Field Evaluation of Fall Armyworm (Lepidoptera: Noctuidae) Feeding on Yield and Quality of 'Alicia' Bermudagrass[1]

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ABSTRACT Field evaluation of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) feeding on yield and quality of bermudagrass, *Cynodon dactylon* (L.) Pers., var. 'Alicia,' was studied during the 1983-1984 growing season. Yield losses of 'Alicia' ranged from 0.3 to 0.9 metric ton per ha when plots were infested with population densities of 1.1 to 9.9 larvae/0.1 m^2, respectively. 'Alicia' was more tolerant to fall armyworm than 'Coastal' as indicated by lower damage ratings and losses in forage quality.

KEY WORDS Fall armyworm, *Spodoptera frugiperda,* bermudagrass, *Cynodon dactylon,* forages.

The fall armyworm, *Spodoptera frugiperda* (J. E. Smith), can cause significant yield and quality losses in bermudagrass, *Cynodon dactylon* (L.), pastures (Suber et al. 1979; Martin et al. 1980; Alvarado et al. 1983; Jamjanya and Quisenberry 1988). Jamjanya and Quisenberry (1988) reported that fall armyworm feeding on 'Coastal' bermudagrass resulted in losses of dry matter yield (0.5 to 1.1 metric ton/ha) and yields of digestible dry matter (245 kg/ha) and crude protein (72 kg/ha). In 1977, economic losses in Georgia hay pastures, estimated at $59 million, were attributed to fall armyworm feeding (Todd and Suber 1980). A field study was undertaken to measure the impact of varying fall armyworm densities on yield and quality of 'Alicia' bermudagrass.

Materials and Methods

Barrier plots were established in a stand of 'Alicia' bermudagrass at the St. Gabriel Experiment Station in Iberville Parish, La. Metal barriers (23 cm in height) were implanted (10 cm depth) around each plot (3 × 2 m) and Tanglefoot applied (8 cm band) to the top interior to prevent insect dispersal. Grass was clipped (7 cm height), fertilized with ammonium nitrate (227 kg N/ha), and treated with methyl parathion (1.1 kg AI/ha) to establish insect-free plots 1 week before fall armyworm larvae were released. Carbaryl (0.6 kg AI/ha) was applied to control plots as needed, and after a 2 week feeding period was applied to all plots to remove fall armyworm.

Fall armyworm larvae used in the experiment were from a laboratory colony reared according to procedures of Perkins (1979). Larvae were reared in compartment

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rearing trays (15 × 15 × 1.5 cm; Bioserv, Inc.) containing modified pinto bean diet (230 ml/tray). Trays were infested with neonate larvae (ca. 200/tray), sealed, and maintained under 14:10 (L:D) photoperiod, 26 ± 1° C, and > 50% RH until larvae were 4th instar (ca. 7 days). The number of larvae in each tray was counted 1 day prior to release. Plots were infested by randomly distributing fall armyworm larvae (fourth and fifth instar) at densities of 1.1, 2.2, 3.3, 6.6, and 9.9 larvae/0.1 m^2. In 1983, two studies were conducted (22 July to 15 August and 23 August to 16 September), while in 1984 there was only one study (10 August to 7 September).

In 1983, one (0.06 m^2) grass sample was taken at random in each plot at four consecutive 6-day intervals after fall armyworm infestation. The number of samples per plot was increased to four (0.14 m^2) subsamples taken at 7-day intervals in 1984. A portable leaf area meter (Li-Cor Model LI-3000) was used to determine leaf area of 20 randomly selected leaves/sample. In 1984, fall armyworm feeding damage also was determined for each sample by using damage rating (0 = no damage, 10 = 90-100% defoliation) according to Wilde and Apostal (1983) in 1984.

Bermudagrass quality and yield were determined by clipping at ground level a randomly selected 0.5 m^2 area from each plot at harvest. A subsample (500 g) was oven dried (60° C) and used to calculate total dry matter yield. The dried forage was sufficiently ground in a Wiley mill to pass through a 1-mm screen. Quality analyses of bermudagrass tissue was determined using near infrared spectroscopy calibrated to the respective tests. Calibration samples were analyzed for crude protein by the improved Kjeldahl method (Association of Official Agricultural Chemists 1980), neutral detergent fiber by the method of Goering and Van Soest (1970), and in vitro digestible dry matter (IVDDM) by the modified Van Soest procedure (Nelsen et al. 1976). Dry matter and quality measurements were used to calculate yield of crude protein and digestible dry matter (DDM).

A split-plot design, with whole plots of fall armyworm population gradients, was arranged in a randomized complete block design with five replicates. Subplots consisted of four plant sampling periods, with each plot sampled at 6- and 7-day intervals after fall armyworm infestation in 1983 and 1984, respectively. Data were subjected to analysis of variance using the GLM procedure (SAS Institute 1985). Significant treatment means were separated using Duncan's (1955) multiple range test.

Results and Discussion

Fall armyworm feeding damage, as indicated by a damage rating index, was more severe as the density of larvae increased (Table 1). Feeding on the grass was indicated by wholly or partially missing leaves. The damage rating index at larval densities of 2.2, 3.3, 6.6, and 9.9 larvae/0.1 m^2 was significantly higher on each rating date than the control. At 14 and 21 days after infestation, the damage index rating followed the same pattern as observed at day 7; however, the damage ratings were lower for corresponding larval density levels as plants began to compensate after larvae were removed.

Leaf area was significantly affected by fall armyworm feeding during only the first infestation period in 1983 (Table 2). Leaf area was reduced by feeding on day 12 in plots with densities of 3.3, 6.6, and 9.9 larvae/0.01 m^2 as compared with the control plots.

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Table 1. Damage ratings for fall armyworm feeding on 'Alicia' bermudagrass, Iberville Parish, LA, 1984.*

Larvae released/ 0.1 m²	X̄ Damage rating at indicated days after infestation 7	14	21
0	0 d	0 d	0 b
1.1	1.1 cd	1.5 cd	0.5 b
2.2	1.6 bc	2.4 bc	1.3 a
3.3	2.5 b	2.6 bc	1.3 a
6.6	4.0 a	3.9 ab	1.5 a
9.9	5.1 a	4.8 a	1.8 a

Means within column followed by the same letter are not significantly different (P = 0.05; Duncan's [1955] multiple range test).
* Damage Rating: 0 = no defoliation to 10 = 909-100% defoliation.

Table 2. Effect of fall armyworm feeding on leaf area on 'Alicia' bermudagrass, Iberville Parish, LA, 1983 and 1984.

Larvae released/ 0.1 m²	X̄ Leaf area (cm²)/20 leaves at indicated days after infestation 6-7*	12-14	18-21	28-28
Trial 1†				
0	13.9	19.3 a	17.7	27.8
1.1	12.4	15.0 abc	17.6	28.9
2.2	10.9	17.3 ab	16.1	26.0
3.3	11.6	12.9 bc	14.0	27.0
6.6	10.5	13.7 bc	17.6	32.9
9.9	10.8	11.7 c	15.2	32.7
	NS		NS	NS
Trial 2				
0	19.2	29.7	46.9	36.0
1.1	21.7	27.4	38.0	37.1
2.2	18.3	23.8	41.5	37.3
3.3	19.1	26.7	36.3	31.9
6.6	16.1	24.5	38.6	32.5
9.9	14.2	22.9	36.2	30.5
	NS	NS	NS	NS
Trial 3				
0	17.3	19.7	23.8	18.0
1.1	16.1	19.1	18.9	20.3
2.2	16.5	17.6	20.5	19.7
3.3	14.0	13.4	19.7	21.3
6.6	12.9	17.0	19.4	20.3
9.9	14.7	18.3	19.5	21.3
	NS	NS	NS	NS

Means within column by trial followed by different letters are significantly different (P = 0.05; Duncan's [1955] multiple range test). NS = not significantly different.
* Sampling periods were 6, 12, 18, 24 days after infestation in 1983 and 7, 14, 21, 28 days in 1984.
† Trial 1: 22 July - 15 August, 1983; Trial 2: 23 August - 16 September, 1983; Trial 3: 10 August - August -7 September, 1984.

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Although yield losses of 0.3 to 0.9 metric ton/ha were observed at higher larval densities, quality and dry matter yields of 'Alicia' were not significantly different (Table 3). A trend for lower crude protein concentrations was observed in plots with high larvae numbers during both trials in 1983, but differences were not significant. In 1984, crude protein concentration in plots infested with 9.9 larvae/ 0.1 m^2 was significantly higher than that for the control plot. IVDDM concentrations for all infested plots were significantly lower than that for the control during the first trial in 1983, while significantly lowered IVDDM concentrations were observed in all larval infested plots when compared with the control during the second trial. IVDDM concentration was not significantly affected by fall armyworm in 1984.

Table 3. Effect of feeding by varying fall armyworm densities on crude protein, IVDDM, and yields of dry matter, dry digestible matter, and crude protein in 'Alicia' bermudagrass, Iberville Parish, LA, 1983 and 1984.

	Larvae released/ 0.1 m^2	DM Yield kg/ha	CP %	CP kg/ha	IVDDM %	IVDDM kg/ha DDM
Trial *						
	0	2499	19.2	482	56.9 a	1425
	1.1	2100	17.7	370	55.4 b	1167
	2.2	2272	17.9	404	55.4 b	1261
	3.3	1991	17.7	356	55.5 b	1103
	6.6	1911	18.0	349	55.1 b	1057
	9.9	1756	17.5	312	53.9 b	952
		NS	NS	NS		NS
Trial 2						
	0	3811	17.8	677	53.8 a	2054
	1.1	3940	17.6	697	52.8 b	2028
	2.2	3775	17.5	658	52.9 ab	1002
	3.3	3609	16.3	582	52.2 b	1882
	6.6	3829	16.5	635	52.1 b	2008
	9.9	3656	17.1	623	52.6 b	1992
		NS	NS	NS		NS
Trial 3						
	0	2328	7.7 bc	181	50.1	1162
	1.1	2276	7.2 c	162	47.5	1079
	2.2	2316	7.2 c	167	48.5	1122
	3.3	2322	7.9 bc	184	48.9	1131
	6.6	2183	8.8 ab	189	48.5	1056
	9.9	2182	8.9 a	194	49.1	1070
		NS		NS	NS	NS

Means within column by trial followed by different letters are significantly different (P = 0.05; Duncan's [1955] multiple range test). NS = not significantly different.

CP, crude protein; IVDDM, in vitro digestible dry matter; DM, dry matter yield; DDM, digestible dry matter yield.

* Trial 1: 22 July - 15 August, 1983; Trial 2: 23 August - 16 September, 1983; Trial 3: 10 August - 7 September, 1984.

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'Alicia' showed a higher degree of tolerance to fall armyworm feeding than has been found on other bermudagrass varieties such as Coastal (Jamjanya and Quisenberry 1988). Combs and Valerio (1980) and Quisenberry and Wilson (1985) reported 'Alicia' as a bermudagrass variety with resistance to fall armyworm. Lower digestibility and higher non-digestible content of 'Alicia' as compared with 'Coastal' (Marvin 1976, Montgromery et al. 1979) make it less suitable for larval development. Lynch et al. (1986) found a significant correlation between high crude protein and IVDDM concentrations and enhanced development of fall armyworm.

Although 'Alicia' shows a high degree of tolerance to fall armyworm feeding, 'Alicia' is lower in forage quality because it is not highly digestible (Monroe 1975). We suggest that 'Alicia' could be crossed with other bermudagrasses having higher quality potential to obtain a variety with good agronomic characteristics and tolerance to fall armyworm.

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