POTASSIUM AND SALT INTERACTIONS IN ARID AND SEMIARID COTTON PRODUCTION

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Abstract

Salt accumulations in soil in irrigated cotton production are a major issue in the arid and semiarid regions of western USA. In many years, this leads to premature leaf drop between peak bloom and open boll. The necrosis on the cotton leaf margins prior to senescence is often identified as potassium deficiency. This is despite high soil test potassium levels. We present cotton leaf potassium and salts data from farmer's fields in arid Pecos county to small plot studies in semiarid Lubbock county. We observed that in wet years when soil salts are less of an issue, leaf K is high and leaf Ca is low. In drier years in Lubbock and when leaves drop prematurely in all areas, leaf K is low and leaf Ca is high. The Lubbock county soil is a fine-loamy, mixed, superactive, thermic Aridic Paleustoll, that does not fix K. The soil in Pecos county is a fine smectitic, thermic, Chromic Haplotorrert that can fix K, leading to late season necrosis and leaf drop.

Materials and Methods

Leaf samples at first square were taken from a study on a grower's field in Hockley county Texas from two soil types: fine-loamy, mixed, superactive, thermic, Aridic Paleustalf (alkaline soil) and a fine-loamy, mixed, superactive, thermic Aridic Calciustoll (calcareous soil). Leaves were analyzed N, P, Ca, Mg, P, and K.

Leaf samples were taken ate first open boll from field experiments on fine-loamy, mixed, superactive, thermic Aridic Paleustoll soil in Lubbock county from subsurface drip and furrow irrigated fields from field studies in 2000, 2001, 2005, 2006, and 2007. Leaf samples were taken on fine smectitic, thremic, Chromic Haplotorrert soil on growers' fields in Pecos county in late 2006 and 2007. The 2006 Pecos county samples were taken from the ground in December and the 2007 samples were taken from healthy and necrotic leaves at first open boll. Leaves were analyzed for K, Ca, Mg, Cl, S, and B. Soil samples from 0-6 inches were taken as the same time as the plant samples and were analyzed for extractable nutrients and paste EC.

Results and Discussion

To place the semiarid West Texas cotton leaf analysis in context, we present published data from Arkansas and Georgia (Table 1). Comparatively, the first square cotton leaves in Hockley county were borderline deficient in K. Leaf Ca in Hockley county were much greater than in Arkansas or Georgia, reflecting high extractable Ca in soil. The cotton plant effectively limits Ca uptake, however, even on the calcareous (4500 ppm Ca) soil.

The West Texas late season leaf data showed high Ca and low K concentrations (Table 3 and Fig. 1). The leaf K levels > 2 % were mostly from Lubbock county and Pecos county, which experiences the necrotic leaf margins and leaf drop, had leaf K < 2 %. Interestingly, there is a definite negative correlation between leaf Ca and leaf K across the site-years (Fig. 1). Even within the Lubbock county data, were no leaf drop was observed, wet years had greater leaf K and less leaf Ca and hot, dry years had greater leaf Ca and less leaf K.

Irrigation water salt content was similar between Pecos and Lubbock county (Table 4). Soil Na was greater in Pecos than in Lubbock, but still on 3 % of the cations. Interestingly, 1 M AmOAc-extractable soil K averaged 770 and 420 ppm for Pecos county and Lubbock county, respectively (Table 4). Previous K fertilizer rate studies with cotton showed no response on the Lubbock county soil (Sunderman, et al., 1972). Despite high soil test K in Pecos, we suspect K fixation in the soil clay lattice leads to late season K deficiency and pre-mature leaf drop.

Table 1. Sufficiency ranges for cotton leaf nutrient concentrations (Sabbe et al., 1972)

	Arkansas (Aug 1)	Georgia (June & July)
Leaf nutrient	--------------------- % ------------------------	
N	3.00 – 4.00	3.75 – 4.50
P	0.30 – 0.65	0.30 – 0.50
K	0.90 – 1.95	2.00 – 3.00
Ca	1.90 – 3.50	2.25 – 3.00
Mg	0.30 – 0.75	0.50 – 0.90

Table 2. Nutrient concentrations of center-pivot irrigated cotton at early squaring, Hockley county, Texas, 2000.

	Alkaline soil[a]	Calcareous soil[b]	
Leaf nutrient	------------------- % -----------------		F test
N	4.08	3.88	*
P	0.35	0.30	*
Ca	3.75	4.25	*
Mg	0.68	0.67	
K	2.09	2.12	

[a] Amarillo sandy loam (1754 ppm extractable Ca, 306 ppm soil test K)
[b] Portales loam (4510 ppm extractable Ca, 306 ppm soil test K)

Table 3. Nutrient concentrations of leaves of irrigated cotton from first open boll to harvest, some of which experienced necrosis and pre-mature leaf drop. 2001-2007.

	Necrotic leaves	Healthy leaves	
Leaf nutrient	------------------ % ----------------		F test
Ca	6.04	5.15	*
Mg	0.75	0.82	
K	1.40	1.94	*
Cl	0.86	1.51	
S	1.89	1.93	
B (ppm)	90	88	

Fig. 1. Leaf Potassium vs. leaf Ca at first open boll to harvest, West Texas, 2001-2007.

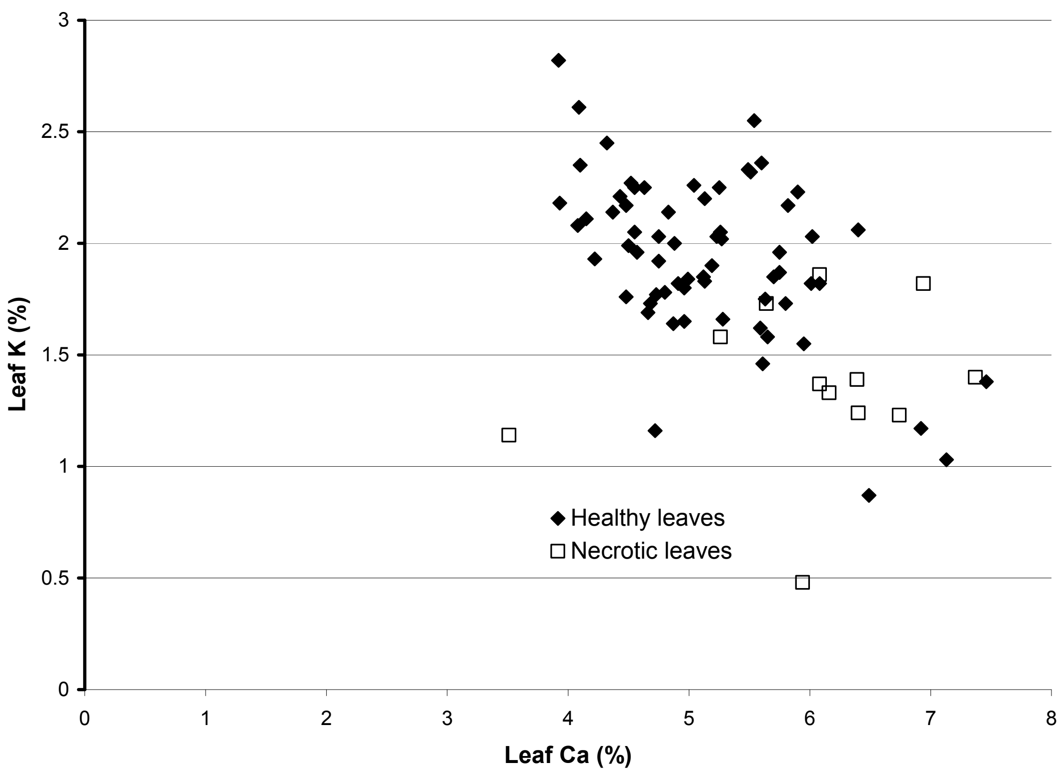

Table 4. Salt concentrations of Lubbock county and Pecos county soils (0 – 6 in.) and irrigation water

	Pecos	Lubbock	
	------------------ ppm ----------------		F test
Ca	5500	1410	*
Mg	518	589	
K	773	421	*
Na	225 (3%)	30 (1%)	*
Paste EC	2.1	1.4	*
Soil pH	8.2	7.7	*
Water EC	1.1	1.2	
Water SAR	2.4	1.2	

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