Physiological Selection in Sugarbeet

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Edited by:
Devon L. Doney

INTRODUCTION

Perhaps the most important problem facing the sugarbeet industry today is the narrow margin of profit or lack of profit in sugarbeet production. There have been numerous proposals on how to solve this problem. One of these solutions is the purpose of this symposium-- that is to improve sugar production per unit land area.

Improvement in sugar production per acre over the past 30 years has not been spectacular, but there has been some major progress. In this period of time we have seen the use and misuse of commercial fertilizer, the introduction of hybrids, monogerm seed, disease resistance, and many other important contributions. As a result, root yields have increased from 12.5 tons per acre to 20.6 tons per acre in 1977. Sharp increases in root yield were obtained in the 50's and early 70's; however, a plateauing effect occurred during the 60's and appears to be re-occurring now. Improvement in sugar production per acre has been less successful. A gradual rise occurred throughout the 40's and 50's. The 60's showed a drop in sugar production per acre, and at present we are producing only slightly more sugar per acre than we were in the late 50's and 60's. This is true in spite of significantly higher root yields. There are many factors affecting these trends, but one thing is apparent, that is, "improving sugar production is a long difficult process."

The reasons are numerous, the negative relationship between root yield and sugar percent, the expense and difficulty of testing and handling a large bulky crop, the high genotype times environmental interaction, the biannual habit of the crop, and the below-ground growth habit are a few examples.

The most difficult job for a plant breeder is to select and exploit superior genotypes. Breeding techniques have consistently failed because of the inability of the breeder to identify and isolate superior lines per se, or line with superior combining ability.

To adequately test sugarbeet genotypes requires large field trials. This reduces the number of genotypes that can be tested, and when testing for yield (which involves 100's of growth genes) the probability of selecting the best genotypes is reduced to almost zero. For example, an F_2 population segregating for 10 genes would have only from 1 in a thousand to 1 in a million plants carrying the best combination of those 10 genes (depending on the heterozygosity of the best combination). With these kinds of odds, it is encouraging that any significant improvements have been made.

This brings us to the purpose of this symposium, "Physiological Selection in Sugarbeet." What is physiological selection? The dictionary says that physiology is the science of the functions of living organisms; therefore, physiological selection would be a selection technique utilizing one or more fundamental functions of the plant as a selection criteria. We have seen great technological advances in the past 30 years that have added many-fold to our basic understanding of the plant and its growth processes. These growth processes can be accurately measured and controlled in the lab or greenhouse with much greater precision than the bulky field tests. To use our knowledge of these growth processes should make it possible to develop selection criteria and to more accurately and efficiently select superior genotypes.

In this symposium, we have assembled experts in a number of disciplines and have asked them to assess the possibilities of developing physiological selection criteria for use by sugarbeet breeders.