RESEARCH PROJECT – BPC and IPNI BRAZIL

RATES AND RESIDUAL EFFECT OF POTASSIUM FERTILIZATION IN A BRAZILIAN OXISOIL

RESULTS FOR SOYBEAN 2010-2011 AND CORN 2nd Crop 2011

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This Report

This report refers to the agronomic results for the crops of soybean 2010-2011 and corn second crop 2011 (first project year). The research project is funded by BPC, coordinated in Brazil by IPNI Brazil and has the field partner as Research Foundation MT.

Introduction

The requirement for worldwide abundant food, feed, fiber, and more recently biofuel, leads to higher amounts of fertilizer utilized in agriculture in diverse parts of the globe. Potassium (K) is, most generally, the second nutrient in terms of plant demand (after nitrogen, N). Potassium

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is highly mobile in most soils and relatively mobile in the plants. This nutrient is responsible for several vital mechanisms for plant development and high yields (enzyme activation, translocation and stock of compounds, osmotic regulation, water maintenance, etc). Potassium fertilizers are very commonly a must in terms of plant nutrition in acid soils of the tropics, including Brazil. In many areas farmers are cutting back on fertilizer expenses, which could compromise good yields, profit and food safety in the future. Farmers expect that the soil supply will be sufficient to provide the ideal conditions for plant development and yield, even with lower or no supply of K fertilizers. Studying the impacts of K fertilizer cut back on Brazilian soils is essential as to demonstrate the effects in the medium to long run.

Objectives

The main objective of the study is to verify the effects of cutting back K fertilizer rates in some Brazilian soils. Also, it will be possible to study other important factors which may affect the K fertilizer effectiveness in tropical soils.

Material and Methods

A. General Information

The experiment takes place having soybean as the main crop and is located in Mato Grosso at the experiment station of Research Foundation MT. The K fertilizer used is KCl. The study is initially planned for six years. The winter crop will be defined locally. In 2011 corn 2nd crop was utilized. The independent (input) variables studied will apply only to the soybean (summer crop), with fertilization being the same across all treatments for the winter crop. The soil is an Oxisol with the chemical and granulometric properties described in Table 1 (medium in K bioavailability).

Table 1. Chemical and physical soil properties, 0 to 20 cm.

Soil pH		P	K	S	Ca	Mg	Al	H	V	OM	Clay	Sand	Silt
H_2O	$CaCl_2$	— mg dm^{-3} —			—— cmol$_c$ dm^{-3} ——				%	g dm^{-3}	——— g kg^{-1} ———		
5.6	4.9	20.4	57	18.6	2.9	0.7	0.0	5.4	41.0	38.9	639	152	209

Zn	Cu	Fe	Mn	B
——— mg dm^{-3} ———				
4.4	1.3	91	26.3	0.46

B. Treatments

The treatments are shown on Table 2 and legends for the variables studied can be found in Table 3. In summary the experiment outline proposes: (1) 4 rates of K in interaction with suppression or not of K after third year, (2) 3 rates of base saturation (BS), (3) 3 rates of phosphogypsum application (PG), (4) suppression of P in different levels after third year, (5) two levels of time of application, and (6) two levels of locality effect. The experiment is designed mainly to study K rates and its residual effect after the third year. Secondarily, the experiment is designed to evaluate other important variables that affect K fertilization, having the regular rate of K (K3) as a standard. The experiment will study the residual effect of K fertilization in interaction with liming and phosphogypsum. Also, the outline will make possible to investigate the phosphorus (P) residual effect and the effect of KCl, regarding time of K application and locality effect. Table 4 summarizes the variables studied. The regular practices in terms of rates, time of application, locality effect, liming and phosphogypsum application will be N3, P3, K3, TA1, LE1, BS L2 and PG L2. Nitrogen is of course not a problem for soybean (due to N fixation when seeds are properly inoculated with *Rhizobium japonicum*) and will not be studied. Variations in rates and other variables will permit several important comparisons as outlined in Table 5.

Some important local decisions related to the input variables for the treatments were made. They are:

1. *Rates of K_2O*: K3 was defined as 90 Kg/ha. K_2O was applied in all treatments, except 23 and 24, by splitting the proper rate in two applications: half at seeding and half in top dressing right after plant emergency.
2. *Rate of N*: not applicable to soybean (inoculation) and 60 Kg/ha for corn 2^{nd} crop.
3. *Rate of P_2O_5*: P3 was defined as 45 Kg/ha.
4. *Lime rates*: Due to soil properties (pH H_2O 5.6) the decision was to start up the experiment by varying the rate only for treatments 14 and 15 (BS L3). These two treatments received 4.5 t/ha of dolomitic lime. All other treatments received no lime at this time.
5. *Phosphogypsum rates (PG)*: Similarly to the lime rates the decision was to start the experiment by varying the PG rates only for treatments 18 and 19 (PG L3). These two treatments received 2 t/ha of phosphogypsum. All other treatments received no phosphogypsum at this time.
6. *Time of application (TA)*: Regular TA was to regularly split the K_2O rates in two applications (half at seeding and half right after plant emergency). The alternative (treatment 23) was to split in three applications (1/3 at seeding, 1/3 at emergency and 1/3 fifteen days after emergency).
7. *Locality effect (LE)*: Regular LE was to apply half of the K_2O rate at seeding (5 cm besides and 5 cm bellow the seeds) and half in top dressing right after plant emergency. The alternative (treatment 24) was to apply all K_2O rate at the soil surface right after plant emergency.

The above mentioned decisions were based on soil, crop and regional knowledge at the region (previous agronomic experimentation). Soybean and corn seeds used were TMG1176 and Dow Agroscience 2B688, respectively.

C. Plots, replicates and statistics

The plot size (6.3 m x 9.5 m; 59.85 m^2) was planned as to permit future subdivisions in case necessary. This will allow new variables to be studied in case of interest. The number of replicate is four per treatment. The statistics will follow proper procedures as to allow the conclusions necessary for the study. Statistics will be initially only for the main output variables studied, i.e., **grain yield and K leaf content**.

D. Evaluatins (Output variables)

(1) Soil K status with time.
(2) Plant K status with time.
(3) Weight of 100 seeds.
(4) Grain yield.

Table 2. Experiment outline.

Treat #	Treat #	Year 1	2	3	4	5	6	Year 1	2	3	4	5	6	Year 1	2	3	4	5	6	Time App (TA)	Locality Effect (LE)	Liming BS Level	PG Level
		Rates of N						Rates of P_2O_5						Rates of K_2O									
1	1	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	0	0	0	0	0	0	TA 1	LE 1	BS L2	PG L2
2	2A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K1	K1	K1	K1	K1	K1	TA 1	LE 1	BS L2	PG L2
3	2B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K1	K1	K1	0	0	0	TA 1	LE 1	BS L2	PG L2
4	3A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K2	K2	K2	K2	K2	K2	TA 1	LE 1	BS L2	PG L2
5	3B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K2	K2	K2	0	0	0	TA 1	LE 1	BS L2	PG L2
6	4A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA 1	LE 1	BS L2	PG L2
7	4B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA 1	LE 1	BS L2	PG L2
8	4C	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K1	K1	K1	TA 1	LE 1	BS L2	PG L2
9	4D	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K2	K2	K2	TA 1	LE 1	BS L2	PG L2
10	5A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K4	K4	K4	K4	K4	K4	TA 1	LE 1	BS L2	PG L2
11	5B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K4	K4	K4	0	0	0	TA 1	LE 1	BS L2	PG L2
12	6A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA 1	LE 1	BS L1	PG L2
13	6B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA 1	LE 1	BS L1	PG L2
14	7A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA 1	LE 1	BS L3	PG L2
15	7B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA 1	LE 1	BS L3	PG L2
16	8A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA 1	LE 1	BSL 2	PG L1
17	8B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA 1	LE 1	BS L2	PG L1
18	9A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA 1	LE 1	BS L2	PG L3
19	9B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA 1	LE 1	BSL 2	PG L3
20	11A	N3	N3	N3	N3	N3	N3	P3	P3	P3	0	0	0	K3	K3	K3	K3	K3	K3	TA 1	LE 1	BS L2	PG L2
21	11B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P1	P1	P1	K3	K3	K3	K3	K3	K3	TA 1	LE 1	BS L2	PG L2
22	11C	N3	N3	N3	N3	N3	N3	P3	P3	P3	P2	P2	P2	K3	K3	K3	K3	K3	K3	TA 1	LE 1	BSL 2	PG L2
23	12A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA 2	LE 1	BS L2	PG L2
24	13A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA 1	LE 2	BSL 2	PG L2

Table 3. Legends for variables in Table 2.

Variable	Specification	Definitions/Observations
Treat	Treatment	
N	Nitrogen	N3 = ideal rate of N for specific crop and region.
P	Phosphorus	Rates of P_2O_5 = 0, P1, P2, P3, with P3 = ideal rate of P_2O_5 for specific crop and region. P1 = P3/4, P2 = P3/2.
K	Potassium	Rates of K_2O = 0, K1, K2, K3, K4, with K3 = ideal rate of K_2O for specific crop and region. K1 = K3/4, K2 = K3/2, K4 = 1.5*K3.
TA	Time of Applicaton	TA 1 = regular practice (ex.: ½ K3 at planting and ½ K3 in top dressing); TA 2 = variation for time of application (1/3 at planting and two top dressings of 1/3 K3 each).
Year		1 to 6
LE	Locality Effect = Placement of K as related to the seed	LE 1 = regular practice (ex.: ½ 5 cm besides and bellow the seeds at planting and ½ at plant emergency); LE 2 = variation for locality effect (all quantity at soil surface).
BS	Base Saturation	Levels of liming BS L1, BS L2, BS L3.
PG	Phosphogypsum	Levels of Phosphogypsum PG L1, PG L2, PG L3.

Table 4. Summary of variables studied at the present experiment outline.

Var #	Specification
1	K rate
2	K residual effect
3	K and base saturation/liming
4	K and phosphogypsum application
5	P rate and P residual effect
6	K time of application
7	K placement

Table 5. Possible comparisons with experiment outline suggested in Table 1.

Comp #	Comparison	Treatments Involved
1	Response curve to K_2O with continuous application of K and regular practices for N, P, K time of application, K locality effect, liming and PG level.	T1, T2, T4, T6 and T10 (A).
2	Response curve to K_2O with K application up to 3rd year and regular practices for N, P, K time of application, K locality effect, liming and PG level (B)	T1, T3, T5, T7 and T11 (B).
3	A vs B = Effect of suspension of K application after 3rd year at regular practices	
4	Effect of different rates of K in residual effect as related to ideal rate (K3)	T6, T7, T8 and T9 (C).
5	Effect of liming on K fertilization with continuous application of K and regular practices	T12, T6 and T14 (D).
6	Effect of liming on K fertilization with application of K up to 3rd year and regular practices	T13, T7 and T15 (E).
7	D vs E = Effect of liming on suspension of K application after 3rd year at regular practices	
8	Effect of phosphogypsum on K fertilization with continuous applicaton of K at regular practices	T16, T6 and T18 (F).
9	Effect of phosphogypsum on K fertilization with application of K up to 3rd year at regular practices	T17, T7 and T19 (G).
10	F vs G = Effect of phosphogypsum on suspension of K application after 3rd year at regular practices.	
11	Response curve to P with full P only up to 3rd year and regular practices	T20, T21, T22 and T6.
12	Effect of timing of K application at regular practices	T6 and T23.
13	Placement effect of K application at regular practices	T6 and T24.

Regular practices = N3, P3, K3, TA1, LE1, BS L2 and PG L2

Results and discussion

Tables 6 to 8 show, respectively, the raw data obtained for 2010-2011 soybean yield, 2010-2011 soybean K leaf content, and 2011 corn 2nd crop yield. K leaf content for corn 2nd crop is not available at this time (in lab for tissue analysis). Tables 6 to 8 also provide mean comparisons, $p<0.05$, where applicable (comparisons 5, 6, 8, 9, 12 and 13 of Table 5). Some comparisons do not make sense now because they were planned to produce feasible results only with time (after suspension of K_2O application in some of the treatments). For example, comparison # 3 do not make sense at this stage once differences among these the two response curves (comparing 1 and 2, Table 5) will only make sense after suspension of K application to study the residual effect. The same applies to comparisons # 7 and # 10 of Table 5.

As mentioned, due to soil properties, only two, and not three, rates of lime and phosphogypsum were applied to this moment. Consequently, the decision was to evaluate such comparisons by mean average and not by model regression as initially expected.

Figures 1 to 4 shows the response curves for K application as a function of rates. Figures 1 and 2 are for soybean and Figures 3 and 4 are for corn 2nd crop. While Figures 1 and 3 shows comparisons 1 and 2 (according to Table 5), figures 2 and 4 combines all data into only one figure for each crop. This is due to the fact that there is still no absence of K to study the residual effect. It is quite clear, by all response curves, that there is a small response to K for soybean (for example, from 3502 kg/ha when no K_2O was applied to around 3750 kg/ha when 90 kg/ha of K_2O was used), which would be expected in a soil with a medium content of K (57 mg/dm^3). In terms of data analysis there was a statistical significant rate effect for K_2O application for soybean yield (Figure 5) and soybean leaf K content (Figure 6). A quadratic and a linear model was adjusted describing such relationships, i.e., soybean yield or soybean K leaf content as a function of applied rates of K_2O. For corn 2nd crop there was no statistical increment in crop yield as a function of K_2O applied previous to the soybean crop. The relative small response to K for soybean and the absence of K response to corn 2nd crop is in the interest of this research project once the idea was to increase the K soil level up to the third year and then start studying the residual effect from different scenarios related to K fertilization (suppression of K addition in different levels as related to no suppression). The results for this first year indicated that we may anticipate cutting back on K rates even before the fourth crop year, as initially planned. We have decided to grow the crops for a second cycle (2011 – 2012) and then make a decision regarding this protocol change.

From all other possible comparisons (lime application, phosphogypsum application, time of application and locality effect; comparisons 5, 6, 8, 9, 12 and 13 of Table 4) only the effect of phosphogypsum (PG) showed statistical difference, with 2 t/ha of PG (treatments 18 or 19) leading to higher soybean K leaf contents, as related to no PG applied (treatments 6, 7, 16 and 17). This is already a sign that application of PG could have resulted in more roots in lower soil layers, leading to higher K uptake by the plants. It is interesting to note that this effect of PG was noticed in both set of treatments (6, 16, 18 and 7, 17, 19; Table 7).

The fact that other comparisons did not lead to differences is not important once this is only the first crop year. It will be interesting to find out what effects for the different treatments will occur with time, most especially those related to the comparison of treatments with continuous K versus suppression of K. Some of the questions we seek answers are:

(1) For how long (crops) will the suppression of K not influence crop yields?
(2) What will be the response curves to K previously applied, with suppression or not of K_2O application?
(3) What will be the effect of liming in K response (with and without suppression of K_2O application)?
(4) What will be the effect of phosphogypsum application in K response (with and without suppression of K_2O application)?
(5) For how long (crops) will the suppression of P not influence crop yields?
(6) Will there be an effect of timing of K application at regular practices?
(7) Will there be an effect of K placement at regular practices?

Conclusions for first crop year (2010 – 2011):

(1) Response to K was low for soybean and statistically inexistent for corn 2^{nd} crop.
(2) There was no effect of lime rate, time of application and locality effect for these first two crops.
(3) Phosphogypsum application lead to higher K leaf contents for soybean but there was no effect in yield at this time.
(4) Results are in agreement with initial expectations.
(5) It is possible that we will be able to anticipate suppression of K application (after second crop year cycle and not after third as previously planned).
(6) It will be interesting to find out the effect of liming and phosphogypsum application in the suppression or not of K.

Table 6. <u>Soybean yield</u> (2010-2011).

Treat	**Treat**	**Replicate**				**Average**	**Comparison**					
#	**#**	**1**	**2**	**3**	**4**		**5**	**6**	**8**	**9**	**12**	**13**
		Kg/ha										
1	1	3513	3542	3509	3444	**3502**						
2	2A	3581	3659	3696	3533	**3617**						
3	2B	3801	3664	3880	3697	**3760**						
4	3A	3779	3628	3686	3615	**3677**						
5	3B	3759	3741	3763	3684	**3737**						
6	4A	3647	3641	3615	3717	**3655**	A		A		A	A
7	4B	3870	3699	3732	3790	**3773**		A		A		
8	4C	3744	3690	3843	3704	**3745**						
9	4D	3837	3723	3810	3718	**3772**						
10	5A	3827	3657	3608	3611	**3676**						
11	5B	3639	3757	3636	3639	**3668**						
12	6A	3793	3644	3673	3637	**3687**	A					
13	6B	3693	3608	3728	3676	**3676**		A				
14	7A	3628	3674	3764	3737	**3701**	A					
15	7B	3836	3609	3625	3657	**3681**		A				
16	8A	3728	3751	3814	3604	**3724**			A			
17	8B	3791	3730	3646	3688	**3714**				A		
18	9A	3825	3737	3638	3700	**3725**			A			
19	9B	3705	3871	3724	3722	**3756**				A		
20	11A	3659	3671	3804	3783	**3729**						
21	11B	3624	3712	3656	3826	**3705**						
22	11C	3871	3719	3659	3808	**3764**						
23	12A	3710	3633	3747	3614	**3676**					A	
24	13A	3860	3569	3679	3650	**3689**						A
						CV	**1.9**	**1.4**	**2.3**	**2.0**	**1.9**	**2.6**
						msd	**152.5**	**116.6**	**180.3**	**161.0**	**160.3**	**214.8**

Same capital letters in the column indicate no statistical mean difference at $p<0.05$.

Comparisons 1 to 4, 7, 10 and 11 relates, with proper statistics, to Figures and not single average comparisons.
Comparison # 5 = treatments 12, 6 and 14 = lime application.
Comparison # 6 = treatments 13, 7 and 15 = lime application.
Comparison # 8 = treatments 16, 6 and 18 = phosphogypsum application.
Comparison # 9 = treatments 17, 7 and 19 = phosphogypsum application.
Comparison # 12 = treatments 6 and 23 = effect of time of application.
Comparison # 13 = treatments 6 and 24 = effect of K locality effect.
For details in such comparisons refer to Table 5.

Table 7. <u>Soybean leaf K content</u> (2010-2011).

Treat	**Treat**		**Replicate**					**Average**		**Comparison**					
#	**#**		**1**	**2**	**3**	**4**				**5**	**6**	**8**	**9**	**12**	**13**
			Kg/ha												
1	1		21.8	19.9	15.8	17.4		**18.7**							
2	2A		17.6	18.8	19.4	16.6		**18.1**							
3	2B		18.6	16.4	20.4	19.0		**18.6**							
4	3A		19.0	16.0	20.8	20.2		**19.0**							
5	3B		16.0	17.8	16.0	20.0		**17.5**							
6	4A		21.2	20.0	17.2	18.5		**19.2**		A		AB		A	A
7	4B		17.8	18.6	18.4	18.4		**18.3**			A		B		
8	4C		18.6	17.4	22.0	21.6		**19.9**							
9	4D		19.6	20.8	21.0	21.8		**20.8**							
10	5A		22.8	21.8	23.4	25.0		**23.3**							
11	5B		17.4	19.2	19.0	21.6		**19.3**							
12	6A		23.0	17.4	28.6	21.6		**22.7**		A					
13	6B		19.9	19.2	18.4	22.2		**19.9**			A				
14	7A		17.4	16.2	19.0	18.4		**17.8**		A					
15	7B		17.8	19.9	20.0	17.4		**18.8**			A				
16	8A		20.0	19.0	16.6	17.6		**18.3**				B			
17	8B		22.0	21.6	17.0	21.6		**20.6**					AB		
18	9A		22.4	19.6	23.6	23.2		**22.2**				A			
19	9B		21.2	21.0	24.2	23.8		**22.6**					A		
20	11A		19.8	23.4	24.0	25.8		**23.3**							
21	11B		23.2	24.2	19.4	18.0		**21.2**							
22	11C		17.6	23.0	22.6	17.8		**20.3**							
23	12A		17.2	20.5	28.8	19.6		**21.5**						A	
24	13A		22.4	20.6	21.6	19.8		**21.1**							A
								CV		**15.2**	**7.7**	**8.8**	**9.5**	**22.9**	**6.0**
								msd		**6.57**	**3.16**	**3.80**	**4.22**	**10.5**	**2.72**

Same capital letters in the column indicate no statistical mean difference at $p<0.05$.
Comparisons 1 to 4, 7, 10 and 11 relates, with proper statistics, to Figures and not single average comparisons.
Comparison # 5 = treatments 12, 6 and 14 = lime application.
Comparison # 6 = treatments 13, 7 and 15 = lime application.
Comparison # 8 = treatments 16, 6 and 18 = phosphogypsum application.
Comparison # 9 = treatments 17, 7 and 19 = phosphogypsum application.
Comparison # 12 = treatments 6 and 23 = effect of time of application.
Comparison # 13 = treatments 6 and 24 = effect of K locality effect.
For details in such comparisons refer to Table 5.

Table 8. <u>Corn yield</u> (2nd Crop 2011).

Treat	Treat		Replicate					Average		Comparison					
#	**#**		**1**	**2**	**3**	**4**				**5**	**6**	**8**	**9**	**12**	**13**
			Kg/ha												
1	1		3737	4415	3047	4067		**3816**							
2	2A		4447	4559	3818	4829		**4413**							
3	2B		4640	4975	4231	4801		**4661**							
4	3A		4616	4052	4384	3715		**4192**							
5	3B		4523	4486	4182	4525		**4429**							
6	4A		3867	4081	4371	3456		**3944**		A		A		A	A
7	4B		4953	3930	4941	3697		**4380**			A		A		
8	4C		4919	4669	4769	3767		**4531**							
9	4D		4198	3504	4186	3681		**3892**							
10	5A		5049	4267	3636	4140		**4273**							
11	5B		4360	4505	3977	4221		**4266**							
12	6A		4747	4000	3723	3581		**4013**		A					
13	6B		4220	4243	4042	3292		**3949**			A				
14	7A		4680	3978	4756	4577		**4498**		A					
15	7B		4863	4571	4608	3589		**4408**			A				
16	8A		5365	4512	4151	4587		**4654**				A			
17	8B		4214	3872	3686	3779		**3888**					A		
18	9A		3916	3589	3706	4581		**3948**				A			
19	9B		4876	5103	4174	4209		**4591**					A		
20	11A		4267	4961	4284	4008		**4380**							
21	11B		5093	3884	4555	3804		**4334**							
22	11C		4314	3849	4279	3650		**4023**							
23	12A		4742	3953	3700	4238		**4158**						A	
24	13A		5163	4393	4608	4465		**4657**							A
								CV		10.1	6.8	12.4	10.5	13.0	8.6
								msd		909.8	624.0	1126.3	972.2	1183.4	829.2

Same capital letters in the column indicate no statistical mean difference at $p<0.05$.
Comparisons 1 to 4, 7, 10 and 11 relates, with proper statistics, to Figures and not single average comparisons.
Comparison # 5 = treatments 12, 6 and 14 = lime application.
Comparison # 6 = treatments 13, 7 and 15 = lime application.
Comparison # 8 = treatments 16, 6 and 18 = phosphogypsum application.
Comparison # 9 = treatments 17, 7 and 19 = phosphogypsum application.
Comparison # 12 = treatments 6 and 23 = effect of time of application.
Comparison # 13 = treatments 6 and 24 = effect of K locality effect.
For details in such comparisons refer to Table 5.

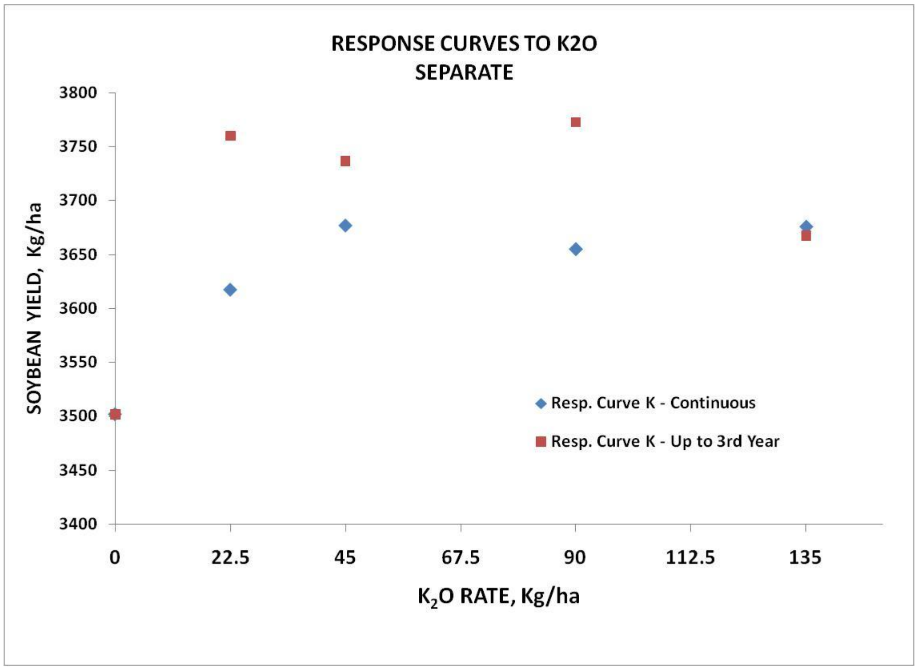

Figure 1. Soybean yield response curve to K_2O rates (separate curves for comparisons 1 and 2 at Table 5).

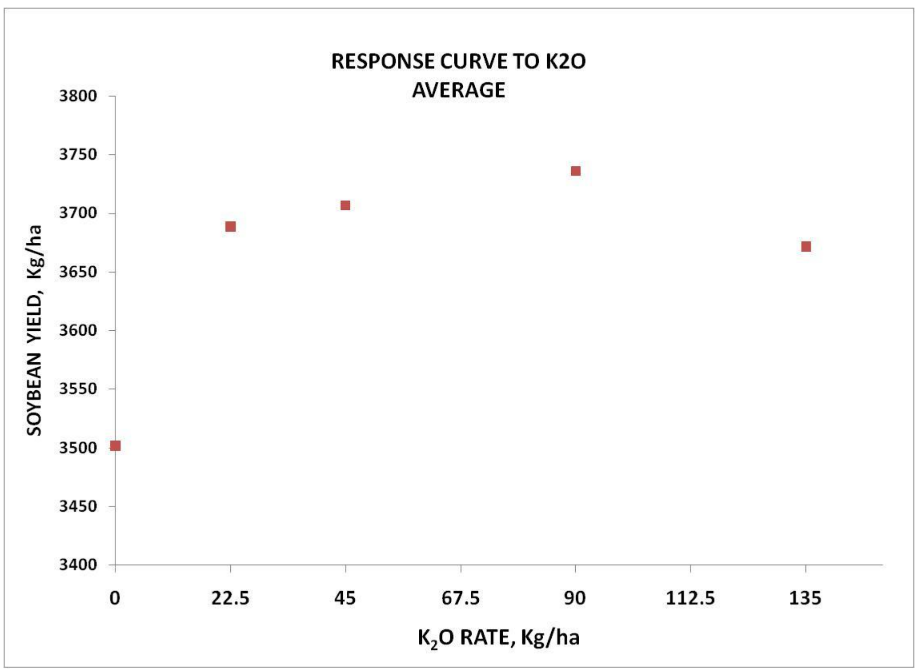

Figure 2. Soybean yield response curve to K_2O rates (average for comparisons 1 and 2 at Table 5).

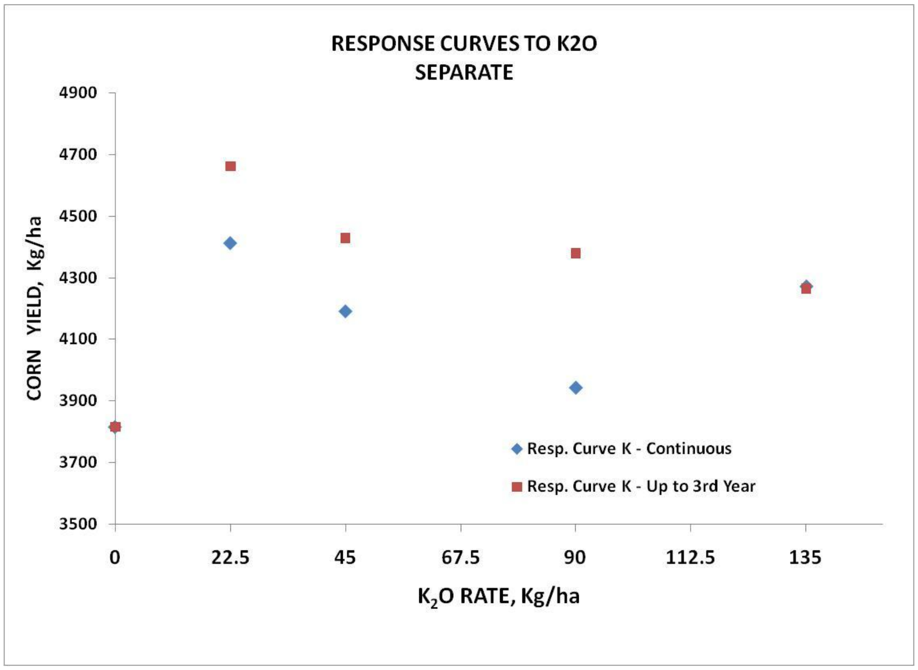

Figure 3. Corn 2nd Crop yield response curve to K_2O rates (separate curves for comparisons 1 and 2 at Table 5).

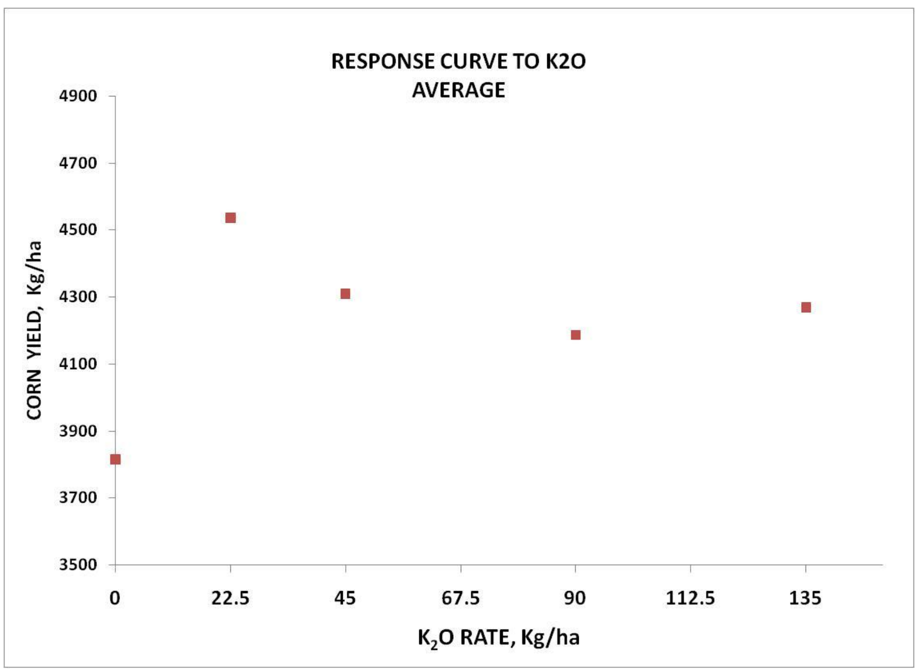

Figure 4. Corn 2nd Crop yield response curve to K_2O rates (average for comparisons 1 and 2 at Table 5).

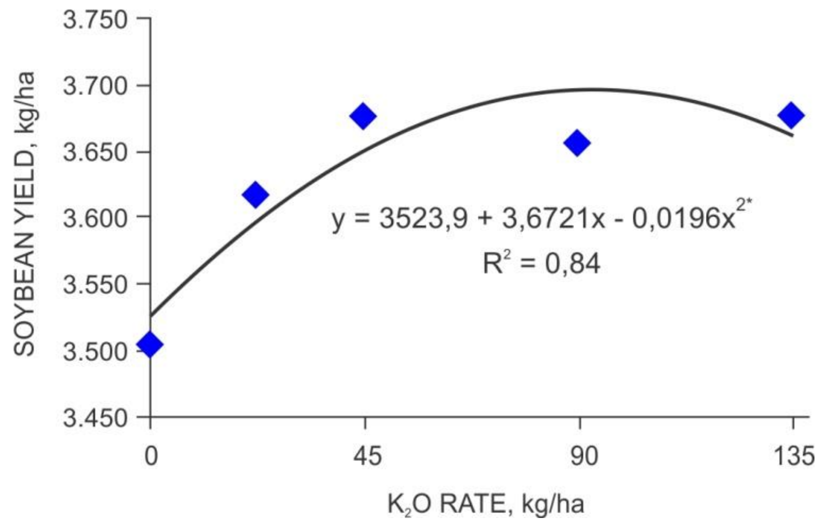

Figure 5. Soybean yield response curve to K_2O rates with quadratic model adjusted.

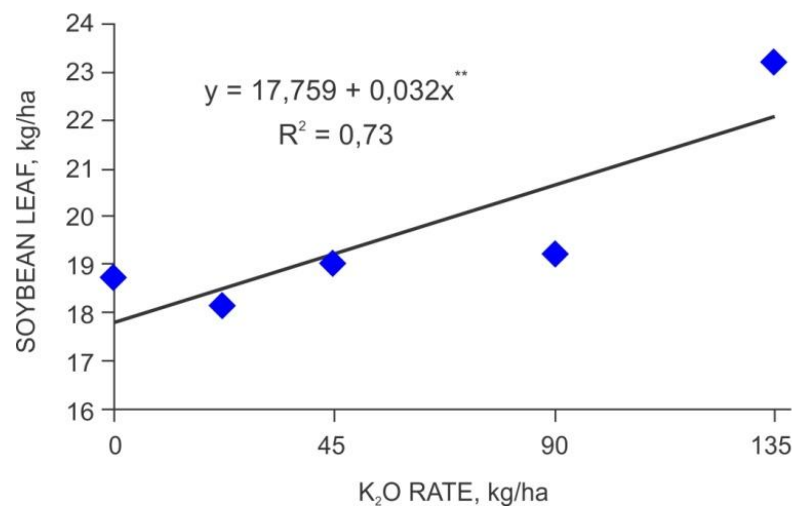

Figure 6. Soybean leaf K content response curve to K_2O rates with linear model adjusted.