Potassium Management in Processing Tomato Production

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Summary

Processing tomato yield responses to supplemental applications of potassium have been demonstrated in field tests from 2011 to 2016 in the lower Sacramento Valley and upper Delta. Yield increases occurred primarily in soils with potassium levels below 200 ppm K using an ammonium acetate extraction method and, as a secondary indicator, not exceeding 2% of the cation exchange capacity. Composted poultry manure was initially used as a microbial stimulant, before understanding the value appeared primarily as a potassium source. The manure treatment was aimed to reduce premature vine senescence, a pervasive plant disorder common to the region. Early testing began with several UC Davis plant pathologists when pathogens were suspected as causal to vine decline. Subsequently, composted manure was compared and eventually substituted with manufactured potassium as the research shifted to be nutrient focused. For experimental field design simplicity and ease of application, after the initial years, most of the K treatments were preplant sidedressed using granular KCl.

Introduction

Composted animal manures have not been a common fertilizer source nor a nutrient supplement in conventional processing tomato production in California's Central Valley. Field studies were conducted which initially targeted treatments with potential to reduce premature vine senescence. Premature vine senescence common to Sacramento Valley processing tomato production occurs approximately 5 weeks before harvest with a decline in plant vigor. As vines collapse, fruit become sun-damaged and yield is reduced. While the cause of 'vine decline' has not been identified, a complex of soilborne pathogens was suspected. Initially, treatments included the application of biocides, fungicides and biologicals to suppress the pathogens, the addition of composted poultry manure to stimulate microbes and supplemental nutrients to support plant vigor and growth. While disease level was not affected, only the composted manure treatment increased fruit yield. Nutrient management became the focus of the research after the initial several years of field tests, while fungicides and biological materials were dropped in favor of applications of synthetic NPK fertilizers and synthetic potassium fertilizer sources, primarily KCl. The norm had been that only modest levels of K, if any, were part of the nutrient management program.

Materials and Methods

Two field tests per year from 2011 to 2013 were evaluated in commercial fields with a history of vine decline. Selected fields were irrigated by buried drip irrigation to facilitate applications of conventional fungicides and biological agents. The experimental design was a randomized complete block with 4 replications with each row representing a plot. Row lengths tended to be more than 1,000 feet long and most beds were on 5-foot centers. Materials over the years included conventional fungicides, biologicals, a preplant biocide, NPK fertilizers and composted poultry manure. Well-aged, composted poultry manure was applied on the bed top in a continuous pile on 100 feet of row ahead of shallow, springtime seedbed tillage. In later years, materials included potassium sulfate or potassium chloride sources and in one test, potassium carbonate. While tests remained primarily buried-drip irrigated, subsequent to the early tests, experimental setup switched to a more compact design with replications down the row and to ease application, K applied solely as a sidedress of granular KCl.

Yields were measured by hand harvest of a 15-foot subsection of row in 2011 and 2012. In subsequent years, mostly 100-foot plot lengths were mechanically harvested using the grower's commercial equipment with yields measured using a portable weigh-scale trailer. Fruit pH, °Brix and color were measured from a subsample of non-defect, red ripe fruit by the Processing Tomato Advisory Board.

Soil exchangeable K was measured by atomic emission spectrometry following ammonium acetate extraction (Thomas, 1982). The relative abundance of K was expressed as a percent of milliequivalents of base cations (Ca, Mg, Na and K) based on this extraction.

The field sites were used only in a single year while two of the earlier test fields were retested, but not positioned over the original test locations.

Results and Discussion

The presence of soilborne pathogens were initially thought to contribute to vine decline. The deficiency of plant nutrients was initially not widely perceived to be an issue. Commercially available products were selected in an attempt to suppress soilborne pathogens (fungicides and biological), to stimulate soil microbial populations (biologicals and composted manure) and to provide supplemental nutrients to support plant vigor and growth. All treatments were supplemental to the grower fertilizer program with generally robust nitrogen and phosphorus applications to support high production. Cultural practices beyond the application of treatments were those of the commercial growers including standard nutrient management.

Vine decline was observed to varying degrees in all sites; however, the incidence of recovery of pathogens in the laboratory (data not shown) was not affected by any treatment.

Yields were generally increased in the plots with composted chicken manure. Marketable yield increased in select fields. On a percentage basis, the yield increases were equivalent to 32%, 41% and 25% in 2011, 2012 and 2013, respectively. From those initial tests, a series of tests from 2014 to 2016 were conducted to establish a rough threshold level to help guide K management decisions.

In 2016, 3 tests were conducted, all in soils with less than 200 ppm K. Two of the tests had no yield response. A response occurred in an upper Delta site in a mineral soil with Egbert clay, with ~150 ppm K and 1.5% on the cation exchange. A positive linear yield response was measured with K applications from 50 to 800 pounds per acre of K_20 in a furrow irrigated field (Figure 3).

The results indicate yield increases to composted poultry manure applications are related to soils with potassium levels below 200 ppm and potassium levels not exceeding 2% of the cation exchange capacity (Figures 1 and 2).

Conclusion

Yields in fields with a history of vine decline were generally increased with the addition of composted manure. The contribution by composted poultry manure of supplemental nutrients, especially in soils with low potassium, was primary benefit of this practice. The studies did not demonstrate a direct link between improved yield and suppression of soilborne pathogens.

Yield response to potassium application may well be a combination of low available soil K, continued K mining without replenishing and higher tomato crop yield from improved cultivars and adoption of drip irrigation.

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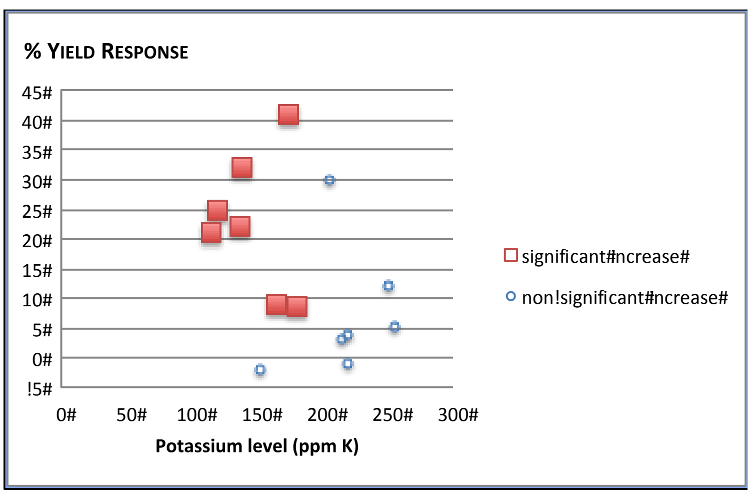

Figure 1. Influence of soil K level (in ppm) on processing tomato yield response to potassium fertilizer applications, Yolo-Solano, 2011-2015.

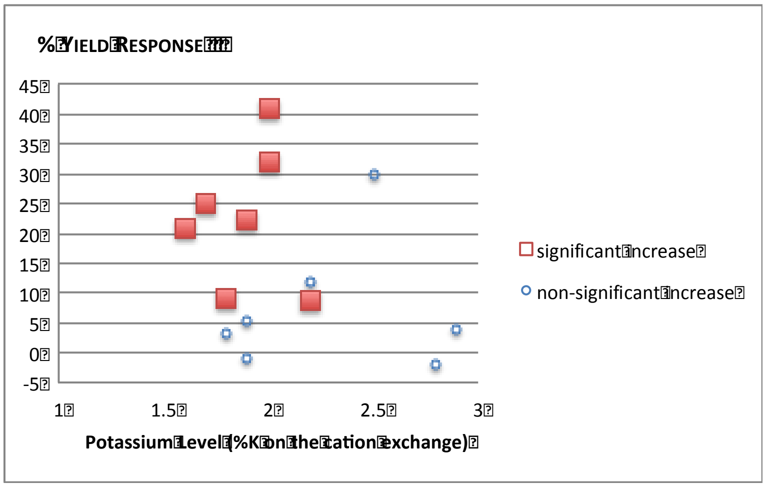

Figure 2. Influence of % K of the cation exchange capacity on processing tomato yield response to potassium fertilizer applications, Yolo-Solano, 2011-2015.

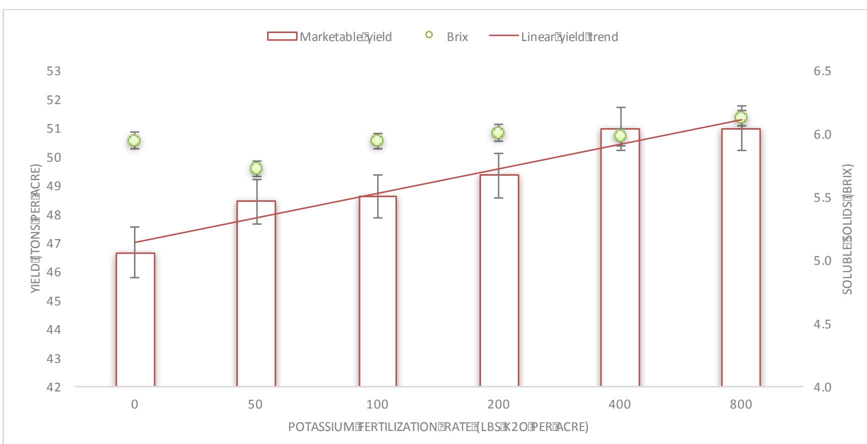

Figure 3. Effect of KCl application on processing tomato yield, Egbert clay, 150 ppm K, upper Delta, 2016.