HOFFMAN, CHRISTA M., JENS LOEL, CHRISTINE KENTER and BERNWARD MAERLAENDER*, Institute of Sugar Beet Research, Holtenser Landstr. 77, 37079 Goettingen, Germany. **Analysis of the breeding progress of sugarbeet.**

ABSTRACT

Breeding of new sugarbeet varieties results in an increasingly higher performance. The aim of this study was to quantify the extent of the breeding progress in sugarbeet and to analyze which plant characteristics were modified by breeding. The analysis concentrated on physiological aspects, while aspects of resistance were not considered. Sugarbeet varieties registered from 1964 to 2003 were cultivated in field and greenhouse experiments thereby keeping the environment constant. Results show that breeding caused an increase in the white sugar yield of about 0.6 to 0.9 t per ha and year. This progress was realized by an increased harvest-index (higher root/leaf ratio and higher sugar/marc ratio), an improved technical quality (decreased impurities) and an improved assimilation (higher chlorophyll content, improved efficiency of the photosynthesis) of sugarbeet.

Objective of the Research:

Further yield increase is of major importance for the economics of future crop production. Yield increase is a result of the technical progress including improved farmers management. Yield increase due to breeding progress as part of the technical progress, however, is rather difficult to quantify, particularly in sugarbeet. Varieties are hybrids which cannot be identically composed decades after their registration. The aim of the presentation is to summarize novel knowledge from various projects carried out in the Institute of Sugar Beet Research in Germany since 1991 in order to quantify the proportion of breeding on the entire technical progress. The experiments focused on physiological effects while specific aspects of resistance breeding were not considered.

Material and Methods:

Long-term studies included white sugar yield and corrected sugar yield of the newly registered (best) varieties year by year of the official trials of the Federal Plant Variety Office from 1976 onwards, published first by Märländer (1991). The increase of sugar yield in EU Member States was evaluated in an IIRB questionnaire in 2005 and was taken from Fuchs et al. (2008). Chemical composition and particularly marc content were analyzed in field trials series carried out nation-wide in 2006 and 2007 (Kenter and Hoffmann 2008). The varieties registered from 1964 to 2003 were compared in field trials near Göttingen and greenhouse pot experiments in 2008 (Loel et al. 2010). The proportion of the breeding progress in relation to the entire technical progress was calculated from data of several publications, cited by Loel et al. (2010).

Results:

From 1976 to 2009 the corrected sugar yield increased from approximately 8 to more than 12 t per ha with an average increment of 1.5% p.a. It was similar in all EU Member States except the former Eastern European countries, where the increase reached up to 5% p.a. coming from a lower yield level of 5 to 8 t per ha in 2001 to 2005.

The increase of the corrected sugar yield was mainly due to the continuous increase in root yield. The sugar content remained stable while the impurities in particular potassium decreased mar-

kedly by 30 to 50%. For varieties registered from 1964 to 2003 an increase of the chlorophyll content was found resulting in a higher photosynthesis rate and consequently an increase of root yield of up to 30%. The marc content summarizing the insoluble cell wall compounds, mainly lignin, hemicelluloses, and cellulose, decreased from approximately 4.5% to less than 4% for varieties registered from 1964 to 2003. In contrast, the composition of marc did not change. Contrary to the expectations no changes were observed for the leaf area index and leaf area duration (vegetation length), so that the light interception of new varieties had not improved.

Overall, the breeding progress as proportion of the entire technical progress was calculated to be 40% for white sugar yield, 50% for total dry matter yield and 30 to 40% for impurities. The dry matter formation of new varieties was improved by an increased radiation use efficiency (assimilation root/ root yield), an increased harvest index (beet to leaf, sugar to marc-ratio) and an improved technical quality (impurities).

Conclusions:

In summary, breeding progress resulted in a crop well adapted to the demands of sugar manufacturing. This was achieved by a decrease of the impurities and a more beneficial relation of short-chain carbohydrates (sugar) to long-chain (cell wall) carbohydrates. It has to be tested whether this is a result of higher internal energy efficiency of the plant. It is expected that variety improvement in terms of physiological processes will continue further. This change of carbohydrate partitioning will hopefully not result in a higher susceptibility against pests and diseases.