REVISTA TÓPICOS
ISSN 2965-6672 | Qualis A2

END-OF-CYCLE DISEASE PROGRESS, SEED-ASSOCIATED FUNGI, AND AGRONOMIC PERFORMANCE OF SOYBEAN CULTIVARS IN THE SOUTHWESTERN BRAZILIAN AMAZON

PROGRESSO DE DOENÇAS DE FINAL DE CICLO, FUNGOS ASSOCIADOS ÀS SEMENTES E DESEMPENHO AGRONÔMICO DE CULTIVARES DE SOJA NO SUDOESTE DA AMAZÔNIA BRASILEIRA

Ciências Agrárias • 14/09/2026

REGISTRO DOI: 10.70773/revistatopicos/789228759

Iricelia Vieira Cardoso[1]

Cleyton Silva de Araújo[2]

Janaira Almeida dos Santos[3]

Niqueli Cunha da Costa Sales[4]

Joaes Alves da Silva Pereira[5]

Maria Alcirlândia da Silva Bezerra[6]

Mauro Jorge Ribeiro[7]

Josimar Batista Ferreira[8]

ABSTRACT

End-of-cycle diseases (ECD) are an emerging phytosanitary concern for soybean production in the humid southwestern Brazilian Amazon. This study characterized ECD incidence, severity, cumulative disease progress, seed-associated fungi, and agronomic performance of Dagma 7921 IPRO, Olimpo IPRO, and Dagma 7621 I2X grown in Porto Acre, Acre State, Brazil, under a common preventive crop-protection program. The cultivars were evaluated in four field replications. Disease was assessed on 100 leaflets per experimental unit at 60, 75, 90, and 100 days after planting. Cycle-wide mean incidence ranged from 41.25% to 51.75% and mean severity from 3.13% to 5.71%, with no significant differences among cultivars. Descriptive AUDPC values were 174.90, 131.77, and 125.27 for Dagma 7921 IPRO, Olimpo IPRO, and Dagma 7621 I2X, respectively. Five fungal groups were detected in harvested seeds. Dagma 7921 IPRO had the highest grain yield (7,342 kg ha^{-1}), whereas Dagma 7621 I2X had the highest thousand-seed weight and the lowest proportion of seeds with fungal growth. These findings provide baseline information for late-season disease monitoring and cultivar evaluation in Acre.

Keywords: *Glycine max*; end-of-cycle diseases; AUDPC; seed health; soybean yield.

RESUMO

As doenças de final de ciclo (DFC) constituem uma preocupação fitossanitária emergente para a produção de soja no ambiente úmido do sudoeste da Amazônia brasileira. Este estudo caracterizou incidência, severidade, progresso acumulado da doença, fungos associados às sementes e desempenho agronômico das cultivares Dagma 7921 IPRO, Olimpo IPRO e Dagma 7621 I2X, cultivadas em Porto Acre, Acre, sob um programa preventivo comum de manejo

fitossanitário. As cultivares foram avaliadas em quatro repetições de campo. A doença foi avaliada em 100 folíolos por unidade experimental aos 60, 75, 90 e 100 dias após o plantio. A incidência média ao longo do ciclo variou de 41,25% a 51,75% e a severidade média de 3,13% a 5,71%, sem diferenças significativas entre cultivares. Os valores descritivos de AACPD foram 174,90, 131,77 e 125,27 para Dagma 7921 IPRO, Olimpo IPRO e Dagma 7621 I2X, respectivamente. Cinco grupos fúngicos foram detectados nas sementes colhidas. Dagma 7921 IPRO apresentou a maior produtividade (7.342 kg ha^{-1}), enquanto Dagma 7621 I2X apresentou a maior massa de mil sementes e a menor proporção de sementes com crescimento fúngico. Os resultados fornecem informações de base para o monitoramento tardio das DFC e a avaliação de cultivares no Acre.
Palavras-chave: *Glycine max*; doenças de final de ciclo; AACPD; sanidade de sementes; produtividade da soja.

1. INTRODUCTION

Soybean (*Glycine max* (L.) Merr.) is one of the most important agricultural commodities worldwide and a strategic source of vegetable protein and oil for food, animal feed, and industrial applications. In Brazil, the crop is central to agribusiness and has expanded rapidly through genetic improvement, mechanization, biological nitrogen fixation, and increasingly intensive crop-management systems. National grain production reached 350.2 million tons in the 2024/25 season, with soybean accounting for a major share of the record output (Cattelan; Dall'Agnol, 2018; Conab, 2025).

Although Brazilian soybean production remains concentrated in the Central-West and Southern regions, cultivation has advanced into newer agricultural frontiers, including the Legal Amazon. Acre State is part of this recent expansion and has shown increasing planted area and production, creating opportunities for regional diversification but also exposing the crop to environmental conditions that differ from those of traditional production areas (Franke *et al.*, 2023; IBGE, 2025). This context makes local information on cultivar performance and phytosanitary constraints particularly important.

The southwestern Brazilian Amazon is characterized by high temperatures, high relative humidity, and frequent rainfall during the soybean-growing season. These conditions can prolong canopy wetness and favor infection, sporulation, and secondary spread of foliar pathogens. The epidemiological response, however, also depends on crop phenology, cultivar susceptibility, initial inoculum, canopy architecture, and the timing and effectiveness of disease-management practices (Seixas *et al.*, 2020; Godoy *et al.*, 2020).

Among the foliar problems of soybean, the end-of-cycle disease (ECD) complex is especially relevant during reproductive development. It is commonly associated with *Cercospora kikuchii* and *Septoria glycines* and may coexist with other foliar pathogens. When disease becomes severe, lesion expansion, premature senescence, and loss of photosynthetically active leaf area can impair grain filling and reduce yield. Under lower epidemic pressure or effective preventive protection, however, disease incidence may become widespread while affected leaf area remains limited, making the joint assessment of incidence and severity necessary (Henning *et al.*, 2014; Seixas *et al.*, 2020).

Disease progress over time provides information that cannot be obtained from a single field rating. Incidence describes the frequency of symptomatic leaflets, severity quantifies the proportion of affected leaf area, and the area under the disease progress curve (AUDPC) integrates successive severity observations into a cumulative measure of epidemic development (Martins *et al.*, 2004; Shaner; Finney, 1977). In cultivar comparisons, AUDPC is therefore useful as a descriptive indicator of how quickly and how strongly symptoms accumulate during the crop cycle, although resistance classifications require appropriate inferential testing and validation across environments.

Seed-health assessment adds another phytosanitary dimension because fungi associated with foliar, stem, pod, or storage diseases may also be recovered from harvested seeds. Blotter tests are useful for detecting fungal growth and describing seed-associated communities, but morphology-based identifications should be interpreted conservatively when isolation, microscopy, or molecular confirmation is unavailable (Goulart, 2018; Hosseini *et al.*, 2023).

Despite the expansion of soybean production in Acre, regional information jointly describing foliar ECD progress, seed-associated fungi, and agronomic performance remains limited. Such baseline data are needed to guide field scouting, cultivar selection, and the design of future experiments with contrasting disease-management regimes. Therefore, this study aimed to characterize ECD incidence, severity, and cumulative progress; describe fungal groups detected in seeds; and compare agronomic traits and grain yield of three commercial soybean cultivars grown under a common preventive crop-protection program in Porto Acre, Acre State, Brazil.

2. MATERIALS AND METHODS

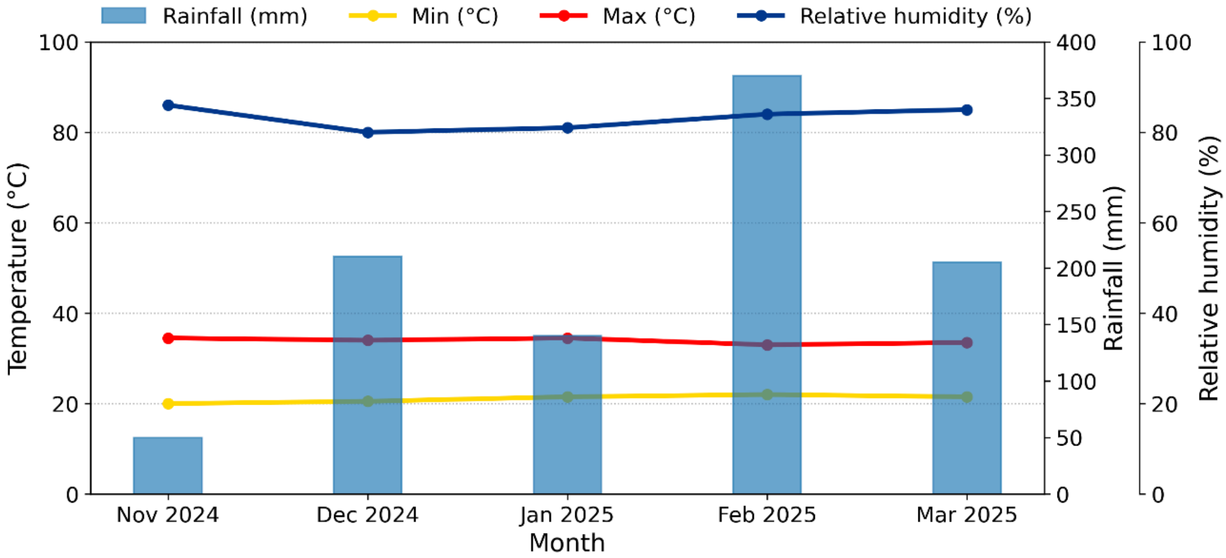
2.1. Study Area And Experimental Site

The field experiment was conducted at São João Farm, km 57 of Highway BR-317, Porto Acre municipality, Acre State, Brazil (9°50.9' S, 67°26.4' W; 190 m above sea level). The soil was classified as a dystrophic Red Ultisol with medium-to-clayey texture and gently undulating relief. Before sowing, soil sampled at 0–20 cm had pH (H_2O) 5.62, P 39.65 mg dm^{-3}, K 73 mg dm^{-3}, Ca 2.15 cmolc dm^{-3}, Mg 0.61 cmolc dm^{-3}, Al 0.06 cmolc dm^{-3}, sum of bases 2.95 cmolc dm^{-3}, cation-exchange capacity at pH 7.0 of 5.57 cmolc dm^{-3}, base saturation of 52.93%, and organic matter of 12.16 g dm^{-3}.

2.2. Regional Climate

The regional climate is Am according to Köppen's classification, corresponding to a humid tropical climate with a short dry season. The soybean cycle evaluated in this study extended from November 2024 to March 2025. Monthly rainfall, mean minimum and maximum air temperatures, and mean relative humidity recorded for Rio Branco, the nearest climatic reference used in the original study, are shown in Figure 1. The period included marked variation in monthly rainfall, with the highest accumulation occurring in February 2025, while mean air temperature and relative humidity remained comparatively stable.

Figure 1. Monthly rainfall, mean minimum and maximum air temperatures, and mean relative humidity in Rio Branco, Acre State, Brazil, from November 2024 to March 2025.



2.3. Experimental Design, Treatments, And Crop Management

The trial was arranged in cultivar strips, with three soybean cultivars —Dagma 7921 IPRO, Olimpo IPRO, and Dagma 7621 I2X—evaluated in four replicated experimental units per cultivar, totaling 12 experimental units. Each unit consisted of four 10-m rows spaced 0.45 m apart. Phytosanitary and agronomic assessments were conducted in the two central rows to reduce border effects, corresponding to approximately 40 usable plants per experimental unit.

Sowing was performed on November 10, 2024, at a density of 240,000 seeds ha^{-1}. Seeds were obtained after industrial treatment with insecticide, fungicide, and nematicide. At sowing, inoculation was performed with *Bradyrhizobium japonicum* (Bradymax®) and *Azospirillum brasilense* (Biomax®). General crop establishment and cultural practices followed technical recommendations for soybean production (Seixas *et al.*, 2020).

All cultivars received the same preventive crop-protection program. Four tractor-mounted applications were recorded during the crop cycle. The first included Maxcel (0.1 L ha^{-1}), Azimut (0.5 L ha^{-1}), and lambda-cyhalothrin (0.15 L ha^{-1}). The second included Excalia

Max/Vessara (0.5 L ha^{-1}), mancozeb (Manfil 800 WP; 1.5 kg ha^{-1}), Maxcel (0.1 L ha^{-1}), methomyl (1.0 L ha^{-1}), and lufenuron 100 EC (0.15 L ha^{-1}). The third included Viovan/Fox (0.6 L ha^{-1}), Funginil (2.0 L ha^{-1}), imidacloprid 480 (0.3 L ha^{-1}), and acephate (1.0 L ha^{-1}). The fourth included Azimut (0.5 L ha^{-1}), acephate (1.0 L ha^{-1}), imidacloprid 480 (0.3 L ha^{-1}), and Funginil (2.0 L ha^{-1}). Products were applied at the rates recorded in the field log. Because no untreated control was included, the experiment was not designed to quantify fungicide efficacy.

2.4. Disease And Agronomic Assessments

Phytosanitary assessments focused on incidence and severity of symptoms compatible with the soybean ECD complex and on AUDPC. For each assessment date, 100 leaflets per experimental unit were randomly collected from the lower-to-middle canopy within the usable area. Severity was visually estimated as the percentage of affected leaf area using the diagrammatic scale proposed by Martins *et al.* (2004). Incidence was determined from the presence or absence of visible symptoms on each sampled leaflet and expressed as the percentage of symptomatic leaflets.

Assessments were conducted at 60, 75, 90, and 100 days after planting (DAP), covering the period from initial symptom establishment to late reproductive development. These repeated observations were used to describe the temporal trajectory of disease in each cultivar.

2.4.1. Area Under The Disease Progress Curve (AUDPC)

AUDPC was calculated for each experimental unit by integrating disease severity over time using the trapezoidal method of Shaner and Finney (1977):

$$AUDPC = \sum_{i=1}^{n-1} [\frac{(x_i \, x_{i+1}]}{2})(t_{i+1} - t_i)$$

where n is the number of evaluations, x_i and x_{i+1} are disease severity at consecutive evaluations, and (t_{i+1} − t_i) is the interval in days between them. AUDPC values were calculated from severity expressed consistently as percentages and were used to summarize cumulative disease development over the evaluated period.

2.4.2. Yield Components And Grain Yield

At crop maturity, harvest sampling was performed within the same usable plot area. Five subsamples were collected per experimental unit, each corresponding to a 1.2-m linear section of row. At 0.45-m row spacing, each subsample represented 0.54 m^2 and the five subsamples together represented 2.70 m^2 of sampled ground area per experimental unit. Plants were manually uprooted and threshed, grain mass was measured, and grain moisture was determined using a portable meter.

Agronomic assessments included plant height from the collar to the apex of the main stem, number of branches per plant, number of pods per plant, number of seeds per pod from a random sample of 100 pods per experimental unit, and thousand-seed weight (TSW). Grain mass and TSW were corrected to 13% moisture. Grain yield was converted to kg ha^{-1} from the corrected grain mass and the corresponding sampled area using:

$$\text{Yield}(\text{kg ha}-^{1}) = \text{GM} \times \frac{100 - \text{M}}{100 - 13} \times \frac{10{,}000}{\text{A}}$$

where GM is grain mass obtained from the sampled area (kg), M is grain moisture at harvest (%), A is the corresponding sampled ground area (m^2), and 13 is the standard moisture content (%) used for correction.

2.4.3. Seed-Associated Fungi Detection

Seed health was evaluated by the blotter test using 250 seeds per cultivar. Seeds were distributed among ten Petri dishes with 25 seeds each and were not surface-disinfested. Each dish contained four sterile filter-paper sheets moistened with sterile distilled water and diluted agar solution (30 g L^{-1}). Plates were incubated in the dark for seven days at 20–24 °C.

Fungal occurrence was expressed as the percentage of seeds on which each fungal group was detected. Identification was based on colony and reproductive morphology following Goulart (2018). Because molecular confirmation was not performed and the available records do not provide isolate-level diagnostic data, results are reported conservatively at genus or morphotype level in the article.

2.5. Statistical Analyses

Overall incidence, overall severity, and agronomic traits were analyzed by analysis of variance using the four field replications as experimental replicates. Residual normality and homogeneity of variances were evaluated using the Shapiro–Wilk and Levene tests. When necessary, data were transformed as $\log_{10}(x + 1)$. Significant cultivar effects were followed by Tukey's test at the 5% probability level. Analyses were performed in SISVAR (Ferreira, 2011).

Incidence and severity at the individual assessment dates were used descriptively to characterize temporal disease progress. AUDPC was summarized descriptively by cultivar because no inferential comparison of plot-level AUDPC was performed. Seed-associated fungal frequencies were also treated descriptively. Consequently, numerical differences in AUDPC and seed contamination are not interpreted as formal resistance classes or statistically demonstrated cultivar effects.

3. RESULTS AND DISCUSSION

3.1. End-Of-Cycle Disease Progress

End-of-cycle disease (ECD) symptoms were observed in all soybean cultivars evaluated under field conditions in Porto Acre. Mean incidence ranged from 41.25% in Dagma 7621 I2X to 48.25% in Dagma 7921 IPRO and 51.75% in Olimpo IPRO, whereas mean severity ranged from 3.13% in Dagma 7621 I2X to 3.86% in Olimpo IPRO and 5.71% in Dagma 7921 IPRO. No significant differences among cultivars were detected for either variable (Table 1), indicating that the numerical contrasts were insufficient to demonstrate a cultivar effect when disease assessments were averaged across the crop cycle.

Table 1. Overall mean incidence (%), severity (%), and area under the disease progress curve (AUDPC) for end-of-cycle diseases in three soybean cultivars.

Cultivar	Incidence (%)	Severity (%)	AUDPC	Descriptive ranking

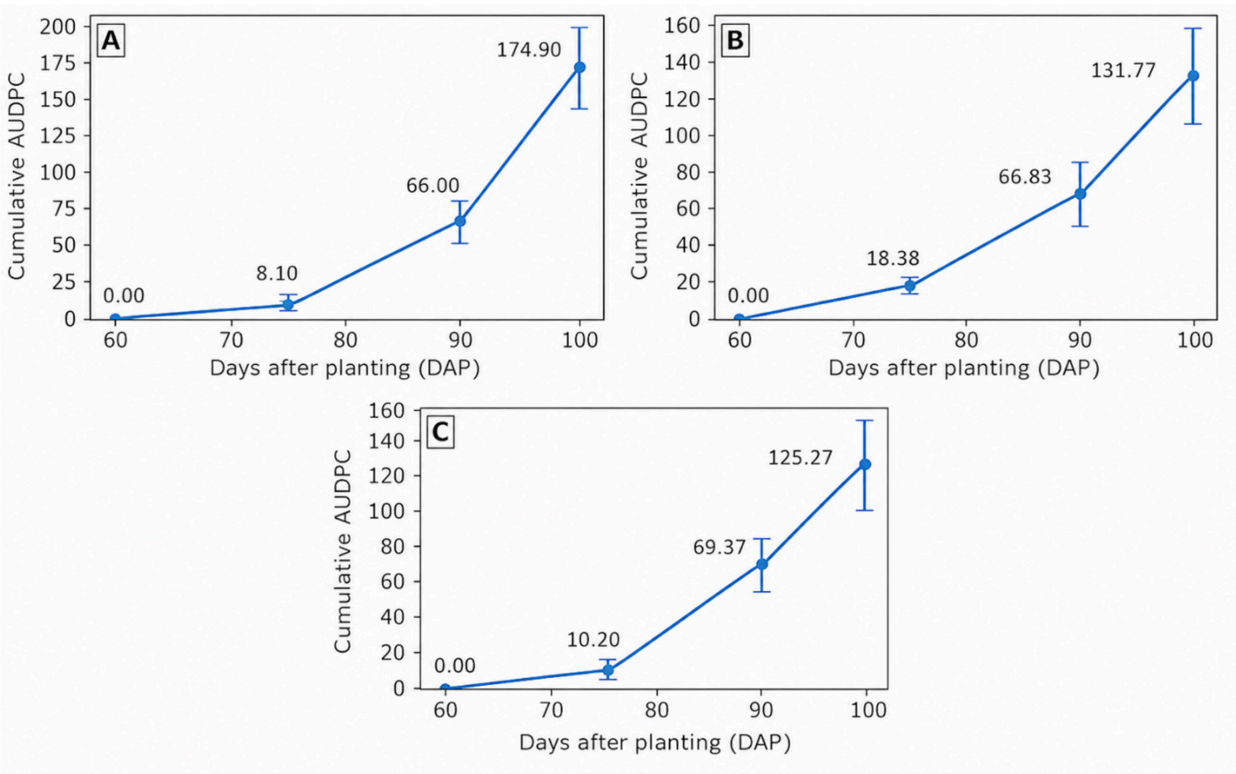
Dagma 7921 IPRO	48.25 a	5.71 a	174.90	Highest
Olimpo IPRO	51.75 a	3.86 a	131.77	Intermediate
Dagma 7621 I2X	41.25 a	3.13 a	125.27	Lowest
CV (%)	15.20	21.32	—	—
F statistic	0.3820	0.2750	—	—

Note: means followed by the same letter within a column do not differ by Tukey's test ($p \leq 0.05$). AUDPC values are descriptive cultivar means and were not subjected to inferential comparison in the available dataset.

Despite the relatively high incidence, overall severity remained low, indicating widespread symptom occurrence without a proportional expansion of affected leaf area. This distinction is epidemiologically relevant because incidence reflects the frequency of symptomatic leaflets, whereas severity represents the extent of tissue damage. Under the conditions of the present experiment, the ECD complex therefore became established throughout the canopy but remained at comparatively low intensity during most of the crop cycle. Such a pattern can arise from the combined effects of cultivar response, inoculum availability, crop phenology, weather, and preventive fungicide protection; because these factors were not manipulated independently, their individual contributions cannot be separated.

Cumulative disease progress provided additional resolution beyond the overall means. AUDPC was highest in Dagma 7921 IPRO (174.90), followed by Olimpo IPRO (131.77) and Dagma 7621 I2X (125.27) (Figure 2). The higher value observed for Dagma 7921 IPRO reflects a stronger late-season accumulation of diseased leaf area, whereas Dagma 7621 I2X showed the lowest numerical cumulative disease burden. Because AUDPC was interpreted descriptively and was not subjected to inferential comparison in the available dataset, these values should not be treated as formal resistance classes. They are most appropriately interpreted as observed differences in epidemic trajectory under the common management regime.

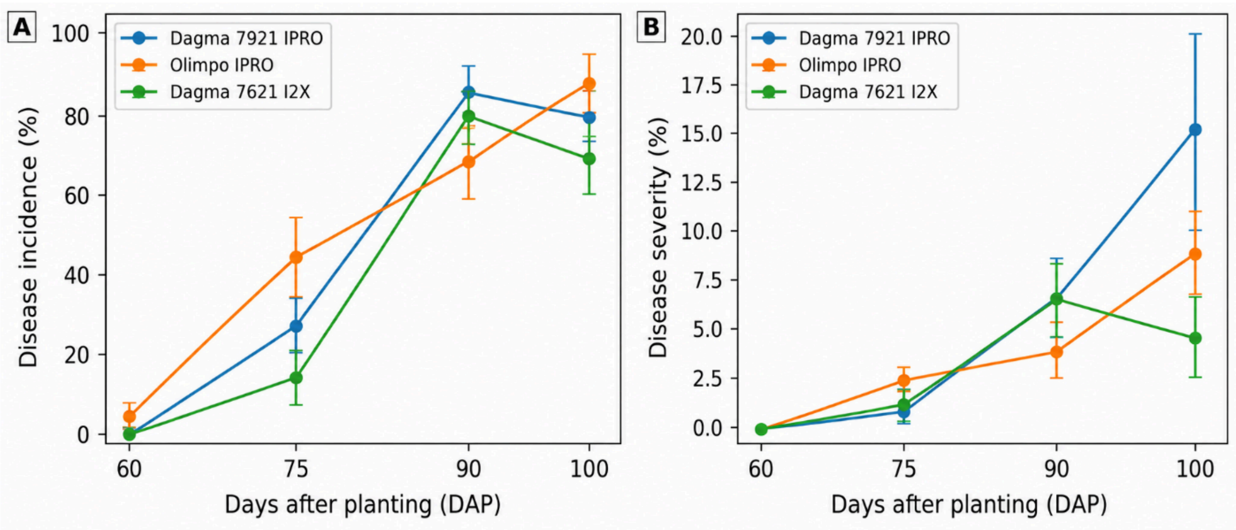
Figure 2. Cumulative area under the disease progress curve (AUDPC) at 60, 75, 90, and 100 days after planting for Dagma 7921 IPRO (A), Olimpo IPRO (B), and Dagma 7621 I2X (C). Values summarize mean severity over time and are interpreted descriptively.



The temporal evaluations revealed clearer contrasts than the cycle-wide means. Severity was negligible at 60 DAP and remained low at 75 DAP, when values were approximately 1.08% in Dagma 7921 IPRO, 2.45% in Olimpo IPRO, and 1.25% in Dagma 7621 I2X. By 90 DAP, severity increased to approximately 6.64%, 4.01%, and 6.53%, respectively. The largest divergence occurred at 100 DAP: Dagma

7921 IPRO reached 15.14%, Olimpo IPRO reached approximately 8.98%, and Dagma 7621 I2X declined to about 4.65% (Figure 3B). Thus, cultivar trajectories separated primarily during the late reproductive phase rather than at disease onset.

Figure 3. Incidence (A) and severity (B) progress of end-of-cycle disease symptoms in Dagma 7921 IPRO, Olimpo IPRO, and Dagma 7621 I2X at 60, 75, 90, and 100 days after planting.



Incidence showed a broader and earlier expansion than severity. Symptoms were absent or uncommon at 60 DAP, increased markedly after 75 DAP, and became widespread by the final assessments. At 100 DAP, incidence was approximately 80% in Dagma 7921 IPRO, 88% in Olimpo IPRO, and 70% in Dagma 7621 I2X (Figure 3A). The divergence between high incidence and comparatively low severity is important for interpreting disease status: many leaflets can express symptoms while only a limited proportion of their area is affected. Consequently, incidence alone would overstate the amount of foliar tissue damaged in this experiment, whereas severity and AUDPC better describe the intensity and cumulative burden of the epidemic.

The absolute disease levels were lower than those commonly reported under high ECD pressure. Costa (2024), for example, recorded substantially greater final severity in Olimpo IPRO under more conducive epidemic conditions. Cooperative fungicide trials likewise show that untreated or less effectively protected plots can reach high disease severity accompanied by measurable yield reductions, whereas effective protection generally maintains lower severity (Godoy et al., 2023, 2024). Direct comparison among studies should nevertheless be cautious because cultivar background, inoculum pressure, weather, crop stage, and fungicide programs differ among environments.

In the present trial, all cultivars received the same preventive fungicide program and no untreated control was included. Consequently, it is not possible to estimate the disease level that would have occurred without fungicide or to quantify the proportion of yield preserved by chemical protection. The results should therefore be interpreted as cultivar performance under a shared preventive management regime rather than as an assessment of fungicide efficacy. Even under this protection, the sharp increase in disease after 75 DAP highlights the importance of late-season monitoring, particularly during grain filling, when preservation of photosynthetically active leaf area is critical for maintaining assimilate supply to developing seeds.

3.2. Seed-Associated Fungi

The blotter test detected five fungal groups associated with soybean seeds: *Aspergillus* sp., *Cercospora* spp., *Colletotrichum* spp., *Fusarium* spp., and *Penicillium* sp. (Table 2). Total seed contamination was 29.2% for Dagma 7921 IPRO, 28.4% for Olimpo IPRO, and 14.4% for

Dagma 7621 I2X. These values indicate a markedly lower overall frequency of seed-associated fungi in Dagma 7621 I2X under the evaluated conditions, although the seed-health data were analyzed descriptively and therefore do not establish a statistically significant cultivar effect.

Table 2. Occurrence of fungal groups associated with seeds of three soybean cultivars, determined by the blotter test.

Fungal group	Cultivar		
	Dagma 7921 IPRO	Olimpo IPRO	Dagma 7621 I2X
Aspergillus sp.	2 (0.8%)	11 (4.4%)	4 (1.6%)
Cercospora spp.	6 (2.4%)	12 (4.8%)	15 (6.0%)
Colletotrichum spp.	28 (11.2%)	15 (6.0%)	16 (6.4%)
Fusarium spp.	31 (12.4%)	34 (13.6%)	3 (1.2%)
Penicillium sp.	2 (0.8%)	2 (0.8%)	3 (1.2%)
Seeds with fungal growth	73 (29.2%)	71 (28.4%)	36 (14.4%)

Note: more than one fungal group could occur on the same seed; therefore, the sum of individual fungal occurrences may equal or exceed the total number of contaminated seeds.

Fusarium spp. was the most frequent group in Dagma 7921 IPRO and Olimpo IPRO, occurring in 12.4% and 13.6% of seeds, respectively. *Colletotrichum* spp. was also frequent, particularly in Dagma 7921 IPRO (11.2%), whereas *Cercospora* spp. reached its highest numerical occurrence in Dagma 7621 I2X (6.0%). These contrasting frequencies show that a lower total contamination rate did not correspond to uniformly lower occurrence of every fungal group; instead, the cultivars differed in the composition of their seed-associated fungal community. Because identification was based on colony and reproductive morphology rather than molecular confirmation, genus-level reporting is the most defensible interpretation (Goulart, 2018; Hosseini et al., 2023).

Septoria glycines was not detected in the blotter test. This finding does not demonstrate absence of the pathogen from the field because the test evaluated a finite seed sample and morphology-based detection has limited sensitivity. Brown spot is primarily expressed on foliage, and recovery of *S. glycines* from seeds can be less consistent than foliar symptom expression, particularly when disease severity remains low (Henning et al., 2014; Soares et al., 2023). The low frequencies of *Aspergillus* sp. and *Penicillium* sp. are also relevant from a post-harvest perspective because these fungi may colonize seeds during maturation, harvest, or storage. Overall, the seed-health assessment complements the foliar data by showing that cultivar performance also differed numerically in the sanitary profile of the harvested product.

3.3. Agronomic Performance

Cultivar effects were detected for most agronomic traits (Table 3). Olimpo IPRO was the tallest cultivar (102.76 cm), followed by Dagma 7621 I2X (95.77 cm) and Dagma 7921 IPRO (87.75 cm). Dagma 7921 IPRO produced the highest number of branches (4.96 $plant^{-1}$) and pods (83.67 $plant^{-1}$), whereas Dagma 7621 I2X had the highest thousand-seed weight (TSW; 187.12 g). Seeds per pod did not differ significantly among cultivars, indicating that this component contributed little to the observed variation in final yield.

Grain yield ranged from 6,791.56 to 7,342.00 kg ha^{-1} and differed significantly among cultivars. Dagma 7921 IPRO produced the highest yield (7,342.00 kg ha^{-1}), whereas Olimpo IPRO (6,791.56 kg ha^{-1}) and Dagma 7621 I2X (6,792.70 kg ha^{-1}) did not differ from each other. The superior yield of Dagma 7921 IPRO was accompanied by greater branching and pod production, suggesting that reproductive sink number contributed more strongly to its yield advantage than seed mass. In contrast, Dagma 7621 I2X produced fewer branches and pods but heavier seeds, illustrating distinct yield-component strategies among cultivars.

Table 3. Agronomic traits and grain yield of three soybean cultivars evaluated under field conditions in Porto Acre, Acre State, Brazil.

Cultivar	Yield (kg ha^{-1})	Height (cm)	Branches (no.)	Pods plant^{-1} (no.)	Seed pod^{-1} (no.)
Dagma 7921 IPRO	7342.00 a	87.75 c	4.96 a	83.67 a	2.96
Olimpo IPRO	6791.56 b	102.76 a	4.07 b	60.06 b	3.07
Dagma 7621 I2X	6792.70 b	95.77 b	3.58 b	62.93 b	2.97

⚠ Esta tabela possui muitas colunas e foi cortada para impressão. Para visualizá-la completa, acesse o artigo original em: https://revistatopicos.com.br/artigos/end-of-cycle-disease-progress-seed-associated-fungi-and-agronomic-performance-of-soybean-cultivars-in-the-southwestern-brazilian-amazon?noblockage

Note: means followed by the same letter within a column do not differ by Tukey's test ($p \leq 0.05$). TSW = thousand-seed weight.

The coexistence of lower numerical AUDPC and greater TSW in Dagma 7621 I2X is biologically interesting, but it is not sufficient to demonstrate that lower ECD severity caused heavier seeds. Cultivars differ genetically in seed size, architecture, phenology, and reproductive allocation, and the experiment did not include plot-level regression linking disease variables to TSW or grain yield. TSW should therefore be interpreted primarily as an agronomic cultivar trait in this dataset. Likewise, the higher number of branches and pods in Dagma 7921 IPRO cannot be attributed to disease response because these traits are strongly genotype-dependent and are established largely before the period of greatest late-season disease expression.

Notably, Dagma 7921 IPRO combined the highest numerical AUDPC with the highest grain yield, whereas Dagma 7621 I2X combined the lowest numerical AUDPC with the highest TSW but not the highest yield. This contrast argues against a simple inverse relationship between cumulative disease and productivity across the three cultivars. Under the moderate disease pressure observed here, cultivar-specific reproductive architecture appears to have compensated for differences in foliar disease burden, reinforcing the need to interpret sanitary and agronomic traits jointly rather than infer yield performance from a single disease indicator.

3.4. Integrated Cultivar Response And Implications

Considering disease progress, seed health, and agronomic traits together revealed distinct cultivar profiles. Dagma 7921 IPRO combined the greatest grain yield and the highest numbers of branches and pods with the highest numerical AUDPC and one of the highest levels of seed contamination. Dagma 7621 I2X, in contrast, showed the lowest numerical disease accumulation, the lowest total seed contamination, and the highest TSW, although these favorable sanitary and seed-mass attributes did not translate into superior grain yield. Olimpo IPRO generally occupied an intermediate position for cumulative disease and seed contamination and produced a yield statistically similar to Dagma 7621 I2X. These patterns demonstrate that cultivar performance in Acre cannot be adequately described by a single phytosanitary or agronomic indicator. A cultivar may maintain high productivity despite greater disease accumulation when other yield components compensate for moderate foliar damage, whereas a cultivar with a more favorable sanitary profile may not necessarily achieve the highest yield. The present study therefore provides baseline evidence of contrasting combinations of disease progression, seed-associated fungi, and agronomic performance in soybean grown in the southwestern Brazilian Amazon. Broader recommendations require multi-season and multi-location validation, preferably including untreated controls or contrasting fungicide programs and plot-level analyses linking epidemic variables to yield components.

4. CONCLUSION

Under the preventive management adopted in Porto Acre, soybean end-of-cycle diseases occurred in all cultivars, with incidence increasing markedly during the late reproductive stages while overall severity remained low and did not differ significantly among cultivars. Dagma 7921 IPRO showed the highest numerical AUDPC and grain yield, whereas Dagma 7621 I2X combined the lowest numerical AUDPC and total seed contamination with the highest thousand-seed weight, revealing contrasting phytosanitary and agronomic profiles among cultivars. However, these patterns should not be interpreted as causal effects of disease on yield because the experiment lacked an untreated control and was conducted in a single season and location. Overall, the findings provide baseline information on soybean disease progress and cultivar performance in Acre, support intensified late-season disease monitoring, and highlight the need for multi-environment and multi-season trials with contrasting disease-management strategies to clarify cultivar responses and disease–yield relationships.

REFERENCES

CATTELAN, A. J.; DALL'AGNOL, A. The rapid soybean growth in Brazil. **OCL – Oilseeds and Fats, Crops and Lipids,** v. 25, n. 1, D102, 2018. DOI: 10.1051/ocl/2017058.

COMPANHIA NACIONAL DE ABASTECIMENTO (CONAB). **Acompanhamento da safra brasileira de grãos: safra 2024/25, 12° levantamento.** Brasília, DF: Conab, 2025. Disponível em: https://www.conab.gov.br/info-agro/safras/graos. Acesso em: 6 ago. 2026.

COSTA, E. V. C. **Posicionamento da aplicação de fungicidas em soja para o controle de doenças de final de ciclo.** 2024. 52 f. Dissertação (Mestrado em Produção Vegetal) – Universidade de Rio Verde, Rio Verde, 2024.

FERREIRA, D. F. Sisvar: a computer statistical analysis system. **Ciência e Agrotecnologia,** v. 35, n. 6, p. 1039–1042, 2011. DOI: 10.1590/S1413-70542011000600001.

FRANKE, I. L.; MARINHO, J. T. de S.; AMARAL, E. F. Pesquisa e extensão do cultivo da soja no estado do Acre. In: REUNIÃO DE PESQUISA DE SOJA, 38., 2023, Londrina. **Resumos expandidos.** Londrina: Embrapa Soja, 2023. p. 35–37.

GODOY, C. V.; UTIAMADA, C. M.; MEYER, M. C. **Doenças da soja e seu manejo integrado.** Londrina: Embrapa Soja, 2020. 72 p.

GODOY, C. V.; UTIAMADA, C. M.; MEYER, M. C.; CAMPOS, H. D.; LOPES, I. de O. N.; FARIAS, A. de; CARVALHO, A. G. de; DIAS, A. R.; KONAGESKI, F. T.; SANTOS, J. dos; GRIGOLLI, J. F. J.; ROY, J. M. T.; BELUFI, L. M. de R.; SILVA, L. H. C. P. da; FANTIN, L. H.; GOUSSAIN JÚNIOR, M. M.; SENGER, M.; STEFANELO, M. S.; DEBORTOLI, M. P.; MARTINS, M. C.; TORMEN, N. R.; KONAGESKI, T. F. **Eficiência de fungicidas para o controle das doenças de final de ciclo da soja, na safra 2022/2023: resultados sumarizados dos ensaios cooperativos.** Londrina: Embrapa Soja, 2023. 11 p. (Embrapa Soja. Circular Técnica, 193).

GODOY, C. V.; UTIAMADA, C. M.; MEYER, M. C.; CAMPOS, H. D.; LOPES, I. de O. N.; TOMEN, A.; MOCHKO, A. C. R.; DIAS, A. F.; FORCELINI, C. A.; SIQUERI, F. V.; SANTOS, J. dos; GALDINO, J. V.; ASCARI, J. P.; ARAÚJO JÚNIOR, I. P.; BELUFI, L. M. de R.; SILVA, L. H. C. P. da; SATO, L. N.; GOUSSAIN JÚNIOR, M. M.; SENGER, M.; STEFANELO, M. S.; MÜLLER, M. A.; DEBORTOLI, M. P.; TORMEN, N. R.; ROEHRIG, R. **Eficiência de fungicidas para o controle das doenças de final de ciclo da soja, na safra 2023/2024: resultados sumarizados dos ensaios cooperativos.** Londrina: Embrapa Soja, 2024. 11 p. (Embrapa Soja. Circular Técnica, 205). Disponível em: https://www.infoteca.cnptia.embrapa.br/handle/doc/1164967. Acesso em: 6 ago. 2026.

GOULART, A. C. P. **Fungos em sementes de soja: detecção, importância e controle.** 2. ed. Brasília, DF: Embrapa, 2018. 74 p. ISBN 978-85-7035-823-3.

HENNING, A. A.; ALMEIDA, A. M. R.; GODOY, C. V.; SEIXAS, C. D. S.; YORINORI, J. T.; COSTAMILAN, L. M.; FERREIRA, L. P.; MEYER, M. C.; SOARES, R. M.; DIAS, W. P. **Manual de identificação de doenças de soja.** 5. ed. Londrina: Embrapa Soja, 2014. 76 p. (Embrapa Soja. Documentos, 256).

HOSSEINI, B.; VOEGELE, R. T.; LINK, T. I. Diagnosis of soybean diseases caused by fungal and oomycete pathogens: existing methods and new developments. **Journal of Fungi,** v. 9, n. 5, art. 587, 2023. DOI: 10.3390/jof9050587.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). **Levantamento Sistemático da Produção Agrícola.** Rio de Janeiro: IBGE, 2025. Disponível em: https://www.ibge.gov.br/estatisticas/economicas/agricultura-e-pecuaria/9201-levantamento-sistematico-da-producao-agricola.html. Acesso em: 15 ago. 2025.

MARTINS, M. C.; GUERZONI, R. A.; CÂMARA, G. M. de S.; MATTIAZZI, P.; LOURENÇO, S. A.; AMORIM, L. Escala diagramática para a quantificação do complexo de doenças foliares de final de ciclo em soja. **Fitopatologia Brasileira,** v. 29, n. 2, p. 179–184, 2004. DOI: 10.1590/S0100-41582004000200009.

SEIXAS, C. D. S.; NEUMAIER, N.; BALBINOT JUNIOR, A. A.; KRZYZANOWSKI, F. C.; LEITE, R. M. V. B. de C. (ed.). **Tecnologias de produção de soja.** Londrina: Embrapa Soja, 2020. 347 p. (Embrapa Soja. Sistemas de Produção, 17).

SHANER, G.; FINNEY, R. E. The effect of nitrogen fertilization on the expression of slow-mildewing resistance in Knox wheat. **Phytopathology,** v. 67, p. 1051–1056, 1977. DOI: 10.1094/Phyto-67-1051.

SOARES, R. M.; GODOY, C. V.; SEIXAS, C. D. S.; COSTAMILAN, L. M.; MEYER, M. C.; HENNING, A. A.; ALMEIDA, A. M. R.; YORINORI, J. T.; FERREIRA, L. P.; DIAS, W. P. **Manual de identificação de doenças de soja.** 6. ed. Londrina: Embrapa Soja, 2023. 79 p. (Embrapa Soja. Documentos, 256).

---

[1] PhD candidate in Plant Production at the Federal University of Acre (UFAC). Rio Branco, Acre, Brazil. E-mail: acesse o artigo original para visualizar o e-mail

[2] PhD in Plant Production from the Federal University of Acre (UFAC). Rio Branco, Acre, Brazil. E-mail: acesse o artigo original para visualizar o e-mail

[3] PhD candidate in Plant Production at the Federal University of Acre (UFAC). Rio Branco, Acre, Brazil. E-mail: acesse o artigo original para visualizar o e-mail

[4] PhD candidate in Plant Production at the Federal University of Acre (UFAC). Rio Branco, Acre, Brazil. E-mail: acesse o artigo original para visualizar o e-mail.

[5] PhD in Plant Production from the Federal University of Acre (UFAC). Rio Branco, Acre, Brazil. E-mail: acesse o artigo original para visualizar o e-mail

[6] PhD in Plant Production from the Federal University of Acre (UFAC). Rio Branco, Acre, Brazil. E-mail: acesse o artigo original para visualizar o e-mail; acesse o artigo original para visualizar o e-mail; acesse o artigo original para visualizar o e-mail.

[7] PhD in Biodiversity and Biotechnology from the Federal University of Amazonas (UFAM) and Professor at the Federal University of Acre (UFAC). Rio Branco, Acre, Brazil. E-mail: acesse o artigo original para visualizar o e-mail.

[8] PhD in Plant Pathology from the Federal University of Lavras (UFLA) and Professor at the Federal University of Acre (UFAC). Rio Branco, Acre, Brazil. E-mail: acesse o artigo original para visualizar o e-mail.