Gerhard Wormanns, Andree Jacobs and Thomas Hoffmann, Potsdam-Bornim

Picture analysis for determination of potato blackspot

The identification of potatoes affected by blackspot through mechanical damage is an important criterium within those research projects which have as target a decrease in blackspot tendency in potato varieties and types, or the evaluation of harvesting and grading machinery. In order to be able to rationally measure the appearance of different blackspot portions of the potato tuber in a large series of trials, a special picture analysis system was developed in the Institute for Agricultural Engineering in Bornim (ATB).

Potato blackspot is brought about by mechanical damage to the tuber and is a serious quality problem with ware, industrial and also seed potatoes.

The coloration of the flesh in different types of potatoes depends on influence factors such as, e.g., variety, starch content and intensity of mechanical stress. Further known influencing factors are tuber temperature during stress, tuber physiological age and the presence of elements such as potassium, ascorbic acid and different amino acids in the tuber.

Exact measurement of the coloured proportion of the tuber taken from longitudinal slices has a high manual labour demand whereby the concrete geometric form of the flecks can only be approximately estimated. In practice, the proportion of fleck is therefore only visually estimated and then allotted to a class. The individual classes are weighted and, from this, a blackspot index created [1,2,3]. Disadvantageous here is the subjective errors that occur through visual estimations. The disadvantages can be large when, within a trial series or in trails over several years, the personnel changes.

Because of this, simple, time-efficient measurement methods had to be developed, making possible an objective description of the colour fleck.

Data collecting

The target in the development of the methodology was the achievement, with minimum investment, of an objective measurement result. For this reason, an economically-priced video camera from a mass sales source was chosen for the computer picture analysis.

The webcam used, a Kodak DVC323, had a CCD chip with 640(480 picture dots and 24 bit colour depth with a simple lens and focus of 12.7 cm to infinity. The price was around 300 DM. It is connected to a PC via a USB connection without additional card. The picture analysis working station *(fig. 1)* is also cost-effectively constructed with lighting consisting of five halogen lamps.

Typical for the type of camera used are the non-homogenous light and colour sensitivity of the individual picture dots. Neither was the picture area sufficiently well lit by the halogen lamps.

This led to a necessity for the improvement of picture quality via program-side recalculation of primary picture information with the help of special algorithms. This calculation process was supported by a debit-credit comparison between the actual, definite, picture data from calibrated norms- and that taken from the camera images.

Sufficient for the special application case is a two-dot balance with help from a homo-

Fig. 1: Work place for image analysis

Dr. agr. Gerhard Wormanns and Dr. rer. agr. Thomas Hoffmann are members of the scientific staff in the department of Technique in Preparation, Storage and Conservation at the Institute for Agricultural Technology Bornim e.V. (ATB), Max-Eyth-Allee 100, 14469 Potsdam-Bornim (scientific director: Prof. Dr.-Ing. Jürgen Zaske). Dipl.-Ing. Andree Jacobs is scientific-technical member of the staff in the same department of this institute. E-mail: gwormanns@atb-potsdam.de

Keywords
Potatoes, black spots, picture analysis

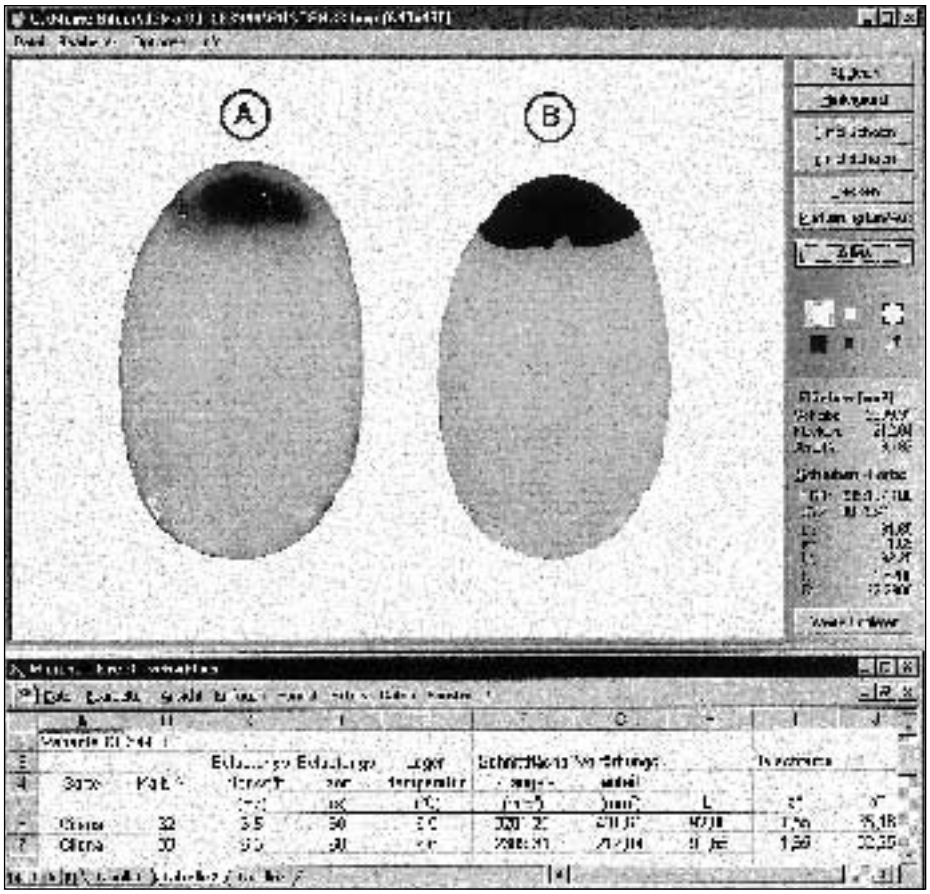

Fig. 2: Image analysis for ascertaining share of black spots; A: original potato slice with peel; B: virtually peeled potato slice with marked black spot

genous white and a homogenous black area as calibration norms. In the white area, the ground colours are red, green and blue, in each case at maximum intensity, and with minimum intensity in the black area.

In the result, two calibration matrices appear on the basic surface of the camera picture with in each case 640(480 picture dots and three colour values per dot. Between the two matrices straight lines are created in calculation form for each ground colour through the dots with the same co-ordinates. Pictures of improved quality are produced through application of the measured colour values in the straight line equations.

The data achieved in this way was transformed from RGB-colour range into L*a*b* colour range. Especially suitable for rapid analysis of the pictures is the lightness L and the colour intensity C.

In the pre-trial work it was already clear that, the at times closely classified, colour changes on the screen then had to be corrected when the colouring on the slice area of the potato (ironspot, ingrowth) could not be attributed to blackspot. The PC program was thus equipped with correction tools for colour alteration.

Data calculation

The picture analysis took place in several stages:

- Concerning the evaluation of the lightness L, the picture dots of the very light background have first to be separated from those of the darker potato slices. These were marked as not belonging to the potato slice and set as uniform white for visual control *(fig 2)*.
- All remaining picture dots were evaluated by the program as the image of the potato slice. Over a fixed factor, dependant on the distance of the camera to the potato slice, the counted pixel number produced the actual area in mm^2.
- In that dark coloured parts of the potato peel can resemble the blackspot flecks, the peel was removed by computer (virtual peeling) through deleting the outer picture dots.
- Black flecks were characterised by the fact that certain limits for the colour intensity C and the lightness L could not be exceeded. If a fleck contains some dots marked by the potato flesh ground colour then picture dots of this colour would be designated to the fleck because of their location. The replacing of the dot through a uniform black enabled the visual control.
- The proportion of blackspot is calculated from the size of the black fleck area in relation to the total area of the slice.

Data assessment

A rational assessment of the collected data is possible through a table calculation program. Through this, all investigated areas and coloured parts were immediately transferred to an Excel table (fig. 2) where they are at once available for statistical evaluation.

First results

In an extensive series of trials with 30 different potato varieties and several repetitions at different times, around 4,800 measurements of blackspot proportions were necessary. This large number of measurements could be coped with in the shortest time and with objective results even with changing personnel.

Summary

Through the development of appropriate software, a picture analysis working station could be created with limited finances. In this, the use of an economical camera and a simple lighting system proved adequate.

.

Literature

Books are signified with •

[1] • *Trenckmann, St.*: Versuche zur Verminderung der Schwarzfleckigkeit von Kartoffeln durch verschiedene Verfahren der Erwärmung. Forschungsbericht Agrartechnik des Arbeitskreises Forschung und Lehre der Max-Eyth-Gesellschaft, Heft 148, Diss., Göttingen,1988

[2] • *Kobelt, G.*: Zur Beurteilung mechanischer Kartoffelbeschädigungen. Ingenieurhochschule Berlin-Wartenberg. Diss., Berlin,1989

[3] *Wirsing, F.*: Erkenntnisse zum Auftreten und zur Vermeidung von Schwarzfleckigkeit. Bornimer Agrartechnische Berichte, 1997, Heft 13, S. 33 – 47