Control of Ergot in Buffelgrass with Triadimefon

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ABSTRACT

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The systemic fungicide triadimefon was tested for its ability to control ergot in buffelgrass at concentrations of 0.00375, 0.0075, or 0.015% a.i., applied at the rate of 1 L/80 cm^2 clump of grass, with spray application frequencies of twice per week, once per week, and once every 2 wk. Significant ($P < 0.01$) negative relationships were found between ergot incidence and triadimefon concentration and between ergot incidence and the number of applications per 2-wk interval. In two field trials with ergot incidences of 71 and 54% in the check treatments, the most effective triadimefon treatment, 0.015% a.i. applied twice per week, reduced ergot incidences to 8 and 2%, respectively.

Buffelgrass (*Cenchrus ciliaris* L. [syn. *Pennisetum ciliare* (L.) Link.]) is a perennial bunchgrass indigenous to Africa and India. Buffelgrass is an important forage and pasture crop for the southwestern region of the United States because of its vigor and drought tolerance. Its use has been restricted by the lack of winter-hardy cultivars that combine good seed production with good forage production (12). Reproduction in buffelgrass is characteristically apomictic (asexual)—a situation that precluded the use of standard breeding methods to develop inproved cultivars (1). However, the discovery of a sexual buffelgrass plant made it possible to exploit the heterogeneity present in the species (1,12).

Ergot of buffelgrass has been reported in Africa and India (7,11); both *Claviceps microcephala* (Wallr.) Tul. and *Sphacelia sorghi* McRae have been reported as causal agents (7). For several years, the U.S. Department of Agriculture program in buffelgrass improvement at College Station, TX, has been severely hampered by epiphytotics of ergot in the buffelgrass research nurseries and seed production fields. Attempts to control the disease by placing nurseries in fields where buffelgrass had never been grown were unsuccessful, possibly because of the spread of the disease from other host species. Ergot of the common weed dallisgrass (*Paspalum dilatatum* Poir.), caused by *Claviceps paspali* F. L. Stevens & J. G. Hall (9), is endemic in this region. However, pathogenicity of *C. paspali* to buffelgrass has not been demonstrated. Several researchers have tested fungicides for their ability to control ergot, but no effective procedures suitable for field use have been reported (6,10,16).

Recently, K. W. Hignight tested several fungicides against ergot in buffelgrass and discovered that triadimefon (Bayleton) controlled the disease (K. W. Hignight, *unpublished*). Triadimefon is a systemic fungicide used as a protectant against several foliage diseases (2,8). The study reported here was conducted to confirm Hignight's results and to determine the minimal fungicide concentration and application frequency required for an acceptable level of control of ergot in buffelgrass.

MATERIALS AND METHODS

The study was conducted during the summer of 1989 in a field nursery planted with the buffelgrass accession PI 409704. The nursery, located on the Texas A&M University farm near College Station, was planted in 1987 with seedlings spaced 102 cm apart in rows spaced 102 cm apart. Two years after planting, growth from the original seedlings had produced large, uniformly spaced tussocks of grass. For this experiment, the nursery was converted into a series of square, 25-clump (5 × 5) blocks by mowing intersecting alleys, 203 cm wide and 510 cm apart, throughout the nursery.

Two trials were conducted. The first trial compared triadimefon concentrations at different frequencies of application for effectiveness of ergot control. The experimental design was a split plot with three main plot treatments, four subplot treatments, and six replications. The subplots were the stands of grass at each corner of a grass block. The main plots consisted of the four subplots in the grass block. The main plot treatments were three frequencies of fungicide application—twice per week (Tuesday and Friday), once per week, and biweekly. The number of applications per treatment during the trial were four, two, and one for the twice weekly, weekly, and biweekly treatments, respectively, with approximately 1 L of spray applied per subplot at each application. Subplot treatments were three concentrations (w/v) of triadimefon (0.00375, 0.0075, and 0.015% a.i.) in water (% a.i.= g a.i./100 ml) and a control treatment of water. The four subplot treatments were assigned at random to the four corner stands of each grass block.

The second trial was conducted to retest the effect of the triadimefon concentrations applied at the application frequency found most effective in the first trial. The experimental design was a randomized complete block with four treatments (triadimefon concentrations) and six replications.

A low level of ergot incidence was present in the nursery in August. On 29 August, the blocks of buffelgrass were mowed at a height of approximately 40 cm. The field was irrigated with the approximate equivalent of a 5-cm rain to provide conditions favorable for the development of ergot (9). Seven days later, the grass clumps selected for subplot treatments were examined, all heads at anthesis were removed, and the fungicide applications were initiated. One drop of Tween 20 per liter was added to the spray solutions as a spreader, and the plants in the experimental plots were sprayed until the liquid ran off the leaves.

Two weeks after the initial fungicide applications, the heads at the postanthesis stage (stigmas of some florets were dead) were harvested and examined for honey dew (sticky exudate composed of conidia of the ergot pathogen). The incidence of ergot (percentage of harvested heads with ergot) was determined for each subplot. The data were subjected to arcsine transformation to equalize treatment variances and analyzed statistically to determine the significance of differences among the treatment means (5). The single degree of freedom contrast procedure was used to determine the significance of differences among the application frequency treatment means for incidence of ergot (5). Regression analyses of the data were conducted to determine relationships between triadimefon concentrations and incidence of ergot at each of the three frequencies of application (5).

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The twice-per-week application frequency produced the best control of ergot, and the effect of fungicide concentrations at this frequency of application was retested in a second trial. Five days after the conclusion of the first trial, application of the four fungicide concentration treatments was resumed in the twice-per-week application plots.

Two weeks after the second trial began, all heads of buffelgrass at the postanthesis stage were harvested from the treatment plots and examined for ergot symptoms. Statistical analyses to determine significance of differences in ergot incidence among treatments and the regression relationships of triadimefon concentration and ergot incidence were conducted as described for the first trial.

Table 1. Effects of triadimefon fungicide concentrations and application frequencies on incidence of ergot (%) in buffelgrass

Triadimefon[a] (% a.i.)	Application frequency[b] Trial 1: 1	Trial 1: 2	Trial 1: 4	Trial 2: 4
0.000	79[c]	73	71	54
0.00375	64	37	17	22
0.0075	55	34	9	12
0.015	48	24	8	2

[a]Triadimefon (% a.i.) = grams a.i./100 ml.
[b]Number of applications during 2-wk trial.
[c]Frequency (arcsine transformations) of heads with ergot presented as percentage of heads harvested, mean of six replications. Differences in ergot incidence among application frequency treatments and fungicide concentration treatments were significant ($P < 0.01$).

RESULTS AND DISCUSSION

Seven days after the field was irrigated, honey dew exudate was observed on the inflorescences of the buffelgrass stands that surrounded the subplots. The incidence of infection in these stands increased rapidly and provided large amounts of inoculum for infection of the plants in the subplots. Ergot was observed in the subplots 7 days after the spray schedule began. At the conclusion of the first trial, the incidences of ergot in the control (water) treatments were severe and similar to that observed in this field in previous years (Table 1).

The main plot treatment (application frequencies) means for numbers of buffelgrass heads that reached the postanthesis stage of development during the first trial were 56, 49, and 46 heads for the biweekly, weekly, and twice-per-week frequencies, respectively. The differences in mean number of heads between the biweekly treatment and the other application frequency treatments were statistically significant ($P = 0.05$, LSD = 3.4). However, there was no significant correlation between frequency of application and the number of postanthesis grass heads. The subplot treatment (triadimefon concentrations) means for numbers of postanthesis grass heads ranged from 48 to 59 heads, with no significant ($P = 0.05$) differences among the subplot treatment means.

The difference in ergot incidence among application frequencies (main plot treatments) and among fungicide concentrations (subplot treatments) were statistically significant ($P < 0.01$) (Table 1). No significant interaction was found between fungicide concentrations and application frequencies. The application frequency treatment means, derived from the aggregates of ergot incidence in the three triadimefon subplot treatments, were 56, 32, and 11% ergot incidence for one, two, and four fungicide applications, respectively (Fig. 1). The treatment means differed significantly ($P = 0.01$) from each other. The regression analysis indicated a significant, negative nonlinear relationship between fungicide concentration and incidence of ergot at each of the three frequencies of application (Fig. 1). This relationship represents a decrease in the response of ergot incidence to higher concentrations of triadimefon.

Increased frequency of application increased the total amount of fungicide applied for a given fungicide concentration treatment during the trial period. However, this increase in total fungicide applied accounts only in part for the more effective ergot control associated with more frequent fungicide application (Table 1).

One possible reason for the beneficial effect of more frequent fungicide applications is that the duration of the protective effect of the fungicide is too short to provide adequate protection during a 7- or 14-day interval between fungicide applications. However, loss of efficacy of triadimefon within 14 days after application is unlikely. Research on the control of rust, powdery mildew, and Septoria leaf blotch in wheat by triadimefon found that the fungicide provided protection against these diseases for more than 4 wk after a single foliar application (2,8).

The probable cause of the application frequency effect was that the lower frequency treatments had more heads that had not been sprayed with triadimefon before flowering. If translocation of the

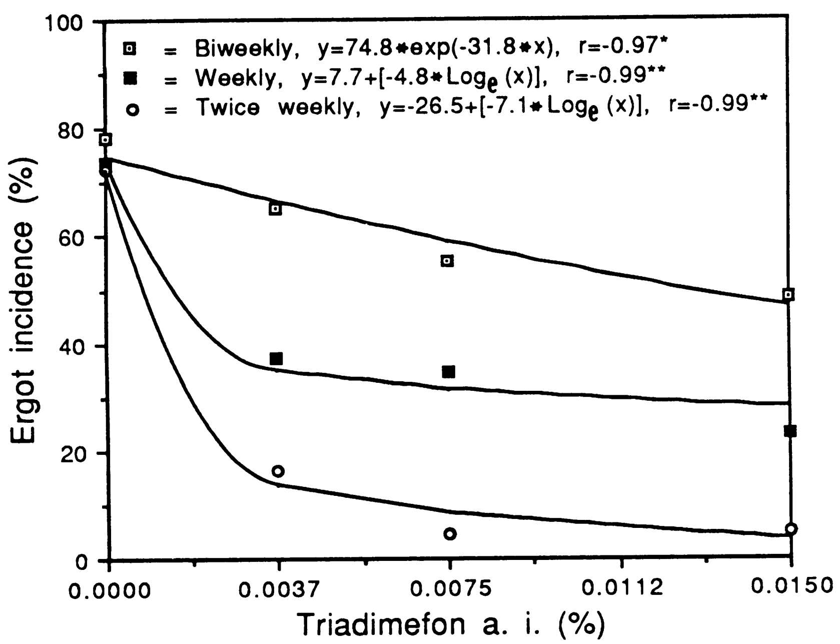

Fig. 1. Relationships of triadimefon concentrations to incidence of ergot in buffelgrass at fungicide application frequencies of twice per week, once per week, and biweekly. Each data point is the mean of six replications. * and ** = Significant correlation coefficients (r) at $P = 0.05$ and $P = 0.01$, respectively. Standard errors of estimates of regression coefficients for biweekly, weekly, and twice-per-week application frequencies are 5.8, 0.55, and 0.46, respectively.

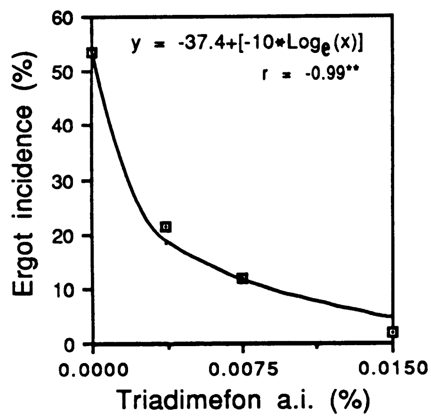

Fig. 2. Relationship of triadimefon concentrations applied twice per week to incidence of ergot in buffelgrass. Each data point represents the mean of six replications. ** = Significant correlation coefficient (r) at $P = 0.01$. Standard error of estimate of regression coefficient is 0.77.

systemic, protective factor from the foliage to the inflorescence is restricted or absent, protection of the floral organs would require direct fungicide application to the head. Heads that emerged between fungicide applications would not be protected, and the exposure of invasion sites, style or ovary wall (9,10, 14), before the next application of fungicide would result in infection. The longer the interval between fungicide applications, the greater the probability of infection. Puranik and Mathre (10) reported that the systemic fungicide benomyl gave better control of ergot in barley when applied to the florets than when applied to the foliage, another apparent example of failure to translocate the fungicide from the foliage to the infloresence.

The second trial of the effect of concentration of triadimefon applied twice per week on ergot incidence achieved results similar to those secured in the first trial. The fungicide concentration treatments differed significantly ($P < 0.01$) in ergot incidence (Table 1). A significant, negative nonlinear relationship was found between increases in fungicide concentration and incidence of ergot (Fig. 2).

The use of the same field plots for both trials provided conditions similar to those present in grass nurseries used for repeated harvests of seed in a single season, but it also introduced the possibility of residual effects from earlier applications of triadimefon. Presumably, the effect of this residue on the control of ergot in the second trial would be favorable. The trial results gave no indication that the control of ergot by triadimefon treatments was more effective in the second trial (Table 1) and suggests that any residue effects were minimal.

The experimental conditions of this study were designed to provide the maximum opportunity for infection by surrounding the subplots with large amounts of inoculum produced on adjacent untreated plants. In a practical ergot control situation, the fungicide would be applied to the entire field. This would drastically reduce the supply of inoculum and provide more effective ergot control. After the completion of this study, triadimefon was used to control ergot in a local buffelgrass seed production nursery that was severely infected earlier in the season. The field was mowed, and triadimefon was applied twice per week at a concentration of 0.0056% a.i. No ergot was found in the nursery when seed was harvested.

In species of cereals susceptible to ergot, male sterility is associated with increased severity of the disease, possibly because of delays in fertilization (3,4,10, 13–15). Ergot has caused severe damage to male sterile lines of barley and wheat in the United States, and in Africa and Asia, ergot is a major threat to cytoplasmic male sterile hybrids of pearl millet and sorghum (4,5,10,13,14). The results achieved with triadimefon in the control of ergot in buffelgrass could be applicable to the problem of ergot in these crops.

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