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Comparison of Preplant Potassium Sources and Rates for Tomato Production in Florida

Bielinski M. Santos*

University of Florida, IFAS, Gulf Coast Research and Education Center, 14625 CR 672,
Wimauma, FL 33598

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The performance of tomato (*Solanum lycopersicum*) was compared under different preplant potassium (K) rates and sources. Tomato plants were established and grown with seepage (subsurface) irrigation and either sulfate of potash (SOP; 50% K_2O) or muriate of potash (MOP; 60% K_2O). Preplant K rates were 0, 50, 100, 200, 300, 400, and 500 lb/acre. Elemental sulfur (S) was used to balance S content in SOP. Foliar K concentrations at 4 WAT increased steadily as K rates increased from 0 to 300 lb/acre, regardless of the preplant K source utilized. However, K concentrations in newly-opened mature leaves declined from approximately 3.6% at 300 lb/acre of K to about 2.6% with 500 lb/acre when MOP was used. In contrast, these K concentrations remained unchanged in the same rate range when SOP was applied to the soil. When SOP was used as the preplant K source, the soil EC remained ≤1.5 dS/m, regardless of the K rate. However, the preplant application of MOP steadily increased the soil EC across K rates, reaching a maximum of 3.1 dS/m with 500 lb/acre of K. However, there were no differences in soil EC between the two K sources at rates from 0 to 300 lb/acre of K. There were no differences in extra-large fruit weights when preplant K rates were between 0 and 400 lb/acre, regardless of K sources. However, as preplant K rates increased from 400 to 500 lb/acre using MOP as the K source, fruit yield declined, which could be attributed to the elevated salinity in the soil. The data suggest that, while rate dependent, MOP is a viable source for partially replacing SOP in preplant K fertilizer blends, which can reduce production cost for tomato growers.

Potassium (K) is one of the two most absorbed essential nutrients for tomato (*Solanum lycopersicum*) plant growth and development. In Florida, the vast majority of the 32,000 commercial acres of tomato (USDA, 2011) are set in polyethylene-mulched fumigated beds and grown with one of two irrigation systems: seepage (subsurface) or seepage plus drip. In the latter system, fertilizer applications are generally split between granular preplant formulas and liquid injection through the drip lines, whereas in the former system, the fertilizer is applied exclusively before planting. Preplant fertilizers for tomato production are applied in two procedures: a) broadcast to the soil ("cold mix"), and b) banded on bed tops ("hot mix"). The "cold mix" usually consists of 25% to 35% of all the nitrogen (N) and K, and all the micronutrients. The rest of the N and K are applied in one or two bands on bed tops.

Tomato growers obtain granular fertilizer from suppliers that blend formulas according to soil analysis recommendations and use sulfate of potash (SOP; 0–0–50 + 17% S), muriate of potash (MOP; 0–0–60), and potassium nitrate (13–0–45) as the most common K sources. However, MOP has a very elevated salt index (salt index = 116) in comparison with that for SOP (salt index = 46) (Maynard and Hochmuth, 2007). High salt injury has been observed routinely when all or the majority of preplant K is obtained from MOP in tomato fields of southwest and west-central Florida, which has forced growers to be careful when applying MOP. However, in the last decade K application rates have changed dramatically. Informal surveys among tomato growers indicated that between 400 and 550 lb/acre of K were applied per season a decade ago, whereas now only between 250 and 350 lb/acre are used. This is partially due to the steady increase of worldwide fertilizer prices, and specifically because traditionally SOP has been more expensive than MOP (USDA, 2012). Therefore, this situation opens an opportunity to re-evaluate the use of MOP in K fertilizer blends at lower rates than those used at the beginning of the current century. The objective of this study was to compare the performance of tomato under different preplant K rates and sources.

Materials and Methods

Two field studies were conducted during fall 2009 and 2010 at the Gulf Coast Research and Education Center of the University of Florida in Balm, FL. The soil at the experimental site is a sandy, siliceous, hyperthermic Oxyaquic Alorthod with <1.5% organic matter and pH of 6.8. Prior to the experiment, the soil was tilled twice at an approximate depth of 8 inches to ensure proper soil structure. A standard bedder was used to create raised beds that were 5 ft apart at the center, 8 inches high, 28 inches wide across the top, and 32 inches wide at base. Raised beds were fumigated in late July of each year with a 50:50 (v:v) methyl bromide and chloropicrin mixture at 170 lb/acre to eliminate weeds, nematodes, and soil pathogens. 'Tygress' tomato seedlings at the four true-leaf stage were transplanted in a single row with 2-ft spacing between plants in the third week of August of each year. Tomato plants were established and grown with seepage irrigation only, using daily volumes that fluctuated between 10,000 and 14,000 gal/acre per day, depending on the local potential evapotranspiration and rainfall, as outlined by Simonne and Dukes (2009). Plants were staked and tied as described by Csizinszky et al. (2005). All other

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*Corresponding author; phone: 813-634-000; email: bmsantos@ufl.edu

crop management was conducted according to current recommendations for tomato production in Florida (Olson et al., 2011).

Treatments were combinations of two K sources (SOP and MOP) and five K rates (0, 50, 100, 200, 300, 400, and 500 lb/acre). Treatments were arranged in a randomized complete block design with six replications. Either SOP (50% K_2O; Compass Minerals, Salt Lake City, UT) or MOP (60% K_2O) were applied as two, 2-inch-deep bands located 12 inches apart on top of raised beds before soil fumigation and plastic mulch application. Elemental S (Tiger 90 CR, 90% S, prills of 2.6 mm in diameter; Tiger-Sul, Calgary, Alberta, Canada) was used to balance S content in SOP. Other nutrients were applied at non-limiting rates on bed tops using recommended rates based upon growth stages and interpretation of pre-season soil test results (Olson et al., 2011; Simonne and Hochmuth, 2009).

Soil samples were collected for electrical conductivity (EC) at 4 weeks after transplanting (WAT). Six soil cores, which constituted a soil sample of about 1 lb per sample, were taken from between tomato plants on the center of raised beds to a depth of 6 inches. Soil samples were air dried before shipment to a commercial agricultural laboratory for analysis (Waters Agricultural Laboratory, Camilla, GA). Plant tissue samples for K leaf concentrations were collected at 4 and 8 WAT using 10 most recently matured tomato leaves adjacent to an inflorescence. A 2-g subsample of each sample was submitted to the same commercial laboratory as described for total K. Following local practices, tomato fruit were harvested twice at 10 and 12 WAT during both seasons, and they were graded as extra-large (≥2 25/32 inches in diameter) and total marketable, according to the current standards for size categories (Brown, 2011). Marketable tomato fruit weight was calculated as the sum of all marketable fruit, including the extra-large grade. All collected measurements were subjected to an analysis of variance to determine single-factor and interactions significance ($P < 0.05$) using a general linear model, as well as the effects of linear contrasts through regression analysis (Statistix Analytical Software, Tallahassee, FL). Individual treatment means were separated with standard error bars.

Results and Discussion

There were no significant season by treatment interactions for all the variables, thus data were combined for analysis. Sources and rates of preplant K interactively influenced foliar K concentrations at 4 WAT (Fig. 1a). Foliar K concentrations increased steadily as K rates increased from 0 to 300 lb/acre, regardless of the preplant K source utilized. However, K concentrations in newly-opened mature leaves declined from approximately 3.6% at 300 lb/acre of K to about 2.6% with 500 lb/acre when MOP was used. In contrast, these K concentrations remained unchanged (approximately 3.8% K) at the same rate range when SOP was applied to the soil. Olson et al. (2011) indicated that the K sufficiency for tomato plants during blooming is between 2.5% and 5%, which suggested that K supply was not a growth-limiting factor during these concentration fluctuations, thus not reducing crop performance. In this case, tomato plants had foliar K concentrations of 2.5% or higher consistently in plots treated with application rates of 200 lb/acre of either source. At 8 WAT, there was a significant effect of K rates on foliar K concentrations in newly-opened mature leaves (Fig. 1b). However, K sources and the interaction between K sources and rates did not influence this variable. Foliar concentrations at this stage increased from about 1.3% with no preplant K applied to 2.5% with the application of 200 lb/acre of preplant K and then remained relatively stable slightly below 3% with K rates between 300 to 500 lb/acre. Using MOP as the preplant K source did not affect foliar K concentration at 8 WAT, which suggested that both K sources were similarly available for plant absorption during the season.

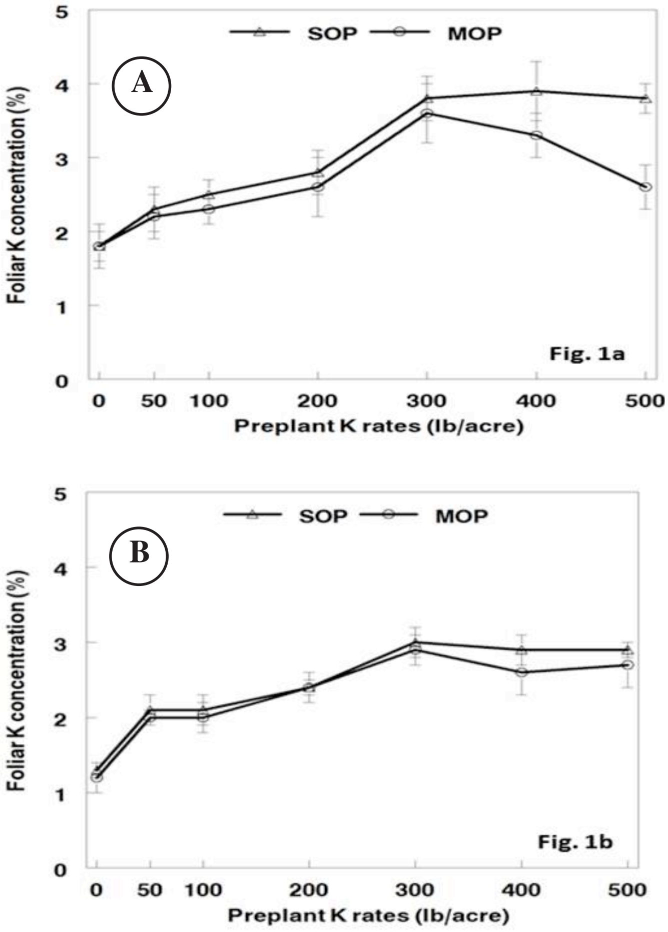

Fig. 1. Effects of preplant potassium (K) sources and rates on foliar K concentrations at (**A, top**) 4 weeks and (**B, bottom**) 8 weeks after transplanting. SOP = sulfate of potash (50% $K_2O \approx 42\%$ K) and MOP = muriate of potash (60% $K_2O \approx 50\%$ K). Values separated with error bars.

The soil EC at 4 WAT was interactively affected by the two factors (Fig. 2). When SOP was used as the preplant K source, the soil EC remained ≤1.5 dS/m, regardless of the K rate. However, the preplant application of MOP steadily increased the soil EC across K rates, reaching a maximum of 3.1 dS/m with 500 lb/acre of K. However, there were no differences in soil EC between the two K sources at rates from 0 to 300 lb/acre of K. Preplant K sources and rates interactively influenced extra-large and total marketable tomato fruit weights. There were no differences in extra-large fruit weights when preplant K rates were between 0 and 400 lb/acre, regardless of K sources (Fig. 3a). However, as preplant K rates increased from 400 to 500 lb/acre using MOP as the K source, fruit yield declined from 12 to 10 ton/acre, whereas there was no variation in extra-large fruit weight with the other K source. A very similar pattern was observed for total marketable fruit weight, in which plots treated with preplant MOP and SOP provided the same yields for K rates of 400 lb/acre or less (Fig. 3b).

Increasing soil EC in plots fertilized with MOP at 400 lb/

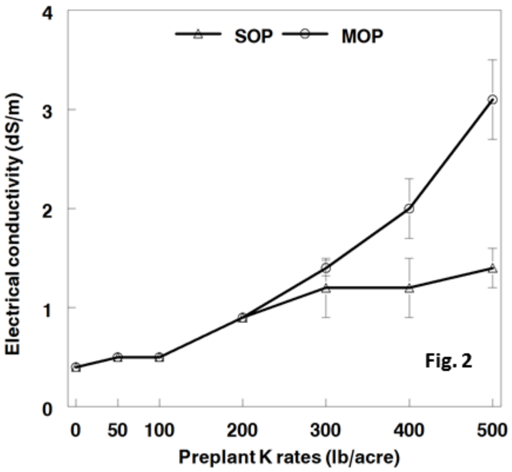

Fig. 2. Effects of preplant potassium (K) sources and rates on soil electrical conductivity at 4 weeks after transplanting. SOP = sulfate of potash (50% $K_2O \approx 42\%$ K) and MOP = muriate of potash (60% $K_2O \approx 50\%$ K). Values separated with error bars.

acre of K may have been the leading cause for the decline in extra-large and total marketable yields of tomato. These soil EC values surpassed the reference soil EC threshold for tomato production of 2.5 dS/m (Maynard and Hochmuth, 2007). These results suggest that, while rate dependent, MOP is a viable source for partially replacing SOP in preplant K fertilizer blends, which can reduce production cost for tomato growers. For instance, if a 50:50 blend of both sources is prepared for a base rate of 300 lb/acre of K, then a grower would incur a total cost of $776/ton, whereas if only SOP were used as the K source it would mean an investment of $905/ton.

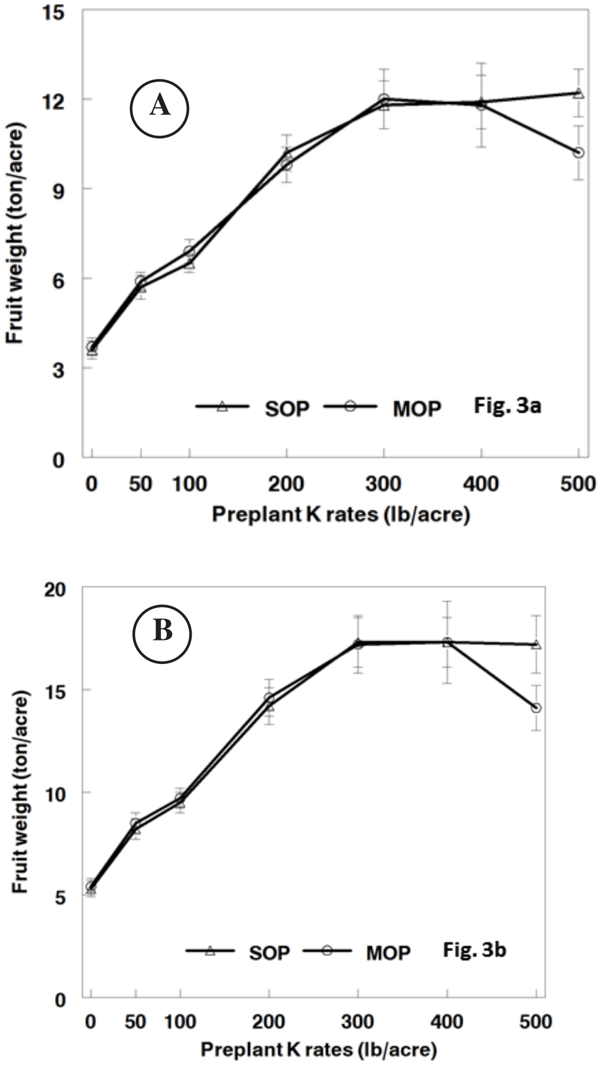

Fig. 3. Effects of preplant potassium (K) sources and rates on (**A, top**) extra-large and (**B, bottom**) total marketable fruit weights. SOP = sulfate of potash (50% $K_2O \approx 42\%$ K) and MOP = muriate of potash (60% $K_2O \approx 50\%$ K). Values separated with error bars.

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