SURVEY OF CENTRAL WASHINGTON FERTILIZER RECOMMENDATIONS

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Revision of the Washington State Fertilizer Guide for Irrigated Potatoes for Central Washington (FG-7, 1974) was initiated to develop a nutrient management guide which would maximize nutrient use efficiency and minimize the potential for pollution of surface and groundwater. During the initial part of the revision process, a survey of crop consultants, responsible for providing fertilizer recommendations to producers who farm significant acreages, was identified as a means of estimating current nutrient management practices. Survey results were to be used to compare industry recommendations with published research and help identify research priorities, to meet industry needs. Six representatives of fertilizer companies, two private agronomists and three agronomists employed by soil testing laboratories were interviewed. The survey results were not expected to give a definitive measure of current practices, but rather a range of current practices.

During winter and spring of 1995-96, personal interviews were conducted with industry and crop consultants. Survey questions were formulated to evaluate: 1) major and minor nutrient application rates, which are recommended to sustain crop production and; 2) use of plant and soil nutrient status evaluation in formulating application rates. Specifically, the influence of yield goals, crop rotation, soil type, irrigation system, and fertilizer type were explored in the survey. Major fertilizer management strategies which emerged from the survey process have been consolidated to create an overview of current industry management recommendations for potato production in Central Washington. In the following discussion, numbers contained within parentheses indicate the number of responses which were received in each category.

I. GENERAL MANAGEMENT PRACTICES

Soil Analysis

- All respondents report using soil analysis to determine pre-plant nutrient status; with all using soil samples from a depth of 12" and four taking additional samples from a soil depth of 24".

- All respondents believe nitrate nitrogen (NO_3-N), ammonium nitrogen (NH_4-N), phosphorus (P), potassium (K), sulfur (S), zinc (Zn), and boron (B) should be analyzed in soil samples from the first 12".

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However, additional nutrients and soil characteristics which are identified using soil analysis vary widely, due to personal preference of respondents and/or clientele. Additional nutrients and/or soil characteristics which may be identified in samples from the first 12" include: calcium (Ca), copper (Cu), magnesium (Mg), manganese (Mn), iron (Fe), sodium (Na), pH, cation exchange capacity (CEC), soluble salts (SS), organic matter (O.M.), total bases, and effervescence. Those respondents (4) which also sample at 24" believe it is important to determine availability of N, S, P, or K to that depth.

-The number of times soil tests are repeated during the production season varies from: never to seldom (7), some to approximately 5-6 times during the production season (2), or every other week to weekly (2). Several respondents indicated that in-season soil samples can be used to predict a reduction in nitrogen availability before decreases in petiole nitrate are seen.

Petiole Analysis

- All respondents report analyzing petiole tissue on a weekly basis during the growing season.

- Ten of the respondents recommend or use petiole sampling on a weekly basis, prior to or after row closure, to monitor nutrient status and make nutrient recommendations. One of the respondents does not recommend using petiole analysis as a basis for in-season fertilizer application recommendations.

- Five respondents report using the 4th leaf from the tip as the sample leaf; two use the 5th leaf and four use the 4/5th leaf for sampling.

- Ten respondents sample the same portion (4th, 5th or 4/5th leaf) of the plant in the same area in the field throughout the growing season. One respondent samples throughout the field using the same plant "type" at each sampling.

- Nitrate nitrogen was perceived as the most important plant nutrient to be identified by petiole analysis; other plant nutrient concentrations commonly identified using petiole analysis include P, K, S, Zn, B, Cu, Fe, and total N if a problem is suspected.

- The range of nutrients identified using petiole analysis did not vary during the growing season (7) or varied based on grower preference (4).

Yield

- Six of the respondents consider yield potential in adjusting fertilizer application rates/acre when formulating their recommendations; three respondents use 30 ton as a standard yield potential for their recommendations and do not adjust recommendations to the yield potential of an individual cultivar, grower, or field; the other respondents (2) only make recommendations based on N concentration identified using soil analysis and do not consider yield potential.

-The range in expected yield potential varies widely from 28 to 45 tons based on the influence of weather, disease, grower management and cultivar (short vs. long season) produced.

- Most respondents believe crop history (8), grower history (7), and potential of the irrigation system (7) should be used to modify expected yield potential. However, this modification was hard to see in actual recommendations, due to standard application rates which did not appear to take these factors into consideration.

Application Method and Plant Health

- Respondents who make specific recommendations for fertilizers to be applied as foliar application (via airplane) were as follows: micronutrient (4); in-season fertilizer applications for nutrients other than N (1); P if unable to apply through the sprinkler (1). Petiole analysis (4) and the degree of the problem (1) are criteria used in recommending foliar application of fertilizers.

- Ten respondents believe nutrition directly affects plant health (less early blight), quality and internals (hollow heart, IBS, and specific gravity).

- Six of the respondents are involved in sampling for precision farming, with three making recommendations based on these samples.

II. MACRO-NUTRIENTS

Nitrogen

- All respondents look at the total nitrogen requirement needed to reach their target yield and then make adjustments for nitrogen availability and application throughout the season. Recommendations for total N (lb. N/acre) required to produce a 30-35 ton/acre, long season crop, on sandy soils were as follows: 300-375 (6); 400-430 (2); 450-500 (2); and 700 or no cap on application (1).

- Total N (lb. N/acre) recommended to produce a 30-35 ton/acre, long season crop, on silt loam soils were as follows: 250 (1); 300-320 (3); 400-425 (1); or no answer, because these cultivars are not grown in their territory on silt loam soils (6).

- For the majority of respondents (8), N application recommendations are not adjusted based on previous crop for long season cultivars. Those which adjust recommendations (3), increase N application rates by 20-30 lb./acre following non-legume rotation crops, unless this exceeds their maximum N application recommendation. If the previous crop was legume, N rates are decreased by 20-30 lb./acre.

- Approaches to pre-plant nitrogen application vary. Most respondents (7) report using values from the soil test analysis, residue from previous crop and release/tie up as factors in calculating pre-plant application rates. Some respondents (2) make a general recommendation of 50-100 lb. N/acre pre-plant application regardless of the soil analysis value. The remaining respondents (2) only recommend total season N application rates based on soil analysis without breaking out pre-planting rates.

- The percentage of recommended pre-plant N application, for long-season cultivars, grown on sandy soil, with sprinkler irrigation, varied from: 10% (approximately 30 lb. N/acre) (1); 30% of total season N (5); or 20 to 50% of total season N dependent on soil and irrigation system (3). Two respondents do not make any pre-plant application recommendations. On average, respondents recommended pre-plant application rate was 1/3 of the total amount of N to be applied over the growing season.

- Respondents tended to increase the proportion of total N applied pre-plant for long-season cultivars, grown on silt loam soils, with furrow irrigation. Pre-plant application rates ranged from 20 to 50% of the total N applied during the growing season.

- Respondents who deal with short season production systems on sandy soils, with sprinkler irrigation, were almost equally divided on whether they altered their recommendations for N application; four respondents make the same N recommendations as they do for long season cultivars, compared to five respondents who decrease both pre-plant and total N application for short season cultivars. Two respondents do not deal with short season cultivars. Six out of the seven respondents who recommend N application rates for short season cultivars, produced on silt loam soils, use the same approach in making recommendations for N applications as they do for long season cultivars produced on silt loams or short season cultivars produced on sandy soils.

- Recommendations for N application at mark-out or planting varied widely and appeared to be related to clientele preference and available equipment. For most respondents the major proportion of pre-plant N is broadcast and incorporated (10). However, five respondents at least occasionally recommend pre-plant applications at planting, with banding ranging from banded 2 inches down and 2 inches out to 4 inches out and 2 inches down from the seed piece. Growers who apply N pre-plant and at planting may apply a band of a dry or liquid N source, dependent on equipment and grower preference.

- All respondents said petiole analysis was used to determine when and how much in-season N was applied. However, the way in which information obtained from petiole analysis is used varies between: 1) using the ppm values as a guide to maintain desired N concentrations (8) and; 2) using the values to adjust N application according to growth stage (3).

- Target adequate petiole values vary widely: 30,000 to 20,000 ppm for short-season cultivars; 30,000 to 12,000 ppm for mid-season; and 15,000 to 8,000 ppm for late-season.

- Several of the respondents have found that with appropriate seasonal management, a nitrogen application rate of approximately 35 lb. N/acre/week is adequate to support potato nitrogen uptake rates during tuber bulking. Higher weekly rates are sometimes used if petiole nitrate levels fall significantly below the desired range.

- Only five of the respondents make specific nitrogen source recommendations. They believe it is important to consider formulation (dry/liquid), environmental conditions (cold/warm spring), soil type (silt loam/sandy), and/or irrigation system (sprinkler/furrow) when making N application recommendations.

In contrast, six of the respondents do not believe it is necessary to make specific nitrogen source recommendations under any of these differing cultural or environmental conditions.

-Respondents indicate that higher than average levels of nitrogen may need to be applied due to management and environmental problems which include: 1) suboptimal irrigation timing and quantity; 2) suboptimal timing of nitrogen fertilizer application, based on potato growth stage; 3) disease and/or pest pressures; 4) periods of unusually high precipitation.

Phosphorous

- Most (10) of the respondents recommend pre-plant P applications based on soil test results. However, they differ in how soil test values (to a depth of 12") influence recommended pre-plant application rates. The majority of respondents (7) would recommend no pre-plant application at a soil test cut-off value between 30-40 ppm. In contrast, four would recommend pre-plant P application rates ranging from 50 to 350 lb. P/acre regardless of soil test values.

- Six respondents do not adjust P application rates based on yield potential. Those respondents who do consider yield potential (2), apply "110% of need." Three respondents had no answer to the question. All who responded indicated little difference in P recommendations based on soil texture.

- Average and maximum P application rates to produce a 30-35 ton/acre crop range as follows: average = 100-350 lb. P_2O_5/acre; and maximum = 275-420 lb. P_2O_5/acre.

- Opinions varied on the advantages associated with banding a portion of P prior to or at the time of planting. For all respondents pre-plant, banded P was considered as part of the total P. Some respondents (4) believe they get better early season growth and tuber set with P banded at planting.

- Most of the respondents (8) recommend in-season P applications, with six of these basing in-season application rates on maintaining desired petiole P concentrations. Four of the respondents use Westermann's relationship (from Idaho) to determine in-season P application recommendations. Others used an adequate petiole value for P ranging from 0.22 - 0.8% as the level at which they apply in-season P. These respondents recommend from 10-30 lb. P_2O_5/acre each week for in-season applications, when petioles fall below the adequate level. Two respondents recommend regular applications of 10-30 lb. P_2O_5/acre ("spoon-feed") throughout the season regardless of petiole values. Two respondents rarely recommend in-season P application due to their opinion that in-season P uptake is less efficient; but, if petiole levels indicated a problem, a foliar application might be recommended. One respondent does not recommend any in-season P applications.

- The majority of respondents (8) do not consider previous rotation crops in formulating P application rate recommendations.

- In general soil texture was not a major factor in determining phosphorus application rates. However, soil texture in conjunction with soil pH and free lime concentration is used to indicate the need to adjust phosphorus rates upward.

- In general, recommendations for short season P application and management are handled the same as long season cultivars. However, lower rates of phosphorus are recommended for short season crops by some consultants. The majority of respondents (6 out of 10) do not recommend application of P at planting to "jump start" short season cultivars. Those who do recommend P to "jump start" short season cultivars (4), recommend a dry formulation be banded at planting.

- Most respondents (9) use in-season petiole analysis to monitor P petiole concentrations. Adequate P values were as follows: Westermann curve (3), test laboratory values (1); range of adequate values to be maintained ranged from 0.55 to 3% (4).

- P source recommendations varied from liquid to dry sources (5). Other respondents said they believed there was no real difference in P source or used whatever source was available (6).

- Recommendations as to placement of P at planting, relative to the seed piece, varied for the seven respondents who make recommendations: "mark-out" (1); 6" (1); 2" x 2" (3); liquid band at 4" out and 2" up (1); 3" up and 3" out (1).

Potassium

- All respondents recommend pre-plant K application for long season cultivars, on sandy or silt loam soils. Five respondents use charts developed by testing labs or university recommendations. The other respondents have developed their own curves (1); recommend a maximum and minimum/zero amount of K to be applied based on pre-season soil K ppm values (4); or recommend 12 lb. K_2O/acre for each ton produced based on the expected yield from the field and cultivar (1).

- Seven respondents said they do not adjust K application rate to reflect potential yields. Some respondents (4) recommend K regardless of the soil test levels. Ranges of soil test values deemed to <u>not</u> require additional K application and were therefore considered to be a "cut-off" value varied: 350 ppm (1); 380 ppm (1); 350-400 ppm (1); 420 ppm (1); 400-500 ppm (3).

- The majority of respondents (9) do not use the Unocol time release K soil test in formulating their application recommendations.

- Recommended maximum total seasonal K applications to produce a 30-35 ton crop range from 350 lb. K/acre to 525 lb. K/acre. Petiole analysis is used by seven of the respondents to determine in-season K levels. However, seven respondents recommend 100% of the expected total K in-season application should be made by planting. Two respondents do not make any specific recommendations on when K application should be divided between total and in-season applications. One respondent recommends periodic applications ("spoon feed") to get K into the wetting zone (although rate of application was not specified).

- None of the respondents adjust their K application recommendations based on the previous crop.

- In general, recommended K application rates for short season cultivars are the same as long season cultivars.

- Although six respondents stated they used petiole analysis for monitoring in-season K status, only two respondents stated they use adequate petiole values to determine in-season K applications rates. Adequate K petiole values were: 10% over the season or 11.7% - short-season, 10.1% - mid-season, and 8.5% - late-season.

- Five respondents stated they have no specific preference or follow the grower's preference in recommending K sources. Stated preferences for K sources include: K_2SO_4 (2); KCl (3); base recommendations on salt index (1).

- Only two respondents believe low K nutrition has a direct effect on disease problems in potato by decreasing plant vigor or increasing vascular problems.

- There was not a clear consensus on the effect of potassium source on tuber quality. At least one respondent indicated that high rates of potassium chloride could be associated with lower specific gravity and poor tuber quality.

Sulfur

- Ten respondents determine sulfur application recommendation by using soil analysis values. The other respondent rarely recommends sulfur application based on a soil sample to a depth of 12" because of the opinion it's not adequate for determining sulfur availability.

- The total amount of sulfur (lb. S/acre) believed to be essential to produce a 30 ton/acre potato crop varied as: 40 (1); 40-50 (2); 50 (3), with 75 applied if soil test concentrations are low (1); 60 (2); 80 (1); 250 (1); and at a 5:1 ratio (N:S) at second irrigation, to attain .16 petiole sulfur during early season, then use a standard "spoon feed" all season (1).

- In-season monitoring of petiole values to determine application rate is recommended by three respondents. Others who recommend in-season sulfur applications (2), maintain a 6:1 (N:S) ratio through irrigation water to reduce powdery mildew (1) or recommend in-season sulfur application begins with the second irrigation and continues until late in the season (1).

- Recommended sulfur application is not adjusted based on previous crop.

- In general recommendations for sulfur application for short and long season cultivars are the same. Five respondents make the same sulfur application recommendations for short season as for long season cultivars. One respondent recommends 60 lb. S/acre for short season cultivars. The remaining respondents (5) do not make any recommendations for sulfur application for short season cultivars.

- Eight respondents use in-season monitoring to determine sulfur status, with in-season status being determined primarily through petiole analysis.

Adequate S petiole values vary as: if S > P then there's a problem (1); use testing lab adequate values which are 0.22-0.25% (early), 0.20-0.22 (mid-season), and 0.18-0.02 (late) (3); adequate value = 0.22% (1); adequate value = 0.3% (1); 0.28% (early), 0.25% (mid-season), and 1.7% (late-season) (1); maintain 0.22-0.24% (1).

- Respondents differ on S source recommendations: sulfate form (3); $(NH_4)_2SO_4$ or K_2SO_4 (3); degradable sulfur (1); whatever is contained in the pre-plant fertilizer blend (1); no recommendation on source (3).

- Specific source recommendations can be influenced by needs to alter soil pH for six respondents, though specific recommendations vary. Three respondents do not consider altering soil pH with S source in their recommendations, because of the low availability of elemental S.

- Decreasing potential disease pressure through sulfur fertilizer application was considered important by only three respondents.

III. ADDITIONAL NUTRIENTS

- Range in adequate soil test values for micro-nutrients:

	Sandy	Silt Loam
Boron	0.3 - 0.6	0.3 - 0.6
Zinc	0.8 - 1.2	0.8 -1.2
Calcium	none -4.0	none
Copper	none - 1.0	none
Manganese	none - <10	none
Fe	none - 15.0	none

- One respondent has developed curves for 30 ton/acre for recommending micro-nutrients application rates based on 15 years of production.

- Recommended rates of pre-plant B, Zn, Ca, Cu, & Mn application pre-plant soil analysis for long-season cultivars:

	Sandy lb./acre	**Silt Loam** lb./acre
Boron	none - 5	none - 5 lb.
Zinc	none - 10	none - 10
Calcium	none - 300	none
Copper	none - 4	none
Manganese	none - 5	none

- Petiole analysis was reported to be a tool for determining in-season micro-nutrient application for some respondents (5), although they may not test for B, Zn, Ca, Cu, & Mn on a regular basis throughout the season. One respondent looks for specific in-season soil test values which are below a critical range prior to recommending additional Zn applications.

- Recommendations for micro-nutrient applications are the same for long and short season cultivars According to five out of eleven respondents, with the remaining respondents not making specific recommendations for short season cultivars.

- Recommended application methods were specified by only four respondents. Recommended application methods for micro-nutrients include: all pre-plant broadcast (1); band all but B, which is applied as a liquid with herbicide (1); B applied as pre-plant broadcast and Zn foliar (1); all applied foliar (1).

- Overall, little micro-nutrient application was thought to occur as a result of applying other macro-nutrient sources or chemical application such as fungicides.

- The above summary was produced from the responses provided by the eleven potato industry representatives that were interviewed. It is meant to be only a sampling of current practices and does not represent an industry wide survey of practices. The comments made in this survey do not necessarily represent Washington State University suggested best management practices.