Spread of Tall Fescue Endophyte by Cattle

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MOST CATTLEMEN are now aware of the adverse effects on livestock gains and reproduction which can result from the presence of *Acremonium coenophialum,* the fungus common in pastures of tall fescue in Alabama. Consequently, many have gone to great lengths to eliminate the fungus from their pastures. Unlike most fungi which are spread by spores carried by wind or water, this fungus is an endophyte which lives within fescue plant tissue. It is spread only as live fungus within viable seeds of its host, tall fescue. Therefore, once an endophyte-free fescue pasture is established, the level of endophyte cannot change unless infected fescue seed are somehow introduced or survival of infected plants is favored.

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It appears that the level of endophyte infection has slowly increased in some of the experimental pastures at the Black Belt Substation at Marion Junction, table 1, and at the Piedmont Substation at Camp Hill, table 2. Endophyte levels in these pastures have been closely monitored for 3 and 4 years, respectively, and over that period the rate of increase for all pastures has averaged about 2 percent per year. Most alarming is the appearance of the endophyte in fields which previously had been endophyte-free. Other researchers[2,3] have shown that in-

[2]Clay, K. 1988. Fungal Endophytes of Grasses: A Defensive Mutualism Between Plants and Animals. Ecology 69(1);10-16.

[3]West, C.P., E. Izekor, D.M. Oosterhuis, and R.T. Robbins. 1987. Association of Endophytic Fungus with Drought Tolerance and Nematode Resistance in Tall Fescue. Arkansas Farm Research Journal, Vol. 37.

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fected plants are better able to withstand drought and insect feeding, which would result in the infection level increasing in a partially infected field. However, this would not account for uninfected pastures becoming infected.

MATERIALS AND METHODS

Siegel et al.[4] were able to recover endophyte-infected seed from the feces of a steer which had been fed seed via a rumen cannula. This prompted the initiation of an experiment at the Alabama Agricultural Experiment Station to quantitatively determine the survival of the endophyte after it has passed through the digestive system of a steer under more normal conditions. In this experiment, one 400-pound steer was placed in a metabolism stall so that feed intake and fecal output could be closely monitored. For 1 week prior to the experiment, the steer was fed twice daily a meal consisting of 10 pounds of chopped Coastal bermudagrass hay containing 13 ounces (375 grams) of 98 percent infected seed which had been heated to kill both seed and endophyte. This was to (1) condition the animal to eating seed so that the treatment meal would not be refused, (2) remove any live fescue seed from the animal, and (3) establish a constant rate of feed movement through the animal.

The steer was then fed a single meal containing 7 ounces (188 grams) of live endophyte-infected seed (approximately 83,000 seed) mixed with the hay diet. For the remainder of the experiment, the previous diet was resumed. After 10 hours, collection of fecal samples was begun. Sampling intervals were as follows: from 10 to 48 hours—every 2 hours; from 48 to 96 hours—every 4 hours; from 96 to 168 hours—every 6 hours. After 168 hours, fecal collection was ended. The fecal samples were weighed, dried, and 10 grams was planted in four replications in greenhouse pots in a manner that would duplicate conditions which might occur in the field. After 8 weeks, seedlings were counted to determine percentage of viable surviving seed and the percent of endophyte infection was determined by the staining test.[5]

[4]Siegel, M.R., M.C. Johnson, D.R. Varney, W.C. Nesmith, R.C. Buckner, L.P. Bush, P.B. Burns, T.A. Jones, and J.A. Boling. 1984. A Fungal Endophyte in Tall Fescue: Incidence and Dissemination. Phytopathology 74:932-937.

RESULTS

A substantial percentage of fescue seed were able to survive passage through the gut.

[5]Shelby, R.A. and L.W. Dalrymple. 1987. Incidence and Distribution of the Tall Fescue Endophyte in the United States. Plant Disease 71;783-786.

TABLE 1. CHANGES IN ENDOPHYTE LEVELS AT BLACK BELT SUBSTATION, 1984-88

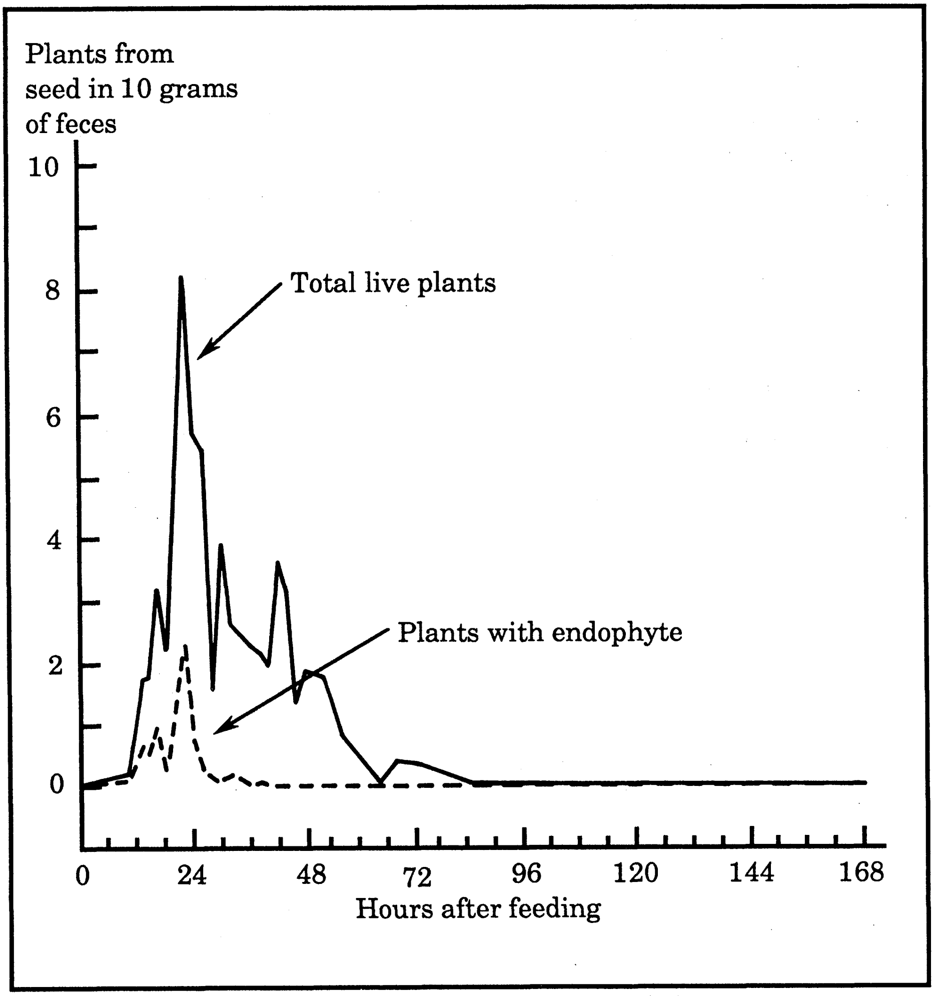
Field	1984	1988	Change[1]
S2	0	0	0
S5	0	0	0
S11	0	0	0
S7	0	7.5	7.5
F60A	0	8	8
F1D	5	16	11
S6	10	7	-3
F54A	20	26	6
F3	35	37	2
F4	35	37	2
F1C	38	33	3
F59	45	85	40
S9	52	70	18
S4	55	78	31
S10	60	62	2
E4	75	95	20
E2	85	93	8
E13	89	94	5
E6	90	93	3
E8	90	100	10
S3	90	93	3
E14	100	100	0

[1]Average increase = 7.8 percent in 4 years; average annual increase = 1.95 percent.

TABLE 2. CHANGES IN ENDOPHYTE LEVELS AT PIEDMONT SUBSTATION, 1983-88

Paddock	1983	1988	Change[1]
4	0	13	13
1	5	8	3
8	6	16	10
11	16	14	-2
5	50	73	23
6	50	70	20
9	50	70	20
10	59	97	38
12	61	78	17
7	63	67	4
2	69	75	6
3	83	74	-3

[1]Average increase = 11.9 percent in 5 years; average annual increase = 2.38 percent.



Numbers and endophyte status of fescue plants originating from feces.

Twelve percent of the live seeds fed to the steer germinated and grew normally into vigorous plants. Passage of live seeds in the feces reached a peak at 22 hours, see figure, and declined slowly until the last live seeds were passed at 84 hours. Similarly, in a substantial number of seed, the endophyte was able to survive passage. As in the case of total live seed, endophyte-infected seed reached a peak at 22 hours, but declined more rapidly. The last infected seed was recovered at 38 hours. Apparently, conditions in the rumen are sufficiently adverse to kill the endophyte, given enough time. For the entire period, the average infection of recovered samples was 12 percent, down from the original infection level of 98 percent.

CONCLUSIONS

The amount of endophyte able to survive passage is potentially harmful. This experiment attempted to duplicate conditions in which cattle might be grazing an endophyte-infected pasture with seedheads, or be fed infected hay containing viable seed. Several factors will probably affect the efficiency and chronology of endophyte dissemination. First, 7 ounces of seed is a conservative estimate of the daily intake of live seed for cattle. Cattle are known to sometimes selectively graze fescue seed heads; when they do, they might consume many times that quantity, resulting in more infected seed being passed for a longer period. Second, digestibility of the total forage intake will also affect passage time. For example, a more digestible forage, such as alfalfa hay, would speed up the rate of passage; conversely, a less digestible diet might prolong the passage of infected seed. Finally, it is possible that nonruminants, such as horses, might be even more effective in spreading infected seed, since the conditions in the gut are not as severe.

Because of the possibility of spreading endophyte-infected seed when moving cattle between infected and noninfected pastures, cattlemen are cautioned against letting infected pastures make seed or allowing grazing or hay making while infected seed are present. In case cattle eat viable infected seed, it is suggested that they be quarantined and fed an endophyte-free diet for a minimum of 48 hours before being moved to noninfected pastures. Although the rate of spread of infection by this method is slow, it can potentially allow the expense and effort of establishing endophyte-free pastures to be compromised by increasing endophyte levels over time.