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INFLUENCE OF ASSOCIATIONS BETWEEN CHEMICAL PACKAGES AND INOCULANTS WHEN SOYBEAN PRE-SOWING OR NOT. 2018/2019 HARVEST; PINDORAMA-SP

Ivana Marino Bárbaro
Colina Regional Research and Development Unit/SP
ORCID ID - 0000-0002-2954-2693

Everton Luis Finoto
Pindorama Regional Research and Development Unit/SP
http://lattes.cnpq.br/2248948833470312

Elaine Cristine Piffer Gonçalves
Colina Regional Research and Development Unit/SP
ORCID ID – 0000-0001-5797-6264

Fabio Oliviere de Nóbile
UNIFEB – Barretos/SP
ORCID ID – 0000-0001-9423-8420

José Antonio Alberto da Silva
Colina Regional Research and Development Unit/SP
http://Lattes.Cnpq.Br/1398758607886303

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Fernando Bergantini Miguel
Colina Regional Research and Development Unit/SP
ORCID ID – 0000-0002-4778-8961

Anita Schmidek
Colina Regional Research and Development Unit/SP
http://lattes.cnpq.br/3709782731891847

Marcelo Henrique de Faria
Colina Regional Research and Development Unit/SP
http://lattes.cnpq.br/4131019883040512

Regina Kitagawa Grizotto
Colina Regional Research and Development Unit/SP
http://lattes.cnpq.br/2809175495850519

Abstract: With the aim of analyzing parameters with a direct and indirect relationship to biological nitrogen fixation and production components in soybeans subjected to different seed treatments with inoculants containing different concentrations of bacteria associated or not with the use of a protector on the day of sowing and the 7 and 14 days prior to sowing (DAS), and their comparison with three different synthetic chemical packages from Basf, Bayer and Syngenta, three experiments were installed in the experimental area of APTA - Polo Regional Centro Norte located in Pindorama-SP, 2018/19 harvest .Each experiment involved a synthetic package applied to the six treatments, therefore with 24 experimental plots. The treatments tested were: T1 = Control (without inoculation); T2 = Nitrogen fertilization with 200 kg nitrogen ha-1 (in installments); T3 = Standard Inoculation1 (Inoculant A = lower concentration of Bradyrhizobium bacteria applied via seed on the day of sowing; T4 = Inoculation (Inoculant B = Higher concentration of Bradyrhizobium bacteria+ Max Protection) applied via seed on the day of sowing; T5 and T6 = Pre-inoculation (Inoculant B + Max Protection) applied to the seed with respectively 7 and 14 DAS The parameters analyzed in R2 in three plants per plot were NODT = total number of nodules; root; MSNDOT= total dry mass of nodules; and in R8, at harvest, the components MMG = mass of one thousand grains and PG = grain productivity. The experimental design was in a simple factorial scheme, 3 packages versus 6 treatments, each experiment. it was in randomized complete blocks with 4 replications. The data were subjected to analysis of variance using the F test and the means compared using the Tukey test at 5%. From the results obtained, it was observed that the overall average of the experiments was the package. from Basf was statistically superior to the others tested for NNOT and MSPA with average values of 17.57

units respectively. plant-1 and 28.64 g. plant-1. In turn, Bayer increased MSNODT, MSR, and PG with respectively 176.50 mg plant-1, 4.54 g plant-1, and 2837.92 kg ha-1 in relation to the other two packages. In relation to treatments, it was found that T4 stood out statistically in relation to the other treatments tested in the average of the three chemical packages in terms of all variables tested, being: with respectively: 34.38 nodules plant-1, 293.03 mg plant -1, 4.71 g, 31.89 g, 172.63 g and 2955.83 kg ha-1. The pre-inoculation treatment at 7 DAS using the B + protective inoculant (T5), despite being inferior to T4, was positioned shortly after and was equivalent to the treatment (T3) that used the standard inoculant A on the day of sowing. for the variables MSNOT, MSR, MSPA, MMG and PG, on the average of the three packages tested. Therefore, considering PG, it can be concluded that greater increases were related to the association of the Bayer chemical package with the T4 treatment, whose grain yield was 3037.50 kg. ha-1.
Keywords: Glycine max. L.; early inoculation, osmoprotector, concentration of Bradyrhizobium in the formulation, fungicides and insecticides.

INTRODUCTION

The traditional inoculation practice consists of applying the bacteria (Bradyrhizobium) to soybean seeds. Thus, soon after germination, the bacteria penetrates the root, colonizes and forms nodules, fixing atmospheric nitrogen. Substantial productivity gains are obtained with annual re-inoculation in soybean areas, which is what research carried out in the last decade has unanimously demonstrated. Therefore, the option to use rhizobia, in Brazil, is considered an established practice that presents productivity gains with a viable cost-benefit ratio for this crop, which represents one of the main Brazilian commodities (HUNGRIA et al., 2007).

Thus, inoculation using living organisms, if exposed to unfavorable conditions, the inoculum may lose its viability, as an example is the storage of seeds already inoculated and/or with phytosanitary treatment. Therefore, it is customary to recommend that seeds be inoculated after treatment with pesticides and on the same day as sowing (FIPKE, 2015). According to the same author, this becomes a major obstacle as the activity needs to be carried out carefully, especially "on farm", with a great demand for time and labor.

In turn, it is undeniable that the pests that attack soybean crops in both the root system and the aerial part must be combated via seed treatment, using insecticides, in order to prevent their damage to seeds and young plants (MARTINS et al., 2009). The initial treatment of seeds with phytosanitary products aimed at protecting seedlings against fungi and other pathogens, in this system, can represent up to 22% of the cost of purchasing seeds in Brazil (MALONE et al., 2007).

The least harmful way to use several active ingredients or commercial products is to apply them separately, mainly chemical products from biological ones. The furrow inoculation system offers this possibility with the advantage that it can be carried out simultaneously with the sowing operation, thus avoiding direct and harmful contact between the biological fraction and the chemical formulations, simply by using suitable equipment (PASTORE, 2016).

Other technologies have emerged to assist farmers in the inoculation process, such as pre-inoculation (early inoculation) made possible by the use of osmoprotectors (FIPKE, 2015). In search of optimizing the survival of the bacteria, and enabling the practice of inoculation in advance of the day of sowing (pre-inoculation), osmoprotective products can be used.

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Such substances provide the formation of a film, preventing direct contact with the inoculant and providing a substrate for the bacteria to survive during the period preceding the symbiosis. Complementing the function of osmoprotectors, inoculants with a higher concentration of bacteria can be used, as well as "communication" substances between seedlings and bacteria in order to enhance the early formation of nodules (FIPKE, 2015).

In view of the above, the objective of this work is to analyze parameters with a direct and indirect relationship to biological nitrogen fixation and production components in soybeans cultivated in Pindorama-SP, 2018/19 harvest, subjected to different seed treatments with inoculants. containing different concentrations of bacteria associated or not with the use of a protector in 0, 7 and 14 days prior to sowing, and their comparison with three different synthetic chemical packages from Basf, Bayer and Syngenta.

MATERIAL AND METHODS

EXPERIMENT LOCATION

The experiments were installed under field conditions, on November 22, 2018 and collected on April 4, 2019 at the Regional Center for Technological Development of Agribusiness in the North Center, linked to the São Paulo Agency for Agribusiness Technology – APTA, located in the municipality from Pindorama – SP. The region's relief is undulating with altitudes ranging from 498 to 594 m, whose geographic coordinates are 21º 13' south latitude and 48º 55' west longitude.

According to the Köppen Climate Classification (1948), the climate falls under Aw, defined as a dry winter mesothermal climate, where the average temperature of the coldest month is below 18 °C and of the hottest month, above 22 °C. °C. Table 1 contains the monthly meteorological data for the North Center Pole, with the averages for maximum and minimum temperatures being 31.13°C and 19.55°C, respectively, with average monthly precipitation of 167.3 mm, lower than the of the last harvest, which was 200 mm (CIIAGRO, 2019).

CHEMICAL PACKAGES, BIOINPUTS AND EXPERIMENTAL DESIGN

Three synthetic chemical packages were used to compose each experiment, being: 1 – BASF, 2 – BAYER and 3 – SYNGENTA.

1 – BASF package: composed of the commercial product Standak® Top (Pyraclostrobin + Methyl Thiophanate + Fipronil) at a dose of 2 mL per kg of seed;

2- BAYER package: composed of the commercial products Derosal Plus® (Carbendazim + Thiram) at a dose of 2 mL per kg of seed and Cropstar® (Imidacloprid + Thiodicarb) at a dose of 5 mL per kg of seed;

3- SYNGENTA package: composed of commercial products: Fortenza® (Cyantraniliprole)at a dose of 0.8 mL kg of seeds -1; Cruiser® 350 FS (Thiamethoxam) at a dose of 2 mL kg of seeds -1 and Maxim® XL (Fludioxonil + Metalaxyl-M) at a dose of 1 mL kg of seeds -1;

The treatments tested, as well as the doses of inoculants and protectant used in the present work are described in Table 2.

The experimental plot consisted of 4 lines of 15 m in length, and the useful area was considered to be the two central lines of 15 m in length and spacing between lines of 0.5 m (15 m2).

Thus, the experimental design was randomized blocks in a simple 3 x 6 factorial scheme composed of 3 synthetic chemical packages and 6 treatments described above

MONTH	Temp max ABSOL	Min temp ABSOL	Max temp MONTHLY	Temp Min. MONTHLY	MEDIUM Temperature	PRECIP	DCCH
	------------------------°C---------------------- ------------					mm	days
NOV 2018	34.5	16.2	29.9	19.3	24.6	142.8	17
DEC 2018	36	14	31.9	20.1	26	139.1	16
JAN 2019	36.4	18.7	32.8	20.7	26.8	78.7	14
FEB 2019	36.8	17.3	31	19.9	25.4	254.7	19
MAR 2019	34.4	16.6	30.9	19.4	25.2	242.6	13
APR 2019	33.9	12.3	30.3	17.9	24.1	145.9	10

Table 1: Monthly meteorological data from Pindorama-SP, referring to the period in which the experiments were conducted. Agricultural Year 2018/19. Source CIIAGRO: (2019).

DCCH = days of the month with rain; precip = precipitation; temp = temperature; absol. = absolute.

Number	Treatments	Inoculant Dose	Dose Max Protection
T1	Control (without inoculation)	---	----
T2	200 kg ha-1 of N (in installments at the base and in coverage)	---	----
T3	Inoculant A applied via seed on the day of sowing	100 mL/ 50 kg seeds	----
T4	B + Max Protection inoculant applied via seed on the day of sowing	100 mL/ 50 kg seeds	5 mL/ 5 kg seeds
T5	B + Max Protection inoculant applied via seed 7 days before sowing.	100 mL/ 50 kg seeds	5 mL/ 5 kg seeds
T6	B + Max Protection inoculant applied via seed 14 days before sowing.	100 mL/ 50 kg seeds	5 mL/ 5 kg seeds

Table 2: Treatments and doses of inoculants and protectant used to conduct experiments involving each chemical package. Agricultural Year 2018/19. North Central Regional Center. Pindorama-SP.

Inoculant A: Biomax® Premium Soy Liquid; Inoculant B: Biomax ® 10. Treatments T5 and T6 were stored in an air-conditioned place at 16°C until the sowing date of the experiments.

with 4 replications (Table 2). Each experiment involved a synthetic package applied to the six treatments, therefore with 24 experimental plots.

The description of the inoculants used in these experiments is below:

A) BIOMAX® PREMIUMLIQUID SOY (standard inoculant): liquid inoculant for soy, registered and produced by ``*Vittia Fertilizandos e Biológicas S/A*``, with bacteria as a guarantee *Bradyrhizobium japonicum* (Semia 5079 and Semia 5080), at a concentration of 7 x 109 colony forming units (CFU)/mL.

B) BIOMAX ® 10: Liquid inoculant for soybeans, registered and produced by ``*Vittia Fertilizandos e Biológicas S/A*``, guaranteed by bacteria Bradyrhizobium japonicum (Semia 5079 and Semia 5080), with higher concentration of CFU (colony forming units) per liter can guarantee: 1x1010 CFU/mL.

c) Max Protection: Additive for the inoculant that guarantees protection and adherence of bacteria to the seeds during inoculation, guaranteeing greater efficiency in nodulation. Its formulation contains an energy source for bacteria, ensuring concentration and enhancing inoculation efficiency.

CONDUCTING THE EXPERIMENT

Before installation, soil samples were collected from the experimental area for subsequent chemical and granulometric analysis, in addition to counting Bradyrhizobium bacteria and associative diazotrophic bacteria in the soil before sowing. The bacteria count was carried out at the Agricultural Microbiology Laboratory at FCAV/UNESP, Jaboticabal/SP campus in accordance with the recommendations of Dobereiner et al. (1995). The values found in the sample were: 6.69 x 107 CFU g-1 of dry soil of total bacteria, 3.56 x 107 CFU g-1 of dry soil of Bradyrhizobium bacteria and 3.5 x 106 CFU g-1 of dry soil of diazotrophic bacteria.

Soil samples for chemical (RAIJ et al., 2001) and granulometric (DAY, 1965) characterization were collected in October 2018, in the 0-0.20 m depth layer, and the results obtained were: pH (CaCl2) = 5.80; MO = 10.00 g dm-3; CO = 5.8 g dm-3; P =36.00 mg dm-3;K =3.1 mmolc dm-3; Ca = 26.00mmolc dm-3; mg = 11.00mmolc dm-3; H + Al =16.00mmolc dm-3; V = 71%,Total Sand = 892 g kg-1 of soil; Clay = 72 g kg-1 of soil and Silt = 36 g kg- of soil, with conventional soil preparation.

Sowing fertilization was carried out with fertilizer formulated 4-30-16, at a dose of (350 kg. ha-1). Only in Treatment T2 (200 kg ha-1 of Nitrogen) were the remainder of the N dose manually applied, half at the base and half as top dressing using the urea source, 35 days after emergence.

The soybean cultivar used was BRS 7380 RR. This cultivar is one of the highlights of the new generation of RR cultivars from Embrapa's genetic improvement program, being transgenic, free from patent technological fees, and has an early cycle, maturity group 7.3, resistance to the herbicide glyphosate, and associates resistance to races 3, 4, 6, 9, 10 and 14 of the soybean cyst nematode (Heterodera glycines) with resistance to the two root-knot nematodes, Meloidogyne incognita and Meloidogyne javanica, as well as presenting a low multiplication factor to the nematode Pratylenchus brachyurus . Due to these characteristics of multiple resistance to nematodes and their early cycle, it allows their use in the production system in succession of crops in regions whose soils have a history of problems with the aforementioned nematodes, increasing the sustainability of the agricultural production system (EMBRAPA, 2019).

35 seeds m-1 were sown in an experimental plot seeder with the aim of obtaining 16 plants per linear meter. For this, manual thinning was carried out to obtain the final average population of 320,000 plants ha-1.

Thus, in the laboratory, before sowing, that is, approximately 10 days before carrying out pre-inoculation, procedures were carried out to treat the seeds with the three chemical packages already mentioned. Subsequently, to compose the different treatments when using biological inputs, only treatments T3, T4, T5 and T6 were prepared according to the procedures described in Table 2, with treatments T1 and T2 not having the addition of inoculants or protectant and only the synthetic chemical packages.

Some precautions were adopted to ensure greater efficiency of the inoculants, such as seed inoculation carried out in the shade and uniform distribution of inoculants across all seeds. Thus, there was no direct contact between the inoculants and the chemical packages used in seed treatment. The treatments involving pre-inoculation were stored in an air-conditioned room at a temperature of 16°C until the date of sowing.

Fertilizer containing the micronutrients cobalt and molybdenum was applied via foliar spray at phenological stage V5 (FEHR; CAVINESS, 1977), in all treatments including the non-inoculated control. Disease and pest control were also carried out using fungicides and insecticides when necessary.

All soybean cultivation techniques, such as cultivar choice, sowing time, plant population, control of weeds, insects and diseases followed the technical recommendations for soybean cultivation by EMBRAPA (2013).

ASSESSMENTS

At full flowering R2, 3 plants were collected per experimental plot in each of the experiments conducted. Thus, the parameters evaluated were: total number of nodules (NODT) in unit, plant-1; total dry nodule mass (MSNODT) in mg plant-1, dry mass of the shoot (MSPA) and root (MSR) in g plant-1.

At maturation (R8) the following were evaluated:

-mass of a thousand grains (MMG) = determined by weighing three subsamples of 100 grains, per repetition, multiplying the results by 10 (BRASIL, 2009);

- grain productivity (PG) = harvested in the two central lines of 15 m in length and spacing between lines of 0.5 m. From the average values referring to the production of the plots of each treatment, productivity was calculated, expressed in kg ha-1 (values corrected for 13% humidity).

STATISTICAL ANALYSIS OF RESULTS

The results obtained were subjected to simple analysis of variance (ANAVA). If there was a difference between treatments, the means were compared using the Tukey test with a significance of 5%. Statistical analyzes were carried out using the SISVAR statistical program (FERREIRA, 2011).

RESULTS AND DISCUSSION

In Table 3 The general results obtained for parameters related to biological nitrogen fixation and production components are included in the comparison of three synthetic chemical packages for soybeans subjected to six treatments involving inoculation with commercial inoculant B with a higher concentration of Bradyrhizobium bacteria associated with a protector applied to 0, 7 and 14 days before sowing, as well as traditional inoculation (inoculant A with the usual number of bacteria applied on the day of sowing), chemical nitrogen fertilization and control without inoculants.

Significant effects of the factors packages (P), treatments (T) and interaction P versus T were noted for all variables analyzed, with the exception of the factor P for MMG which was non-significant.

When analyzing the synthetic chemical package factor (Table 3) it is noted that in the general average of the experiments, the BASF was statistically superior to the others tested for NNOT and MSPA with average values of 17.57 units respectively. plant-1 and 28.64 g. plant-1. According to Alcântara Neto et al. 2014, treatment involving the use of Standak Top® (fipronil, pyraclostrobin and methyl thiophanate) and inoculant demonstrated a lower toxic effect on rhizobial bacteria. On the other hand, the Bayer package stood out for most of the variables analyzed MSNODT, MSR, and PG, being statistically superior to the others tested with respectively 176.50 mg plant-1, 4.54 g plant-1, and 2837. 92 kg ha-1. The Syngenta package was the least expressive among the packages tested for MSNODT and MSR in the overall average with respectively 113.33 mg and 3.48g. plant-1. In research carried out by Costa et al. (2013), for example, it was reported that the use of a fungicide based on carbendazim + thiram and another based on fludioxonil + mefenoxam caused a slightly

CHARACTERS	NODT[1]	MSNOT[1]	MSR[1]	MSPA[1]	MMG	PG
	Unit plant-¹	mg plant-¹	----------G--------		g	kg ha-¹
PACKAGES (P)						
1-BASF	17.57 a	134.72b	3.77b	28.64 a	167.34 a	2600.92b
2-BAYER	11.50 b	176.50 to	4.54 to	24.07c	167.37 a	2837.92 a
3-SYNGENTA	12.01b	113.33c	3.48c	25.76b	167.62 a	2606.33b
F(P)	35.29**	77.57**	66.80**	27.09**	0.163ns	109.39**
TREATMENTS (T)						
T1 = Control (without addition of biological inputs)	5.17	78.26c	3.36d	20.33 d	160.08 and	2408.33 and
T2 =Nitrogen chemical fertilizer (200 kg N ha-¹)	3.75 and	76.69c	4.36 ab	28.11b	170.36b	2665.83c
T3=Inoculant A applied via seed on the day of sowing	19.31b	129.44b	3.76c	26.53b	166.64 CD	2741.00 bc
T4=Inoculant B + Protector applied via seed on the day of sowing	34.28 a	293.03 to	4.71 to	31.89 to	172.63 a	2955.83 a
T5=Inoculant B + Protector applied via seed 7 days after sowing	12.28c	144.51b	4.07 bc	26.83b	168.86 bc	2750.17b
T6=Inoculant B + Protector applied via seed 14 days after sowing	7.39d	127.17b	3.34d	23.25c	166.10d	2569.17d
F (T)	208.32**	236.90**	33.76**	40.44**	63.79**	102.19**
F INTERACTIONS						
F (PXT)	15.80**	35.78**	5.07**	4.38**	3.05*	15.88**
CV (%)	20.27	12.63	8.35	8.31	1.12	2.36
GENERAL AVERAGE	13.69	141.52	3.93	26.16	167.45	2681.72

Table 3. Parameters evaluated at flowering full (R2) and at harvest (R8) of experiments involving the use of three synthetic chemical packages and their interaction with pre-inoculation treatments or not with inoculant B with a higher concentration of bacteria (Bradyrhizobium) associated with the use of a protector in soybean and its non-inoculated controls, chemical nitrogen fertilization and inoculation with standard inoculant A on the day of sowing. Agricultural Year 2018/19. North Central Regional Center. Pindorama-SP.

Average of four repetitions followed by the same lowercase letters in the column do not differ from each other by the Tukey test at 5%;T1 = Control (without inoculation); T2 = Nitrogen fertilization with 200 kg nitrogen ha-1 (in installments); T3 = Standard Inoculation1 (Inoculant A = Biomax® Premium Liquid Soy) applied via seed on the day of sowing; T4 = Inoculation (Inoculant B = Biomax® 10 + Max Protection) applied via seed on the day of sowing; T5 = Pre-inoculation (Inoculant B = Biomax®10 + Max Protection) applied via seed 7 days before sowing; T6 = Pre-inoculation (Inoculant B =Biomax®10 + Max Protection) applied via seed 14 days before sowing; NODT = total number of nodules; MSPA = aerial part dry mass; MSR = root dry mass; MSNDOT= total dry mass of nodules; MMG = mass of one thousand grains; PG = grain productivity; 1 Average of three plants per replication respectively.

toxic effect on nodulation. These authors used soils from native forests, which did not have efficient populations of Bradyrhizobium.

The compatibility between synthetic and biological chemical inputs is of great importance in preserving the beneficial species that inhabit agroecosystems. An example of this is the need for compatibility of inoculants based on Bradyrhizobium spp., Azospirillum spp. and, more recently, Bacillus spp. which are usually made available to plants via seed treatment with insecticides, fungicides and micronutrients (SANTOS et al., 2021). Among the benefits of the compatible use of bioinputs with synthetic inputs is the greater sustainability of the production system, with less frequent pest outbreaks (as a result of the balance of the agroecosystem), reduction in application costs, greater efficiency of biological nitrogen fixation and promotion of plant growth. These benefits will provide greater profitability for soybean farmers and contribute to more sustainable agriculture (MEYER et al., 2022).

Regarding the Treatments factor, it was found that the T4 treatment, whose inoculation was carried out on the day of sowing with inoculant B with a higher concentration of bacteria + protector, stood out statistically in relation to the other treatments tested on the average of the three chemical packages in terms of all the variables tested being: NODT, MSNODT, MSR, MSPA, MMG and PG with respectively: 34.38 nodules plant-1, 293.03 mg plant-1, 4.71 g, 31.89 g, 172.63 g and 2955.83 kg ha-1. In turn, treatment T2 (chemical nitrogen fertilization) regarding the NODT and MSNODT parameters ranked with the worst average values among the treatments tested with respectively 3.76 nodules plant-1 and 76.69 mg plant-1.

Regarding the pre-inoculation treatment 7 days before sowing with the use of inoculant B + protector (T5), it is noted that despite being statistically inferior to T4, it was positioned immediately after and was equivalent to the treatment (T3) who used inoculant A on the day of sowing for the variables MSNOT, MSR, MSPA, MMG and PG. However, the same pre-inoculation treatment when carried out 14 days before sowing (T6) was equivalent to a non-inoculated control (T1) for NODT and MSR and superior to T1 for PG, MMG, MSPA and MSNODT. The non-inoculated control (T1) promoted the greatest decreases in all tested variables NODT, MSNODT, MSR, MSPA, MMG and PG when compared to the other treatments tested.

When unfolding packages within each treatment (Table 4) for NODT, it was found that for the non-inoculated control (T1), chemical nitrogen fertilization (T2) and pre-inoculation at 14 days after sowing using the protective inoculant B + (T6) there are no statistical differences between the tested packages. Analyzing the T4 treatment, the statistical superiority of the Basf package for NODT is noted, followed by Bayer's, which was superior to Syngenta's. For T5, Basf's was also superior to the other packages, with Bayer's and Syngenta's being inferior to the first and statistically similar. As for T3, it is noted that the highlight was that of Basf, but that of Syngenta was statistically superior to that of Bayer. When breaking down the Basf package into treatments, it was found that the T4 treatment was statistically superior to the others, with an average value of 43.25 nodules. plant-1. Then, T3 was positioned with 31.83 nodules, being superior to treatments T5, T6, T2 and T1. Treatment T5 with 16.33 nodules was statistically superior to T6, which presented 8 nodules and did not differ from the control treatments without inoculant (T1) and chemical nitrogen fertilization (T2), with respectively 3.5 and 2.5 nodules per plant. Considering the Bayer package, it is noted that again T4, which used inoculant B with a higher concentration of bacteria +

protector applied on the day of sowing, was the highlight with 32.67 nodules plant-1. Treatment T5 was positioned after T4, not differing from treatments T6, T3 and T1. The worst treatment for NODT in the Bayer package was chemical nitrogen fertilizer (T2) which showed an average number of nodules of 3.5 nodules per plant. In turn, when analyzing the Syngenta package, T4 also stood out with 26.92 nodules. T3 was positioned next, with 17.17 nodules plant-1, being higher than the other treatments tested, which were statistically similar.

For MSNODT, it is noted that for treatments T1, T2 and T3 the packages did not differ significantly according to the means test applied. Considering T4, Bayer's package stood out, being superior to the others, followed by Basf's, which was statistically superior to Syngenta's. For T5, the Bayer package also stood out, followed by the Basf and Syngenta packages, which did not differ from each other. In T6, the highlight was also Bayer, followed by Syngenta, which was statistically superior to Basf. In turn, within the Basf package, it appears that T4 stood out with 311.60 mg plant-1, differing from the other treatments tested. Next were treatments T3 and T5, which were statistically similar and superior to treatments T1, T2 and T6, which were statistically equal and promoted the smallest increases in MSNODT of respectively 85.03, 70.83 and 77.50 mg.plant- 1. In the Bayer package, T4 was again statistically superior with 410 mg plant-1. Soon after, T5 and T6 were positioned with respectively average values of 173.50 and 191.50 mg plant-1. The T3 treatment was statistically inferior to those mentioned with 135.00 mg and superior to the T1 and T2 treatments, which did not differ from each other and presented respectively 79.75 and 69.25 mg.plant-1. Within the Syngenta package, treatments T4, T5 and T3 stood out and were statistically similar with average values of 157.50, 127.50 and 122.50 mg plant-1 being higher than the others. T6, which consisted of pre-inoculation at 14 days, was positioned shortly after with an average of 112.50 mg, being statistically superior to the T1 and T2 treatments with 70 and 90 mg plant-1. It is known that the application of certain insecticides and fungicides in the treatment of legume seeds, such as soybeans, can cause a reduction in the population of diazotrophic bacteria used in microbial inoculants (ANNAPURNA, 2005). This problem can be aggravated in pre-inoculated seeds, as these are stored until the day of planting and thus there is a greater possibility of chemicals interacting with bacteria (LOPES,2016).

For MSR, it is noted that for treatments T1 and T3 there are no differences in relation to the packages tested. Considering the T4 treatment, the Bayer package stood out, being superior with 5.44 g, followed by Basf and Syngenta, which did not differ from each other and presented respectively averages of 4.55 and 4.14 g. For T5, the Bayer package with 5.25 g plant-1 also stood out, followed by the Basf (3.49 g) and Syngenta (3.47g) packages, which did not differ from each other. In T6, the highlight was also that of Bayer with an average value of 3.74 g, differing statistically only from the Syngenta package with 2.94 g plant-1. In the breakdown of the Basf package, treatments T4 and T2 stood out and were statistically similar to each other with averages of 4.55 and 4.24 g. plant-1.

Then, T3 was positioned with 3.74 g, which was higher than the treatments T1, T5 and T6, which were statistically equal and with averages of 3.27, 3.49 and 3.34 g, respectively. In the Bayer synthetic package, it is noted that T2, T4 and T5 were the treatments that most increased root dry biomass with respectively 5.27, 5.44 and 5.25 g, statistically differing from the other treatments T1, T3 and T6 which were statistically similar with respectively 3.68, 3.88 and 3.74 g. plant-1. In the Syngenta synthetic package, it was found that the highlights were the treatments T2, T3, T4 and T5 with average values of respectively 3.57, 3.66, 4.14 and 3.47 g, which were statistically similar and superior to the others. treatments. T6 was statistically inferior to the non-inoculated control (T1), presenting respectively 2.94 and 3.13 g. plant-1.

In relation to MSPA only for the non-inoculated control (T1) the packages were similar to each other. In the other treatments, there were statistical differences between the treatment versus packages interaction. In relation to treatments T3 and T5, it is noted that the Basf and Syngenta packages stood out and did not differ from each other with respectively 29.33; 29.17, 28.83 and 28.00 g, being higher than the Bayer package with 21.42 and 23.33 g respectively for T3 and T5. For T4, Basf and Bayer did not differ from each other and presented averages of 34.67 and 31.17 g respectively, with the Basf package differing only from Syngenta's, which had an average of 29.83 g. As for T6, it is noted that the Basf package was statistically superior to the others with 26.34 g plant-1 and the two other packages were statistically similar. As for the treatments within the Basf package, it appears that T4 and T2 stood out and did not differ from each other with the highest average values between the treatments tested, respectively 34.67 and 32.50 g. plant-1. Next were treatments T3 and T5 with 29.33 and 29.17 g respectively, which differed from T6 with 26.34 g, which was higher than T1, which had the worst average MSPA value of 19.83 g plant-1. In the Bayer package, T4 stood out with 31.17 g and was superior to the other treatments. Treatments T2 and T5 were positioned later at 26.50 and 23.33 g. plant-1. And with the worst increases in terms of MSPA within the Bayer package were T1, T3 and T6 with respectively 20.83, 21.42 and 21.17 g. plant-1. In the Syngenta package for this same parameter, it is noted that treatments T2, T3, T4 and T5 were not statistically different from each other and were superior to the other treatments tested with means of respectively 25.33, 28.83, 29.83 and 28.00 g plant-1. Next was T6 with 22.25 g and the lowest average value within the package was associated with the non-inoculated control (T1) with 20.33 g. plant-1.

Benedett, 2016, found that the dry mass of the aerial part per plant did not change significantly in relation to the control, with no statistical differences between any of the treatments evaluated for this parameter. The same author analyzes that his result suggests that some plants, which practically did not nodulate, obtained a supply of nitrogen from the soil. Due to the presence of nitrogen in the soil, the correlation between nodulation and dry mass of the shoot was not evident.

In Table 5, for MMG in the breakdown of each treatment within the tested packages, it is noted that only for treatments T1 (non-inoculated control) and T6 (early inoculation at 14 days after sowing with inoculant B of higher bacterial concentration + protector) had differences between the tested packages. In the case of T1, the Basf package was superior to the other two with an average of 162.43 g. In relation to T6, Syngenta's was higher than Basf's, not differing from Bayer's, with an average value of 168.02 g of thousand grain mass. In the breakdown of the Basf synthetic package, it is noted that treatments T2, T4 and T5 were statistically equal and were superior to the other treatments tested. It is worth mentioning that in this situation, chemical nitrogen fertilization was equivalent to the use of inoculant B with a higher concentration of bacteria + protector and could be sown up to 7 days in advance (T5), as it was equivalent to T4. Then, T3 (standard inoculant A) was positioned, which was statistically superior to

NODT – Number of total nodules in plant-1 units				
	Technological chemical packages			
Treatments	1-Basf	2-Bayer	3-Syngenta	F(T)
T1	3.50 A d	6.17 A bc	5.83 BC	1.10ns
T2	2.50 A d	3.50 ac	5.25 BC	1.00ns
T3	31.83 Ab	8.92C bc	17.17 Bb	69.95**
T4	43.25 A to	32.67 B a	26.92 C a	35.64**
T5	16.33 BC	10.59 Bb	9.92 B c	6.46**
T6	8.00 A d	7.17 A bc	7.00 BC	0.15ns
F (P)	143.43**	58.87**	37.62**	-
MSR – Root dry mass in grams plant-1				
Treatments	1-Basf	2-Bayer	3-Syngenta	F(T)
T1	**3.27 BC**	**3.68 A b**	**3.13 A bc**	**2.95ns**
T2	**4.24 B ab**	**5.27 A to**	**3.57 C abc**	**27.38****
T3	**3.74 A bc**	**3.88 A b**	**3.66 A ab**	**0.45ns**
T4	**4.55 B a**	**5.44 A to**	**4.14 B a**	**16.58****
T5	**3.49 Bc**	**5.25 A to**	**3.47 B abc**	**38.82****
T6	**3.34 AB c**	**3.74 Ab**	**2.94 Bc**	**5.94***
F (P)	**9.96****	**27.34****	**6.59****	
MSPA – Dry mass of the aerial part in grams plant-1				
Treatments	1-Basf	2-Bayer	3-Syngenta	F(T)
T1	**19.83 A d**	**20.83 BC**	**20.33 BC**	**0.12ns**
T2	**32.50 A ab**	**26.50 B b**	**25.33 B ab**	**12.52****
T3	**29.33 A bc**	**21.42 B c**	**28.83 A to**	**16.64****
T4	**34.67 A to**	**31.17 AB a**	**29.83 B a**	**5.27***
T5	**29.17 A bc**	**23.33 B bc**	**28.00 A to**	**8.06****
T6	**26.34 BC**	**21.17 Bc**	**22.25 Bbc**	**6.28****
F (P)	**22.83****	**14.02****	**12.36****	
MSNODT – Dry mass of total nodules in mg. plant-1				
Treatments	1-Basf	2-Bayer	3-Syngenta	F(T)
T1	**85.03 BC**	**79.75 A d**	**70.00 A d**	**0.73ns**
T2	**70.83 BC**	**69.25 A d**	**90.00 A CD**	**1.67ns**
T3	**130.83 A b**	**135.00 BC**	**122.50 abc**	**0.51ns**
T4	**311.60 B a**	**410.00 A to**	**157.50 C a**	**202.89 ****
T5	**132.53 B b**	**173.50 A b**	**127.50 B ab**	**7.98****
T6	**77.50 C c**	**191.50 A b**	**112.50 Bbc**	**42.72****
F (P)	**103.04****	**193.75****	**11.67****	

Table 4: Breakdown of the interaction for parameters related to biological nitrogen fixation evaluated at the R2 phenological stage in experiments involving three synthetic chemical packages subjected to six treatments, including pre-inoculation with inoculant B with a higher concentration of bacteria associated with the use of a protector, compared to inoculation on the day of sowing with standard inoculant A, non-inoculated control and chemical nitrogen fertilization. Pindorama-SP. 2018/19 harvest.

Average of four repetitions followed by the same uppercase letters in the row and lowercase letters in the column do not differ from each other by the Tukey test at 5%;T1 = Control (without inoculation); T2 = Nitrogen fertilization with 200 kg nitrogen ha-1 (in installments); T3 = Standard Inoculation1 (Inoculant A = Biomax® Premium Liquid Soy) applied via seed on the day of sowing; T4 = Inoculation (Inoculant B = Biomax® 10 + Max Protection) applied via seed on the day of sowing; T5 = Pre-inoculation (Inoculant B + Max Protection) applied via seed 7 days before sowing; T6 = Pre-inoculation (Inoculant B + Max Protection) applied via seed 14 days before sowing; NODT = total number of nodules; MSPA = aerial part dry mass; MSR = root dry mass; MSNDOT= total dry mass of nodules; 1 Average of three plants per replication respectively.

the non-inoculated control (T1) and equally compared to T6 (use of inoculant B with a higher concentration of bacteria + protector) applied after 14 days of prior to planting.

In the Bayer package for MMG, it was found that T4 and T2 stood out in relation to the others, with T2 not differing from T5 and T3, which were superior to the non-inoculated control with 158.98 g. Treatment T6 was superior to T1 and similar to T5 and T3 with an average of 165.76 g. Within the Syngenta package, T2 and T4 also stood out statistically with averages of 171.89 and 173.45 g, respectively. Soon after were treatments associated with the use of higher inoculant B

Concentration of bacteria +protector applied 7 and 14 days in advance, which did not differ from T3, which consisted of the use of standard inoculant A applied on the day of sowing. The worst treatment was the non-inoculated control (T1) with an average MMG value of 158.84 g.

When analyzing the PG, in the breakdown of each treatment within the tested packages, it is noted that for treatments T2 and T4, the Bayer and Syngenta packages were statistically similar and superior to Basf, with average values of respectively 2745.00 and 2752.50 kg. ha-1 for T2 and 3037.50 and 2970.00 kg. ha- 1 in T4. For treatments T3, T5 and T6, the Bayer package stood out compared to the others, with Basf and Syngenta being statistically similar. For the non-inoculated control, Bayer's was also superior to the other two, followed by Basf's, which was superior to the Syngenta package. In the breakdown of the Basf package, it is noted that T4 was statistically superior to the other treatments tested with an average value of 2860 kg. ha-1. Soon after, treatments T3 and T5 were positioned, the first consisting of the use of a traditional inoculant with a lower concentration of bacteria and the second with an advance application of 7 days of sowing with an inoculant with a higher bacterial concentration associated with the protector, with average values of respectively 2695.50 and 2690.00 kg. ha-1 which were higher than treatments T1, T2 and T6 which obtained the lowest average PG values. Within the Bayer package, T4 was again the highlight with 3037.50 kg. ha-1. Then, T3 and T5 were positioned, which were equivalent to each other and also between T6 and T2. The lowest average value among the treatments tested was the non-inoculated control T1, which presented an average of 2710.00 kg. ha-1. For the Syngenta package, a similar situation occurred to the others, that is, the highlight was T4 with 2970 kg. ha-1. Soon after, treatments T2, T3 and T5 were positioned with averages of respectively 2752.50, 2675 and 2718 kg. ha-1, followed by T6 with 2410 kg. ha-1 which was lower than those already mentioned, but statistically higher only T1 which presented an average of 2112.50 kg. ha-1.

Zilli, Campo and Hungary (2010), studying the feasibility of pre-inoculation of soybean seeds, showed that it was possible to carry out it up to 5 days before sowing, however in their study there was no use of a synthetic package and only bioinputs. In turn, Fipke et al. (2015) found the possibility of bringing forward inoculation within 7 days of sowing with the use of synthetic packages, more bioinputs and osmoprotectant in the seed without compromising soybean productivity.

CONCLUSIONS

On average of the three chemical packages tested, treatment T4, that is, inoculation with commercial inoculant B with a higher concentration of bacteria + protector, stood out in terms of all the variables tested;

Despite this, it is worth highlighting that the treatment of pre-inoculation 7 days before sowing using inoculant B + protective (T5) despite being inferior to T4, it was positioned immediately afterwards and was equivalent

Treatments	1-Basf	2-Bayer	3-Syngenta	F(T)
	Technological chemical packages			
MMG – Mass of a thousand grains in grams				
T1	**162.43 A d**	**158.98 B d**	**158.84 B d**	**4.68***
T2	**168.93 A ab**	**170.25 A ab**	**171.89 A b**	**2.49ns**
T3	**167.08 A bc**	**167.77 A bc**	**165.08 BC**	**2.20ns**
T4	**171.18 A to**	**173.26 A to**	**173.45 A to**	**1.80ns**
T5	**169.90 A ab**	**168.21 A bc**	**168.47 A bc**	**0.93ns**
T6	**164.53 Bcd**	**165.76 AB c**	**168.02 A bc**	**3.54***
F (P)	**12.64****	**26.43****	**30.91****	-
PG -Grain productivity in kg. ha-1				
Treatments	1-Basf	2-Bayer	3-Syngenta	F(T)
T1	**2402.50 Bc**	**2710.00 BC**	**2112.50 Cd**	**88.93****
T2	**2500.00 B c**	**2745.00 A bc**	**2752.50 A b**	**20.56****
T3	**2695.50 Bb**	**2852.50 A b**	**2675.00 Bb**	**9.39****
T4	**2860.00 B a**	**3037.50 A to**	**2970.00 A to**	**7.99****
T5	**2690.00 Bb**	**2842.50 A b**	**2718.00 Bb**	**6.56****
T6	**2457.50 B c**	**2840.00 A bc**	**2410.00 B c**	**55.36****
F (P)	**30.70****	**12.96****	**90.29****	

Table 5: Breakdown of the interaction for parameters related to production components in experiments involving three technological chemical packages subjected to six treatments, including pre-inoculation with an inoculant with a higher concentration of bacteria associated with the use of a protector, compared to inoculation on the day of sowing with inoculant standard, control and chemical nitrogen fertilization. Harvest.2018/19. Pindorama-SP

Average of four repetitions followed by the same uppercase letters in the row and lowercase letters in the column do not differ from each other by the Tukey test at 5%;T1 = Control (without inoculation); T2 = Nitrogen fertilization with 200 kg nitrogen ha-1 (in installments); T3 = Standard Inoculation1 (Inoculant A = Biomax® Premium Liquid Soy) applied via seed on the day of sowing; T4 = Inoculation (Inoculant B = Biomax® 10 + Max Protection) applied via seed on the day of sowing; T5 = Pre-inoculation (Inoculant B + Max Protection) applied via seed 7 days before sowing; T6 = Pre-inoculation (Inoculant B + Max Protection) applied via seed 14 days before sowing; MMG = mass of one thousand grains; PG = grain productivity.

to the treatment (T3) that used standard inoculant A on the day of sowing for the variables MSNOT, MSR, MSPA, MMG and PG, on the average of the three packages tested.

On average of the treatments tested, the packages differed in terms of the variables tested, with the Basf package increasing the NNOT and MSPA, Bayer's MSNOT, MSR and PG and the Syngenta package had the lowest expression in terms of the variables tested;

In terms of PG, considering the interaction of packages versus treatments, the highlight was the association of the Bayer chemical package with the T4 treatment with a grain yield of 3037.50 kg. ha-1, highlighting that this package was superior in all treatments tested.

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