RESEARCH PROJECT – URALKALI and IPNI BRAZIL

RATES AND RESIDUAL EFFECT OF POTASSIUM FERTILIZATION IN A BRAZILIAN OXISOIL

RESULTS FOR SOYBEAN AND MAIZE SECOND CROP 2014-2015

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This Report

This report refers to the agronomic results for the soybean and maize 2nd crop of 2014-2015 (fifth year of the project). The research project is funded by Uralkali, coordinated in Brazil by IPNI, and has the field partner as Research Foundation MT.

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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 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 took 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 to run for six years. During the 2014-2015 season, maize was grown as a second crop after the soybean. The independent (input) variables studied apply for both crops: soybean (1st crop) and maize (2nd crop). The soil is an Oxisol with, originally, the chemical and granulometric properties described in Table 1 (medium in K bioavailability).

Table 1. Chemical and physical soil properties prior to the trial establishment in 2010 (0 - 20 cm).

Soil		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 NPK rates, time of application, locality effect, liming and phosphogypsum application will be identified as N3, P3, K3, TA1, LE1, BS L2 and PG L2, respectively. 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. In the 2013-2014 season, suppression of K was initiated according to treatments.
2. *Rate of N*: not applicable to soybean (inoculation).
3. *Rate of P_2O_5*: P3 was defined as 45 kg/ha P_2O_5. In the 2013-2014 season, suppression of P was initiated according to treatments.
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 in 2010. All other treatments received no lime at any time. In 2013, after maize harvest and the 2012-2013 season was finished, 2 t/ha of dolomitic lime were applied to every treatment with exception of treatment 12 and 13.
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 in 2010. All other treatments received no phosphogypsum at any time. In 2013, after maize harvest and the 2012-2013 season was finished, 2 t/ha of dolomitic lime were applied to every treatment with exception of treatment 16 and 17.
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 variety used in 2014-2015 was TMG1168 RR and maize hybrid was RB 9110 PRO.

C. Plots, replicates and statistics

The plot size (6.3 m x 9.5 m; 59.85 m^2) was planned to allow future subdivisions in case of need. This will allow new variables to be studied in case of interest. The numbers of replicates are four per treatment. The statistics will follow proper procedures to allow the conclusions necessary for the study. For this season (2014-2015), statistics are for the main output variables studied, i.e., **grain yield, K leaf content, soil K availability, weight of seeds, and plant height**.

D. Evaluations (Output variables)

(1) Soil K status with time. (2) Plant K status with time. (3) Weight of 1000 seeds, (4) Grain yield, (5) Plant height.

For soil test, samples were collected in number of 12 subsamples per plot (8 between plant lines and 4 on the plant line) from the first 8 inches of depth.

For grain yield, all soybean plants or maize ears were harvested out of a 3.6 m^2 area in two points of each plot.

For plant nutrient status, twenty random leaves of soybean or maize were collected at each plot.

For plant height, ten plants of soybean or maize of each plot were measured before harvest.

For seeds weight, five subsamples with 100 seeds each were weighed per plot after harvest.

Table 2. Experiment Outline.

Treat #	Treat #	Year						Year						Year						Time App (TA)	Locality Effect (LE)	Liming BS Level	L
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6				
		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	TA1	LE1	BSL2	P
2	2A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K1	K1	K1	K1	K1	K1	TA1	LE1	BSL2	P
3	2B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K1	K1	K1	0	0	0	TA1	LE1	BSL2	P
4	3A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K2	K2	K2	K2	K2	K2	TA1	LE1	BSL2	P
5	3B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K2	K2	K2	0	0	0	TA1	LE1	BSL2	P
6	4A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA1	LE1	BSL2	P
7	4B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA1	LE1	BSL2	P
8	4C	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K1	K1	K1	TA1	LE1	BSL2	P
9	4D	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K2	K2	K2	TA1	LE1	BSL2	P
10	5A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K4	K4	K4	K4	K4	K4	TA1	LE1	BSL2	P
11	5B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K4	K4	K4	0	0	0	TA1	LE1	BSL2	P
12	6A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA1	LE1	BSL1	P
13	6B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA1	LE1	BSL1	P
14	7A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA1	LE1	BSL3	P
15	7B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA1	LE1	BSL3	P
16	8A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA1	LE1	BSL2	P
17	8B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA1	LE1	BSL2	P
18	9A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA1	LE1	BSL2	P
19	9B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	0	0	0	TA1	LE1	BSL2	P
20	11A	N3	N3	N3	N3	N3	N3	P3	P3	P3	0	0	0	K3	K3	K3	K3	K3	K3	TA1	LE1	BSL2	P
21	11B	N3	N3	N3	N3	N3	N3	P3	P3	P3	P1	P1	P1	K3	K3	K3	K3	K3	K3	TA1	LE1	BSL2	P
22	11C	N3	N3	N3	N3	N3	N3	P3	P3	P3	P2	P2	P2	K3	K3	K3	K3	K3	K3	TA1	LE1	BSL2	P
23	12A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA2	LE1	BSL2	P
24	13A	N3	N3	N3	N3	N3	N3	P3	P3	P3	P3	P3	P3	K3	K3	K3	K3	K3	K3	TA1	LE2	BSL2	P

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	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	T1, T3, T5, T7 and T11 (B).
3	A vs B = Effect of suspension of K application after 3rd year	
4	Effect of different rates of K in residual effect as related to	T6, T7, T8 and T9
5	Effect of liming on K fertilization with continuous application	T12, T6 and T14
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 application 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	T20, T21, T22 and
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 14 show, data obtained for 2014-2015 soybean yield, soybean seeds weight, soybean plant height, soybean K leaf content, maize 2nd crop yield, maize 2nd crop seeds weight, maize 2nd crop plant height, maize 2nd crop K leaf content, and soil K availability, respectively. Tables 6 to 14 also provide mean comparisons, $p<0.10$, where applicable (comparisons 4, 5, 6, 8, 9, 11, 12, and 13 of Table 5).

From all other possible comparisons (lime application, phosphogypsum application, time and locality of K application, residual K rates, and residual P rates effect; comparisons 4, 5, 6, 8, 9, 11, 12, and 13 of Table 5), these were identified with statistical difference:

(i) effect of phosphogypsum application (comparison 8) on soybean plant height and soybean K leaf content leading to higher seed weight and K leaf content: PG L3 ≥ PG L2 ≥ PG L1 and PG L3 > PG L2 = PG L1, respectively (Tables 8 and 9).

(ii) effect of residual K rates (comparison 4) on maize K leaf content and soil K availability leading to higher K leaf content and higher K availability with higher K rates, respectively (Tables 13 and 14).

(iii) effect of time of K application (comparison 12) on soybean seed weight, soybean plant height, soybean K leaf content, maize leaf content, and soil K availability where all rate of K_2O applied at seeding time lead to higher soybean seed weight and plant height, as related to 1/3 of K application at 15 days after emergence (treatment 23), while the opposite was true for soybean and maize K leaf content and for soil K availability (Tables 7, 8, 9, 13, and 14).

(iv) effect of liming application (comparison 5) on soybean K leaf content, maize 2nd crop yield, and maize 2nd crop plant height leading to higher yield and plant height, but lower K leaf content: BS L3 > BS L2 = BS L1 and BS L1 > BS L3 = BS L2, respectively (Tables 9, 10, and 12).

(v) effect of liming application with residual K rates (comparison 6) on soybean yield, maize 2nd crop plant height and soil K availability leading to lower yield (BS L3 < BS L2 = BS L1, Table 6) and higher K plant height and K availability (BS L3 ≥ BS L2 = BS L1, Tables 12 and 14).

(vi) effect of phosphogypsum application with residual K rates (comparison 9) on soybean plant height leading to higher K plant height as related to no application: PG L3 = PG L2 > PG L1 (Table 8).

Figures 1 and 2 show the soybean yield response curves to K_2O rates with continuous and discontinuous application, respectively (comparisons 1 and 2, according to Table 5). Response is observed to K application for soybean yield, for example, from 2643 kg/ha when no K_2O was applied to approx. 3071 kg/ha when 90 kg/ha of K_2O was continuous used or to approx. 3028 kg/ha when K_2O application was suppressed. In terms of data analysis, an exponential model was adjusted to the data due to the statistical significant rate effect for K_2O application for soybean yield.

Figure 3 shows, respectively, the soybean plant height, seed weight, and K leaf content response curves to K_2O rates with continuous or discontinuous application (comparisons 1 and 2). Models were adjusted to the data (exponential, for soybean seed weight) for the statistical significant rate effect for K_2O application.

Figures 4 and 5 show maize 2nd crop yield response curves to K_2O rates with continuous or discontinuous application, respectively (comparisons 1 and 2, according to Table 5). Response is also observed to K application for maize 2nd crop yield, for example, from 5135 kg/ha when no K_2O was applied to approx. 7280 kg/ha when 90 kg/ha of K_2O was continuously applied to soybean every year or to approx. 7007 kg/ha when K_2O application was suppressed. In terms of data analysis, models were adjusted to the data due to the statistical significant rate effect for K_2O application.

Figure 6 shows, respectively, the maize 2nd crop plant height, seed weight, and K leaf content response curves to K_2O rates with continuous or discontinuous application (comparisons 1 and 2). Models were adjusted to the data for the statistical significant rate effect for K_2O application: exponential, for plant height and seed weight, and linear, for K leaf content.

Figures 7 and 8 show the soil K availability response curves to K_2O rates with continuous or discontinuous application, respectively (comparisons 1 and 2, according to Table 5). In terms of data analysis, a linear model was adjusted to the data due to the significant rate effect for K_2O application for soil K availability. Figures 9 and 10 show the soybean and maize 2nd crop yield response curve to residual P_2O_5 rates (comparison 11, Table 5) where no significance was observed.

Figures 11 and 12 present, respectively, the average (five years) soybean and maize 2nd crop yield response curves to K_2O rates with continuous K application. No significant effect was observed. Figure 13 shows the yield gap between the recommended K rate (90 kg K_2O/ha) and control for soybean and maize 2nd crop along the five years of the project. This was the second season with K suppression and, for this clay soil, K residual supply was able to sustain soybean grain yield, but maize 2nd crop yield has shown significant decrease due to lack of K availability in soil.

Figures 14 and 15 show, respectively, soybean and maize 2nd crop yield as affected by the level of bases saturation in the soil and K_2O application, for the 2014/2015 crop season. Important observation may be drawn from Figure 15: K application increased maize 2nd crop yield in soil presenting higher levels of bases saturation.

Figures 16 and 17 present, respectively, soybean and maize 2nd crop yield as affected by the level of phosphogypsum and K_2O application, for the 2014/2015 crop season. No significant effect was observed for soybean yield in all comparisons and for maize 2nd crop yield with no K application. However, maize 2nd crop yield with 90 kg K_2O/ha was higher under PG L3 than PG L1.

Table 15 presents a summary of statistical analysis for all comparisons since the beginning of the project.

Considerations up to date

It has been interesting to observe the effects for the different treatments with time, most especially those related to the comparison of treatments with continuous versus discontinuous K application. Some of the questions we can answer or still need answers are:

(1) For how long will the suppression of K rates not influence crop yields?
Soybean yield has not shown any significant decrease yet, but maize 2nd crop yield has shown significant decrease after two years of K suppression.

(2) What will be the response curves to K previously applied, with suppression or not of K_2O application?
Soybean and maize 2nd crop yield have already shown great response curves to K application, while maize 2nd crop yield also shows great response curve with K suppression.

(3) What will be the effect of liming in K response (with and without suppression of K_2O application)?
Still need another crop season for better evaluation.

(4) What will be the effect of phosphogypsum application in K response (with and without suppression of K_2O application)?
Use of phosphogypsum in the soil improves maize 2nd crop yield with K application.

(5) For how long will the suppression of P rates not influence crop yields?
Still need another crop season for better evaluation.

(6) Will there be a consistent effect of timing of K application at regular practices?
Results indicate that the best time to apply K is at soybean seeding time.

(7) Will there be a continuous effect of K placement at regular practices?
No significant effect related to grain yield has been observed in the project.

The project is to be discontinued next season (2015/2016), as previously planned. Important data have been collected so far and results have shown intensified effects over the time. A final and complete report will be presented next year with a broad perspective and final conclusions of the findings.

Table 6. Soybean yield (2014-2015).

Treat #	Treat #	Replicate 1	2	3	4	Average	Comparison 4	5	6	8	9	11	12	13
		kg/ha				kg/ha								
1	1	2347	2555	2773	2899	**2643**								
2	2A	3149	2802	3066	3774	**3198**								
3	2B	3000	3056	3020	2884	**2990**								
4	3A	2979	3144	3137	3148	**3102**								
5	3B	3020	2510	2765	3321	**2904**								
6	4A	2887	2803	3295	3298	**3071**	A	A		A		A	A	A
7	4B	3002	2896	3090	3124	**3028**	A		A		A			
8	4C	2995	2712	3249	3178	**3033**	A							
9	4D	2750	2743	3102	3384	**2995**	A							
10	5A	3135	3122	3006	3301	**3141**								
11	5B	2880	2736	3124	3187	**2982**								
12	6A	2918	3214	3224	3121	**3119**		A						
13	6B	2800	3198	3080	3144	**3055**			A					
14	7A	2542	2634	3198	3264	**2910**		A						
15	7B	2651	2796	2719	3019	**2796**			B					
16	8A	2759	2995	3039	3174	**2992**				A				
17	8B	3039	3127	3224	2975	**3091**					A			
18	9A	2725	3160	3144	3121	**3038**				A				
19	9B	2767	2957	2988	3245	**2989**					A			
20	11A	2939	3024	3122	3510	**3149**						A		
21	11B	3034	2839	3085	3364	**3080**						A		
22	11C	2733	2935	3156	2931	**2939**						A		
23	12A	3165	2788	3220	3216	**3097**							A	
24	13A	3249	3125	3219	3148	**3185**								A
						CV, %	3.9	5.9	4.0	4.6	4.6	4.4	3.9	6.0
						msd	220	318	212	247	247	251	201	312

Same capital letters in the column indicate no statistical mean difference at p<0.1.
Comparisons 1 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. Weight of Soybean seeds (2014-2015).

Treat #	Treat #	Replicate 1	2	3	4	Average	Comparison 4	5	6	8	9	11	12	13
		g/1000				g/1000								
1	1	120.2	119.4	126.8	125.8	**123.1**								
2	2A	125.0	126.0	124.6	121.5	**124.3**								
3	2B	127.1	130.0	129.3	121.4	**126.9**								
4	3A	130.4	130.0	133.5	127.8	**130.4**								
5	3B	130.2	120.1	124.6	127.1	**125.5**								
6	4A	128.2	127.0	128.7	131.2	**128.8**	A	A		A		A	A	A
7	4B	129.3	127.4	131.7	130.8	**129.8**	A		A		A			
8	4C	123.9	124.1	132.0	127.5	**126.9**	A							
9	4D	126.8	121.8	127.6	130.9	**126.7**	A							
10	5A	128.2	127.0	129.2	129.7	**128.5**								
11	5B	121.2	125.1	131.6	130.3	**127.1**								
12	6A	128.8	132.4	129.9	127.7	**129.7**		A						
13	6B	133.3	127.2	133.1	133.3	**131.7**			A					
14	7A	122.1	129.3	131.4	130.6	**128.3**		A						
15	7B	123.6	132.2	122.2	131.2	**127.3**			A					
16	8A	122.3	129.1	127.2	124.8	**125.9**				A				
17	8B	129.5	129.2	122.0	127.3	**127.0**					A			
18	9A	123.7	130.1	125.8	132.4	**128.0**				A				
19	9B	120.7	133.5	126.9	127.2	**127.1**					A			
20	11A	121.9	119.4	127.4	126.1	**123.7**						A		
21	11B	120.7	129.9	125.1	128.2	**126.0**						A		
22	11C	124.8	126.9	130.0	126.0	**126.9**						A		
23	12A	123.3	125.6	126.9	128.2	**126.0**							B	
24	13A	131.9	123.3	128.3	127.3	**127.7**								A
						CV, %	1.5	2.2	3.1	2.1	3.3	2.2	0.9	2.0
						msd	3.7	5.1	7.2	4.8	7.5	5.3	1.8	4.2

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Comparison # 6 = treatments 13, 7 and 15 = lime application.
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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. Soybean plant height (2014-2015).

Treat #	Treat #	Replicate 1	2	3	4	Average	Comparison 4	5	6	8	9	11	12	13
		cm				cm								
1	1	77.6	82.2	76.0	83.4	**79.8**								
2	2A	78.6	80.3	82.0	77.9	**79.7**								
3	2B	86.3	83.8	89.7	75.3	**83.8**								
4	3A	78.3	80.8	88.0	82.6	**82.4**								
5	3B	85.4	80.6	85.6	88.1	**84.9**								
6	4A	78.2	76.6	82.4	90.7	**82.0**	A	A		AB		A	A	A
7	4B	84.6	84.2	81.7	88.3	**84.7**	A		A		A			
8	4C	79.1	83.1	85.9	76.3	**81.1**	A							
9	4D	77.0	79.5	88.4	83.5	**82.1**	A							
10	5A	84.1	79.0	76.9	72.8	**78.2**								
11	5B	77.4	74.8	80.5	83.4	**79.0**								
12	6A	83.6	85.3	86.8	89.2	**86.2**		A						
13	6B	81.1	89.4	81.0	81.2	**83.2**			A					
14	7A	76.7	82.1	82.0	99.0	**85.0**		A						
15	7B	77.6	71.1	92.0	83.4	**81.0**			A					
16	8A	74.6	78.3	80.0	82.6	**78.9**				B				
17	8B	79.3	80.4	80.7	82.4	**80.7**					B			
18	9A	75.4	85.1	87.9	89.9	**84.6**				A				
19	9B	84.1	82.8	85.3	88.6	**85.2**					A			
20	11A	68.4	72.2	78.2	82.6	**75.4**						A		
21	11B	65.3	72.6	76.7	85.1	**74.9**						A		
22	11C	77.9	75.9	77.8	74.2	**76.5**						A		
23	12A	75.2	71.3	80.6	79.1	**76.6**							B	
24	13A	88.6	81.8	81.1	88.9	**85.1**								A
						CV, %		5.6	4.8	8.2	3.7	7.3	3.9	4.9
						msd		8.7	7.2	12.1	2.5	10.4	5.1	6.8

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Comparison # 6 = treatments 13, 7 and 15 = lime application.
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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 9. Soybean leaf K content (2014-2015).

Treat #	Treat #	Replicate 1	2	3	4	Average	Comparison 4	5	6	8	9	11	12	13
		g/kg				g/kg								
1	1	17.6	15.5	16.1	18.4	**16.9**								
2	2A	18.6	16.5	19.6	16.2	**17.7**								
3	2B	17.6	17.7	19.3	18.6	**18.3**								
4	3A	18.2	20.3	18.8	19.0	**19.1**								
5	3B	16.8	17.5	18.8	18.7	**18.0**								
6	4A	16.7	18.0	18.7	17.5	**17.7**	A	B		B		AB	B	A
7	4B	19.2	18.2	16.9	18.7	**18.3**	A		A		A			
8	4C	19.2	16.8	18.5	16.8	**17.8**	A							
9	4D	19.3	17.4	16.5	19.0	**18.1**	A							
10	5A	18.3	17.7	19.2	20.0	**18.8**								
11	5B	19.3	17.9	19.0	19.2	**18.9**								
12	6A	18.4	19.6	18.6	20.3	**19.2**		A						
13	6B	18.3	18.2	18.5	19.9	**18.7**			A					
14	7A	17.0	17.8	19.5	18.3	**18.2**		AB						
15	7B	18.0	18.2	19.6	18.7	**18.6**			A					
16	8A	18.6	17.4	18.1	18.4	**18.1**				B				
17	8B	18.3	18.1	19.7	18.6	**18.7**					A			
18	9A	19.4	19.7	19.2	20.7	**19.8**				A				
19	9B	18.5	17.4	17.4	19.3	**18.2**					A			
20	11A	16.5	17.8	17.6	18.8	**17.7**						AB		
21	11B	18.1	18.7	19.3	19.2	**18.8**						A		
22	11C	16.8	17.6	18.0	16.2	**17.2**						B		
23	12A	18.5	18.3	20.1	17.8	**18.7**							A	
24	13A	21.4	19.9	17.6	18.4	**19.3**								A
						CV, %	6.5	4.1	4.9	4.1	4.9	3.5	3.0	9.2
						msd	2.19	1.35	1.61	1.36	1.62	1.18	0.90	2.8

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Comparison # 6 = treatments 13, 7 and 15 = lime application.
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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 10. Maize 2nd crop yield (2014-2015).

Treat #	Treat #	Replicate 1	2	3	4	Average	Comparison 4	5	6	8	9	11	12	13
		kg/ha				kg/ha								
1	1	5411	5023	5135	5785	**5339**								
2	2A	7335	6521	7616	6317	**6947**								
3	2B	7462	7374	6420	6845	**7025**								
4	3A	6787	6752	7839	7215	**7148**								
5	3B	6416	5758	7833	7126	**6783**								
6	4A	7623	6916	7934	6646	**7280**	A	B		A		A	A	A
7	4B	6643	6315	7161	7908	**7007**	A		A		A			
8	4C	7023	7446	7920	6589	**7244**	A							
9	4D	7237	6959	7253	6756	**7051**	A							
10	5A	7360	6961	7272	6973	**7142**								
11	5B	6364	6931	6817	6448	**6640**								
12	6A	7869	6909	7555	7360	**7424**		B						
13	6B	6216	6711	6969	6003	**6475**			A					
14	7A	8323	7250	8029	8159	**7940**		A						
15	7B	7994	7171	6747	7405	**7329**			A					
16	8A	7105	6603	6752	7153	**6903**				A				
17	8B	7228	7594	7041	7942	**7451**					A			
18	9A	7625	7922	7347	7205	**7525**				A				
19	9B	7361	7096	7621	7610	**7422**					A			
20	11A	6920	6830	7083	6988	**6955**						A		
21	11B	7708	7067	7486	6687	**7237**						A		
22	11C	8077	7736	6685	6856	**7338**						A		
23	12A	7168	7603	7185	7975	**7483**							A	
24	13A	7642	7239	7194	7399	**7368**								A
						CV, %	7.0	3.0	8.6	6.3	5.3	6.2	9.3	6.1
						msd	950	407	1064	807	682	841	1145	741

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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 11. Weight of Maize 2nd crop seeds (2014-2015).

Treat #	Treat #	Replicate 1	2	3	4	Average	Comparison 4	5	6	8	9	11	12	13
		g/1000				g/1000								
1	1	213.3	184.4	194.8	223.1	**203.9**								
2	2A	250.5	253.2	272.6	223.8	**250.0**								
3	2B	254.6	262.0	251.0	237.2	**251.2**								
4	3A	236.5	254.4	284.5	265.5	**260.2**								
5	3B	267.9	224.0	262.5	248.2	**250.7**								
6	4A	282.2	250.8	246.5	258.2	**259.4**	A	A		A		A	A	A
7	4B	226.3	227.2	256.7	255.9	**241.5**	A		A		A			
8	4C	253.6	240.6	277.1	275.4	**261.7**	A							
9	4D	257.4	258.8	261.9	253.2	**257.9**	A							
10	5A	289.8	249.5	254.5	260.5	**263.6**								
11	5B	261.7	247.4	245.7	244.9	**249.9**								
12	6A	266.5	256.6	255.9	253.9	**258.2**		A						
13	6B	229.9	235.1	229.1	239.0	**233.3**			A					
14	7A	268.8	258.0	270.0	278.4	**268.8**		A						
15	7B	290.3	246.2	229.6	218.8	**246.2**			A					
16	8A	280.9	256.8	242.0	278.7	**264.6**				A				
17	8B	257.7	268.0	230.2	224.9	**245.2**					A			
18	9A	261.9	266.4	257.4	261.8	**261.9**				A				
19	9B	246.8	238.1	246.1	260.9	**248.0**					A			
20	11A	256.6	267.3	255.9	270.2	**262.5**						A		
21	11B	264.9	259.2	271.8	251.8	**261.9**						A		
22	11C	266.6	261.8	248.2	262.8	**259.8**						A		
23	12A	266.1	277.5	274.4	273.7	**272.9**							A	
24	13A	266.7	258.8	289.5	258.2	**268.3**								A
						CV, %	4.2	3.6	10.2	4.1	8.2	4.1	5.4	6.6
						msd	20.1	16.7	43.6	19.1	35.8	20.2	24.1	29.1

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Comparison # 6 = treatments 13, 7 and 15 = lime application.
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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 12. Maize 2nd crop plant height (2014-2015).

Treat #	Treat #	Replicate 1	2	3	4	Average	Comparison 4	5	6	8	9	11	12	13
		cm				cm								
1	1	231.1	225.1	222.1	210.7	**222.3**								
2	2A	236.1	223.5	226.8	224.7	**227.8**								
3	2B	219.3	225.7	241.0	221.7	**226.9**								
4	3A	230.0	235.2	238.0	233.5	**234.2**								
5	3B	234.0	233.0	237.7	231.3	**234.0**								
6	4A	232.9	233.5	245.6	236.6	**237.2**	A	B		A		A	A	A
7	4B	232.2	231.7	231.2	240.2	**233.8**	A		AB		A			
8	4C	231.3	238.8	246.9	233.6	**237.7**	A							
9	4D	239.2	231.8	241.9	239.2	**238.0**	A							
10	5A	246.1	238.7	238.3	235.0	**239.5**								
11	5B	236.0	227.8	236.1	234.4	**233.6**								
12	6A	234.7	234.1	244.8	236.2	**237.5**		B						
13	6B	230.3	227.1	227.5	236.7	**230.4**			B					
14	7A	246.5	253.7	257.5	245.6	**250.8**		A						
15	7B	250.9	236.0	243.8	237.9	**242.2**			A					
16	8A	234.0	236.1	238.7	235.9	**236.2**				A				
17	8B	242.4	242.5	221.3	246.3	**238.1**					A			
18	9A	242.3	238.2	219.9	240.6	**235.3**				A				
19	9B	248.7	235.3	247.5	234.3	**241.5**					A			
20	11A	234.1	226.1	234.0	231.9	**231.5**						A		
21	11B	238.0	237.5	236.2	227.0	**234.7**						A		
22	11C	247.5	229.7	229.9	234.3	**235.4**						A		
23	12A	232.0	231.6	236.9	241.0	**235.4**							A	
24	13A	233.4	238.3	239.2	233.6	**236.1**								A
						CV, %	2.0	1.1	2.2	1.9	3.7	2.9	1.6	1.4
						msd	9.0	4.8	9.2	7.9	15.7	12.7	6.3	5.6

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Comparison # 6 = treatments 13, 7 and 15 = lime application.
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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 13. Maize 2nd crop leaf K content (2014-2015).

Treat #	Treat #	Replicate 1	2	3	4	Average	Comparison 4	5	6	8	9	11	12	13
		g/kg				g/kg								
1	1	13.5	15.7	16.3	17.2	**15.7**								
2	2A	18.3	16.0	16.5	13.5	**16.1**								
3	2B	17.1	15.5	19.9	13.1	**16.4**								
4	3A	16.7	22.4	20.3	19.4	**19.7**								
5	3B	15.4	16.4	16.0	19.3	**16.8**								
6	4A	22.0	22.6	22.2	21.8	**22.2**	A	A		A		AB	B	B
7	4B	17.1	17.3	20.3	19.2	**18.5**	B		A		A			
8	4C	19.6	17.7	21.0	19.1	**19.4**	B							
9	4D	21.4	17.4	22.4	19.7	**20.2**	AB							
10	5A	24.4	25.6	24.0	26.7	**25.2**								
11	5B	20.2	20.5	22.4	23.6	**21.7**								
12	6A	22.8	23.2	26.8	30.9	**25.9**		A						
13	6B	23.4	18.5	20.8	21.1	**21.0**			A					
14	7A	22.5	22.8	25.1	27.6	**24.5**		A						
15	7B	24.3	19.5	17.8	19.9	**20.4**			A					
16	8A	21.7	22.2	23.3	25.0	**23.1**				A				
17	8B	18.5	21.3	17.5	21.9	**19.8**					A			
18	9A	22.8	23.4	22.6	20.9	**22.4**				A				
19	9B	17.1	18.3	22.0	19.2	**19.2**					A			
20	11A	23.6	21.7	24.0	22.4	**22.9**						A		
21	11B	21.7	20.7	21.8	21.5	**21.4**						B		
22	11C	22.3	23.5	23.5	23.0	**23.1**						A		
23	12A	24.6	25.6	24.8	27.4	**25.6**							A	
24	13A	24.0	29.8	24.3	29.3	**26.9**								A
						CV, %	5.9	6.2	8.5	5.6	9.9	3.0	4.3	8.8
						msd	2.21	2.64	2.97	2.25	3.38	1.26	1.70	3.6

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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 14. Soil K level (2014-2015).

Treat #	Treat #	Replicate 1	2	3	4	Average	Comparison 4	5	6	8	9	11	12	13
		g/kg				mg/kg								
1	1	33.3	32.8	31.4	34.8	**33.1**								
2	2A	38.1	41.5	36.9	38.7	**38.8**								
3	2B	35.0	42.8	31.1	31.0	**38.3**								
4	3A	54.6	34.9	44.8	45.1	**44.9**								
5	3B	39.0	30.5	39.0	39.2	**39.0**								
6	4A	40.7	57.6	55.1	49.1	**50.6**	A	A		A		A	B	B
7	4B	31.9	32.4	33.3	32.0	**32.4**	C		B		A			
8	4C	34.3	32.8	35.1	41.2	**35.9**	BC							
9	4D	33.1	47.9	43.0	40.8	**41.2**	B							
10	5A	70.9	78.6	54.1	52.5	**64.0**								
11	5B	43.7	44.3	39.7	41.4	**42.3**								
12	6A	56.8	44.5	52.3	51.8	**51.4**		A						
13	6B	35.2	39.0	27.7	44.2	**36.5**			A					
14	7A	52.6	44.7	40.8	47.9	**46.5**		A						
15	7B	47.3	31.0	37.6	33.2	**37.3**			AB					
16	8A	55.2	49.9	47.1	47.4	**49.9**				A				
17	8B	33.3	43.2	35.6	34.5	**36.7**					A			
18	9A	50.7	58.6	54.3	52.2	**54.0**				A				
19	9B	32.0	33.2	36.6	43.8	**36.4**					A			
20	11A	75.1	62.5	44.3	63.4	**61.3**						A		
21	11B	55.9	46.6	56.7	61.9	**55.3**						A		
22	11C	57.3	48.8	43.8	47.2	**49.3**						A		
23	12A	72.7	77.5	64.1	63.3	**69.4**							A	
24	13A	60.1	72.6	79.9	67.1	**69.9**								A
						CV, %	10.2	14.8	9.7	22.3	12.2	17.0	11.6	4.3
						msd	7.6	13.0	6.1	19.3	7.6	17.3	11.6	4.5

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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.

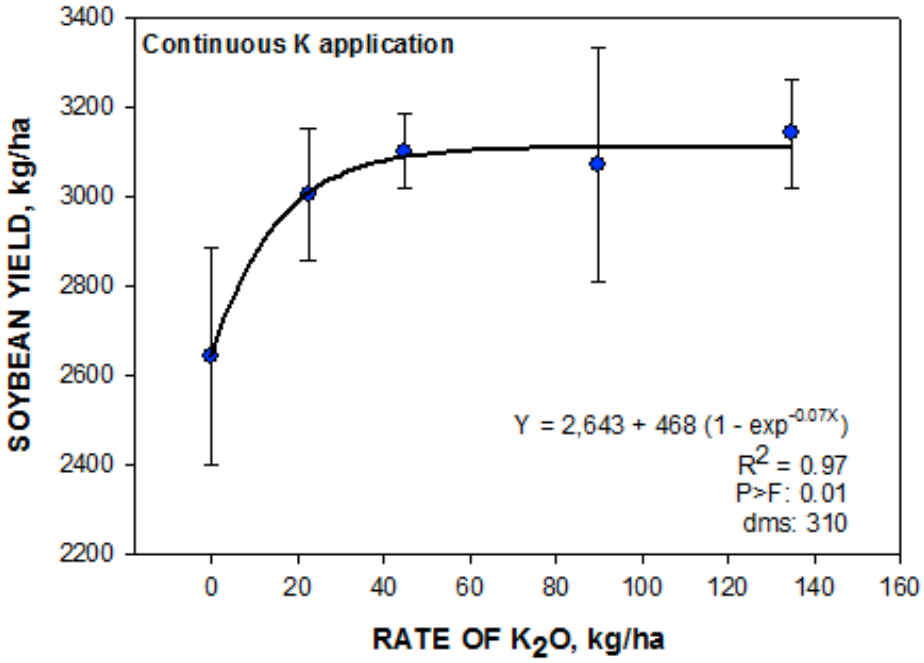


Figure 1. Soybean yield response curve to K_2O rates with continuous K application (comparison 1, Table 5). Crop season 2014-2015. Vertical bars represent standard deviation.

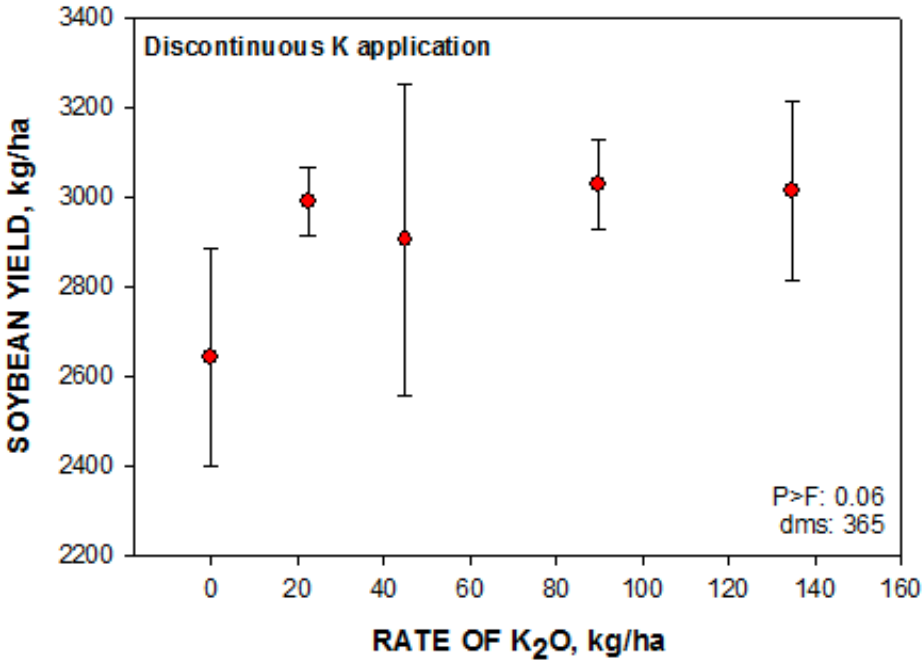


Figure 2. Soybean yield response curve to K_2O rates with discontinuous K application (comparison 2, Table 5). Crop season 2014-2015. Vertical bars represent standard deviation.

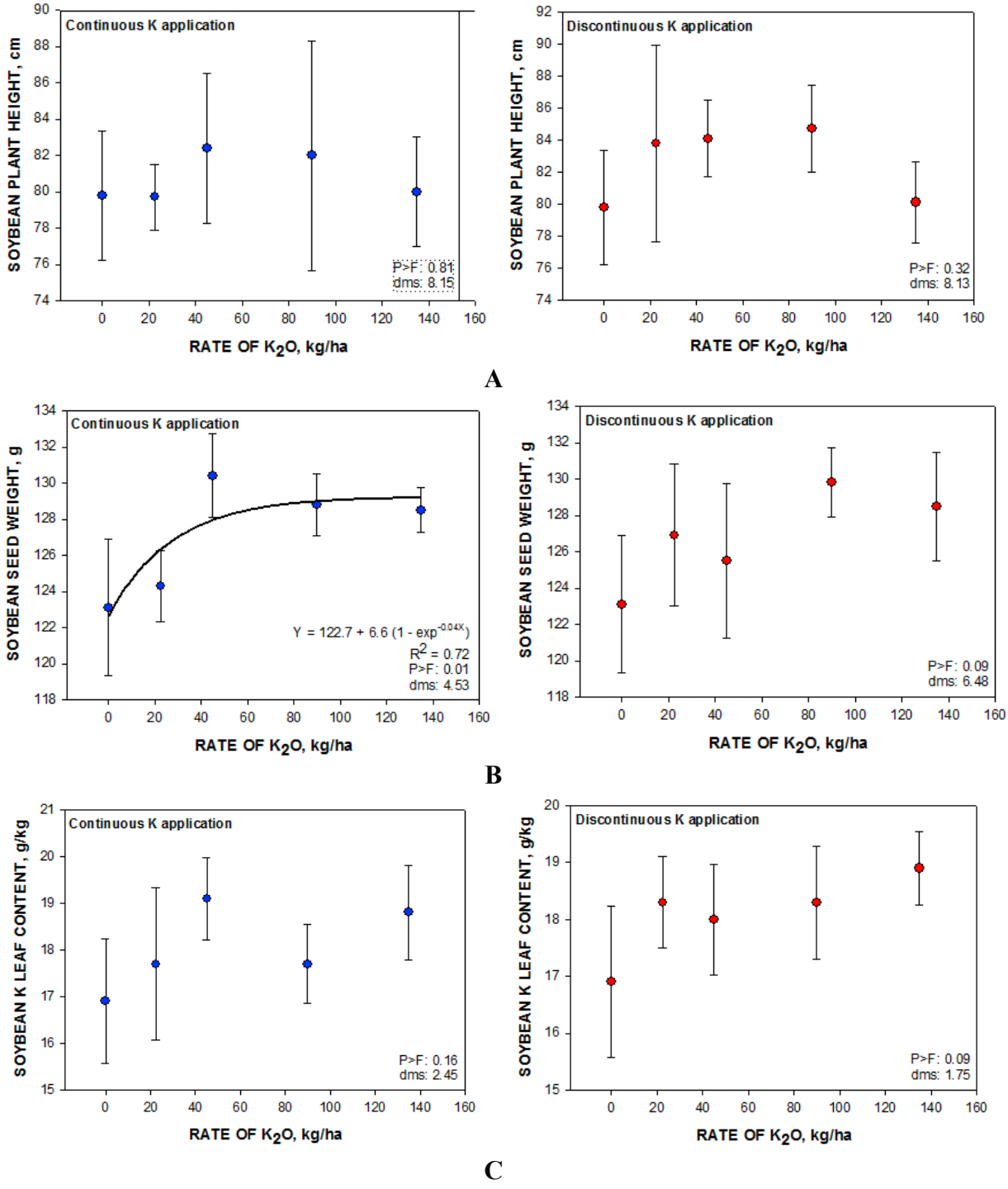


Figure 3. Soybean plant height (A), seed weight (B), and K leaf content (C) response curve to K_2O rates with continuous or discontinuous K application (comparisons 1 and 2 Table 5). Crop season 2014-2015. Vertical bars represent standard deviation.

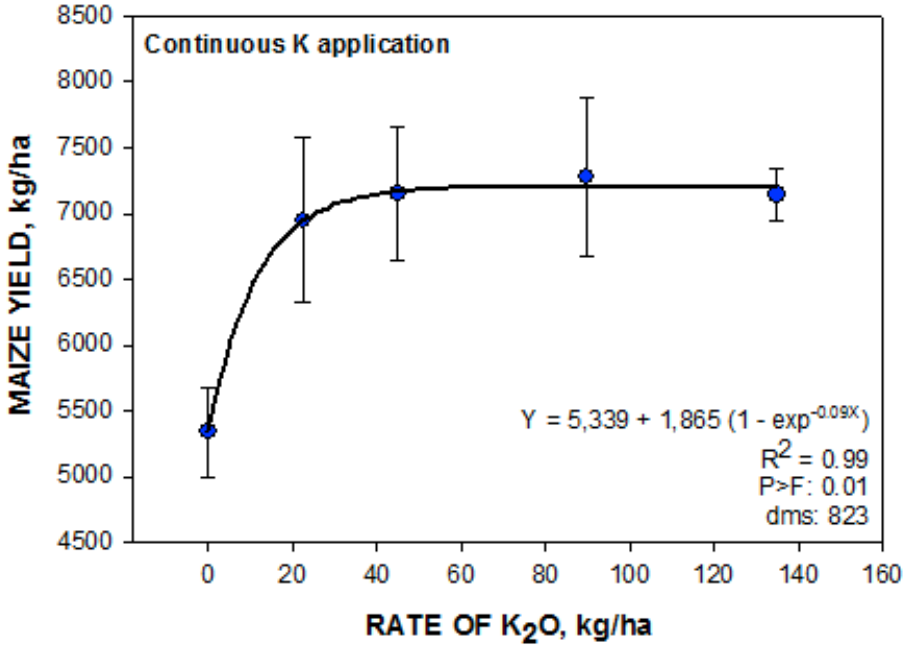


Figure 4. Maize 2nd crop yield response curve to K_2O rates with continuous K application (comparison 1, Table 5). Crop season 2014-2015. Vertical bars represent standard deviation.

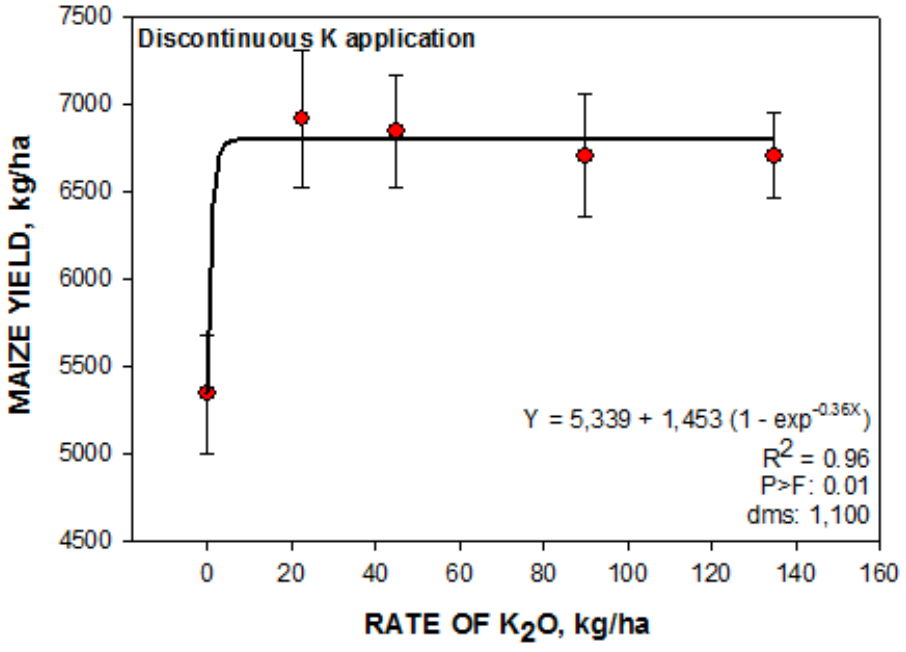
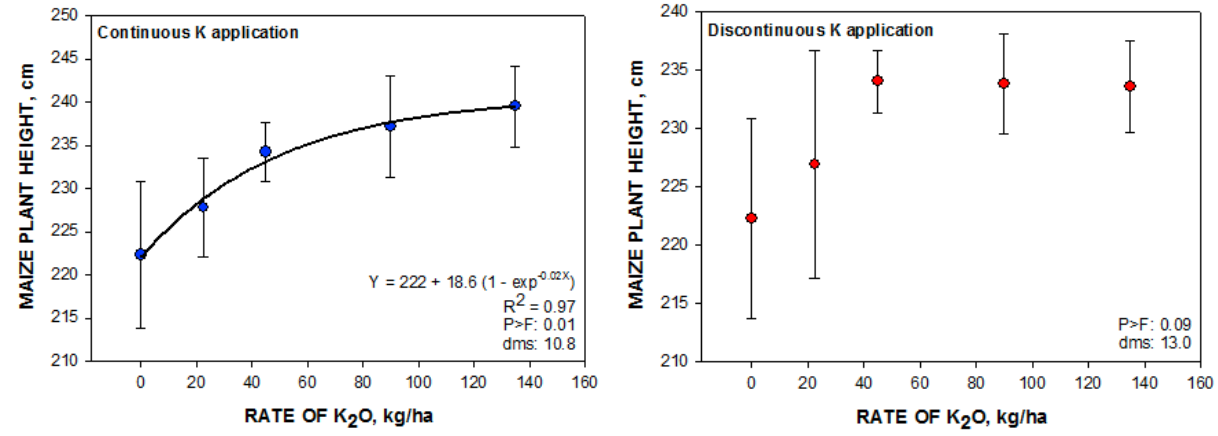
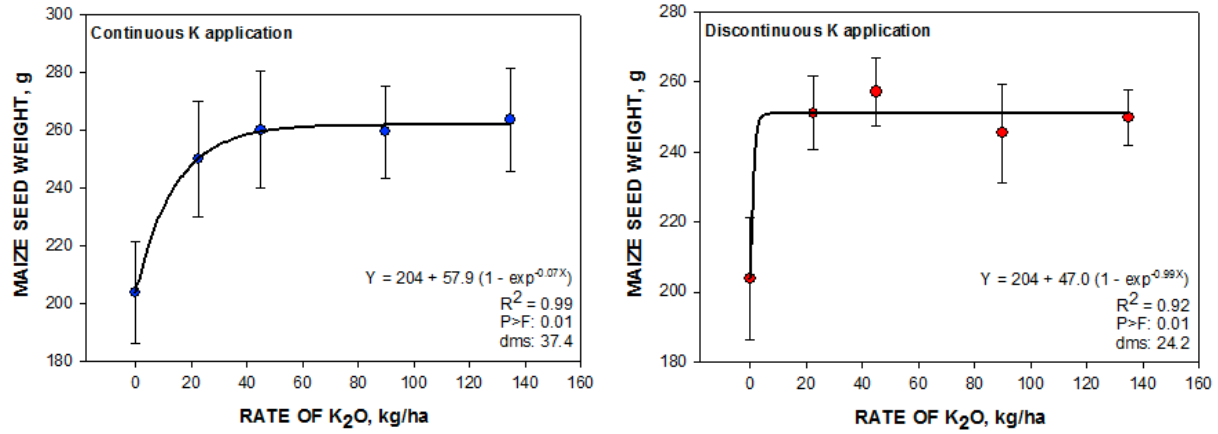


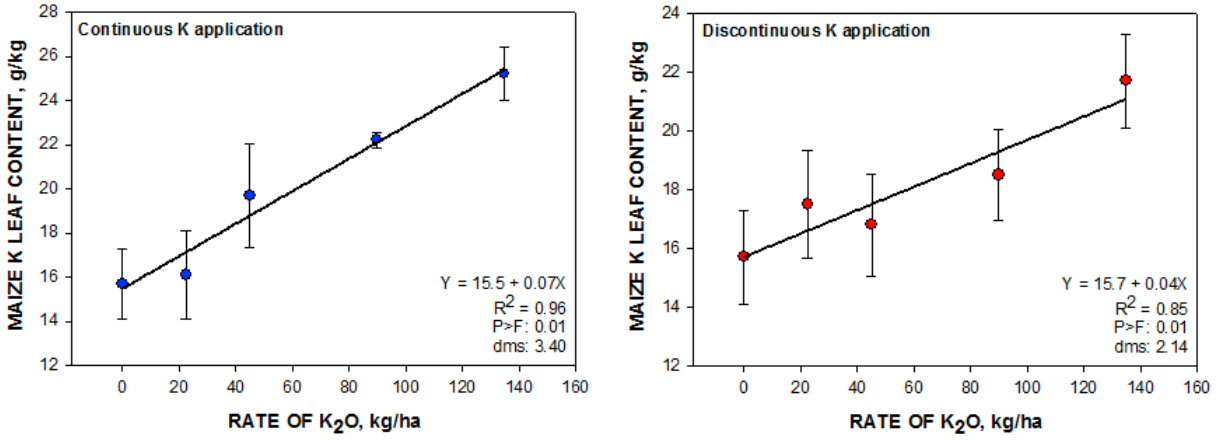
Figure 5. Maize 2nd crop yield response curve to K_2O rates with discontinuous K application (comparison 2, Table 5). Crop season 2014-2015. Vertical bars represent standard deviation.



A



B



C

Figure 6. Maize 2nd crop plant height (A), seed weight (B), and K leaf content (C) response curve to K_2O rates with continuous or discontinuous K application (comparisons 1 and 2 Table 5). Crop season 2014-2015. Vertical bars represent standard deviation.

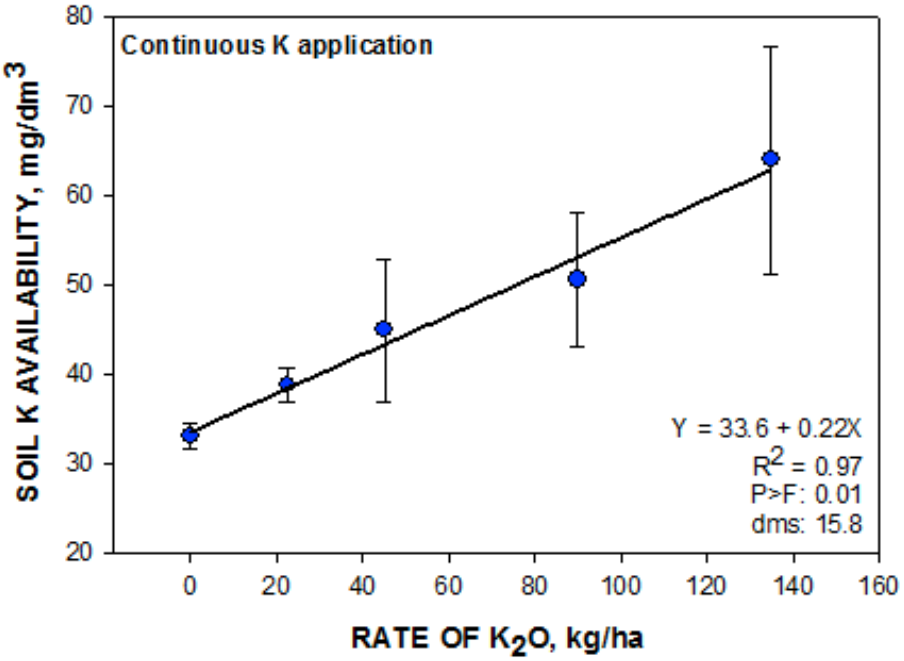


Figure 7. Soil K availability response curve to K_2O rates with continuous K application (comparison 1). Crop season 2014-2015. Vertical bars represent standard deviation.

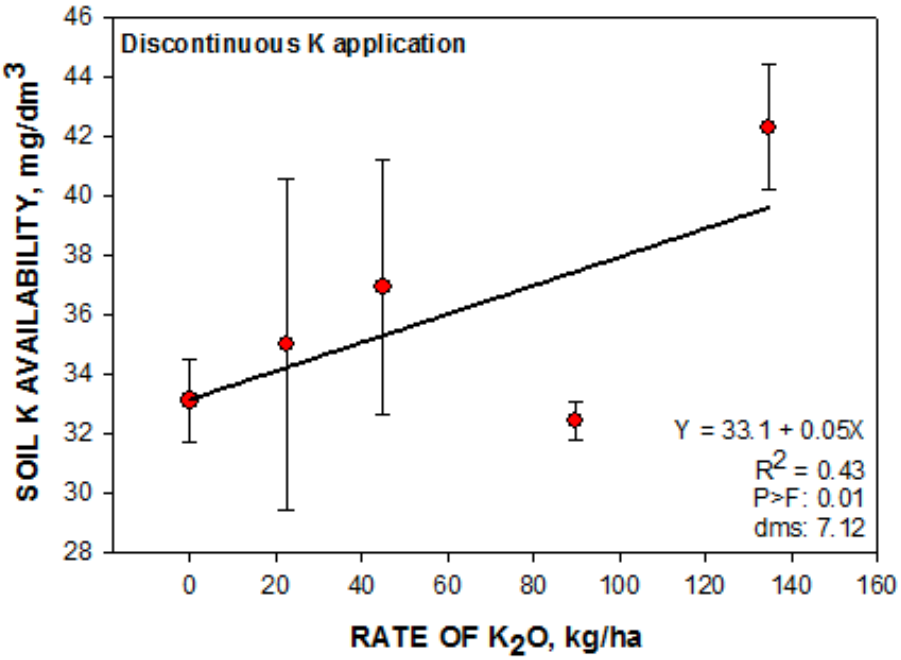


Figure 8. Soil K availability response curve to K_2O rates with discontinuous (comparison 1). Crop season 2014-2015. Vertical bars represent standard deviation.

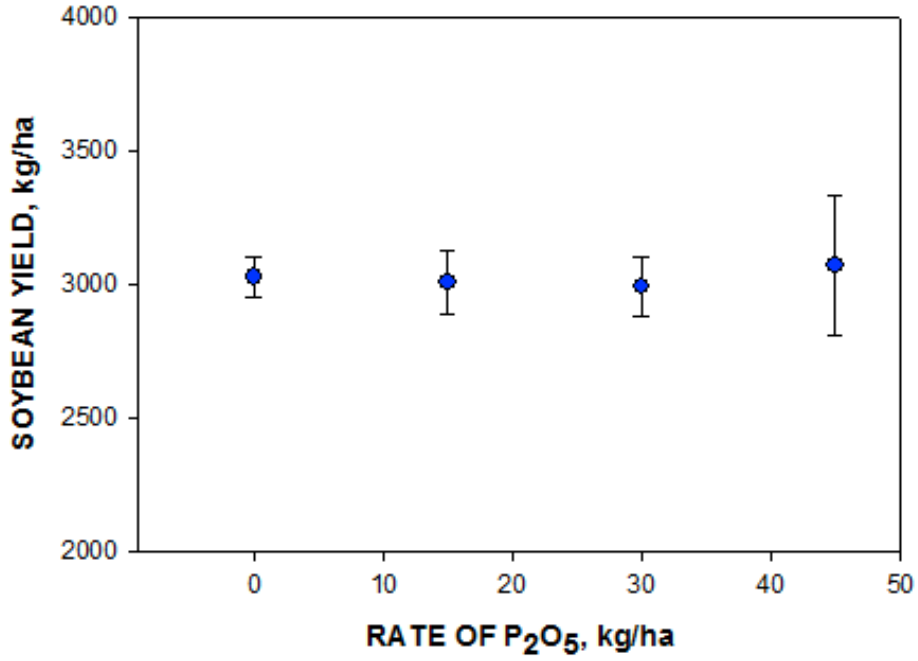


Figure 9. Soybean yield response curve to residual P_2O_5 rates (comparison 11, Table 5). Crop season 2014-2015. Vertical bars represent standard deviation.

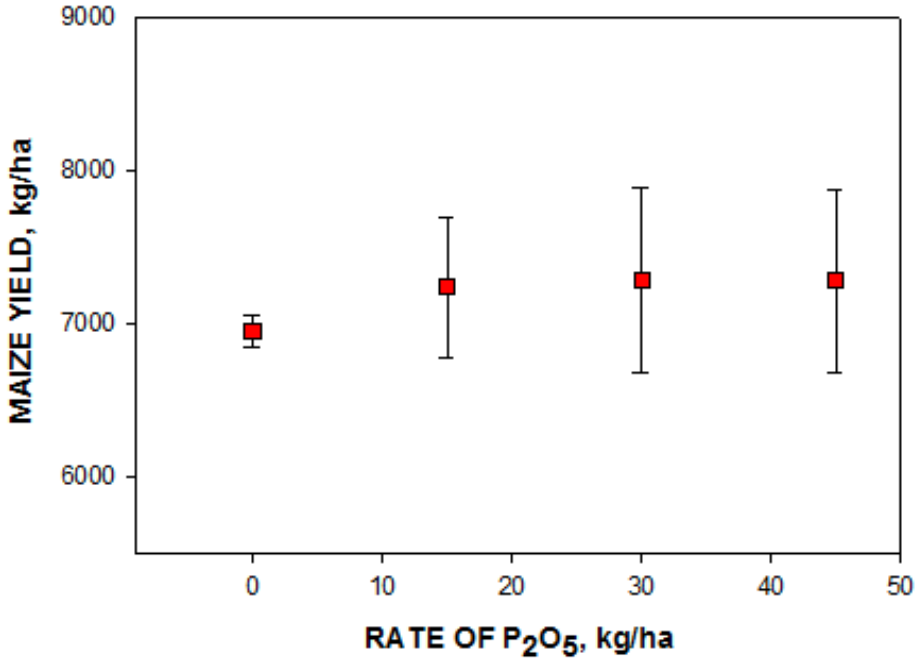


Figure 10. **M**aize yield response curve to residual P_2O_5 rates (comparison 11, Table 5). Crop season 2014-2015. Vertical bars represent standard deviation.

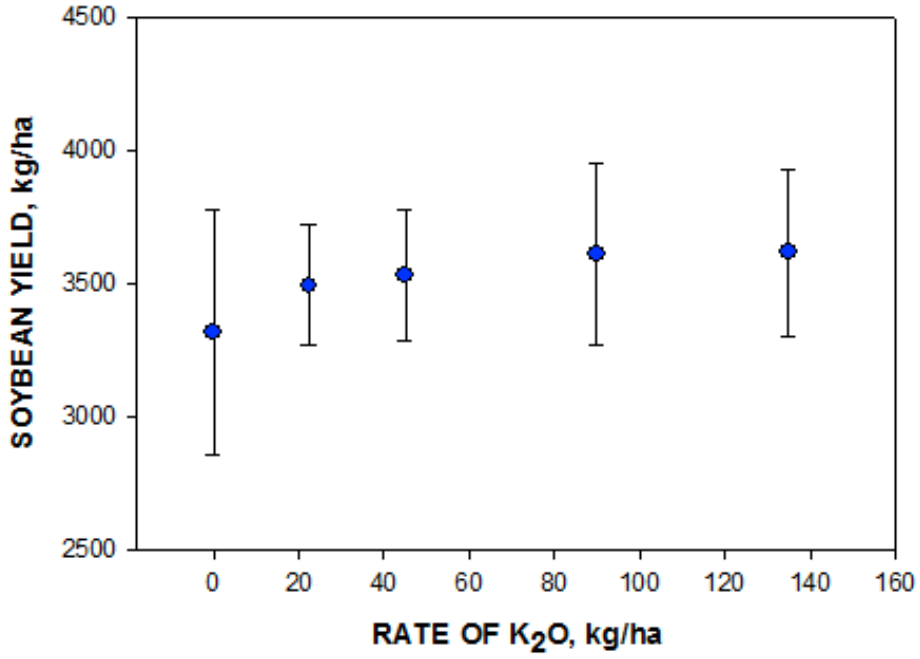


Figure 11. Average soybean yield response curve to K_2O rates with continuous K application along the five years of the project. Vertical bars represent standard deviation.

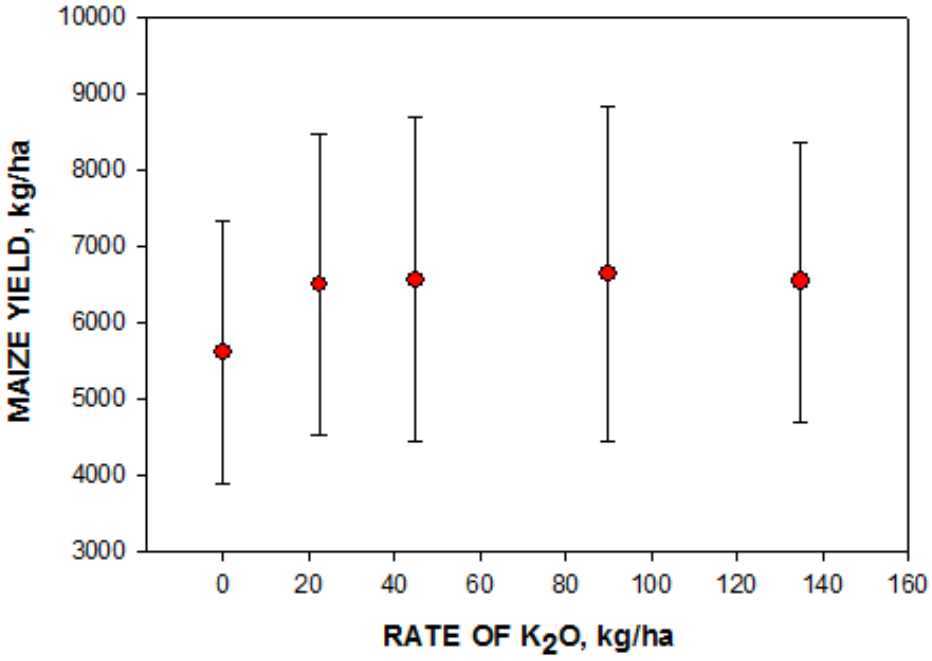


Figure 12. Average maize 2nd crop yield response curve to K_2O rates with discontinuous K application along the five years of the project. Vertical bars represent standard deviation.

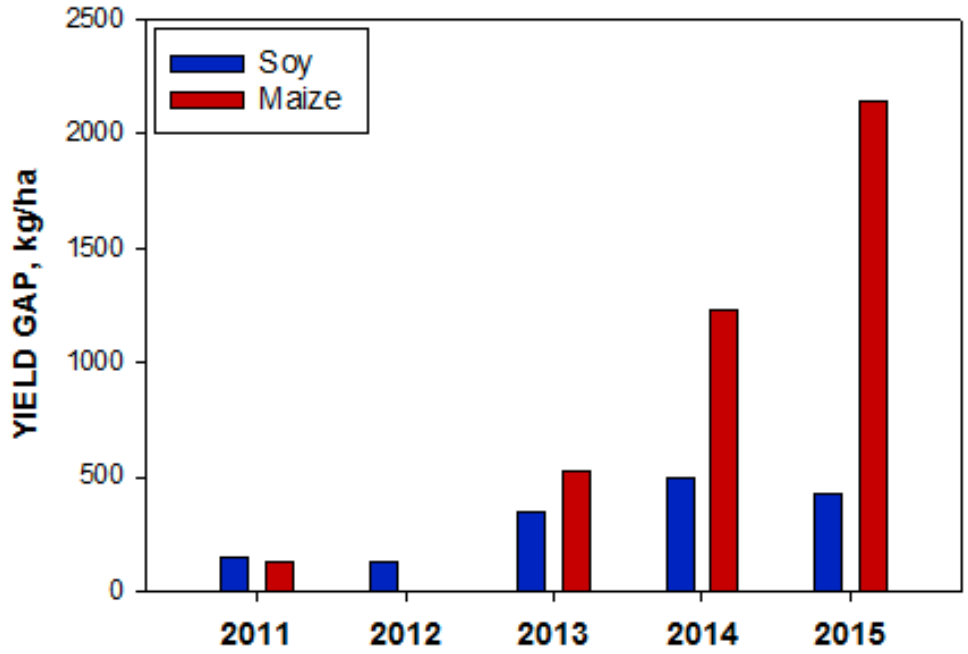


Figure 13. Yield gap (difference between 90 kg K_2O/ha application and control) for soybean and maize 2nd crop along the five years of the project.

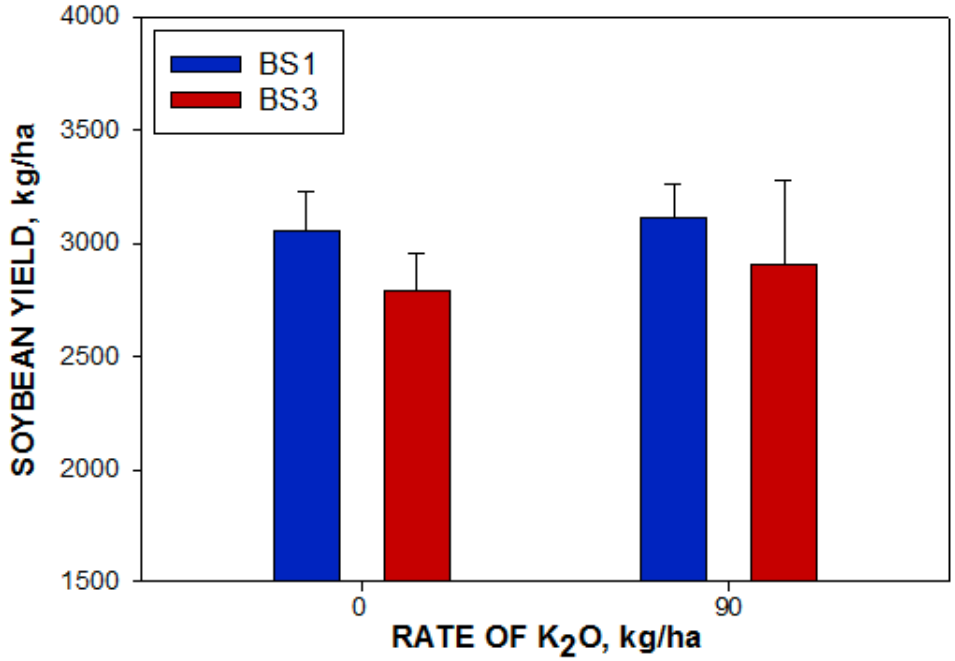


Figure 14. Soybean yield as affected by level of bases saturation in the soil and K_2O application. Crop season 2014-2015. Vertical bars represent standard deviation.

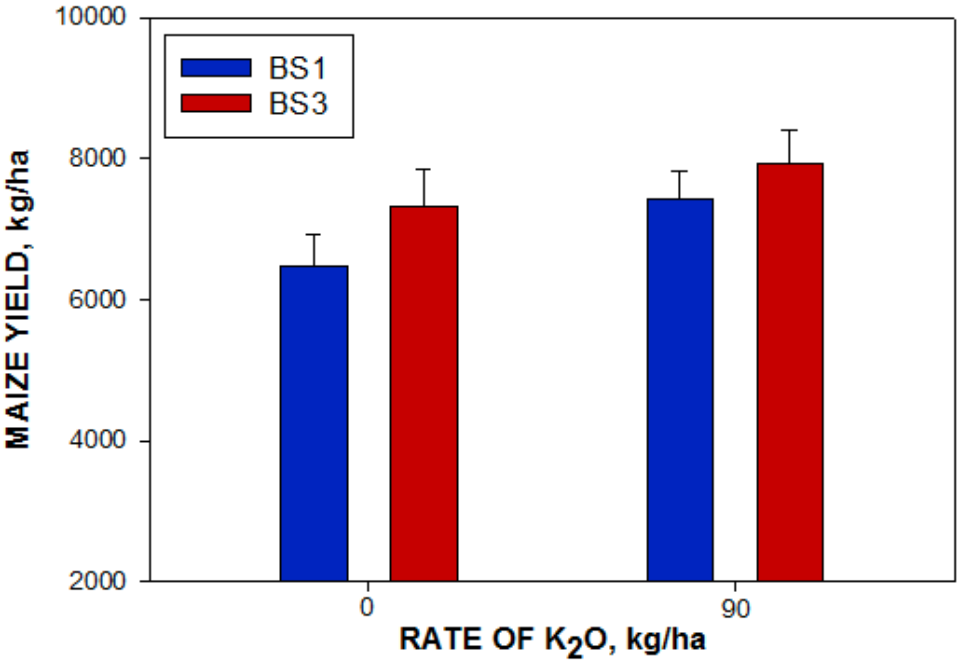


Figure 15. Maize 2nd crop yield as affected by level of bases saturation in the soil and K_2O application. Crop season 2014-2015. Vertical bars represent standard deviation.

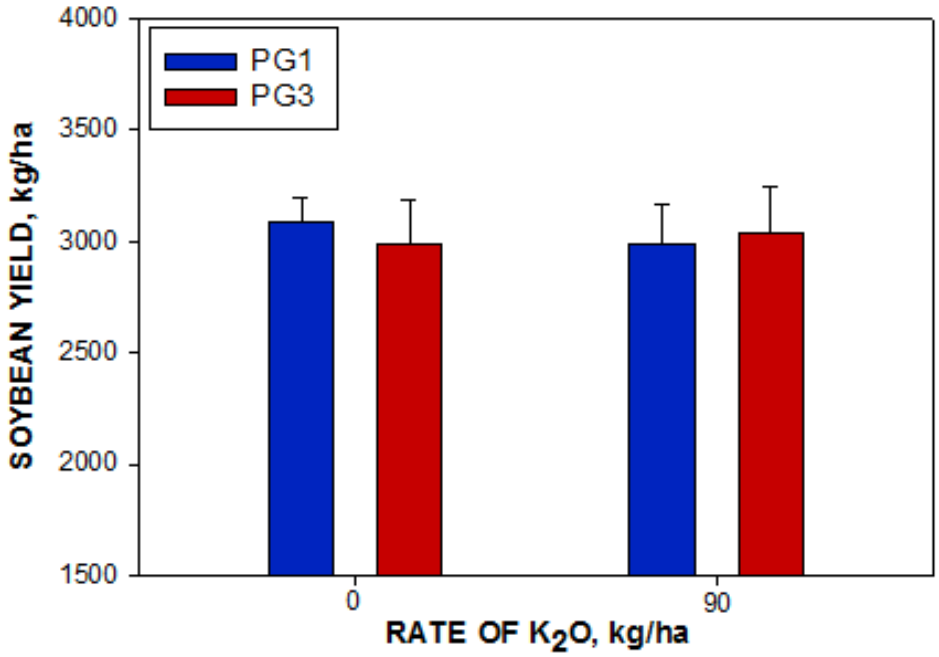


Figure 16. Soybean yield as affected by level of phosphogypsum application and K_2O application. Crop season 2014-2015. Vertical bars represent standard deviation.

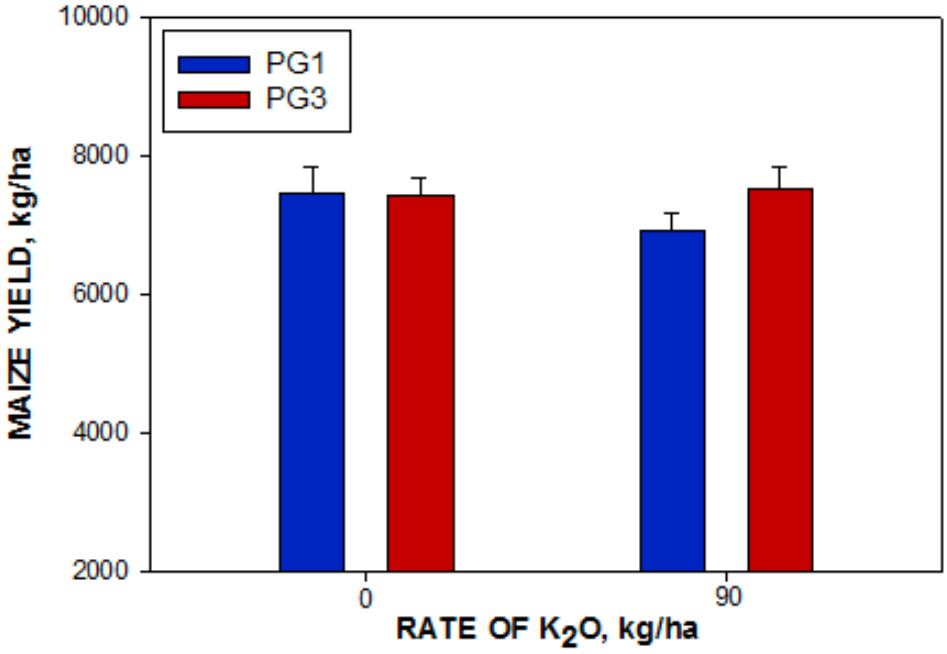


Figure 17. Maize 2nd crop yield as affected by level of phosphogypsum application and K_2O application. Crop season 2014-2015. Vertical bars represent standard deviation.

Table 15. Summary of statistical analysis for all comparisons since the beginning of the project.

Parameter	Season	Comparisons					
		5	6	8	9	12	13
				Soybean			
Grain yield	2010/11	ns	ns	ns	ns	ns	ns
	2011/12	ns	ns	ns	ns	ns	ns
	2012/13	ns	ns	ns	ns	ns	ns
	2013/14	ns	ns	ns	ns	ns	ns
	2014/15	ns	*	ns	ns	ns	ns
Seed weight	2010/11	-	-	-	-	-	-
	2011/12	ns	ns	ns	ns	ns	ns
	2012/13	ns	ns	ns	ns	ns	ns
	2013/14	ns	ns	*	ns	ns	ns
	2014/15	ns	ns	ns	ns	*	ns
Plant height	2010/11	-	-	-	-	-	-
	2011/12	ns	ns	ns	ns	ns	ns
	2012/13	ns	ns	ns	ns	ns	ns
	2013/14	ns	ns	ns	ns	ns	ns
	2014/15	ns	ns	*	*	*	ns
K leaf content	2010/11	ns	ns	*	*	ns	ns
	2011/12	ns	ns	ns	ns	ns	ns
	2012/13	ns	ns	ns	ns	ns	*
	2013/14	ns	ns	ns	ns	*	ns
	2014/15	*	ns	*	ns	*	ns
				Maize 2nd crop			
Grain yield	2010/11	ns	ns	ns	ns	ns	ns
	2011/12	-	-	-	-	-	-
	2012/13	*	ns	ns	*	ns	ns
	2013/14	*	*	ns	ns	ns	ns
	2014/15	*	ns	ns	ns	ns	ns
Seed weight	2010/11	-	-	-	-	-	-
	2011/12	-	-	-	-	-	-
	2012/13	ns	ns	ns	ns	ns	ns
	2013/14	ns	ns	ns	ns	ns	ns
	2014/15	ns	ns	ns	ns	ns	ns
Plant height	2010/11	-	-	-	-	-	-
	2011/12	-	-	-	-	-	-
	2012/13	ns	ns	*	ns	ns	ns
	2013/14	ns	ns	ns	ns	ns	ns
	2014/15	*	*	ns	ns	ns	ns
K leaf content	2010/11	-	-	-	-	-	-
	2011/12	-	-	-	-	-	-
	2012/13	ns	ns	ns	ns	ns	ns
	2013/14	ns	*	ns	*	ns	ns
	2014/15	ns	ns	ns	ns	*	*
				Soil			
K availability	2010/11	-	-	-	-	-	-
	2011/12	ns	ns	ns	ns	ns	*
	2012/13	ns	ns	ns	ns	ns	ns
	2013/14	ns	ns	ns	ns	ns	ns
	2014/15	ns	*	ns	ns	*	*

ns: not statistical significant. *: statistical significant.

Appendix A. Raw data of soybean agronomical features and nutritional status, season 2014-2015.

T#	T#	Rep	Plot#	Yield	PH[1]	SW[2]	Nutrient leaf status (g/kg)					
				(kg/ha)	(cm)	(g/1000)	N	P	K	Ca	Mg	S
1	1	1	1083	2347.2	77.6	120.2	44.8	3.7	17.6	8.70	4.95	2.22
1	1	2	1086	2554.5	82.2	119.4	54.6	4.3	15.5	9.60	4.95	2.58
1	1	3	1088	2772.8	76.0	126.8	42.0	3.9	16.1	9.75	5.85	2.31
1	1	4	1089	2898.7	83.4	125.8	46.2	4.1	18.4	9.30	5.70	2.09
2	2A	1	1065	3148.6	78.6	125.0	44.8	4.4	18.6	7.80	4.50	2.50
2	2A	2	1053	2802.4	80.3	126.0	50.4	4.4	16.5	8.10	4.50	2.36
2	2A	3	1062	3066.2	82.0	124.6	51.8	4.3	19.6	9.30	5.70	2.73
2	2A	4	1057	3773.9	77.9	121.5	42.0	4.0	16.2	8.25	4.95	2.20
3	2B	1	1066	3000.0	86.3	127.1	45.2	4.6	17.6	8.10	5.25	2.45
3	2B	2	1054	3055.8	83.8	130.0	39.2	3.3	17.7	8.55	4.65	2.21
3	2B	3	1061	3020.4	89.7	129.3	44.8	4.1	19.3	7.95	4.95	2.43
3	2B	4	1058	2884.2	75.3	121.4	40.6	4.1	18.6	9.00	6.30	2.60
4	3A	1	1052	2979.1	78.3	130.4	47.6	4.3	18.2	7.65	4.50	2.43
4	3A	2	1063	3143.7	80.8	130.0	40.6	3.9	20.3	9.90	5.10	2.26
4	3A	3	1056	3136.7	88.0	133.5	44.8	4.6	18.8	8.40	5.55	2.67
4	3A	4	1060	3148.1	82.6	127.8	48.3	4.4	19.0	8.25	4.95	2.50
5	3B	1	1051	3019.9	85.4	130.2	56.7	4.8	16.8	7.80	4.65	2.73
5	3B	2	1064	2509.9	80.6	120.1	53.2	4.0	17.5	9.15	5.40	2.54
5	3B	3	1055	2765.1	85.6	124.6	54.6	4.0	18.8	8.70	5.25	2.41
5	3B	4	1059	3321.2	88.1	127.1	58.8	4.6	18.7	9.45	5.85	2.76
6	4A	1	1099	2887.0	78.2	128.2	40.6	3.3	16.7	8.40	4.80	2.30
6	4A	2	1111	2802.7	76.6	127.0	51.8	4.6	18.0	7.95	4.65	2.23
6	4A	3	1110	3295.4	82.4	128.7	44.8	3.7	18.7	7.20	4.05	2.20
6	4A	4	1106	3298.3	90.7	131.2	43.4	3.5	17.5	7.35	4.35	2.17
7	4B	1	1100	3002.4	84.6	129.3	43.4	3.6	19.2	7.65	4.50	2.46
7	4B	2	1112	2896.4	84.2	127.4	47.6	4.1	18.2	7.65	4.50	2.30
7	4B	3	1109	3090.0	81.7	131.7	42.0	3.4	16.9	8.10	4.65	2.33
7	4B	4	1105	3123.9	88.3	130.8	42.0	3.2	18.7	7.95	4.65	2.14
8	4C	1	1113	2994.9	79.1	123.9	42.0	3.9	19.2	7.50	4.50	2.17
8	4C	2	1101	2711.8	83.1	124.1	46.2	3.8	16.8	7.50	4.95	2.52
8	4C	3	1104	3249.5	85.9	132.0	40.6	3.4	18.5	7.35	4.35	2.30
8	4C	4	1108	3177.7	76.3	127.5	43.4	3.5	16.8	8.55	5.10	2.20
9	4D	1	1114	2750.4	77.0	126.8	44.8	4.4	19.3	6.90	4.35	2.39
9	4D	2	1102	2742.9	79.5	121.8	49.0	4.0	17.4	7.95	5.10	2.27
9	4D	3	1103	3101.9	88.4	127.6	44.8	4.5	16.5	7.80	4.80	2.24
9	4D	4	1107	3384.2	83.5	130.9	40.6	3.7	19.0	7.80	4.50	2.15
10	5A	1	1082	3135.1	84.1	128.2	43.4	3.8	18.3	7.05	3.90	2.56
10	5A	2	1079	3121.9	79.0	127.0	43.4	4.1	17.7	8.10	4.80	2.74
10	5A	3	1077	3006.3	76.9	129.2	43.4	3.4	19.2	7.50	4.05	2.36
10	5A	4	1076	3301.3	72.8	129.7	42.0	3.6	20.0	7.80	4.20	2.52
11	5B	1	1081	2880.0	77.4	121.2	51.8	4.5	19.3	8.70	5.10	2.64
11	5B	2	1080	2735.9	74.8	125.1	40.6	3.6	17.9	8.55	4.80	2.65
11	5B	3	1078	3124.0	80.5	131.6	46.2	3.7	19.0	8.25	4.65	2.70
11	5B	4	1075	3187.1	83.4	130.3	40.6	4.5	19.2	7.65	4.20	2.26
12	6A	1	1115	2917.5	83.6	128.8	43.4	3.4	18.4	7.05	3.90	2.14
12	6A	2	1118	3214.4	85.3	132.4	42.0	3.4	19.6	6.75	3.75	2.41
12	6A	3	1125	3223.8	86.8	129.9	39.2	3.3	18.6	7.20	4.20	2.33
12	6A	4	1123	3120.7	89.2	127.7	42.0	4.3	20.3	7.50	4.50	2.25
13	6B	1	1129	2800.3	81.1	133.3	39.2	3.3	18.3	8.70	3.45	2.30
13	6B	2	1127	3197.7	89.4	127.2	46.2	4.1	18.2	7.35	4.80	2.45
13	6B	3	1119	3079.7	81.0	133.1	40.6	3.8	18.5	6.90	4.20	2.26
13	6B	4	1124	3144.0	81.2	133.3	40.6	3.0	19.9	6.90	4.05	2.20

[1] Plant height. [2] Seed weight.

Continuing …

T#	T#	Rep	Plot#	Yield (kg/ha)	PH[(1)] (cm)	SW[(2)] (g/1000)	Nutrient leaf status (g/kg)					
							N	P	K	Ca	Mg	S
14	7A	1	1116	2542.1	76.7	122.1	40.6	3.5	17.0	7.65	4.65	2.19
14	7A	2	1128	2634.5	82.1	129.3	40.6	3.3	17.8	8.40	5.25	2.24
14	7A	3	1120	3197.6	82.0	131.4	43.4	4.6	19.5	8.10	5.25	2.16
14	7A	4	1122	3264.1	99.0	130.6	43.4	4.0	18.3	7.20	4.65	2.29
15	7B	1	1130	2651.0	77.6	123.6	42.0	3.2	18.0	8.40	4.65	2.33
15	7B	2	1117	2796.0	71.1	132.2	43.4	4.4	18.2	7.50	4.95	2.23
15	7B	3	1126	2718.7	92.0	122.2	42.0	3.7	19.6	7.80	4.80	2.14
15	7B	4	1121	3018.6	83.4	131.2	46.2	3.9	18.7	7.65	5.85	2.23
16	8A	1	1131	2759.2	74.6	122.3	40.6	3.6	18.6	7.65	4.50	2.47
16	8A	2	1134	2994.8	78.3	129.1	42.0	3.2	17.4	7.65	4.50	2.29
16	8A	3	1135	3039.2	80.0	127.2	43.4	3.9	18.1	7.50	4.65	2.19
16	8A	4	1140	3174.2	82.6	124.8	44.8	4.4	18.4	7.95	4.95	2.26
17	8B	1	1146	3038.8	79.3	129.5	42.0	3.8	18.3	8.25	5.40	2.56
17	8B	2	1144	3127.1	80.4	129.2	43.4	3.9	18.1	7.20	4.80	2.20
17	8B	3	1142	3224.1	80.7	122.0	40.6	3.5	19.7	7.80	4.80	2.19
17	8B	4	1137	2975.5	82.4	127.3	44.8	3.8	18.6	7.50	4.95	2.20
18	9A	1	1132	2725.1	75.4	123.7	42.0	3.6	19.4	7.80	4.65	2.17
18	9A	2	1143	3159.7	85.1	130.1	42.0	3.7	19.7	7.50	4.35	2.38
18	9A	3	1141	3144.0	87.9	125.8	42.0	4.3	19.2	7.65	4.50	2.57
18	9A	4	1138	3121.5	89.9	132.4	42.0	4.8	20.7	7.80	4.65	2.50
19	9B	1	1145	2767.3	84.1	120.7	40.6	3.5	18.5	7.65	4.35	2.41
19	9B	2	1133	2956.6	82.8	133.5	43.4	4.1	17.4	7.95	4.65	2.26
19	9B	3	1136	2987.7	85.3	126.9	40.6	4.0	17.4	7.35	4.35	2.23
19	9B	4	1139	3245.4	88.6	127.2	40.6	4.0	19.3	8.25	4.80	2.32
20	11A	1	1098	2938.9	68.4	121.9	42.0	3.4	16.5	8.40	4.95	2.24
20	11A	2	1085	3024.0	72.2	119.4	46.2	4.1	17.8	9.45	5.10	2.77
20	11A	3	1094	3122.3	78.2	127.4	40.6	3.9	17.6	8.70	4.50	2.43
20	11A	4	1092	3510.4	82.6	126.1	43.4	3.5	18.8	9.00	4.80	2.15
21	11B	1	1084	3034.2	65.3	120.7	47.6	3.8	18.1	9.15	5.10	2.59
21	11B	2	1095	2838.8	72.6	129.9	44.8	3.7	18.7	8.55	4.65	2.45
21	11B	3	1087	3084.5	76.7	125.1	44.8	4.4	19.3	10.05	5.70	2.45
21	11B	4	1091	3363.6	85.1	128.2	40.6	3.4	19.2	8.70	4.65	2.53
22	11C	1	1097	2733.1	77.9	124.8	49.0	4.1	16.8	7.50	4.95	2.96
22	11C	2	1096	2934.9	75.9	126.9	40.6	3.4	17.6	7.95	4.35	2.39
22	11C	3	1093	3155.5	77.8	130.0	42.0	3.2	18.0	10.05	4.95	2.76
22	11C	4	1090	2931.2	74.2	126.0	61.6	4.4	16.2	9.15	5.40	2.75
23	12A	1	1068	3165.2	75.2	123.3	56.0	4.9	18.5	7.95	5.40	2.74
23	12A	2	1069	2787.5	71.3	125.6	43.4	4.3	18.3	8.85	4.95	2.59
23	12A	3	1072	3219.6	80.6	126.9	46.2	4.0	20.1	7.20	4.05	2.34
23	12A	4	1073	3216.0	79.1	128.2	49.0	4.1	17.8	8.55	4.95	2.70
24	12B	1	1067	3248.6	88.6	131.9	43.4	4.8	21.4	7.50	4.35	2.34
24	12B	2	1070	3124.7	81.8	123.3	44.8	4.4	19.9	7.35	4.20	2.34
24	12B	3	1071	3218.9	81.1	128.3	50.4	4.3	17.6	7.95	4.95	2.78
24	12B	4	1074	3147.5	88.9	127.3	42.0	4.4	18.4	7.95	4.35	2.45

(1) Plant height. (2) Seed weight.

Appendix B. Raw data of maize agronomical features and nutritional status, season 2014-2015.

T#	T#	Rep	Plot#	Yield (kg/ha)	PH[(1)] (cm)	SW[(2)] (g/1000)	Nutrient leaf status (g/kg)					
							N	P	K	Ca	Mg	S
1	1	1	1083	5411.0	231.1	213.3	27.9	2.9	13.5	6.15	4.95	1.75
1	1	2	1086	5023.4	225.1	184.4	27.0	3.5	15.7	6.45	10.50	1.71
1	1	3	1088	4321.8	222.1	194.8	26.5	3.0	16.3	5.10	3.90	1.71
1	1	4	1089	5785.4	210.7	223.1	29.1	2.8	17.2	4.80	4.35	1.67
2	2A	1	1065	7334.6	236.1	250.5	28.0	2.9	18.3	4.65	3.60	1.61
2	2A	2	1053	6520.5	223.5	253.2	29.1	2.8	16.0	6.30	4.35	1.75
2	2A	3	1062	7615.5	226.8	272.6	30.0	2.8	16.5	5.70	3.30	1.75
2	2A	4	1057	6317.0	224.7	223.8	27.7	2.6	13.5	5.70	4.95	1.58
3	2B	1	1066	7461.7	219.3	254.6	27.9	2.7	17.1	5.25	3.75	1.67
3	2B	2	1054	7373.7	225.7	262.0	27.3	2.1	15.5	5.25	3.90	1.57
3	2B	3	1061	6419.9	241.0	251.0	26.7	2.3	19.9	5.25	3.15	1.70
3	2B	4	1058	6845.4	221.7	237.2	25.8	2.5	13.1	6.30	5.40	1.66
4	3A	1	1052	6787.3	230.0	236.5	27.4	2.4	16.7	5.10	3.60	1.63
4	3A	2	1063	6751.6	235.2	254.4	26.3	2.6	22.4	4.50	2.85	1.83
4	3A	3	1056	7839.4	238.0	284.5	29.7	2.8	20.3	4.80	3.30	1.63
4	3A	4	1060	7215.3	233.5	265.5	27.4	2.7	19.4	5.70	3.90	1.58
5	3B	1	1051	6415.7	234.0	267.9	28.1	2.6	15.4	6.00	3.90	1.97
5	3B	2	1064	5758.0	233.0	224.0	28.4	2.7	16.4	4.80	3.90	1.72
5	3B	3	1055	7833.2	237.7	262.5	31.2	2.5	16.0	5.10	3.75	1.72
5	3B	4	1059	7125.5	231.3	248.2	26.5	2.8	19.3	5.40	3.75	1.76
6	4A	1	1099	7622.8	232.9	282.2	31.1	2.9	22.0	3.60	2.55	1.72
6	4A	2	1111	6915.6	233.5	250.8	28.8	2.5	22.6	3.15	1.95	1.72
6	4A	3	1110	7933.9	245.6	246.5	27.3	2.8	22.2	3.30	2.10	1.58
6	4A	4	1106	6645.8	236.6	258.2	27.4	2.7	21.8	3.30	1.80	1.51
7	4B	1	1100	6642.9	232.2	226.3	27.9	2.4	17.1	4.35	3.38	1.74
7	4B	2	1112	6315.1	231.7	227.2	27.3	2.7	17.3	5.70	4.50	1.58
7	4B	3	1109	7161.0	231.2	256.7	28.8	2.7	20.3	3.83	2.40	1.60
7	4B	4	1105	7908.1	240.2	255.9	28.3	2.5	19.2	3.53	2.40	1.58
8	4C	1	1113	7022.7	231.3	253.6	30.2	2.9	19.6	4.35	3.45	1.65
8	4C	2	1101	7446.1	238.8	240.6	29.0	2.6	17.7	4.20	3.45	1.67
8	4C	3	1104	7919.8	246.9	277.1	28.1	2.7	21.0	3.30	1.95	1.60
8	4C	4	1108	6588.9	233.6	275.4	30.5	2.9	19.1	3.90	2.25	1.54
9	4D	1	1114	7237.0	239.2	257.4	29.5	2.6	21.4	3.90	2.10	1.63
9	4D	2	1102	6959.3	231.8	258.8	30.2	2.5	17.4	4.65	3.75	1.75
9	4D	3	1103	7253.0	241.9	261.9	27.4	2.6	22.4	3.45	2.70	1.69
9	4D	4	1107	6756.5	239.2	253.2	28.6	2.8	19.7	3.75	2.25	1.59
10	5A	1	1082	7360.4	246.1	289.8	28.6	3.0	24.4	3.15	2.10	1.71
10	5A	2	1079	6961.0	238.7	249.5	26.7	2.8	25.6	3.00	1.65	1.67
10	5A	3	1077	7272.3	238.3	254.5	30.5	3.0	24.0	3.09	1.80	1.61
10	5A	4	1076	6972.8	235.0	260.5	31.2	3.1	26.7	3.15	1.50	1.58
11	5B	1	1081	6363.5	236.0	261.7	26.3	3.1	20.2	3.30	1.95	1.64
11	5B	2	1080	6930.7	227.8	247.4	25.3	2.7	20.5	3.45	2.40	1.61
11	5B	3	1078	6816.7	236.1	245.7	26.5	2.6	22.4	2.85	1.95	1.65
11	5B	4	1075	6448.0	234.4	244.9	28.3	2.6	23.6	3.45	1.95	1.71
12	6A	1	1115	7869.2	234.7	266.5	31.6	2.7	22.8	4.05	2.25	1.57
12	6A	2	1118	6909.4	234.1	256.6	28.0	2.5	23.2	3.45	2.25	1.61
12	6A	3	1125	7555.2	244.8	255.9	30.8	2.5	26.8	3.00	1.80	1.54
12	6A	4	1123	7360.3	236.2	253.9	29.4	2.5	30.9	3.15	1.50	1.57
13	6B	1	1129	6215.6	230.3	229.9	32.2	2.7	23.4	2.93	2.10	1.52
13	6B	2	1127	6711.0	227.1	235.1	33.6	2.6	18.5	4.35	3.00	1.58
13	6B	3	1119	6968.6	227.5	229.1	28.3	2.6	20.8	3.68	2.55	1.58
13	6B	4	1124	6003.1	236.7	239.0	33.6	2.4	21.1	3.90	2.85	1.65

[(1)] Plant height. [(2)] Seed weight.

Continuing …

T#	T#	Rep	Plot#	Yield (kg/ha)	PH[1] (cm)	SW[2] (g/1000)	Nutrient leaf status (g/kg)					
							N	P	K	Ca	Mg	S
14	7A	1	1116	8322.5	246.5	268.8	27.9	2.9	22.5	3.90	2.85	1.67
14	7A	2	1128	7249.6	253.7	258.0	30.8	2.5	22.8	3.15	2.25	1.62
14	7A	3	1120	8028.7	257.5	270.0	28.7	2.7	25.1	3.38	2.70	1.65
14	7A	4	1122	8159.3	245.6	278.4	32.2	2.7	27.6	3.45	2.55	1.62
15	7B	1	1130	7994.2	250.9	290.3	29.4	2.8	24.3	3.45	2.25	1.60
15	7B	2	1117	7171.1	236.0	246.2	29.3	3.0	19.5	3.60	2.40	1.53
15	7B	3	1126	6746.7	243.8	229.6	29.4	2.3	17.8	4.95	3.75	1.61
15	7B	4	1121	7404.8	237.9	218.8	30.8	2.9	19.9	5.55	3.60	1.53
16	8A	1	1131	7104.5	234.0	280.9	32.2	2.6	21.7	3.30	1.95	1.58
16	8A	2	1134	6603.1	236.1	256.8	30.8	2.3	22.2	3.08	2.25	1.57
16	8A	3	1135	6752.0	238.7	242.0	33.6	2.7	23.3	3.15	1.95	1.65
16	8A	4	1140	7152.7	235.9	278.7	28.0	2.5	25.0	3.30	1.95	1.61
17	8B	1	1146	7228.0	242.4	257.7	32.2	2.5	18.5	3.75	2.25	1.53
17	8B	2	1144	7593.9	242.5	268.0	30.8	2.9	21.3	3.15	2.10	1.54
17	8B	3	1142	7041.1	221.3	230.2	30.1	2.4	17.5	6.00	4.80	1.58
17	8B	4	1137	7942.3	246.3	224.9	29.4	2.4	21.9	3.75	2.25	1.67
18	9A	1	1132	7625.0	242.3	261.9	30.8	2.5	22.8	3.23	1.88	1.54
18	9A	2	1143	7922.5	238.2	266.4	29.4	2.7	23.4	3.30	2.25	1.67
18	9A	3	1141	7347.2	219.9	257.4	30.8	2.6	22.6	3.45	2.25	1.54
18	9A	4	1138	7204.5	240.6	261.8	32.2	2.5	20.9	3.15	1.95	1.70
19	9B	1	1145	7361.0	248.7	246.8	29.1	2.4	17.1	4.05	2.55	1.58
19	9B	2	1133	7096.0	235.3	238.1	26.6	2.4	18.3	3.75	2.70	1.61
19	9B	3	1136	7621.2	247.5	246.1	28.0	2.5	22.0	3.60	2.55	1.57
19	9B	4	1139	7609.8	234.3	260.9	28.7	2.6	19.2	3.60	2.40	1.57
20	11A	1	1098	6919.7	234.1	256.6	26.9	2.7	23.6	3.15	2.40	1.66
20	11A	2	1085	6829.7	226.1	267.3	30.9	3.1	21.7	3.30	2.10	1.68
20	11A	3	1094	7082.5	234.0	255.9	28.0	2.4	24.0	3.45	2.55	1.76
20	11A	4	1092	6988.3	231.9	270.2	27.4	3.0	22.4	3.23	2.10	1.74
21	11B	1	1084	7707.8	238.0	264.9	26.9	2.6	21.7	3.15	1.95	1.63
21	11B	2	1095	7067.0	237.5	259.2	29.3	2.7	20.7	3.60	2.25	1.80
21	11B	3	1087	7485.7	236.2	271.8	28.3	2.9	21.8	3.30	2.25	1.75
21	11B	4	1091	6686.9	227.0	251.8	29.8	3.2	21.5	3.30	1.95	1.66
22	11C	1	1097	8077.0	247.5	266.6	28.4	2.8	22.3	3.30	2.55	1.63
22	11C	2	1096	7736.1	229.7	261.8	28.3	2.5	23.5	3.53	2.63	1.67
22	11C	3	1093	6684.7	229.9	248.2	30.9	3.3	23.5	3.15	1.95	1.68
22	11C	4	1090	6856.0	234.3	262.8	28.1	3.1	23.0	4.20	3.15	1.58
23	12A	1	1068	7168.0	232.0	266.1	27.7	2.9	24.6	3.30	1.95	1.57
23	12A	2	1069	7603.5	231.6	277.5	29.3	2.8	25.6	3.00	2.10	1.60
23	12A	3	1072	7185.3	236.9	274.4	28.3	2.6	24.8	3.08	1.58	1.68
23	12A	4	1073	7974.7	241.0	273.7	27.9	2.5	27.4	3.23	1.50	1.63
24	12B	1	1067	7642.0	233.4	266.7	27.2	2.5	24.0	4.20	2.10	1.72
24	12B	2	1070	7238.6	238.3	258.8	26.9	2.2	29.8	3.15	1.73	1.59
24	12B	3	1071	7193.9	239.2	289.5	27.4	2.7	24.3	3.30	1.65	1.75
24	12B	4	1074	7399.1	233.6	258.2	27.7	2.9	29.3	3.15	1.65	1.66

[1] Plant height. [2] Seed weight.

Appendix C. Raw data of soil testing after the maize harvest, season 2014-2015.

T#	T#	Rep	Plot#	Soil pH		P	K	Ca	Mg	H	CEC	OM	BS
				H_2O	$CaCl_2$	mg/dm^3		cmol$_c$/dm^3				g/kg	%
1	1	1	1083	5.8	5.0	12.7	33.3	2.6	1.0	4.3	8.0	33.9	46.4
1	1	2	1086	5.8	5.1	26.3	32.8	3.1	1.1	4.7	9.0	37.8	47.5
1	1	3	1088	5.8	5.1	27.1	31.4	2.9	1.1	4.6	8.7	36.8	46.9
1	1	4	1089	5.9	5.2	20.5	34.8	3.0	1.1	4.3	8.4	34.9	48.9
2	2A	1	1065	6.1	5.3	25.6	38.1	3.4	1.2	4.1	8.8	36.8	53.5
2	2A	2	1053	6.2	5.4	23.6	41.5	3.5	1.2	3.8	8.7	36.8	55.9
2	2A	3	1062	5.8	5.1	21.1	36.9	2.7	1.0	4.4	8.1	33.0	46.1
2	2A	4	1057	5.9	5.1	22.3	38.7	2.9	1.1	4.2	8.3	33.9	49.3
3	2B	1	1066	5.8	5.1	23.6	48.1	2.7	1.0	4.4	8.3	33.9	46.4
3	2B	2	1054	6.1	5.2	24.9	42.8	3.1	1.2	4.1	8.5	35.8	51.6
3	2B	3	1061	5.7	5.0	19.9	31.1	2.7	1.0	4.5	8.2	33.9	45.9
3	2B	4	1058	6.1	5.2	27.1	31.0	3.4	1.2	4.3	9.0	38.9	52.2
4	3A	1	1052	6.2	5.5	22.3	54.6	3.8	1.3	3.8	9.0	38.9	57.9
4	3A	2	1063	6.1	5.2	17.1	34.9	3.0	1.1	4.1	8.2	34.9	50.6
4	3A	3	1056	6.1	5.3	25.6	44.8	2.9	1.1	3.5	7.6	31.2	53.4
4	3A	4	1060	6.1	5.3	18.8	45.1	3.1	1.1	3.7	8.0	33.0	53.7
5	3B	1	1051	6.1	5.4	21.1	39.0	3.3	1.2	3.5	8.2	33.9	56.9
5	3B	2	1064	6.0	5.3	22.9	30.5	3.0	1.1	4.1	8.2	33.9	50.4
5	3B	3	1055	5.7	4.9	20.5	47.4	2.7	1.0	4.7	8.5	37.8	44.4
5	3B	4	1059	6.2	5.5	27.8	39.2	3.4	1.2	3.6	8.4	34.9	56.7
6	4A	1	1099	6.0	5.2	11.4	40.7	2.9	1.1	4.1	8.2	17.4	49.8
6	4A	2	1111	6.1	5.2	24.2	57.6	3.2	1.2	4.3	8.8	37.8	50.9
6	4A	3	1110	6.0	5.2	22.3	55.1	3.1	1.1	4.3	8.6	36.8	50.2
6	4A	4	1106	6.1	5.2	19.3	49.1	3.1	1.2	4.2	8.6	36.8	51.1
7	4B	1	1100	5.9	5.2	18.8	31.9	2.8	1.0	4.1	8.0	32.1	49.2
7	4B	2	1112	6.0	5.3	21.1	32.4	3.1	1.2	4.2	8.5	35.8	51.1
7	4B	3	1109	5.8	5.0	20.5	33.3	2.7	1.0	4.5	8.2	33.9	45.7
7	4B	4	1105	5.7	5.0	11.8	32.0	2.6	1.0	4.7	8.3	35.8	44.2
8	4C	1	1113	6.1	5.4	26.3	34.3	3.4	1.2	3.9	8.6	36.8	54.8
8	4C	2	1101	6.1	5.4	16.6	32.8	3.5	1.2	3.8	8.5	35.8	56.1
8	4C	3	1104	5.7	4.9	16.1	35.1	2.6	1.0	4.8	8.4	34.9	43.4
8	4C	4	1108	5.7	5.0	14.1	41.2	2.6	1.0	4.8	8.4	34.9	43.4
9	4D	1	1114	5.8	5.1	19.3	33.1	2.7	1.0	4.3	8.0	33.9	47.1
9	4D	2	1102	5.8	5.1	19.3	47.9	2.7	1.0	4.4	8.2	33.9	46.6
9	4D	3	1103	6.1	5.2	17.7	43.0	3.2	1.2	4.1	8.5	36.8	51.9
9	4D	4	1107	5.9	5.1	17.1	40.8	2.9	1.1	4.4	8.4	35.8	48.5
10	5A	1	1082	6.1	5.3	22.3	70.9	2.9	1.1	3.7	7.8	32.1	53.0
10	5A	2	1079	5.9	5.1	19.3	78.6	2.9	1.1	4.1	8.3	33.9	50.5
10	5A	3	1077	5.7	5.0	18.2	54.1	2.3	0.9	4.3	7.7	32.1	43.8
10	5A	4	1076	5.9	5.2	15.6	52.5	3.0	1.1	4.2	8.3	35.8	50.1
11	5B	1	1081	6.0	5.2	18.2	43.7	3.1	1.1	4.1	8.4	34.9	51.0
11	5B	2	1080	5.8	5.1	16.1	44.3	3.0	1.1	4.3	8.4	35.8	49.4
11	5B	3	1078	5.9	5.2	18.8	39.7	2.7	1.0	4.0	7.8	33.0	48.8
11	5B	4	1075	5.8	5.1	16.1	41.4	2.9	1.1	4.3	8.3	34.9	49.0
12	6A	1	1115	5.8	5.0	21.7	56.8	2.7	1.0	4.7	8.5	37.8	44.9
12	6A	2	1118	5.8	5.0	24.9	44.5	2.5	1.0	4.3	7.8	33.0	45.0
12	6A	3	1125	5.6	4.8	16.6	52.3	2.3	0.9	4.8	8.1	34.9	41.0
12	6A	4	1123	5.7	4.9	20.5	51.8	2.3	0.9	4.6	7.9	33.0	42.3
13	6B	1	1129	5.9	5.1	23.6	35.2	2.4	0.9	3.7	7.1	30.4	48.2
13	6B	2	1127	5.9	5.1	27.1	39.0	2.9	1.1	4.4	8.4	34.9	48.1
13	6B	3	1119	5.7	5.0	24.2	27.7	2.6	1.0	4.6	8.2	34.9	44.5
13	6B	4	1124	5.7	4.9	19.9	44.2	2.0	0.9	4.7	8.1	33.9	44.3

Continuing …

T#	T#	Rep	Plot#	Soil pH		P	K	Ca	Mg	H	CEC	OM	BS
				H_2O	$CaCl_2$	mg/dm^3		cmol$_c$/dm^3				g/kg	%
14	7A	1	1116	6.2	5.4	27.8	52.6	3.6	1.2	3.8	8.7	36.8	56.5
14	7A	2	1128	6.4	5.6	22.9	44.7	3.7	1.3	2.8	7.9	33.0	65.0
14	7A	3	1120	6.3	5.6	25.6	40.8	3.4	1.2	3.1	7.8	32.1	60.7
14	7A	4	1122	6.2	5.5	19.3	47.9	3.4	1.2	3.6	8.3	33.9	57.1
15	7B	1	1130	6.3	5.6	27.1	47.3	3.6	1.2	3.1	8.0	33.0	61.7
15	7B	2	1117	6.2	5.5	23.6	31.0	3.3	1.2	3.5	8.0	33.9	56.0
15	7B	3	1126	6.2	5.5	24.9	37.6	3.7	1.3	3.7	8.7	37.8	58.2
15	7B	4	1121	6.4	5.6	12.7	33.2	3.1	1.2	2.7	7.1	30.4	61.4
16	8A	1	1131	5.7	4.9	17.1	55.2	2.4	0.9	4.6	8.0	33.9	42.3
16	8A	2	1134	6.0	5.2	23.6	49.9	3.0	1.1	4.1	8.3	34.9	50.3
16	8A	3	1135	5.7	5.0	19.9	47.1	2.4	0.9	4.4	7.8	32.1	43.6
16	8A	4	1140	5.7	4.9	19.9	47.4	2.3	0.9	4.4	7.6	32.1	43.0
17	8B	1	1146	5.7	5.0	22.3	33.3	2.3	0.9	4.2	7.5	31.2	43.8
17	8B	2	1144	6.0	5.3	24.9	43.2	2.9	1.1	3.9	8.0	33.0	51.2
17	8B	3	1142	5.8	5.1	21.1	35.6	2.7	1.0	4.4	8.2	33.9	46.3
17	8B	4	1137	5.4	4.7	17.1	34.5	2.0	0.7	5.0	8.1	34.9	34.4
18	9A	1	1132	5.7	5.0	15.1	50.7	2.3	0.9	4.4	7.7	32.1	43.2
18	9A	2	1143	6.1	5.2	22.9	58.6	3.2	1.2	4.0	8.5	35.8	52.6
18	9A	3	1141	6.2	5.5	18.8	54.3	3.4	1.2	3.4	8.2	34.9	58.7
18	9A	4	1138	5.8	5.0	22.9	52.2	2.5	1.0	4.3	7.9	32.1	46.0
19	9B	1	1145	5.8	5.0	12.7	32.0	2.7	1.0	4.5	8.2	34.9	45.6
19	9B	2	1133	5.8	5.0	19.3	33.2	2.6	1.0	4.4	8.1	33.9	45.8
19	9B	3	1136	5.9	5.2	26.3	36.6	2.9	1.1	4.2	8.2	33.9	49.3
19	9B	4	1139	5.8	5.1	18.2	43.8	2.6	1.0	4.4	8.1	33.9	46.0
20	11A	1	1098	5.9	5.1	11.0	75.1	3.1	1.1	4.3	8.7	18.7	50.4
20	11A	2	1085	6.2	5.4	13.2	62.5	3.6	1.2	4.3	9.2	39.9	53.7
20	11A	3	1094	5.9	5.1	11.0	44.3	3.2	1.2	4.7	9.2	39.9	48.4
20	11A	4	1092	6.0	5.2	14.6	63.4	2.9	1.1	4.0	8.1	33.9	50.6
21	11B	1	1084	6.1	5.2	17.1	55.9	3.6	1.2	4.7	9.7	42.2	51.7
21	11B	2	1095	6.0	5.2	13.6	46.6	2.9	1.1	4.2	8.3	17.4	49.5
21	11B	3	1087	6.1	5.3	12.3	56.7	3.2	1.2	4.0	8.5	35.8	53.2
21	11B	4	1091	6.1	5.2	17.1	61.9	3.2	1.2	4.1	8.5	36.8	52.5
22	11C	1	1097	6.2	5.4	18.2	57.3	3.7	1.3	3.8	8.9	21.3	57.8
22	11C	2	1096	6.1	5.3	12.7	48.8	3.4	1.2	3.9	8.6	20.6	55.4
22	11C	3	1093	5.9	5.2	11.4	43.8	2.9	1.1	4.3	8.3	34.9	49.0
22	11C	4	1090	5.8	5.0	19.3	47.2	2.7	1.0	4.5	8.3	33.9	45.6
23	12A	1	1068	6.3	5.5	16.1	72.7	3.5	1.2	3.2	8.1	33.9	60.4
23	12A	2	1069	6.1	5.2	21.7	77.5	3.0	1.1	4.1	8.3	34.9	50.8
23	12A	3	1072	5.9	5.1	13.2	64.1	2.6	1.0	4.1	7.8	33.0	48.1
23	12A	4	1073	6.1	5.2	19.9	63.3	3.0	1.1	4.0	8.3	35.8	51.8
24	12B	1	1067	6.0	5.2	15.6	60.1	2.8	1.1	4.0	8.1	33.0	50.1
24	12B	2	1070	5.9	5.2	33.7	72.6	2.9	1.1	3.9	8.1	33.9	51.7
24	12B	3	1071	5.8	5.1	27.1	79.9	2.7	1.0	4.3	8.1	35.8	47.5
24	12B	4	1074	5.8	5.1	20.5	67.1	2.9	1.1	4.2	8.3	33.9	49.5

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75,6 m

95 m	6,3 m	6,3 m	6,3 m	6,3 m	6,3 m	6,3 m	6,3 m	6,3 m	6,3 m
	3 NPK0 1058	**5** NPK0 1059	**24** NPK3 (sup) 1074	**11** NPK0 1075	**22** NPK3 1090	**21** NPK3 1091	**6** NPK3 1106	**9** NPK2 1107	**14** NPK3 1122
	corredor de 3 m								
	2 NPK1 1057	**4** NPK2 1060	**23** NPK3 (2cob) 1073	**10** NPK4 1076	**1** NPK0 1089	**20** NPK3 1092	**7** NPK0 1105	**8** NPK1 1108	**15** NPK0 1121
	corredor de 1 m								
	4 NPK2 1056	**3** NPK0 1061	**23** NPK3 (2cob) 1072	**10** NPK4 1077	**1** NPK0 1088	**22** NPK3 1093	**8** NPK1 1104	**7** NPK0 1109	**14** NPK3 1120
	corredor de 3 m								
	5 NPK0 1055	**2** NPK1 1062	**24** NPK3 (sup) 1071	**11** NPK0 1078	**21** NPK3 1087	**20** NPK3 1094	**9** NPK2 1103	**6** NPK3 1110	**13** NPK0 1119
	corredor de 1 m								
	3 NPK0 1054	**4** NPK2 1063	**24** NPK3 (sup) 1070	**10** NPK4 1079	**1** NPK0 1086	**21** NPK3 1095	**9** NPK2 1102	**6** NPK3 1111	**12** NPK3 1118
	corredor de 3 m								
	2 NPK1 1053	**5** NPK0 1064	**23** NPK3 (2cob) 1069	**11** NPK0 1080	**20** NPK3 1085	**22** NPK3 1096	**8** NPK1 1101	**7** NPK0 1112	**15** NPK0 1117
	corredor de 1 m								
	4 NPK2 1052	**2** NPK1 1065	**23** NPK3 (2cob) 1068	**11** NPK0 1081	**21** NPK3 1084	**22** NPK3 1097	**7** NPK0 1100	**8** NPK1 1113	**14** NPK3 1116
	corredor de 3 m								
	5 NPK0 1051	**3** NPK0 1066	**24** NPK3 (sup) 1067	**10** NPK4 1082	**1** NPK0 1083	**20** NPK3 1098	**6** NPK3 1099	**9** NPK2 1114	**12** NPK3 1115

Appendix E. Field trial layout.