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Effects of alternative extracts in the agronomic performance of two soybean cultivars

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The soybean cultivation along the years has required big investments and high technological level to develop new and more productive cultivars. However, the advent of biotic stress, such as diseases, can lead to losses in yield. To attenuate this interference and obtain the expected yield, chemical products have been used to control these diseases. This technique has shown good efficiency in short-term, but can damage the environment and promote the appearance of resistant biotypes in the long-term. So, alternative methods of diseases control, such as pyroligneous extract and the fungus *Pycnoporus sanguineus* have been used in soybean and other cultures to control diseases without the prior negative aspects of chemical products. The aim of this study was to evaluate possible interferences of these treatments in the agronomic performance of soybean culture. The experiment was conducted in the 2012/2013 harvest, submitting two soybean cultivars to pyroligneous aqueous extract in the 0.6 and 1.3% concentrations and the fungus *P. sanguineus* extract in the 2.5 and 5% concentrations, thus comparing their results with a positive control and water control treatment. The results showed that the 2.5% fungus concentration statistically reduced the yield of the Turbo RR® BMX cultivar and the 5% fungus concentration reduced the grain mass of Vmax RR® NK 7059. The pyroligneous extracts reduced the number of pods of the Turbo RR® BMX cultivar and the height of Vmax RR® NK 7059, but did not affect the yield. In either cultivar, the plant growth regulator obtained the best results for all characteristics.

Key words: pyroligneous, *Pycnoporus sanguineus,* plant growth regulator.

INTRODUCTION

The high technological level employed in the soybean cultivation system requires big investments, which are offset by an increasing yield. Thus, any factor that limits gains in production must be attenuated, aiming to ensure a good yield and, consequently, good profits. In this scenario, among the factors that most limit the soybean production are diseases. Most of these problems are caused by fungus, bacteria, nematodes and virus, and they have already been reported in Brazil (Yorinori, 1986).

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Commonly, the disease control in the crops is based on chemical substances. One of the main chemical products used are fungicides, which, due to its easy manipulation and good disease control, had shown an increase of use of 276.2% from 1964 to 1991 (Pansera et al., 2012). The utilization of these products has many advantages in short-term, but, in long-term, it can cause problems due to the residue accumulation in the soil and environment, being necessary the development of alternative methods of disease control (Viecelli et al., 2010; Ghini and Kimathi, 2000). So, the use of pyroligneous extract and the plant resistance induction with natural products are methods that come up with high potential (Schwan-Estrada and Stangarlin, 2005).

The pyroligneous extract, also known as pyroligneous acid, pyroligneous liquid or wood vinegar, is a natural liquid product obtained by the smoke condensation, from wood carbonization, collected under controlled temperatures (Schwengber et al., 2007; Alves et al., 2007; Silveira, 2010). This liquid is basically made of water (80 to 90%), containing around 200 different compounds, with prominence of acetic acid (8%), methanol (± 2%) and acetone (± 1%) (Zanetti et al., 2004).

This product is being used with different aims in agriculture, such as fertilizer in rice (*Oryza sativa* L.), sorghum (*Sorghum bicolor* L.) and sweet potato (*Ipomoea batatas* L.), nematicide and fungicide (Tsuzuki et al., 2000; Esechie et al., 1998; Shibayama et al., 1998; Cuadra et al., 2000). Moreover, it is being recommended to control mite and insects by foliar pulverization or straight application in soil (Schwengbers et al., 2007).

Plant resistance induction is characterized by the activation of the latent defense system in response to the interaction with an external agent (Stangarlin et al., 1999). This defense is stimulated by elicitors, which are molecules capable to protect the plant against future infections caused by pathogens (Pascholati and Leite, 1995; Smith, 1996; Stangarlin et al., 1999).

Among the elicitor agents, there are the plant extracts and essential oils, as well as mushroom extracts (Stangarlin et al., 1999; Schwan-Estrada et al., 2003; Schwan-Estrada and Stangarlin, 2005; Di Piero et al., 2005). In this last example, the basidiomycete *Pycnoporus sanguineus* (L. ex Fr.) Murr. has its aqueous extract being used in agriculture as an alternative method for diseases control. *P. sanguineus* showed an efficient control of *Colletotrichum* in bean, inhibiting the germination of conidia (Assi, 2005).

Studies that relate benefits of alternative methods of disease control do not point any possible interference to the soybean yield. So, the aim of this study was to verify any possible interference in yields of two soybean cultivars caused by the use of pyroligneous and *P. sanguineus* extracts, comparing the results with a plant growth regulator.

MATERIALS AND METHODS

The experiment was conducted during the 2012/2013 harvest, in Maripa city, located in Western Parana, in a clayey oxisol soil (Embrapa, 2006). The weather is Cfa, according to Koppen classification (Koppen and Geiger, 1928). The cultivars Turbo RR® BMX and Vmax RR® NK 7059 were chosen to be used in this study due to their large cultivation in the region. The experimental area altitude was 320 m. The plots contained six 5 m lines, spaced 45 cm between rows. The useful area was of 5.4 m^2, using the four central rows and eliminating 1 m of each extremity. The fertilization, seedling and the phytosanitary control was made according to Embrapa (2011).

The pyroligneous extract used was obtained through eucalyptus wood carbonization, using brick furnace and submitted to decantation during 6 months. After this time, the dilutions were prepared at the 0.6 and 1.3% concentrations.

Samples of *P. sanguineus* were collected from a eucalyptus cultivation area located in Maripa, PR, which was drought in forced circulation greenhouse at 45°C, until it reached constant weight. Following, they were crushed and submitted to extraction in the proportion of 1 g of the fungus and 14 mL of distillated water. The solution was kept for 24 h at 4°C and then the dilutions of 2.5 and 5% were prepared (Figueiredo, 2012).

For each soybean cultivar used, the randomized block design was considered, with six treatments in three repetitions. In each case two extract concentrations were analyzed, and also a water control (T1), and a positive control (T2) composed by the commercial product Stimulate®. The pyroligneous aqueous extract was tested in 0.6 (T3) and 1.3% (T4) concentrations, while the *P. sanguineus* extracts in the 2.5 and 5.0% (T5 and T6, respectively) concentrations. The commercial product Stimulate®, a plant growth regulator containing 0.009% of kinetin, 0.005% of gibberellic acid and 0.005% of IBA, was applied in the 0.5 L ha^{-1} dose, during the soybean fifth and sixth-node stage (Adapar, 2014).

The applications were made during the beginning bloom (R1) using a CO_2 pressurized backpack sprayer, with a 2 BAR (29 psi) constant pressure, in a flow rate of 0.65 L min^{-1} (Fehr et al., 1971). The bar contained 6 Teejet type XR 110.0 nozzles. During the application, the bar was positioned 50 cm apart the target, with a constant speed of 1 m second $^{-1}$ and 50 cm width range, providing a spray volume of 200 L ha^{-1}.

The parameters evaluated were: plant stand, plant height, number of pods, 100 grains mass and yield (kg ha^{-1}).To evaluate the plants height, 10 plants were chosen randomly in the useful area of the plot, and their heights were measured in cm by using a wood ruler. The evaluation of the number of pods was made manually, counting the number of pods of 10 random plants during the soybean full-maturity stage. To plant stand, it was counted the number of plants per meter within the floor area of the plot

The plants were harvested manually in full-maturity, when 95% of the pods had reached their mature pod color (Fehr et al., 1971). Next, the material harvested was threshed with an experimental threshing machine and stored in paper-bags, which were later weighed to obtain the yield. The determination of 100 grains mass was made separating and weighting in eight samples of each plot.

The data were analyzed according to Pimentel-Gomes and Garcia (2002), submitting the data to variance analysis. When the F value was significant, the T test (LSD) at 5% was realized.

RESULTS AND DISCUSSION

The results obtained from the Statistical evaluation of the soybean cultivar Turbo RR® BMX results are shown in Table 1. According to the results, the number of pods and

Table 1. Agronomic parameters evaluated in the soybean cultivar Turbo RR® BMX, submitted to different treatments.

Treatments	Height (cm)	Number of pods	100 grains mass (g)	Yield (kg ha^{-1})
T1	78.20^{A}	47.40^{D}	19.00^{A}	3137.50^{AB}
T2	77.10^{A}	62.55^{A}	18.25^{A}	3425.75^{A}
T3	77.90^{A}	55.05B^{C}	19.25^{A}	3194.00^{AB}
T4	78.85^{A}	57.35^{B}	18.50^{A}	3287.00^{AB}
T5	78.45^{A}	57.95^{B}	18.50^{A}	2762.50^{B}
T6	76.90^{A}	51.45^{C}	19.00^{A}	3156.75^{AB}
CV %	5.08	4.38	3.56	11.24

*Same letter on the columns are not significant different (p > 0.05) by the T test (LSD); T1 = water control; T2 = positive control; T3 = 0.6% pyroligneous extract; T4 = 1.3% pyroligneous extract; T5 = 2.5% *P. sanguineus* extract; T6 = 5% *P. sanguineus* extract.

Table 2. Results of the agronomic parameters evaluated in the soybean cultivar Vmax RR® NK 7059, submitted to different treatments.

Treatments	Height (cm)	Number of pods	100 grains mass (g)	Yield (kg ha^{-1})
T1	83.50^{AB}	50.35^{A}	16.34^{B}	3017.75^{A}
T2	87.25^{A}	45.25^{A}	17.45^{A}	3279.00^{A}
T3	86.50^{AB}	50.70^{A}	16.85^{AB}	3214.50^{A}
T4	78.85^{B}	53.20^{A}	16.73^{AB}	2660.25^{A}
T5	88.00^{A}	45.35^{A}	16.87^{AB}	2884.50^{A}
T6	82.70^{AB}	50.80^{A}	16.28^{B}	2714.75^{A}
CV %	5.08	4.38	3.56	11.24

*Same letter on the columns are not significant different (p > 0.05) by the T test (LSD); T1 = water control; T2 = positive control; T3 = 0.6% pyroligneous extract; T4 = 1.3% pyroligneous extract; T5 = 2.5% *P. sanguineus* extract; T6 = 5% *P. sanguineus* extract.

yield showed significant difference for the cultivar Turbo RR® BMX. T2 is significantly superior (p<0.05) than the other treatments for the number of pods basically because it is a commercial plant growth regulator and it contains 0.009% of kinetin, 0.005% of gibberellic acid and 0.005% of IBA, which provide a hormonal balanced dose that improves the plant growth and development (Adapar, 2014). The result in this study for Stimulate® is similar to another study, in which the application of this product also caused an increase in the soybean number of pods (Bertolin et al., 2010).

Still considering this parameter, the higher pyroligneous extract concentration (T4) presented a number of pods statistically superior (p<0.05) than the higher *P. sanguineus* extract concentration (T6). So, in this study, a difference between the two concentrations of *P. sanguineus* was noticed for the number of pods, where the lower concentration provided a bigger number of pods, indicating that the fungus can cause some injury to the plant. The two pyroligneous extract tested did not show significant difference each other, but yet provided a number of pods higher than the water control, as well as the other treatments. This parameter is inferred directly in soybean yield, but according to Braz et al. (2010) this variable is related mainly to plant genetic potential.

The yield results for the cultivar Turbo RR BMX showed that all treatments tested did not differ significantly from the water control. In a study conducted by Bertolin et al. (2010) the authors indicate possible provides increase in number of pods per plant and grain yield both application via seed as foliar, caused by the use of Stimulate®, something that seems to have occurred in present work. Viecelli et al. (2010) verified that the *P. sanguineus* had an efficient disease control in other legumes, like bean.

The results of the different treatments in the cultivar Vmax RR® NK 7059 are shown in Table 2. It is possible to see that for all agronomic parameters tested, none of the treatments differ from the water control. Beninca (2007) shows in his work the resistance induction efficiency in soybean plants by the use of *P. sanguineus* extract. This way, it can be seen that the application of these natural products did not affect the productivity of cultivars soy worked. The 100 grain mass results show that only the positive control (T2) presented a mass significantly higher (p<0.05) than the water control.

Conclusion

The pyroligneous and *P. sanguineus* extracts are alternative methods that efficiently control plant diseases. However, the interference of these methods over the agronomic parameter evaluated in the soybean culture could not be inferred. In the conditions of this study, the interference of the extracts can be significant according to the cultivar analyzed, where the results vary from one cultivar to another.

Conflict of Interest

The authors have not declared any conflict of interest.

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