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COOPERATIVE EXTENSION SERVICE

AGRONOMY NOTES

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1986 UPDATE OF AGRONOMIC AND ANIMAL PERFORMANCE OF DIFFERENT TALL FESCUE VARIETIES

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USDA-ARS and University of Kentucky

The objective of the tall fescue breeding program at the University of Kentucky is the development of varieties characterized by superior nutritive value (including reduced levels of perloline and loline alkaloids), minimal infestation of the fungal endophyte, Acremonium coenophialum), higher palatability, improved disease resistance, and wider adaptation through the derivation of intergeneric and interspecific hybrids of ryegrass and tall fescue species. Kentucky 31, Kenwell, and Kenhy were varieties released from this breeding program. Johnstone tall fescue, developed cooperatively by the Kentucky Agricultural Experiment Station and USDA-ARS, is the most recently released variety. It is characterized as having low levels of perloline alkaloid and the fungal endophyte (Acremonium coenophialum) and improved forage quality during summer. Ample Johnstone seed should be available to meet demand during 1986.

Commercial tall fescue varieties have been developed from plant materials of either northern European or Mediterranean origin. Varieties developed at the University of Kentucky -- Kentucky 31, Kenmont, Kenwell, Kenhy, and Johnstone -- trace to plant materials of northern European origin. The Kentucky varieties have later maturity dates and have greater resistance to foliar diseases during summer than varieties that are of Mediterranean origin (i.e., Alta, Fawn, Goar, AU-Triumph, and Forager) when grown under environmental and management conditions prevaling in Kentucky. Varieties of Mediterranean origin have excellent early spring and late fall growth when foliar diseases are not a problem, however, foliar diseases may cause them to be of inferior forage quality and to make poor growth during the summer. Generally, tall fescue is used for hay and for spring, summer, and fall pasture in Kentucky. Agronomic research data indicate that varieties of northern European origin are superior to varieties of Mediterranean origin for forage purposes in Kentucky.

Tall fescue varieties were evaluated in pure stands which were seeded in the fall at 15 lbs/acre and irrigated to facilitate stand establishment. The varieties were evaluated under the following two management systems: (1) hay and pasture; and (2) fall-winter stockpiled forage in association with seed production.

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UNIVERSITY OF KENTUCKY, KENTUCKY STATE UNIVERSITY, U.S. DEPARTMENT OF AGRICULTURE, AND KENTUCKY COUNTIES, COOPERATING

Forage Yield

While yield is an important characteristic of tall fescue, it is not considered to be a critical problem of the species. In evaluation tests, the Kentucky 31 variety is used as the standard check as it is the major variety used in Kentucky and the central United States. New varieties are considered to be satisfactory for yield and adaptation when they equal the performance of Kentucky 31.

Yields were determined when the grass was in the boot stage of maturity. To simulate rotational grazed pasture conditions, aftermath growth was harvested every 4 to 6 weeks during the remainder of the growing season. Hay and pasture management included fertilization with 100 lb/acre of ammonium nitrate (34 lbs/A nitrogen) in March, June and September on soils testing medium to high in phosphorous and potassium. Forage dry matter yields are presented in Table 1.

Seed

Seed production management involves harvesting the varieties for seed in June, removing the forage in August and permitting growth until frost to simulate stockpiling forage for winter use. Grass in this management system was fertilized with 200 lb/acre of ammonium nitrate (68 lbs/A nitrogen) approximately September 1 and again December 1. Seed yield data are presented in Table 2.

Forage Quality

Tall fescue is a well adapted, widely used pasture species occupying approximately 5.5 million acres in Kentucky and 35 million acres in the south central United States. Existing stands of tall fescue are widely infected with the endophyte and toxin(s) associated with the endophyte and/or perloline alkaloid severely inhibits the performance of cattle grazing on tall fescue during summer. The endophytic fungus is thought to be transmitted exclusively through tall fescue seed. Because of variable forage quality, however, animal response from grazing tall fescue during the summer is often erratic.

The Kenhy variety was the first to be developed utilizing ryegrass-tall fescue hybrids. Kenhy is characterized by superior forage quality and yield, disease resistance and wide adaptation. Comparative performance data of Kentucky 31 and Kenhy are presented in Table 3. The new Johnstone variety is characterized by having low (<5%) levels of the fungal endophyte (A. coenophialum), greater succulence during drought, improved palatability and low levels of perloline (an alkaloid that inhibits digestibility in ruminants). Comparisons of Johnstone with Kenhy and Kentucky 31, for color, palatability and perloline content are presented in Tables 4 to 6.

Plant variety protection has been approved specifying sale of Johnstone seed by variety name only as a class of certified seed. A seed certification program has been approved, requiring seed of Johnstone to have low level (<5%) fungal endophyte (A. coenophialum) infection. Johnstone has been competively released by USDA and the University of Kentucky under an exclusive production and marketing arrangement with Kentucky for Progress Incorporated, Hardinsburg, Kentucky.

Management of Low Endophyte Pastures

Tall fescue pastures should be seeded during Fall and allowed to become well established before initial grazing. Legumes should be inter-seeded into well established grass pastures the following Spring and should be managed according to the recommendations desirable for maintaining legumes in stand. Controlled, or rotational grazing, with animals will help to maintain stands of grasses and legumes and maximize profit potential when using varieties improved for forage quality. Farmer-producers should avoid overgrazing pastures seeded to low endophyte tall fescue varieties.

Table 1. Forage dry matter yields of tall fescue varieties evaluated at Lexington and Princeton 1980 through 1985.+

Variety	Evaluation Seasons					
	1980-84	1982-84	1983-84	1984-85	1985	1985
	Lexington					Princeton
	Tons/Acre/Year					
Kenhy	2.0	3.1	3.7	3.5	1.8	3.8
Ky 31	2.1	3.2	3.6	3.1	1.8	4.2
Mo. 96	2.1	3.1	3.4	---	1.9	---
Forager	2.0	2.9	3.2	2.8	2.0	3.9
Johnstone	---	3.0	3.7	3.0	1.6	3.7
AU Triumph	---	---	3.0	---	2.0	4.0
Festorina	---	---	---	---	1.4	---
STEF	---	---	---	---	1.6	3.2
Ondine	---	---	---	---	2.1	---
Manade	---	---	---	---	1.8	---
Clairine	---	---	---	---	1.7	---
Lubrette	---	---	---	---	1.5	---
Fawn	---	---	---	---	1.9	4.0
L.S.D .05	n.s.	n.s.	0.3	0.2	0.3	0.5
C.V. (%)	11.2	7.9	9.1	7.0	10.7	9.1

+Six separate forage yield tests are summarized. In the first column, the 1980-84 figures give the years of harvest of a trial seeded in the fall 1979. Data in columns two thru six are from tests seeded during 1981 through 1984, respectively.

Table 2. Clean seed yields of tall fescue varieties evaluated in tests at Lexington from 1980 through 1985.+

Variety	Evaluation Seasons 1980-84	1982-84	1983-84	1984-85	1985	AVERAGE
	lbs/A/yr					
Kenhy	339	543	750	664	145	488
Ky 31	424	555	658	672	327	527
Mo. 96	246	370	499	---	242	339
Forager	367	446	474	628	196	422
Johnstone	---	443	691	610	173	479
AU Triumph	---	---	342	---	163	253
Festorina	---	---	---	---	281	---
STEF	---	---	---	---	9	---
Manade	---	---	---	---	143	---
Ondine	---	---	---	---	145	---
Clarine	---	---	---	---	35	---
Lubrette	---	---	---	---	55	---
Fawn	---	---	---	---	220	---
L.S.D. .05	73	59	135	n.s.	76	
C.V. (%)	20.9	13.1	23.1	14.6	28.0	

+Five separate tests are summarized. In the first column, 1980-84 figures give the years of harvest of a trial seeded in the fall of 1979. Data in columns two through five are from tests seeded during 1981 through 1984, respectively.

Table 3. Agronomic and forage quality characteristics of Kenhy and Kentucky 31 tall fescue at Lexington (1970-75).

Characteristics	Variety Kenhy	Kentucky 31
Leaf roll during drought (%)	53	65
Color+	1.2	4.8
Digestibility	66.4	63.5
Lignin (% of dry matter)	1.9	2.2
Palatability grazed by sheep (%)	67.3	17.3
Palatability rating during summer++	4.0	8.3

+ 1=green; 9=brown. Figures are means of ratings during various seasons of the year.

++ Free-choice cattle grazing trials: 1=best grazed, 9=ungrazed.

Table 4. Seasonal color scores[+] of Kenhy, Johnstone and Kentucky 31 tall fescue.

Variety	Test 109 1978 March	Test 109 1978 July	Test 109 1978 November	Test 107 Year 9/4/75	Test 107 Year 8/30/76
	color score				
Kenhy	3.5	3.5	3.0	1.0	3.7
Johnstone	1.0	2.0	1.5	--	--
Ky. 31	5.0	8.5	5.5	3.7	5.7
L.S.D 0.05	1.4		1.3	1.6	1.4
C.V. (%)	26		33	30	24

[+] 1=green; 9=brown

Table 5. Palatability scores of tall fescue varieties when grazed free-choice with cattle during summer.[+]

Variety	Tests[++] 110 1976-77	119 1981-82	122 1982;1984-85	125 1984-85	138 1985	Average test/years
Kenhy	4.8	5.1	4.5	4.3	3.3	4.4
Johnstone	2.8	3.5	3.8	2.8	2.5	3.0
Ky 31	6.6	7.3	7.5	7.1	7.7	7.2
Forager	--	--	8.4	8.3	7.0	8.0
Fawn	--	--	--	--	9.0	--
AU Triumph	--	--	--	--	9.0	--
Mo. 96	--	--	8.4	8.8	8.5	8.6
Festorina	--	--	--	--	9.0	--
L.S.D. .05	1.0	1.3	1.3	1.1	2.5	
C.V. (%)	25.2	31.2	27.1	18.8	26.2	

[+] 1=best grazed; 9=ungrazed.

[++] Tests 110, 119, 122, 125, and 138 were seeded during Aug 1975, 1980, 1981, 1983, and 1984 respectively.

Table 6. Perloline alkaloid levels during summer of Kenhy, Johnstone and Kentucky 31 tall fescue.

Variety	Season 1975	1976	1977
	ppm		
Kenhy	1000	2440	587
Johnstone	318	820	213
Ky 31	--[1]	--[1]	427
L.S.D. 0.05	295	875	149
C.V. (%)	16	20	33

[1] levels not determined.

Animal Performance

The ability of tall fescue varieties to provide the energy and nutrient requirements for specific levels of performance by animals is perhaps the best measure of forage quality. Many animal performance studies on tall fescue with other grass pastures, both in pure and mixed seedings and in fescue-legume mixtures, have shown performance to be superior in some tests but inferior in others. Poor performance of animals grazing tall fescue corresponds in time (July, August, and September) to the accumulation of the perloline alkaloid and the presence of toxin(s) associated with the fungal endophyte and the concurrence of heat stress on animals. Perloline inhibits digestibility in ruminants and the endophyte is associated with many negative animal performance factors as well as reduced forage intake. Kenhy has perloline levels comparable to those of Kentucky 31; but seed may be obtained that is certified as having low levels of A. coenophialum.

Comparative performance data of cattle grazing pure stands of Kentucky 31 and Kenhy tall fescue are presented in Tables 7 and 8. The effect of the endophyte on animal performance is reflected in data presented in Table 8. Pregnancy rates were reduced 26% in cows grazing heavily infected Ky 31 when compared with Kenhy which had very little infection.

Performance data of growing beef cattle, and mid-lactation Holstein cows when fed Kentucky 31 with, and without A. coenophialum, Kenhy (less than 1% endophyte infection), and Johnstone P.V.R. (genetically identical to Johnstone but containing more than 5% endophyte infection) and orchardgrass-alfalfa control are presented in Tables 9 and 10. Growing steers grazing endophyte infected Kentucky 31 had lower gains during the 112-day grazing study than those grazing the low endophyte varieties. Endophyte-free Kentucky 31 resulted in lower gains when compared with those of cattle grazing the low endophyte improved varieties Johnstone P.V.R. and Kenhy. Body temperatures were elevated and serum prolactin was suppressed in cattle grazing endophyte infected Kentucky 31. Perloline level was lowest in Johnstone P.V.R., which reflects the selection for low concentration of this alkaloid. N-acetyl plus N-formyl loline alkaloid (FALA) concentrations were reflective of infection of the different fescues with the endophyte. These data demonstrate the effects of the toxin(s) associated with alkaloids, fungal endophyte and selection of tall fescue for

improved nutritional quality and the resulting improvement of cattle performance.

Mid-lactation Holstein cows fed endophyte infected Kentucky 31 had lower daily dry matter intake and body weight changes than those fed the orchardgrass-alfalfa control, Kenhy or Johnstone (P.V.R.). Intake of Kentucky 31 endophyte-infected was different from Kentucky 31 endophyte-free (Table 10). Milk yields followed a similar trend with those cows fed endophyte-infected Kentucky 31 producing less milk than those consuming other forages. Average milk production was similar for those animals fed Johnstone (P.V.R.), Kenhy, endophyte-free Kentucky 31, and the orchardgrass-alfalfa control. During 1983, cows fed the control forage had the highest prolactin levels, followed by Kenhy, both of which were significantly higher than cows fed Kentucky 31 infected. In 1984, cows fed Kenhy had the highest prolactin levels followed by the control forage, Kentucky 31 endophyte-free, Johnstone (P.V.R.) and Kentucky 31 infected. Yearly averages showed prolactin levels of cows fed the Johnstone P.V.R. to be significantly lower than the endophyte-free varieties as well as the control. Cows fed Kentucky 31 endophyte-infected forage had significantly lower prolactin levels than cows fed the other endophyte-free varieties or the control. The data show that toxin(s) associated with the endophyte (A. coenophialum) reduced dry matter intake, milk production, body weight change and prolactin levels during 1984, while resulting in higher rectal temperatures of cows fed infected tall fescue forage. Animals fed Kenhy, which was essentially free of the endophyte, had higher intake than any of the other tall fescue varieties tested and the performance of cows fed Johnstone P.V.R. was affected as consequence of the harmful influence of 11% endophyte infections.

Table 7. Productivity of cattle on Kenhy and Kentucky 31 tall fescue varieties.[+]

Location	Grazing Period			Average Daily Gain	
	Years	Total Days	Season	Kenhy	Kentucky 31
				-----LB/day-----	
Georgia[++]	1974-75	212	Winter	0.8	0.6
Oklahoma[++]	1974-75	134	Winter	0.3	-0.1
Missouri[++]	1974-75-76	336	Summer	1.3	0.9
Illinois[++]	1975	189	Summer	0.7	0.7
Virginia[++]	1972-73-74	---	Summer	0.8	1.0
Arkansas[*]	1980-81	266	Summer	1.1	0.8
Kentucky	1981-82	200	Summer	1.4	0.8

[+]Data provided by Dr. R. S. Lowry, Dr. H. G. Williams, Dr. A. G. Matches, Dr. C. G. J. Kaiser, Dr. H. T. Bryant, Dr. J. W. Spears and Drs. Nelson Gay and G. D. Lacefield from the respective locations.

[++]It was not known whether Acremonium coenophialum infected the grasses in these tests.

[*]Kentucky 31 and Kenhy was 95% and <5% infected with A. coenophialum, respectively.

Table 8. Performance of cows and calves grazing endophyte infected Kentucky 31 and uninfected Kenhy tall fescue at Western Kentucky Agricultural Experiment Station, Princeton, KY.

Variety	Year	Cows/ Calves	No. Days Grazed	Calves adjusted 205-day wean wt. (lbs.)	% Conception
Ky 31[+]	1983-84 (2 yr.avg.)	58/51	188	398	63.8
Kenhy[++]	1983-84 (2 yr.avg.)	44/41	178	460	89.8

[+]Cattle were on nitrogen-fertilized grass throughout the grazing season.

[++]Kentucky 31 and Kenhy was 95% and <5% infected with A. coenophialum, respectively.

Source: Dr. Nelson Gay, et. al., unpublished data, University of Kentucky.

Table 9. Effect of the perloline alkaloid and the toxin(s) associated with the fungal endophyte (Acremonium Coenphialum on beef cattle performance during 112-day grazing period (April-August, 1983). J. A. Boling et. al., unpublished data. University of Kentucky and USDA-ARS.

	Treatment (Cultivars)			
	Kentucky 31		Johnstone	
Item	(1) Infested (I)	(2) Free (f)	(3) P.V.R.*	(4) Kenhy
Number of steers	10	10	10	10
Daily gain (avg.) lbs.[a,b,+]	0.99	1.54	1.96	1.85
Body temperature C (day 112)[a+]	40.7	39.8	40.0	39.9
Prolactin, ng/ml (day 112)[a,c,+]	80	280	544	570
Perloline, ug/g[++]	248 e	324 de	170 e	443 d
FALA, ug/g[++**]	565 d	4 e	56 e	22 e
Endophyte, %[#]	61	0	6.7	0

*Johnstone P.V.R. is genetically identical to Johnstone but was 6.7%-13% endophyte infected.

+Orthogonal contrasts: a (Treatment (Trt) 1 vs. 2, 3, 4, P < .01); b (Trt). 2 vs. 3, 4, P<.01); c (Trt. 2 vs 3, 4, P<.05).

++Means on the same line bearing different superscripts differ significantly d, e (P < .05).

**FALA=N-acetyl and N-formyl alkaloids.

#Determined from analyses of seed heads collected in May.

Table 10. Performance of lactating dairy cows fed green chop forage of Johnstone (P.V.R.), Kenhy and endophyte-infected and endophyte free Kentucky 31 tall fescue and Orchardgrass-alfalfa control during summer 1983-84 at Lexington.

Parameter	Johnstone P.V.R.	Kenhy	Kentucky 31 Infected	Kentucky 31 Free	Orchardgrass-Alfalfa[1/]
Number of cows, per trt/yr	5[2/]	5	5	5	5
Forage dry matter intake, lb/day[3/]	22.5^{bc}	25.8^{d}	15.6^{a}	20.0^{b}	24.0^{cd}
Milk yield, lb/day	41.6^{b}	46.3^{b}	34.4^{a}	43.2^{b}	46.9^{b}
Body wt. change, lb	41.0^{b}	61.2^{b}	-25.8^{a}	26.4^{b}	30.8^{b}
Rectal temp. (F.)	102.3^{ab}	101.9^{b}	102.7^{a}		102.1^{ab}
Serum prolactin (mg/ml)1983	70^{ab}	129^{b}	50^{a}	101^{ab}	164^{b}
Serum prolactin (mg/ml)1984[4/]	39^{b}	73^{c}	10^{a}	61^{c}	63^{c}
Endophyte, (% plant tissue)	11	0	64	0	0

[1]Harvested at a more mature stage of growth than the other forages.

[2]Cows were fed 18 lb/day and 20 lb/day of grain concentrate during 1983 and 1984, respectively.

[3]Averages in the same row with different superscripts differ significantly ($P<.05$).

[4]Averages differ significantly ($P<.01$).

Source: S. R. Strahan, R. W. Hemken, J. H. Jackson, Jr., R. C. Buckner, L. P. Bush, and M. R. Siegel et. al., Jour. Dairy Science, In Press.

Summary:

Current agronomic and animal performance data are presented for different tall fescue varieties.

The effect of plant toxin(s) associated with the tall fescue endophyte (acremonium coenophialium) and the alkaloid perloline (inhibits rumen digestibility) on animal performance is demonstrated.

Through the science of plant breeding and genetics tall fescue varieties were developed combining the palatability and nutritional forage qualities of ryegrass with the excellent agronomic characteristics of tall fescue into superior varieties. Selection of varieties characterized as having improved forage quality and lowered anti-quality factors (perloline alkaloid and endophyte levels), and of superior animal performance, in conjunction with introduction of legumes and the utilization of selective pasture management techniques offers farmer-producers the opportunity to maximize thier profit potential in a pasture-livestock enterprise.

Cross-reference Publications:

The following additional information regarding management and use of tall fescue may be obtained from the University of Kentucky County Extension Offices.

1. Special Report 1-85 Johnstone Tall Fescue
2. AGR-60 Kenhy - A New Tall Fescue Variety
3. AGR-59 Tall Fescue
4. AGR-108 Tall Fescue in Kentucky
5. AGR-44 Season of the Year Affects Nutritional Value of Tall Fescue
6. AGR-85 Efficient Pasture Systems
7. AGR-26 Renovating Grass Fields
8. AGR-45 The Effects of Weather on Hay Production
9. AGR-62 Quality Hay Production
10. AGR-61 Hay Feeding Systems
11. AGR-103 Fertilization of Cool-Season Grasses
12. ID-33 Renovating Grass Fields with a Renovation Seeder
13. ID-46 Hay Perservatives
14. OPTIONS-12 Hay and Seeds
15. AGR-33 Growing Red Clover in Kentucky
16. AGR-24 Kenstar Red Clover
17. AGR-70 "Woodford" Bigflower Vetch--A New Winter-Annual Forage Legume
18. AGR-104 'Fergus' Birdsfoot Trefoil
19. ASC-56 Producing Slaughter Beef With Grain on Pasture
20. ASC-67 Forage-Related Cattle Disorders
21. PR 291 1985 Beef Cattle Research Report
22. PR 287 Kentucky Red Clover Variety Trials Through 1984

** PPA-30 Sampling for the Tall Fescue Endophyte in Pasture or Hay Stands

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