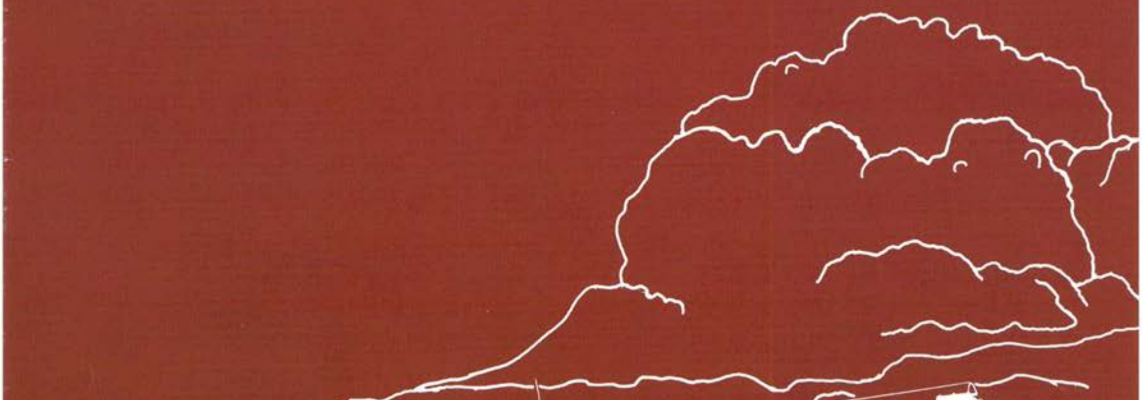
BETTER CROPS
WITH PLANT FOOD

Summer 1988

Inside this issue:
- Breaking the Alfalfa Yield Barrier
- Resource Management Achieves Conservation and Profits

. . . and much more



"Last Load Today"

BETTER CROPS With Plant Food

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Contents

Our Cover: The scene depicting wheat harvest is from an original illustration titled "Last Load Today," by R. King Murphy of Woodlands, Texas.

Dr. David W. Dibb Named President-Elect of Potash & Phosphate Institute (PPI)

THE BOARD OF DIRECTORS of the Potash & Phosphate Institute (PPI) has unanimously chosen Dr. David W. Dibb as President-Elect, effective July 1, 1988, and President, January 1, 1989.

Dr. Dibb

"David Dibb will become the fifth President of the Institute since it was founded in 1935. He is a talented young man and we are confident he will continue the tradition of outstanding leadership. His selection speaks well of the respect we have for PPI staff," said Mr. C.C. "Kip" Williams, Chairman of the PPI Board of Directors. Mr. Williams is Senior Vice President, Wholesale Marketing, IMC Fertilizer Group, Inc., of Northbrook, Illinois.

"We are extremely pleased that Dr. Dibb has accepted this new responsibility," noted Dr. R.E. Wagner, who has served as President of PPI since 1975 and recently announced his intention to retire at the end of 1988. "Dr. Dibb has a combination of capabilities that translates to strong leadership for this organization," Dr. Wagner added.

In 1985, Dr. Dibb was named Vice President for Domestic Programs and has been located in the PPI regional office at West Lafayette, Indiana. In 1987, his title became Senior Vice President. He has primary responsibility for coordinating the efforts of PPI's agronomic staff in the United States and Canada, in addition to directing agronomic research support.

Dr. Dibb is a native of Draper, Utah, and received his B.Sc. degree in Agronomy-Soils at Brigham Young University. He earned his Ph.D. degree in Soil Fertility and Plant Nutrition from the University of Illinois in 1974.

Before joining the staff of the Institute in 1975, Dr. Dibb had responsibility for a multidisciplinary soybean research project at North Carolina State University.

He was located at Columbia, Missouri, from 1975 to 1982 as Regional Director responsible for Institute programs in Missouri, Illinois, Kansas and Nebraska. He moved to the PPI headquarters office in Atlanta in 1982 as Coordinator for Latin America programs and Southeast Director.

A member of the American Society of Agronomy (ASA), the Soil Science Society of America, Alpha Zeta, and Gamma Sigma Delta, Dr. Dibb has been active in professional and community activities. He recently completed a term as President of ASA's Agronomic Science Foundation and is currently serving as Chairman of ASA's Budget and Finance Committee.

Dr. Dibb, his wife Vivian and their four children plan to move from West Lafayette, Indiana, to the Atlanta area during the summer of 1988. ■

Dr. Larry S. Murphy Appointed Vice President of PPI

DR. LARRY S. MURPHY of Manhattan, Kansas, has been named Vice President of the Potash & Phosphate Institute (PPI). His new responsibilities beginning July 1 will include serving as North America Program Coordinator and Director of Research for the Institute.

Announcement of the new assignment came from Dr. R.E. Wagner, President of PPI. "This is the first in a series of moves by PPI's President-Elect, Dr. David Dibb, to put together his management team. It is appropriate that this should be the first in that it places an exceptionally well-qualified person in a key position," Dr. Wagner stated. "Larry Murphy has unique abilities for his new role and will give added strength to PPI. He is widely known and respected among academic, industry and agricultural groups."

Dr. Murphy, formerly Great Plains Director of PPI, assumes the duties held previously by Dr. Dibb.

A native of Greenfield, Missouri, Dr. Murphy holds B.S., M.S. and Ph.D. degrees from the University of Missouri. After receiving his doctorate in 1965, he joined the Department of Agronomy faculty at Kansas State University. He held research responsibilities in soil fertility and fertilizer technology. He also taught courses in soil fertility, directed the graduate programs of students and helped train international students in soil fertility. His work involving interactions, application methods and responses to fertilizer gained widespread attention.

Dr. Murphy is an author in a wide range of publications, including books, professional journals, technical bulletins, extension information and in the agricultural press. He has been an invited speaker at numerous meetings of professional, industry and farm groups.

In 1978, Dr. Murphy joined the staff of PPI as Great Plains Director. Since then, he has become a catalyst in encouraging soil fertility research, extension education, field demonstrations, state and regional workshops, and other innovative programs in the Great Plains, Western and Midwest States. He has been extremely successful in gaining acceptance of maximum economic yield (MEY) systems in his region. In North Dakota, for example, more than 50 "MEY Clubs" have been formed under the leadership of extension, industry and local farm groups.

Dr. Murphy

Throughout his career, Dr. Murphy has also maintained involvement in international agriculture. Earlier this year he completed a six-week wheat industry study trip to Australia. He also visited Brazil recently as speaker for a major fertilizer conference. In 1984, he studied wheat production methods in Europe. On several occasions he has worked with international study groups in the U.S. and other countries.

In recognition of his work, Dr. Murphy has received numerous honors and awards, including the Citation of Merit by the University of Missouri Alumni Association and the Ciba-Geigy Award of the American Society of Agronomy (ASA). He was also recognized as Fellow of ASA and of the Soil Science Society of America. He is a member of Sigma Xi, Omicron Delta Kappa, Alpha Zeta, Gamma Sigma Delta, and Phi Kappa Phi honorary societies.

Dr. Murphy and his wife, Sandy, will continue to reside in Manhattan, Kansas. A PPI office has been established there and the office at West Lafayette, Indiana, has closed. ■

Dr. Mark D. Stauffer Is the New Western Canada Director of PPIC

DR. MARK D. STAUFFER was recently appointed Western Canada Director of the Potash & Phosphate Institute of Canada (PPIC), effective May 1, 1988.

He will be responsible for PPIC research and education programs related to agricultural use of potash and phosphate in the four western provinces of Canada, formerly under the direction of Dr. James D. Beaton, PPIC Vice President. Dr. Beaton will continue some responsibilities in Canada, but will focus his main attention on increasing international programs.

A native of Ontario, Dr. Stauffer graduated from the University of Guelph and earned his Doctorate in Agronomy at Virginia Polytechnic Institute and State University. With a background in agricultural research, sales and management, he will expand on the agronomic programs already in place.

Dr. Stauffer

The appointment of Dr. Stauffer was made possible by the recent grant from the Government of Canada through the Western Diversification Program (WDP). ■

Dr. Sam Portch Joins PPI/PPIC as Deputy Director for China Programs

DR. SAM S. PORTCH has been named to the new position of Deputy Director, China Programs, of the Potash & Phosphate Institute (PPI) and Potash & Phosphate Institute of Canada (PPIC). He is stationed in Hong Kong and will work with China Programs Director Dr. Stephen F. Dowdle.

"The new appointment is a direct result of new funding made available to PPIC by the Government of Canada through the Western Diversification Program (WDP)," noted Dr. K.M. Pretty, President of PPIC. "With his demonstrated capabilities, Dr. Portch will help us increase current activities and expand to new locations in China."

Dr. Portch is a Canadian who earned undergraduate and graduate degrees in Soil Science from Macdonald College of McGill University and the University of Arkansas. He has experience in agricultural research and education programs in the developing countries of Asia and Latin America. His work has resulted in numerous publications in two languages and a host of soil fertility programs which have benefited farmers and the economies of developing countries. Dr. Portch has also been instrumental in establishing training programs to help local agricultural leaders upgrade their research and extension capabilities.

Dr. Portch

Currently, PPI/PPIC programs designed to increase agricultural production and potash use are underway in more than 10 provinces of China. The Ministry of Agriculture and provincial research institutions are the major cooperators with PPI/PPIC.■

A Note on Alfalfa Yields

IN RECENT YEARS, a yield of 10 tons/A or more for non-irrigated alfalfa has been an optimistic goal for many researchers and farmers. The goal has been achieved only rarely and those who have reached it agree that precise management is essential.

In the summer of 1987, University of Maryland scientists Dr. Les Vough and Dr. Morris Decker produced a top yield of 11.3 tons/A in a variety trial at Ellicott City, Maryland.

In the following article, Dr. Edward Jones of Delaware State College reports a yield of 12 tons/A in an alfalfa variety trial. Many consider this the highest yield of non-irrigated alfalfa ever recorded.

Research at high yield levels is important in identifying the management systems needed for growers to achieve maximum economic yield (MEY).■

Photo courtesy of Dr. Garry Lacefield, University of Kentucky

12 tons/A Non-irrigated Alfalfa— Breaking a Yield Barrier

By Edward Jones

Higher potash rates, improved varieties, more intensive harvest schedules, and a complete management system resulted in outstanding yields in this research.

BECAUSE maximum economic yield (MEY) production is the goal of progressive forage growers, the researcher evaluating alfalfa cultivars must incorporate practices that will allow for maximum expression of yield and persistence in comparison trials. Previous cultivar trials in Delaware have seldom yielded more than 6 tons/A/year when all entries are averaged. Soil fertility has been maintained at high levels, and fall growth was not harvested.

Unpublished research at Delaware State College indicated that alfalfa did not respond to high soil levels of phosphorus (P) and potassium (K). However, more recent studies at other experiment stations have shown response to fertilizer K. Therefore, we changed our philosophy when the latest cultivar trial was initiated in August 1985 on a Metapeake silt loam soil in Delaware.

Soil test levels prior to initiation of the study were: pH 6.7; P, 52 lb/A (medium); and K, 124 lb/A (medium). The site was fertilized with 200 lb/A each of P_2O_5 and K_2O before alfalfa was seeded. After the establishment year, plots were fertilized according to removal by a 10 ton/year crop using values of 15 lb P_2O_5 and 60 lb K_2O/ton. Application of the 150 lb P_2O_5 and 600 lb K_2O/A was split—one-half applied after both the first and third harvest, with 2 lb/A of boron (B) applied after both harvests.

Spring harvests were made at bud stage. Three regrowth harvests were then made at 35-day intervals before the fall rest period. The fourth harvests were made on August 25, 1986 and August 25, 1987. The 1986 growing season was extremely dry; therefore, the trial was not stressed by removing a fifth harvest. A fifth harvest was made October 22, 1987. The average date of first frost for the area is October 19.

Leafhopper sprays were applied once in 1986 and twice in 1987. Minor weed encroachment during a brief 1987 dry period was controlled chemically.

In 1987, the highest yielding cultivar produced 12.0 tons/year at 12% moisture. The top 10 cultivars averaged 11.6 tons/A, and the 34-cultivar trial averaged 11.2 tons/A. The top 10 cultivars produced an accumulative average yield of 19.3 tons/A for the first two harvest years of the trial, despite continual moisture stress during the 1986 growing season.

We have underestimated the yielding potential of alfalfa in Delaware. Our research showed that when P and K fertilizer rates were dramatically increased alfalfa appeared to respond accordingly.

Although yields were extremely good in 1987, the 1986 yields under dry conditions support the importance of K supply when plants are stressed by drought. The top 10 cultivars in 1986 averaged 7.8 tons/A even though June-October rainfall totaled only 11.9 inches. April-May rainfall data were not available at the test site. ■

Dr. Jones is Professor of Agriculture, Delaware State College, Dover, DE 19901

Maintaining Potassium Soil Test Level Is Key in Intensive Management of Alfalfa

By R.W. Sheard

High yields of alfalfa can quickly depress the soil test levels of potassium (K). This research in Ontario shows the importance of K fertilizer application during the lifetime of alfalfa stand, particularly with intensive management.

FOR OPTIMUM YIELDS AND PROFITS, alfalfa requires intensive management in frequency of harvesting, choice of cultivars, pest control, establishment procedures and irrigation, in addition to mineral nutrition.

This approach could be called "intelligent crop management."

The potassium (K) required for top yields must come from either soil or fertilizer sources. If fertilizer K_2O use is restricted, more soil K will be removed and soil test K_2O levels will drop. A key objective should be to avoid reducing soil test level over the lifetime of the alfalfa stand. How much fertilizer K_2O is required to prevent such a drop?

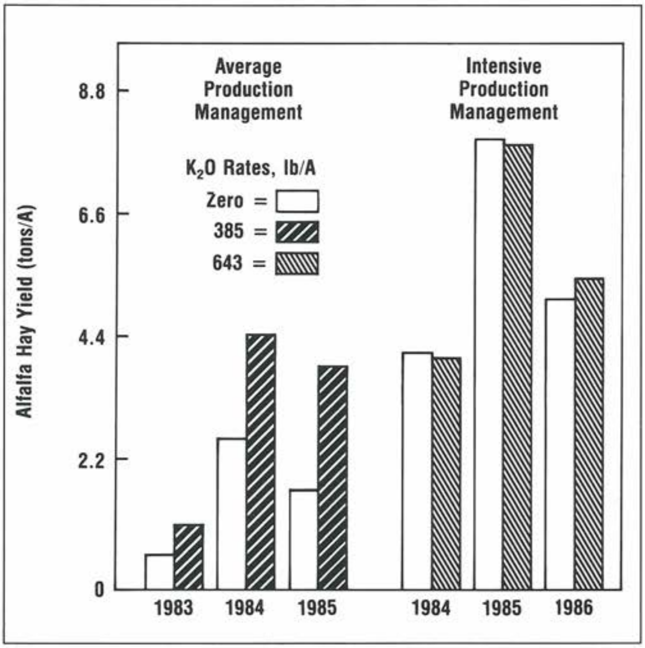


Figure 1. Comparison of alfalfa yield response with average production management (low initial soil test) and intensive management (high initial soil test).

Two similar experiments illustrate the effect of production level on soil test K. One was at an average level of production on a low K, silt loam soil. The other was at an intensive level of production on a high K, very fine sandy loam soil.

The low K soil, using an average three-cut production system, responded to K_2O in the establishment year and each of two hay years **(Figure 1).** The production level, however, reached a maximum at 4.98 tons/A (11.2 mt/ha).

The K_2O removal was equal to or less than the amount applied **(Figure 2).** As a result, the K_2O soil test (NH_4OAc exchangeable K) was increased

Dr. Sheard is with the Department of Land Resource Science, O.A.C., University of Guelph, Ontario.

each season by all rates beyond 64 lb K_2O/A.

Three consecutive years of K application, however, failed to achieve a soil test which would indicate a zero K_2O requirement at 150 ppm[1].

The high K soil, using an intensive five-cut management system, pest control and a higher yielding cultivar, did not respond to K until the third year **(Figure 1).**

Nevertheless, 86% more production was obtained over the three seasons than on the low K soil. The K removal was greater than the amount applied until 429 lb K_2O/A was used **(Figure 2).** In fact, during the major production year, over 600 lb K_2O/A was removed by alfalfa receiving 322 lb K_2O/A or more.

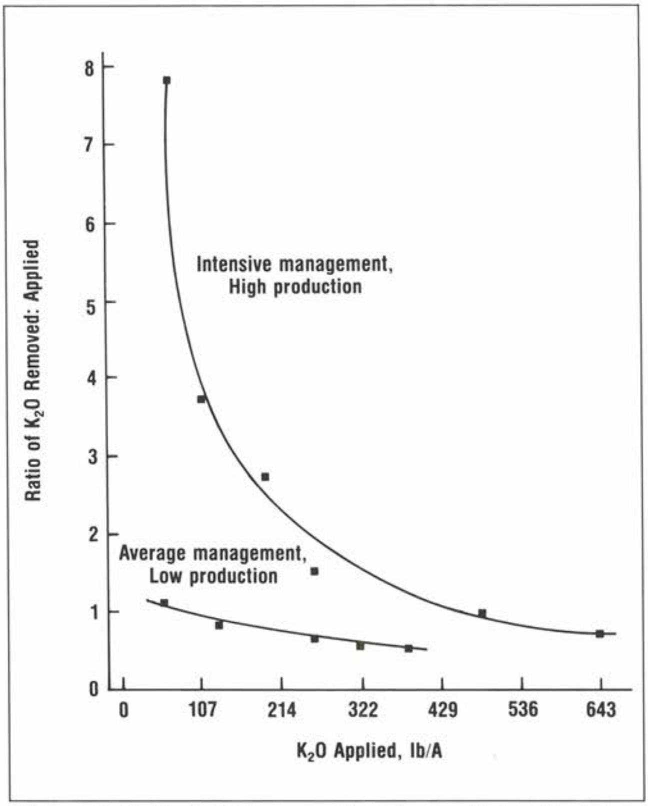


Figure 2. Ratio of K_2O removed to rates applied under intensive and average management production systems for alfalfa.

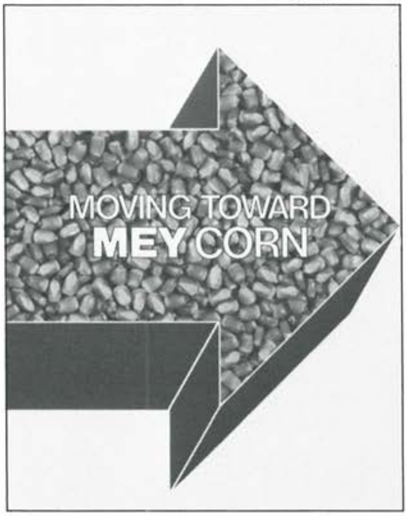
Although this soil initially had a soil test indicating a zero requirement for K_2O, the high level of alfalfa production rapidly decreased the soil test level. An application of 322 lb K_2O/A per year was necessary to maintain the soil test at the starting point.

Lower rates rapidly depleted the soil test level such that significant amounts of K would be required as the rotation moves to a corn crop.

Commencing with a low testing soil and an average production management system, more than three applications of 322 lb K_2O/A per year were required to increase the soil test to a zero requirement level. At the same time, under an intensive production management system, more than three applications of 322 lb K_2O/A per year were required to maintain the soil test at the zero requirement level.■

[1]Zero requirement according to Ontario soil test requirement for potassium on alfalfa (O.M.A.F. Publ. #296).

Moving Toward MEY Corn publication now available. See page 23.



Potash Boosts Nutritive Value and Yields of Coastal Bermudagrass

By Marcus M. Eichhorn, Jr. and Billy D. Nelson

Louisiana research found that potash fertilization boosted yields of Coastal bermudagrass hay and increased nutritive value. Crude protein and mineral content was high enough to meet needs of most classes of beef cattle. Digestibility was also improved.

THE ULTIMATE GOAL of our forage fertilization and management program is to produce a maximum economic yield (MEY) that will provide digestible nutrients required for reproduction, growth, and body maintenance of cattle with a minimum of supplemental feed.

A five-year study determined effects of potassium (K) fertilization on the nutritive value of harvested Coastal bermudagrass forage at MEY on Coastal Plain soil. An existing planting on Mahan fine sandy loam soil was chosen for the experimental site. Hay yield from the site had declined to an estimated 60% of yield potential after 11 years of hay cropping; severe stand loss was evident. Soil K at 0 to 6-inch and 6 to 12-inch depth was very low, even though fertilizer K had been applied annually at rates up to 100 lb/A of K_2O.

Rates of K_2O up to 600 lb/A were applied annually for five years and in two and four split applications. Each year, fertilizer nitrogen (N), phosphate (P_2O_5), sulphur (S), and boron (B) were applied at 400 (100/cutting)-150-90-2 lb/A. Dolomitic limestone was applied at 2 tons/A in 1979 and one ton/A in 1983. Forage was harvested four times annually, except in 1983 when drought prevented the grass from producing a fourth cutting. Grass was harvested at early seedhead growth stage.

Digestible Dry Matter and Quality Factors

Digestible dry matter, that fraction of a forage digested and utilized by ruminant animals for production, is the most important forage component from a quality standpoint. Feeding trials with stocker steers have shown that a 1% increase in digestibility of bermudagrass forage will increase average daily gain by 5%.

Forage digestibility increased as K_2O was increased from 100 to 400 lb/A, **Table 1.** Where MEY was produced with 400 lb/A of K_2O applied annually, forage digestibility averaged 1.7% higher than that produced without K fertilizer during the five-year study.

A 1% increase in K concentration, increased forage digestibility 12% within the digestibility range of 44 to 68%.

Potassium fertilizer not only increased yields but produced forage that was lower in neutral-detergent fiber (NDF), acid-detergent fiber (ADF), and acid-insoluble lignin (AIL) and higher in cell content (CC) than forage produced without K fertilizer.

MEY was produced over five years where K fertilizer was applied at 400 lb/A of K_2O. Data for 1984 indicated that maximum animal performance should

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Table 1. Effects of K fertilization on mean forage yields and digestible dry matter (DDM) and concentrations of neutral-detergent fiber (NDF), acid-detergent fiber (ADF), acid-insoluble lignin (AIL), and cell content (CC) in Coastal bermudagrass, 1984.[1]

Annual K_2O rate	Forage yield	DDM Mean	Forage component			
			NDF	ADF	AIL	CC
lb/A	lb/A	'80-'84	-----%-----			
	Among rates over all application frequencies					
0	6,733	53.3	69.4	33.4	5.0	26.2
100	12,798	54.5	69.1	32.7	4.2	27.0
200	14,795	54.6	69.0	32.7	4.1	27.5
400	15,700	55.0	68.9	32.4	4.1	27.1
600	15,841	55.0	68.7	32.3	4.2	26.7
	**		*	**	**	*

*F value significant at 5% level of probability. **F value significant at 1% level of probability.
[1]Concentrations of all forage components were determined only on forage harvested in 1984.

occur when forage grown at MEY level of K fertilization is fed to cattle.

Crude Protein and Mineral Concentrations

Animal nutritionists have proposed that daily crude protein requirements for beef cattle are satisfied by feeding a ration ranging in crude protein from 5.9% for dry cows to 13.9% for finishing steers. Moreover, the ration should contain concentrations of phosphorus (P), calcium (Ca), and magnesium (Mg) at 0.22, 0.22, and 0.18%, respectively, to satisfy the daily mineral requirements of these cattle. In addition, a ration having a Ca to P ratio of 2:1 is considered most desirable for feeding cattle. Data in **Table 2** reveal that crude protein, mineral concentrations of P, Ca, and Mg, and ratio of Ca to P in harvested forage were ample to meet the ration requirements for most classes of beef cattle, irrespective of annual K fertilization rate.

Summary

The effects of K fertilization on the nutritive value of Coastal bermudagrass were determined for five years on a K-deficient Coastal Plain soil. Forage was cut and harvested four times annually in early seedhead development.

Results show that K fertilization was essential for maintaining the nutritive feed value of Coastal bermudagrass harvested for hay. Forage produced MEY where 400 lb/A of K fertilizer was applied annually. Forage digestibility was 1.5% higher than similar forage produced with no K fertilizer. The K-fertilized forage was also higher in cell content and lower in antiquality components including neutral-detergent fiber, acid-detergent fiber, and acid-insoluble lignin. Concentrations of crude protein and minerals in forage were ample to meet the daily ration requirements of most classes of beef cattle. ■

Table 2. Effects of K fertilization on the mean concentrations of crude protein and minerals in Coastal bermudagrass forage, 1980-84.

Annual K_2O rate	Crude Protein			P%	K%	Ca%	Mg%	Ca:P
	1980	1984	avg.					
lb/A	-----%-----				-----5-year average-----			
0	13.2	15.2	15.0	0.23	0.77	0.40	0.23	1.7:1
100	13.1	15.1	14.2	0.22	1.17	0.38	0.22	1.7:1
200	12.7	14.9	13.8	0.21	1.46	0.38	0.21	1.8:1
400	13.1	15.2	13.9	0.20	2.00	0.38	0.18	1.9:1
600	12.7	15.4	13.8	0.20	2.24	0.38	0.17	1.9:1
	ns	ns	**	**	**	ns	**	ns

nsF value not significant at 5% level of probability.
*F value significant at 5% level of probability.
**F value significant at 1% level of probability.

Six Graduate Students Selected for J. Fielding Reed PPI Fellowships

SIX OUTSTANDING graduate students have been named as 1988 winners of the "J. Fielding Reed PPI Fellowships" awarded by the Potash & Phosphate Institute (PPI). Grants of $2,000 each are presented to the individuals. All are candidates for either the Master of Science (M.S.) or the Doctor of Philosophy (Ph.D.) degree in soil fertility and related sciences.

The 1988 recipients were chosen from nearly 50 applicants who sought the Fellowships. The six are:

- **Jessica G. Davis-Rainey, Texas A&M University,** College Station, Texas;
- **Matthew J. Eick, University of Delaware,** Newark, Delaware;
- **Seth H. Frisbie, Cornell University,** Ithaca, New York;
- **Stuart J. Georgitis, Montana State University,** Bozeman, Montana;
- **Brian J. Lang, University of Minnesota,** St. Paul, Minnesota;
- **Richard P. Wolkowski, University of Wisconsin,** Madison, Wisconsin.

"We are very pleased to offer this recognition and encouragement for an elite group of young scientists. All of the applicants for the Fellowships have impressive records," said Dr. R.E. Wagner, President of PPI and the Foundation for Agronomic Research (FAR). "These individuals and their educational institutions can be justly proud."

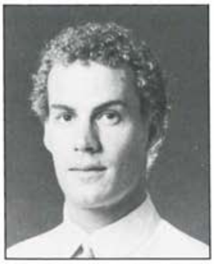
Scholastic record, excellence in original research, and leadership are among the important criteria evaluated for the Fellowships. Following is a brief summary of information for each of the winners.

Jessica G. Davis-Rainey is a candidate for the Ph.D. (Doctoral) degree in Soil Fertility at Texas A&M University. Her research program involves root distribution of sorghum and millet as influenced by fertilization and soil physical and chemical properties. She conducted research in West Africa and has gathered considerable data on intercropping and the soil-root-nutrient system. Previously, Ms. Davis-Rainey completed a B.S. degree at Cornell University and a M.S. degree at Texas Tech University, where Dr. H.M. Taylor was her major professor. She graduated from Abington (Pennsylvania) High School and has an outstanding record academically and in other activities. Dr. L.R. Hossner serves as chairman of her Ph.D. research advisory committee.

Matthew J. Eick is pursuing the M.S. degree at the University of Delaware. His research program is concerned with the effect of salinity on potassium (K) reactions in soils and soil fractions. Data from Israeli and Delaware soils will be used with plant uptake and yield data to model the effects of saline (salt) water on K availability and mobility. This information should have implications for quality of water used in crop irrigation in many areas of the world. Mr. Eick earned his B.S. in Agronomy-Soil Science at Virginia Polytechnic Institute and State University, graduating with honors (cum laude). A native of New Jersey, he has also been a leader in various community and charitable groups. His program of research is under the direction of Dr. D.L. Sparks.

Seth H. Frisbie is seeking the Ph.D. degree in Soil Fertility at Cornell University. His research is addressing the loss of nitrogen (N) by ammonia volatilization. His hypothesis is that, with proper organic matter management, the loss of N due to ammonia volatilization can be significantly reduced. As part of his M.S. program, also at Cornell, Mr. Frisbie developed an analytical technique for measuring inorganic carbon in small volumes of solution. A native of Massachusetts, he graduated with honors from the University of Massachusetts at Amherst and currently is a member of three national honor societies. His Ph.D. work is under the direction of Dr. D.R. Bouldin.

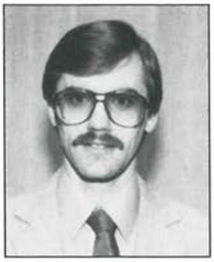
Jessica Davis-Rainey



Matthew J. Eick

Seth H. Frisbie

Stuart J. Georgitis



Brian J. Lang

Richard Wolkowski

Stuart J. Georgitis is working toward the Ph.D. degree in Soil Fertility at Montana State University. His program concerns improvement of soil testing methodology for K, phosphorus (P), and sulphur (S) by development of a multi-element extraction technique—the phytoavailability soil test (PST). Such a technique could be a more reliable and practical tool in soil analysis and should also serve as a scientific tool for understanding soil-plant interactions and ion movement in soils. A native of Maine, Mr. Georgitis attended Colby College and received his B.S. and M.S. degrees from the University of Maine. He has also been involved in various college and community activities. Dr. Earl O. Skogley serves as advisor for his Ph.D. program.

Brian J. Lang is a candidate for the Ph.D. degree in Agronomy-Plant Physiology at the University of Minnesota. His research is directed at understanding the roles of K, harvest management and cultivar in dinitrogen fixation and winter survival of alfalfa. The hypothesis is that the degree of dinitrogen fixation may affect the coldhardiness and winter survival of the plant. In a related study, he will determine the effect of cultivar and K fertilization on photosynthate partitioning of alfalfa during cold acclimation. A native of Wisconsin, Mr. Lang received the B.S. and M.S. degrees from the University of Wisconsin. Dr. Craig C. Sheaffer serves as major advisor for his Ph.D. program.

Richard P. Wolkowski is pursuing the Ph.D. degree in Soil Science at the University of Wisconsin-Madison. His research project is investigating soil compaction and plant nutrient interactions. He is seeking to assess the effects of soil compaction on the plant availability of nutrients and the crop response to applied N, P and K. Results indicate that detrimental effects (reduced corn yields) from soil compaction may be partly offset by fertility management, particularly row-applied K. Mr. Wolkowski recently relinquished his staff appointment in Cooperative Extension in order to devote full-time to his Ph.D. program. He earned his B.S. and M.S. degrees at the University of Wisconsin. His Ph.D. work is under the supervision of Dr. Larry G. Bundy.

The Fellowship winners are selected by a committee of individuals from PPI and the PPI Advisory Council. The Fellowships are named in honor of Dr. J. Fielding Reed, retired President of PPI; Dr. Reed continues to serve on the Selection Committee.

"Each year, we admire the attitude, dedication and commitment shown by applicants for the Fellowships. The 1988 group carries the same high level of achievement, not only in academic work but also in other aspects of their lives," Dr. Reed stated.■

No-till, P_2O_5 Boost Corn Silage Yields and Increase Root Distribution in Soil

By V.C. Baligar and R.J. Wright

A tillage study on acid, infertile soils shows higher corn silage yields with no-till. Root system weight and length were greater with no-till and could have contributed to enhanced absorption of water and P.

THE APPALACHIAN REGION of the eastern United States is losing soil to erosion at twice the national average because of its topography, soils and climate. Conservation tillage practices that maintain a sod cover and minimize erosion are necessary for crop production.

Plant-available phosphorus (P) in the acid, infertile soils of the region frequently limits crop production.

This study was conducted to determine the effect of tillage method and P rate on corn silage yield, P concentration in plants and distribution of roots and P forms in the soil profile.

A field experiment was established in 1983 near Beckley, West Virginia, on a Gilpin silt loam soil (elevation 2,700 feet). Tillage treatments (conventional till, no-till) were the main plots and P rates (50, 100, 200 and 400 lb/A P_2O_5) were the subplots. The conventional till plots were plowed and disked twice the first year and rototilled in subsequent years. The no-till plots were in an orchardgrass sod and received atrazine and paraquat at rates of 3 and 0.5 lb/A, respectively. Both tillage treatments received annual broadcast applications of N and K_2O at rates of 150 and 110 lb/A, respectively. During the first year, one ton/A of dolomitic lime was applied. The four P treatment rates were broadcast annually. Corn was planted using a no-till planter at a rate of 25,000 plants/A with a 30-inch row spacing.

At the dent stage, two 10-foot sections of row were harvested in each plot for silage yield determination. Dried silage samples were ground and analyzed for P. Soil cores were taken to determine the influence of treatment on corn root distribution and forms of P in the soil profile. Cores were taken perpendicular to the corn row and at a distance of 1, 8, and 15 inches from a plant. The cores were sectioned into depth intervals. Extractable P, organic P and root distribution were determined in each section.

Table 1. Corn silage yield (65% moisture) by tillage method and P rate.

	Silage Yield (tons/A)[1]			
	1983		1984	
P_2O_5 rate lb/A	Conventional	No-till	Conventional	No-till
50	9.9	16.6	13.2	15.8
100	11.3	23.0	15.2	16.7
200	12.5	22.1	17.7	18.9
400	20.5	25.5	18.8	18.8

[1]Values in the table represent a mean from 4 replications.

The authors are with USDA-ARS, Appalachian Soil and Water Conservation Research Laboratory, Beckley, West Virginia.

Table 2. Influence of tillage methods and P_2O_5 rates on root growth and P concentration of silage corn.[1]

Tillage Method	P_2O_5 rate	Root weight	Root length	Core Distance from plant - inches			Silage P Conc.
				1	8	15	
	lb/A	lb/plant	ft/plant x 10^3	----------ft/plant----------			%
Conventional Till	50	0.050	11.9	148	105	98	0.13
	400	0.060	14.2	220	98	102	0.16
No-till	50	0.079	17.9	272	151	108	0.15
	400	0.077	19.5	239	194	118	0.33

[1]Values in the table represent mean of three replications over a three-year period.

Silage Yields

Corn silage yields from the 1983 and 1984 harvests are shown in **Table 1.** In 1983, yields under no-till were higher than those under conventional tillage. Differences were particularly noticeable during 1983 at the low P rate where silage yield was 68% greater in the no-till system. In 1983, the lowest P rate (50 lb/A P_2O_5) under no-till produced a greater silage yield than 200 lb/A P_2O_5 with conventional tillage. Overall silage yields were lower in 1984 than 1983. Conventional and no-till produced similar silage yields at the highest P rate in 1984. Silage production in no-till was still greater than conventional till at the low P rates. Phosphorus utilization was more efficient under no-till in the first few years of cropping on this soil.

Root Distribution and P Concentration

The no-till treatment (**Table 2**) gave higher root weight and root length than the conventional till treatment. In both tillage methods, increasing P rates increased root growth. In both the tillage methods the majority of the roots were found close to the plant row. Silage P concentration was higher in the no-till system than in the conventional till system; this trend was observed at both P levels.

Phosphorus Distribution in Soil Profile

Extractable P, organic P and inorganic P values are given as a function of treatment and depth in **Table 3.** Bray-1 extractable P levels were similar for a given

(continued on page 17)

Table 3. Influence of tillage method and P treatments on amounts and forms of P in the soil profile.

Tillage	Depth, inches	Phosphorus[1] Extractable	Inorganic	Organic
		---lb/2 million lb of soil---		
		50 lb/A P_2O_5		
Conventional Till	0-1	124	344	462
	1-2	24	186	502
	2-3	12	128	508
	3-6	6	100	486
		400 lb/A P_2O_5		
	0-1	484	1,580	480
	1-2	208	648	632
	2-3	94	362	520
	3-6	24	190	486
		50 lb/A P_2O_5		
No-till	0-1	114	338	632
	1-2	30	160	640
	2-3	10	118	530
	3-6	6	94	530
		400 lb/A P_2O_5		
	0-1	620	1,808	1,448
	1-2	172	584	600
	2-3	50	240	544
	3-6	12	118	480

[1]Extractable Bray-1 P. Inorganic and organic P by Olsen and Sommers. 1982. Soil Analysis Part 2. American Soc. of Agronomy Publication.
Values represent an average for 1983, 1984, 1985.

In Tennessee

Resource Management Program Achieves Conservation and Profits on Farms

By Estel Hudson

Tennessee farmers are enrolled in this conservation program to reduce erosion and improve water quality without having an adverse effect on net farm profit. The program began in 1979. Farmers in the top quarter of farm income produced higher yields and had lower per acre machinery costs than those farmers in the lower quarter of farm income. The bottom quarter recorded a net farm loss.

THE TENNESSEE RESOURCE Management Conservation (RMC) Farm Program is a cooperative effort of the Tennessee Cooperative Extension Service, SCS, TVA, ASCS, FHA, and the Forest Service. The RMC program places an educational emphasis on farm management, soil erosion, and improved water quality. Its overall purpose is to demonstrate that soil erosion can be reduced to acceptable levels—without an adverse effect on net farm income—by making appropriate adjustments in farm resource use.

Objectives of RMC demonstrate that:

- **Current technology is available to maintain acceptable soil losses and improve water quality;**
- **Conservation measures can be adapted to a commercial farm without adversely affecting farm income;**
- **Adoption of conservation measures can be promoted through the use of various media methods.**

Farmers are accepted to participate in the RMC program if their farm offers the opportunity to demonstrate solutions to resource problems. On selected farms, a farm plan is developed after a resource inventory. The cooperating agencies offer help and guidance to the enrolled farmers. Accurate farm records are essential.

RMC FARM TOUR in Hardeman County, Tennessee

Net farm income is the return to unpaid labor, operator's capital and management. Two drought years, 1980 and 1983, reduced net farm income for the enrolled farms. In general, those farmers who followed the proposed farm plan had the highest net farm income, except in 1980. Farmers who followed the farm's crop plan (but not livestock) ranked next in net farm income; farmers who did not follow the plans had the lowest net farm income.

Successful farmers in the RMC program had farm plans developed that selected the correct farm enterprises to fit

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Table 1. Comparison of top 25% and bottom 25% of RMC program farms.

Item	Top 25%	Bottom 25%	Difference Top/Bottom
Total investment	$477,142	$426,911	+$50,231
Net farm income	52,700	-35,688	+$88,388
Open acres	794	840	-46 acres
Soybean acres	428	460	-32 acres
yield, bu/A	28	23	+5 bu
Cotton acres	312	306	+12 acres
yield, lb/A	590	468	+122 lb
Corn acres	183	176	+7 acres
yield, bu/A	100	81	+19 bu
Wheat acres	168	189	-21 acres
yield, bu/A	41	35	+6 bu
Machinery cost, $/A	58	70	-$12
Fertilizer & Lime Cost, $/A	28	21	+$7
Days of work/worker	201	170	+31

Six-year average, 1981-86

their farm resources and then managed and followed those plans to produce profitable high yields over the life of their enrollment in the program.

There was a large difference in net farm income of the top one-fourth of farms and the bottom one-fourth. See **Table 1.**

About 81% of the difference in net farm income between the two groups can be accounted for in higher yields (68%) and lower per acre machinery costs (13%) of the top one-fourth.

Much of the difference in yields came from higher soil fertility, better weed control, and timeliness of farm operations. Lower machinery costs resulted from fewer trips over the fields, better maintenance, and purchase of used machinery instead of new. The top one-fourth had lower repair costs and less depreciation. Interest cost was figured at 9% on all farms.

Also the top one-fourth had improved marketing of crops. For example, they averaged 30 cents more per bushel on soybeans sold over a seven-year average. In 1986, the top one-fourth spent $28/A for fertilizer and lime, while the lower one-fourth spent only $21/A.

The Tennessee RMC program successfully demonstrates that soil erosion can be controlled and water quality improved. Using present farm technology, net farm income can be maintained or improved. Farmers should seek all available help to inventory farm resources and fit crop and livestock enterprises to those resources. ■

No-till...from page 15

P addition in both the no-till and conventional till treatments.

The no-till treatments had higher organic P levels, especially in the zero to one-inch depth. This could enhance P availability in the no-till treatments relative to the conventional till treatments. Phosphorus concentrations in the silage were 15% and 106% higher in the 50 and 400 lb/A P_2O_5 no-till treatments than the conventional till treatments (**Table 2**).

Summary

Corn silage yields were generally greater under no-till than conventional till in the current study. Yield differences were especially noticeable at low P application rates. Root system weight and length were greater under no-till and could have contributed to enhanced absorption of water and P. Analysis of forms of soil P with depth indicated a buildup of organic P in the surface layers of the no-till treatments. These reserves of organic P should serve as a source of P for future crops. ■

In Western Canada

Residual Phosphorus Application Effective for Cereal Crops

By T.L. Roberts and J.W.B. Stewart

Broadcasting large, single applications of phosphate (P_2O_5) fertilizer can sustain cereal production in western Canada, over a several year period, as effectively as small annual additions of seed-placed phosphorus (P).

THE IDEA of broadcasting and incorporating fertilizer phosphorus (P) appears to contradict current thinking about fertilizer placement.

Many studies have shown that banding fertilizer P with or near the seed results in a greater efficiency of fertilizer P and crop yield response when compared to broadcast and incorporation of P **(Figure 1).** However, the agronomic advantages of banding fertilizer P over broadcasting are apparent at only low application rates. Banding is successful because it places a concentrated source of available P near the growing plant roots.

When in a concentrated band, the fertilizer has less exposure to the soil and hence less opportunity to be converted into less available forms. The problem with banding is that plant roots explore a very small percent (less than 3%) of the total soil volume and P is very immobile in the soil.

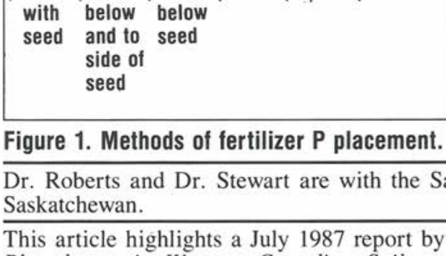

Figure 1. Methods of fertilizer P placement.

The ideal situation would be to fertilize the entire volume of soil, thus ensuring greater access of plant roots to immobile nutrients like P. The transformation of applied P into less available forms is a relatively slow process. When applied in large amounts sufficient P remains available to growing crops for several years.

Recent studies in Saskatchewan and Manitoba have shown residual applications of fertilizer P to yield as well and often better than annually applied seed-placed P for periods of up to 8 years. One study, in Saskatchewan, found a combination of large, single P application with annual seed-placed treatments produced a better yield than either treatment applied alone **(Figure 2).** In this trial, the maximum yield required a total fertilizer input of 180 kg P/ha (80 kg P/ha broadcast initially and 20 kg P/ha applied annually) over a 5-year period. Two other combinations, a broadcast application of 40 kg P/ha with 10 kg P/ha seed-placed annually and a broadcast application of 80 kg P/ha with 2.5 kg P/ha seed-placed annually, produced yields greater than 95% of the maximum and required only 90 and 92.5 kg P/ha, respectively.

In the above study, detailed investigations of the forms of applied P remaining in the

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This article highlights a July 1987 report by the authors, titled *Update of Residual Fertilizer Phosphorus in Western Canadian Soils* available from the Department of Soil Science, University of Saskatchewan, Saskatoon, Sask. S7N 0W0.

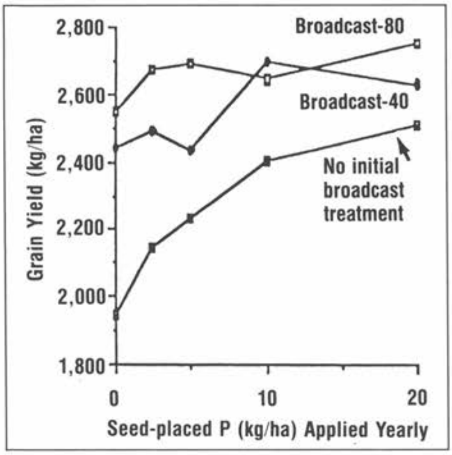

Figure 2. Grain yields (5-year means) from plots receiving P treatments of 20, 40, 80 kg P/ha and annual seed-placed treatments of 0, 2.5, 5, 10 and 20 kg P/ha.

soil showed that after 5 years less than 15% had been converted to unavailable forms. The remaining fertilizer P should be available for subsequent crops for many years.

When applying high rates of fertilizer P, the potential interaction with other nutrients must be considered. Research has shown that maximum residual crop response to applied P can be expected only if sufficient fertilizer nitrogen (N) was supplied or available N was present in the soil.

Significant interactions between applied P and micronutrients have also been found. Zinc (Zn) is particularly sensitive to P fertilization. High application rates of P are known to induce a Zn deficiency which can have a yield-limiting effect. However, this deficiency can be alleviated by the application of Zn fertilizer.

The apparent long-standing effects of residual fertilizer P offer several agronomic advantages for crop production in western Canada. A moderate to large one-time application of fertilizer P provides a viable alternative to the traditional approach of applying small amounts of P annually with the seed. A large, single application of P prior to crop initiation could be particularly important in supplying the P requirements for the future.

Residual P applications also provide a means of overcoming the variable P deficiency that is commonly associated with eroded knolls and leveled land. Other advantages include supplying P for crops such as canola or flax which are sensitive to large amounts of fertilizer P placed with or close to the seed.

The question arises as to the profitability of residual P applications. Cost benefit analysis using Saskatchewan yield data, current fertilizer P costs, simulated grain prices and discount interest rates has shown that 80 kg P/ha broadcast initially can be as economically viable as 20 kg P/ha seed-placed P applied annually over a 5-year period **(Table 1).**

Thus, the utilization of residual fertilizer P may now be considered a viable management option for cereal production in western Canada, particularly in the calcareous, high pH soils of Brown, Dark Brown and Black soil zones. Residual application of fertilizer P may not be practical in areas with low pH soils (i.e. less than pH 7.0) because of the formation of different fertilizer reaction products.■

Table 1. Net present value ($/ha) of return for dollars invested in fertilizer[1] for an initial single broadcast P application and annual seed-placed P applied consecutively for 5 years.

Interest Rate	Grain Price ($/tonne)[2] 150	225	300	150	225	300
	Broadcast 80 kg P/ha			Seed-placed 20 kg P/ha		
(%)	Net Present Value ($/ha)					
8	$317.34	$509.71	$702.08	$273.75	$445.33	$616.92
10	302.85	487.97	673.10	259.20	422.37	585.53
12	289.45	467.88	646.31	245.82	402.23	556.64

[1]Assumes a P fertilizer cost of $0.78/kg P (equivalent to $0.35/lb P or $0.15/lb P_2O_5).
[2]Grain prices are equivalent to $/bu as follows: 150 = $4.08; 225 = $6.12; 300 = $8.16.

Units in this article are given in metric numbers for greater usefulness in Canada. The following factors can be used to convert to English units: multiply kg P/ha by 2.05 to equal lb P_2O_5/A; multiply $/ha by 0.405 to equal $/A.

Comparison of DRIS and M-DRIS for Diagnosing P and K Deficiencies in Soybeans

By W.B. Hallmark

This research determined that modifying the DRIS to include nutrient concentrations (M-DRIS) improved nutrient diagnoses by detecting situations where nutrients were not limiting yields.

THERE IS GROWING INTEREST in using the Diagnosis and Recommendation Integrated System (DRIS) as a tool to detect nutrient deficiencies in crops. Though DRIS has done well in detecting deficiencies, it has a flaw. It diagnoses that at least one nutrient is limiting each time it is used, and, therefore, does not provide a mechanism to distinguish between situations where nutrients do and do not limit yields.

DRIS and M-DRIS Data Bases

DRIS and modified-DRIS (M-DRIS) soybean nutrient norms **(Table 1)** were developed from full-bloom trifoliate leaves from 532 soybean samples yielding in excess of 52 bu/A. While the DRIS uses only nutrient ratios in formulating diagnoses, the M-DRIS uses both concentrations and ratios.

Table 1. DRIS and M-DRIS soybean nutrient norms developed from published data.

Variable	$\overline{X}$	CV
	%	
n/dm	4.91	0.108
p/dm	0.329	0.165
k/dm	1.97	0.183
ca/dm	1.09	0.368
mg/dm	0.332	0.248
n/p	15.2	0.126
n/k	2.63	0.200
n/ca	5.00	0.288
mg/n	0.0684	0.308
p/k	0.172	0.216
p/ca	0.331	0.286
p/mg	1.04	0.238
k/ca	2.01	0.350
mg/k	0.175	0.354
mg/ca	0.322	0.264

Diagnoses of P and K Deficiencies

Tissue nutrient concentrations from four soybean cultivars from a lime x phosphorus (P) x potassium (K) soil fertility study in Iowa were used to compare the ability of DRIS and M-DRIS to diagnose whether P or K were deficient. Treatments with more than 2 bu/A yield responses to P or K application were considered deficient, while those with smaller responses were considered nondeficient.

Table 2 shows that DRIS was more accurate than M-DRIS in detecting P and K deficiencies in soybeans. However, in six of the nine cases where DRIS detected P and K deficiencies overlooked by M-DRIS, yield responses would have been less than 4.0 bu/A; in only three cases would yield response to P or K have been 4.0+ bu/A. This lack of precision by M-DRIS was more than compensated for, because of its ability to detect 48 of 73 cases where P and K were not deficient. This was not the case when using DRIS, where all 73 situations were incorrectly diagnosed as deficient.

Though M-DRIS was superior in its overall diagnoses, it still failed to detect six P deficiencies and 12 K deficiencies and incorrectly diagnosed 25 treatments as deficient when this was not the case **(Table 2).** However, in only two of the incorrect P diagnoses and one incorrect K diagnosis would yield responses to these

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Table 2. Accuracy of P and K deficiency diagnoses by the DRIS and M-DRIS.

Situation	Diagnoses	DRIS	M-DRIS
1) P most deficient	correctly diagnosed	5	2
2) P most deficient	incorrectly diagnosed	3	6
3) K most deficient	correctly diagnosed	37	31
4) K most deficient	incorrectly diagnosed	6	12
5) Nutrients not deficient	correctly diagnosed	0	48
6) Nutrients not deficient	incorrectly diagnosed	73	25

elements have been greater than 4.0 bu/A.

Furthermore, in five of the 25 cases where P and K were incorrectly diagnosed as deficient, yield responses of 0.5 to 1.9 bu/A would have been obtained with either P or K addition. However, in the remaining 20 cases P and K fertilizer applications based on M-DRIS diagnoses would have resulted in a waste of fertilizer. This demonstrates the need to further develop and refine the M-DRIS to improve its diagnoses.

Summary

Results in this study show that the M-DRIS did better than DRIS in detecting situations where P and K were not deficient in soybeans. M-DRIS also did well in detecting K deficiencies. Use of the M-DRIS should help producers increase their profit margins through a better understanding of when to apply or not apply nutrients to crops. Further work is needed to improve the accuracy of nutrient diagnoses by M-DRIS.■

Louisiana Research

High-Population Sugarcane Increases Need for N and K

By Ray Ricaud and Allen Arceneaux

The wide-furrow method of planting sugarcane looks promising for increasing yields, but information available on fertilization requirements is limited. This study provides some guidelines.

THE WIDE-FURROW method of planting sugarcane offers the advantages of increased stalk populations and higher cane yields than conventional single drill methods. The system consists of planting cane in furrows 16 to 22 inches wide, at an average rate of three to four continuous lines of stalks in each furrow on row spacings 6 feet wide.

This technique has the potential to boost state average yields at least 20% (from 25 to 30 tons/A). The yield increase is apparently due to less competition among plants and better utilization of sunlight, especially early in the growing season.

(continued on next page)

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Sugarcane...from page 21

Limited fertilization information has been available on high population, wide-furrow cane production.

Experiments were conducted at the LSU St. Gabriel Research Station and on farmer production fields at Allendale Plantation, Port Allen, and Patout Plantation, near Jeanerette, with plant cane and first stubble cane from 1980 to 1985. All location information on varieties, crop year, soil test data and soil types used in the experiments is given in **Table 1.**

Table 1. The year, location, soil type, cane variety and soil analysis for the six fertilizer experiments with sugarcane.

	Experiment Number					
	1	2	3	4	5	6
Year	1980-81	1980-81	1981-82	1982-83	1984-85	1981-82
Location[1]	AD	---------- St. Gabriel ----------				MAP
Soil type	---------- Commerce silt loam ----------					Jeanerette sil
Cane variety	CP70-330	---------- CP65-357 ----------			CP72-370	CP65-357
Cane crop	Plant 1st stubble	Plant 1st stubble	Plant 1st stubble	Plant 1st stubble	Plant 1st stubble	1st stubble 2nd stubble
			Soil test analysis			
K, ppm	137	142	61	97	62	61
Ca, ppm	1,758	1,880	1,577	2,003	1,566	1,126
Mg, ppm	387	414	303	366	277	302
P, ppm	206	196	168	168	249	53
Organic Matter, %	0.82	1.06	0.31	0.81	1.47	0.70
pH	7.3	6.5	7.9	7.0	6.8	5.9

[1] AD = Allendale Plantation; St. Gabriel = Research Station; MAP = M.A. Patout Plantation.

Nitrogen (N) and potassium (K) were studied at St. Gabriel and Allendale. Phosphorus (P), N and K were studied at Patout.

The cane was planted during September and October and the fertilizer treatments were applied in the off-bar burrows during the following April of each crop year. Harvests were during November and December.

Summary of Results

Results indicate that fertilizer needs for high population sugarcane are 120 and 150 lb/A N for plant and stubble cane, respectively, on Commerce soil. Stubble cane on Jeanerette soil needs 160 lb/A. Higher N rates did not increase yield.

Commerce soil is low in extractable soil K; potash fertilizer is needed at rates up to 180 lb/A with plant cane and 90 lb/A with stubble cane. Higher potash rates increased stubble yields in one crop year. Jeanerette soil is low in soil P and K; rates of at least 40 lb/A phosphate and 140 lb/A potash are needed with a 160 lb N rate for stubble cane.

The current recommended rates of 160 lb/A of N for stubble cane on both soil types and 40 lb/A of phosphate for stubble cane on Jeanerette soil are adequate for high population cane. However, high population cane needs more than the recommended 80 lb/A rate of N and potash for plant cane on Commerce soil and of potash for stubble cane on Jeanerette soil.■

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