MANAGING ALFALFA NUTRITION BY SOIL ANALYSIS IN THE DESERT SOUTHWESTERN UNITED STATES

By Aron A. Quist and Michael J. Ottman[1]

Introduction: High producing alfalfa responds well to phosphorus and potassium applications in soils deficient in these nutrients. Many soils along the Lower Colorado River flood basin do not have sufficient amounts of these nutrients to maintain high yields. Calcareous high pH soils are known to precipitate phosphate ions to unavailable forms of phosphorus. Therefore, regular applications of phosphorus are recommended to maintain high yields. Palo Verde Valley average yields range from 8 to over 10 tons/acre[4]. Normal phosphorus removal rates are 8 lbs P_2O_5/ton of quality alfalfa produced[1]. Normal rates of phosphorus fertilizer applied range from none to 150 lbs P_2O_5/acre per year depending upon soil analysis, book value nutrient management plans, yield potential, and other factors. The Lower Colorado River floodplain soils were formed from sediment re-deposited from the upper watershed (Grand Canyon)[5]. Soils contain minerals that contain high amounts of exchangeable potassium: in the form of feldspars, Muscovite and biotite. These minerals are found in abundance in loam and clay soil textures. Potassium is a primary nutrient that has been known to be applied in the Palo Verde Valley. Alfalfa removal rates are 60 lbs K_20/ac per ton produced[1]. At normal yields, the removal rate is 480 – 600 lbs K_20/ac. Common application rates vary from none to 240 lbs K_20/acre per year.

Background: In the 1960's, Garn Stanworth, former owner of Stanworth Crop Consultants, began sending soil and plant samples to Ohio State University for chemical analysis to help growers manage fertilizer applications on local soils[2]. In the 1970's, Stanworth Crop Consultants built the first local lab in the area. Initially, alfalfa nutrient management was performed utilizing the alfalfa mid-stem sampled at 10% bloom and analyzed for soluble PO_4-P. After several years of conducting nutrient management programs, it became apparent that although the tissue testing program worked well, analysis needed to be performed prior to each cutting. This intensity of sampling frequency and the importance of the timing of sampling (10% bloom), caused Stanworth Crop Consultants to investigate using soil sampling in lieu of the tissue testing program. The program was successful and after several replicated research projects was in full use by the 1980's [3].

Sampling Protocols: Soils are sampled up to three times per year for phosphorus and potassium. Soil texture is estimated using SP (saturation percentage) analysis[6]. Sampling timing is: Fall - September through November; Winter - January through March; and Spring - April through June. Each field is divided into quadrants and soil sampling locations are

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established. No less than two sample locations are selected and composite soil sampling is discouraged. For field sizes larger than 35 acres, additional sample areas are added for each 17 acre increment. For example, 4 sample locations for a 70 acre field and 8 sample locations for 140 acres. After arriving at the sample location, the fieldman walks 25 steps into the field, then the area is sampled along a transect walking toward the opposite corner of the field[5]. Every 10 steps a subsample is taken, a total of 20 subsamples are taken in each location. For phosphorus, a 0-3 inch soil sample depth is taken and for potassium, a 0-12 inch sample is taken. Special attention is paid to the depth as variation in sample depth can significantly bias the eventual test result particularly for phosphorus. The soil is analyzed by the Olsen bicarbonate extraction for both P and K.

Database Review: In the 1980's, Stanworth Crop Consultants created a custom data base program to follow: plant and soil analysis, irrigation data, fertilizer recommendations, fertilizer applications and yields (if available). Recently, we have begun to tap the database for agronomic information. A review of our soil analysis data from alfalfa fields has yielded records of soil analysis from established alfalfa fields totaling 86,618 samples for phosphorus and 47,464 samples for potassium. Preplant soil samples were excluded from the data base and samples only from established fields were selected. Samples were taken based upon Stanworth Crop Consultants protocols with rare exceptions. The database allows allocation of samples from each specific location. Because the areas have been tested for soil texture (saturation percentage), each sample was grouped with other samples of the same soil texture. The critical levels for soil test P were: 1) >15 ppm = above, 2) 12-15 ppm = at, and 3) <12 = below. The critical levels for soil test K were: 1) >80 ppm = above, 2) 60-80 ppm = at, and 3) <60 = below.

Soil texture had little or no influence on the percentage of soils testing at or below the critical level for phosphorus (Fig. 1). About 45 to 50% of the soil samples showed a need for additional phosphorus with small differences depending on soil texture. However, for potassium, the percentage of soils testing at or below the critical level was highest for sandy soils, intermediate for loams, and lowest for clays. Over twenty years of data, about 45% of soils from sandy fields required applications of potassium, compared to about 10% of soils from clay fields needing additional potassium (Fig. 2).

Long term trends show that samples locations that require additional phosphorus have decreased over the last 20 years from 65% of the areas at or below the critical zone in the early 1990's to 47% recently at or below the critical zone for phosphorus (Fig. 3). Potassium is showing similar trends with 39% of sample locations being at or below the critical zone in the mid-1990's to 18% recently of sample locations being at or below the critical zone (Fig. 4).

Conclusion: Soil testing has proven itself an excellent long term tool to help manage nutrient applications on alfalfa in the Desert Southwest. Stanworth database confirms that sandy soil texture locations on established alfalfa fields generally require more potassium fertilizer than loam or clay soil texture locations. However, soil texture was not such a clear indication of need for phosphorus.   The number of sample locations that require phosphorus and potassium fertilizer have been decreasing over the last twenty years.

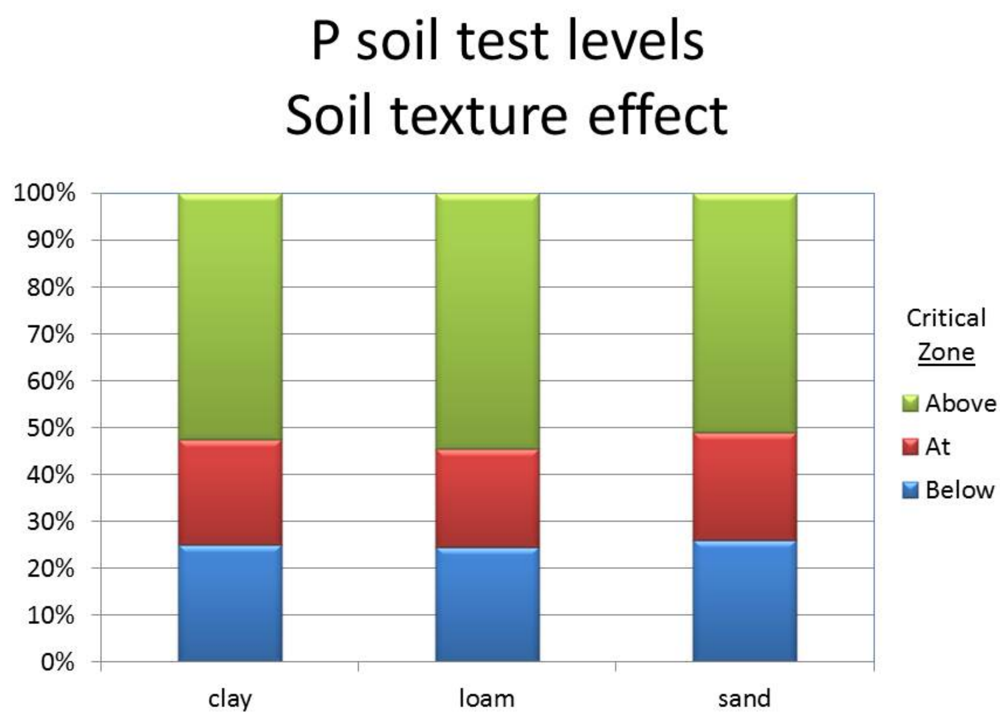

Fig. 1. Phosphorus (P) levels above, at, or below the critical zone for clay, loam, and sand soils in samples collected by Stanworth Crop Consultants from 1991 to 2013.

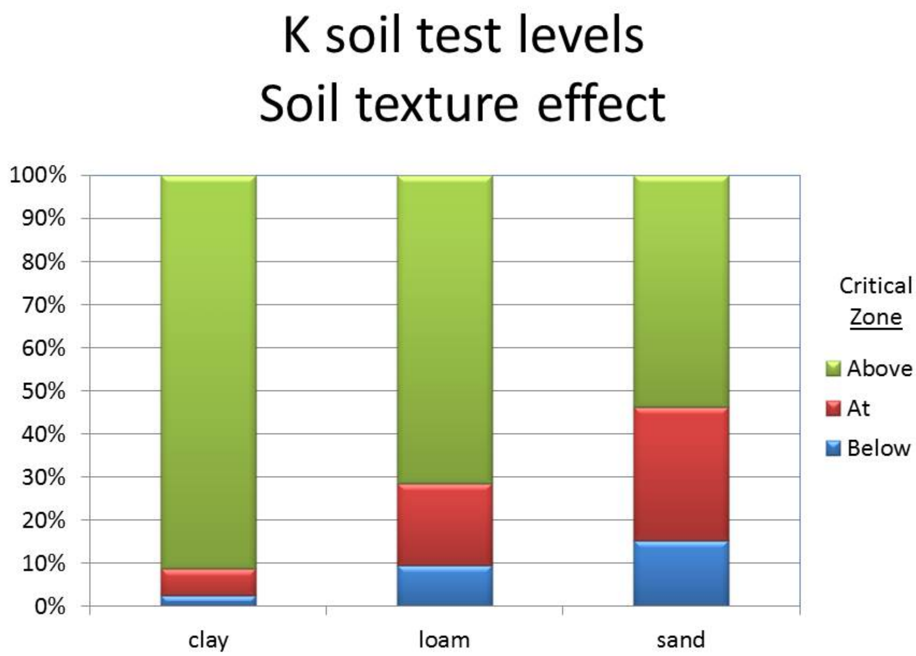

Fig. 2. Potassium (K) levels above, at, or below the critical zone for clay, loam, and sand soils in samples collected by Stanworth Crop Consultants from 1995 to 2013.

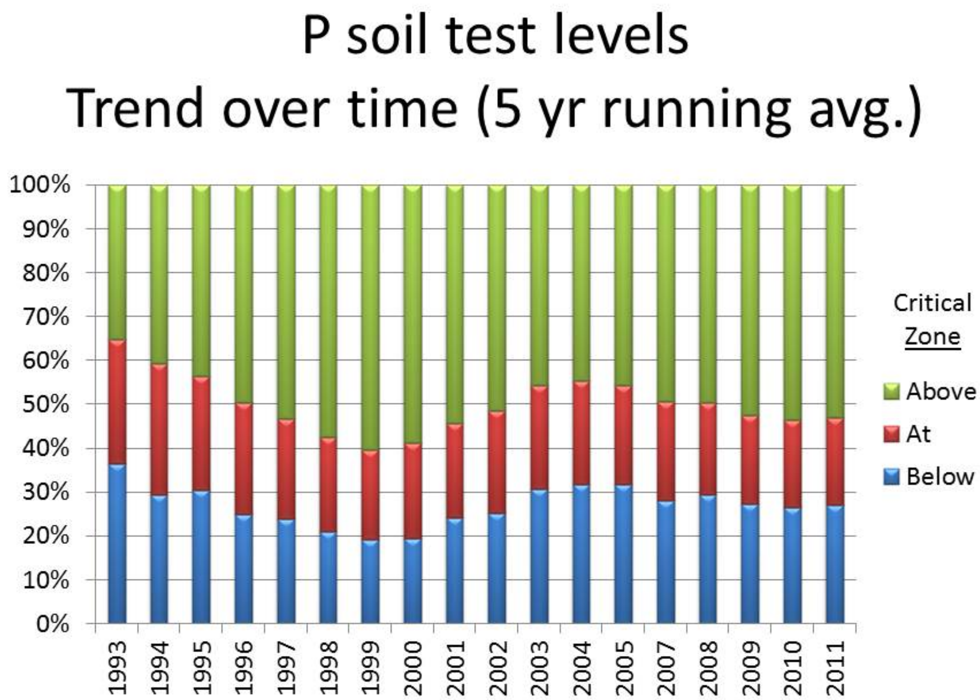

Fig. 3. Phosphorus (P) levels above, at, or below the critical zone in samples collected by Stanworth Crop Consultants from 1991 to 2013. The years on the graph represent the midpoint of a 5-year running average.

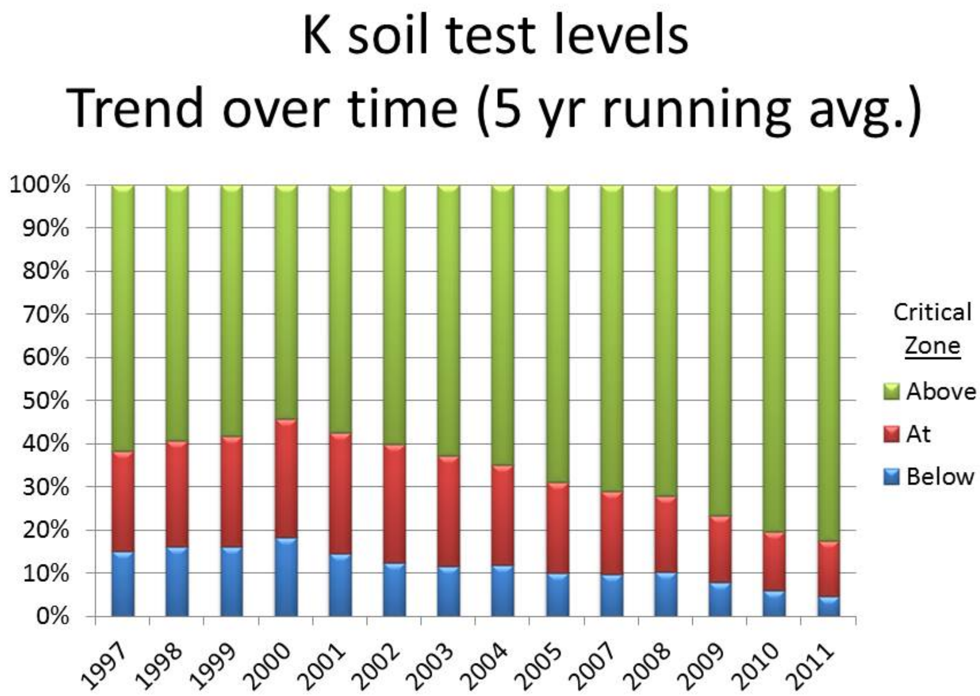

Fig. 4. Potassium (K) levels above, at, or below the critical zone in samples collected by Stanworth Crop Consultants from 1995 to 2013. The years on the graph represent the midpoint of a 5-year running average..

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