SEVERAL ALTERNATIVE METHODS FOR THE FALL DORMANCY STANDARD TEST

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Fall dormancy is considered an adaptation trait to different climatic conditions, driven by photoperiodism and air temperature in fall and winter, and is related to plant growth, biomass accumulation and abiotic stress tolerance of the alfalfa plant. Fall dormancy is measured and reported for alfalfa using a standardized test (Teuber et al., 1998) comparing new cultivars with historically established check varieties planted in a space plant configuration. Due to the use of historical checks, this method requires a special trial and typically is performed at few locations. We propose alternative methodologies enabling the use of yield trial plots, the inclusion of modern check cultivars, and the use of remote sensing to measure height, all of which will create a more robust dataset for dormancy estimation. These alternatives, singly or collectively, are not meant to supplant the existing methodology but to provide alternatives that may be more easily conducted for some users.

FIELD ESTABLISHMENT

Sward Plot Procedure

Location and Timing.....Directly seed alfalfa experimental and commercial varieties into uniform soil types and field conditions in the spring (April-June) of the year using a minimum of three replicates per location.

Plot Size.....Plant plots in standard small plot variety trial configurations (0.9-1.5 m wide by 4.5-9.0 m long with row spacing of 15-20 cm) using small plot planting equipment for uniform distribution and depth of seed.

Culture.....Maintain weed-free plots and adequate fertilization, irrigation, weed control, and pest management to maintain vigorous growth.

HARVEST MANAGEMENT

Sward Plot Procedure

Summer Harvest.....Harvest small plots two to three times during the summer with the last summer cut prior to August 1-10, depending on location and cutting interval.

Early Fall Harvest.....Make a fall cut in September with the appropriate final clipping date determined at each location based on local experience for when this fall cut will provide the greatest separation among varieties for fall dormancy (e.g., September 8 at Rosemount, MN, and Tulelake, CA, October 3 at Davis, CA, October 23 at Imperial, CA, etc.). It is critical that regrowth occurs during the late September and early October period but before a severe frost (less than -6.2 C) event.

MEASURING PLANT HEIGHT

For sward plot trials, approximately 25-30 days after the early fall harvest, measure plant canopy height of individual plots using one of two techniques. The first is to measure actual plant height in 3-5 locations within each plot and then averaging the readings to get a mean plot height. Plant canopy height is considered the distance from the soil surface to the top of the canopy as it naturally stands in the field. Alternatively, researchers could use drone-based remote sensing technology (e.g., a drone equipped with a camera calibrated for measuring differences in alfalfa canopy height) to determine plant height. When using remote sensing technology, multiple drone flights can be made during the fall data collection period to obtain more accurate plant height separation. The standard test does not specify any particular sensor technology, but the user is expected to have solid ground truth data showing that the drone-based measurement is accurate.

Measurement at 21 to 25 days may be necessary in trials with nondormant entries.

CHECK CULTIVARS

To date, a single set of check cultivars representing fall dormancy classes (FDC) 1 to 11 were selected to maintain the intended relationship between the original set of nine check cultivars (Standard Tests, March 1991) and to have minimal variation across environments. In the table shown here, the Fall Dormancy Rating (FDR; based on the historical University of California regression) and the Fall Dormancy Class (FDC; as designated by the Certified Alfalfa Seed Council) for each check cultivar are shown.

Variety	FDR[1]	FDC
Maverick	0.8	1.0
Vernal	2.0	2.0
Pioneer 5246	3.4	3.0
Legend	3.8	4.0
Archer	5.3	5.0
ABI 700	6.3	6.0
Dona Ana	6.7	7.0
Pierce	7.8	8.0
CUF101	8.9	9.0
UC-1887	9.9	10.0
UC-1465	11.2	11.0

[1]Number is the value calculated using the University of California equation.

To address improvements in alfalfa genetics, a seed company may establish its own set of standard test cultivars to be used in determining FDR. Potential new standard check cultivars must be tested against the current standard check cultivars at representative areas of adaptation at a minimum of five (5) locations and four (4) years and exhibit stable expression of the measured FDR. An individual trial can be measured across multiple years assuming good plot uniformity and acceptable stand percentage.

Standard check varieties used must be chosen to bracket the expected FDC for the new test cultivar by 1.5 or more dormancy classes to ensure good regression model outcomes from the plant canopy height data. For example, if the experimental variety is expected to have an FD4 rating, then use known check varieties with a range from FD2.5 to FD5.5. Fall dormancy is reported to the nearest 0.1 class. At least 10 standard checks must be used within the FD class window to produce a regression if the entire set of historical checks is not used. Seed companies may rotate new varieties into this set whenever they have met the requirement of 5 locations and 4 years of data providing an established FDC value.

STATISTICAL ANALYSIS

Height data should be analyzed using appropriate statistical methods to generate least squares means or best linear unbiased estimators (BLUEs) across replications and locations. Transformation of data is usually not necessary. Data may be combined across years for more accuracy. Height should be regressed against the FDR of established FD checks to develop a prediction equation that is then used to predict the FDR for experimental entries in the trial.

Although fall dormancy is a strongly expressed trait, genotype by environment (GxE) interactions can be significant. Fall dormancy ratings of new cultivars or germplasm should be obtained by testing for a minimum of two years at three representative locations.

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