WATER CONSERVATION THROUGH PLANT BREEDING - ALFALFA

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Most plant breeders have directed their efforts toward maximizing production under intensive management systems. This philosophy has encouraged the development of varieties capable of utilizing large quantities of environmental resources, including water. Pumping costs, restrictions on amounts of water that can be pumped, and inconsistent supplies of surface water have forced a re-evaluation of "stress" level production.

Many research papers have been published on specific plant measurements in response to moisture stress. Most of these techniques are very time-consuming and expensive and not adapted to use in a plant breeding program. Essentially no work has been published in which an effort has been made to transmit these characteristics across generations and result in a variety with increased performance under stress conditions.

Alfalfa normally requires large amounts of water for optimum production. However, many studies have commented on its drought resistance. This points out the apparent flexibility in alfalfa. This variation in behavior illustrates the possibilities of genetic manipulation to develop varieties which will perform better than existing varieties under some level of moisture stress. The possibilities of such an accomplishment in terms of future world food needs and water conservation certainly warrants investigation.

The objectives of this study are as follows:

1. To determine production levels that can be expected under limited moisture conditions;
2. To determine if genetic variability exists for performance under limited moisture conditions;
3. To establish techniques that would be useful in screening large plant populations for improved performance under limited moisture conditions; and
4. To evaluate selected plants for their ability to transmit these traits to their progeny.

Twenty-four alfalfa varieties are being evaluated under 16, 48 and 80-acre-inch per year irrigation regimes. Significant differences were obtained among varieties, among irrigation regimes and for the variety x irrigation regime interaction.

Forage yields relative to the optimum irrigation treatment (80 acre inches) were 44 percent for the low irrigation regime (16 acre inches) and 106 percent for the intermediate regime (48 acre inches). In 1979, one of the 80 acre inch plots was killed by Phytophthora, a disease associated with excess soil moisture. This may have biased the results, but illustrates that problems exist with excess as well as minimal moisture.

Varieties performed differently when averaged among irrigation regimes or when compared across regimes. Some varieties performed well under all moisture regimes; others performed well under low moisture regimes; some performed well only under high moisture, and

some performed poorly regardless of irrigation treatments. These results are encouraging to the plant breeder because they suggest that by genetic manipulation, it may be possible to develop varieties which will perform better than existing varieties under limited moisture conditions.

Further evidence of useful plant variation was obtained by comparing plants selected from the various screening procedures with unselected populations. Selection intensity was five percent. In one test (field capacity - 1979), the average forage production of the selected plants within the low moisture regime exceeded the average of all plants in this regime by 247 percent; exceeded the average of the intermediate regime by 141 percent, and exceeded the average of the optimum regime by 113 percent. Similar increases have been obtained from other selection procedures.

Analysis of amounts of phenotypic variation (coefficient of variation) among varieties indicated that some varieties were more variable than others. The ideal plant breeding situation would be to identify a germplasm source with high average performance with high amounts of variability. Several varieties appeared to meet these requirements. Zia was prominent in this regard in most tests.

These results definitely show the existence of phenotypic variability for performance under less than optimum moisture conditions. The critical point is -- how much of this apparent gain will be transmitted to the next generation? Both field and greenhouse tests have been established in 1979-80 to evaluate this

potential. If progress can be demonstrated, it will be only a matter of time until varieties can be produced specifically for moisture stress environments. Procedures and techniques derived from this project could also be applied to other crop species.