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Soil water restriction and performance of soybean seeds treated with phytosanitary products[1]

Restrição hídrica no solo e desempenho de sementes de soja tratadas com produtos fitossanitários

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HIGHLIGHTS:
Simulated soil water restriction results in assertive results compatible with the field realities.
The superficial water deficit does not affect the performance of soybean seeds and seedlings.
With dry soil, the effect of seed treatment on early soybean development depend on the product and the time of application.

ABSTRACT: The effect of phytosanitary products on the initial performance of soybean crops under soil water deficit conditions was determined via seed treatment before and after storage. A randomized block design was used in a split-plot scheme with four replicates. Plots with and without soil water deficit were established in a previously cultivated field. The subplots consisted of the following phytosanitary chemical seed treatments: Abamectin + thiamethoxam + fludioxonil + metalaxyl-M + thiabendazole, Fipronil + pyraclostrobin + methyl thiophanate, Fludioxonil + metalaxyl-M + thiabendazole, Fludioxonil + metalaxyl-M, Tiofanato-metílico+Fluazinam, Carbendazim + tiram, Chlorantraniliprole, Acetamiprid, Fipronil, Thiamethoxam, Imidacloprid + thiodicarb, and a control (water). The emergence percentage, emergence speed index, mean emergence time, and seedling dry matter were evaluated immediately after phytosanitary treatment and after six months of storage for the treated seeds. Initial seedling development was impaired by soil water deficit, with a mean matric potential of -26 kPa at a soil depth of 5 cm and -20 kPa at 10 cm. The treatment of seeds with fungicides favored the initial development of soybean seedlings, especially under soil water restriction. It was determined that treatment with insecticidal and nematicides for six months in advance affects seed vigor and the initial performance of soybean crops with different intensities depending on the active ingredient.

Key words: *Glycine max*, safe storage, water deficit, drought, seed treatment

RESUMO: O objetivo foi verificar o efeito de produtos fitossanitários via tratamento de sementes, antes e após o armazenamento, sobre o desempenho inicial da soja em condição de déficit hídrico no solo. O delineamento foi em blocos casualizados em esquema de parcelas subdivididas, com quatro repetições. A parcela principal foi constituída pela ausência e presença de déficit hídrico no solo, em um campo previamente cultivados. As subparcelas foram constituídas pelos tratamentos químicos fitossanitários de sementes: Abamectin + thiamethoxam + fludioxonil + metalaxyl-M + thiabendazole, Fipronil + pyraclostrobin + methyl thiophanate, Fludioxonil + metalaxyl-M + thiabendazole, Fludioxonil + metalaxyl-M, Tiofanato-metílico+Fluazinam, Carbendazim + tiram, Chlorantraniliprole, Acetamiprid, Fipronil, Thiamethoxam, Imidacloprid + thiodicarb e Controle (água). As avaliações da porcentagem de emergência, índice de velocidade de emergência, tempo médio de emergência e massa seca de plântulas foram realizadas logo após o tratamento fitossanitário e após seis meses de armazenamento das sementes tratadas. O desenvolvimento inicial das plântulas é prejudicado pelo déficit hídrico no solo, com potencial matricial médio de -26 kPa, à 5 cm, e -20 kPa à 10 cm de profundidade do solo. O tratamento de sementes com fungicidas favorece o desenvolvimento inicial de plântulas de soja, principalmente sob restrição hídrica no solo. O tratamento com inseticidas e nematicida e armazenamento das sementes por seis meses, afeta o vigor das sementes e desempenho inicial da cultura soja, com diferentes intensidades em função do ingrediente ativo.

Palavras-chave: *Glycine max*, armazenamento seguro, déficit hídrico, seca, tratamento de sementes

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Introduction

In agriculture, due to inconsistencies and climatic phenomena, it is common to have an irregular distribution of rainfall immediately after sowing, resulting in reduced stands and plant growth. Seed treatment, in addition to promoting the control of pathogens and pests, may favor the emergence and development of plants subjected to water stress.

Some compounds can promote beneficial changes in plants, increasing their tolerance to water stress and consequently yield (Balardin et al., 2011). Conceição et al. (2014) reported better stands from seeds treated with fungicide and insecticides during presowing. Bortoletto et al. (2017) reported that seed treatment should be applied up to 90 days before sowing, depending on the products used.

Although early treatment of soybean crops 60 days before sowing can affect initial development, especially when insecticides are applied, it does not affect productivity. Phytotoxicity caused by the early treatment of soybean seeds is evident from their root length (Carvalho et al., 2020). Treatments with insecticides affect the germination and growth variables of seedlings, with more severe phytotoxic effects than those observed for fungicides (Rocha et al., 2020).

Several variables are involved in the relationship between the chemical treatment of seeds and soybean performance in the field, including the composition of constantly evolving seed treatment formulations such as fungicides, insecticides, and nematicides. Thus, studies involving the use of different molecules in seed treatment and storage and their relationship with the initial performance of soybeans are necessary, especially under conditions of soil water deficit during their establishment.

The present study aimed to verify the effects of phytosanitary products (insecticides, fungicides, and nematicides) applied as an early seed treatment and at the time of sowing on the initial performance of soybeans subjected to water stress in the field.

Material and Methods

The experimental field of the study was located in Monte Carmelo, Minas Gerais, Brazil (18° 42' 43.19" S, 47° 29' 55.8" W Gr) with a mean altitude of 873 m. According to the Köppen classification, the climate is Aw (tropical climate with a dry winter season). The soil was classified as Oxisol, with a texture consisting of 240, 50, and 710 g kg^{-1} total sand, silt, and clay, respectively. The soil water retention curve for the experimental area is shown in Figure 1.

A randomized block design was used with four replicates in a split-plot scheme, with the experimental unit consisting of 50 seeds with beds 1.2 m wide. The plots were characterized by the occurrence or absence of soil water deficit, simulated with supplementary irrigation to maintain ideal soil moisture during the initial 14 days. For the water stress condition, irrigation was not used during the initial development of the crop; both plots were irrigated on the day of sowing until 70% of the field capacity was reached. Subsequently, as only the plot without water deficit received daily irrigation, the soil water tension at a 5-cm depth remained close to 10 kPa. Tensiometry was used to monitor water availability in the soil, and puncture tensiometers were installed at depths of 5 and 10 cm; the tension was measured daily with a tensiometer.

The subplots consisted of seeds treated with different phytosanitary products. Before the seed treatments, the water content was determined using the incubator method at 105 °C for 24 h (Brasil, 2009), with four replicates of 50 seeds.

Seeds from the SYN 9074 RR soybean cultivar lot were divided into 2-kg portions and then treated with phytosanitary products. The seed treatments involved 11 phytosanitary products, while the control treatment only used water (Table 1).

The maximum solution volume was 1000 mL (product + water, where the indicated product dosage was used, and the remaining volume was water) 100 kg^{-1} of seeds. After

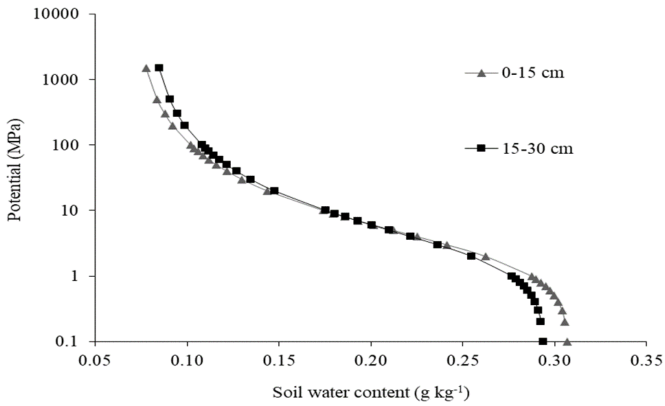


Figure 1. Soil water retention curve performed in the experimental area

Table 1. Active ingredients, commercial products, classification, and doses used in the soybean seed treatment

Active ingredient	Commercial name	Classification[1]	Commercial product dose[2]	Water dose[3]
Imidacloprid + thiodicarb	Cropstar ®	I + I	600	400
Thiamethoxam	Cruiser 350 FS®	I	300	700
Tiofanato-metílico + Fluazinam	Certeza®	F	180	420
Acetamiprid	Pyramid ®	I	200	800
Abamectin + thiamethoxam + fludioxonil + metalaxyl -M + thiabendazole	Avicta Complete ®	N + I + F	500	500
Fludioxonil + metalaxyl-M + thiabendazole	Maxim Advanced ®	F	100	900
Fludioxonil + metalaxyl-M	Maxim XL ®	F + F	100	900
Carbendazim + tiram	Protreat ®	F	200	800
Fipronil + pyraclostrobin + methyl thiophanate	Standak Top ®	I + F + F	200	800
Chlorantraniliprole	Dermacor ®	I	200	800
Fipronil	Belure ®	I	100	900
Control	-	-	-	1000

[1] I - Insecticide; F - Fungicide; [2] Commercial product dose - mL 100 kg^{-1} of seeds; [3] Water dose - mL 100 kg^{-1} of seeds; solution volume: 1000 mL 100 kg^{-1} of seeds

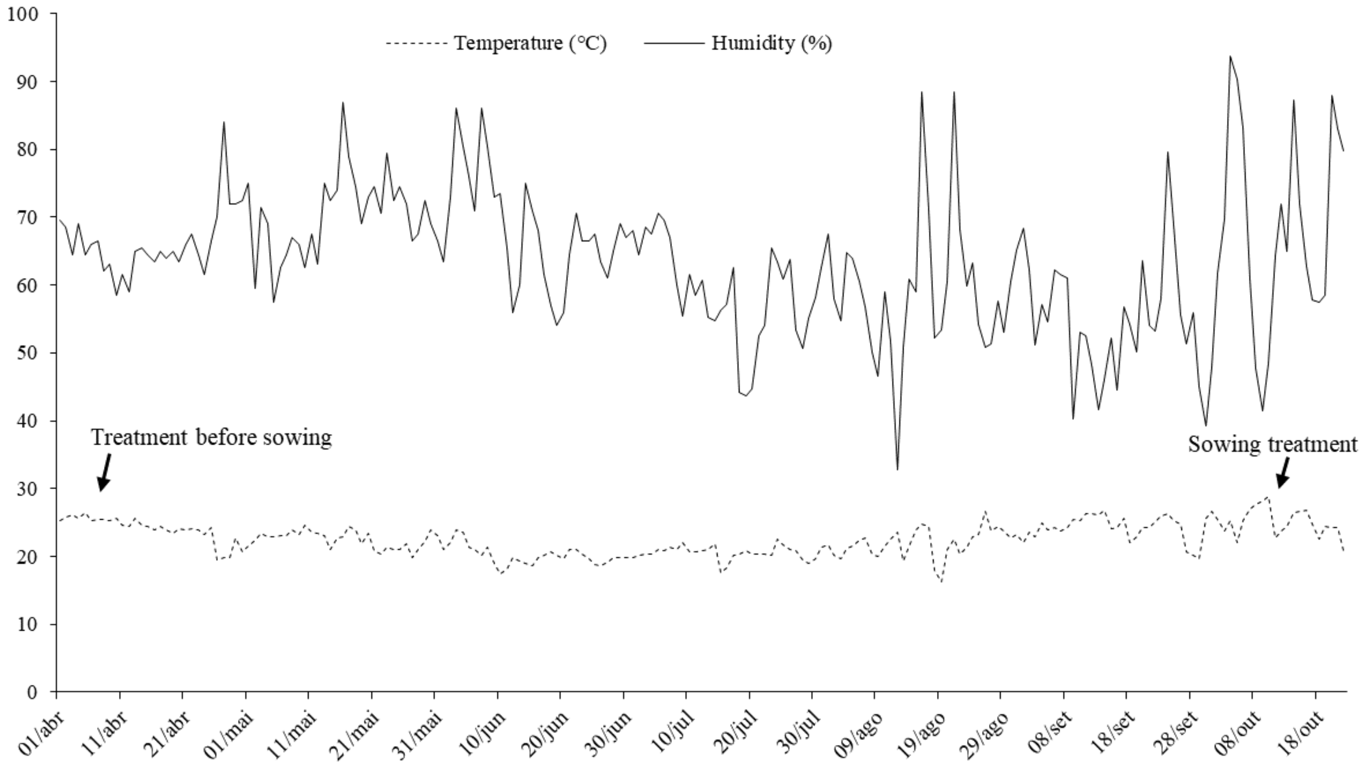


Figure 2. Temperature and relative air humidity data over the experimental period

treatment, the seeds were left in the shade at a temperature of approximately 20 °C for 20 min to dry.

Seeds were treated in April and early fall. Seeds for storage were packed in multilayered kraft paper and stored in an uncontrolled environment for six months (Figure 2).

Performance analyses of the soybean seedlings occurred immediately after seed treatment in April and after the storage period of the treated seeds in October. Sowing was carried out in experimental field beds that had been cultivated with soybean in previous harvests. The following evaluations were performed:

Emergence at five days (E5): After five days of sowing, a count was performed, and the percentage of emerged seedlings, cotyledons completely out of the soil, was calculated.

Emergence at 10 days (E10): Ten days after sowing, counting was performed, and the percentage of emerged seedlings was calculated.

Final emergence (EF): At 14 days after sowing, a final count was performed, and the result was expressed as the percentage of normal seedlings that emerged.

Emergence speed index (ESI): From the emergence of the first seedling, daily evaluations were performed to calculate the number of seedlings that emerged until stabilization. Thus, the ESI was calculated according to the formula proposed by Maguire (1962).

Mean emergence time (MET): The MET was calculated from the daily count of emerged plants according to the base formula for mean germination time according to Silva & Nakagawa (1995). The number of seeds that emerged at each evaluation time was multiplied by the corresponding time (days), and the result was divided by the total number of seeds that emerged at the end of the test (14 days).

Seedling dry matter (DM): At 14 days after sowing, the emerged seedlings were collected, dried in an oven with forced air circulation at 65 °C until reaching constant weight, and then weighed on a precision scale with two decimal precision.

Statistical analyses were performed independently for the analyses performed immediately after seed treatment and after the storage of the treated seeds. The data were subjected to analysis of variance with the aid of Sisvar® software (Ferreira, 2014) at $p \leq 0.05$, using the F test, and the means were grouped using the Scott-Knott test ($p \leq 0.05$).

Results and Discussion

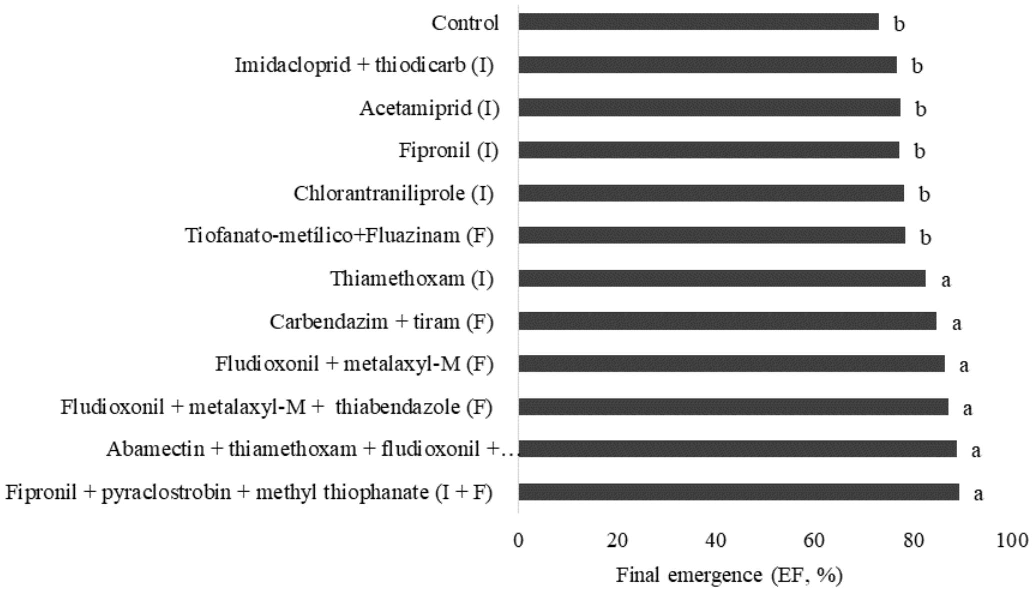
Before storage

The seed lots showed uniformity in water content, with values close to 10.5% and a difference of only 0.5% between the lowest and highest values, ensuring reliable evaluations of the physiological potential of the seeds.

In the plots with a soil water deficit, the tensiometers installed at depths of 5 and 10 cm in the soil showed average values of -28.66 and -23.50 kPa, respectively. Under controlled water conditions with supplementary irrigation, the corresponding values were -10.14 and -9.55 kPa. In soils typical of tropical regions, the field soil matric potential usually has values between -6 and -10 kPa (Reichardt, 1988; Martorano et al., 2009).

The seed treatment products affected the final emergence of soybean (EF) and seedling dry matter (DM). The soil water deficit influenced all evaluated characteristics. There was no interaction between the soil water deficit and the seed treatment products immediately after treatment.

For the final emergence at 14 days after sowing (Figure 3), regardless of the soil water condition, seeds treated with Fipronil + pyraclostrobin + methyl thiophanate (I + F), Abamectin + thiamethoxam + fludioxonil + metalaxyl-M + thiabendazole (N + I + F), Fludioxonil + metalaxyl-M + thiabendazole (F),



Means followed by the same letter do not differ by the Scott-Knott test at p ≤ 0.05; N - Nematicide; I - Insecticide; F - Fungicide

Figure 3. Final emergence of soybean seedlings as a function of different soybean seed treatments

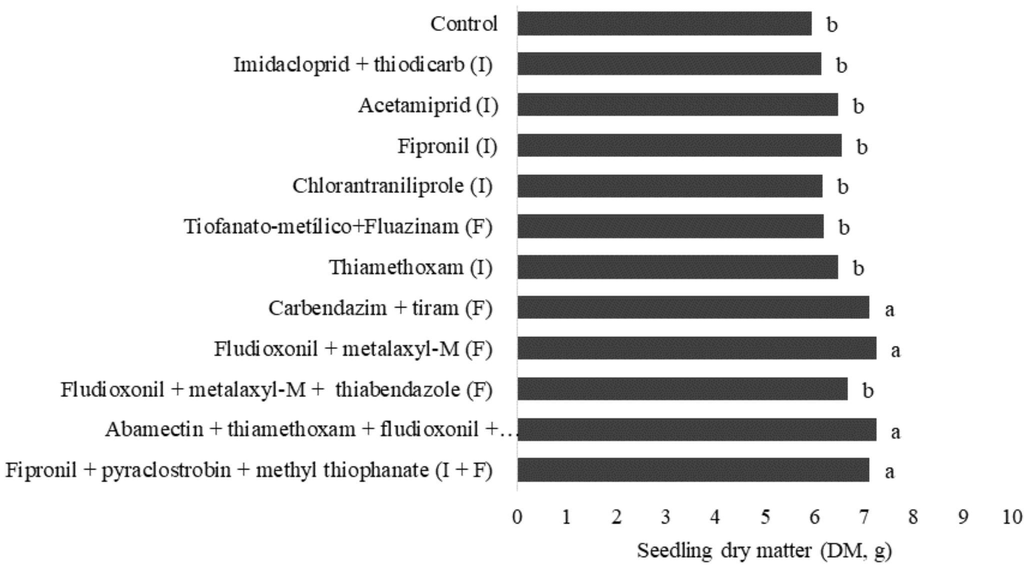
Fludioxonil + metalaxyl-M (F), Carbendazim + tiram (F), and Thiamethoxam (I) showed mean values higher than 82.5%, higher than those in the other treatments, which did not differ from the control (72.9%).

Regarding seedling dry matter (Figure 4), four of the six products that provided the greatest emergence also had higher DM values (Fipronil + pyraclostrobin + methyl thiophanate (I + F), Abamectin + thiamethoxam + fludioxonil + metalaxyl-M + thiabendazole (N + I + F), Fludioxonil + metalaxyl-M (F), and Carbendazim + tiram (F)), while the other treatments did not differ from each other or the control.

Balardin et al. (2011) found that in the field, treatment with fipronil + methyl thiophanate + pyraclostrobin and abamectin + thiamethoxam + fludioxonil + metalaxyl-M + thiabendazole resulted in greater emergence, plant height, and grain yield in soybean. Thus, the presowing treatment of soybean seeds with fungicides and insecticides may favor stand and seedling establishment (Conceição et al., 2014; Brzezinski et al., 2015).

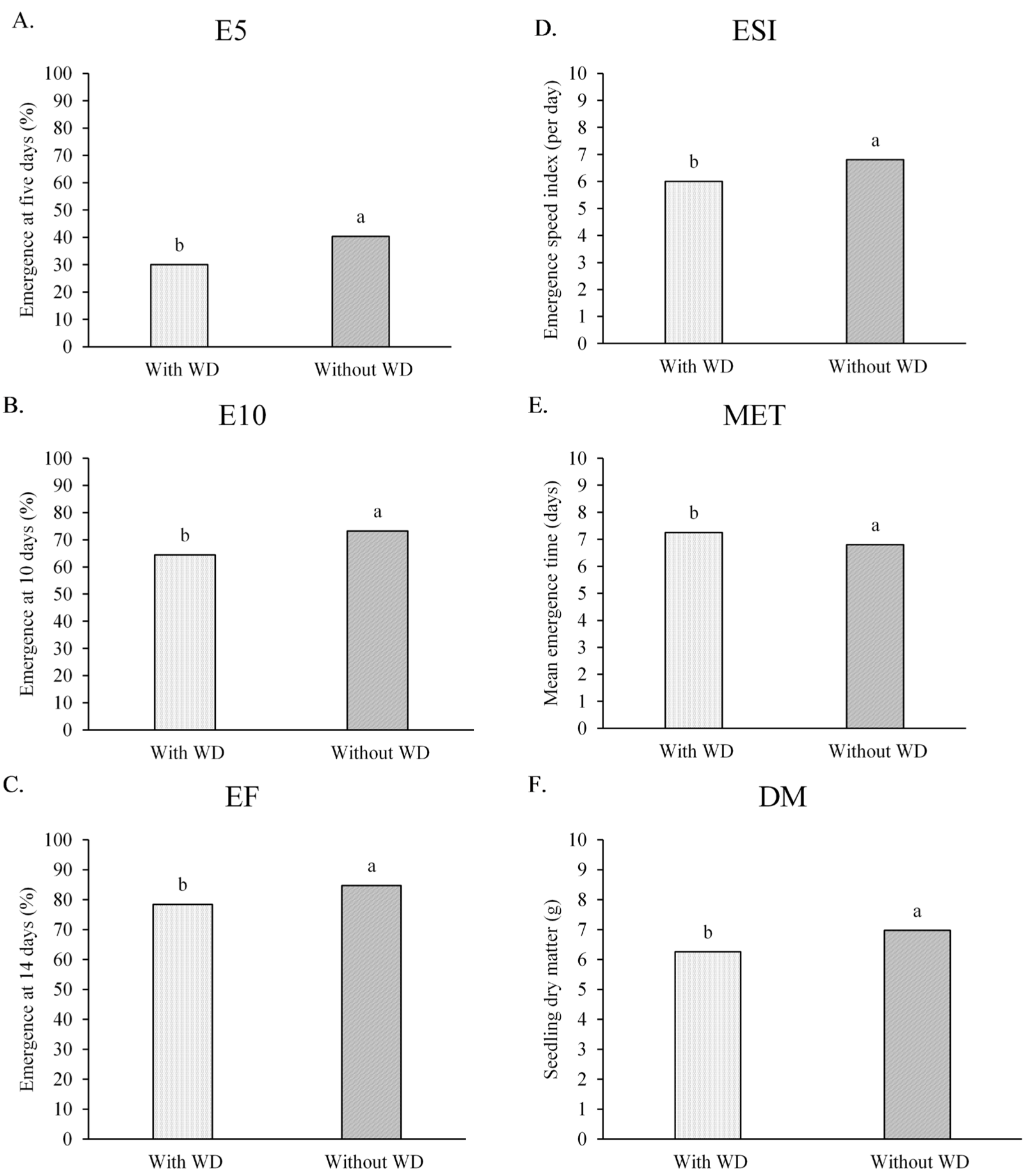
According to the tensiometer readings observed under water deficit, the water levels in the soil were sufficient to cause initial stress during seedling emergence (Figure 5). In all analyzed soybean seed variables, the results under water stress conditions were lower, regardless of the product used for seed treatment.

The emergence of soybean at five days (E5) was 10% lower with water deficit than under ideal water conditions (Figure 5A). For emergence at 10 days (E10) and 14 days (EF), the values for soil without water restriction were 73% and 85%, whereas with water deficit, the values decreased to 64% and 78%, respectively (Figures 5B and 5C). Similar results were also observed for emergence speed index, mean emergence time and seedling dry matter (Figures 5E, 5D, and 5F). In soil with water restriction, soybean seeds showed lower initial performance with values of -28.66, 5, and -23.50 kPa at 10 cm, regardless of the chemical treatment applied to the seeds. This result confirms the importance of monitoring the soil water



Means followed by the same letter do not differ by the Scott-Knott test at p ≤ 0.05. N - Nematicide; I - Insecticide; F - Fungicide

Figure 4. Seedling dry matter as a function of different soybean seed treatments



Means followed by the same letter do not differ by the F test at $p \leq 0.05$

Figure 5. Percentage of seedling emergence at five days (5A), 10 days (5B), and 14 days (5C); emergence speed index (5D); mean emergence time (5E); and seedling dry matter (5F) in soil with water deficit (With WD) and without water deficit (Without WD)

matric potential, as it can affect soybean establishment and final yield (Martorano et al., 2009). The decrease in seedling emergence can be attributed to the reduction in the speed and amount of water absorbed by the seeds, as the water deficit during germination inhibits the absorption of water by the tissues, thus retarding the start of germination (Pelegrini et al., 2013).

After treated seed storage

After storage for six months, the evaluations in October yielded an average soil water deficit of -24.20 and -15.53 kPa at 5 and 10 cm, respectively, for soils under water stress. Under adequate water conditions (irrigation), the corresponding values were -12.46 and -11.46 kPa.

The magnitude of difference was greater after storage, even though the average water deficit after storage was -19.87 kPa, while that before storage was more severe with a value of -26.08 kPa; the decrease in seed vigor after storage led to greater susceptibility to water deficit at the beginning of development.

For emergence at five days after sowing, under adequate water conditions (Table 2), there were differences between the products: seeds treated and stored with the fungicide Tiofanato-metílico+Fluazinam showed larger values. After 10 days of water deficit, lower values were observed for the seeds treated and stored with the insecticides imidacloprid + thiodicarb and Fipronil, and relative to the control, lower results for these treatments were also observed for final emergence. Under stressful soil water conditions, the seeds treated with Fipronil + pyraclostrobin + methyl thiophanate, Carbendazim + tiram and Fludioxonil + metalaxyl-M showed greater emergence at 10 days. A greater final emergence was observed for seeds treated with Fipronil + pyraclostrobin + methyl thiophanate and Carbendazim + tiram. All these superior treatments contained fungicidal compounds.

When the soil conditions were adverse, some products, especially those containing fungicides, favored the emergence of soybean. Under ideal water conditions, the treatments with

Table 2. Percentage of seedling emergence at five days (E5), 10 days (E10) and 14 days (EF) for treated soybean seeds stored for 6 months and subjected to water deficit (With WD) and without soil water deficit (Without WD)

Treatment	E5		E10		EF	
	With WD	Without WD	With WD	Without WD	With WD	Without WD
Control	0 Ba	41 Ab	23 Bc	83 Aa	46 Bc	82 Aa
Abamectin + thiamethoxam + fludioxonil + metalaxyl -M + thiabendazole (N + I + F)	0 Ba	35 Ac	36 Bb	65 Ab	64 Bb	71 Ab
Fipronil + pyraclostrobin + methyl thiophanate (I + F)	2 Ba	36 Ac	49 Ba	69 Ab	73 Ba	74 Ab
Fludioxonil + metalaxyl-M + thiabendazole (F)	0 Ba	45 Ab	32 Bb	92 Aa	64 Bb	94 Aa
Fludioxonil + metalaxyl-M (F)	0 Ba	38 Ac	41 Ba	82 Aa	59 Bb	86 Aa
Tiofanato-metílico + Fluazinam (F)	0 Ba	54 Aa	35 Bb	89 Aa	66 Bb	90 Aa
Carbendazim + tiram (F)	0 Ba	39 Ac	45 Ba	77 Aa	77 Ba	82 Aa
Chlorantraniliprole (I)	0 Ba	33 Ac	33 Bb	74 Ab	58 Bb	76 Ab
Acetamiprid (I)	0 Ba	44 Ab	30 Bb	69 Ab	56 Bb	72 Ab
Thiamethoxam (I)	0 Ba	36 Ac	29 Bb	69 Ab	56 Bb	77 Ab
Fipronil (I)	0 Ba	30 Ac	17 Bc	66 Ab	44 Bc	73 Ab
Imidacloprid + thiodicarb (I)	0 Ba	26 Ac	15 Bc	50 Ac	34 Bc	60 Ab

Means followed by the same lowercase letter in the column and uppercase letter for same seedling emegence in the row differ by the Scott-Knott test at $p \leq 0.05$; N - Nematicide; I - Insecticide; F - Fungicide

the best results did not differ from the control, but those with insecticidal molecules showed lower results due to six months of seed storage with these active ingredients.

Under ideal water conditions, the emergence at 10 days was lower for seeds treated and stored with the insecticide Imidacloprid + thiodicarb and with the fungicides Fludioxonil+ metalaxyl-M + thiabendazole, Tiofanato-metílico+Fluazinam, Fludioxonil + metalaxyl-M, and Carbendazim + tiram compared to the control. A similar result was found for final emergence, in which the control showed better results than seeds treated and stored with products that contained at least one active ingredient with insecticides.

Brzezinski et al. (2015) treated seeds in advanced seeds with Fipronil + pyraclostrobin + methyl thiophanate products; (Imidacloprid + thiodicarb) + Derosal Plus®; Abamectin + thiamethoxam + fludioxonil + metalaxyl-M + thiabendazole, Derosal Plus® (fungicide: carbendazim + tiram), Fludioxonil + metalaxyl-M + thiabendazole, and Vitavax-Thiram 200 SC® (fungicide: carboxin + tiram) and subjected the treated seeds to 240 days of storage. The results of that study demonstrated that the treatment of seeds before storage negatively affected soybean establishment and grain yield compared to those obtained with presowing treatment.

Studies evaluating the relationship between treatment and quality during storage are especially relevant for insecticidal molecules as such compounds tend to provide greater phytotoxicity than fungicides (Rocha et al., 2020). The advanced treatment of soybean seeds with insecticides can affect the initial development of the plants, with characteristic damage to root length, without affecting productivity (Carvalho et al., 2020).

With water deficit, the emergence speed index (ESI) of the seeds treated with the insecticides Imidacloprid + thiodicarb and Fipronil and the control were the lowest (Table 3). Without water deficit, the treatment with Imidacloprid + thiodicarb also had a low ESI, and the best results were obtained with the seeds treated and stored with the fungicides Tiofanato-metílico+Fluazinam, Fludioxonil + metalaxyl-M + thiabendazole, and Fludioxonil + metalaxyl-M, which did not differ from the control, surpassing the results for samples treated and stored with products containing insecticidal molecules and with the fungicide Carbendazim + tiram.

The seedling dry matter (DM) under water deficit was lower in the seeds treated and stored with the insecticides Fipronil, Imidacloprid + thiodicarb, Thiamethoxam, Acetamiprid, and Chlorantraniliprole, which did not differ from the control; the other treatments, predominantly fungicides, were superior (Table 3).

With adequate soil water availability, the lowest mean seedling dry matter was observed for seeds treated and stored with the Imidacloprid + thiodicarb insecticide. The highest means, which did not differ from the control, were in the

Table 3. Emergence speed index (ESI) and seedling dry matter (DM, g) of treated soybean seeds stored for six months and subjected to water deficit (With WD) and without soil water deficit (Without WD)

Treatment	ESI		DM	
	With WD	Without WD	With WD	Without WD
Control	2.19 Bb	7.16 Aa	3.33 Bb	14.57 Aa
Abamectin + thiamethoxam + fludioxonil + metalaxyl -M + thiabendazole (N + I + F)	3.01 Ba	6.25 Ab	6.43 Ba	10.80 Ab
Fipronil + pyraclostrobin + methyl thiophanate (I + F)	3.68 Ba	6.34 Ab	6.79 Ba	11.79 Ab
Fludioxonil + metalaxyl-M + thiabendazole (F)	2.96 Ba	8.12 Aa	5.40 Ba	13.73 Aa
Fludioxonil + metalaxyl-M (F)	2.80 Ba	7.62 Aa	5.30 Ba	13.25 Aa
Tiofanato-metílico + Fluazinam (F)	3.14 Ba	8.41 Aa	5.80 Ba	15.34 Aa
Carbendazim + tiram (F)	3.57 Ba	6.54 Ab	7.19 Ba	14.80 Aa
Chlorantraniliprole (I)	2.63 Ba	6.48 Ab	4.57 Bb	12.78 Aa
Piramid® (I)	2.77 Ba	6.83 Ab	4.67 Bb	11.49 Ab
Thiamethoxam (I)	2.69 Ba	6.49 Ab	4.75 Bb	11.83 Ab
Fipronil (I)	2.11 Bb	6.21 Ab	3.57 Bb	12.39 Ab
Imidacloprid + thiodicarb ® (I)	1.62 Bb	4.73 Ac	2.43 Bb	8.42 Ac

Means followed by the same lowercase letter in the column and uppercase letter for the same variable in the row differ by the Scott Knott test at $p \leq 0.05$; N - Nematicide; I - Insecticide; F - Fungicide treatments that contained only fungicidal molecules, with the exception of the insecticide Chlorantraniliprole. The other treatments containing the active ingredients of insecticides showed intermediate means.

These results, in which water restriction was simulated and variables were evaluated under field conditions, are relevant and highly applicable because most studies that relate the germination, emergence, and initial development of soybean seedlings were performed on a paper substrate under artificial water restriction, commonly simulated using mannitol or polyethylene glycol (PEG) 6000, to obtain more severe water restriction levels on the order of MPa. Moraes & Menezes (2003) used a paper substrate and PEG 6000 and verified that a water potential of -0.80 MPa prevents the germination of soybean seeds.

Costa et al. (2004) used germination on paper and controlled the water potential with mannitol, finding that the germination of soybean seeds was favored when the seeds were subjected to water restriction at -0.46 to -0.52 MPa; at -1.8 MPa, the stress was high, and the seeds did not germinate. Soares et al. (2015) subjected seeds to potentials of 0, -0.3, -0.6, -0.9, and -1.2 MPa induced by mannitol, reporting decreased soybean seed germination with increased water restriction, mainly at -1.2 MPa. Rocha et al. (2020) evaluated soybean seed treatments (fungicides and insecticides) and five osmotic potentials (0, -0.25, -0.5, -0.75, and -1.0 MPa) with mannitol solution moistening the germination substrate paper and reported that an increase in water restriction (-0.75 and -1.0 MPa) drastically reduced the percentage of normal seedlings.

Balardin et al. (2011) concluded that treatment with fipronil, methyl thiophanate, pyraclostrobin, and abamectin + thiamethoxam + fludioxonil + metalaxyl-M + thiabendazole resulted in a higher grain yield in soybean plants under water restriction. Conceição et al. (2014), who used presowing treatments involving the fungicide Derosal Plus®, the insecticide Imidacloprid + thiodicarb, micronutrients, and polymer, reported that chemical treatment favored soybean stand establishment.

Piccinin et al. (2013) performed seed treatment using the insecticides thiamethoxam (Cruiser 700 WS®) and fipronil (Standak®) and subsequent storage for 180 days, identifying negative effects on the physiological quality and root development of seedlings. Conceição et al. (2016) reported that treatment with the fungicide Derosal Plus®, the insecticide Imidacloprid + thiodicarb, micronutrients, and polymer did not affect the physiological quality of soybean seeds over eight months of storage. According to Bortoletto et al. (2017), treatment with thiamethoxam did not promote losses in the vigor of stored seeds; however, the other insecticides tested caused significant losses.

Conclusions

1. The emergence and initial development of soybean seedlings is hampered by soil water deficit.

2. The treatment of seeds with fungicides favors the establishment and initial development of soybean seedlings, especially under soil water deficit conditions.

3. Treatment with insecticidal and nematicide molecules six months in advance affects seed vigor and the initial performance of soybean seedlings with different intensities depending on the active ingredient.

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