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FOLIAR NUTRITION AND THE INDUCTION OF RESISTANCE OF SOYBEAN PLANTS TO DISEASES

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Agriculture is the biggest source of income to move the commerce of the cities located in the northwest of Rio Grande do Sul, being formed by small and medium farmers who cultivate soy as their main activity. The soybean crop has several forms of use and can be an input for the production of by-products such as table vegetable oil, human food, soybean meal, animal food, or even a source of renewable energy when used in the composition of biodiesel (SILVA, 2006). All these by-products are possible because soybean grains are basically formed by 45% protein, 20% lipids and 34% carbohydrates (SILVA, 2006).

In order to have a good development of the culture and to obtain the levels of protein, lipids and carbohydrates that make up its grains, good amounts of micro and macronutrients are necessary, as well as a balance between them (FERREIRA, 1991). This need, difficult to meet due to natural leaching by rainfall and also by soil acidity, one of the factors that affects the availability of nutrients for plants, as is the case of nutrients such as iron, copper, manganese and zinc that have the reduced availability as soil acidity increases, while molybdenum has increased availability as soil acidity increases (FERREIRA, 1991).

Another factor that affects the good development of the soybean crop is leaf diseases that make the use of fungicides increasingly necessary during the crop cycle (LIMA et. al.1999). Study carried out by LIMA et. al. (1999), shows a positive effect of foliar nutrition with potassium silicate, which may be a good strategy to reduce the use of pesticides to combat diseases in some of their work with barley, wheat and soybeans. On the other hand, POZZA (2001), researching foliar diseases in coffee crops, found that with the increase in potassium nutrition, there is a parallel increase in some foliar diseases. Therefore, it is necessary to research the effect of foliar fertilization on the occurrence and severity of diseases in soybean.

The objective of this research was to evaluate the influence of plant foliar nutrition on the induction of disease resistance based on the severity of pathological attack. The work was carried out in the municipality of Pejuçara, RS, in the 2016/2017 agricultural season. Foliar Nutrition (with a product based on Nitrogen (71gL-1), Phosphate (85.2gL-1), Phosphite (56.8gL-1), Potassium (99.4gL-1), Calcium (17.04gL-1), Magnesium (7.10gL-1), Boron (8.52gL-1), Sulfur (42.6gL-1), Copper (8.52gL-1), Manganese (56.8gL-1), Molybdenum (1,42gL-1), Nickel (1,42gL-1) and Zinc (14,2gL-1)) in soybean cultivar (NS5445Ipro) was evaluated as an inducer of plant resistance to diseases associated with Fungicide A (Picoxystrobin 200gL-1 + Cyproconazole 80gL-1) and individualized, combined with fungicide B (Trifloxystrobin 150gL-1 + Protioconazole 175gL-1) and individualized. The treatments used were carried out at the same times, in the phenological stages of the plant in V4, V9 and R1, during the crop cycle. Sowing was carried out during the agricultural zoning period, in spacing of 0.45 meters and 3 cm deep with base fertilization of 300 kg ha-1 of formula 03-23-23. The experimental design was randomized blocks, with six treatments (T1= Fungicide A + Foliar Fertilization; T2= Fungicide B + Foliar Fertilization; T3= Fungicide A; T4= Fungicide B; T5= Foliar Fertilization; T6= No Fungicide and No Fertilization Foliar.) and four replications. The evaluated variables were: Leaf Area Index (LAI), Number of Legs per Plant (NLP), Number of Grains per Leg (NGL), Plant Height (AT), Rust Attack Severity (SAF), Attack Severity Leaf Spot (SAM), Stem and Pod Dryness (NH) and Kilograms per Hectare (kg ha-1). For that, a quantitative approach was used, a statistical procedure, with data collected by direct observation and

Variable		IAF	NLP	NGL	AT	SAF	SAM	NH	kg ha^{-1}
Source of Variation	GL	Square average	Square average	Square average	Square average	Square average	Square average	Square average	Square average
Blocks	3	ns	ns	ns	ns	ns	ns	ns	ns
Treatments	5	ns	ns	ns	ns	486.990*	367.178*	8.733*	ns
Detour	3	1,930	12,193	0,102	6,587	11,781	12,267	1,823	580,092
Residue	15	3,643	157,043	0,007	26,426	43,288	71,358	1,808	282671,111
Total	26								
Average		7,84	61,63	2,47	113,53	9,83	14,16	3,31	4137,5
Coef. Variation		24,33	20,33	3,33	4,53	66,91	59,66	40,61	12,85

* =Significant at 5% probability of error by F-test. ns = Not significant.

Table 1- Summary of variance analysis for the variables: Leaf Area Index (LAI), Number of Legs per Plant (NLP), Number of Grains per Leg (NGL), Plant Height (AT), Rust Attack Severity (SAF) , Severity of Leaf Spot Attack (SAM), Stem and Pod Dryness (NH) and Kilograms per Hectare (kg ha-1) of soybean subjected to different treatments.

	Variables analyzed															
Treatment	IAF (layer m^2)		NLP		NGL (cm)		AT (%)		SAF (%)		SAM (%)		NH			
1. Fungicide A + leaf nutrition	7,409	a	58,15	a	2,366	b	117,539	ab	5,75	a	14,40	ab	4,377	b	4025,0	a
2. Fungicide B + leaf nutrition	9,622	a	64,85	a	2,466	ab	107,175	b	2,20	a	8,80	a	4,719	b	4605,0	a
3. Fungicide A	7,216	a	66,50	a	2,528	ab	114,286	ab	3,80	a	5,60	a	0,887	a	3632,5	a
4. Fungicide B	8,263	a	69,40	a	2,589	a	108,445	b	2,00	a	5,60	a	2,182	ab	4507,5	a
5. Leaf nutrition	6,989	a	51,70	a	2,464	ab	112,611	ab	15,25	a	21,00	ab	3,664	ab	4225,0	a
6. Witness	7,568	a	59,20	a	2,406	b	121,103	a	30,00	b	29,55	b	4,034	b	3830,0	a
Average	7,845		61,63		2,469		113,526		9,83		14,16		3,311		4137,5	
Coefficient of variation (%)	1,930		12,19		0,102		6,587		11,78		12,27		1,824		5,801	

Means followed by the same letters do not differ at 5% significance by Tukey's test.

Table 2 - Summary of Tukey test and F Test for the variables: Leaf Area Index (LAI), Number of Legs per Plant (NLP), Number of Grains per Leg (NGL), Plant Height (AT), Rust Attack Severity (SAF), Severity of Leaf Spot Attack (SAM), Stem and Pod Dryness (NH) and Kilograms per Hectare (kg.ha-1) of soybean subjected to different treatments. Pejuçara/RS, 2017.

measurement of grain yield components for further treatment using averages and Tukey's test at the level of 5% error probability. The rainfall that occurred during the crop cycle was 940 mm.

This rainfall volume helped to express the potential of the crop, which had its development favored by humidity, but this same condition favored the development of foliar pathogens, in which it was possible to evaluate the functioning of the treatments carried out in the plots and collect their results.

The results of the analysis of variance for the variables: Leaf Area Index (LAI), Number of Legumes per Plant (NLP), Number of Grains per Leg (NGL), Plant Height (AT) and Kilograms per Hectare (kg ha- 1), revealed no significant difference at the 5% error probability level between treatments (Table 1).

For the variables Severity of Rust Attack (SAF), Severity of Leaf Spot Attack (SAM) and Stem and Pod Dryness (NH), there was a significant difference between treatments at the 5% probability level by the F test (Table 1).

Comparing the Foliar Nutrition treatment with the Control, Table 2, a reduction in the severity of disease attacks was observed. This difference in severity can be explained by the fact that the product used as a source of nutrition contains the elements Copper (Cu), Boron (B), Manganese (Mn), Zinc (Zn) and Sulfur (S) in its formulation. Such elements play a fundamental role in the synthesis of phenols, quinones and phytoalexins, as well as in the shikimic acid route, the main plant defense route (FANCELLI, 2003).

When comparing treatments 1 and 2 with treatments 3, 4 and 5, apparently there is a loss of efficiency of the fungicide or the attack of diseases has intensified. One can hypothesize that foliar fertilization is causing an antagonistic effect by modifying the pH of the syrup when added to the other two products (fungicides A and B), thus causing their loss of efficiency. Ramos (2006) recalls mixing products in a spray tank and explains some unwanted effects that can be expected when this practice is carried out.

It is concluded that under the soil and climate conditions in which the present research was carried out, the foliar nutrition of plants in the soybean crop did not make them more resistant to pathogens, thus not justifying their use for this purpose. In general, the use of foliar nutrition did not alter plant morphology and did not influence gains for grain yield components.

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