SUMMARY RESEARCH PROGRESS REPORT FOR 1997

AND RESEARCH PROPOSAL FOR 1998

Submitted to:
SLV Research Center Committee
and the
Colorado Potato Administrative Committee (Area II)

TITLE: Phosphorus Forms and Application Methods for Potatoes

PROJECT LEADERS: Asunta (Susie) Thompson-Johns, Research Horticulturist, SLV Research Center, and Jessica G. Davis, Associate Professor and Extension Soil Specialist, Soil and Crop Science, CSU.

PROJECT JUSTIFICATION:

Nutritional management is a key in irrigated cropping systems. Improper nutrient levels can decrease yield and quality, create a stress environment conducive to pest influence, reduce profitability and adversely affect the environment.

Phosphorus is one of the sixteen essential nutrients required by potatoes. It is utilized in formation of nucleic acids (DNA and RNA) and in storage and transfer of energy (by ATP and ADP) (Soil Improvement Committee California Fertilizer Association, 1980) in plants. Phosphorus promotes cell division in roots, however has little effect on cell elongation. Stimulation of early growth and root development is favored over canopy expansion. Supplementation is especially important under conditions of growth in cold weather, when root growth is limited and top growth rapid (Soil Improvement Committee California Fertilizer Association, 1980). Phosphorus is readily absorbed by potato roots in the form of phosphate from the soil solution. It can move upward and downward in the plant and, in the case of deficiency, will transfer from older to younger tissue (Tindall *et. al.*, 1991). Delayed growth and stunted plants, dark green foliage compared to non-deficient plants, and purpling in some plants are typical deficiency symptoms (Houghland, 1960; Soil Improvement Committee California Fertilizer Association, 1980; Tindall *et. al.*, 1991). As severity increases leaflets begin to roll, cupping upward, revealing the normal gray-green coloration of the leaflet's underside (Houghland, 1960; Soil Improvement Committee California Fertilizer Association, 1980; Tindall *et. al.*, 1991). Potato cultivars may exhibit an increase in flowering, an internal purpling of tuber flesh, reduced tuber number, root size and specific gravity levels (Tindall *et. al.*, 1991). Net on russet cultivars may be reduced if an abundance of nitrogen is available and phosphorus levels are deficient, (Tindall *et. al.*, 1991). In other crop plants maturity may be delayed (Soil Improvement Committee California Fertilizer Association, 1980),

although similar reports for potato are not found in the literature.

Phosphorus availability during early vegetative growth is important (Houghland, 1960). In potatoes, uptake increases rapidly during tuber initiation, levels off during bulking and ceases with maturation (Soltanpour, 1969; Tindall *et. al.*, 1991). About 7 lbs. of phosphorus (~ 16 lbs. P_2O_5) are removed from the soil for each 100 cwt. of potato yield. Thus, a 500 cwt./acre yield will require about 35 lbs. (~ 80 lbs. P_2O_5). Vines remove, on average, another 11 lbs. (~25 lbs. P_2O_5) per acre.

Guidelines were recently updated in 1997 for phosphorus nutrition of potatoes in southeastern Idaho (Tindall, *et. al.*, 1997). SLV and southeastern Idaho production environments are somewhat similar because soil pH and percent free lime tend to be high. Both conditions result in a reduction of phosphorus availability and restricted mobility. Recommendations for the San Luis Valley indicate banding is preferred to broadcasting (Mortvedt *et. al.*, 1994). Previous work in Idaho on highly calcareous soils, when phosphorus was broadcast, then plowed or disked in, compared to banding, resulted in a yield increase, (McDole *et. al.*, 1987; Tindall, *et. al.*, 1991). Additionally, the phosphorus fertilizer suggestions for Colorado potato production are lower than the new information available for Idaho production (Mortvedt *et. al.*, 1994, Tindall, *et. al.*, 1997). The 1997 guidelines for Idaho, raise soil sufficiency levels, make an adjustment for percent free lime, advocate a starter application of 80-100 lb. P_2O_5/A, and provide an adjustment for yield goal. Prior work reported lower yields when acid urea phosphate was applied compared to use of ammonium polyphosphate (10-34-0) (Tindall, *et. al.*, 1991).

San Luis Valley producers have many questions regarding phosphorus nutrition. Questions posed include those about split applications and spoon feeding, ways to make the native phosphorus more available, and if toxicity can develop over time due to the inherent high soil levels which are unavailable for plant use. A recent project (Ford, 1996, unpublished) has indicated that soil pH and free lime levels are changing in the valley, due to the influence of cultural practices. This same work also indicated a cultivar specific response, although previous work in the SLV had not (Soltanpour, 1969). Currently, nutrient recommendations for potato production regions do not contain cultivar specific suggestions for phosphorus, as they do for nitrogen applications. These questions, in combination with changing research information and recommendations, indicate a need for renewed phosphorus nutrition inquiry for San Luis Valley potato production. Two objectives are being addressed by the current proposal, including 1.) establishment of critical petiole levels and updating current recommendations for phosphorus on potato for the SLV and 2.) determining the effect of application method and phosphorus form on yield and grade, as well as, the economic feasibility of each.

Relevant Literature

Houghland, G.V.C. 1960. The influence of phosphorus on the growth and physiology of the potato plant. Am. Potato J. 37:127-138.

Mahler, R.L. 1993. Nitrogen and phosphorus BMP - Fertilizer placement. University of Idaho Current Information Series 757.

McDole, R.E., D.T. Westermann, G.D. Kleinschmidt, G.E. Kleinkopf and J.C. Ojala. 1987. Idaho fertilizer guide - Potatoes. University of Idaho Current Information Series No. 261.

Mortvedt, J.J., P.N. Soltanpour, R.T. Zink and R.D. Davidson. 1994. Fertilizer suggestions for potatoes. Colorado State University Service in Action no. 0.541.

Roberts, S. and A.I. Dow. 1982. Critical nutrient ranges for petiole phosphorus levels of sprinkler-irrigated Russet Burbank potatoes. Agron. J. 74:583-585.

Soil Improvement Committee California Fertilizer Association. 1980. Western Fertilizer Handbook. Sixth Edition. California Fertilizer Association. Sacramento, Calif. 269 p.

Soltanpour, P.N. 1969. Accumulation of dry matter and N, P, K by Russet Burbank, Oromonte and Red McClure potatoes. Am. Potato J. 46:111-119.

Tindall, T.A., J.C. Stark, C.L. Falen and L.D. Bywater. 1997. Cooperative fertilizer evaluation program: New phosphorus recommendations for potatoes. The Spudvine. March.

Tindall, T.A., D.T. Westermann, J.C. Stark, J.C. Ojala and G.E. Kleinkopf. 1991. Phosphorus nutrition of potatoes, University of Idaho Current Information Series No. 903.

Walworth, J.L. and J.E. Muniz. 1993. A compendium of tissue nutrient concentrations for field-grown potatoes. Am. Potato J. 70:579-597.

PROJECT STATUS: Second Year

PROJECT DURATION: Two Years (minimum)

SIGNIFICANT ACCOMPLISHMENTS FOR 1997:

Fertilizer form had no impact on potato yield or quality parameters for the banded treatments. When P fertilizer was broadcast, the granular treatment had more US No. 2's than the liquid treatment.

The impact of fertilizer application method varied with fertilizer form. For granular fertilizer, broadcasting resulted in more US No. 2's (yield and percent) than banding. For the liquid treatments, banding increased cull weight and percentage when compared to

broadcasting.

US No. 2's and culls increased in yield and percentage when granular fertilizer was broadcast pre-plant, versus the granular split (pre-plant and drag-off) treatment. Applying liquid broadcast pre-plant resulted in a higher yield and percent of US No. 1's than the liquid /granular broadcast split. The liquid/granular split reduced total yield, US No. 1's (yield), US No. 2's (yield and percentage) and average tuber weight, and increased undersized tubers when compared with the broadcast granular treatment. The liquid/ granular split had more undersized tubers (yield and percentage), lower percentage of US No. 1's, and lower average tuber weight than the granular split application.

On farm testing kits did not detect phosphorus levels in plant tissue until late in the growing season. Apparently the level detectable by the kits is higher than potato petiole sap levels until near vine maturation and senescence.

OBJECTIVES FOR 1997/1998:

1. Establish critical petiole levels and update the current recommendations for phosphorus on potato for the SLV.
   a. Compare on farm testing to laboratory tests.

2. Determine the effect of application method and phosphorus form on yield and grade, as well as, economic feasibility of each.

FUNDING REQUEST:

1997 Allocation: $5,000

1998 Request:

Sample Analysis	$3,150
Travel	600
Temporary Help	1,250
Total Request	$5,000