

## Evapotranspiration of Tall Fescue Turf

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Additional index words. *Festuca arundinacea*, lysimeter, crop coefficient, water use rate

**Abstract.** Mini-lysimetry was used for evapotranspiration (ET) assessment of six tall fescue cultivars (*Festuca arundinacea* Schreb.) grown under field conditions. Crop coefficients ( $K_c$ ) and fraction of available soil water were calculated. Cultivars differed in ET by as much as 18%. Turf-types had lower ET than forage-types, with ET rates of 6.6 and 7.2 mm·day<sup>-1</sup>, respectively. 'Kenhy' and 'Kentucky 31' had the highest and 'Rebel' and 'Mustang' had the lowest total ET for 16 days measured during Summer 1984. Cultivars differed in extraction of available soil water and capacity to meet ET demand. Cultivars differed in wilting tendency. 'Mustang' and 'Rebel' had low ET, but wilted early. 'Adventure' had a relatively high ET, but did not show signs of wilt.

Tall fescue is increasingly being accepted as a turfgrass species, particularly with the introduction of turf-type cultivars (5, 6). Tall fescue has better high temperature and drought stress performance compared to other cool-season turfgrasses, which may be attributed partially to its physiological characteristics and its deep and prolific root system (1, 14). ET has been determined for tall fescue when compared to other species (2-4, 7, 8) or under different management practices (2, 7), but not on an intraspecific basis.

It is important to improve understanding of tall fescue water requirements, since there is increased interest in its use as a reduced maintenance species. This study was initiated to compare ET rates and to assess crop coefficients of six tall fescue cultivars.

In May 1983, six tall fescue cultivars, representing diverse genetic origins and growth habits, were established in a field evaluation at the Univ. of Nebraska Agricultural Research and Development Center located near Mead. Turf-type tall fescues ('Adventure', 'Houndog', 'Mustang', and 'Rebel') and forage-types ('Kenhy' and 'Kentucky-31') were established on a Sharpsburg silty clay loam (*Typic argiudoll*) in a randomized complete block design with four blocks. Treatment plots were 1.8 × 1.8 m with a turfgrass fetch of 150 m. Mini-lysimeters were placed in the center of each treatment plot. Field plots and lysimeters were seeded at 35 g·m<sup>-2</sup>; fertilized with N (31N-0P-0K) at 10 g·m<sup>-2</sup> per season; mowed weekly at 76 mm; and

watered to prevent visual drought stress symptoms.

Lysimeters were constructed from 200-mm-diameter polyvinyl chloride pipe cut to a 330-mm length (10). Plexiglass bottoms glued to the inside of the lysimeter had four 45-mm-diameter holes to facilitate drainage and capillary activity, when not in the ET measurement phase. Lysimeters were carefully packed to a bulk density of 1.25 g·cm<sup>-3</sup> with a 25-mm headway. Construction details and the method used for determining water use rates were previously described (7, 9, 10). Lysimeters were drained in place for 24 hr to obtain gravitational water content. A plastic sleeve was placed around the base of the lysimeter to break soil contact, seal it, and prevent gravitational water loss prior to weighing. Lysimeters were weighed to the nearest gram using a Mettler PE 24 digital readout scale. ET measurements were terminated after 4 days. Seals were removed from the lysimeters. Lysimeters were then returned to the test area.

ET measurements were taken 14 to 17 July (T-1), 26 to 29 July (T-2), 14 to 17 Aug. (T-3), and 2 to 5 Sept. (T-4) 1984. Daily ET rates were measured and totaled for the 4 days. Cultivar crop coefficient ( $K_c$ ) was determined as ET(actual)/ET(potential), using

the Nebraska modified Penman equation. The fraction of available water was determined daily using volumetric water contents (VWC) based on the soil desorption curve using the formula:

$$\frac{(\text{VWC at time (t)} - \text{VWC at 15.0 bars})}{(\text{VWC at 0.3 bar} - \text{VWC at 15.0 bars})}$$

These values were plotted against the crop coefficient for each cultivar on a daily basis. Visible wilt symptoms were evaluated using a 1 to 5 scale based on severity of leaf rolling, with 1 = none, 2 = slight, 3 = moderate, 4 = moderate-severe, and 5 = severe. Data were subjected to analysis of variance and means were separated by Duncan's multiple range test. Planned contrasts were made comparing turf-type to forage-type cultivars.

Tall fescue cultivars had significantly different ET rates for three of four of the 4-day totals and for the 16-day total (Table 1). Daily ET rates differed on 8 of 16 days measured. Cultivar ET rates were not different on the first day of each 4-day time period, except during T-3 (i.e., 14 Aug.). Cultivar ET exceeded potential ET ( $ET_p$ ) on the first day of each 4-day period, with the exception of 14 Aug. in T-3. This result may well have been anticipated, since the turfs were maintained under well-watered conditions prior to initiating ET determinations, and researchers have reported ET rates in excess of  $ET_p$  shortly after irrigation (1, 7, 9).

During T-1, cultivars differed in ET on 15, 16, and 17 July and for the 4-day total ET. 'Houndog' and 'Adventure' had the highest ET rates, and 'Rebel' and 'Mustang' had the lowest. 'Kentucky 31' and 'Kenhy' (forage-types) had the highest ET during T-3 and T-4. During T-3, daily ET rates differed for all days and for the 4-day total. 'Kentucky-31' and 'Kenhy' had the highest ET. 'Rebel' had an ET rate that was 15% lower than 'Kenhy'. Cultivar ET rates differed on the 3rd and 4th day and for the 4-day total during T-4. 'Kenhy' and 'Kentucky 31' had the highest ET and 'Rebel' the lowest ET.

Tall fescue cultivars differed in total ET for the 16 days measured during 1984 (Table 1). Based on planned comparison contrasts,

Table 1. Evapotranspiration rates for six tall fescue cultivars assessed on 14 to 17 July (T-1), 26 to 29 July (T-2), 14 to 17 Aug. (T-3), and 2 to 5 Sept. (T-4) 1984.

| Cultivar    | Evapotranspiration rate <sup>a</sup> |                    |                    |                    | Total<br>(mm/16 days) |
|-------------|--------------------------------------|--------------------|--------------------|--------------------|-----------------------|
|             | T-1<br>(mm/4 days)                   | T-2<br>(mm/4 days) | T-3<br>(mm/4 days) | T-4<br>(mm/4 days) |                       |
| Houndog     | 32.9 a <sup>b</sup>                  | 23.3 a             | 30.0 ab            | 23.1 ab            | 109.3 a               |
| Adventure   | 32.7 a                               | 23.4 a             | 29.4 ab            | 23.5 ab            | 109.0 ab              |
| Kenhy       | 31.0 ab                              | 24.7 a             | 32.7 a             | 25.1 a             | 113.5 a               |
| Kentucky 31 | 30.9 ab                              | 24.6 a             | 31.9 a             | 25.0 a             | 112.4 a               |
| Rebel       | 28.4 bc                              | 23.1 a             | 27.7 b             | 21.0 b             | 100.3 c               |
| Mustang     | 26.6 c                               | 23.1 a             | 31.2 a             | 24.1 a             | 105.0 bc              |
| $ET_p^*$    | 33.0                                 | 21.8               | 32.5               | 21.6               | 108.9                 |

<sup>a</sup> Evapotranspiration was assessed daily using mini-lysimeters. Values are expressed as mm per 4 and 16 days.

<sup>b</sup> Values in a column followed by the same letter are not significantly different at the 0.05 probability level, Duncan's multiple range test.

<sup>c</sup>  $ET_p$  based on the Penman equation.

Received for publication 6 Feb. 1987. Published as Paper no. 8239 Journal Series, Agricultural Research Division, Univ. of Nebraska, Lincoln, NE 68583. This research was supported in part by funds from the Nebraska Turfgrass Foundation. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.

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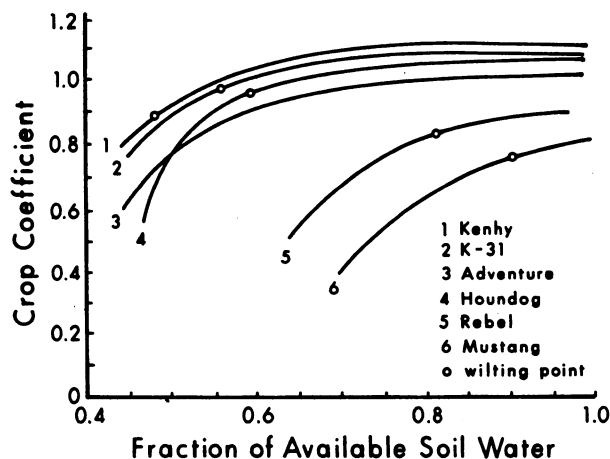


Fig. 1. Relationship of cultivar crop coefficient, fraction of available soil water, and wilting point for six tall fescue cultivars.

forage-types had higher ET rates than turf-types in three of four of the 4-day intervals studied and for the 16-day total ET. Mean daily ET rate for turf-types was  $6.6 \text{ mm} \cdot \text{day}^{-1}$  and  $7.2 \text{ mm} \cdot \text{day}^{-1}$  for forage-types.

'Mustang' and 'Rebel' had lower  $K_c$  values, had lower mean daily ET rates, used less available water, and reached moderate wilt values at higher available soil water levels than the other cultivars (Fig. 1). 'Kentucky 31' and 'Kenhy' had higher  $K_c$  values and used more soil water before wilting than the turf types. 'Hounddog' had the highest crop coefficient and used the greatest fraction of available water among turf-types. 'Adventure' had an intermediate  $K_c$  value, used a considerable amount of available soil water, but did not show wilt symptoms.

The hypothesis that turf-type cultivars used more water and wilted sooner than germplasm previously used was not valid in terms of ET rates or soil water availability. Other mechanisms related to water stress and leaf wilt may be involved, such as depth and ex-

tent of rooting, soil moisture extraction, osmotic adjustment, morphology, arrangement of bulliform cells, and sensible heat loss (1, 8, 11-13). Wilt may be a water conservation mechanism, but its utility in most turf situations is undesirable.

ET and water use data are available for forage-type tall fescue (3, 10), but not for turf-types. These data are the first results indicating tall fescue cultivar ET rates differ under mowed conditions. Tall fescue cultivars differed in their visible wilt response, which was not entirely dependent on soil water stress. These cultivar relationships are important, since irrigation often is scheduled with the onset of visual wilt symptoms. Judicious selection of cultivars must be part of a maintenance program under minimal irrigation.

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