Breeding for high nodulation and root modification in desert-type Alfalfas

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For a number of years an important objective of our project at the University of Arizona has been to modify the structure of low desert valley type alfalfas. A typical plant found in fields of such varieties has a narrow crown producing a small number of stems and a root system composed mainly of a prominent taproot and a few fine-diameter lateral roots.

In order to observe and select from millions of plants, they are grown on deep sandy soils on the Yuma mesa and dug mechanically. Each year four or five elite experimental alfalfas are planted in rows in half-acre isolated blocks for seed increase using one pound of seed per acre. Two crops of seed are produced the following summer from each block. After the second crop of seed has been harvested, plants in these plots are managed so as to have about 30 inches of stem growth by mid-winter. At that time plants are dug and examined for healthy foliage, dense crowns, and vigorous, healthy lateral root systems. Since approximately 100,000 plants are available in each block, selected plants are limited to 100 of the most vigorous individuals. At this time approximately a dozen entries have completed the second cycle of phenotypic recurrent selection for vigorous lateral roots and dense crowns. As the frequency of the genes controlling these traits increases, significant changes in the structure of our low desert valley type alfalfas can be detected. Some of the better plants in these space-planted plots have crowns 2 to 3 feet in diameter with 400 to 600 stems.

Efforts are also underway to increase nodulation and nitrogen fixation induced by strains of Rhizobium meliloti, indigenous to the low desert valley areas of southern Arizona. In 1976, a variety named 'Lew' was released by the Arizona Agricultural Experiment Station. This variety has the following desirable attributes: high forage and seed yield, resistance to the stem nematode found in southern Arizona, and significantly more nodulation than any of the other varieties developed and released by our program.

In an effort to determine if it is possible to concentrate genes controlling nodulation and nitrogen fixation in our alfalfas, seedlings of Lew, 'Hayden' and 'Sonora-70' were planted in flats of soil in the greenhouse. Seed were inoculated with Arizona strains of Rhizobium. After growing for six months, the seedlings were removed from the soil and scored for relative amount of nodule formation.

The second cycle of phenotypic selection for this trait is currently in progress. Thirty-one of the most highly nodulated seedlings of Lew from Cycle I were vegetatively propagated. These clones were established in a crossing block for the production of polycross (PX) seed in 1979. PX seed of these clones has been planted and will be used for the second cycle of selection. Subsequent tests will be conducted to isolate plants which are both highly nodulated and also efficient in nitrogen fixation.

The Potential for a Photorespiration Breeding Program in Alfalfa

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INTRODUCTION

The dispute over water use in Arizona and the depletion of ground water reserves has created the need for research in the areas of plant water consumption and efficiency of water use. A means of increasing the latter would be to decrease the amount of water used by the plant per unit of carbon fixed in photosynthesis (PS). This could theoretically offset water cost by increasing dry matter yield per acre. An amenable crop for this type of research would be a forage crop, such as alfalfa. Water is a primary management concern for alfalfa growers, and investigations of this sort would improve the water-use-efficiency of alfalfa. In addition, all above-ground dry matter would be accounted for during harvest, making an ideal test material for carbon metabolism studies.