Induction of Flowering in Alfalfa, Birdsfoot Trefoil, and Red Clover as an Aid in Testing for Varietal Purity

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CURRENT methods of testing forage crop seeds for varietal purity are expensive and slow. Since seeds of most forage varieties cannot be distinguished by visual inspection, it is necessary to grow plants from the seeds and observe them for distinguishing characteristics.

Previous work done under the NEM-22 project has been devoted to finding varietal differences in the vegetative stage (9, 10). It was recognized that the reproductive stage would be useful in varietal purity testing because such characteristics as bloom date, flower color, number of blooms per plant, and length of the flower stalks could be observed. Thus, seedlings were grown under different environmental conditions in growth chambers to develop methods of promoting blooming as soon as possible after being planted. Observations were also made to detect any differences among varieties in amount of bloom or number of inflorescences per plant.

REVIEW OF LITERATURE

A great deal of work has been done on the conditions of light quality and length of the light or dark period needed to induce flowering in plants. Much of this research has been done with plants grown in the greenhouse to a suitable size and then induced to flower by manipulation of the light or dark period. The problem in varietal purity testing is not only to induce flowering, but also to grow the plants to suitable size or stage of maturity as soon as possible.

All three species used in this study are long day plants. Critical daylength for birdsfoot trefoil appears to be between 14 and 14½ hours (7) with profuse blooming occurring at 16 hours (6, 7). Critical daylength for medium red clover is above 10 hours (4) and for Vernal alfalfa it is near 12 hours (7). Varieties and strains of red clover as well as plants within varieties differ in their photoperiod requirements (2). Alfalfa strains and varieties differ in their photoperiod requirements for stem elongation (8, 11).

Bula (1) grew 3 varieties of red clover with 1,500 f.-c. and 3,000 f.-c. of light, 90% of which was supplied by incandescent bulbs and 10% by cool white fluorescent tubes. The temperature was kept near 24 °C. With 1,500 f.-c. and 20-hour photoperiods the following percent of the plants had started to elongate flower stalks in 4 weeks: Pennscott, 83; Kenland, 91; and Dollard, 42. Results with 3,000 f.-c. were similar to results with 1,500. Under both intensities, Dollard had more flowers per plant than Kenland, Doorenbos and Wallensiels (3) state that, at normal greenhouse temperatures and 16-hour photoperiods, red clover bloomed. With the same photoperiod and 5 °C. the plants did not bloom. A warm photophase and a cold nyctophase also prevented blooming, but with a cold photophase and warm nyctophase floral induction started.

MATERIALS AND METHODS

Varieties of three species of forage legumes were used in this study. They included 3 varieties of alfalfa, 8 varieties of red clover, ‘California Common’, ‘Caliverdi’, ‘DuPuits’, ‘India’, ‘Narragansett’, ‘Ranger’, ‘Vernal’, and ‘Williamsburg’; 5 varieties of broadleaf birdsfoot trefoil, Lotus corniculatus L., ‘Empire’, European, and ‘Vernal’; and 4 varieties of medium red clover, Trifolium pratense L., ‘Chesapeake’, ‘Dollard’, ‘Kenland’, and ‘Pennscott’. Of these, California Common and India alfalfa as well as European broadleaf birdsfoot trefoil should probably be referred to as eco-types, but for the sake of brevity will be called varieties in this paper. The European birdsfoot trefoil was a blend of five seed lots imported from France. California Common and India alfalfa were seed lots obtained from the Agricultural Research Service, USDA, and the other varieties were either certified or foundation seed lots.

The 3 species were planted in 51 X 36 cm. greenhouse flats with soil depth of 6.5 cm. The seeds were planted in rows of hills with 4 seeds per hill, 13 hills per row, and 14 rows per flat. After emergence, the plants were thinned to one per hill. This allowed only 1.01 sq. cm. per plant. In most cases, test plants would have to be spaced close together so an adequate number of plants could be tested in the limited space available in growth chambers. In some treatments, alfalfa was also planted at a wider spacing of 37.5 sq. cm. per plant to see if this would increase the amount of blooming. One row at each end of the flat was used as a border.

A randomized block design was used with 2 flats for each variety. This made 3 replications for the alfalfa, 8 for the birdsfoot trefoil, and 6 replications for the red clover. The plants were placed in growth chambers supplied with 1,920 f.-c. of light from cool white fluorescent tubes plus 280 f.-c. from incandescent bulbs for a total of 2,200 f.-c. The light intensity varied 14% higher and 14% lower than this figure due to location within the chamber. The 2 flats of each species were arranged in the chamber so that the average intensity for the species was 2,200 f.-c. Position within the chamber caused relatively little difference in blooming. Two experiments were conducted with 1,100 f.-c. to evaluate the effect of reduced light intensity.

The air temperature was maintained near 25 °C. from that of the thermostat setting. Temperature fluctuations were relatively rapid and the average was very close to that desired. Two chambers with a capacity of 10 flats each were available for this research so a series of experiments extending over a period of nearly 2 years was conducted to obtain all of the conditions desired. Each experiment was terminated and evaluated 5 weeks after the seed was planted. The number of plants with flowers or flower buds visible to the unaided eye was recorded. In addition, the number of inflorescences per plant was recorded for some of the alfalfa and red clover treatments. Some of the tests compared one or two photoperiods during a 24-hour period. Different combinations of day and night temperatures were used. In addition, a number of tests were conducted with continuous light. Constant temperatures as well as combinations of periods of high and low temperatures were used with continuous light.

EXPERIMENTAL RESULTS

For all three species, environmental conditions were found that caused a high percentage of the plants to become reproductive, that is with blooms or visible flower buds. However, each species varied in its requirements for maximum reproduction. Conditions were also found that caused differential varietal response in each species. Figure 1 shows the results obtained with 9 different combinations...