3-1985

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COOPERATIVE EXTENSION SERVICE

AGRONOMY NOTES

Volume 18. No. 1 March 1985

AGRONOMIC AND ANIMAL PERFORMANCE OF DIFFERENT TALL FESCUE VARIETIES

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The objective of the tall fescue breeding program is the development of varieties characterized by superior nutritive value (including reduced contents of perloline and loline alkaloids and minimal infestation of the fungal endophyte, Acremonium coenophialum), palatability, disease resistance, and adaptation through the utilization of intergeneric and interspecific hybrid derivatives of ryegrass and tall fescue species. Kentucky 31, Kenwell, and Kenhy were previously released from this breeding program. Johnstone tall fescue, developed cooperatively by the Kentucky Agricultural Experiment Station and USDA-ARS, was released March 1, 1982 as a new variety. Johnstone is characterized as having low levels of perloline alkaloid and the fungal endophyte (Acremonium coenophialum) and improved forage quality during summer. It is expected that seed of Johnstone will be available commercially during 1985, and a good supply be available for spring and summer 1986 plantings.

Commercial tall fescue varieties were developed from plant materials of either northern European or of 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 in Kentucky environmental and management conditions. Varieties of Mediterranean origin have excellent early spring and late fall growth when foliar diseases are not a problem however, diseases may cause them to be of poor forage quality and to make poor growth during 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. The varieties are evaluated under the following two management systems that are used in Kentucky: (1) hay and pasture; and (2) seed and fall-winter stockpiled forage.

Yields

Forage - 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 by taking a hay harvest when the grass was in the boot stage of maturity. To simulate pasture conditions, aftermath growth was harvested every 4 to 6 weeks during the remainder of the growing season. Hay and pasture management included fertilization at the rate of 100 lb/acre of ammonium nitrate 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 is fertilized with 200 lb/acre of ammonium nitrate approximately September 1 and again December 1. Yields of clean seed/acre are presented in Table 2.

Forage Quality

Tall fescue is a well adapted, widely used pasture species occupying approximately 6 million acres in Kentucky and 25 - 35 million acres in the south central United States. Thus, it is an extremely desirable cool-season species for this region. Because of variable forage quality animal response from grazing tall fescue during summer often is erratic. Criteria used to determine forage quality are acceptability, intake, and digestibility.

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 are presented in Table 3. The Johnstone variety is characterized by improved forage succulence during drought, improved palatability and low levels of perloline (an alkaloid that inhibits digestibility in ruminants). A seed certification program has been approved, requiring seed of Johnstone to have low level (<5%) fungal endophyte (*A. coenophialum*) infestation. This endophytic fungus is thought to be transmitted exclusively through tall fescue seed. Existing stands of tall fescue are widely infected with the endophyte. The endophyte and/or perloline alkaloid severely inhibits the performance of cattle grazing on tall fescue during summer. Comparisons of Johnstone with Kenhy and Kentucky 31, for color, palatability and perloline content are presented in Tables 4 to 6.

Table 1. Forage dry matter yields of tall fescue varieties evaluated in tests at Lexington from 1980 through 1984.†

Variety	Evaluation Seasons		
	1980-84	1982-84	1983-84
	Ton/Acre/Year		
Kenhy	2.0	3.1	3.7
Ky 31	2.1	3.2	3.6
MO. 96	2.1	3.1	3.4
Forager	2.0	2.9	3.2
Johnstone	--	3.0	3.7
AU-Triumph	--	--	3.0
L. S. D. 05	0.2	n.s.	0.3
C. V. (%)	11.2	7.9	9.1

† Three 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 of 1979. Data in columns two and three are from tests seeded during 1981 and 1982, respectively.

Table 2. Clean seed yields of tall fescue varieties evaluated in tests at Lexington from 1980 through 1984.†

Variety	Evaluation Seasons		
	1980-84	1982-84	1983-84
	Pounds/Acre/Year		
Kenhy	339	543	750
Ky 31	424	555	658
MO. 96	246	370	499
Forager	367	446	474
Johnstone	--	443	691
AU-Triumph	--	--	342
L.S.D. 05	73	59	135
C.V. (%)	20.9	13.1	23.1

† Three 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 and three are from tests seeded during 1981 and 1982, 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
Platability 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.†

	Test 109			Test 107	
	1978			Year	
Variety	March	July	November	9/4/75	8/30/76
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 Kenhy, Johnstone and Kentucky 31 varieties when grazed free-choice with cattle during summer.†

Variety	Tests ‡ 110 1976-77	119 1981-82	125 1984
Kenhy	4.8	5.1	4.5
Johnstone	2.8	3.5	2.8
Ky. 31	6.6	7.3	6.8
L.S.D. 0.05	1.0	1.3	1.9
C.V. (%)	25.2	31.2	33.8

† 1 = best grazed 9 = ungrazed

‡ Tests 110, 119, and 125 were seeded during August, 1975, 1980, and 1983, 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	--	--	427
L.S.D. 0.05	295	875	149
C.V. (%)	16	20	33

Animal Performance

The ability of tall fescue to provide the nutrient requirements for specific levels of performance by animals is perhaps the best measure of forage quality. Many animal performance studies on tall fescue pastures, both in pure and mixed seedings and in fescue-legume mixtures, have shown performance to be superior to other grass species in some tests but inferior in others.

Poor performance of animals grazing tall fescue corresponds in time (July, August, and September) to the greater accumulation of the perloline alkaloid and the presence of fungal endophyte. Perloline inhibits digestibility in ruminants and the endophyte is associated with reduced forage intake. Kenhy has perloline levels comparable to those of Kentucky 31. Seed may be obtained of Kenhy that is certified as having low levels of A. coenophialum.

Comparative performance of cattle grazing pure stands of Kentucky 31 and Kenhy tall fescue is presented in Tables 7 and 8. The effect of the fungal endophyte on animal performance is reflected in data presented in Table 8.

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 infestation), and G1-320 (genetically identical to Johnstone but containing more than 5% endophyte infestation) and orchardgrass-alfalfa are presented in Tables 9 and 10. Growing steers grazing endophyte infested 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 compared with those of cattle grazing the low endophyte improved varieties (G1-320 and Kenhy). Body temperatures were elevated and serum prolactin suppressed in cattle grazing endophyte-infested Kentucky 31. Perloline was lowest in G1-320, which reflects the selection for low concentration of this alkaloid. N-acetyl plus N-formyl loline alkaloid (FALA) concentrations were reflective of infestation of the different fescues with the endophyte. These data demonstrate the effects of the fungal endophyte and selection of fescue for nutritional quality on growing cattle performance.

Mid-lactation Holstein cows fed endophyte infested Kentucky 31 had lower daily dry matter intake than those fed the orchardgrass or alfalfa control, Kenhy and G1-320 (Johnstone). Intake for Kentucky 31 endophyte-infected was not different to Kentucky 31 endophyte-free (Table 10). Milk yields followed a similar trend, with those cows fed endophyte-infested Kentucky 31 producing less milk than those consuming other forages. Average milk production was similar for those animals fed G1-320, Kenhy, endophyte-free Kentucky 31, and the orchargrass or alfalfa control. Serum prolactin is one of the hormones involved in milk secretion. Prolactin concentration of cows fed endophyte-infected Kentucky 31 was lower than in cows fed either the control forage or Kenhy, and was similar to that of those fed endophyte-free Kentucky 31 and G1-320 forage. The data show that A. coenophialum reduces dry matter intakeand milk production of cows fed infested tall fescue forage. Animals fed Kenhy with low levels of endophyte infestation had dry matter intakes and body weight changes significantly higher than orchardgrass or alfalfa green chop; and those fed G1-320 had performance equal to the control forage perhaps as consequence of the harmful effect of 11% endophyte infestation of G1-320.

Table 7. Productivity of cattle on Kenhy and Kentucky 31 tall fescue varieties.†

Location	Grazing Period Years	Total Days	Season	Average Daily Gain Kenhy	Kentucky 31
				- - - - Pounds - - - -	
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. 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 infested the grasses in these tests.

¶ Kentucky 31 had >95% and Kenhy had <5% infestation of A. coenophialum, respectively.

Table 8. Performance of cows and calves grazing endophyte infested Kentucky 31 and uninfested 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 had >95% and Kenhy had <5% infestation of A. coenophialum, respectively.

Table 9. Effect of alkaloids and the fungal endophyte (Acremonium coenophialum) 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.

Item	TREATMENT (Cultivars) Kentucky 31 (1) Infested (I)	(2) Free (F)	(3) G1-320*	(4) Kenhy
Number of cows	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

* G1-320 is genetically identical to Johnstone but contains 6.7% endophyte infestation.

† 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 - Effect of the fungal endophyte (Acremonium coenaphialum) on performance of Holstein cows fed green chop forage in addition to 18 lbs/day concentrate during 5 July - 9 August 1983. R. W. Hemken et al., unpublished data. University of Kentucky and USDA-ARS.

	TREATMENT (Cultivars)				
	Kentucky 31				
	(1) Infested (I)	(2) Free (F)	(3) G1-320†	(4) Kenhy	(5) Orchardgrass-alfalfa control
Number of cows	5	5	5	5	5
Dry matter intake, lbs/day‡	15.8 [a]	19.1 [a,b]	20.9 [b,c]	22.9 [c]	22.9 [c]
Milk yield, lbs/day ‡	37.0 [a]	44.9 [b]	44.4 [b]	46.6 [b]	48.0 [b]
Body weight change, lbs ‡	-9.7 [a]	15.6 [a,b]	44.4 [b,c]	78.1 [c]	26.6 [a,b]
Body temperature, °C	39.2	38.9	39.0	38.8	39.1
Serum prolactin, ng/ml	50	101	70	129	164
Endophyte, % ¶	64	0	11	0	0

† G1-320 is genetically identical to Johnstone but seed contained 6.7% endophyte infestation.

‡ Means on the same line bearing different superscripts differ (P<.05).

¶ Endophyte analysis determined from forage samples taken from the field in May of the following year (1984).