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Assessment of fungal diseases on corn under various farming cultural practices

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Abstract

A study was conducted to assess the fungal diseases of corn under various management practices. The study was laid out in split-split plot arrangement in Randomized Complete Block Design (RCBD) with fertilizer treatments as the main plot. The hedgerow pruning treatments represented the sub-plot while mulching treatments were assigned to represent the sub-subplot. Findings show that the three common fungal diseases infecting corn include corn rust, *Stenocarpella* leaf blight and *Physoderma* brown spot. For corn rust, all the treatments were categorized as susceptible. Those applied with biofertilizer had the lowest rust infection with 66.20% and 65.78% for the first and second cropping period, respectively. Host reaction for *Stenocarpella* leaf blight among the treatments was categorized as moderately resistant. Similarly, those applied with biofertilizer had the lowest mean percent severity of 2.12% for the first cropping and 13.18% for the second cropping period. As for *Physoderma* brown spot, host reaction was categorized as resistant to the disease in the first cropping while this was absent in the second cropping period. The treatment without fertilizer application had the highest severity rating of *Physoderma* brown spot. In terms of hedgerow pruning and mulching practices, no significant difference was noted among the treatments. However, general findings revealed that the treatment with biofertilizer application showed the lowest mean percent severity of the three fungal diseases identified on the alley crop. These findings could be attributed to the beneficial effects of biofertilizer to resist pest and diseases when applied to crops.

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Introduction

The objectives of agriculture generally have been to achieve maximum yields, operate with a minimum profit, minimize year-to-year instability in production and prevent long-term degradation of the productive capacity of the agricultural system (Altieri *et al*., 1983). With the ecological and environmental pollution, specifically of agricultural lands brought about by excessive and injudicious use of agrochemicals, environmental and human health risks have been one of man's major concerns. A degraded and polluted land is a sign of an unhealthy environment and promises no economic advancement and growth for man.

However, with farmers' attempt to attain higher yield, measures to mitigate problems on pollution and contamination of soil by judicious use of agrochemicals with detrimental effects to humans, had been less prioritized. Hence, to reduce input of chemical fertilizers yet sustain productivity and maintain the agrosystem, biofertilizers have become ideal substitute for fertilization and conditioning of the soil (Jee, 2007).

Researchers recommend that application of biofertilizers not only minimize fertilizer loss and maximize nutrient uptake but also reduce incidence of common pests and diseases of many crops. Various cultural practices in the farm may also influence occurrences of pest and diseases. These include the proper timing of fertilizer application, type of fertilizer applied, soil amelioration practices and cropping patterns. The most appropriate practices need to be determined to give the best economical benefit to the farmers. Thus, this study aimed to assess the severity of diseases on corn under various farming cultural practices for recommendation to local farmers.

Material and methods

Location and description of the study site

The study was conducted at the northeastern part of Central Mindanao University, Musuan, Bukidnon (Fig. 1). The average elevation is 430 m asl and the slope gradient ranges from 25 to 30%. The area has a soil taxonomic classification of aeric tropaquepts according to Commendador as cited by Raymundo (1985). It belongs to the third climatic type of the Philippines having no very pronounced season. Dry season is usually from November to April and the rest of the year is wet.

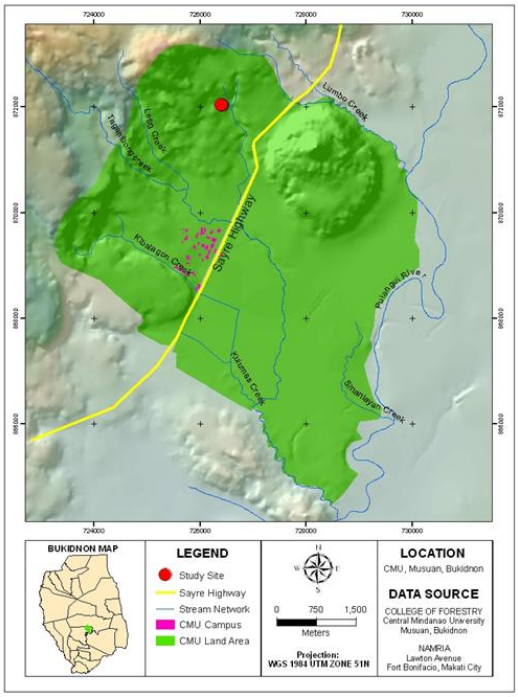


Fig. 1. Location map of the study site.

Experimental materials

Jatropha seedlings of the Bukidnon provenance were used as hedgerow plant in this study. Seedlings were raised using 10 cm by 18 cm polyethylene bags at the Jatropha Nursery. When the seedlings reached the age of four months, these were out-planted to the experimental site as hedgerows of the alley cropping system.

Corn (CMU OPV var 12) was used in this study as the alley crop. This variety is said to be acid-tolerant and matures at 100-105 days. Seeds were purchased from the CMU-Agricultural Experiment Station.

Experimental design and treatments

The study was laid-out in split-split plot arrangement in Randomized Complete Block Design (RCBD). The treatments were as follows:

Main Plot	Fertilizer Application
F1	No Fertilizer
F2	Biofertilizer
F3	Inorganic Fertilizer
Sub Plot	**Pruning Regimes**
P1	75-cm Pruning
P2	50-cm Pruning
Sub-Subplot	**Mulching**
M1	With Mulch
M2	Without Mulch

Plot length per main plot was sixteen meters (16 m) with half a meter buffer at the edge of the alley and one (1) meter buffer per treatment. Main plot was divided into two to serve as sub-plots (pruning treatment) at 8 meters distance each. Each sub-plot was further divided into halves as sub-subplot treatments (mulching). Length per sub-sub-plot was 4 meters with 0.5-meter buffer at both ends. Distance between rows of the alley was 0.67 m.

Considering the age of *J. curcas,* the pruning (sub-plot) and mulching (sub-sub plot) treatments were only done during the second cropping period while the fertilizer treatment (main plot) was observed for two periods on the alley crop. The experimental design of the first cropping was Randomized Complete Block Design (RCBD).

Control plots (No Hedgerows) were laid out in every replication. Data from the control plots were not included in the statistical analysis but were used as bases of comparison to the treatment plots of the alley farming system.

X-Tekh Biofertilizer was used in this study for the biofertilizer treatment. Application was done using a knapsack sprayer and the prescription was based on the standard recommendation or protocol of the company. The application protocols were as follows:
10 – 15 DAP : 35 ml or 50 ml biofertilizer/16 L water
25 – 30 DAP : 70 ml or 50 ml biofertilizer/16 L water
35 – 45 DAP:100 ml biofertilizer Micro/16 L water + 100 ml Potassium/16 L water

Two (2) bags of inorganic fertilizer (complete or 14-14-14 was also applied per hectare apart from the liquid X-tekh biofertilizer.

Inorganic fertilizers applied were based on the recommendations from the analysis of the soil samples. Fertilizer recommendation based on the analysis ranged from 1 ¾ to 2 ½ bags per hectare of 18-46-0 fertilizer for basal and ¼ to ¾ bag of 46-0-0 for side dressing.

Hedgerow and alley preparation

The entire area of the study was cultivated by using a carabao-drawn plow. Hedgerow location was done using an "A" frame. The hedgerows were planted with jatropha seedlings at 0.5-meter distance.

After alley preparation for corn planting, sowing of corn seeds was made a week after hedgerow establishment. Sowing was done through drill method with 2-3 seeds per hill at 25 cm distance within row and 67 cm between rows. There were 5 rows in the 4-meter width of the alley where the two outer rows served as buffer while the 3 inner rows were considered as data or measurement rows.

Cultural treatments

Weeding was done twice throughout the cropping period. The first was done 21 days after sowing (DAS) and the second was 75 DAS. Three weeks after sowing, hilling up was done on the experimental plots.

Data gathered

Disease severity

Disease severity was assessed by randomly tagging ten plant samples per plot. During the observation at reproductive stage, three diseases were noted namely: corn rust, *Stenocarpella* leaf blight and *Physoderma* brown spot. These diseases were rated following the modified standard rating scale used by Alejandro *et al.* (2002) as recommended during the 1989 "National Symposium-Workshop on Evaluation of Host Plant Resistance to Pathogens and Insect Pest in Corn and Sorghum".

Scale	Description	Host Reaction
1	1-10% of whole plant area infected	Resistant
2	11-30% of whole plant area infected	Moderately Resistant
3	31-50% of whole area infected	Moderately Susceptible
4	51-100% of whole area infected	Susceptible

Hedgerow pruning

Jatropha hedgerows were pruned 50 cms and 75 cms above the soil surface as the subplot treatments of the study. Amount of prunings was determined by using a weighing balance. Pruning was done 7 DAS of the second cropping period on the upper and lower hedgerows.

Mulching

Prunings removed from the hedgerows were used as mulch on the treatments. The amount of mulch (5.2 kg) was made uniform in all the treatments. These were uniformly scattered throughout the surface of every plot. Only the leaves and soft portion of upper twigs pruned were used as mulch. The woody stems with more than 2 cm diameter were removed and laid horizontally at the base of the hedgerow parallel to the contour line (Visco, 1997; Asaduzzaman, 2000).

Data analysis

The test of significant difference among treatments was determined through the Analysis of Variance (ANOVA) using the Statistical Package for the Social Sciences Program (SPSS) version 16. Least significant difference and Tukey's, on the other hand, were used in comparing treatment means.

Results and discussion

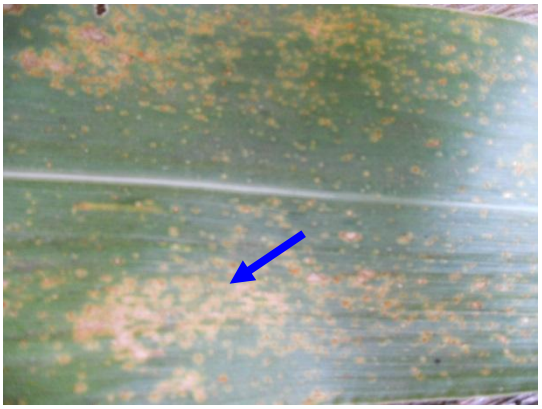
There were three fungal diseases observed and identified in the alley crop during the first cropping period namely, corn rust, *Stenocarpella* leaf blight and *Physoderma* brown spot (Table 1). However, during the second cropping period, only two fungal diseases were noted: corn rust and *Stenocarpella* leaf blight (Table 1). Symptoms and signs of the mentioned diseases are shown in Fig. 2.

Table 1. Mean rating of corn rust, *Stenocarpella* leaf blight and *Physoderma* brown spot on corn as affected by fertilizer applications.

Treatments	Disease severity (%)								
	Corn Rust			*Stenocarpella* Leaf Blight			*Physoderma* brown Spot		
	1st Cropping	2nd Cropping	Host Reaction	1st Cropping	2nd Cropping	Host Reaction	1st Cropping	2nd Cropping	Host Reaction
F1	71.2	71.047	Susceptible	4.46	13.983	Moderately Resistant	3.12[b]	0	Resistant
F2	66.2	65.783	Susceptible	2.12	13.175	Moderately Resistant	1.28[a]	0	Resistant
F3	75.3	68.500	Susceptible	7.41	15.725	Moderately Resistant	2.18[a]	0	Resistant
F-Test	ns	ns		ns	ns		*		
CV (%)	6.4	14.24		26.5	33.32		25.1		
No Hedge[x]	77.17	74.167	Susceptible	3.99	14.333	Moderately Resistant	1.89	0	Resistant

ns = not significant, x = not statistically analyzed, * = significant

F1 = No Fertilizer, F2 = Organic Fertilizer, F3 = Inorganic Fertilizer



(a)

(b)

(c)

Fig. 2. Symptoms of foliar diseases in the alley crop: (a) Corn rust; (b) *Stenocarpella* leaf blight and (c) *Physoderma* brown spot.

For corn rust, all treatments were categorized as susceptible. Statistical analysis revealed that there was no significant difference among the treatment means. The biofertilizer treatment (F2), however, had the lowest mean percent severity of corn rust at 66.20% and 65.78% for the first and second cropping periods, respectively.

Host reaction for *Stenocarpella* leaf blight among the treatments was categorized as moderately resistant. Statistically, the three treatments were found to have no significant difference at 5% significant level. F2, however, had the lowest rating with 2.12% for the first cropping and 13.18% for the second cropping period.

With *Physoderma* brown spot, host reaction was categorized as resistant to the disease during the first cropping while this was absent in the second cropping period. The F2 and F3 treatments showed comparable means with 1.28% and 2.18%, respectively while F1 treatment was found to be significantly different from F2 and F3 with a disease severity rating of 3.12%. This is further illustrated through a bar graph (Fig. 3). However, based on the rating scale set by Mayee and Datar (1986), *Physoderma* brown spot ratings for all treatments meant moderate resistance to the disease.

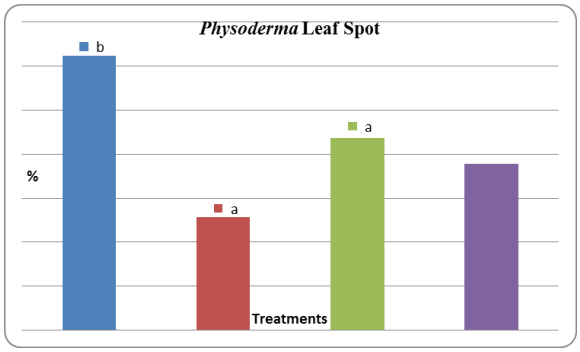


Fig. 3. Severity of *Physoderma* brown spot in corn as affected by fertilizer application.

F2 had the lowest severity ratings on the three diseases identified on the alley crop. This finding could be attributed to the beneficial effects of biofertilizer to resist pest and diseases once applied on crops. According to Acidera (2008) as cited by Sarian (2008), symbiotic microorganisms cluster around the roots and associatively help convert soil nutrients and also protect plants from diseases caused by harmful conditions in the soil. This is consistent with the findings of Yardim and Edwards (2003) that there were lower populations of aphids on tomatoes grown with the organic fertilizer than on those grown with the synthetic fertilizers indicating that organic fertilizers may have the potential to reduce pest

attacks in the long term. Furthermore, the result of the study conducted by Yu-Tzu *et al.* (2009) on cabbage (*Brassica oleracea* L.) presented parallel findings where organic treatment can increase a plant's biomass production and may have a lower pest occurrence.

Influence of hedgerow pruning on disease severity on corn

Of the two diseases observed in corn 75 DAS, no significant difference was observed on the two types of pruning treatments (Table 2).

Though P1 (Pruning at 75 cm height) had slightly higher means than P2 (pruning at 50 cm height), the degree of disease severity was more or less the same and crops are categorized as susceptible. The corn plants, however, were classified to be moderately resistant to *Stenocarpella* leaf blight in both pruning treatments. This finding is consistent with what was presented by Girma *et al.* (2000) where they stressed that the effect of hedgerows on pest infestations of crops and their role as refuge for predators cannot be generalized but depends on the specific pests.

Table 2. Mean rating of corn rust and *Stenocarpella* leaf blight severity in corn as affected by types of pruning treatments.

Pruning	Disease			
	Corn rust		*Stenocarpella* leaf blight	
	% Severity	Host Reaction	% Severity	Host Reaction
P1	70.64	Susceptible	13.67	Moderately Resistant
P2	66.25	Susceptible	14.92	Moderately Resistant
F-test	ns		ns	
C.V. (%)	14.24		33.32	
Control× (No Hedge)	74.17	Susceptible	14.33	Moderately Resistant

ns = not significant, × = not statistically analyzed

P1 = Pruning height at 75 cm, P2 = Pruning height at 50 cm

Disease severity on corn as affected by mulching practices

Result of the analysis revealed no significant difference between with and without mulch treatments (Table 3). The degree of infection of both corn rust and *Stenocarpella* leaf blight were more or less the same. The host reaction was categorized as susceptible and moderately resistant to both diseases, respectively. However, though not significant, the severity of the disease in M1 (with mulch) treatment was slightly lower as compared to M2 (without mulch). The beneficial effects of mulching can be attributed to these findings. Galindo *et al.* (1982) reported similar findings on dry beans where this crop when mulched with rice husks greatly reduced splashing of inoculum and lowered disease severity of web blight caused by *Rhizoctonia solani*. Furthermore, the study reported by Huia-Gu (2010) on rice mulched on rice –wheat rotation showed that the disease indices were lower in the mulched plots than in the unmulched control.

Effects of fertilizer and pruning practices on the severity of diseases on corn

Findings revealed no significant difference among treatments for both corn rust and *Stenocarpella* leaf blight (Table 4). Host reactions were identified to be susceptible and moderately resistant to corn rust and *Stenocarpella* leaf blight, respectively in all treatment combinations.

Observations also revealed that the Control (no hedge) had more or less the same degree of severity when compared to plants with the *J. curcas* hedgerow. This shows that the presence of *J. curcas* as hedges has no influence on the severity of diseases during the said cropping period.

Table 3. Mean percent severity of corn rust and *Stenocarpella* leaf blight diseases in corn as affected by mulching treatments.

Mulching	Disease			
	Corn rust		Stenocarpella leaf blight	
	% Severity	Host Reaction	% Severity	Host Reaction
M1	67.78	Susceptible	13.73	Moderately Resistant
M2	69.11	Susceptible	14.86	Moderately Resistant
F-test	ns		ns	
C.V. (%)	14.24		33.32	
Control× (No Hedge)	74.17	Susceptible	14.33	Moderately Resistant

ns = not significant, × = not statistically analyzed

M1 = With Mulch, M2 = Without Mulch

Table 4. Mean percent severity of corn rust and *Stenocarpella* leaf blight as affected by fertilizer applications and pruning treatments.

Fertilizer × pruning	Disease			
	Corn rust		Stenocarpella leaf blight	
	% Severity	Host Reaction	% Severity	Host Reaction
F1 × P1	74.09	Susceptible	13.13	Moderately Resistant
F1 × P2	68.00	Susceptible	14.83	Moderately Resistant
F2 × P1	66.32	Susceptible	12.27	Moderately Resistant
F2 × P2	65.25	Susceptible	14.08	Moderately Resistant
F3 × P1	71.50	Susceptible	15.62	Moderately Resistant
F3 × P2	65.50	Susceptible	15.83	Moderately Resistant
F-test	ns		ns	
C.V. (%)	14.24		33.32	
Control× (No Hedge)	74.17	Susceptible	14.33	Moderately Resistant

ns = not significant, × = not statistically analyzed

F1 = No Fertilizer, F2 = Organic Fertilizer, F3 = Inorganic Fertilizer, P1 = Pruning height at 75 cm, P2 = Pruning height at 50 cm

Effects of fertilizer and mulching practices on the severity of diseases on corn

Findings showed no significant difference observed among treatment combinations for corn rust and *Stenocarpella* leaf blight (Table 5). Treatment F2 ×M1 had the least mean for corn rust with 64.75% while F2 × M2 (12.60%) was lowest for *Stenocarpella* infection.

All treatment combinations, however, were classified as susceptible and moderately resistant to corn rust and *Stenocarpella* leaf blight, respectively. Findings showed that treatment combination with F2 (biofertilizer) had the least percent disease severity which can be attributed to the beneficial components of biofertilizer in protecting the alley crop from infections.

Table 5. Mean percent severity of corn rust and *Stenocarpella* leaf blight as affected by fertilizer applications and mulching treatments.

Fertilizer × mulching	Disease			
	Corn rust		Stenocarpella leaf blight	
	% Severity	Host Reaction	% Severity	Host Reaction
F1 × M1	71.83	Susceptible	14.50	Moderately Resistant
F1 × M2	70.26	Susceptible	13.47	Moderately Resistant
F2 × M1	64.75	Susceptible	13.75	Moderately Resistant

Fertilizer × mulching	Disease			
	Corn rust		Stenocarpella leaf blight	
	% Severity	Host Reaction	% Severity	Host Reaction
F2 × M2	66.82	Susceptible	12.60	Moderately Resistant
F3 × M1	66.75	Susceptible	12.95	Moderately Resistant
F3 × M2	70.25	Susceptible	18.50	Moderately Resistant
F-test	ns		ns	
C.V. (%)	14.24		33.32	
Control× (No Hedge)	74.17	Susceptible	14.33	Moderately Resistant

ns = not significant, × = not statistically analyzed

F1 = No Fertilizer, F2 = Organic Fertilizer, F3 = Inorganic Fertilizer, M1 = With Mulch, M2 = Without Mulch

Effects of pruning and mulching practices on severity of diseases on corn

Data revealed no significant difference among treatment combination means for corn rust and *Stenocarpella* leaf blight (Table 6). All treatment combinations were classified as susceptible and moderately resistant to corn rust and *Stenocarpella* leaf blight, respectively. However, the treatment combinations on pruning (50cm) and mulching hadthe lowestcorn rust severityrating og 65.67% while the highest rating was noted in P1×M2with a mean of 71.38%.

In the case of *Stenocarpella* leaf blight, the lowest disease severity was recorded from P1×M1.

These data indicate that mulching has an influence on the severity of foliar diseases in corn.

Effects of fertilizer, pruning and mulching practices on disease severity on corn

There were no significant differences among treatment combinations for corn rust and *Stenocarpella* leaf blight (Table 7). Host reactions of corn to rust and *Stenocarpella* diseases were classified as susceptible and moderately resistant, respectively. Among the treatment combination means for corn rust, F3 × P2 ×M1 had the least infection of 62.83% while F2 × P1 × M1 (11.50% infection) was the lowest mean for *Stenocarpella* leaf blight.

Table 6. Mean rating of corn rust and *Stenocarpella* leaf blight in corn as affected by pruning and mulching treatments.

Pruning X Mulching	Disease			
	Corn rust		Diplodia	
	% Incidence	Host Reaction	% Incidence	Host Reaction
P1 x M1	69.89	Susceptible	12.52	Moderately Resistant
P1 x M2	71.38	Susceptible	14.82	Moderately Resistant
P2 x M1	65.67	Susceptible	14.94	Moderately Resistant
P2 x M2	66.83	Susceptible	14.89	Moderately Resistant
F-test	ns		ns	
C.V. (%)	14.24		33.32	
Controlx (No Hedge)	74.17	Susceptible	14.33	Moderately Resistant

ns = not significant, x = not statistically analyzed

P1 = Pruning height at 75 cm, P2 = Pruning height at 50 cm, M1 = With Mulch, M2 = Without Mulch

Table 7. Mean rating of corn rust and *Stenocarpella* leaf blight in corn as affected by fertilizer applications, pruning and mulching treatments.

Fertilizer X Pruning X Mulching	Disease			
	Corn rust		*Diplodia*	
	% Severity	Host Reaction	% Severity	Host Reaction
F1 x P1 x M1	74.00	Susceptible	11.83	Moderately Resistant
F1 x P1 x M2	74.19	Susceptible	14.43	Moderately Resistant
F1 x P2 x M1	69.67	Susceptible	17.17	Moderately Resistant
F1 x P2 x M2	66.33	Susceptible	12.50	Moderately Resistant
F2 x P1 x M1	65.00	Susceptible	11.50	Moderately Resistant
F2 x P1 x M2	67.63	Susceptible	13.03	Moderately Resistant
F2 x P2 x M1	64.50	Susceptible	16.00	Moderately Resistant
F2 x P2 x M1	66.00	Susceptible	12.17	Moderately Resistant
F3 x P1 x M1	70.67	Susceptible	14.23	Moderately Resistant
F3 x P1 x M2	72.33	Susceptible	17.00	Moderately Resistant
F3 x P2 x M1	62.83	Susceptible	11.67	Moderately Resistant
F3 x P2 x M1	68.17	Susceptible	20.00	Moderately Resistant
F-test	ns		ns	
C.V. (%)	14.24		33.32	
Control[x] (No Hedge)	74.17	Susceptible	14.33	Moderately Resistant

ns = not significant, x = not statistically analyzed

F1 = No Fertilizer, F2 = Organic Fertilizer, F3 = Inorganic Fertilizer, P1 = Pruning height at 75 cm, P2 = Pruning height at 50 cm, M1 = With Mulch, M2 = Without Mulch

Results of treatment combinations show that lower disease severity ratings were assessed from plants with biofertilizer regardless of whether pruning and mulching practices were applied on the plants.

Conclusion

Results of the study revealed that pruning of hedgerows and mulching as cultural practices have no effect on the severity of corn rust since the crops were evaluated as susceptible to the disease. However, both farm operations have an influence on the low percent severity of *Stenocarpella* leaf blight making the crops moderately resistant to the disease. Similarly, the application of biofertilizer in combination with pruning or mulching did not control corn rust disease.

The application of biofertilizer on corn, on the other hand, has an influence on the severity of fungal diseases on the plants as evidenced by the lowest percent mean severity of corn rust and *Stenocarpella* leaf blight in both cropping periods and the absence of *Physoderma* brown spot disease during the second cropping period.

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