Effect of Anthracnose on Yield of the Tropical Forage Legume, *Stylosanthes hamata*

Jillian M. Lenné and R. M. Sonoda

Former postdoctoral research associate and associate professor, respectively, University of Florida Agricultural Research Center, Fort Pierce 33450. Present address of senior author: Centro Internacional de Agricultura Tropical, CIAT, Apartado Aéreo 67-13, Cali, Colombia.

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ABSTRACT

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The effect of anthracnose, which is caused by *Colletotrichum gloeosporioides*, on the yield of two selections of the tropical forage legume, *Stylosanthes hamata*, was measured in the field in southern Florida during 1977 to 1979. Representative plots were sprayed with benomyl or mancozeb for yield comparison with plots in which anthracnose was not controlled. Yield reduction due to anthracnose ranged 26–58% in *S. hamata* IRFL 7303 and 31–58% in IRFL 7413. Lesion counts were positively correlated with yield reduction percentages. There were no significant differences in yields of plots treated with different fungicides and, initially, between plots treated with fungicides and peptone. Peptone, however, lost efficacy in 1978. Seed from control, peptone-, and mancozeb-sprayed plots was 8–21% infected with *C. gloeosporioides* whereas seed from benomyl-sprayed plots was free of this fungus. Levels of forage loss measured during 1977 to 1979 were considerable and indicate the need for anthracnose control measures.

Of all tropical forage legumes, greatest interest has been shown in the genus *Stylosanthes* (15). *Stylosanthes* generally is tolerant of acid, infertile soils (6) and has great potential for improving cattle production in tropical regions (2). The species *Stylosanthes hamata* (L.) Taub., indigenous to the Caribbean (13), has shown potential as a forage in southern Florida (4).

Anthracnose of *Stylosanthes* was first recorded in Brazil in 1937 (1). Since then, with increased planting, anthracnose has become a widespread and damaging disease affecting all *Stylosanthes* spp. currently under evaluation at tropical forage centers in the Americas (2,11,16), Australia (7,14), Asia (10), and Africa (5).

Although two species of *Colletotrichum* cause anthracnose, *Colletotrichum gloeosporioides* (Penz.) Sacc. is the more important in southern Florida (10). The disease becomes manifest as leaf spots 1–4 mm in diameter with pale centers and dark margins, and as stem, petiole, and inflorescence lesions 0.5 to 5 mm long, elliptical, and with coloration similar to the leaf spots. In severe cases, leaf spots coalesce and leaves become yellow and fall. Stem, petiole, and inflorescence lesions develop into cankers which cause leaf, flower, and seed losses, as well as stem girdling and plant death.

Since the early 1970s, there have been field reports of serious forage and seed losses in *Stylosanthes* due to anthracnose. In general, yield loss information has been based on estimates and opinions. No detailed loss studies have been made previously.

S. hamata has been evaluated at the Agricultural Research Center, Fort Pierce, FL (ARC-FP), for several years (4). Evaluation is continuing on several herbaceous selections agronomically suited to the environment (3) and considered relatively resistant to anthracnose. The effect of anthracnose on yield of *S. hamata* IRFL 7303 and IRFL 7413 (ARC-FP accession numbers) was studied at the ARC-FP from 1977 to 1979 and is reported in this manuscript. Because no other damaging diseases or pests have yet been detected on *S. hamata* in southern Florida, the measured yield loss was attributed entirely to anthracnose.

MATERIALS AND METHODS

Seed of *S. hamata* 7303 and 7413 were scarified mechanically and germinated in fine sand in petri dishes. Seedlings were grown at 20–30 C with natural photoperiod in Jiffy-mix in flats. All seedlings were inoculated with standard Rhizobium inoculum. Plants were transplanted to the field at 4 wk (June 1977) in a randomized complete block with five replications of four treatments. Each of the 20 plots (2 × 4 m) contained two subplots (1 × 4 m), one of each selection. There were 104 plants, 52 of each selection, per plot.

Two fungicides, benomyl (0.53 g [formula weight] per liter) and mancozeb (2.36 g [formula weight] per liter), chosen because of their efficacy in controlling diseases caused by *C. gloeosporioides* in other tropical crops, were used to control disease in plots used to estimate yield in the absence of disease. The nutrient, peptone, was applied as a 1% solution. Previously, peptone was found to inhibit in vitro appressorium formation in *C. gloeosporioides* (9). Spraying was commenced immediately after planting and continued at weekly intervals until December. In 1978 and 1979, plants also were sprayed weekly from June to December. Unsprayed plants exposed to natural seasonal infection served as controls.

Forage was harvested in September and December 1977, in July and December 1978, and December 1979. Each plot was mowed to a height of 20 cm and fresh and oven-dry (60 C for 48 hr) weights were determined. Lesions were counted on random samples of 200 cm of stem and 20 trifoliolate leaves from each subplot. Yield reduction percentage was calculated by subtracting the yield of control plots from the yield of sprayed plots, dividing by the latter, and multiplying by 100 for each treatment. Dry matter production, yield reduction, and lesion assessment were compared by analysis of variance and Duncan's multiple range test.

Seeds harvested in September 1978 were assayed for associated fungi by plating untreated seed directly on oatmeal agar (10) in petri dishes (20 seeds per dish). Fungi growing from the seed were identified and recorded after 5 days at 22–28 C. Five hundred seeds per treatment (100 seeds per subplot) were assayed.

RESULTS

There were no significant differences in mean dry matter production (Table 1) or in lesion counts (Table 2) among treatments for both *S. hamata* selections in September 1977. By December 1977, however, mean dry matter production of the unsprayed control plots was significantly less than that of all sprayed plots (Table 1) and yield reduction in both selections was ≥50% (Table 3). At the same time, unsprayed control plants had significantly more lesions than sprayed plants (Table 2). There were no significant differences in dry matter production, yield reduction, or lesion number among peptone and fungicide treatments in December 1977 (Tables 1–3).

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From December 1977 to December 1979, mean dry matter production in both selections was significantly greater in fungicide treated plots than in the unsprayed control plots (Table 1) and yield reduction ranged 25.9–58.2% (Table 3). Control plants had significantly more lesions than sprayed plants (Table 2), but there were no significant differences in any parameter between fungicides (Tables 1–3).

After the first year, however, no significant differences were found in dry matter production between control and peptone treatments (Table 1). By December 1979, the control treatment outyielded the peptone treatment (Table 3) and lesion numbers were the same in both treatments, being significantly greater than those in the fungicide treatments (Table 2).

Nine genera of fungi were associated with seed from the yield experiment (Table 4). *C. gloeosporioides* and species of *Fusarium* and *Curvularia* were most common. Although *C. gloeosporioides* was associated with 8–21% of seed harvested from control, peptone, and mancozeb treated plots, it was not found on seed from benomyl treatments (Table 4).

DISCUSSION

Anthracnose, which is caused by *C. gloeosporioides,* caused high levels of forage loss (26–58%) in two agronomically adapted selections of the tropical forage legume, *S. hamata,* in experimental plots in southern Florida from 1977 to 1979. These results emphasize a need for control of this damaging disease.

Initially peptone, as a 1% solution, was equally as effective as a fungicide in controlling anthracnose. This supports the previous observation that peptone effectively reduces appressorium formation (9). Its efficacy, however, was considerably reduced in 1978 and by 1979, peptone-sprayed plots were as diseased as controls. In 1978, initial infection by *C. gloeosporioides* may have occurred before spraying resumed in June and inoculum level within these plots may have been high enough to overcome protection by peptone. More work is needed to clarify this result.

Infection of seed of *S. hamata* with *C. gloeosporioides* not only facilitates pathogen transmission, it also reduces germination and seedling development (12) and may affect pasture persistence by reducing the number and vigor of seedlings. The value of benomyl in reducing seed infection by *C. gloeosporioides* is therefore twofold. Although the most desirable method of producing disease-free seed is in a disease-free environment, the technology of tropical forage seed production is still developing. Strategic use of fungicides during flowering and seed set may prove to be an important short-term method of producing anthracnose-free seed.

The results have clearly shown that selections of *S. hamata* considered relatively resistant to anthracnose are sustaining considerable forage losses in experimental plots in southern Florida. Plant resistance is the most practical and economical means of controlling diseases of forages (8); therefore, further screening of *S. hamata* germ plasm is desirable to select plants with high levels of resistance to anthracnose for use as forage legumes in southern Florida and other subtropical and tropical areas.

TABLE 1. Effect of *Colletotrichum gloeosporioides* on dry matter production of *Stylosanthes hamata* accessions IRFL 7303 and 7413 in southern Florida from 1977 to 1979

	Mean dry matter production (g/subplot)							
	7303				7413			
Harvest date	Control	Peptone	Benomyl	Mancozeb	Control	Peptone	Benomyl	Mancozeb
September 1977	359 a[z]	371 a	368 a	400 a	142 a	118 a	119 a	150 a
December 1977	94 b	186 a	219 a	221 a	201 b	427 a	428 a	481 a
July 1978	919 b	897 b	1,315 a	1,335 a	724 b	683 b	1,275 a	1,208 a
December 1978	765 b	780 b	1,457 a	1,386 a	593 b	640 b	1,182 a	1,051 a
December 1979	1,155 b	805 b	1,879 a	1,559 a	1,178 b	997 b	1,918 a	1,709 a

[z]For each harvest date, means followed by different letters are significantly different, $P = 0.05$, according to Duncan's multiple range test.

TABLE 2. Effect of various spray treatments on numbers of lesions caused by *Colletotrichum gloeosporioides* on plants of *Stylosanthes hamata* accessions IRFL 7303 and 7413 in southern Florida from 1977 to 1978

	Number of lesions[y]							
	7303				7413			
Harvest date	Control	Peptone	Benomyl	Mancozeb	Control	Peptone	Benomyl	Mancozeb
September 1977	5 a[z]	0 b	0 b	0 b	67 a	21 b	1 b	3 b
December 1977	221 a	49 b	19 b	7 b	186 a	30 b	20 b	9 b
July 1978	148 a	90 b	39 c	56 bc	138 a	107 a	44 b	60 b
December 1978	131 a	108 a	40 b	34 b	181 a	91 b	32 c	36 c
December 1979	198 a	186 a	29 b	38 b	215 a	175 a	35 b	30 b

[y]Leaf and stem lesions.
[z]For each harvest date, means followed by different letters are significantly different, $P = 0.05$, according to Duncan's multiple range test.

TABLE 3. Yield reduction caused by *Colletotrichum gloeosporioides* in *Stylosanthes hamata* accessions IRFL 7303 and 7413 in southern Florida from 1977 to 1979

	Yield reduction (%)[y]					
	7303			7413		
Harvest date	Peptone	Benomyl	Mancozeb	Peptone	Benomyl	Mancozeb
December 1977	49.5 a[z]	57.0 a	57.5 a	52.9 a	53.0 a	58.2 a
July 1978	−2.4 b	30.1 a	31.2 a	−6.0 b	43.2 a	40.1 a
December 1978	1.9 b	47.5 a	44.8 a	7.3 b	49.8 a	43.6 a
December 1979	−43.5 b	38.5 a	25.9 a	−18.2 b	38.6 a	31.1 a

[y]Yield reduction in control compared to each spray treatment equals mean yield sprayed treatment minus mean yield control divided by mean yield sprayed treatment multiplied by 100.
[z]For each harvest date, means followed by different letters are significantly different, $P = 0.05$, according to Duncan's multiple range test.

TABLE 4. Fungi associated with seed of *Stylosanthes hamata* accessions IRFL 7303 and 7413 under various spray treatments

Fungi	Seed infested (%)[x]			
	Control	Peptone	Benomyl	Mancozeb
Fusarium spp.	65[y]	77	78	68
	78[z]	75	71	69
Curvularia spp.	10	7	22	10
	11	2	26	9
Colletotrichum gloeosporioides	9	15	0	10
	21	8	0	13
Alternaria sp.	0	0	1	0
	0	0	0	0
Aspergillus spp.	0	1	1	0
	0	0	5	0
Drechslera sp.	0	1	2	0
	0	0	1	0
Penicillium spp.	0	1	0	1
	0	2	0	0
Phoma sp.	1	0	0	0
	0	0	0	0
Rhizopus spp.	0	2	1	2
	4	4	3	2

[x]Mean for 500 seeds plated on oatmeal agar.
[y]Seed of 7303 infested with fungi.
[z]Seed of 7413 infested with fungi.

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