Comparison of Land Grant University Soil Test Recommendations for Nitrogen, Phosphorus and Potassium

Dr. Mark McFarland, Texas A&M University
Dr. Dan Devlin, Kansas State University
Dr. Richard Koenig, Washington State University
Dr. Deanna Osmond, North Carolina State University

Introduction

It is important to recognize there are many aspects to soil testing that cause differences in nutrient recommendations. Soil testing and the resulting nutrient application recommendations have progressed over many decades. Soil test extractants, methodologies, and calibration of nutrient recommendations to yields were developed primarily at state levels. Different soil test philosophies also developed. For instance, many labs use the Mehlich-3 extractant, but the nutrient recommendations will be different due to the "philosophy" that the soil test lab uses; one lab may use a sufficiency philosophy, while another will use a buildup and maintenance strategy. These differences in philosophy will change the fertilizer recommendations. In addition to these differences, resources for continued calibration of soil tests and the development of new soil test procedures have been scarce for at least twenty years. Some recommendations may be outdated due to the lack of resources, both human and monetarily, in the realm of soil testing.

The Conservation Security Program (CSP) is a new program that rewards farmers for good conservation practices, including nutrient management, and focuses on watersheds. However, some watersheds cross state boundaries and personnel of USDA-NRCS have discovered that nutrient recommendations may vary between states. As a consequence, land-grant faculty representing the three NRCS regions compared nutrient management recommendations across adjoining states. The information is presented below.

Summary

! Overall, soil test recommendations for N, P and K in adjoining states within a region (West, Central, East) were very similar across the range of soil test levels from Very Low to Very High for the major crops and cropping systems evaluated.
! Variations in fertilizer N, P and K recommendations based on soil test and/or yield goal, soil type, organic matter content, or nutrient index (e.g. P-Index) typically ranged from 0 to 14%. This application range is often within the range of fertilizer spreader technology and in the area of nutrient application does not represent true differences.
! Differences in soil test methods and philosophies do exist among states within a region; however, recommendations generally are not substantively different where sufficient field calibration has been possible.
! Management practices, such as method of application (band vs. broadcast) can significantly affect recommendations and apparent consistency between/among states.
! Differences among states in other nutrient management tools such as the P-Index and Code 590 standards can contribute to differences in recommended fertilizer application rates across state boundaries and within a shared watershed.

- Establishment and publication of standard soil testing methods and procedures for states, multi-state groups, and where possible, regions could promote greater consistency in soil testing procedures and fertilizer recommendations among private and public laboratories. For example, the Western Region has developed a manual (Gavlak, et al., 2003) that summarizes extraction and analytical methods recommended for use in the Western U.S.
- Development and publication of multi-state guides for major crops could provide significant opportunity to identify and minimize the degree of variation among states in fertilizer recommendations. Some states and/or regional groups already have worked to coordinate development of recommendations for some major crops, e.g., Oregon and Washington use the same fertilizer guide for potatoes.
- Results strongly suggest that support for enhanced collaboration among LGU nutrient management personnel could lead to significant and meaningful improvement in nutrient management recommendations available to agricultural producers, land managers and state and federal land and water resource management agencies.

Approach

- LGU nutrient management personnel compared soil test recommendations for adjacent states in the Western U.S. (Washington, Idaho, Oregon), Central U.S. (Kansas, Nebraska, Oklahoma), and Eastern U.S. (North Carolina, Virginia, Tennessee).
- A common spreadsheet was used to compare N, P and K recommendations for 3 major crops across soil test ranges of very low, low, moderate, high and very high, and yield goals, as appropriate.
- Recommendations for selected crops were developed and compared for “scenario” soil samples representative of potential situations in shared watersheds.

Nitrogen

- In general, there was a high degree of consistency among states within a region for N fertilizer recommendations based on soil test nutrient level and/or a combination of other parameters including yield goal, soil mapping unit, organic matter content, etc.
- Variations in N recommendations generally ranged from 0 to 14% for samples in the low to medium soil test categories.
- In many cases, fertilizer recommendation ranges between/among states overlapped or were inclusive of ranges for adjacent states; thus, differences in observed recommendations would be due to site specific interpretations.
- Selected cases of more substantial percentage variation (33 - 150%) in N recommendations were observed, but typically were associated with the Very High soil test range where lesser total amounts of fertilizer N are recommended. For example, N recommendations for 200 bu/acre irrigated corn in soils testing Very High were 20 and 50 lbs N/acre for Idaho and Oregon, respectively.
- Many northcentral and southeastern U.S. states do not utilize a soil test for N; thus, credits for measured N used by some states could result in differences in fertilizer recommendations. In addition, some states provide N credits based on measured or classified soil organic matter content while others do not.

- Differences in fertilizer N recommendations for some scenarios were related to differences in predicted crop yield potential, not differences in soil test results.
- Some states have developed fairly sophisticated predictive tools based on state-specific research (e.g. North Carolina recommendations are based on yield potential, soil mapping unit and soil management group) that result in more prescriptive recommendations.

Phosphorus

- Recommendations for fertilizer P were remarkably consistent among states within a region for the major crops evaluated; variations generally were less than 10%.
- Significant exceptions were observed for corn, Very High potatoes and Very Low wheat in the Western region, and soybean in the Eastern region
- Management practices, such as method of application (band vs. broadcast) can significantly affect recommendations and apparent consistency. For example, the Washington recommendation for wheat is based on subsurface banding and is doubled if fertilizer is applied broadcast, while Idaho makes no distinction based on method of application.
- Scenario samples indicate that state-to-state variation may occur due to lack of sufficient yield based sensitivity in recommendations for some states. In some cases, insufficient field validation data may be present to support more prescriptive rate recommendations.
- The potential value of common guides, where appropriate, is evidenced by consistency in rate recommendations for potatoes in Oregon and Washington.

Potassium

- Potassium recommendations were reasonably consistent for the major crops evaluated with the exception of High and Very High potatoes in the West where Idaho was markedly lower than Oregon or Washington (which use the same fertilizer guide), and wheat in the East.
- Recommendations for wheat were notably lower in Tennessee for all soil test ranges and for soybean in the Low range compared to North Carolina or Virginia.
- Significant variations in fertilizer K recommendations may demonstrate the tendency for broader classification that is based on soil characteristics (texture, mineralogy) and original research in the predominant production areas for a crop within a state. For example, Oregon's wheat guide indicates that soil potassium levels are naturally high or very high and no fertilizer potassium is recommended. In addition, due to its greater leaching potential K unlike P can be more transient in coarse textured soils.
- In general, potassium appears to be less aggressively managed than N or P, as might be expected based on historical economics and limited environmental concern.

Recommendations

These recommendations assume additional resources will be available. Over the past twenty years, universities have lost faculty positions that deal with soil testing and calibration. In addition, funding agencies are no longer willing to support this type of research. Thus, there is no funding for the remaining personnel to collaborate and work on this area.

- Promote greater coordination among state LGU nutrient management programs and with NRCS personnel to better understand soil test recommendations for the primary nutrients in states with significant shared production zones and watersheds.
- In concert with state NRCS personnel, identify critical areas where special projects (joint LGU/NRCS) may be warranted to address substantive variations in fertilizer recommendations based on LGU recommendations and/or implementation of state specific Code 590 or other impacting standards.
- Support implementation of a national initiative focused on collaborative multi-state/regional development of crop fertility recommendations that:
  1) evaluates existing soil test methods and recommendation procedures used for major crops and cropping systems,
  2) identifies and addresses critical areas of research need related to method development, correlation and calibration, and
  3) facilitates the development of more similar nutrient guidelines and recommendations (when appropriate) between/among adjacent states for crops and cropping systems in similar production zones.

Pacific Northwest (PNW) Western Region Report (Idaho - Oregon – Washington)

Prepared by Richard T. Koenig
Washington State University
509-335-2726; richk@wsu.edu

Summary points

- Land grant university fertilizer rate recommendations are normally based on maximum economic yield for a given scenario and production yield. Environmental consequences are certainly a consideration in developing recommendations and are often expressed in best management practices designed to minimize nutrient loss and maximize availability and uptake by the crop. No crop is 100% efficient at absorbing nutrients from soil and, since soil is an open system, some losses always occur. As of yet, no one has been able to assign an "economic consequence value" to, for example, a pound of nitrogen entering surface or ground water. If this value was available, economic return models could include the cost of fertilizer as well as additional costs associated with nutrient losses in routines used to optimize fertilizer recommendations. If an environmentally optimum rate of a given nutrient was derived and found to be lower than the rate providing maximum economic yield then some form of positive (compensation) or negative (regulation) incentive would have to be developed to encourage use of these rates among growers and the consultants that serve them.
- Overall, there is good consensus across the Western U.S. in soil extract and other test methodologies. This has been driven in large part by the North American Proficiency Testing (NAPT) program as well as the WERA-103 (Nutrient Management and Water Quality; http://isnap.oregonstate.edu/WCC103/wcc103.htm) and ISNAP (Integrated Soil Nutrient and Pest Water Quality Education; http://isnap.oregonstate.edu/) groups. The West is also working toward greater consensus in soil testing lab results through the NAPT Proficiency Assessment Program (PAP).
- For fertilizer guides that are up-to-date and available from each of the three Pacific Northwest (PNW) states the rate recommendations are relatively similar for a given soil and cropping system scenario. Some exceptions in recommendation uniformity across state lines do occur but are explainable based on differences in, for example, yield potentials and site-specific conditions. Some differences in nutrient management (split applications, timing of application, use of nitrification inhibitors and other technologies, etc.) recommendations do exist among states. These would be expected based on differences in climate and production systems.
- Fertilizer guides for many important crops are outdated or do not exist. There is little current research or incentive to update guides for minor crops that do not enjoy commodity group support. This will be a problem for CSP and other USDA programs that defer to land grant university fertilizer guides as standards.

Task 1: Compile standard operating procedures for soil testing methods used by states adjacent to each lead state for nitrogen, phosphorus and potassium.

A comprehensive summary of standard operating procedures for nitrogen, phosphorus and potassium can be found in the following reference:

Gavlak, R., D. Horneck, R. Miller, and J. Kotuby-Amacher. 2003. Western States Laboratory Plant, Soil and Water Analysis Manual, 2nd Edition. Western Region Extension Publication no. 125.

This publication is available online at: http://isnap.oregonstate.edu/WCC103/Soil_Methods.htm

The manual summarizes extraction and analytical methods recommended for use in the Western U.S. region. Methods contained in the guide are also those used by the North American Proficiency Testing (NAPT) program. The manual includes original, scientific references concerning the development of the method. Rather than reproduce the methods in detail here (which would require several dozen pages), the reader is referred to the web site above for information.

Note that labs conducting sample analysis for growers enrolled in USDA financial program are required to be enrolled in the NAPT program and therefore should be following the methods contained in the manual cited above. The NAPT is a voluntary program and cannot require a lab to use a particular method. The recent extension of the NAPT program – the Performance Assessment Program (PAP) – does enforce the use of appropriate methods as well as accurate analytical results.

Note that Washington and Oregon no longer have land grant university-run labs. Idaho still retains a lab at the main campus in Moscow; however, most growers still send their samples to private labs since the private labs offer faster turn-around times. Washington and Oregon jointly offer a publication summarizing labs performing analytical services in these states. Through a form included in this publication labs can request to be added to this list. This publication can be found through the following link:
http://cru84.cahe.wsu.edu/cgi-bin/pubs/EB1578E.html?id=iV6uDsNQ

Task 2: Provide fertilizer recommendations for 3 major crops over the employed yield ranges and soil test ranges encompassing low, medium, high and very high for each nutrient.

See the attached spreadsheet for results of the analysis.

The three crops selected for the analysis include irrigated grain corn, irrigated Russet Burbank potatoes, and dryland winter wheat. These crops were chosen because they are grown in each of the Pacific Northwest States. Irrigated grain corn and potatoes are grown in areas of north-central Oregon and Central Washington, and in southern Idaho. Dryland winter wheat is grown in eastern and north-central Oregon, eastern Washington and Northern Idaho. A bibliography of fertilizer guide references used in the analysis is included at the end of this section.

The oldest fertilizer recommendations are for corn. Wheat and potato guides have been updated more recently. Research in wheat and potatoes is heavily supported by their respective commodity groups. Corn has no commodity group in the PNW states and therefore no source of funding for research with which to update fertilizer guides.

Note that different land grant university guides have chosen to divide soil test categories differently for P and K. Also, categories do not strictly conform to the "very low", "low", etc. divisions. An attempt was made to match similar categories among university guides based on numeric soil test value for each scenario. See the spreadsheet for more information.

<u>Overall comments on spreadsheet comparison</u>
The spreadsheet comparison indicates a high degree of similarity among PNW states in fertilizer recommendations for these three major crops. In nearly all cases recommendations are within 10-20% across states. This suggests that growers using any of the guides published by these three states would obtain similar results.

There are some notable differences in fertilizer recommendations, including potassium for potatoes where Idaho recommendations tend to be higher in the lower soil test categories, and Oregon/Washington recommendations are higher in the higher soil test categories. Phosphorus recommendations for corn in Washington are considerably higher than in Oregon or Idaho. No ready explanation can be offered for either disparity. Note, however, that the Washington guide for corn is old and likely rarely used by the industry today.

Each state has chosen to emphasize different aspects of nutrient recommendations and management in each of their guides. Each guide also has some unique and valuable information for these crops. The relative similarity among recommendations coupled with the value of information contained in guides from each of the three states suggests that combining guides across states for similar crops and production environments would not only be logical but would produce a more comprehensive and valuable end product. Currently, however, there are few incentives and many disincentives to developing regional fertilizer guides. Barriers such as funding, professional credit, differences in interpretation and others would have to be addressed and removed to facilitate the development of regional guides.

Bibliography of fertilizer guides used to prepare recommendation comparisons:

Corn

Brown, B.D. and D.T. Westermann. 1988. Irrigated field corn for silage or grain. University of Idaho fertilizer guide CIS 372, 2 p.

Dow, A.I., K.I Morrison, C.E. Nelson, D.W. James and A.R Halvorson. 1979. Irrigated field corn for grain or silage. Washington State University fertilizer guide 6, 2p.

Gardner, E.H., L.F. Hall and F.V. Pumphrey. 2000. Field Corn: eastern Oregon – east of Cascades. Oregon State University fertilizer guide no. 71, 3 p.

Potatoes

Lang, N.S., R.G. Stevens, R.E. Thornton, W.L. Pan and S. Victory. 1999. Potato nutrient management for central Wasington. Washington State University Extension Bulletin no. 1871, 17p.

Stark, J., D. Westermann and B. Hopkins. 2004. Nutrient management guidelines for russet Burbank potatoes. University of Idaho Extension Bulletin no. 840, 12p.

Wheat

Koenig, R.T. 2005. Eastern Washington Nutrient Management Guide: Dryland Winter Wheat. Washington State University Extension Bulletin no. 1987, 5p.

Mahler, R.L. 2004. Northern Idaho Fertilizer Guide: Winter Wheat. University of Idaho fertilizer guide CIS 453, 4p.

Petrie, S.E., D.W. Wysocki, D.A. Horneck, L.K. Lutcher and J.M. Hart. *In press.* Winter wheat in continuous cropping systems, high precipitation zone (more than 18 inches of annual precipitation). Oregon State University fertilizer guide no. 54-E.

Task 3: Design, determine and compare soil test recommendation results for 3 "scenario" soil samples representative of shared watersheds for companion states.

Scenario 1: Eastern Washington-Northern Idaho, Rock Creek watershed. This watershed entered the CSP program in 2004-05. The main crop grown in this watershed is dryland soft white winter wheat in 3-year rotations consisting of winter wheat-spring grain (wheat or barley)-spring broadleaf (canola or mustard). Yields of winter wheat are high, often exceeding 100 bushels/acre. Annual precipitation ranges from 18 to 24 inches across the watershed.

In this situation, soil would commonly be sampled to the 5 or 6-foot depth and analyzed for pH, organic matter, soil test P, K, S, Cl, ammonium-N and nitrate-N in the surface foot; S and Cl in the second foot; and nitrate-N below the 1-foot depth. Other micronutrients are generally not tested in this area.

Scenario soil test information	Other pertinent scenario data
Surface 1-foot sample	Annual precipitation
pH = 6.3	22 inches
Organic matter = 3%	
Soil test P (bicarbonate method) = 8 ppm	Yield goal
Soil test K (acetate method) = 275 ppm	100 bushels/acre
Ammonium-N = 5 ppm	
Nitrate-N = 10 ppm	Previous crop
Sulfate-S (top 2 ft) = 8 ppm	spring peas, 2000 lb/ac yield
Cl (top 2 ft) = 8 ppm	
Subsurface 2 to 5-ft depth samples	Tillage: conventional
Nitrate-N = 15 ppm	
	Texture: silt loam

Fertilizer recommendations:

	Washington	Idaho
Nitrogen		
Base rate	100 × 2.7 = 270 lb N/ac	100 × 2.7 = 270 lb N/ac
Soil test credit	30 ppm × 3.5 = 105 lb N/ac	30 ppm × 4 = 120 lb N/ac
Pea residue credit	15 lb N/ac (table value)	23 lb N/ac (table value)
Organic matter credit	20 × % OM = 60 lb N/ac	60 lb N/ac (table value)
Net recommendation	90 lb N/ac	67 lb N/ac
Phosphorus	30 lb P2O5/ac	40 lb P2O5/ac
Potassium	0 lb K2O/ac	0 lb K2O/ac
Sulfur	10-20 lb S/ac	20 lb S/ac
Chloride	10 lb Cl/ac	0 lb Cl/ac

Interpretation
Fertilizer guides from both states have elaborate routines for calculating N requirements for wheat. These involve, in general, a base N requirement calculation (yield × a per bushel N requirement) and credits or debits to the base according to residual N, the previous crop, organic matter mineralization/immobilization reactions, etc. As one can see from the scenario, there are slight differences in values for the pea residue and soil organic matter credits. Similar differences occur with debits taken for immobilization from grain straw as a previous crop, and for soil organic matter mineralization differences with tillage practices. Overall, however, the differences are relatively small and well within the margin of error.

More substantial differences occur in nutrient management recommendations between guides for Washington and Idaho. For example, the Idaho guide emphasizes fall-spring split or spring only applications of N in higher rainfall environments. Rainfall increases dramatically moving from eastern Washington into northern Idaho. In eastern Washington rainfall totals are low enough that all fall or fall-spring split applications of N are appropriate for winter wheat. As one crosses the border into northern Idaho a shift to applying more N in the spring is appropriate. These site-specific management recommendations are included in text portions of each guide.

Phosphorus management recommendations also differ between states. The Washington guide states that the recommendations are appropriate for P banded below the surface; if broadcast, P rates should be doubled. The Idaho guide states that P recommendations are appropriate regardless of the application method.

Scenario 2: South-central Washington to North-central Oregon (Paterson-Umatilla area). This area is not currently in the CSP program but straddles the Columbia River south of Kennewick, Washington. A diversity of crops is grown under irrigation in this area. Rotations are complex and may include corn, alfalfa, small grains, onions, potatoes, other vegetables, vineyards and orchards. This scenario will focus on grain corn following alfalfa.

In this scenario, soil may be sampled to the 4-foot depth and analyzed for pH, organic matter, salinity, soil test P, K, S, Zn, ammonium-N and nitrate-N in the surface foot; and nitrate-N below the 1-foot depth.

Scenario soil test information	Other pertinent scenario data
Surface 1-foot sample	Yield goal
pH = 7.5	200 bushels/acre
Organic matter = 0.5%	
Soil test P (bicarbonate method) = 6 ppm	Previous crop: alfalfa stubble
Soil test K (bicarbonate method) = 175 ppm	
Ammonium-N = 3 ppm	Tillage: conventional
Nitrate-N = 2 ppm	
Sulfate-S (top 2 ft) = 15 ppm	Texture: sandy loam
Zn = 0.5 ppm	
Salinity = 1.5 mmhos/cm	
Subsurface 2 to 4-ft depth samples	
Nitrate-N = 10 ppm	

Fertilizer recommendations:

	Washington	Oregon
Nitrogen		
Base rate	260 lb N/ac	250 lb N/ac
Soil test credit	15 ppm × 4 = 60 lb N/ac	15 ppm × 4 = 60 lb N/ac
Alfalfa credit	included in base rate	included in base rate
Organic matter credit	none	none
Net recommendation	200 lb N/ac	190 lb N/ac
Phosphorus	159 lb P2O5/ac	0-100 lb P2O5/ac
Potassium	0 lb K2O/ac	0-100 lb K2O/ac
Sulfur	0 lb S/ac	0 lb S/ac
Zinc	10 lb Zn/ac	10 lb Zn/ac

Interpretation

Fertilizer guides from both states credit residual soil N and mineralization from previous legume crops similarly. Neither state credits soil organic matter mineralization. This is likely due to the low soil organic matter levels in areas in which corn is grown under irrigation. Both guides also emphasize the importance of split application and other N management practices to reduce leaching under irrigation. There is considerable agreement on N recommendations between these two guides.

Larger differences in P and K recommendations occur between Washington and Oregon. Oregon soil test categories and recommendations for P and K are "coarse" in that they include few categories and broad ranges in recommendations. Washington P recommendations are relatively high compared to Oregon for similar soil test categories. For example, Oregon recommends 100-150 lb P2O5/ac for a soil test range of 0-5 ppm; Washington recommends 295, 204, and 159 lb P2O5/ac for soil test levels of 2, 4 and 6 ppm, respectively. There is no ready explanation for the higher P recommendations in Washington. The Washington guide is old (published in 1979) and in need of updating.

Scenario 3: A hypothetical watershed in Idaho and Oregon/Washington where irrigated Russet Burbank potatoes are grown in rotation with other diverse irrigated crops. This hypothetical example was selected since there is no common watershed bordering Idaho and either Oregon or Washington in which potatoes are grown under irrigation. Similar climates, soils and production systems can be found in Idaho, Oregon and Washington, however, so the comparison is likely valid. One notable difference in potato production among these states is that yields in Oregon and Washington are considerably higher than in Idaho.

In this scenario, soil may be sampled to a depth of 12 inches and analyzed for pH, organic matter, salinity, and soil test P, K, S, B, Zn, Fe, Cu, Mn. Subsurface sampling is not done.

Scenario soil test information	Other pertinent scenario data
Surface 1-foot sample	Yield goal
pH = 7.5	400 cwt/acre (20 t/ac)
Organic matter = 0.5%	
Soil test P (bicarbonate method) = 9 ppm	Previous: wheat (100 bu/ac)
Soil test K (bicarbonate method) = 125 ppm	
Ammonium-N = 3 ppm	Tillage: conventional
Nitrate-N = 2 ppm	
Sulfate-S = 15 ppm	Texture: sandy loam
B = 0.8 ppm	
Zn = 0.5 ppm	0% soil free lime content
Fe = 15 ppm	
Cu = 0.8 ppm	
Mn = 4 ppm	
Salinity = 1.0 mmhos/cm	

Fertilizer recommendations:

	Washington/Oregon	Idaho
Nitrogen		
Base rate	200 lb N/ac	250 lb N/ac
Soil test credit	5 ppm × 4 = 20 lb N/ac	5 ppm × 4 = 20 lb N/ac
Straw debit	50 lb N/ac immobilized	60 lb N/ac immobilized
Organic matter credit	none	none
Net recommendation	230 lb N/ac	290 lb N/ac
Phosphorus	159 lb P2O5/ac	160 lb P2O5/ac
Potassium	360 lb K2O/ac	200 lb K2O/ac
Sulfur	0 lb S/ac	0 lb S/ac
Boron	0 lb B/ac	0 lb B/ac
Zinc	10 lb Zn/ac	10 lb Zn/ac
Iron	insufficient data	0 lb Fe/ac
Copper	insufficient data	0 lb Cu/ac
Manganese	insufficient data	5-10 lb Mn/ac

Interpretation

Fertilizer guides for Washington/Oregon and Idaho use similar routines for calculating N rates. Both use a base N rate that depends on yield potential of the site; however, the base rate is higher in the Idaho guide for a given yield. There is no ready explanation for the higher base N rate

used in the Idaho guide. Both guides include similar credits and debits for soil test N, previous legume or grain crops, and irrigation water contributions. Neither guide credits N release by organic matter, as potatoes are commonly grown in very low soil organic matter environments. Both guides heavily emphasize the importance of split applications of N and in-season sampling of potato petiole tissue for guiding N application timing.

Phosphorus recommendations are similar in this example. Potassium recommendations are higher in the Washington/Oregon guide. This is likely due to higher tuber yields achieved in Washington/Oregon compared to Idaho and the fact that K recommendations are based only on soil test level and not on yield. Idaho includes recommendations for micronutrients iron, copper and manganese; Washington/Oregon state there is insufficient data to make recommendations for these micronutrients.

Soil Test Recommendation Comparison Table - WEST

Soil Test Recommendation

Nitrogen (lbs N/acre)

Crop	Yield Goal		Very Low			Low			Medium			High			Very High	
	(if applicable)	10 ppm	50 lb/ac	10 ppm	30 ppm	100 lb/ac	30 ppm	40 ppm	150 lb/ac	40 ppm	50 ppm	200 lb/ac	50 ppm	70 ppm	250 lb/ac	70 ppm
Corn	(bu/acre)	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA
(irrigated)	100	175			95			55			15			0		
	150	215			135			95			55			0		
	200	260	250	280	180	200	200	140	150	160	100	100	120	20	50	40
			Very Low			Low			Medium			High			Very High	
		0 ppm	0 ppm	0 ppm	5 ppm			10 ppm	10 ppm	10 ppm	15 ppm			20 ppm	20 ppm	20 ppm
Potatoes	(cwt/acre)	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA
	300	200			180			160			140			120		
	400	240	200	200	220			200	160	160	180			160	120	120
	500	280	250	250	260			240	210	210	220			200	170	170
	600	320	300	300	300			280	260	260	260			240	220	220
			Very Low			Low			Medium			High			Very High	
		0 ppm	0 lb/ac	0 lb/ac	10 ppm	40 lb/ac	40 lb/ac	20 ppm	80 lb/ac	80 lb/ac	30 ppm	120 lb/ac	120 lb/ac	40 ppm	160 lb/ac	160 lb/ac
Wheat	(bu/acre)	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA
(dryland)	50	125	120	135	85	80	95	45	40	55	5	0	15	0	0	0
	75	188	180	203	148	140	163	108	100	123	68	60	83	28	20	43
	100	250	240	270	210	200	230	170	160	190	130	120	150	90	80	110

Additional Explanation

Assumptions: no credit/debit for mineralization/immobilization from previous crop or soil organic matter; conventional tillage where applicable; 20 inch rainfall zone for wheat.

Oregon guide for corn states "for yields of at least 150 bu/acre" and "mineral soils with low organic matter" (assume there is no credit given to organic matter mineralization).

Washington guide for corn does not state a yield potential so assumed 200 bu/acre (appropriate for well-managed corn in irrigated central Washington).

Base N rate for wheat from all three states is calculated from yield potential multiplied by per bushel N rate; adjustments are then made based on soil test, organic matter, etc.

Oregon and Washington use the same fertilizer guide for potatoes (see bibliography for citation).

Phosphorus (lbs P2O5/acre)

Crop	Yield Goal		Very Low			Low			Medium			High			Very High	
	(if applicable)	0 ppm	0-5 ppm	2 ppm	5 ppm		4 ppm	10 ppm	5-12 ppm	6-8 ppm	15 ppm	>12 ppm	10 ppm	20 ppm		>10 ppm
Corn	(bu/acre)	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA
(irrigated)	100	180	100-150	295	100		204	20	0-100	115-160	0	20-30	68	0		0
	150	180	100-150	295	100		204	20	0-100	115-160	0	20-30	68	0		0
	200	180	100-150	295	100		204	20	0-100	115-160	0	20-30	68	0		0
			Very Low			Low			Medium			High			Very High	
		0 ppm	3 ppm	3 ppm	5 ppm	6 ppm	6 ppm	10 ppm	9 ppm	9 ppm	15 ppm	12 ppm	12 ppm	20 ppm	12-20 ppm	12-20 ppm
Potatoes	(cwt/acre)	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA
	300	320	295	295	240	204	204	160	159	159	80	114	114	0	68	68
	400	320	295	295	240	204	204	160	159	159	80	114	114	0	68	68
	500	320	295	295	240	204	204	160	159	159	80	114	114	0	68	68
	600	320	295	295	240	204	204	160	159	159	80	114	114	0	68	68
			Very Low			Low			Medium			High			Very High	
		0-8 ppm	0-5 ppm	0-4 ppm	8-10 ppm	6-10 ppm	4-8 ppm	10-12 ppm	11-15 ppm	8-12 ppm	>12 ppm	>15 ppm	12-16 ppm			>16 ppm
Wheat	(bu/acre)	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA
(dryland)	50	60	30-35	40	40	20-30	30	20	10-20	20	0	0	10			starter
	75	60	30-35	40	40	20-30	30	20	10-20	20	0	0	10			starter
	100	60	30-35	40	40	20-30	30	20	10-20	20	0	0	10			starter

Additional Explanation

Idaho P recommendations increase with soil free lime content. Lime contents of 0 and 5% assumed for examples with potatoes and corn, respectively.

Oregon guide for corn recommends P be applied in a 2 by 2 band in cool soil even when soil test levels exceeds 12 ppm.

None of the guides vary P recommendation with yield.

Washington guide includes provisions for starter applications of P for wheat even when soil test levels exceed 16 ppm. This has been supported by current research.

Washington guide for wheat is based on subsurface-banindg of P; guide recommends 2x rate if fertilizer is broadcast.

Oregon and Washington use the same fertilizer guide for potatoes (see bibliography for citation).

Potassium (lbs K2O/acre)

Crop	Yield Goal		Very Low			Low			Medium			High			Very High	
		0 ppm	0-100 ppm	30 ppm	50 ppm		60 ppm	100 ppm	00-150 ppr	90 ppm	150 ppm	50-200 ppr	120 ppm			
Corn	(bu/acre)	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA
(irrigated)	100	240			160			80			0					
	150	240	150-200	240	160		192	80	100-150	96	0	0-100	0			
	200	240			160			80			0					
			Very Low			Low			Medium			High			Very High	
		50 ppm	60 ppm	60 ppm	75 ppm			100 ppm			125 ppm	120 ppm	120 ppm	150 ppm	180 ppm	180 ppm
Potatoes	(cwt/acre)	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA
	300	450	480	480	350			250			150	360	360	50	240	240
	400	500	480	480	400			300			200	360	360	100	240	240
	500	550	480	480	450			350			250	360	360	150	240	240
	600	600	480	480	500			400			300	360	360	200	240	240
			Very Low			Low			Medium			High			Very High	
		0-35 ppm						35-75 ppm		<75 ppm	>75 ppm		>75 ppm			
Wheat	(bu/acre)	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA	ID	OR	WA
(dryland)	100	80						60		50-100	0		0			
	150	80						60		50-100	0		0			
	200	80						60		50-100	0		0			

Additional Explanation

Oregon wheat guide states residual soil potassium levels are high or very high so potassium fertilizer is not recommended.

Oregon and Washington use the same fertilizer guide for potatoes (see bibliography for citation).

East Region Report (North Carolina – Tennessee – Virginia)

Prepared by Deanna Osmond
North Carolina State University

Nutrient Management Recommendation: Comparison Virginia and North Carolina

North Carolina and Virginia both use a yield goal concept to determine nitrogen rates based on soil series. The nitrogen recommendation for corn for the Cecil is almost identical, whereas the yield goal for the Norfolk is similar but not identical. It also has to be kept in mind that climatic variables affect yield goals. For instance, even on the same soil series, wheat yields are almost always greater in Virginia than North Carolina due to climate.

Virginia uses Mehlich I soil extract, whereas North Carolina uses Mehlich III. Similarly, both identify the soil's nutritive value as Low, Medium, High or Very High. Under similarly identified nutritive status, North Carolina and Virginia soil test recommendations for phosphorus and potassium are very similar.

Nitrogen

Cecil:

Crop: Corn
Yield Goal VA = 120 bu/ac
Yield Goal NC = 123 bu/ac
N Factor VA = 1.1 lb N/bu
N Factor NC = 1.11 lb N/bu
N Fertilizer Recommendation VA = 132 lb N/ac
N Fertilizer Recommendation NC = 136 lb N/ac

Norfolk:

Crop: Corn
Yield Goal VA = 140 bu/ac
Yield Goal NC = 115 bu/ac
N Factor VA = 1.1 lb N/bu
N factor NC = 1.14 lb N/bu
N Fertilizer Recommendation VA = 154 lb N/ac
N Fertilizer Recommendation NC = 131 lb N/ac

Soil Test	**Virgina**	**North Carolina**
Units	**lb/ac**	
Potassium-Low	80-100	90-120
Potassium-Medium	40-80	40-90
Potassium-High	20-40	0-40
Phosphorus-Low	80-100	80-150
Phosphorus-Medium	0	30-80
Phosphorus-High	0	0-20

Soil Test Recommendation Comparison Table - EAST

Soil Test Recommendation

Nitrogen (lbs N/acre)

Crop	Yield Goal (if applicable)	Very Low			Low			Medium			High			Very High		
Corn	(bu/acre)	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN
	100-125	2*	100-140	120		100-140	120		100-140	120		100-140	120		100-140	120
	125-150		140-170	150		140-170	150		140-170	150		140-170	150		140-170	150
	150-175		170-190	180		170-190	180		170-190	180		170-190	180		170-190	180
	175-200		190-210	210		190-210	210		190-210	210		190-210	210		190-210	210
	200-225			240			240			240			240			240

		Very Low			Low			Medium			High			Very High		
		0-5			5-10			10-15			15-20			>20		
Soybean	(bu/ac)	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN
		3*	0	0		0	0		0	0		0	0		0	0

		Very Low			Low			Medium			High			Very High		
		0-5			5-10			10-15			15-20			>20		
Wheat	(bu/acre)	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN
		2*	100-120	90		100-120	90		100-120	90		100-120	90		100-120	90

Additional Explanation

No soil tests done for N in TN. Recommendations for corn based on yield potential

TN wheat recommendation is for 15 to 30lbs at establishment (15 lbs if following soybeans otherwise 30lbs); 30 to 60 lbs topdressed (lower rate where lodging is a problem)

2* NC has no soil test for N, but rather uses crop yield goal by soil mapping unit to determine realistic yield expectation (RYE). This value is then multiplied by a N factor (dependent on crop and soil management group) to determine the amount of N for the crop. Since there are so many permutations of this number, please find recommendations at http://www.soil.ncsu.edu/nmp/yields/

3* Soybeans can be manured and the amount of N is calculated just like all other crops using RYE values that can be found at http://www.soil.ncsu.edu/nmp/yields/

Virgnia: For corn N recommendations are based on expected yield goal. Our recommendation is basically 1 to 1.1 lb N/bushel of expected yield. VA has calibrated the pre-sidedress soil nitrate test for Virginia soils. This test is used most frequently on soils with a history of manure/biosolids applications. The only other soil N testing that is recommended (not used much!!!) is a soil nitrate testpre-plant for wheat. For wheat we recommend 25-30 lbs N/acre pre-plant, with the remainder applied Midwinter based on growth stage, tiller development and/or tissue tests.

Phosphorus (lbs P2O5/acre)

Crop	Yield Goal (if applicable)	` Very Low			Low			Medium			High			Very High		
		quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure		
Corn	(bu/acre)	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN
Mineral -4*	100-125	120-150	120	100	80-120	80-100	100	30-80		50	0-20		25	0		0
Organic-5*	125-150	110-150		120	50-100		120	0-50		60	0		30	0		0
	150-175			140			140			70			35			0
	175-200			160			160			80			40			0
	200-225			180			180			90			45			0

		Very Low			Low			Medium			High			Very High		
		quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure		
Soybean	(bale/acre)	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN
Mineral -4*		120-150	120	40	80-120	80-100	40	30-80	40-80	20	0-20	20-40	0	0	0	0
Organic-5*		110-150			50-100			0-50			0			0		

		Very Low			Low			Medium			High			Very High		
		quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure		
Wheat	(bu/acre)	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN
Mineral -4*		120-150	120	80	80-120	80-100	80	30-80	40-80	40	0-20	20-40	0	0	0	0
Organic-5*		110-150			50-100			0-50			0			0		

Additional Explanation

1) No Very Low soil test class in TN. Note: Soil extract is Mehlich 1; not Mehlich 3 as used in NC. Soil test recommendations at http://bioengr.ag.utk.edu/SoilTestLab/pubList.asp

Mineral -4*:NC does not use yield goal for P recommendations. The values range based on index readings and are a function of soil class, and these values are for mineral soils based on humic acid determination.

Organic - 5*:NC does not use yield goal for P recommendations. The values range based on index readings and are a function of soil class, and these values are for organic soils based on humic acid determination. For more information please see http://www.agr.state.nc.us/agronomi/obook.htm

Virginia: Except for the Very High category, we use "-" and "+" categories. For example, L-, L & L+, with recommendations of 120, 100 and 80 lbs/acre, respectively for corn. VA Tech Soil Testing Laboratory uses the Mehlich 1 extract.

Potassium (lbs K2O/acre)

Crop	Yield Goal (if applicable)	Very Low			Low			Medium			High			Very High		
		quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure		
Corn	(bu/acre)	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN
	100-125	120-150	120	100	90-120	80-100	100	40-90	40-80	50	0-40	20-40	25	0	0	0
	125-150			120			120			60			60			0
	150-175			140			140			70			70			0
	175-200			160			160			80			80			0
	200-225			180			180			90			90			0

		Very Low			Low			Medium			High			Very High		
		quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure		
Soybean	(bale/acre)	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN
		120-150	120	80	90-120	80-100	80	40-90	40-80	40	0-40	20-40	0	0	0	0

		Very Low			Low			Medium			High			Very High		
		quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure			quantity and unit of measure		
Wheat	(bu/acre)	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN	NC	VA	TN
		120-150	120	40	90-120	80-100	40	40-90	40-80	20	0-40	20-40	0	0	0	0

Additional Explanation

TN: No Very Low soil test class in TN. Note: Soil extract is Mehlich 1; not Mehlich 3 as used in NC. Soil test recommendations can be found at http://bioengr.ag.utk.edu/SoilTestLab/pubList.asp

NC: NC does not use yield goal for K recommendations. The values range based on index readings. For more information please see http://www.agr.state.nc.us/agronomi/obook.htm

Virginia: Except for the Very High category, we use "-" and "+" categories. For example, L-, L & L+, with recommendations of 120, 100 and 80 lbs/acre, respectively for corn. VA Tech Soil Testing Laboratory uses the Mehlich 1 extract.