YIELD AND NUTRITION OF COTTON CULTIVARS UNDER DIFFERENT POTASSIC FERTILIZATION MANAGEMENT IN A SANDY SOIL

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Abstract

Potassium plays an important role in plant metabolism because it is related to numerous physiological functions such as stomatal control, carbohydrate transport, water relations, enzymatic activation, load balance, whose directly affect cotton growth, development, production and quality. In addition, it is quickly released from plant residues, allowing for anticipated applications in systems under no-till. The objective of this work was to evaluate the response of cotton cultivars to potassium fertilization when grown in rotation with a forage crop. Treatments included: 1- No K without *U. ruziziensis*; 2 - No K with *U. ruziziensis;* 3 - 140 kg ha^{-1} of K_2O applied on cotton without *U. ruziziensis*, 50% at 30 DAE and 50% at 50 DAE; 4 - 140 kg ha^{-1} of K_2O applied on cotton 50% at 30 DAE and 50% at 50 DAE with *U. ruziziensis;* 5- 140 kg ha^{-1} of K_2O applied in the *U. ruziziensis*; 6 - 70 kg ha^{-1} of K_2O applied on *U. ruziziensis* and 70 kg ha^{-1} of K_2O on cotton at 30 DAE; and the early cultivar FM 913GLT and the late cultivar FM 983GLT. The late cultivar showed an increase of 19.8% for height and 17% for the average boll weight in relation to the early cultivar. Boll number was 13.8% higher in the early cultivar than in the late cultivar. Seed cotton yield was 33% higher when potassium was split in cotton (30 and 45 DAE) without *U. ruziziensis* in relation to the absence of potassium application (with and without *U. ruziziensis*). The leaf content of phosphorus, potassium, magnesium, sulfur and zinc was higher in the early cultivar (9.7%; 10.9%; 11.6% and 17%), respectively. The application of potassium in *U. ruziziensis* increased the potassium content by 57% compared to 0 K without *U. ruziziensis.* The application of potassium decreased the leaf magnesium content in average of 26.45%.

Introduction

Potassium (K) is a nutrient required by cotton (*Gossypium hirsutum* L.) in a quantity similar to that of nitrogen (N) (CASSMAN, 1993). Potassium deficiencies can impair many physiological functions, including water relations, enzymatic activation, load balancing, reduced growth and production, as well as the reduction of stress resistance (OOSTERHUIS et al., 2013)

The main characteristics of sandy soils are low natural fertility, low water retention and cation exchange capacity due to the low organic matter and clay contents (MENDONÇA et al., 2006). In these soils, potassium has fewer negative charges to associate to. Hence, when in the presence of water, non-adsorbed potassium will be in the soil solution, increasing the possibility of being leaching, as demonstrated by Rosolem and Nakagawa (2001).

The cultivation of cover crops may result in increased levels of nutrients in the soil surface layers (FIORIN, 1999), mainly K, because it is not metabolized in the plant and forms connections with organic molecules of easy reversibility, besides being the most abundant ion in plant cells (MARSCHNER, 1995). Thus, the amount of K in the cover crop may constitute an expressive source of the nutrient for subsequent crops (ROSOLEM et al., 2006). The objective of this work was to evaluate the response of cotton cultivars under different management of potassic fertilization.

Materials and Methods

The experiment was conducted at the Experimental Farm of São Paulo Western University. The soil is an Ultisol (Soil Taxonomy). Chemical analysis in the 0-20 cm layer (Raij et al., 2001) showed the following values: pH ($CaCl_2$ 1 mol L^{-1}) 4.7; 13.6 g dm^{-3} M.O .; 2.8 mg dm^{-3} of P resin; 17.6 mmolc dm^{-3} of H + Al; 0.8 mmolc dm^{-3} of

K; 7.3 mmolc dm^{-3} of Ca; 5.1 mmolc dm^{-3} of Mg; 30.7 mmolc dm^{-3} of CEC; 42.6% base saturation; 0.34 mg dm^{-3} Boron (B) and 0.4 mg dm^{-3} Zinc (Zn). In the 20-40 cm layer the particle size analysis revealed: 841 g kg^{-1} of sand, 137 g kg^{-1} of clay and 23 g kg^{-1} of silt. The climate, according to the classification of Köppen, is type Aw, and the recorded weather data during the season is shown in Figure 1.

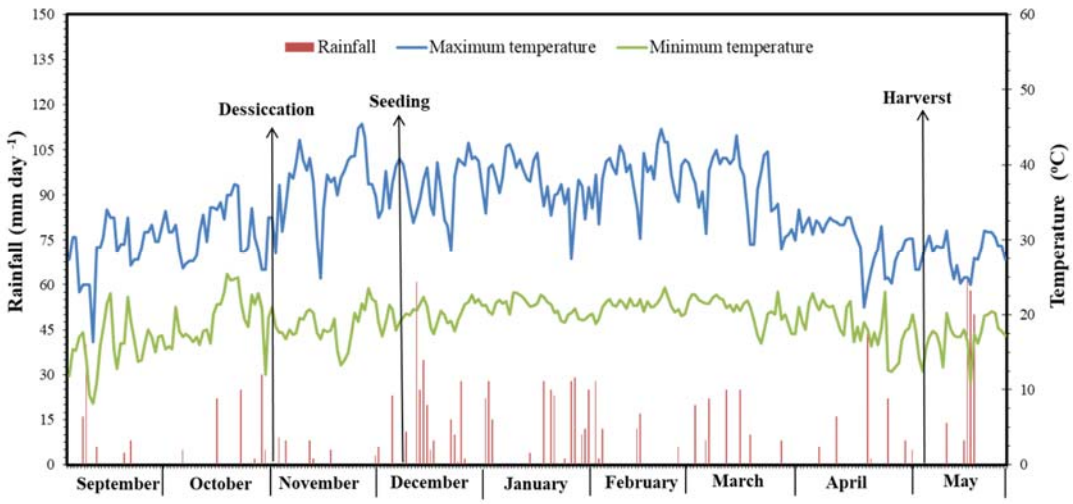

Figure 1.Rainfall, maximum temperature and minimum temperature during the season 2016/2017.

The experimental design was a factorial 6x2 with five replications. Treatments included: 1- No K without *U. ruziziensis*; 2 - No K with *U. ruziziensis;* 3 - 140 kg ha^{-1} of K_2O applied on cotton without *U. ruziziensis*, 50% at 30 DAE and 50% at 50 DAE; 4 - 140 kg ha^{-1} of K_2O applied on cotton 50% at 30 DAE and 50% at 50 DAE with *U. ruziziensis;* 5- 140 kg ha^{-1} of K_2O applied in the *U. ruziziensis*; 6 - 70 kg ha^{-1} of K_2O applied on *U. ruziziensis* and 70 kg ha^{-1} of K_2O on cotton at 30 DAE; and the cotton cultivars: early cultivar FM 913GLT and late cultivar FM 983GLT.

Cotton leaves (4th or 5th leaf from the apex of the main stem) were sampled in 10 plants per plot, at full blooming for foliar diagnosis. The samples were processed according to Malavolta et al. (1997). At harvest the final population, plant height (5 per plot in the central rows), number of nodes (5 plants per plot in the central rows) were evaluated. For yield components determination (number and boll weight) and seed cotton yield, 2 m of each central row were harvested. The data were submitted to Analysis of Variance and for the significant effects the averages compared by the Tukey test ($p < 0.05$).

Results and Discussion

Cotton plants receiving K application at 30 and 45 DAE without *U. ruziziensis* were taller than in the absence of K (with and without *U. ruziziensis*) or when K was applied on cotton with *U. ruziziensis* with an increase of 16.6%, 16.8% and 19.1% respectively. In addition, the late cultivar presented taller plants than the early cultivar (19.80%) (Table 1). Boll weight in the late cultivar was increased by 17% in relation to the early cultivar (Table 1). Seed cotton yield was higher when potassium was split on cotton at 30 and 45 DAE without *U. ruziziensis* as compared with treatments without K, with and without *U. ruziziensis,* with an increase of 38 and 28% respectively (Table 1). Boll number was higher for the early cultivar when potassium was split at 30 and 45 DAE without *U. ruziziensis* as compared with the other treatments. For the late cultivar there was also an increase on boll number when potassium was split at 30 and 45 DAE without *U. ruziziensis* compared with 0 K with *U. ruziziensis* treatment (Figure 2).

TABLE 1- Plant height, average weight of bolls, number of bolls per square meter, and seed cotton yield per hectare.

Treatment	Height (cm)	Boll weight (g)	Boll m²	Seed Cotton Yield (kg ha^{-1})
0 K-without *U.r*	77,92 b	3,06 a	54,06 b	1646 bc
0 K- with *U.r*	78,02 b	3,09 a	50,06 b	1522 c
140 K on *U.r*	83,06 ab	3,25 a	54,95 b	1784 abc
70 K on *U.r* and 70 K on C	83,26 ab	3,22 a	59,36 b	1906 abc
140 K on C- without *U.r*	91,02 a	3,01 a	70,62 a	2109 a
140 K on C- with *U.r*	76,44 b	3,19 a	56,37 b	1774 abc
F	4,13**	0,80 ^{ns}	7,30**	6,26**
Cultivar				
FM 913GLT	74,41 b	2,9 b	61,29 a	1754,45 a
FM 983GLT	89,15 a	3,4 a	53,86 b	1826,45 a
CV (%)	10,69	10,8	14,39	14,39
F	42,67**	31,43**	12,06**	1,17 ^{ns}
F int	1,02 ^{ns}	1,34 ^{ns}	2,77*	2,06 ^{ns}

CV (%) = coefficient of variation. F = value of F calculated for the source of variation Treatment and for interaction Treatment x Cultivate. *, ** and ns, significant ($p < 0.05$), ($p < 0.01$) and not significant, respectively. U.r.: *Urochloa ruziziensis*. C: cotton

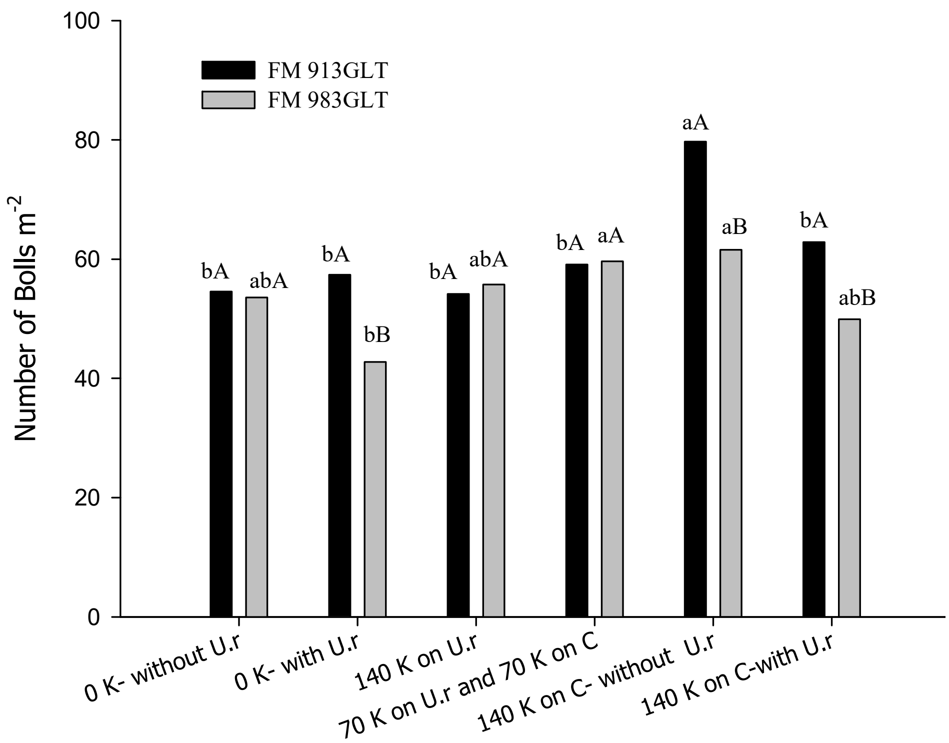

Figure 2. Boll number of cotton cultivars under different managements of potassic fertilization. Means followed by lower case letters compare the cultivar in different treatments and upper case letters compare the cultivars in the same treatment. Equal letters do not differ from each other by the t test at 5% probability ($P < 0.05$). U.r.: *Urochloa ruziziensis*. C: cotton

The K concentration on cotton leaves was 57% higher when K was applied integrally on *U. ruziziensis* compared to the treatment that did not receive potassium (Table 2), but K concentrations were below the level of sufficiency (15-25 g kg^{-1}) in all treatments. Leaf Mg was 26% higher in the treatment that did not receive the application of K without *U. ruziziensis*, compared with the others that were fertilized with K. The early cultivar showed an increase of 9.79; 10.93; 11.62 and 17.02% in the leaf P, K, Mg and S in relation to the late cultivar.

Table 2- Characteristics of macronutrients of plant tissue

Tratamento	**Macronutrients**					
	N	**P**	**K**	**Ca**	**Mg**	**S**
	g kg^{-1}					
0 K- without *U.r*	43,40 a	2,46 a	5,58 b	35,41 a	10,66 a	4,30 a
0 K- with *U.r*	43,85 a	2,53 a	6,47 ab	33,07 a	9,73 ab	3,85 a
140 K on *U.r*	45,08 a	2,47 a	8,77 a	31,44 a	8,41 b	4,15 a
70 K on *U.r* and 70 K on C	44,25 a	2,41 a	6,98 ab	30,93 a	8,21 b	4,02 a
140 K on C- without *U.r*	42,79 a	2,41 a	7,70 ab	31,49 a	8,69 b	3,90 a
140 K on C- with *U.r*	43,74 a	2,50 a	7,93 ab	31,69 a	8,40 b	3,89 a
F	$1,47^{ns}$	$0,29^{ns}$	2,50*	$1,57^{ns}$	6,48**	$1,03^{ns}$
Cultivar						
FM 913GLT	43,53 a	2,58 a	7,61 a	36,74 a	9,51 a	4,33 a
FM 983GLT	44,17 a	2,35 b	6,86 a	27,93 a	8,52 b	3,70 b
Level of sufficiency	35-43	2,5-4	15-25	20-35	3-8	4-8
CV (%)	4,61	11,31	31,32	13,01	13,38	13,65
F	$1,47^{ns}$	10,2**	$1,64^{ns}$	65,79**	10,17**	19,78**
F int	$0,71^{ns}$	$0,39^{ns}$	$0,93^{ns}$	$0,96^{ns}$	$0,69^{ns}$	$0,83^{ns}$

CV (%) = coefficient of variation. F = value of F calculated for the source of variation Treatment and for interaction Treatment x Cultivate. *, ** and ns, significant ($p < 0.05$), ($p < 0.01$) and not significant, respectively. U.r.: *Urochloa ruziziensis*. C: cotton.

Summary

Leaf concentrations of phosphorus, potassium, magnesium and sulfur were higher in the early cotton cultivar than in the late cultivar. The application of potassium on *U. ruziziensis* increased K concentration in cotton, but the supply of K decreased the foliar concentration of magnesium. The mean height and boll weight were higher in the late cultivar than in the early one, but boll number was higher in the early cultivar when K was split, both with and without *U. ruziziensis,* and in the 0 K treatment with *U. ruziziensis*. Seed cotton yield was higher when K fertilizer was split on cotton (30 and 45 DAE) without *U. ruziziensis.*

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