What's Cropping Up?

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Phosphorus and Agriculture VIII: The New Phosphorus Index for New York State

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Introduction

The NY-PI is designed to assist producers and planners in identifying fields or portions of fields that are at highest risk of contributing phosphorus (P) to lakes and streams. The NY-PI assigns two scores to each field based upon its characteristics and the producer's intended management practices. One of the two scores, the **Dissolved P Index**, addresses the risk of loss of water-soluble P from a field (flow across the field or through the soil profile) while the **Particulate P Index** estimates the risk of loss of P that is either attached to soil particles or a component of manure.

The NY-PI scores will rate a field to determine its susceptibility to P losses. Fields with high or very high site vulnerability should be managed with minimizing P losses in mind. A low or medium ranking implies management can be nitrogen based. The NY-PI score will also indicate whether other management changes such as winter spreading must be addressed.

It is important to note that the PI is not a measure of actual P loss, but rather an indicator of potential loss. A high or very high PI score is a warning to further examine the causes, and a low PI score means the risk of phosphorus loss is reduced, but perhaps not eliminated.

In this article, the NY-PI is described. In a future issue of "What's Cropping Up?" the source and transport components will be explained in more detail and management options will be discussed.

Table 1: NY-PI scores and their rankings and management implications.

Ranking Values	Site Vulnerability	Management
< 50	Low	N based management
50 – 74	Medium	N based management with BMP's
75 – 99	High	P applications to crop removal
≥ 100	Very High	No P_2O_5 fertilizer or manure application

The NY-PI in general

The NY-PI's are separated into two main parts: potential sources of P ("source score") and potential movement of P ("transport score"). The final score is the multiplication of the source score and the transport score:

Dissolved P index =
P Source score x Dissolved P Transport score

Particulate P index =
P Source score x Particulate P Transport score

Rankings and management implications for final field scores are listed in Table 1. Both P forms (dissolved and particulate) are a concern for water quality. They should be managed jointly.

PI Source Components

Contributing to the source component are soil test P level, as well as manure and fertilizer additions:

P Source Score =
Soil Test P + Fertilizer P + Organic P

The Soil Test P portion of the NY-PI score is obtained by multiplying Morgan soil test P by 1.25:

Soil test P = 1.25 * Morgan's Soil Test P (lbs P/ac)

Soil test P results based on Mehlich-III and modified Morgan must be converted to a Morgan P equivalent (see the March-April 2001 issue (Vol 11, No 3) of

"What's Cropping Up?" or http://www.css.cornell.edu/nutmgmt/index.html). The fertilizer and organic P scores are first determined by a multiplication of application rate (lbs P_2O_5/ acre) by the weighing factors for application timing and method (see Tables 2 and 3), and then the scores are added to the Soil Test P score.

Table 2: To obtain the fertilizer P score for the NY-PI, P_2O_5 application rate, timing and method scores need to be multiplied.

Fertilizer P =	$(P_{fa}) * (P_{ft}) * (P_{fm})$				
Fertilizer P application rate (P_{fa})	lbs P_2O_5 / acre				
Fertilizer P timing (P_{ft})	May – August 0.4	September – October 0.7		November – January 0.9	February – April 1.0
Fertilizer P method (P_{fm})	Injected or subsurface banded 0.2	Broadcast and incorporated within 1-2 days 0.4	3-5 days 0.6	Surface applied or broadcast and incorporated >5 days after application 0.8	Surface applied on frozen, snow covered or saturated ground 1.0

PI Transport Components

To assess dissolved P transport, the NY-PI considers soil drainage class, flooding frequency and predominant water flow distance to a stream (Table 4).

Dissolved P Transport Score = Soil drainage + Flooding frequency + Flow distance to stream

(if Dissolved P Transport is > 1, then Dissolved P Transport = 1)

The soil drainage classification is determined from a soil survey and the category should not be modified to reflect any drainage practices that may have been installed. The flooding frequency is also determined from the soil survey or sometimes this information may be available on flood hazard boundary maps. The flow distance is the edge of "field" drainage path that excess water takes as it leaves a field and finds it way downhill to a watercourse (blue line stream). This can be estimated by field observation or determined from topographic maps whereby the flow path is perpendicular to the contour lines.

Table 3: To obtain the organic P score for the NY-PI, P_2O_5 application rate from organic sources, timing and method scores need to be multiplied.

Organic P =	$(P_{oa}) * (P_{ot}) * (P_{om})$				
Organic P application rate (P_{oa})	0.75 * lbs P_2O_5 / acre				
Organic P timing (P_{ot})	May – August 0.4	September – October 0.7		November – January 0.9	February – April 1.0
Organic P method (P_{om})	Injected or subsurface banded 0.2	Broadcast and incorporated within 1-2 days 0.4	3-5 days 0.6	Surface applied or broadcast and incorporated >5 days after application 0.8	Surface applied on frozen, snow covered or saturated ground 1.0

The particulate P component of the NY-PI is similar to the dissolved P component in that flooding frequency and the predominant water flow distance to a stream are again considered (Table 5). Additionally, particulate P loss potential is influenced by soil erosion and the presence of concentrated flow paths. Soil erosion rate is estimated using the Universal Soil Loss Equation (USLE) or the Revised Universal Soil Loss Equation (RUSLE).

Table 4: The Dissolved P Transport score is obtained by adding factors for soil drainge, flooding frequency and predominant flow distance to stream.

Dissolved Transport P =	D + F + FLD			
Soil Drainage (D)	Well / Excessively well drained 0.1	Moderately-well drained 0.3	Somewhat poorly drained 0.7	Poorly / very poorly drained 1.0
Flooding frequency (F)	Rare / Never > 100 years 0	Occasional 10 - 100 years 0.2		Frequent < 10 years 1.0
Flow distance to blue line stream as depicted on topographic map or equivalent (FLD in feet) Intermittent Stream = dashed blue line. Perennial Stream = solid blue line.	Intermittent Stream >200 feet Perennial Stream >300 feet 0	Intermittent Stream 25 to 200 feet Perennial Stream 50 to 300 feet Intermittent Stream 1 – (Distance–25)/175 Perennial Stream 1 – (Distance–50)/250		Intermittent Stream <25 feet Perennial Stream < 50 feet 1.0

Acknowledgments

The NY-PI has been developed by individuals representing NRCS, Cornell faculty and educators, and the New York State Soil and Water Conservation Committee. In addition to the authors of this article, the PI Work Group consists of: Greg Albrecht, Shawn Bossard, Ray Bryant, Dale Dewing, Fred Gaffney, Dean Hively, Paul Ray, Tammo Steenhuis, and Jeff Ten Eyck. A spreadsheet calculator is available at http://www.css.cornell.edu/nutmgmt/index.html (click on software) and a detailed user manual will be available sometime this summer.

The determination of whether or not concentrated flow paths are present in the field is best done through field observation. The current resolution of contour lines on topographic maps may not be sufficient to indicate whether a concentrated flow path is present.

Particulate P Transport Score = Soil erosion + Flooding frequency + Flow distance to stream + Concentrated flow

(if Particulate P Transport is > 1, then Particulate P Transport = 1)

One should note that both the dissolved and particulate P Transport Scores are set equivalent to 1.0 when the various transport components add to more than one. Thus, the dissolved and particulate P Transport Scores represent a percentage of the P source factor.

Table 5: The Particulate P Transport Score is obtained by adding factors for soil erosion, flooding frequency, predominant flow distance to stream and the presence or absence of concentrated flow patterns.

Dissolved Transport P =	SL + F + FLD + CF		
Soil erosion RUSLE or USLE (SL)	0.1 * Erosion rate (tons/acre)		
Flooding frequency (F)	Rare / Never > 100 years 0	Occasional 10 - 100 years 0.2	Frequent < 10 years 1.0
Flow distance to blue line stream as depicted on topographic map or equivalent (FLD in feet) Intermittent Stream = dashed blue line. Perennial Stream = solid blue line.	Intermittent Stream >200 feet Perennial Stream >300 feet 0	Intermittent Stream 25 to 200 feet Perennial Stream 50 to 300 feet Intermittent Stream 1 –(Distance–25)/175 Perennial Stream 1 –(Distance–50)/250	Intermittent Stream <25 feet Perennial Stream < 50 feet 1.0
Is concentrated flow (CF) present?	No 0	Yes 0.2	

Nutrient Management

Conversion Equations Part 2: Do Mehlich-III K, Ca and Mg Have Morgan Equivalents?

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Introduction

In the March-April issue of "What's Cropping Up?" (Vol 11, No 3) we reported our findings on the use of Mehlich-III soil test phosphorus (P) to derive Cornell University based fertilizer recommendations. We concluded that, while the most accurate recommendations are derived using the Morgan soil extraction solution, acceptable recommendations for New York can be derived with modified Morgan as well as Mehlich-III P input data from the participating commercial laboratories if the soil pH, Mehlich-III calcium (Ca) and Mehlich-III aluminum (Al) are known. In this article, we focus on conversions for potassium (K), Ca, and magnesium (Mg).

Field Sampling and Analyses

The same soils dataset as those on which the P conversion equations were based was analyzed for exchangeable K, Ca, and Mg. Personnel from Agway Inc., Agricultural Consulting Services Inc., ConsulAgr Inc., Cooks Consulting Services and the Miner Institute collected the 235 plow-depth soil samples representing 27 soil types and eight major agricultural soil groups from across NY (see Table 1 on page 2 of "What's Cropping Up?" Vol 11, no 3). Each sample was analyzed for Morgan extractable K, Ca, and Mg at Cornell's Nutrient Analysis Laboratory and for Mehlich-III extractable K, Mg, Ca at Brookside Laboratories Inc.

Results

The 235 soil samples covered a wide range of soil K, Ca, and Mg levels. Soil K levels ranged from 20 to 549 ppm K (Morgan extraction); soil Ca levels varied from 416 to 7854 ppm Ca and soil Mg covered the range from 60 to 538 ppm Mg.

Morgan extractable K, Ca, and Mg were linearly related to Mehlich-III extractable K, Ca and Mg, respectively, according to the following equations:

Morgan K (ppm) =
1.1 * Mehlich-III K (ppm) - 24 (r^2=0.94)

Morgan Ca (ppm) =
1.2 * Mehlich-III Ca (ppm) - 411 (r^2=0.93)

Morgan Mg (ppm) =
1.0 * Mehlich-III Mg (ppm) - 9 (r^2=0.94)

In these equations *all data are in ppm.* To convert ppm to lbs/acre, multiply by 2. Figures 1 through 3 show the regression analyses for each of the soil nutrients.

Conclusions

Our results indicate that the Mehlich-III solution extracted on average slightly more K and Mg and slightly less Ca than the Morgan extraction solution but that the relationship between the Mehlich-III and Morgan extracted Ca, K and Mg is essentially a one-

Figure 1: Relationship between Morgan and Mehlich-III extractable K for 235 NY soils.

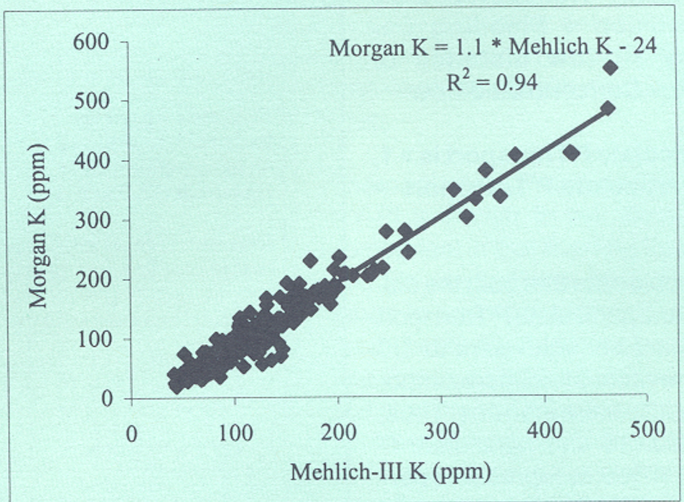
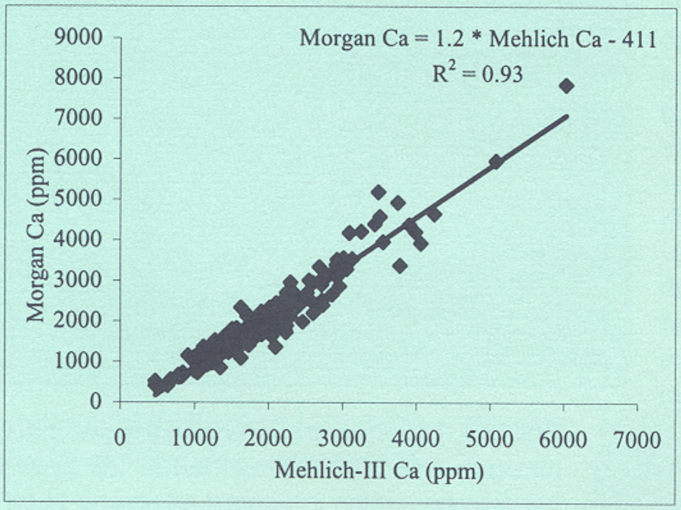


Figure 2: Relationship between Morgan and Mehlich-III extractable Ca for 235 NY soils.

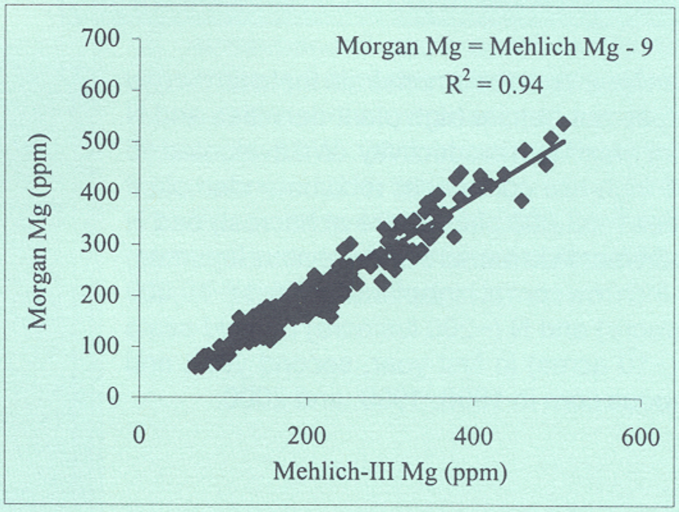


to-one relationship. Thus, Cornell based fertilizer recommendations for K, Ca, and Mg can be derived with Mehlich-III input data. As was the case for P extractions, separate studies are needed to address conversions for other extractants and when laboratory procedures are changed.

Acknowledgments

We thank Mark Flock (Brookside Laboratories Inc.) for collaborating on this project and donating laboratory services. Agway Inc., ConsulAgr Inc., Cooks Consulting Services, Agricultural Consulting Services Inc., and the Miner Institute were involved in field sampling and the Cornell Nutrient Analyses Laboratory staff processed the samples. This study was part of a larger project on Mehlich-III to Morgan conversions (including the P conversions) that was funded by a grant from the Natural Resources Conservation Service, and NY State's Departments of Agriculture & Markets and Environmental Conservation and, through analytical services, sponsored by Spectrum Analytic Inc., A&L Laboratories Inc., and Brookside Laboratories Inc.

Figure 3: Relationship between Morgan and Mehlich-III extractable Mg for 235 NY soils.



Crop Management

Does Narrow Row Corn Require High Plant Densities and N Rates?

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Some New York dairy producers, mostly in western New York, have adopted narrow row (15 in.) corn silage production. Many in the agricultural industry believe that narrow row corn performs best at high plant densities (>40,000 plants/acre) and high N rates (>200 lbs/acre). In small plot studies, however, we reported that 15 and 30-inch row corn responded similarly to plant densities with optimum densities at around 33,000 plants/acre at harvest (What's Cropping Up?, Vol. 7: p. 2-3). Furthermore, we reported that 15 and 30 inch-row corn responded similarly to N rates with optimum rates at about 165 lbs N/acre (Cox and Cherney, Agron. J. 93:597-602). In 1998, we initiated a 3-year study on an large dairy farm in western New York to demonstrate that narrow row corn does not require high plant densities and N rates for maximum productivity. We evaluated 15 and 30 inch row corn under recommended plant densities (~33,000 plants/acre at harvest) and N (~150 lbs/acre via manure and previous legumes) vs. 15-inch row corn at high plant densities (~40,000 plants/acre) and N (~200 lbs/acre) on field-scale plots (~10 acres) in first year, second year, and continuous corn in 1998, 1999, and 2000.

Table 1: Soil NO_3-N concentrations in mid-June, averaged across the 1998, 1999, and 2000 growing seasons, in 15 and 30-inch row corn at recommended plant densities and N and in 15-inch row corn at high plant densities and N.

	1998-2000			
SPACING	1ST YEAR	2ND YEAR	CONT.	MEAN
	ppm			
30"	50	52	61	54
15"	44	45	59	49
15" high	51	59	74	61
	48	52	65	
LSD 0.05	NS	9	NS	11

Table 2: Corn silage yields (35% dry matter), averaged across the 1998, 1999, and 2000 growing seasons, in 15 and 30-inch row corn at recommended plant densities and N and in 15 inch row corn at high plant densities and N.

	1998-2000			
SPACING	1ST YEAR	2ND YEAR	CONT.	MEAN
	tons/acre (35% DM)			
30"	23.1	21.5	22.6	22.4
15"	24.1	22.0	23.6	23.3
15" high	25.2	23.3	23.8	24.1
	24.1	22.3	23.3	
LSD 0.05	1.1	1.2	NS	0.5

Soil NO_3-N concentrations with the pre sidedress nitrogen test (PSNT) exceeded 25 ppm in all treatments, which indicated adequate N for optimum yield, regardless of N rate (Table 1). When averaged across years and rotations, the narrow row treatment with high N rates did average more soil NO_3-N concentrations when compared with the narrow row treatment with recommended N rates. Likewise, the narrow row treatment with high plant densities and N rates averaged 0.8 more tons/acre at harvest when compared with the narrow row treatment with recommended N rates (Table 2). The additional 7000 plants/acre at

Table 3: In vitro true digestibility, averaged across the 1998, 1999, and 2000 growing seasons, in 15 and 30-inch row corn at recommended plant densities and N and in 15-inch row corn at high plant densities and N.

	1998-2000			
SPACING	1ST YEAR	2ND YEAR	CONT.	MEAN
	%			
30"	79.8	80.8	78.7	79.8
15"	80.9	80.7	79.8	80.6
15" high	80.2	79.6	78.1	79.3
	80.3	80.4	78.9	
LSD 0.05	NS	NS	NS	NS

Table 4: Neutral detergent fiber, averaged across the 1998, 1999, and 2000 growing seasons, in 15 and 30-inch row corn at recommended plant densities and N and in 15-inch row corn at high plant densities and N.

	1998-2000			
SPACING	1ST YEAR	2ND YEAR	CONT.	MEAN
	-------------------------%-------------------------			
30"	42.3	40.4	42.6	41.8
15"	41.9	41.2	42.4	41.8
15" high	42.3	41.5	42.1	41.9
	42.1	41.0	42.3	
LSD 0.05	NS	NS	NS	NS

of high plant densities, which resulted in similar corn silage quality between the narrow row treatments.

Narrow row corn under high plant densities and N rates vs. recommended rates averaged more than twice the residual soil NO_3-N concentrations (Table 6). The use of high N thus doubles the risk of potential NO_3- contamination of groundwater supplies. Narrow row corn producers must balance the potential for 3.5% greater yield vs. twice the risk of NO_3- contamination. In our small plot studies, we did report that narrow row corn at high vs. recommended plant densities did take up about 20 more lbs N/acre at harvest. We recommend that narrow row corn producers apply an additional 20 to 30 lbs more N/acre than the recommended N for 30-inch row corn. We believe that the additional 20 to 30 more lbs N/acre will provide most of the yield benefit without the added risk of NO_3- contamination.

harvest and 50 lbs/acre of N in narrow row corn thus resulted in a 3.5% yield increase.

We previously reported, however, that corn silage quality shows a negative response to increased plant densities (What's Cropping Up? Vol. 7: p. 2-3). On the other hand, increased N rates improve corn silage quality (Cox and Cherney, Agron. J. 93:597-602). In our 3-year Demonstration, narrow row con had similar in vitro true digestibility (Table 3),neutral detergent fiber (NDF, Table 4), and NDF digestibility (Table 5) under recommended or high plant densities and N rates. Apparently, the positive effect of high N rates offset the negative effect

Table 5: Neutral detergent fiber digestibility, averaged across the 1998, 1999, and 2000 growing seasons, in 15 and 30-inch row corn at recommended plant densities and N and in 15-inch row corn at high plant densities and N.

	1998-2000			
SPACING	1ST YEAR	2ND YEAR	CONT.	MEAN
	-------------------------%-------------------------			
30"	52.5	52.4	49.7	51.5
15"	52.8	50.3	47.7	50.3
15" high	54.5	52.4	52.7	53.2
	53.3	51.7	50.0	
LSD 0.05	NS	NS	NS	NS

Table 6: Residual soil NO_3-N concentrations in late September, averaged across the 1998, 1999, and 2000 growing seasons, in 15 and 30-inch row corn at recommended plant densities and N and in 15-inch row corn at high plant densities and N.

	1998-2000			
SPACING	1ST YEAR	2ND YEAR	CONT.	MEAN
	-------------------------ppm-------------------------			
30"	14	10	11	12
15"	11	5	13	10
15" high	29	13	23	21
	18	9	16	
LSD 0.05	18	NS	7	8

Calendar of Events

July 6	Weed Science Field Day, Valatie Research Farm, Valatie, NY
July 17	Weed Science Field Day, Musgrave Research Farm, Aurora, NY
July 18	Weed Science Field Day, Thompson Research Farm, Freeville, NY
August 15	Aurora Field Day, Robert B. Musgrave Research Farm, Aurora, NY
Oct. 21-25	ASA-CSSA-SSSA Annual Meetings, Charlotte, NC
Oct. 30	Field Crop Dealer Meeting, Chaucers Restaurant, Clifton Park, NY
Oct. 31	Field Crop Dealer Meeting, Ramada Inn, New Hartford, NY
Nov. 1	Field Crop Dealer Meeting, Batavia Party House, Batavia, NY
Nov. 2	Field Crop Dealer Meeting, Holiday Inn, Auburn, NY

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