapefruit. This may have been due to the way growing and fruiting habits of limes differ with oranges and grapefruit.

Also, the experimental block was adequately irrigated, so the trees could use heavy applications of fertilizer to an advantage.

Such heavy fertilization of limes appears to be economically justifiable. For example, after the treatments became measurably effective in the second and third years (1965 and 1966), the best yield was from the maximum amounts of both nitrogen and potassium (N_3K_3).

This treatment supplied a total of 4.9 pounds of nitrogen and 4.7 pounds of potash per tree per year, producing a yearly average of 10.95 boxes (1.25 bu. box) of fruit per tree. The medium rate of fertilization (N_2K_2) supplied 3.2 pounds of nitrogen and 3.1 pounds of potash, producing a yearly average of 9.13 boxes per tree. It required 5.1 pounds of ammonium nitrate and 2.7 pounds of muriate of potash per tree per year, at a cost of about 4¢ and 3¢ a pound, respectively, to bring the nitrogen and potash levels up from the medium rates to the high rates.

Thus, the cost of the supplemental materials, which produced an additional 1.82 boxes of fruit per tree each year, amounted to about 28¢ per tree per year, or about 15¢ a box for the extra fruit. Since these amounts of nitrogen and potash could be included readily in the fertilizer mixtures, there would be no additional cost for application, and production cost of the extra fruit would be only that of the extra nitrogen and potash.

The medium nitrogen and potassium fertilization rates produced an average of 0.98 box more fruit than the low rates each year for the two years, at an annual cost of 29¢ a box for the extra fertilizer. The high rates produced an average of 2.8 boxes more per year than the low rates, at a cost of 20¢ a box each year for the extra fertilizer.

THE END

Weather **Traffic**

Can Your Turf (Lawn) Take

POTASSIUM puts muscle into turf and lawn nutrition. And this spring is a good time to apply that muscle, modern research shows.

Renovating a sick turf is costly. Keeping it healthy with a well-balanced diet is much cheaper. That is why so many home lawns, golf courses, public parks, sports fields, roadsides, school and church grounds are now fertilized year-round—in spring and fall.

How does potassium put muscle into your turf's nitrogen-phosphorus-potassium diet? Research from several land-grant universities points to many trends:

Potassium puts weather-facing muscle into turf.

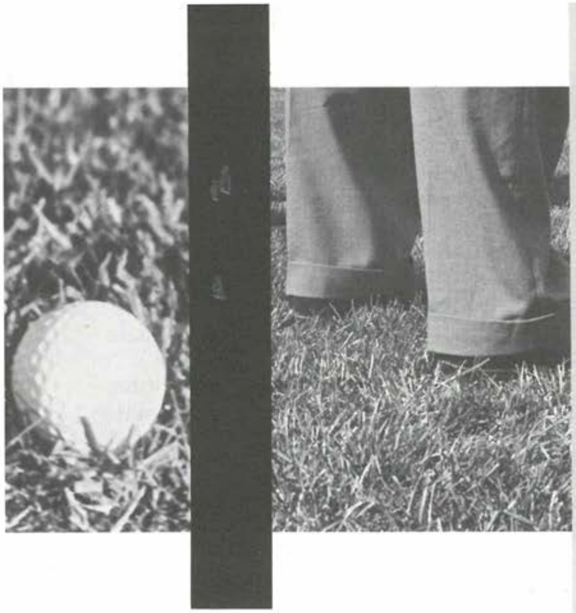
For cold winter, adequate phosphorus-potassium in the fertilizer ratio have increased turf survival from Maine to Alabama. Michigan found bluegrass survives winter best when potassium equals at least half the nitrogen used, while Carolina turf stood winter best when potassium nearly equaled nitrogen.

Potassium helps keep the food lines between leaves and roots open by increasing the concentration of dissolved substances, largely soluble carbohydrates, in the cell sap. Increased carbohydrate sugar reserves in cell sap and roots help make the turf more cold tolerant, scientists believe.

For hot summer, Iowa trials showed potassium important in reducing high temperature injury to bluegrass turf. It meant denser turf, more vigor. It enabled the plant to "perspire" and "breathe" more slowly than soft low-potash turf. And it built a fuller root system for the turf to seek more moisture in hot weather.

Potassium puts disease-fighting muscle into turf.

The U.S. Department of Agriculture Yearbook on Plant Diseases says potassium is responsible for "retarding more plant diseases than any other substance." Why? "Perhaps because potassium is so essential for catalyzing (speeding up) cell activities," the Yearbook explains.



With K Muscle

IN THE U.S. GOLF Association's GREEN SECTION RECORD, Washington State University scientists, Drs. Roy Goss and C. J. Gould, report on the role of potassium in fighting turfgrass diseases. They conclude with these comments:

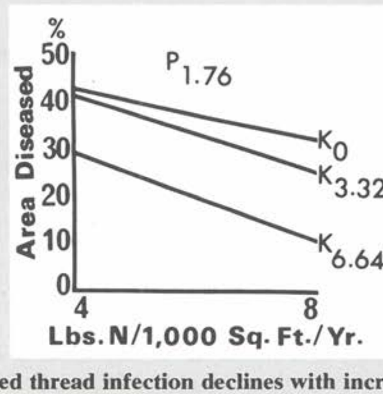
"Our results to date show that a balanced program made up of three parts of nitrogen, 1 part of phosphorus, and 2 parts potassium is giving best results in our turfgrass management programs.

"On putting green turf, 12 pounds of nitrogen, four pounds of phosphorus (P_2O_5), and eight pounds of potassium (K_2O) per 1,000 sq. ft. per season have given best results.

"On less intensely managed areas, such as good quality lawns or fairways, we have found six to eight pounds nitrogen, two to three pounds phosphorus (P_2O_5), and four pounds potassium (K_2O) per 1,000 sq. ft. per season is a good program.

"Soil potassium levels declined constantly when nitrogen was applied at 12 and 20 pounds per 1,000 sq. ft. and potassium at four and eight pounds per 1,000 sq. ft. per season. These same potassium levels at the six-pound nitrogen rate are holding soil levels fairly constant.

"Where no potassium has been applied for eight years some plots, particularly in the high nitrogen range, show levels as low as 90 pounds per acre in 1967. These levels have dropped from a level exceeding 500 pounds per acre when the experiment was initiated." THE END



Red thread infection declines with increasing rates of both nitrogen and potassium.

Disease

It This Year?

When the grass plant becomes deficient in potassium, look for many things to invite disease attack:

(1) Soft, easily crushed grass leaves invite the disease to enter after frequent cutting.

(2) Excessive sugars and nitrates build up in the leaves to give the disease a shot of energy to take over the turf.

(3) New cells fail to develop because of too little amino acids to form protoplasm.

(4) Healthy tissue grows too slowly to replace diseased tissue.

(5) And thinner cell walls and tissues invite lurking diseases.

Florida scientists found potassium and sulphur helped Tifway bermuda resist dollarspot disease, while Auburn specialists found leafspot disease 10 times greater on potash-hungry plots than on well-fed plots. Similar results occurred with Timothy in Alaska.

Spring Potash Puts Muscle Into Turf Nutrition

Washington State scientists found patch

disease thrived on tender high-nitrogen grass but declined on grass hardend by enough phosphorus and potassium to "balance" the nitrogen. Penn State specialists found potassium and phosphorus must be increased as nitrogen is increased to reduce tendency of brown patch disease in turf.

Balanced fertility doesn't cure disease, of course. Texas A&M specialist H. E. Hampton explained it this way: "Any practice that promotes plant vigor will help combat disease. If a disease persists in spite of regular use of fungicides, it is wise to check the potassium status of the soil." Virginia found generally no antagonism between potash and herbicides.

Potassium puts traffic-taking muscle into turf.

It improved root growth and tended to stiffen the foliage for heavy traffic in both Florida and Iowa trials. It caused turf to show better cover and growth traits in Washington State tests. In Maryland trials, it influenced the plant's metabolism and root growth. And turf receiving well balanced nitrogen-phosphorus-potassium treatment produced 28% more tops below clipping level than plots receiving only nitrogen, New Jersey tests showed even years ago.

Potassium prepares turf to take heavy traffic by serving as chemical traffic policeman within the plant itself. It creates larger, more evenly distributed food-carrying vessels between the turf's leaves and roots, insuring better root branching. It insures more, larger, less sluggish plant stomata—the little mouth-like openings through which turf breathes and exchanges gas.

Potassium puts nutrient-nourishing muscle into turf soil.

Any turf grower who overdraws his bank account can go bankrupt. He can also bankrupt his turf soil by failing to deposit enough plant food to replace the nutrients going out with the clippings and down with rains and waterings.

Many lawn and turf soils test low-to-medium in potassium, with golf greens notoriously low because of frequent clippings. A Penn State survey showed over 80% of the golf greens, 65% of the surveyed lawns needing potash.

A Purdue survey showed potassium needed on most irrigated Midwest turf areas. It showed the following Midwest turf areas testing from very low to medium potassium: 92% of 400 lawn areas to be planted, 58% of 800 established lawn soils, 78% of 1600 putting greens, 66% of 260 fairways, and 73% of 40 athletic fields.

A USGA Turfletter, cited by the Purdue survey, reported 65% to 70% of the putting greens tested in the Southeast needed potassium, while 45% of the fairways needed it.

Scientists estimate most grasses remove anywhere from 5 to 8 lbs. of nitrogen, 1.5 to 2 lbs. phosphate, and 3 to 4 lbs. potash per 1,000 sq. ft. each year. They say it takes 40 to 50 lbs. per 1,000 sq. ft. of a 15-5-10 fertilizer, for example, just to recoup these losses in your soil.

Roles of potassium in building turf quality are available to readers through two popular folders issued by the American Potash Institute. As long as supplies last, sample copies can be secured by writing **Quality Turf Folders, American Potash Institute, 1649 Tullie Circle, N. E., Atlanta, Georgia 30329.**

THE END

Plant Analyses

PLANT TISSUE collected and analyzed from 59 of Indiana's 92 counties has uncovered hidden hunger in 3 major crops: corn, soybeans, and alfalfa.

Above-normal precipitation in June, 1968, created nitrogen deficiencies that would not have been expected otherwise. And much potassium hunger may have been caused by the wet soils and later shallow rooting. This summary helps show why plant analysis is growing as a diagnostic tool across Indiana.

SUMMARY OF 643 PLANT ANALYSES COLLECTED IN INDIANA DURING 1968

CROP	Samples Received	Appearance		No. of Deficiencies Observed										
		Normal/	Abnormal	N	P	K	Ca	Mg	Mn	Fe	B	Cu	Zn	Mo
CORN	556	498	58	152	30	149	3	82	16	0	0	0	12	0
SOYBEANS	66	40	26	12	2	12	2	2	9	0	1	1	0	1
ALFALFA	21	9	12	7	2	7	11	8	7	0	11	3	1	2

Uncover Hidden Hunger in Indiana

ELDON L. HOOD
PURDUE UNIVERSITY

CORN—only 58 of the 556 leaf samples tested LOOKED abnormal when collected. But the tests uncovered 152 samples deficient in nitrogen, 149 short in potassium. What a prime example of *Hidden Hunger!* Added to these were 82 magnesium shortages, perhaps temporary in nature or nutritionally induced. And 28 samples were deficient in micronutrients—16 in manganese, 12 in zinc.

SOYBEANS—Relatively few plants are tested each year. Growers try to get top yields, but seem convinced fertilizer supplied for the previous corn crop will serve soybeans. Even so, nearly 40% of the 66 samples LOOKED abnormal to the grower or fertilizer representative. The plant tests showed Indiana soybeans shortest in nitrogen, potassium, and manganese.

ALFALFA—Nearly 43% of the samples —9 out of 21—came from NORMAL APPEARING fields. Tests showed a need for continued emphasis on potassium, limestone, manganese, and boron. The list of deficiencies showed alfalfa runs less than a 50-50 chance of having all elements in sufficient concentration in the plant. This spotlights the need for keeping this crop well fed. **THE END**

COMMUNICATION has been called an art, a science, an emerging discipline, and by some a nuisance.

Whole departments at our universities and industries have developed since the word was rediscovered:

• **The Department of Journalism has been renamed the Department of Journalism, Broadcasting, and Communications.**

Communications must keep

GIVE INFORMATION . . . MAKE SOME WAVES

• **The old employee bulletin is now called internal communications.**

• **I have even read and heard the word "Communicologist" used, and with a sneer at that.**

Those who attempt to inflate the meaning of the word point out and, with some justification, that it encompasses the science of everything from anthropology to zoology, from the biological to the behavioral sciences.

Others point out that all forms of *art* are attempts to communicate a feeling from the artist to the beholder.

Look at all the elements.

The amoeba communicates its existence to us humans. Cells communicate chemically with each other as they work together to build the multicelled organism that we may call a tree.

Communication does take many forms. There is physical—that is tactile and thermal. There is chemical—divided into gustatory and olfactory. There is auditory—called stripital and phatic. And there is visual.

NOW IT MIGHT occur to you that man can participate in all of these forms of communication. In fact, he is the only one that can. Some animals have a noise that says, "Here is Food," and another noise that says, "Danger." But they have no way of combining the two sounds to say, "Here is food but stay away because there is danger connected with it."

Man can do this. Man can even combine words into new words. For example, chuckle and snort are combined into chortle.

I merely mention these things to show how complicated communication can be and usually is and how difficult it is even to define the word. Let's try. First the dictionary. "The act of communicating." Well there certainly isn't much help there.

How about "The transmission (and reception) of ideas/information/meaning/attitudes, from person(s) to person(s)."

Are we sure transmission and reception actually take place. And how many other terms must we define to make the meaning clear?

Here's another: "A social structure consisting of (1) people who formulate, (2) a message, (3) transmitted over one or several channels, (4) in one or more symbol systems, (5) to one or more persons, (6) in the expectation that actual responses of the receiver(s) will conform in some degree, (7) to the intended response(s)."

Difficulty of definition is clear! Personally, I'll choose a very simple one and that is, INTERACTION WITH A MESSAGE. It is not only simple but rather all encompassing. It takes care of all types of communication I mentioned earlier.

THERE ARE MANY levels of communication, or interaction with a message. On the lowest level is a sort of gross mes-

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pace . . .

. . . not OVERestimating knowledge or UNDERestimating intelligence!

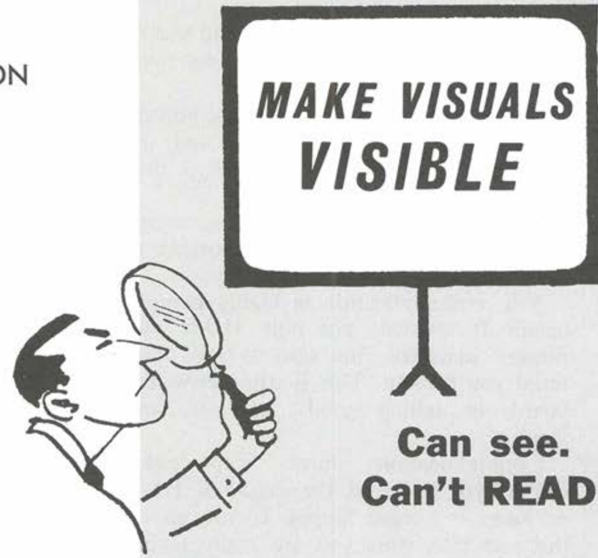
sage which everyone understands. On the highest level of this continuum is perhaps something that no one understands. Just below that, just for the communicator.

In each interaction you participate, you bring your total self with all your experience, knowledge, and biases to the event. Because of this, each of you will perceive messages and meanings that are both similar and different.

This may be why your memos are misunderstood. People do read between the lines. They hear inflections in a phone conversation, see raised eyebrows in face to face communication, and even feel things intuitively.

You are usually misunderstood for a very good reason. That is because you put the misunderstanding there. It was there for the person to pick up if his past experience, knowledge or attitude allowed it. Even words like stop, no, or fire can mean go, yes, or look at me mom.

THERE ARE EVEN times when we wish to be ambiguous. We even have words that help us. Did you ever hear a dairy judge as he gives reasons for a class he has placed? He says, "Dairy character, milkiness, and upstanding." No one really



Can see. Can't READ!

IN HIS WIDELY acclaimed lecture on communications, William Folwell features slides that show researchers how they can capture or lose their audience. Why does a researcher project complicated charts and tables? To impress people with his "larnin"? What a naive person! The more a man knows about his subject, the clearer he can project it. People know that—even "the colleagues."

How do you clarify charts? Folwell advises us to boil down our material or split it into component parts so no slide has more than 5 lines with no more than 19 letters per line, including spaces. The goal is to get readable size in the projected or final image. The original image from which a slide is made should be sized so the letters will project at 3½″ to 4″ on a 4-foot screen for easy reading at 100 feet.

The American Society of Agronomy gives some simple rules for clear slides: (1) One idea per slide. (2) Large (bulletin) type or (better still) lettering. (3) When photographing typewritten material, use no larger area than 3″—a 2.5″ area is safer than a 3.5″ area. (4) Never use typed tables filling 8½″ x 11″ sheets. (5) Use the slide ONLY when you can read everything on the SLIDE FILM at your normal reading distance without enlargement.

knows what these terms mean and yet he has given an excuse for a particular placing.

Did you ever see an agronomist pull up his soil auger, feel some of the soil, get that faraway look in his eye and pronounce, "This soil has good tilth"?

What does that mean? It really means that he could find nothing important to say about that soil.

Yes, communication is highly complicated! It involves not only HOW you present materials, but also WHAT material you present. This is true across the board—in selling goods, services, and ideas.

Communications must keep pace! Maybe you've heard the slogan K:I:S:S or Keep It Simple Stupid. If you go by this principle, what you are really saying is Keep It Simple, the Audience Is Stupid. You aim your communication at a lower than middle educational or experience level for each audience. The twelve year old mentality. You talk down to them. Is this the way it should be done?

RECENT PSYCHOLOGICAL research on experimenter bias has a distinct bearing on this question. Let me cite three experiments:

1—The first experiment divided naive experimenters into two groups. One group was told to administer a test to some students that had been selected randomly. The experimenters were simply told that the average score on this test would probably be about +5.

The other experimenters were told to give the same test to another randomly selected group of students and that the average score would be about −5. Sure enough, the first group tended significantly toward +5 and the second group toward −5. Experimenter bias took over.

2—The second experiment used rats. One group of experimenters was told that the particular family of rats they were working with had been raised way out in California and had been selectively bred for years to be maze dull.

The other group of experimenters were told that the rats they were using had been bred for years and through intensive selection were maze bright.

Sure enough the maze dull rats averaged a much longer time to run through the maze than the maze bright rats. Of course, the rats had been randomly chosen from one batch where no particular selection had taken place prior to the experiment.

How did experimenter bias cause this? It was the way the rats were handled. Those that thought the rats were maze dull dropped them into the maze where they landed somewhat bewildered and finally found their way through, there to be rudely picked up and dropped again at the other end to start over.

The experimenters who thought their rats were bright, placed them in the maze, timed them as they ran through, lifted them up for a short petting as they looked at them and observed in cooing tones how obvious it was that they were indeed bright, and then placed them again in the maze.

The rats soon learned that the quicker they ran through, the sooner the handling, petting, and cooing.

3—The third experiment used matched pairs of students. The measurable dimension upon which they were paired is I.Q. For each I.Q. of (n) in one group there was an I.Q. of (m) in the other. For each 120 in group A there was a 120 in group B. This means that the mean of I.Q. of A was identical to B. The scores ranged from 90 to 130 or so.

The teachers of group A were told that their students have been observed and tested for a number of years with revolutionary devices and that it can be accurately predicted that these students are about to blossom forth. Their I.Q.'s will show a decided advance in the next few months.

The teachers of group B are told nothing.

Sure enough the predicted takes place. I.Q.'s of A rose, some as much as 30 I.Q. points. Think of the implications. The method of putting so-called average students together would seem to insure that they remain average.

In other words, keep it simple stupid keeps them simple. Talking down, or communicating down to people is a dangerous practice unless you want to keep your audience at a low level. I think we overestimate knowledge but we constantly underestimate understanding and intelligence.

We put this notion to the test at Penn State. We dare to produce a film which treated the audience as an intelligent and perceptive group of people. In this film on limestone, we discuss *pH, ions and ion exchange, radioactive* isotopes, and other scientific phenomena, showing in many laboratory scenes how limestone is the key to soil fertility.

THE REACTION to our efforts has proved us to be correct. Farmers have shown a tremendous interest in the sophisticated concepts put forth in this film. They are asking additional questions as their curiosity is aroused. The film has received international recognition by both education and industry.

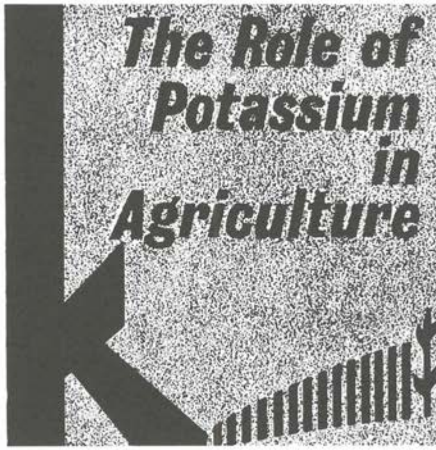
If someone tells you, "I know farmers and they'll never grasp what you are trying to say," he doesn't know today's farmer. Today's farmers are hungry for facts that will help them with their problems. They no longer look at a seeding failure and "figger I'll have to do better next year."

They want to know what to do now. They are running just as fast as possible—to stay even. It's up to us to help them. It's up to us to find and give them the information they need. This information has to have relevance and be honest.

People are no longer interested in platitudes and generalizations and slide presentations that say nothing. Circulars, films, brochures, speeches, face to face, yes all forms of communication must be designed to supply the new and eliminate the obvious. Forget the twelve year old mentality—they've grown up, too.

Perhaps you have seen a voice on an oscilliscope. You see the wavy lines going up and down as the voice modulates. If no information is given the line is straight. **Communication must keep pace. Give information, cause a few waves.**

THE END



6—Role of Potassium in Photosynthesis and Respiration, W. A. Jackson, R. J. Volk—Measurement of gas exchange components; photosynthesis, photorespiration, primary and secondary effects; modern concept of role of K in respiration.

7—Effect of Potassium on Carbohydrate Metabolism and Translocation, W. C. Liebhardt—The carbohydrate fraction; enzyme systems; translocation, general patterns, plant mobilizing forces, movement of compounds; parenchyma breakdown.

8—The Effects of Potassium On The Organic Acid and Nonprotein Nitrogen Content of Plant Tissue, M. R. Teel—Organic acids; cation-anion ratios; variation in organic acid composition; variation in NPN; implications; organic acids, nonprotein nitrogen.

9—The Effect of Potassium and Other Univalent Cations on The Potassium Conformation Of Enzymes, Richard H. Wilson, Harold J. Evans—Actions of univalent cations in enzyme activation, their effects on protein structure and conformation, enzyme stability; conclusions.

10—Role of Potassium in Human and Animal Nutrition, W. S. Wilde—K in cells; membrane ATPase; K fluxes during activity; K deficiency; avenues of K loss; other alkali metals.

11—The Effects of Potassium On Disease Resistance, R. L. Goss—Effects of soluble K on field crops, turfgrasses, horticultural and tropical crops; nonparasitic diseases.

12—Effect of Potassium On Quality Factors—Fruits And Vegetables, G. A. Cummings, G. E. Wilcox—Fruit: color, size, acidity, storage and shelf life; vegetables: K deficiency symptoms, uptake and requirement response to K, yields, color, ripening.

13—Soil Factors Affecting Potassium Availability, G. W. Thomas, Billy W. Hipp—Chemical factors; cation-exchangers, clay mineralogy, soil reaction; physical factors; water, soil, moisture, soil oxygen content, temperature.

14—Mechanisms of Potassium Absorption By Plants, S. A. Barber—K movement into plant root; influence of Ca on K absorption; exchange capacity

TO INSIDE BACK COVER

NPK TEAM WORK

CONDENSED FROM
LEE DONG SUK REPORT

기술협력
KOREAN OBSERVER

THE KOREAN government is focusing its agricultural research and development on increasing rice production, staple food of the nation.

Also, most Korean farmers base their farming operation on expanding rice production.

Seed improvement, change in transplant time, improved manuring, expansion of irrigation facilities, and insect control are major ways to increase rice production.

Efficient use of manure greatly helps increase rice production.

NUTRIENT NEEDS of rice differ according to growing stage. To insure a big rice yield, the grower should give a certain amount of nutrients in each growing stage.

Rice needs carbon, hydrogen, oxygen, potash, nitrogen, phosphorus, sulphur, calcium, magnesium, iron, copper, boron, zinc, molybdenum, etc. to grow. It also needs silicon.

Nitrogen, phosphate and potash are the three most important nutrients of rice.

To produce 3 sok of polished rice, 10.5 kilograms of nitrogen, 3 kilograms of phosphate and 7.5 kilograms of potash are needed. Thus, to produce 1 sok of polished rice, a third of the amounts will be needed. But Korean farmers generally use too much nitrogen, disregarding the importance of potash and phosphate, because nitrogen causes plants to grow quickly.

Regrettably, such inefficient fertilizer use has almost become a habit of Korean farmers, reducing yields at times.

NITROGEN is a major ingredient of protein which forms the protoplasm of a cell. Proper nitrogen use helps rice enlarge its leaf area and accelerates its assimilation processes, increasing the accumulation of carbohydrates. But if nitrogen is given excessively, rice will grow tall but weak, becoming vulnerable to damage from insects and diseases such as rice blast.

Rice absorbs 50 per cent of the nitrogen it needs by peak tillering stage, 20 per cent during young head to full heading stage, and the remaining 30 per cent after heading period.

So, to get a stable but big yield of rice, nitrogen should be given steadily in proper quantity according to the said absorption rate—not too much or too little.

With nitrogen, the ratio between basic manuring and additional manuring differs according to weather, seed and method of cultivation. To elevate the effect of nitrogen, it is necessary to apply phosphate, potash, and silicate when nitrogen is given.

PHOSPHATE is needed in the tillering stage where the cell-division process is most active to help rice tiller. It plays an important role in forming starch and cellulose.

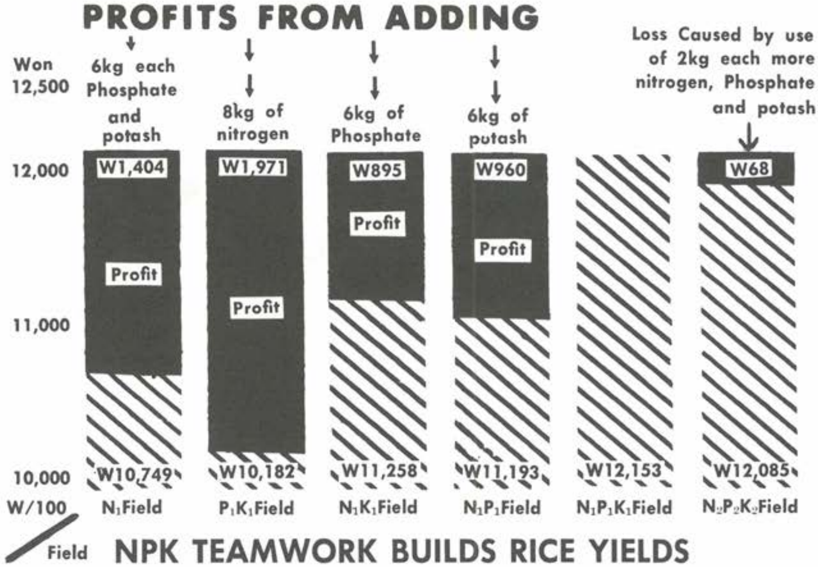
Inadequate phosphate causes dark green, withering leaves, and late heading and ripening.

POTASH helps such organic functions as protein metabolism and sugar metabolism go very smoothly, strengthening the rice plant's resistance to lodging and such diseases as red withering.

Inadequate potash causes rice to weaken its assimilative function, while strengthening its respiratory function thus diminishing carbohydrate production.

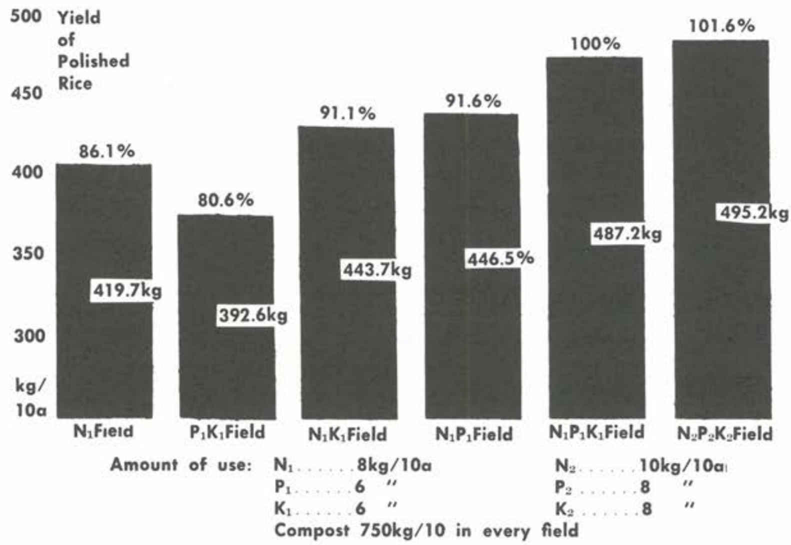
Potash is needed in forming protein, so the more nitrogen is given, the more

Vital To Rice Profits In Korea



NPK TEAMWORK BUILDS RICE YIELDS

FIGURE 1 compares rice yields among fields receiving different NPK rates. The basic index of 100 is applied to the standard NPK field. Yields declined 19.4% without added nitrogen, 8.9% without phosphate, 8.4% without potash. Withholding 6 kilograms each of phosphate and/or potash **REDUCED** yields 67.5 kilograms in the N-only field, 43.5 kilograms in the no-P field, and 40.7 kilograms in the no-K field.



NPK TEAMWORK BUILDS RICE PROFITS

FIGURE 2 compares profit of standard NPK field with profit from fields using different combinations of these nutrients. Biggest profit decline came in the no-N field, followed by N-only field, the no-K field, and the no-P field. This suggests a 10-*are* rice field can most profitably use 8 kilograms of nitrogen, 6 kilograms of phosphate, and 6 kilograms of potash.

potash will be needed.

Without enough potash, rice is vulnerable to such diseases as stem rot, brown spot and white withering—and easily lodges. If rice straw contains less than 1 per cent potash at harvest, the rice is suffering potash hunger. Potash easily runs short on humus and sandy soils.

Guard against potash running short during peak tillering and young head formation, for nitrogen content reaches its peak in these stages. If ratio of potash to nitrogen stands at less than 0.5 per cent during peak tillering, lower leaves of the plant will suffer from red and brown spots. And inadequate potash during young head formation causes rice to reduce the number of glumous flowers, decreasing production.

IN DEMONSTRATIONS conducted by the Office of Rural Development in 145 areas of the country, the field with increased use of NPK ($N_2P_2K_2$) bore biggest yield, followed by the field with standard NPK use ($N_1P_1K_1$), the field with no potash use (N_1P_1), the field with no phosphate use (N_1K_1), the field with nitrogen use only (N_1), and the field with no nitrogen use (P_1K_1) in that order.

Figure 1 compares yields of rice among fields receiving different rates of NPK. Applying the basic index of 100 to the standard NPK use ($N_1P_1K_1$ Field), we see nitrogen increased rice production the most, followed by phosphate and then potash.

Figure 2 shows how sharply profit can decline when a nutrient is withheld from the NPK team.

In this comparison, we find withholding a nutrient causes a conspicuous decrease in profit from the profit attained from the field with standard use of the three nutrients. The biggest decrease in profit is found in the field with no nitrogen use, followed by the field with nitrogen only, the field with no potash use and the field with no phosphate use. This indicates balanced use of the three nutrients are important to profit.

Thus, the proper quantities of nitrogen, phosphate and potash for use in a 10-are field are 8 kilograms, 6 kilograms and 6 kilograms, respectively. **THE END**

FIGHT STALK ROT with RIGHT Fertility

ALBERT MYER
SOUTHERN
ILLINOIS
UNIVERSITY

STALK ROT has been in the nation's corn fields a long time, but only in recent years has it become a major gremlin to corn farmers. Estimates vary on how much it reduces yields, generally thought to be 8 to 10 percent in the corn belt. It may cost farmers an estimated $100 million yearly in Illinois alone, maybe $1 billion a year in the world.

By applying more fertilizers (especially nitrogen) and increasing plant populations, many farmers have doubled their corn yields in the last decade. This trend has compounded the stalk rot problem.

The two most common stalk rot forms are Diplodia and Gibberella. Being a fungus disease, stalk rot depends on weather conditions that favor its invasion at critical periods of corn growth.

Botanists, plant pathologists, chemists, plant breeders, and soils and crops specialists all have studied the problem. Several theories have been advanced. Some findings seem significant. But the main agreement seems to be that scientists do not have all the answers yet.

Several years of interdepartmental

studies under three scientists at Southern Illinois University's Carbondale campus—plant pathologist A. J. Pappelis, soil scientist J. P. Vavra, and biochemist James BeMiller—have brought the institution to an important place in corn stalk rot research.

Most of the studies at SIU and other institutions boil down to a few generalized viewpoints:

1—Some hybrid corn varieties resist stalk rot damage better than others. This may indicate a heredity problem plant breeders can tackle.

2—A corn stalk is not susceptible to rot fungus infection until pith cells in the plant have died and there is some way the fungus can invade the stalk.

3—A corn crop's fertility program has a bearing on the prevalence and severity of stalk rot.

4—Corn plant lodging does not always result from stalk rot, but may be due to damage by European corn borer, to slender stalks, or other causes.

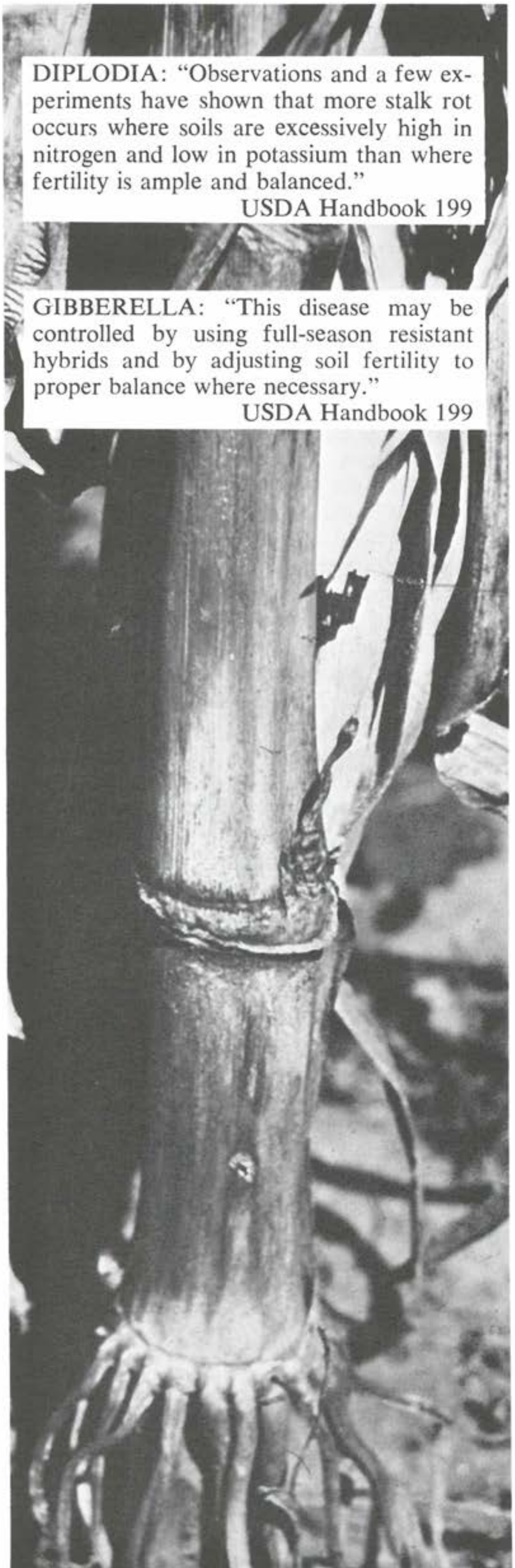
Let's look at these generalizations more carefully.

STANDABILITY is a characteristic the hybrid seed corn companies promote these days. Some hybrids are stronger stemmed and more resistant to stalk rot, corn borer damage, and lodging than others.

This built-in resistance may be due to a slower rate of pith cell death, to a more potent inhibiting substance to protect the plant from disease and insect attack, or to better adaptation to the growing conditions in a certain area.

Pappelis has studied the relation of pith cell death rates to the corn plant's susceptibility to stalk rot for several years. While a doctoral student at Iowa State, he early became convinced that stalk rot was linked to the death of certain pith cells. He found the rot fungi attacked only dead cells.

One of the heredity factors in the plant controls the corn variety's proneness to cell death and, hence, its susceptibility to stalk rot, Pappelis says. He found pith cells in the lower stalk internodes dying much earlier and more rapidly in some corn varieties than in others, often starting about the time stalks begin to silk. Ohio studies indicate similar findings.



FERTILITY may help corn guard against stalk rot. Pappelis and BeMiller have worked primarily on basic studies while Vavra has included some applied research.

In field studies with University of Illinois extension agronomist, Lester Boone, Pappelis found that potassium seemed to retard the rate of cell death in the stalk pith tissue.

Nitrogen stimulated corn growth, but also increased cell death rate and chances of stalk rot infection.

To escape some variables connected with field testing, Pappelis later turned to growing corn under laboratory-controlled conditions without soil. The method is called hydroponics.

He used six-foot livestock watering tanks filled with sterile crushed gravel for anchoring the plant roots. He fed all nutrients to the corn plants through water circulated continuously in the tanks with small electric pumps.

The hydroponics system allows the scientist to study exactly how different combinations of nitrogen, phosphorus and potassium affect corn plants. The combinations consist of high and low rates of the three major nutrients. The high rate is adequate for optimum growth. The low rate is one-tenth that amount.

Pappelis found worst stalk lodging when high nitrogen and phosphorus rates were combined with a low potassium rate. Stalks leaned heavily as they grew and all broke off or collapsed at one of the lower nodes within ten days after silking occurred.

Similar lodging tendencies occurred where normal nitrogen rates were combined with low phosphorus and potassium rates.

Pith cell death rates increased and came early in these instances, more in the lower than the upper internodes.

Pappelis has not been greatly concerned with grain yields, focusing on growth characteristics, changes in internal structure, analysis of nutrient content in various parts of the plant, etc.

THROUGH FIELD studies, Vavra brought the European corn borer into the picture as related to increased nitrogen fertilization and corn lodging. Guiding 1964 graduate student Gene Offerman, he found the amount of corn borer infestation increased rapidly with higher nitrogen rates. He compared two N rates—150 and 300 pounds per acre—with corn grown without added nitrogen. Surface and incorporated applications of mulching materials were also practiced.

Offerman found 72 per cent of the stalks in the nitrogen and mulched plots infected with corn borer, only 17 percent infected stalks in plots without added nitrogen. Larvae entries per ten stalks were 5 times greater in the high nitrogen plots than in the check plots, and the fourth internode was twice as infected as the first internode above the brace roots.

Lodging was greater in the nitrogen fertilizer plots where borer infestation was high, of course, but stalk sampling came too late in the season to reach conclusions about the effect on stalk pith condition. Offerman suggested the differences in the stalk's susceptibility to borer damage might be due to differences in concentrations of the chemical inhibitor, glucoside, which Pappelis and BeMiller had earlier found to be a stalk rot inhibitor.

THESE CHANCE FINDINGS led to a later, more extensive study by graduate student James Kinsella under Vavra's direction, and added work by Vavra.

Kinsella used various combinations of the three major plant nutrients—nitrogen, phosphorus, and potassium—applied at 200 pounds per acre in field test to study the effect of pith cell death, European corn borer infestation, stalk lodging, and corn yields.

Sufficient plots compared both the chloride and the sulphate forms of potassium to check suggestions made by other scientists in earlier studies. He planted a single cross hybrid considered moderately susceptible to stalk rot and corn borer at a moderate population of 17,500 plants per acre.

He took samples of the first four stalk internodes on five occasions during the growing and maturing season, beginning on July 10 at the pre-tassel stage and continuing until two days after harvest on Oct. 14. A windstorm on August 26, while the corn was in the early dent stage, caused much lodging in some plots.

Actual lodging counts were not taken until harvest time, but casual observation after the storm showed much variation and more severe lodging in high nitrogen plots.

FERTILITY AFFECTED pith tissue conditions in some interesting ways:

1—Nitrogen seemed to increase the cell death rate until after the third sampling date on August 19 when it slowed down. A large proportion of cell death came shortly after the pith formed. (These findings corresponded to earlier observations by Pappelis and others.)

2—Phosphorus speeded up plant growth and increased pith cell death early in the season but did not seem to have significant effects later.

3—Potassium in the chloride form decreased pith tissue death in the first and second internodes significantly until after the fourth observation date when the corn was maturing. The pattern was the same for the sulphate form but the rate was slightly slower.

Corn borer damage was substantially higher in the plots with nitrogen applications. Kinsella said this could be correlated with the pith cell death. But he also suggested the borers may have been attracted by a nutritional factor, such as the higher protein tissue available in nitrogen-fertilized plots, or by the lower concentrations of the inhibiting substance.

He says the greater lodging of corn in the high-nitrogen plots during the August storm may have been due (1) to more brittle stalks or weaker stalk tissue resulting from retarded maturity, (2) to greater cornborer damage, and (3) to greater ear weight on the stalks. Many lodged stalks broke off at a corn borer tunnel, Kinsella said.

Surprisingly, the least lodging occurred in plots containing added phosphorus. He suggested that the accelerated plant development in these plots made the stalks more mature at the time of the storm and less subject to breakage.

Kinsella found nitrogen applications increased corn yields about 25 bushels per acre, but the plots were hand harvested. He found many of the ears lying on the ground. If mechanical harvesting had been used, the yield increase certainly would have been much less significant. Phosphorus additions had no effect on yields, but potassium in both forms boosted yields five to eight bushels per acre.

Initial levels of P and K were rather high in the experimental area, he said. Hence, the effects might have been more dramatic on fields with low initial fertility.

MUCH WORK still needs to be done on the rot question and on European corn borer. Until better answers are available Vavra suggests farmers would do well to balance high applications of nitrogen with compensating additions of phosphorus and potassium.

Choosing adapted hybrids with high standability ratings and harvesting as early in the fall as grain moisture levels permit also will help reduce yield losses from down corn. **THE END**

HIGH POPULATIONS BOOST SNAP BEAN AND SWEET CORN YIELDS

H. J. MACK
OREGON STATE UNIVERSITY

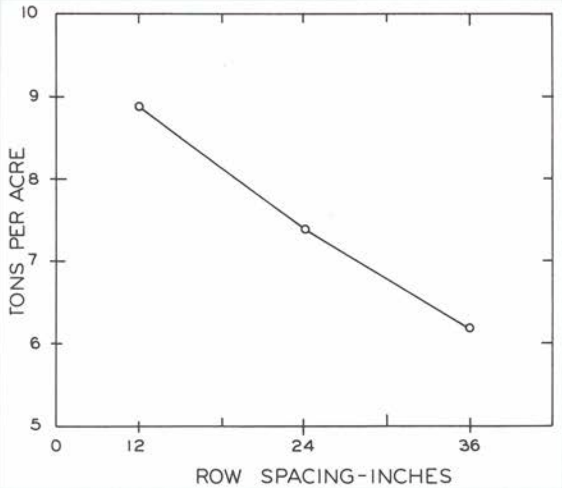
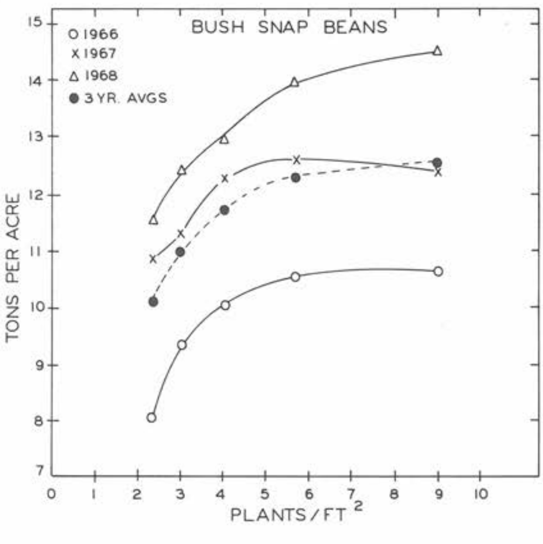


FIGURE 1—As rows got closer bush bean yields climbed higher.

HIGHER YIELDS are needed for more efficient, competitive vegetable production. Higher population densities and different planting arrangements hold a major key to such yields.

Why do plants in more uniform arrangements usually respond with higher yields and more concentrated maturity than closely spaced plants in wider rows. Uniformly arranged plants have an equal opportunity to take in sunlight, water, and nutrients.



Excellent weed control and adequate moisture and fertilizer are essential.

BUSH SNAP BEAN YIELDS increased as row spacings decreased. **Figure 1** shows how 24-inch rows yielded 20% more, 12-inch rows, 45% more than the 36-inch rows. Also, the 12-inch spacing produced more high-value, small beans—sieve size 4 and smaller. Each row spacing contained six to eight plants per foot of row.

Bush beans arranged on the square produced even higher yields—15% to 30% more than the same number of plants in rows 12, 24, or 36 inches apart.

Figure 2 shows how highest yields—adjusted to 50% sieve size 4 and smaller pods—were produced by reducing spacings between plants from 8x8 to 4x4 inches, about 2.2 to 9 plants per square foot.

Yields ranged from 12 to 16 tons per acre with about 50% of pods sieve size 4 and smaller from bush bean plantings in 8-inch rows and at 5x5 inch spacings in 1968. **Table 1** shows top yield exceeding 20 tons per acre in 8-inch rows, but with a high percentage of large pods.

The plots received 100 lbs. N, 132 lbs. P, and 84 lbs. K per acre—about two-thirds of it broadcast and disked in be-

FIGURE 2—As plant spacing declined from 8x8 to "4x4," snap bean yields climbed.

As a 15-ton bean crop removed about 75 lbs. N, 10 lbs. P, and 55 lbs. K per acre—on soils normally high in fertility.

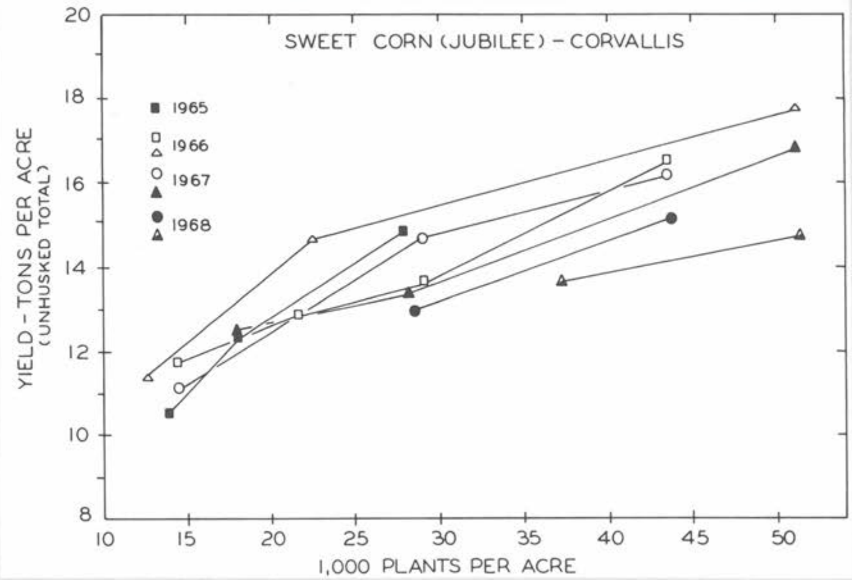


FIGURE 3—Sweet corn yields climbed as plant populations climbed.

fore planting, the remainder banded at planting.

Table 2 shows nutrient contents of leaves at bloom and pods at harvest from this 8-inch planting. A 15-ton crop removed about 75 lbs. N, 10 lbs. P, 55 lbs. K, 20 lbs. Ca and 8 lbs. Mg. per acre. Nutrient content of plants at harvest is estimated to be one-half to two-thirds these values.

SWEET CORN YIELDS climbed nearly 50% as their populations were increased from 14,000 to more than 50,000 plants per acre. **Figure 3** shows this steady rise.

Present commercial plantings usually total 15 to 20,000 plants per acre in 36 to 42-inch rows. As populations climbed, individual ear size declined.

Plant arrangement also appears to influence sweet corn. Some of the highest yields of acceptable ears have come from plants spaced 12 x 12 inches in equilateral triangles. Test spacings of 8 x 8 inches have produced much smaller ears and more cull ears.

Table 1: Yield and sieve sizes of bush beans, 8-inch rows, Corvallis, 1968.

Variety	Harvest Date—Aug. 8		Harvest Date—Aug. 13	
	Tons/A	% Sieve Size 4 and smaller	Tons/A	% Sieve Size 4 and smaller
OSU 58	14.0	64	21.2	30
Gallatin 50	10.9	88	16.4	51
Tempo	11.9	86	15.0	51

Table 2: Percent Nutrient Concentration of bush bean leaves at bloom and of pods at harvest. 8" rows, 1968.

Variety	% Nutrient element (Dry Weight) Leaves					Pods				
	N	P	K	Ca	Mg	N	P	K	Ca	Mg
OSU 58	3.6	.24	1.9	2.0	.36	2.8	.32	1.9	0.7	.28
Gallatin 50	4.3	.32	2.2	2.0	.36	2.1	.28	1.6	0.6	.25
Tempo	4.6	.32	2.5	2.7	.46	—	—	—	—	—

Table 3: Yield and Nutrient content of sweet corn plants, early, and cut-off corn at harvest, 18-inch rows, 1967.

Sample	Fertilizer Rate lbs. N-P-K/Acre	Dry Wt.	Nutrient Content—lbs./Acre N	P	K	Ca	Mg
		gms/plant					
Plants 8-12" height	400-100-100	2.5	9	0.7	9	0.1	0.7
	400-500-500	3.3	12	1.0	12	0.2	1.0
	400-1000-100	3.5	14	1.4	14	0.2	0.8
		Tons/Acre					
Cut-corn at harvest	400-100-100	6.8	79	7.0	40	.34	5.7
	400-500-500	7.0	80	6.7	40	.70	5.1
	400-1000-1000	7.3	81	7.4	40	.73	5.4

High fertilizer rates were included in some of the corn spacing tests—for example, 100-100, 500-500, and 1000-1000 lbs. P-K per acre broadcast and rototilled in fall before spring planting, plus 400 lbs. of N applied about half before planting and half before tasseling.

The 'river bottom' silty clay loam soil tested from 50 to 70 lbs. P per acre and 400 to 550 lbs. K per acre before fertilizer application.

Table 3 shows yields and nutrient content of sweet corn in 18-inch rows (34,800 plants/A) at three fertilizer rates yields rose with rising fertilizing rates, though the increases were not statistically significant.

The lowest fertilizer rate in this test, 400-100-100 lbs. N-P-K per acre, is higher than most commercial applications. Per acre removal of nutrients in cut-off corn totaled about 80 lbs. N, 7 lbs. P, 40 lbs. K, 5 lbs. Mg, and less than 1 lb. of Ca.

Table 4 shows how the 12 x 12-inch spacing produced highest yields while removing the most nutrients. Three fertilizer rates are pooled.

Table 5 shows how cut-off corn constituted about 12 to 14% of the total fresh weight of stalks plus ears in another study. Since no chemical analyses were made on stalks and cobs, per acre nutrient contents of plants could not be calculated.

Just how much high density plantings increase the crop's fertilizer needs require more study.

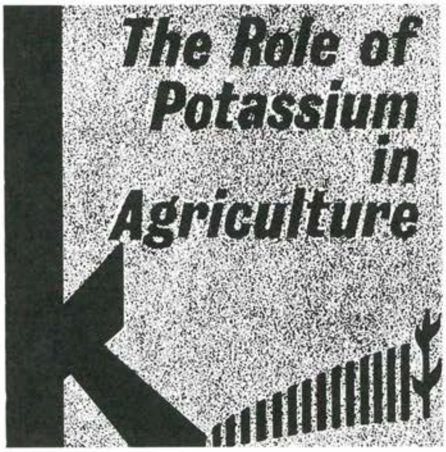
These crops were grown under sprinkler irrigation. Bush beans were sprinkler irrigated at 7 to 10 day intervals and received about 10-12 inches of irrigation for the season. Sweet corn was irrigated at about 10 to 14 day intervals and received 12-16 inches of water. **THE END**

Table 4: Yield and nutrient content of cut-off sweet corn, triangular spacing, 1967 (three fertilizer rates pooled).

Spacing (inches)	Plants/A 1,000	Yield—tons/A Husked acceptable	Cut-off corn	Nutrient content—lbs./Acre N	P	K	Ca	Mg
8×8	113.6	10.2	5.9	61	7.4	34	.49	6.0
12×12	51.2	11.8	7.4	75	9.3	42	.61	7.1
16×16	28.2	9.4	6.0	70	8.1	37	.60	6.4
20×20	18.0	8.3	5.2	67	7.5	36	.45	5.4

Table 5: Effect of triangular spacing on sweet corn yields, 1966.

Spacing (inches)	Yield—tons/Acre Stalks	Unhusked ears	Cut-off corn
12×12	33	17.4	6.6
18×18	25	13.2	5.6
24×24	24	11.2	4.4



of roots and K uptake; quantity-intensity measurements and K absorption.

15—Exchangeable Cations of Plant Roots and Potassium Absorption by the Plant, K. Mengel—K retention as influenced by calcium; the Donnan effect; K movement in the roots and plant; explanation of the phenomenon of the Viets effect.

16—Interaction of Potassium and Other Ions, R. D. Munson—Characteristics of K and other cations; ion relationships; critical level of K; cation relations and organic acids; cation-anion balance.

17—Plant Factors Affecting Potassium Availability and Uptake, Werner L. Nelson—Role of root systems; extent and type of roots, plant spacing, soil aeration and temperature; variety: corn, soybeans, rice; species; the future.

18—Potassium Nutrition of Tropical Crops, H. R. von Uexkuell—Problems; tropical soils; nutrient uptake and removal; effects of K; K and rice, tea, coffee, cocoa, rubber, bananas, oil palm; natural supplies of K.

19—Potassium Nutrition of Forage Crops With Perennials, R. E. Blaser, L. Kimbrough—K composition and yield; growth stage effects, competition of plants, K effects on growth; K applications for perennial forages.

20—Potassium Nutrition of Soybeans And Corn, John Pesek, Jr.—General concepts: Macy's hypothesis, response to fertilizers; K and corn concentration: accumulation, nutritive status; K and soybeans: seed, quality.

21—Potassium Nutrition of Tree Crops, R. C. J. Koo—Apple, avocado, mango, cherry, citrus, nuts, olive, peach, pear, plum, apricot; leaf analysis and K nutrition.

22—Potassium Nutrition of Vegetable Crops, R. E. Lucas—K composition and uptake; K and soil tests, sandy loam, organic soil; excess K: celery, carrot, cabbage, peppers, tomatoes.

These chapters were first delivered as lectures to an international symposium at the National Fertilizer Development Center of TVA. The book was edited by **V. J. Kilmer,** Chief, Soils and Fertilizer Research Branch, Division of Agricultural Development, TVA; **S. E. Younts,** Vice President, American Potash Institute: **N. C. Brady,** Director of Research and of the Cornell University Agricultural Experiment Station.

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