BETTER CROPS
WITH PLANT FOOD

2003 Number 1

In This Issue

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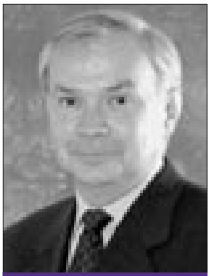
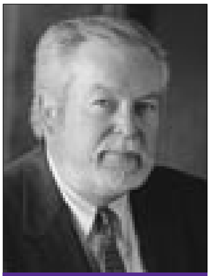


M.M. Wilson

Michael M. Wilson, President and Chief Operating Officer (COO) of Agrium Inc., was elected Chairman of the Potash & Phosphate Institute (PPI) Board of Directors at a recent meeting. He will also serve as Chairman of the Foundation for Agronomic Research (FAR) Board for the coming year. **Charles O. Dunn**, President and Chief Executive Officer (CEO) of Mississippi Chemical Corporation, was elected Vice Chairman of the PPI and FAR Boards.

"With the extensive experience, achievement, and leadership of these men, we welcome them to these important responsibilities for the Institute in the year ahead," said Dr. David W. Dibb, PPI President.



C.O. Dunn

Mr. Wilson joined Agrium (formerly known as Cominco Fertilizers) in 2000 with more than 25 years of management experience in the chemical industry. He is responsible for North American Wholesale (Operations & Technical Services, Marketing and Distribution, and Supply Management), North American Retail, South America, Environment, Health and Safety, and Human Resources. He is a graduate of the University of Waterloo, Ontario, with a Degree in Chemical Engineering.

Agrium is a leading global producer and distributor of fertilizers and other agricultural products and services. The company produces and markets four primary groups of fertilizers: nitrogen, phosphate, potash, and sulfur.

Mr. Dunn, new Vice Chairman of the PPI and FAR Boards, joined Mississippi Chemical in 1978 and began work in the Legal Department. After holding positions in the Finance Division and as president of a subsidiary, he was promoted to Executive Vice President and COO in 1989 and in 1993 became President and CEO. The next year he led the restructuring of Mississippi Chemical from an agricultural cooperative to a publicly traded company.

A native of Mississippi, Mr. Dunn graduated with honors from The Citadel. After serving in the U.S. Army for two years, he attended the University of Alabama School of Law and graduated in 1975.

In other action of the PPI Board, William J. Doyle was elected Chairman of the Finance Committee. Mr. Doyle is President and CEO of PotashCorp. BC

PPI/PPIC on the Web: www.ppi-ppic.org

Learn more about PPI/PPIC programs, research support, publications, and links by visiting the website at **www.ppi-ppic.org**. From the central website, visitors may reach the various individual regional sites where PPI/PPIC programs are at work. BC

InfoAg 2003 Scheduled for July 30 through August 1

The sixth Information Agriculture Conference, InfoAg 2003, is planned for July 30-August 1, at the Adam's Mark Hotel, Indianapolis Airport.

More details regarding program plans, registration and exhibitor fees, and related information will be available at the website: **www.ppi-far.org/infoag.** BC

K A N S A S

Nitrogen and Phosphorus Management for Corn and Soybeans Grown in Rotation

By W.B. Gordon

Nitrogen and P management are critical in crop production for both economic and environmental reasons. Application of N and P has significant economic benefits, but can create unwanted water quality problems. Phosphorus fertilization is essential for optimum production of irrigated corn in central Kansas. Phosphorus is vital to plant growth and plays a key role in many plant physiological processes such as energy transfer, photosynthesis, breakdown of sugar and starches, and nutrient transport within the plant. Phosphorus is also known to enhance maturity of crops. Adequate P fertilization can help maximize corn grain yield and increase N use efficiency. A study was initiated in 1960 to assess the effects of applied N with or without P on corn and soybeans grown in annual rotation.

> This 42-year Kansas study demonstrates the benefit of starter phosphorus (P) fertilization, even on soils high in available P. Addition of starter P fertilizer increased yields, improved nitrogen (N) use efficiency, lowered N requirement, and hastened maturity of the corn crop.

This 42-year experiment was conducted at the North Central Kansas Experiment Field, located near Scandia, on a Crete silt loam soil. The experimental area was ridge-tilled and furrow-irrigated. The treatments applied to corn consisted of five N rates (40, 80, 120, 160, and 200 lb/A) with or without 30 lb P_2O_5/A. An unfertilized check plot and a P only plot were also included. The experimental design was a two factor randomized complete block, replicated four times. The test area was arranged so that 12 corn rows were rotated with 12 adjacent soybean rows every year, thus each crop appears every year. The soybean crop received no fertilizer. Individual plots consist of 6 rows, 30 in. wide and 40 ft. long. Initial Bray P-1 in the top 6 in. of soil (1959) was high...80 parts per million (ppm). Anhydrous ammonia was

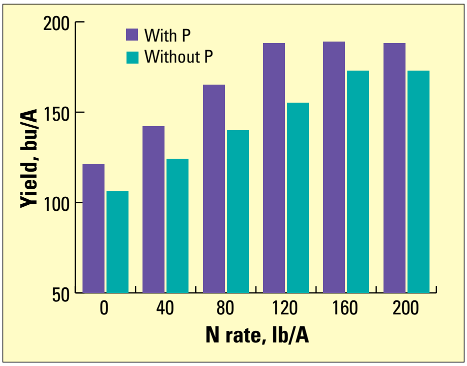


Figure 1. Corn grain yield as affected by N and P rate, 1960-2002.

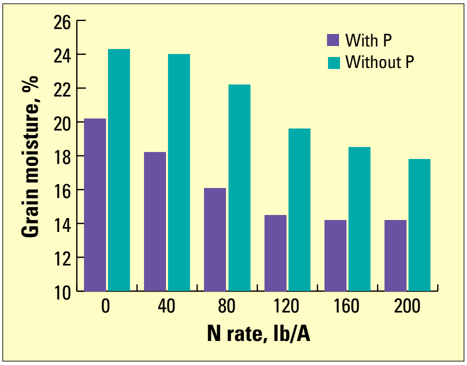


Figure 2. Grain moisture content at harvest as affected by N and P rate, 1960-2002.

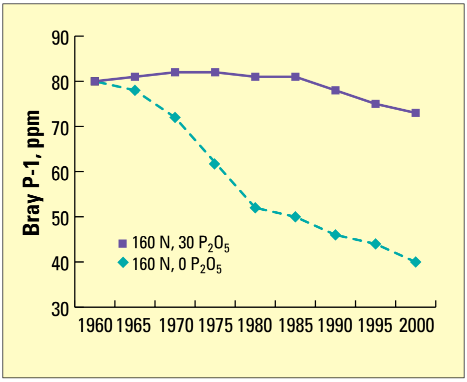


Figure 3. Soil test P changes over time at the 160 lb N/A rate with and without 30 lb P_2O_5/A.

TABLE 1. Nitrogen and P rate effect on number of thermal units from emergence to mid-silk, 1995-2002.

N rate, lb/A	Without P	With P	Difference
	.... Thermal units to mid-silk		
0	1,386	1,290	96
40	1,362	1,280	82
80	1,320	1,210	110
120	1,318	1,208	110
160	1,318	1,210	108
200	1,316	1,210	106
Average	**1,337**	**1,235**	**102**

used as the N source and was applied 7 to 14 days before planting each year. Granular triple superphosphate (0-46-0) was used as the P source and was applied as a starter, 2 in. to the side and 2 in. below the seed at planting.

When averaged over the 42 years of this experiment, plots that received starter P yielded greater than the no P plots at all levels of N (**Figure 1**). Addition of P increased N fertilizer use efficiency. Maximum yield in the plots that received P was achieved with 120 lb N/A, while in the no-P plot yields continued to increase with increasing N rate up to 160 lb N/A.

Phosphorus plays an important role in seed development and can hasten crop maturity. **Figure 2** shows that application of starter P significantly reduced grain moisture at harvest. At the 120 lb N/A rate, grain moisture was reduced from nearly 20% without P to less than 15% with P. Maturity differences that were established early in the growing season persisted up to harvest. Phosphorus fertilizer reduced the number of thermal units needed to go from emergence to mid-silk at all levels of N (**Table 1**).

A long-term study in Kansas found favorable results with starter P in a corn-soybean rotation.

Applied P also improved the yield of soybeans grown in rotation with corn. When averaged over N rates and years, yield of soybeans with P was 61 bu/A and only 51 bu/A without P. Soybean yield was not affected by N applied to the previous year's corn crop.

Annual application of 30 lb P_2O_5/A maintained soil test P at near the initial level until about 1985 (**Figure 3**). Since then, soil P levels have declined. Corn grain yields were 11% greater for the period 1985-2002 than for 1960-1984. This indicates that the 30 lb P_2O_5 rate may not be keeping pace with the higher removal rate. Soil test P has declined to half of the original value in the no P plots. BC

Dr. Gordon (e-mail: bgordon@oznet.ksu.edu) is with the Department of Agronomy, Kansas State University, Courtland, KS 66939.

WESTERN CANADA

Nitrogen and Phosphorus Fertilizer Management of No-Till Flax

By G.P. Lafond, C.A. Grant, A.M. Johnston, D.W. McAndrew, and W.E. May

Flax response to fertilizer phosphorus (P) additions are highly variable, supporting the importance of maintaining medium to high soil P levels to optimize flax yields. Combined nitrogen (N) and P fertilizer placement as a side band when seeding flax was found to be a viable option.

Flax was grown on 1.7 million acres in Canada in 2001, of which 97% was in the western Prairie Provinces. A major shift in seeding practices is also occurring in Canada. In 2001, 59% of the total land prepared for seeding used either a no-till seeding system or a seeding system where most of the crop residues were left on the soil surface. Flax has been shown to respond well agronomically and economically to these new conservation tillage seeding systems over a wide range of growing conditions.

The response of flax to N has been well established, as has the sensitivity of crop emergence and seed yield to seed-placed N. Flax is less sensitive to seed placed monoammonium phosphate (MAP) than N fertilizer and the recommendation of 18 lb P_2O_5/A has been established for a double disc opener on 6 in. row spacing. These allowable rates would meet the P requirements of flax in the majority of cases and at the same time not jeopardize crop emergence.

Maintaining soil P in the medium to optimum range is the best way to assure adequate supply for high yields of flax.

An important issue concerning flax and P fertilizer is the general lack of response to seed-placed applications and the improved response when fertilizer is placed either directly below the seed or below and to the side of the seed in a band. This response of flax to P placement has been reported when the soil is very low in P. Absence of fertilizer P responses on soils with higher P levels suggests that flax benefits from management practices that maintain medium to high soil test P levels.

The objective of this study was to determine the combination of N fertilizer form, and N and P fertilizer placement methods, that maximize flax P uptake, establishment, and yield using a no-till production system. The study was conducted over three years at four locations (12 site-years) across the thin-Black and Black soil zone (Haploborolls) of the western Canadian prairies. Except for the no P control, MAP was applied either seed-placed (Sp), side-banded (Sb) or preplant (Pp) banded using a uniform rate of 18 lb P_2O_5/A for all treatments. Seed was placed at a depth of 1 in. or less, and fertilizer placement depth was approximately 2 to 3 in. for the Pp band and Sb treatments. Three forms of N were evaluated: urea, ammonium nitrate (AN), and ammonium sulfate

TABLE 1. Effect of N and P fertilizer management on crop establishment, plant P uptake, and yield of flax (mean of three years at four locations).

Treatment N	Treatment P	Seedling stand, plants/yd²	P uptake, lb P/A 14 days	P uptake, lb P/A 28 days	P uptake, lb P/A Flowering	Grain yield, bu/A
Urea Pp[1]	Check	350	0.48	2.14	5.54	27.6
Urea Pp	Pp	359	0.51	2.20	6.06	28.2
Urea Pp	Sp	325	0.54	2.23	5.91	27.8
Urea Pp	Sb	343	0.58	2.32	6.27	28.1
Urea Sb	Sb	308	0.49	2.45	6.18	28.3
Urea (NBPT) Sb	Sb	322	0.57	2.49	6.47	28.8
AN Sb	Sb	362	0.61	2.65	6.35	28.8
AS Sb	Sb	356	0.64	2.63	6.53	28.5
AS Pp	Sb	352	0.56	2.47	6.24	28.0
	$LSD_{0.05}$	54	0.15	0.71	1.34	2.2

[1]Pp – preplant banded in the spring; Sb – side-banded at seeding; Sp – seed-placed; AN – ammonium nitrate; AS – ammonium sulfate; rates = 62 lb N/A, 18 lb P_2O_5/A.

(AS), each applied at a uniform rate of 62 lb N/A. The N was applied either as a Pp band or at seeding time in a Sb position. Urea treated with a urease inhibitor (NBPT) was also included as a treatment. Norlin, an early maturing, high yielding flax cultivar adapted to all areas of the study, was grown.

Flax emergence is very sensitive to seed-placed N and P fertilizer, and in this study some injury was observed with urea, even when it was in a Sb position (**Table 1**). Relative to the Pp placement, Sb placement resulted in an 11% reduction in flax establishment. The addition of NBPT to slow down the conversion of urea to ammonia did not improve plant stand when urea was Sb. The effects of AN and AS on crop establishment were less than for urea, but the lack of a N treatment response prevents us from determining if AN and AS reduced plant populations. The effect of Sb urea on crop establishment has also been observed by the authors on canola and spring wheat.

In only one instance, at 14 days after emergence, did adding P fertilizer significantly increase plant P uptake (**Table 1**). When AS and fertilizer P were blended together in a Sb position, P uptake was greater than for urea at the 14 day sampling time. Acidification of alkaline soils can release soil P, allowing for more P uptake by plants. When AS was Pp banded and the P Sb, early season P uptake was less than when AS and P were placed together in a Sb. However, no treatment effects were observed on P uptake by day 28 or at flowering. The lack of treatment differences is possibly due to dissipation, conversion, and overall greater root and plant growth, the end result being that the root system was capable of exploiting soil P. In this study, we found no difference in P uptake whether the P was Sp or Sb, except when N was present in the band with P, with the response varying with N form. The reason for the discrepancy is possibly due to the somewhat high recorded soil P levels in the soils in the study, possibly minimizing the differences between placement methods.

Although the soil residual P levels were relatively high for most site years, there was nonetheless a small seed yield response ($p = 0.062$) to fertilizer P addition. Yield increases were not necessarily related to low soil P, as the three sites where increases resulted tested 11, 23, and 15 parts per million (ppm) P (method: 0.03 M ammonium fluoride + 0.03 M sulfuric acid mixture). Variability in early season P uptake observed for various treatments did not translate into higher seed yields. These results support past research which has shown that unlike cereals, flax does not proliferate roots very well in a fertilizer P band. From emergence through to maturity, the crop tends to take up more P from the soil than from added fertilizer P. When the treatment effect

(continued on page 11)

INDIANA

Enhancing Alfalfa Production through Improved Potassium Management

By W.K. Berg, S.M. Brouder, B.C. Joern, K.D. Johnson, and J.J. Volenec

Additions of K fertilizers have long been associated with increased alfalfa yield and stand longevity. Popular belief is that K addition promotes improved plant persistence through enhanced production of root reserves, especially TNC (total nonstructural carbohydrates). As plant populations decrease, K fertilizer additions are thought to increase shoots/plant, thus sustaining high yields. This study focuses on determining the mechanisms that promote increased yield with addition of K.

Potassium (K) is essential for maximum yield of alfalfa, but the manner in which K increases performance is unclear. This study showed that the greater forage yield obtained with K fertilization of alfalfa primarily resulted from increased mass/shoot. Soil test maintenance fertilizer requirements were 14 lb P_2O_5 and 60 lb K_2O per ton of dry hay removed.

In the spring of 1997, a stand of Pioneer Brand 5454 alfalfa was established at the Throckmorton Purdue Agronomy Center near West Lafayette, Indiana. At the onset of this study, soil test K and P concentrations were approximately 90 parts per million (ppm) and 5 ppm, respectively. Following establishment, a randomized complete block design of five K treatments (0, 100, 200, 300, and 400 lb K_2O/A/year) and four P treatments (0, 50, 100, and 150 lb P_2O_5/A/year) in factorial combination was created. Fertilizer application was split, with half of the specified amount applied after the first harvest in May and the remainder applied after the last harvest in September. Forage yield was obtained four times annually, and a sub-sample of shoots was taken to obtain mass/shoot. Shoots/area was calculated by dividing forage yield per area by mass/shoot. Roots were dug in May and December to monitor plant populations over time, as well as to confirm when plant death occurred...either in summer (May to December) or winter (December to May). Shoot and root tissues were digested, concentrations of P and K determined, and total nutrient uptake calculated using forage yield data.

In each of the five years of this study, K additions increased forage yield (**Figure 1**).

Addition of 400 lb K_2O/A (pictured at right) increased yield through greater mass/shoot over the treatment not receiving K fertilizer (pictured at left). Application of K produced taller and thicker shoots, creating a greater shoot mass in alfalfa. Writing on the yellow handles compares height of growth.

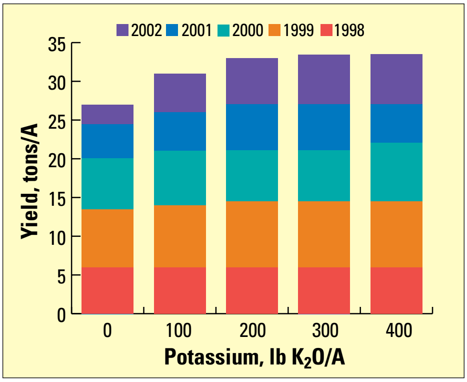


Figure 1. Impact of K addition on yield in each of the five experimental years. Yield was increased with each increment of K.

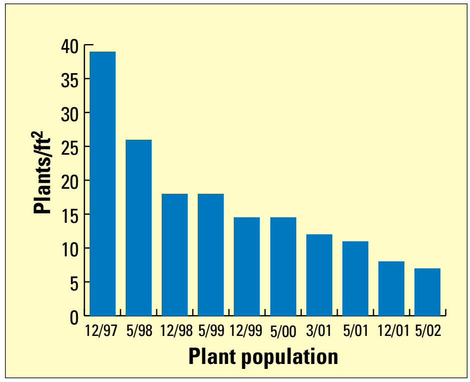


Figure 2. Trends in plant population (plants/ft^2) from December 1997 to May 2002. Data are averaged over P and K fertilization treatments. After the initial decline, plant populations have declined during summer (May to December) but not over winter (December to May).

Application of 400 lb K_2O/A/year improved yield by 600, 480, 560, 440, and 1,760 lb hay/A over the control receiving no K in 1998, 1999, 2000, 2001, and 2002, respectively (see photos). Yield was increased with each additional increment of K.

Analysis of alfalfa yield components (plants/area, shoots/plant, mass/shoot) has led to several unexpected conclusions. Potassium fertilization has yet to affect alfalfa plant populations in any year. Populations have declined since establishment, as expected, but K fertilization has not reduced the rate of plant disappearance (**Figure 2**).

Also, to our surprise, plant death occurred primarily during the summer instead of winter. From December 1998 to May 1999, December 1999 to May 2000, and December 2001 to May 2002, plant losses over winter were 2, 0, and 2 plants/ft^2, respectively. However, injury incurred during winter may weaken plants that ultimately die during summer. Prior to the first harvest, injured plants may not be physiologically prepared for defoliation and subsequent regrowth. Competition from neighboring plants following defoliation may finally kill these weak, slow-growing plants.

Shoots/plant has often been thought of as the yield component that compensates for plant death and stand thinning. It is believed that as stands age and plant populations decrease, increased shoots/plant sustain forage yield once generated by more plants. Through the first four years of the experiment (1998 to 2001), number of shoots/plant was not affected by K fertilization, nor was number of shoots/plant associated with forage yield. In 2002, addition of K increased shoots/ft^2 in each harvest, but increased shoots/ft^2 did not necessarily result in higher forage yield (**Figure 3**). At each harvest, the highest forage yield was not necessarily found in plots with the greatest numbers, and application of the highest K rates did not result in the greatest number of shoots.

Productivity potential of established stands has often been evaluated using 40 shoots/ft^2 as the threshold of acceptance. Alfalfa stands with less than 40 shoots/ft^2 are generally viewed as being shoot-limited, and stand replacement is recommended. In our experiment, forage yields over 1.6 tons dry matter/A/harvest have consistently been obtained in plots containing fewer than 40 shoots/ft^2, whereas plots containing 50 or more shoots/ft^2 have not produced yields over 1.4 tons dry matter/A/harvest. This suggests that shoots/ft^2 is not a good indicator of the productivity potential of an alfalfa stand.

The greater forage yield obtained with K fertilization of alfalfa has primarily resulted from increased mass/shoot. Throughout the first five years, only increases in mass/shoot

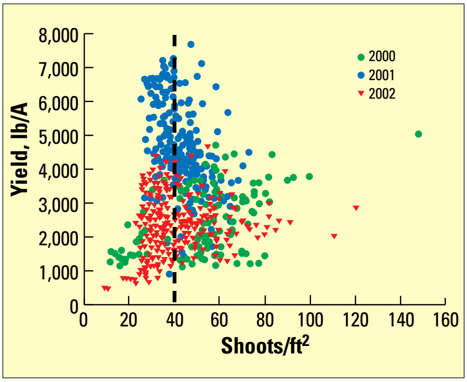


Figure 3. Yield as influenced by shoots/ft^2 in 2000, 2001, and 2002. The dashed line indicates 40 shoots/ft^2. Increased shoots did not necessarily increase yield.

have consistently been associated with increased forage yield (**Figure 4**). Increased mass/shoot is produced through two different mechanisms. First, rapid shoot initiation after defoliation permits shoot growth to resume quickly following harvest, thus increasing mass/shoot. Initiation of regrowth after defoliation is substantially greater when alfalfa is supplied K. Secondly, elongation rate of shoots is increased with increased K fertility, which leads to greater mass/shoot.

Despite the occurrence of acute K deficiency symptoms and greatly reduced forage yields in fall, K fertilization has not enhanced forage yields in May of any year (**Figures 5a, 5b** and photo on next page). The reason is unclear. One working hypothesis is that K

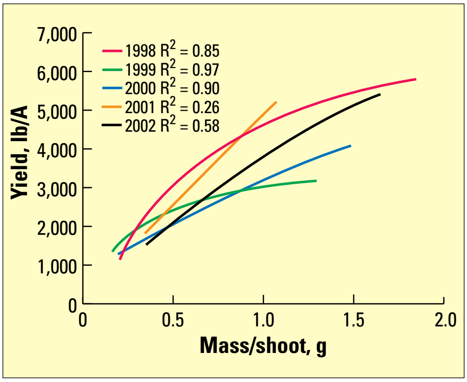


Figure 4. Alfalfa yield as influenced by mass/shoot in 1998 through 2002. Increases in yield have been primarily through enhanced mass/shoot. Each line represents 320 data points taken from harvests each year.

released from the interlayers of clay minerals during late fall through early spring may provide sufficient K to meet the nutritional needs of alfalfa at first harvest, but not in subsequent harvests.

Lack of yield response to K fertilization in Harvest 1 of 2000 indicates that spring-applied K fertilizer is not necessary and could contribute to K luxury consumption. Luxury consumption occurs when plants take up nutrients such as K (and N) in amounts that exceed their required needs. Spring K applications and the associated luxury consumption would decrease fertilizer efficiency and possibly deprive subsequent harvests of need-

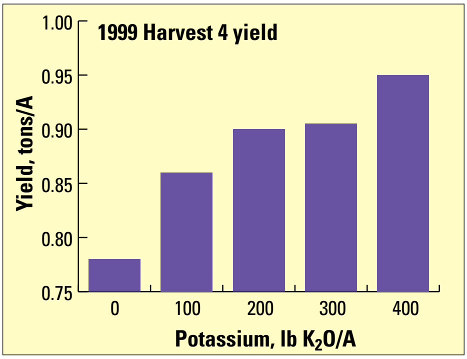


Figure 5a. 1999 Harvest 4 yield. As increased increments of K were provided to alfalfa, yield was dramatically enhanced. LSD = 0.123.

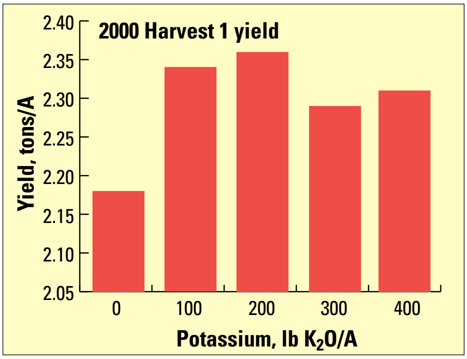
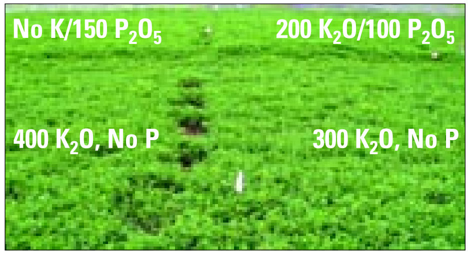


Figure 5b. 2000 Harvest 1 yield. Application of K did not correlate with enhanced yield for the first harvest. LSD = 0.429.

ed K. Applying half the specified amount of K to meet the specific yield goals after the first harvest, and the remainder after the last harvest in the fall, will increase K fertilizer use efficiency.

Seasonal changes in alfalfa response to K application and soil K status also have implications for timing of soil sampling and interpretation of soil test values. Soil samples taken in spring may provide inflated estimates of soil test K concentrations. This could alter fertility management decisions by reducing K applications and subsequently placing the crop at risk of K-deficiency later in the growing season. Also, when comparing soil tests results obtained over a series of years, time of soil sampling must be considered. The most valid comparisons are those tests where the soil sampling is done the same month of each year. This practice would avoid season-induced changes in soil test K values that could be misleading, and provide a clearer indication of how management practices are influencing soil test K concentrations.

By using information on yield and K removal, we can arrive at the following fertilizer recommendations for alfalfa when soil test



Yield increases in May were primarily due to addition of P, whereas additional K supplied without P failed to promote greater alfalfa yield.

P and K are in the maintenance range: 14 lb P_2O_5/ton of dry hay removed/A and 60 lb K_2O/ton of hay removed/A (based on 0% hay moisture). By following these application guidelines, producers can replenish the amount of P and K removed from the soil. To increase soil test P and K levels, greater P or K applications would be required. BC

The authors are in the Department of Agronomy, Purdue University, West Lafayette, Indiana. For additional information contact Kess Berg (e-mail: kberg@purdue.edu) or Jeff Volenec (e-mail: jvolenec@purdue.edu).

Management of No-Till Flax...
(continued from page 7)

was determined for each site-year, we observed treatment differences in three of the 12 trials. In two of those years the treatments where N and P were placed in a Sb position gave the highest seed yields. When all sites are included, the trend was for better seed yields when N and P were placed in Sb position, although the differences were small in absolute terms (**Table 1**). The absence of a flax response to P fertilizer, when the crop takes up more than twice the P per unit of yield than spring wheat, is difficult to explain. It appears that the flax crop is capable of using residual soil P to meet growth and development requirements.

Based on the results of this study, we conclude that no-till flax growers have many N and P management options available. The current trend of adding all the crop's fertilizer requirements during the seeding operation, a one-pass seeding and fertilizing no-till system, may in some cases actually improve seed yields with no apparent negative effects on flax nutrient uptake or seed yield. Limited response of flax to fertilizer P applied at seeding supports the recommendation that maintaining soil P in the medium to optimum range provides the best means of ensuring adequate P supply for high yielding flax production. BC

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GEORGIA

Pine Plantation Fertilization

By E. David Dickens, David J. Moorhead, and Bryan McElvany

Forest fertilization has increased greatly since the 1960s. Currently, there are an estimated 33.7 million (M) acres of loblolly pine, 10.4 M acres of slash pine, and 3 M acres of longleaf pine stands in the Southeastern U.S. (2001 figure). Approximately 1.3 M acres of loblolly and slash pine stands are fertilized in this region. Fertilization can increase loblolly, longleaf, and slash pine wood volume, pine straw production (used for mulch in landscaping), and per acre revenues. Fertilizer recommendations should be site-specifc and be based on soil type, land use history, control of competing vegetation, pine species, age, stocking (trees/A), and target products (pulpwood, sawtimber, poles, pine straw) to maximize fertilizer benefit.

> Many acres of southern pines can potentially benefit from improved forest nutrition and result in sizeable investment returns. Proper fertilization should be considered an integral part of good forest management, and be based on the pine species grown, site and stand characteristics, target product goals, and market prices.

There are five common fertilizer types used in forest fertilization in the southeastern U.S. Common phosphorus (P) fertilizers include triple superphosphate (TSP, 0-46-0), and diammonium phosphate (DAP, 18-46-0). Common nitrogen (N) fertilizers include ammonium nitrate (34-0-0) and urea (46-0-0). Muriate of potash (MOP, 0-0-60) is used to add potassium (K) where needed. In some studies, the growth benefit with the addition of P and K can be two- to three-fold greater than that from N alone in loblolly, longleaf, and slash pine stands.

Fertilization of loblolly, longleaf, and slash pine stands can be economically attractive if the stand/site in question: 1) has a deficiency in one or more nutrients, 2) is responsive to the nutrient(s) being added, and 3) is large enough to be operationally managed (> 40 acres). Generally there are

TABLE 1. Critical ranges or values for soil and foliar nutrients in loblolly, longleaf, and slash pine.

		N	P	K	Ca	Mg	S	B	Cu
Surface soil, 0 to 6 in.	loblolly		<3-5[1]						
	longleaf		<4-6[2]						
	slash pine		<6-8[3]						
Foliage[4]	loblolly	1.2	0.12	0.35	0.12	0.07	0.12	4-8	2-3
	longleaf	0.9	0.08	0.30	0.10	0.06	0.10	4-8	1-3
	slash pine	1.0	0.09	0.30	0.10	0.05	0.10	4-8	1-3

[1]Expressed as parts per million (ppm) – (multiply ppm by 2 to approximate lb/A) – using Mehlich 1 or double acid extract procedures.
[2]Using Mehlich 2 procedure, ppm.
[3]Using Mehlich 3 or Bray P-2 procedures, ppm.
[4]N, P, K, Ca, Mg, and S expressed as %; B and Cu as ppm.

These two photos compare growth of 16-year-old loblolly pine on a Bladen soil (poorly drained) in Berkeley County, South Carolina. At left, management included herbicide, flat plant, but no P. At right, management was herbicide, flat plant, but with 185 lb P_2O_5/A.

three fertilization "windows": 1) at planting or early post-planting, 2) canopy closure (age 5 to 10 years) where crop trees occupy the site and nutrient demand can be greater than soil supply, or 3) after a thinning. Based on preliminary research, fertilization is also being recommended on a 3- to 5-year schedule after canopy closure to enhance pine straw production and maintain stand vigor.

There are an estimated 520,000 acres of mostly loblolly pine plantations that have been fertilized with P at planting, or early post-planting, using either DAP or TSP. Fertilizing at planting typically occurs on somewhat poorly to very poorly drained soils of the Lower Coastal Plain (Flatwoods). Somewhat poorly to very poorly drained (aquic) soils with an argillic (clayey) horizon in the southeastern Coastal Plain generally respond dramatically to P fertilization at planting. These sites are often deficient in plant-available P, especially as the percentage of clay increases (aluminum and iron in the clay will bind with P, making it less plant-available) and as soil drainage decreases.

Phosphorus fertilization with 115 lb P_2O_5/A, using TSP, can greatly increase pine growth. The response lasts 10 to 15 or more years on these sites. Some better-drained Upper Coastal Plain sites that have not been in cultivated crops in recent years can be P deficient. Soil and/or foliage tests can help verify any P deficiency (**Table 1**).

Phosphorus fertilization on these responsive, poorly to very poorly drained sites can be done either by ground or aerial application in conjunction with site preparation or planting. The current cost for P fertilization usually ranges between $40 and $50/A. This low cost along with a long-lived fertilizer response and dramatic volume gain make P fertilization of aquic soils in the southeastern Coastal Plain an attractive management option, especially if bedding (prior to planting) on these poorly drained soils was not performed or was not economically feasible for the landowner. Phosphorus fertilization at planting or early post-planting can mean the difference between having a stand and no stand as indicated in the photos (see above) with 16-year-old loblolly trees on a poorly drained, clayey Bladen soil in Berkeley County, South Carolina.

Often, somewhat poorly to very poorly drained soils of the Flatwoods are not recognized as P-deficient at planting. The resulting seedling growth is poor, needles are sparse and yellow-green to light green, especially in mid-winter. Loblolly pine on these sites often responds to P fertilization through at least the first 5 to 10 years after planting.

Fertilizer application of N plus P and in some cases K (based on needle tissue analysis), is recommended once a pine stand has

Growth response is shown in this wood disk from loblolly pine that was fertilized with NPK at the age of 26 years. Radial growth doubled four years after fertilization. (The split at left is not associated with fertilization.)

fully occupied the site and competing vegetation is sparse. This is one of the most common fertilizer application "windows" in forestry. Approximately 780,000 acres of well-established pine plantations (age 10 to 15 years old) were fertilized in 2001. At this stage in the life of a stand, nutrient demand is nearing its peak and the soil N and P supply can become growth limiting. Fertilizing loblolly, longleaf, and slash pine stands with NP or NPK, once canopy closure is reached or after a first or second thinning, will often increase growth for 5 to 8 years. The average growth response is a wood volume increase of 0.6, 0.5, and 0.4 cords/A per year for loblolly, slash, and longleaf, respectively. Fertilization 5 to 8 years before a first or second thinning or the final cut is recommended to capture the extra growth and to keep the stand from stagnating (when basal area gets above 150 ft^2/A). Knowing foliage N, P, K, calcium (Ca), magnesium (Mg), sulfur (S), boron (B), and copper (Cu) levels, soil extractable P levels, relative leaf area, and the soil series or drainage group will help in determining the probability of response to NP and other fertilization combinations. If pine growth is to be maximized on responsive sites, then repeat fertilization could occur every 4 to 5 years.

Pine plantations can stagnate on droughty, infertile, deep sands (Typic Psamments) such as Alaga, Alpin, Foxworth, Kershaw, Kureb, and Lakeland series found in the Sand Hills physiographic region of the Carolinas, Georgia, and Florida. Smaller doses of NPK fertilizer (100 lb N + 60 lb P_2O_5 + 90 lb K_2O/A every 2 to 3 years) can enhance growth and get the stand to merchantability. Longleaf pine and sand pine are better species choices on these sites.

Various diagnostic tools and techniques are used often in combination, to determine the magnitude, duration and potential economic benefit of fertilizing pine plantations. These diagnostic tools include experimental field trials, estimates of leaf area index, soil analysis, foliar analysis, soil surveys (mapping units), soil group and drainage class identification, and to a lesser extent presence of indicator plants, site index, and fertilization models.

Landowners can delineate the candidate stand(s) to be fertilized on an aerial photo of the property. The Natural Resources Conservation Service (NRCS) county map of the candidate stand can be used to determine the soil series and soils groups.

Pine stands of sufficient size for fertilization should be delineated on a soils map and on the ground into uniform areas of soil series or soil group, land use history (old-field, pasture, or cut-over sites), age, and stocking. Candidate stands for mid-rotation fertilization should meet the following criteria to capture the full benefits of fertilization: 1) stand stocking should be uniform and range from 400 to 900 trees/A in young stands or 60 to 90 ft^2 of basal area (BA/A, BA/A = the cross sectional area at 4.5 ft. above groundline of all trees) for stands 12 to 20 years old, 2) the hardwood component should be less than 10 to 15% of the total BA, 3) live crown length should be at least 15 to 20 ft. or preferably one-third of the tree height, 4) stands with 30% or more fusiform rust should be recognized as having a significant risk of excessive stem breakage from the added crown weight. High risk areas for pitch canker or root rot probably should not be fertilized, 5) any scheduled prescribed burning (to reduce hardwood competition and to lower wildfire risk) should be done either six months prior to or one to three years after fertilization, 6) over-stocked stands (BA/A greater than 120 ft^2) and/or stands with live crown ratios less than 30% should be thinned prior to fertilization. Thinning operations should leave the best trees. Thinning from below to remove poorly formed, suppressed, and intermediate trees will leave co-dominant and dominant trees that will respond best to fertilization. Pine stands that are 25 to 35 years old should respond to fertilization (see photo at left).

TABLE 2. Economics of extra wood grown from NPK fertilization of loblolly, longleaf, and slash pine stands after a first thinning (eight-year response period).

Species	Cost/A[1]	Extra cords/A Chip-n-saw[2]	Return/A[3]	IRR[4]
Loblolly	$106	4.8 cords	$360	16.5%
Longleaf	$72	3.2 cords	$240	16.2%
Slash	$89	4.0 cords	$300	16.4%

[1]Cost/A based on $0.06/lb application fee, DAP @ $200/ton, urea @ $215/ton, potash @ $160/ton (fall 2002 south Georgia prices). Loblolly @ 337 lb of urea, longleaf @ 120 lb of urea, and slash @ 228 lb of urea/A. All received 250 lb of DAP and 100 lb of MOP/A.

[2]Assumes a 0.40, 0.50, and 0.60 cord/A/yr response for longleaf, slash, and loblolly, respectively.

[3]Assumes a stumpage price of $75/cord for chip-n-saw (100% of extra wood grown).

[4]IRR = internal rate of return calculated as $[(\text{return/cost})^{1/8} - 1] \times 100$

Most pine plantation fertilization in the Southeast has been done on an as-needed, one-time, or periodic basis. A common planting or early post-planting P fertilization prescription is 100 to 140 lb of P_2O_5/A, using TSP on responsive Coastal Plain soils. Time of year is not critical with P fertilization of pine stands and application can be by ground equipment, helicopter, or fixed wing aircraft. A common NP fertilization mid-rotation prescription is 80 to 200 lb N/A plus 60 to 115 lb P_2O_5/A on responsive, better-drained soils of the Coastal Plain and Piedmont for loblolly pine. Loblolly pine N prescription is typically 200 lb N/A with P. Slash pine N prescription is typically 150 to 175 lb N/A with P and longleaf is 80 to 100 lb N/A with P. Urea is commonly the N source and researchers believe the best time to apply it is from November to early March to minimize N volitalization losses and to minimize new shoot growth burn when aerially applied. When foliar K is not sufficient, 50 to 90 lb K_2O/A as MOP should be applied along with N and P (**Table 1**). Calcium, Mg, and S fertilization in pine plantations is less frequent, but opportunities should not be overlooked when interpreting foliar analysis. Recently, B and Cu have been found to be insufficient for optimal growth (**Table 1**). Preliminary guidelines are to apply 1 lb of B/A and 3 lb of Cu/A when needle tissue analyses indicate deficiencies.

The economic attractiveness of pine plantation fertilization will vary due to several factors: 1) the extra quantity of wood grown and time frame, 2) the product class(es) grown (pulpwood, chip-n-saw, sawtimber, poles, and plywood logs), 3) extra pine straw grown (where of value and raked), 4) fertilizer amounts and fertilizer plus application costs, and 5) future stumpage prices for the extra wood grown. Generally, P fertilization pays at planting on P-deficient sites in the Flatwoods physiographic region due to low cost/A and the large, long-lived response. Fertilization with NP or NPK at canopy closure is relatively attractive if the growth response is large and pine straw income potential exists. Fertilization with NP or NPK after a thinning is attractive under recent timber prices, even though prices are depressed for chip-n-saw and sawtimber and very depressed for pulpwood. As shown in **Table 2**, internal rate of return (IRR) values in the 16% range are possible with proper fertilization. BC

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NORTH AMERICA

Productivity of Organic Cropping Systems

By T.W. Bruulsema, D.W. Dibb, H.F. Reetz, Jr., and P.E. Fixen

Retail sales of organic food have been growing by about 20% annually since 1990. With the enactment of the USDA Organic Rule in October 2002, media and consumer interest in the topic have also grown. However, organic foods still comprise a small proportion of the total crop area (**Table 1**) and the total retail market (**Table 2**). Sales growth in some of the most intensively organic European countries is slowing. But fast or slow, continued growth raises questions regarding the productivity and sustainability of organic cropping systems.

> The productivity of organic cropping systems is considerably lower than that of conventional or integrated cropping systems. Their lower productivity implies that their widespread adoption could potentially lead to less land available for non-farm uses such as wildlife habitat, greater negative impacts on the environment, and reduced sustainability.

Significance

The notion of organic agriculture is more important to the fertilizer industry than its small percentage of land area would imply. Consumers value the concept because of their perception that the food is produced naturally without impairing the environment. The word "organic" itself resonates pleasantly, and is used in disciplines from chemistry through theology. Though its meaning varies, it rarely connotes anything negative.

While consumers may choose organic out of good motives, the practice does not deliver all they perceive. Consumer preference is important in business – "the customer is always right." We strive to manage plant nutrients to produce the healthy food the consumer demands. But we also need to deliver the facts on organic production.

Productivity

Organic cropping systems clearly yield less than those that have all available technologies at their disposal. While individual crop comparisons may show no difference, analysis of the complete system – including land area required to produce organic sources of nutrients – clearly implies dramatically reduced production of harvestable crops.

Because organic production has greater restrictions on inputs, it is more difficult to maintain the same yield levels sustainably. Organic standards minimize or eliminate use of synthetic or manufactured inputs and encourage maximum use of local natural resources. Organic food producers rarely use soluble mineral nutrients. They also exclude some organic sources, such as

TABLE 1. Area of certified organic production has expanded.

Land type	Certified organic land Acres, 1995	Certified organic land Acres, 2001	Proportion of total land area %, 2001	Rate of expansion 1995-2001 %/yr
Cropland	638,500	1,302,000	0.36	13
Pasture & rangeland	276,300	1,039,000	0.23	25

Source: USDA-ERS, 2001
http://www.ers.usda.gov/

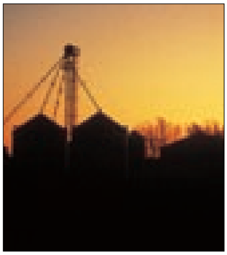
sewage sludge and composts derived from wastes. Thus, they must rely to a greater extent on green manures, crop rotation, and animal manures.

Crops produced organically will not always yield less, but often do. For example, a 21-year study in Switzerland found that yields were 20% less when a rotation including wheat, potato, and forage was managed organically (Mäder *et al.*, 2002). However, the economically most important crop, potato, suffered the greatest yield reduction (38%). Forage crops made up 43% of the rotation, which could imply greater emphasis on animal agriculture than would be justified by local or global demand – not to mention its impact on the environment. As stated by Per Pinstrup-Anderson, leader of the International Food Policy Research Institute (IFPRI), "...yields per unit of total land used for organic farming including the land needed to produce green manure and animal waste are not at a level necessary to avoid encroachment on ecologically fragile soils and still meet future food demands."

Organic systems vary more widely in nutrient availability because of reliance on indigenous soil fertility with high spatial variability. Nutrient input levels in organic farming systems tend to be lower than in conventional systems because the philosophy is aimed at growing crops under more natural conditions. Deficiencies of nitrogen (N), phosphorus (P), and potassium (K) are natural conditions. These deficiencies reduce productivity.

Short-term productivity differences may be smaller than those in the longer term. Sustainable yields depend on the balance of nutrients applied to and removed from the field. Many fertile soils may produce good yields with a deficit in P and K inputs for 10 years or more, but not indefinitely.

External inputs of organic nutrient sources often contain nutrients that were originally supplied in an inorganic form, such as commercial fertilizers. Or they contain nutrients mined from soils external to the farm.



Were organic farming to be more broadly adopted, such practices would lead to extensive soil nutrient depletion. Crops across Canada and the U.S. already remove approximately as much P as, and more K than, that contained in the sum of all recoverable manure plus all commercial fertilizers used.

Across Canada and the U.S., a recent summary of soil tests shows that substantial areas remain deficient in P and K. Of the 2.5 million soil samples submitted for field crops, 47% tested medium or lower in P and about 43% tested in that range for K.

Soil Quality

Productivity depends on soil quality. Soil quality – its structure and its capacity to retain water and nutrients – depends on inputs of organic material to maintain appropriate levels of humus. Nutrient inputs have large impacts on the total quantity of organic material produced and available to build soil humus. When nutrient deficiency limits crop yields, it also limits their contribution of organic material (crop residue) to the soil. Nitrogen has particular importance, since soil humus maintains a carbon (C) to N ratio of 10, and adequate N inputs are necessary to stabilize and build soil C in the long term.

TABLE 2. Organic food markets are growing, but form a small part of total food sales.

	Value of total organic sales in 2000		
Country	US$, millions	% of total food sales	Expected growth, %/yr
Austria	200-225	1.8-2.0	10-15
Denmark	350-375	2.5-3.0	10-15
France	800-850	0.8-1.0	10-15
Germany	2,100-2,200	1.6-1.8	10-15
Japan	2,000-2,500		
Switzerland	450-475	2.0-2.5	10-15
United Kingdom	1,100-1,200	1.0-2.5	15-20
U.S.	7,500-8,000	1.5-2.0	20

From ITC, 2002. Overview world markets for organic food & beverages (estimates). http://www.intracen.org/mds/sectors/organic/overview.pdf

Organic systems often rely on tillage to incorporate organic materials and control weeds. Tillage increases mineralization (breakdown) of soil organic matter. Today's integrated, conventional cropping systems are reducing or eliminating tillage, allowing crop residues to contribute more to increasing soil organic matter content.

Natural or Synthetic?

It is often implied that nutrients used in organic cropping systems are "natural" as opposed to the "synthetic" or "chemical" sources used in conventional systems. Actually, any effort to differentiate foods from a nutrient source standpoint is of limited use because all nutrients are "chemical"...all are "natural" and exist in nature...and all nutrients are absorbed by the plant almost entirely in the soluble inorganic form whether the source of nutrients is organic or inorganic. The "natural" versus "synthetic" distinctions are not defensible on the basis of science.

Environmental Impact

The inputs allowed as fertilizers in organic production are lower and more variable in nutrient content and plant-availability than commercial fertilizers. To meet all the crop's need using these inputs, they have to be applied at high rates. There is greater likelihood of supplying some nutrients at excess rates, which may lead to increased risk of loss and negative environmental impact. A commentary published recently in the journal *Nature* points out, "Manure breakdown cannot be synchronized with crop canopy growth, as is desirable, but continues throughout the growing season. Plowing in of legume crops (a necessary part of the organic method to build soil fertility) and continued manure breakdown leads to nitrate leaching into aquifers and waterways at identical rates to conventional farms."

When today's producers harvest the North American corn crop, they currently remove an amount of N in the grain equivalent to 75% of the fertilizer applied to the crop. The fate of the remaining N concerns them – some does potentially contaminate water. But they have already made progress. They are recovering 25% more than they did in the 1970s and they strive for continued improvement.

Prudent, scientifically sound use of technology in a site-specific management program is essential to minimizing nutrient impacts on the environment. Improved and adapted genetic materials are a key component. Integrated pest management must be included, using best practices from cultural, biological, and chemical approaches. Conservation tillage and other practices to control erosion, maintain water quality, and reduce herbicide use are often critical.

Productivity is important. Not only for profit, not only to feed the growing world, not only to save land for wildlife habitat, but also for the benefit of the soil. No discussion of organic farming fails to mention the importance of organic matter for sustaining soil productivity. But the original source of organic matter is photosynthesis – plant productivity. Land areas deficient in mineral nutrients will not produce as much vital organic material.

The challenge facing agriculture today is to increase the quantity and quality of food produced, with less detrimental impact on the environment. The ability of organic farming (as currently defined) to meet the challenge is limited by the unscientific restrictions placed on inputs that contribute to productivity. BC

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F L O R I D A

Importance of Potassium in a Florida Citrus Nutrition Program

By T.A. Obreza

Citrus groves cover more than 830,000 acres in Florida. Most commercial groves are located south of Orlando, where freeze danger is minimized. Commercial groves thrive from the rolling, excessively-drained, deep sand hills of the central Florida ridge to the low-lying, poorly-drained flatwoods and marsh soils of the coastal areas. Regardless of location, most of the soils used for citrus production have root zones dominated by quartz sand, with very low concentrations of clay or organic matter. As a result, citrus grove managers have a challenging task irrigating and fertilizing their groves because the soils are extremely low in natural fertility and water-holding capacity.

Citrus trees use large quantities of potassium (K), so their yield response is on the same order of magnitude as nitrogen (N) response. The ideal K fertilizer rate is about 200 lb K_2O/A. Fresh citrus growers need to be aware that K affects fresh fruit qualities like size and sweetness, as well as yield. These factors should all be taken into account when formulating a fertilization program.

In a typical citrus fertilization program for mature trees, N and K fertilizers are applied at relatively high rates each year. Annual N application ranges between 150 and 250 lb/A, and K_2O is applied at 1.0 to 1.25 times the N rate. The inefficiency of N fertilizer, primarily due to nitrate (NO_3^-)-N leaching, is well known throughout the humid regions of the world because NO_3^- is a mobile ion in most soils. However, in places other than the Florida peninsula, K is often considered to be a nutrient that is only slightly mobile in the soil. The mobility of K can be limited in soils containing appreciable amounts of organic matter or clay because the positive charge of the K ion enables it to be held by the soil's negatively-charged cation

These two 4-year-old grapefruit trees were grown on a sandy Florida soil, with sufficient N fertilizer. The tree at left received no K fertilizer – note the tight, compact growth and no visible fruit. The tree at right received 200 lb K_2O/A each year – note the increased branching and expansive tree canopy with visible grapefruit.

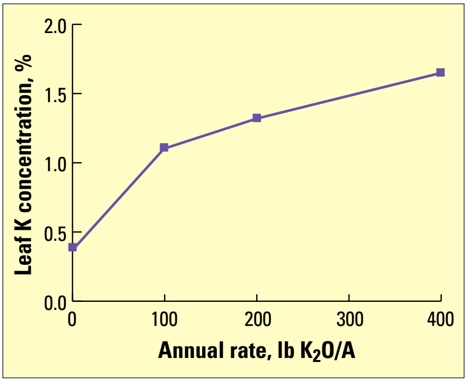

Figure 1. Citrus response to fertilization is reflected in leaf tissue nutrient concentrations.

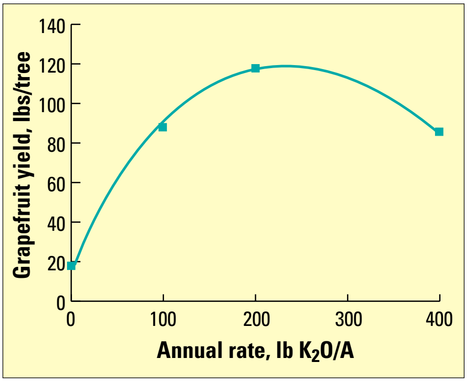

Figure 2. Grapefruit yield response to annual K application rate.

exchange complex. However, if a soil is composed primarily of chemically-inert sand particles, the ability to hold K against leaching can be almost non-existent. Such is the case in most soils where Florida citrus has been planted.

Potassium Use by Citrus

Citrus fruits remove large amounts of K compared with other nutrients. Potassium moves from leaves to fruit and seeds as they develop. Potassium is necessary for basic physiological functions such as formation of sugars and starch, synthesis of proteins, and cell division and growth. It is important in fruit formation and enhances fruit size, flavor, and color. Potassium helps reduce the influence of adverse weather conditions like drought, cold, and flooding.

Potassium also helps regulate the carbon dioxide (CO_2) supply to citrus trees by controlling the opening and closing of stomata. Consequently, the rate of photosynthesis drops sharply when plants are K deficient. A shortage of K can result in lost crop yield and quality. Moderately low plant K concentrations will cause a general reduction in growth without visual deficiency symptoms. The appearance of visual deficiency symptoms means that production has already been seriously impaired.

Evaluating the Response of Citrus to Potassium

Florida citrus growers are advised to annually test their soils for pH and extractable K, phosphorus (P), calcium (Ca), and magnesium (Mg). The information provided by these soil tests increases in value after citrus groves have been annually sampled for 4 to 5 years, because observing year-to-year changes in test values can provide evidence of the degree to which a nutrient is either accumulating in the soil or is perhaps being leached out. While soil test values typically increase following the application of relatively immobile nutrients like P, Ca, and Mg, most citrus grove soils do not show a substantial increase in soil test K even after many years of annual K fertilizer applications.

In 1998, we initiated a P and K fertilizer experiment in a young grapefruit grove planted on a typical flatwoods citrus soil that had not been previously fertilized. The objectives were to calibrate P and K soil tests for Florida citrus production, determine the effects of P and K fertilization on yield and fresh fruit quality, and develop fertilization recommendations that will produce qualities most desired by fresh fruit consumers. After three years of applying P and K fertilizer, we determined that calibrating a K soil test would not be possible because K was not accumulating in the soil. In 1998, soil test K by the Mehlich 1 extraction method was 10 parts per million (ppm), considered very low. By 2001 it had increased to only 19 ppm (low) after three annual applications of 200 lb K_2O/A. In contrast,

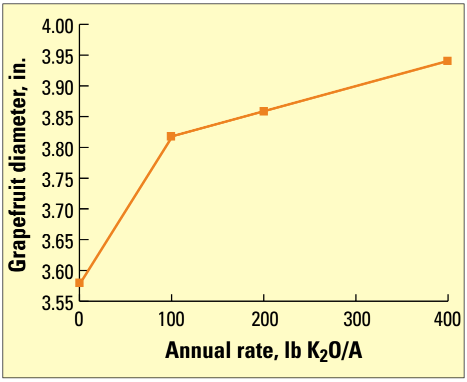

Figure 3. Grapefruit size increased with higher K fertilizer rate.

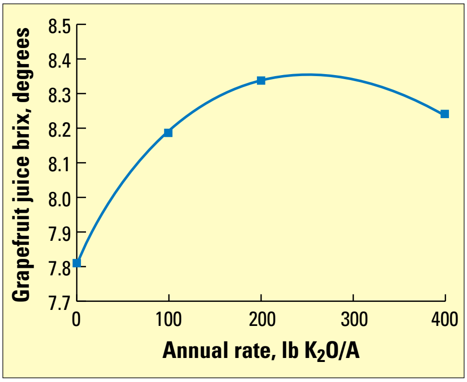

Figure 4. Grapefruit juice brix (sugar content) was maximized at about 200 lb K_2O/A.

soil test P increased from 5 ppm (very low) to 53 ppm (high) following three annual applications of P fertilizer.

Our objective to calibrate a K soil test quickly changed into a K fertilizer rate experiment. We are now evaluating grapefruit tree response to annual K fertilizer applications of 0, 100, 200, and 400 lb K_2O/A. Response variables include canopy volume, fruit yield, and fruit quality factors. One tried and true method of evaluating citrus tree nutrition is leaf tissue analysis. Leaf tissue nutrient concentration standards developed from worldwide research have proven to be a reliable indicator of citrus nutritional status. Citrus response to fertilization is typically reflected in leaf tissue nutrient concentrations, as we observed with K in the study (**Figure 1**). The interpretations for leaf K concentration are: very low, < 0.7%; low, 0.7 to 1.1%; optimum, 1.2 to 1.7%; high, 1.8 – 2.3%; and very high, > 2.3%. The leaf K concentration of trees receiving no K fertilizer was very low; 100 lb K_2O/A raised it to the borderline between low and optimum, after which there was a linear increase of leaf K to the upper end of the optimum range as K fertilizer rate increased. The 200 lb K_2O/A rate was sufficient to maintain optimum leaf K.

The response of tree canopy volume (data not shown) and grapefruit yield (**Figure 2**) to K was characterized by a gradual rise to a maximum followed by a slight decline. The mathematically-fitted response curves predict that maximum tree size and yield will occur when fertilizer is applied at about 200 lb K_2O/A. Visually, the trees that received 200 lb K_2O/A had an expanded, branching canopy compared with the tight, bushy appearance of the trees that did not receive K (see photos). Fruit was easy to find on trees receiving K, but finding a grapefruit on the low-K trees was a difficult task. Interestingly, the low-K trees did not show any obvious visual leaf symptoms of K deficiency such as necrotic edges or off-green color. Rather, the lack of K was expressed as a compact canopy and almost no fruit production.

Three grapefruit internal quality factors important to citrus growers who produce for the fresh market are fruit size (expressed as fruit diameter), juice brix (sugar content), and peel thickness. Larger fruit command higher prices, increased brix may mean that fruit can be harvested earlier in the market season and tastes better, and consumers tend to favor thin-peeled grapefruit. Fruit size increased with increasing K fertilizer rate (**Figure 3**), but brix was maximized at about 200 lb K_2O/A (**Figure 4**). Therefore, it is important to supply sufficient K for fruit sizing, but too much can perhaps cause the brix to be less than maximum. Peel thickness also increased as K fertilizer rate increased (**Figure 5**), indicating that adding K to the system does not provide positive results in all aspects of fruit quality. Growers must consider all factors and strike a balance between them when deciding on the rate of K fertilizer to apply.

Summary

Most citrus growers treat K as they do N, applying approximately the same rate of K_2O and N each year, in split applications or in small doses with irrigation water (fertigation). Soil testing for K is of little use, but leaf tissue tests can be used to gauge tree K nutrition. The ideal annual K fertilizer rate for citrus appears to be about 200 lb K_2O/A. Fresh market citrus growers should recognize that K affects fresh fruit quality factors ...size and sweetness...as well as yield, and then take all these factors into account when formulating a fertilization program. BC

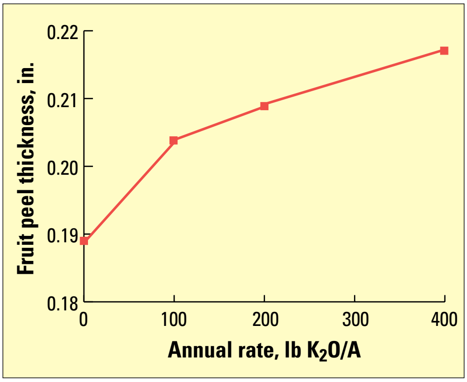

Figure 5. Grapefruit peel thickness increased (a negative effect) as K fertilizer rate increased.

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Tom W. Bruulsema Elected Chairman of ICCA Board

Dr. Tom Bruulsema, PPI/PPIC Regional Director for Eastern Canada and Northeast U.S., has been elected Chairman of the International Certified Crop Adviser (ICCA) Board for 2003. In the responsibility, he will be part of a leadership team for the organization of nearly 15,000 professional crop advisers across the U.S. and Canada.

Tom Bruulsema

"We've recently been putting together a strategic plan for the next three years. Our main goal is clearly to increase the value of certification," Dr. Bruulsema explained. "Certified crop advisers have an important role in assuring quality in crop production and in delivering an important message not only directly to their clients, but also to the food supply chain, and even to today's consumer."

The ICCA Program is a professional certification program offered by the American Society of Agronomy (ASA). It is voluntary and provides an entry level standard of knowledge through testing and seeks to raise that standard through continuing education. The program is administered locally by 37 state/regional/provincial boards (Local Boards) throughout the U.S. and Canada.

Dr. Bruulsema, a native of Ancaster, Ontario, directs the agronomic research and education programs of PPI/PPIC in his diverse region, which includes 14 states and the eastern provinces of Canada. He earned B.S. and M.S. degrees from the University of Guelph and a Ph.D. from Cornell University. Dr. Bruulsema joined the PPI/PPIC staff in 1994 and is located at Guelph, Ontario. He has recently served as Chairman of the Northeast Branch of ASA and the Soil Science Society of America. BC

Cliff S. Snyder Honored with ASA Fellow Award


Cliff S. Snyder

Dr. Clifford S. Snyder, PPI Southeast Regional Director, was recognized as a Fellow of the American Society of Agronomy (ASA) at their recent annual meeting. Fellow is the highest honor bestowed by the Society, and only 0.3% of the Active and Emeritus members may be elected to Fellowship.

Dr. Snyder joined the staff of PPI in 1995 as Midsouth Director, located in Conway, Arkansas. In 2002, he became Southeast Director and now has responsibility for PPI's agronomic research and education programs in the states of Arkansas, Alabama, Louisiana, Mississippi, Tennessee, Georgia, Florida, South Carolina, and North Carolina. In addition to his regional responsibilities, he has played a leadership role in the area of nutrient management and water quality.

A native of Denver, Colorado, Dr. Snyder earned his B.S. and M.S. degrees from the University of Arkansas and his Ph.D. from North Carolina State University. In 1984, he became a state soils specialist with the Cooperative Extension Service in Arkansas, with responsibility for leading and developing statewide programs in aglime and micronutrient education. Later, his responsibilities were expanded to include support of the state soil testing program. He had a similar role with the cotton monitoring program and has conducted numerous soil fertility test programs and demonstrations with university researchers, involving a wide array of crops, plus forestry and fruit and vegetable production.

Dr. Snyder serves as co-chair of the Southern Soil Fertility Conference, was the 2000 Division S-8 Chair of the Soil Science Society of America, and has been active in several other professional organizations and in his community. BC

Paul E. Fixen Recognized with Agronomic Industry Award


Paul E. Fixen

Dr. Paul E. Fixen, PPI Senior Vice President, Coordinator of North American Programs, and Director of Research, received the Agronomic Industry Award at the recent annual meeting of the American Society of Agronomy (ASA). The award recognizes outstanding performance by a private sector agronomist in the development, acceptance, and implementation of advanced agronomic programs, practices, and/or products.

Dr. Fixen has served on many scientific and industry committees and is frequently called upon to represent the fertilizer industry on technical aspects of issues related to nutrients and the environment. He has served as an associate editor for the Soil Science Society of America (SSSA) Journal, as Chair of the Fertilizer Management and Technology Division of SSSA, as president of the North Central Branch of ASA, and is currently on the editorial board of the international Precision Agriculture journal. He is a Fellow of ASA and SSSA.

Before joining the staff of PPI in 1989 as Northcentral Regional Director, Dr. Fixen spent nine years in research and teaching in soil fertility at the University of Wisconsin and South Dakota State University. In these positions, he authored or co-authored more than 150 articles related to soil fertility, including several book chapters.

Dr. Fixen grew up on a farm in southwestern Minnesota, received his B.S. and M.S. degrees at South Dakota State University, and earned his Ph.D. at Colorado State University. BC

Icon or Not – Leave Your Mark

Late last year a world-renowned agronomist – an icon – departed this world. It always saddens me to hear about the loss of such an eminent scientist. Even though I did not know him well, I knew his work, and it was significant. His contributions to soil science were many. In reflecting on his passing, my first thought was that our profession wouldn't be able to replace him.

How do you take up the slack when a great one passes away? After pondering this question for a while, it occurred to me that a large part of progress is to adapt to loss. Icons emerge, contribute, then move on, to be replaced by others. The profession of agronomy will move on as well. That's how society functions, and agronomy is a microcosm of society.

Not all of us achieve greatness. However, we can do our best to make our talents count, no matter what our social position might be or where we rank in our chosen profession. We owe it to ourselves and those around us to be willing to go that extra mile. Those who stretch their talents to the fullest might not wind up being an agronomic icon, but they will be respected, and they will leave their mark...and each of us should leave a mark. Otherwise, how will those who follow know we passed this way?

Leaving a mark means that your work is worth something to your profession. It could be teaching or research, maybe writing...or selling fertilizer. Whatever it is, if it is worthy, others will take it and use it to make things better than they were before.

Icons leave behind significant marks. They aren't difficult to find because they will be referenced in the scientific literature, will appear in the popular agricultural magazines, and will be quoted by those who teach.

It is my guess that most of you who read this magazine are familiar with the work of Dr. Stanley Barber. Some of you knew him personally. All of you have been impacted by the contributions he made to our science. He was truly an icon, one who made his mark. We all know he passed our way.

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