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Agronomic evaluation of Metalosate® Manganese and manganese sulphate on soy bean

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Introduction

In Brazil, soybean is one of the most cultivated crops. In the season 2012/2013, 27.6 million hectares were cultivated, producing a total of 82.0 million tons, with an average yield of 2,968 kg/ha. The State of Mato Grosso currently occupies a prominent position in the Brazilian cereal production, being the largest soybeans producer with 7.8 million ha harvested in 2012/2013, representing 28% of the national area with this crop, and with an average yield of 3,010 kg / ha.

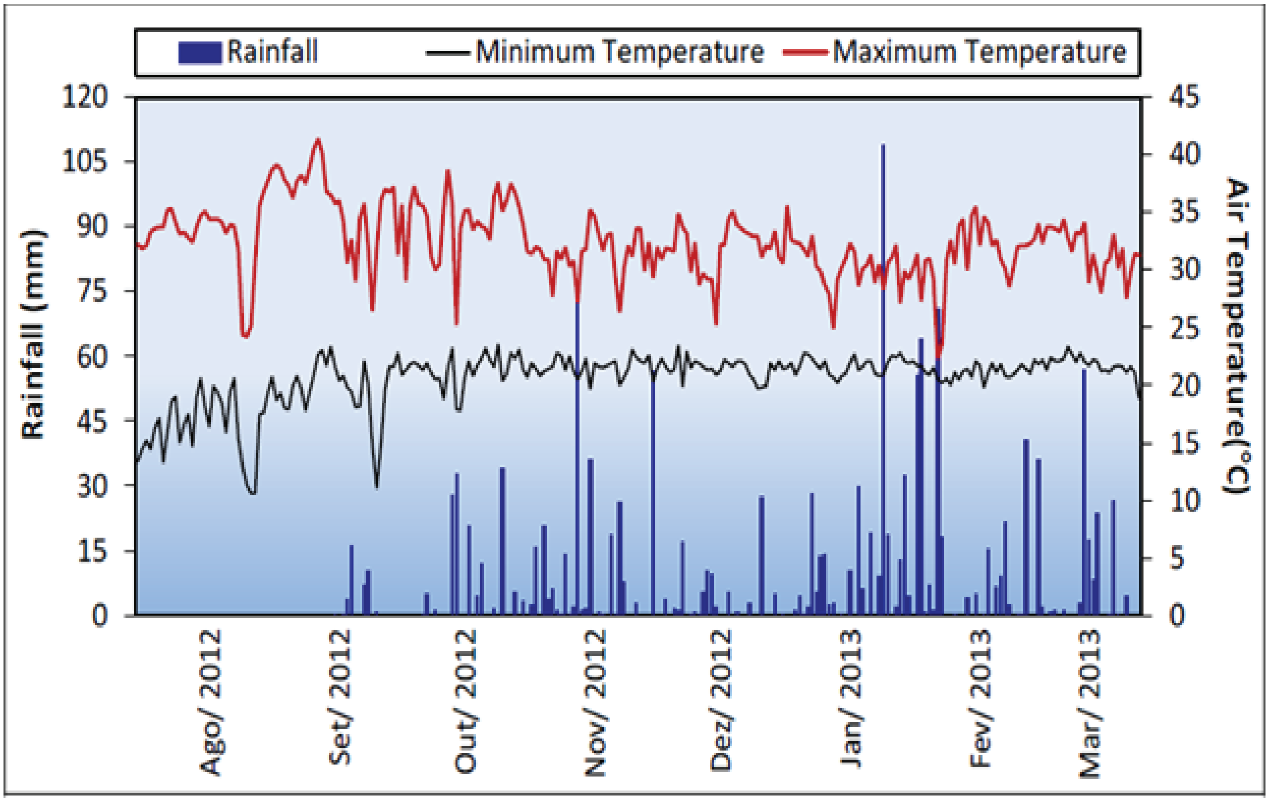
In soybean production, yield, efficiency and profitability are the most relevant aspects. Sustainability in the production scheme is critical(Staut, 2007). Soybeans have a high requirement for nutrients and they are very efficient in absorbing and utilizing the nutrients present in the soil, especially nitrogen, phosphorus, potassium, calcium, magnesium and sulfur. The need to increase soybean yields has led many farmers to seek alternative methods of supplementing fertility, among them foliar fertilization. Manganese (Mn) is an essential element in plant nutrition and plays important roles in photosynthesis, nitrogen metabolism, as well as a precursor of aromatic amino acids, hormones (auxins), phenols and lignins (HEENAN; Campbell, 1980). However, the clearest function is the photosynthetic reaction in which oxygen is formed from water.

With respect to foliar fertilization, there are numerous products on the market containing macro and micro-nutrients, and their use has increased in recent years. The trial results carried out by research institutions have shown great variability in soybean response to these applications.(EMBRAPA, 2005).The attempt to achieve yield increases in soybeans and therefore decrease the relative cost of production has motivated farmers to use these products (Staut, 2007).

Material and Methods

The trial was conducted at the Cachoeira Research Station (attachment 1) from Foundation MT/PMA (17 ° 09 'S, 54 ° 45' W and 490 m of altitude), located at Fazenda Cachoeira, in BR-163, km 40 , in Itiquira - MT. The region is under the Cerrado biome, in which the predominant climate, according to Köppen classification, is Aw, dry winter (RIBEIRO, WALTER, 1998). The average rainfall varies from 1,200 and 1,800 mm and average annual temperature between 22 and 23 C. The daily rainfall and minimum and maximum air temperature during the trial period are shown in Figure 1. There was no moisture stress during the trial.

Figure 1. Daily rainfall and minimum and maximum air temperature registered during the trial.



The Research Station soil is classified as typical dystrophic and very clayey (EMBRAPA, 2006), and chemical-physical characteristics in layer 0-20 cm, are presented in Table 1. The soil where the trial was installed was under annual crop cultivation for 25 years. In 2008, the soil was sub-soiled at a depth of 30 cm.

In the seasons 2008/2009, 2009/2010 and 2010/2011 the area was cultivated in the system soybean / corn "off season" and in the season 2011/2012 there was only soybean. In the season 2012/2013, before the soybeans, there was an application of 2.0 t / ha of lime on the surface, followed by incorporation with harrow depth 0-10 cm.

Table 1. Chemical and physical characteristics from soil 0 – 20 cm layer, from the trial site.

Layer 0 - 20 cm													
Soil pH		P	K	S	Ca	Mg	Al	H	V	MO	Argila	Areia	Silte
H_2O	$CaCl_2$	— mg/dm^3 —			— $cmol_c/dm^3$ —				%	g/dm^3	— g/kg —		
5,6	4,8	15	82	14	2,5	0,9	0,0	5,6	39	40	658	192	150

Zn	Cu	Fe	Mn	B
— mg/dm^3 —				
9,5	2,2	80	25	0,50

Analysis methodology according to Embrapa (1997). Extractor: P, K, Zn, Cu, Fe and Mn (Mehlich-1 - 0.025 N H2SO4 + HCl 0,05 N), S (calcium phosphate), Ca, Mg and Al (potassium chloride - 1 mol L-1), H (calcium acetate pH = 7), MO (potassium bichromate), B (hot water), sand, clay and silt (dispersant NaOH).

Five treatments were studied (Table 2) and arranged in a randomized block design, with five replications. The Metalosate Manganese and manganese sulphate foliar applications, were conducted using a CO2 pressurized backpack sprayer with empty jet cone nozzles, constant pressure of 3.0 kg/cm2 and spray solution rate of approximately 120 lt/ha. The foliar applications were made when the crop was at the growth stage V4 (fourth opened trifoliate leaf) (RITCHIE et al . , 1994) , on November 22, 2012. Roundup ® Original (1) (2.5 L / ha) was applied mixed to the products, and the control treatment received only herbicide application, at the same growth stage (V4) and rate (2.5 L / ha), aiming to isolate its effect and preventing weed competition. The plots consisted of 14 rows 10 m long, spaced 0.45 m, comprising a total area of 63.0 m2 (Appendix 4).

The soybean variety used was GMT 1176 RR (maturity group 7.6). The seeds were treated with Cruiser ® (0.5 ml / kg) Standak Top ® (1.0 ml / kg) Plus ® Derosal (2.0 mL / kg) as ® (3.0 mL / kg) and inoculated with Bradyrhizobium japonicum (2.0 mL / kg). Planting was done on October 24, 2012. It is noteworthy that all treatments, including the control, received the application of these products on the seeds. In pre-sowing, it was applied 120 kg / ha of K2O via potassium chloride (broadcast). At planting it was applied 50 kg / ha of P2O5 and 30 kg / ha S via super-phosphate. A specific planter for no till planting system was used, equipped with mechanical pneumatic seed distribution. Pest control management was carried out with frequent monitoring and, when necessary, insecticide applications were made.

The management of Asian soybean rust was performed preventively through fungicide applications starting when plants were at the stage R1/R2 (flowering) (RITCHIE et al., 1994) and two subsequent applications at intervals of 15 days.

24 hours after foliar Metalosate Manganese and manganese sulphate applications, 20 trifoliate leaves per plot were collected for nutritional analysis. Then the samples were sent to a laboratory for manganese determination, expressed as mg / kg of nutrient
In field conditions, during harvest, on February 14, 2013 (113 days after planting),the following agronomic parameters were evaluated:

i) 1000 grain weight: by 500 grain weight, that was submitted to a precision scale. The results were extrapolated to 1000 grains and the weight adjusted to 13% moisture;

ii) Yield: from mechanical harvest of the useful area of the plot, and converted to kg / ha and adjusted to 13% moisture. In determining yield, there were delimited two points in each plot. The sampling points were composed of two adjacent rows with 4.0 m length. The yield was obtained from the arithmetic mean between the two sampling points.

The results were submitted to the F test of the analysis of variance (ANOVA), comparing the treatment means by Tukey test at 10% probability (PIMENTEL GOMES; GARCIA, 2002). The computer application used was SISVAR (FERREIRA, 2003).

Table 2. Treatments

Treatment	Product	App rate	Timing
1	Control	–	–
2	Metalosate Mn	300 mL/ha	V_4
3	Metalosate Mn	600 mL/ha	V_4
4	Metalosate Mn	900 mL/ha	V_4
5	Sulfato de Mn	1.000 mL/ha	V_4

V_4 – forth opened trifoliate leaf (RITCHIE et al., 1994).

Results

The summary of the analysis of variance for all characteristics evaluated in this study is presented in Table 3. With respect to the relative variations, measured by the coefficient of variation and according to the classification suggested by Pimentel Gomes (2000), the averages of the respective coefficients of variation were considered low (<10%). It is observed that only the foliar manganese content was influenced by the Metalosate ® Manganese and manganese sulphate applications in soybean.

Table 4 shows the average values for manganese leaf, 1000 grain weight and yield of soybean due to the application of Metalosate® manganese and manganese sulphate. Compared to the control, the application of manganese sulphate (1000 ml / ha) increased the manganese content in the leaf, although it did not differ statistically, from the application of Metalosate® manganese at different rates (300, 600 and 900 mL / ha). The average weight of 1000 grains and soybean yield were similar in the treatments considered in this trial.

Table 3. Summary of analysis of variance for foliar manganese, 1000 grain weight and soybean yield due to Metalosate ® Manganese and manganese sulphate application.

Characteristics	Value of F[1]	Probability>F	CV
	Treatment	Treatment	(%)
Mn content,	3,17 *	0,0426	8,83
1000 grain	1,01 ns	0,4314	4,80
weight and yield	0,88 ns	0,4977	4,64

[1]Test F: * – significative at 5% probability. ns – not significative. CV – coeficient of variation.

Table 4. Manganese foliar levels, thousand grain weight (PMG) and soybean yield (PROD)

T	Treatment description	Mn foliar — mg/kg —	PMG[1] — g —	PROD[1] — kg/ha —
1	Control	55,4 b	130,8 a	3.863 a
2	300 mL/ha de Metalosate Mn® em V_4	57,8 ab	131,2 a	3.952 a
3	600 mL/ha de Metalosate Mn® em V_4	57,6 ab	134,0 a	3.892 a
4	900 mL/ha de Metalosate Mn® em V_4	57,2 ab	138,0 a	4.035 a
5	1.000 mL/ha de Sulfato de Mn em V_4	66,0 a	134,1 a	3.850 a
DMS (10%)		8,8	–	–
General average		58,8	133,6	3.918

T – treatment. DMS – minimum significative difference. Means followed by the same letter in columns do not differ by Tukey test at 10% probability. 1 weight adjusted to 13% moisture (wet basis). V4 - fourth trifoliate leaf open (RITCHIE et al., 1994).

Conclusions

In the agronomic conditions of this study, the results showed that:

i) According to the F test and Tukey test at 10% probability, the 1000 grain weight and yield of soybean were not enhanced by foliar application of Metalosate® Manganese and manganese sulphate in V4;

ii) Compared to the control, the application of manganese sulphate (1000 ml / ha) increased the content of Mn in the leaf, although it did not differ statistically, from the application of Metalosate® Manganese (300, 600 and 900 mL / ha);

iii) We emphasize that the results presented here are restricted to a single crop year, to a cultivar and to a soil condition, there is therefore the need for continuation of these studies to obtain consistent results over time.

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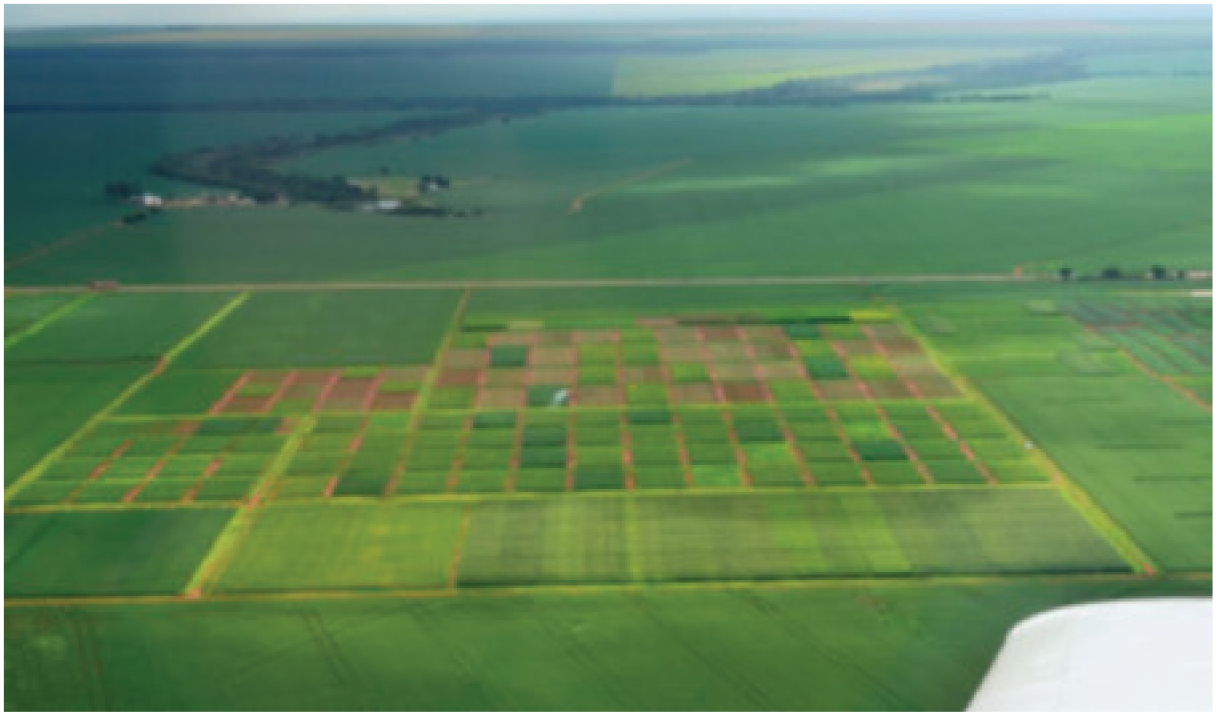
Attachments



Attachment 1. Cachoeira research station, where the trial was conducted.

Attachment 2. General trial view Attachment 3.

Original data from Mn foliar levels, thousand grain weight (PMG) and soybean yield (PROD).

T	Treatment description	Block	Plot	Mn foliar (mg/kg)	PMG[1] — g —	PROD[1] (kg/ha)
1	Control	1	2147	56,0	129,1	3.718,1
1	Control	2	2152	60,0	133,1	3.970,4
1	Control	3	2158	50,0	130,6	4.013,3
1	Control	4	2163	53,0	128,3	3.794,0
1	Control	5	2169	58,0	132,9	3.819,3
2	300 mL/ha de Metalosate Mn® em V_4	1	2150	54,0	128,2	4.260,8
2	300 mL/ha de Metalosate Mn® em V_4	2	2155	58,0	131,2	4.004,7
2	300 mL/ha de Metalosate Mn® em V_4	3	2159	55,0	134,8	3.648,4
2	300 mL/ha de Metalosate Mn® em V_4	4	2166	63,0	130,3	3.912,0
2	300 mL/ha de Metalosate Mn® em V_4	5	2171	59,0	131,7	3.934,2
3	600 mL/ha de Metalosate Mn® em V_4	1	2148	60,0	129,7	4.067,0
3	600 mL/ha de Metalosate Mn® em V_4	2	2153	53,0	136,5	3.771,4
3	600 mL/ha de Metalosate Mn® em V_4	3	2161	62,0	131,6	3.860,2
3	600 mL/ha de Metalosate Mn® em V_4	4	2164	53,0	140,6	3.834,2
3	600 mL/ha de Metalosate Mn® em V_4	5	2167	60,0	131,5	3.929,1
4	900 mL/ha de Metalosate Mn® em V_4	1	2151	62,0	129,7	4.332,0
4	900 mL/ha de Metalosate Mn® em V_4	2	2154	57,0	137,2	4.305,6
4	900 mL/ha de Metalosate Mn® em V_4	3	2157	54,0	137,0	3.742,8
4	900 mL/ha de Metalosate Mn® em V_4	4	2165	61,0	127,6	3.699,5
4	900 mL/ha de Metalosate Mn® em V_4	5	2170	52,0	158,6	4.097,5
5	1.000 mL/ha de Sulfato de Mn em V_4	1	2149	62,0	131,1	4.326,2
5	1.000 mL/ha de Sulfato de Mn em V_4	2	2156	66,0	134,6	3.913,4
5	1.000 mL/ha de Sulfato de Mn em V_4	3	2160	64,0	133,1	3.629,8
5	1.000 mL/ha de Sulfato de Mn em V_4	4	2162	79,0	141,3	3.647,2
5	1.000 mL/ha de Sulfato de Mn em V_4	5	2168	59,0	130,2	3.732,6

T – treatment. Weight adjusted to 13% moisture (wet basis)
. V4 – forth opened trifoliate leaf (RITCHIE et al., 1994).

Attachment 4. Croqui demonstrating the disposition of the treatments in the experimental area.

Metalosate Manganese trial
Cachoeira Research Station

	SEASON							
	2012/2013 37,5 m							
	6,3 m	6,3 m		6,3 m	6,3 m		6,3 m	
50,0 m	**4** Metalosate Mn (900 mL/ha) 2151	**1** Control 2152	Corredor - 3 metros	**3** Metalosate Mn (600 mL/ha) 2161	**5** Mn sulphate (1000 mL/ha) 2162	Corredor - 3 metros	**2** Metalosate Mn (300 mL/ha) 2171	10,0 m
	2 Metalosate Mn (300 mL/ha) 2150	**3** Metalosate Mn (600 mL/ha) 2153		**5** Mn sulphate (1000 mL/ha) 2160	**1** Control 2163		**4** Metalosate Mn (900 mL/ha) 2170	10,0 m
	5 Mn sulphate (1000 mL/ha) 2149	**4** Metalosate Mn (900 mL/ha) 2154		**2** Metalosate Mn (300 mL/ha) 2159	**3** Metalosate Mn (600 mL/ha) 2164		**1** Control 2169	10,0 m
	3 Metalosate Mn (600 mL/ha) 2148	**2** Metalosate Mn (300 mL/ha) 2155		**1** Control 2158	**4** Metalosate Mn (900 mL/ha) 2165		**5** Mn sulphate (1000 mL/ha) 2168	10,0 m
	1 Control 2147	**5** Mn sulphate (1000 mL/ha) 2156		**4** Metalosate Mn (900 mL/ha) 2157	**2** Metalosate Mn (300 mL/ha) 2166		**3** Metalosate Mn (600 mL/ha) 2167	10,0 m
	14 linhas	14 linhas		14 linhas	14 linhas		14 linhas	