Application Note SC001: **Blackpoint Assessment of Wheat using Digital Image Analysis**

B. G. Armstrong[1], M. Weiss[2], T. A. Armstrong[3], R. I. Grieg[1] and G. P. Aldred[1]
[1] Institute of Food and Crop Science, University of Ballarat, PO Box 663, Ballarat, VIC 3353, Australia
[2] Weiss Enterprises Inc, 51 Turtle Bay Drive, Branford, CT 06405 USA
[3] SeedCount Australasia Pty Ltd, 289 Stag Rd, Kingston, Vic 3364, Australia

Introduction

Blackpoint (BPt) is a dark biochemical discoloration primarily on the embryo area of affected kernels (Sulman et al., 2001). It has a negative impact on the value of the grain (Dexter & Matsuo, 1982). Currently, grain quality personnel perform BPt assessments manually by visual appraisal. Considerable variations can occur between different assessors. A standard assessment requires examination of both sides of 300 kernels, a process taking up to five minutes (AWB Limited, 2002). Many receivals depots aim for a total truck processing time of three minutes, making it difficult for operators to perform thorough BPt assessments.

These constraints make rapid, accurate and repeatable digital image analysis (DIA) blackpoint assessments highly desirable. Determining the severity of the BPt discoloration could also help quantify the impact that it will have on the flour.

However, DIA BPt assessment has proved to be an elusive goal. Several systems have been developed, but have failed to deliver the required combination of speed, precision and accuracy (Johnsson, 2003).

Materials and Methods

This paper presents a new approach to DIA BPt. The SeedCount™ system uses bi-modal indented trays and a fast modified flatbed scanner to acquire the image, as described previously (Armstrong et al., 2003). Unique recognition algorithms were then employed to assess the position of the kernel crease and when acceptable, the presence of BPt. The algorithm distinguished the position of the discoloration on the kernel and its extent using a dynamic threshold that varied with the kernel brightness. The bi-modal indented tray increased the complexity of the BPt assessment as separate calibrations were needed for each section of the tray.

Blackpoint affected wheat from several major growing regions and seasons was selected. Some samples were manually assessed using the standard 300-kernel method. All samples were then assessed by the DIA system. The DIA calibration sample set contained six samples (3413 kernels) and the validation sample set used 50 samples (34,500 kernels). To eliminate sampling difference effects in the calibration and assessment of the DIA system, manual BPt assessments were made directly from the digital images, referred to as image-manual assessments. The BPt levels in several of the calibration samples were enhanced by selecting additional BPT seeds from a larger portion of the sample. Two image acquisition systems were used to test the portability of the calibrations from scanner to scanner. Embedded white reference chips in the trays allowed software adjustment of the image brightness.

Results and Discussion

Manual Assessment

A set of seven BPt wheat samples was independently assessed by four grain industry people. Though only one of them was a professional BPt assessor, all were familiar with the BPt assessment process.

Their results are presented in Figure 1, where individual values are plotted against the average assessment. It can be readily seen that there was a very large spread in their assessments, with a Standard Error of their Estimates of 7.66. Some of this spread will be due to sub-sampling differences, but most of it is due to different interpretations of how much BPt discoloration is required before the kernel is marked as BPt. It is probable that a group of highly experienced assessors would have less variation than is seen in Figure 1.

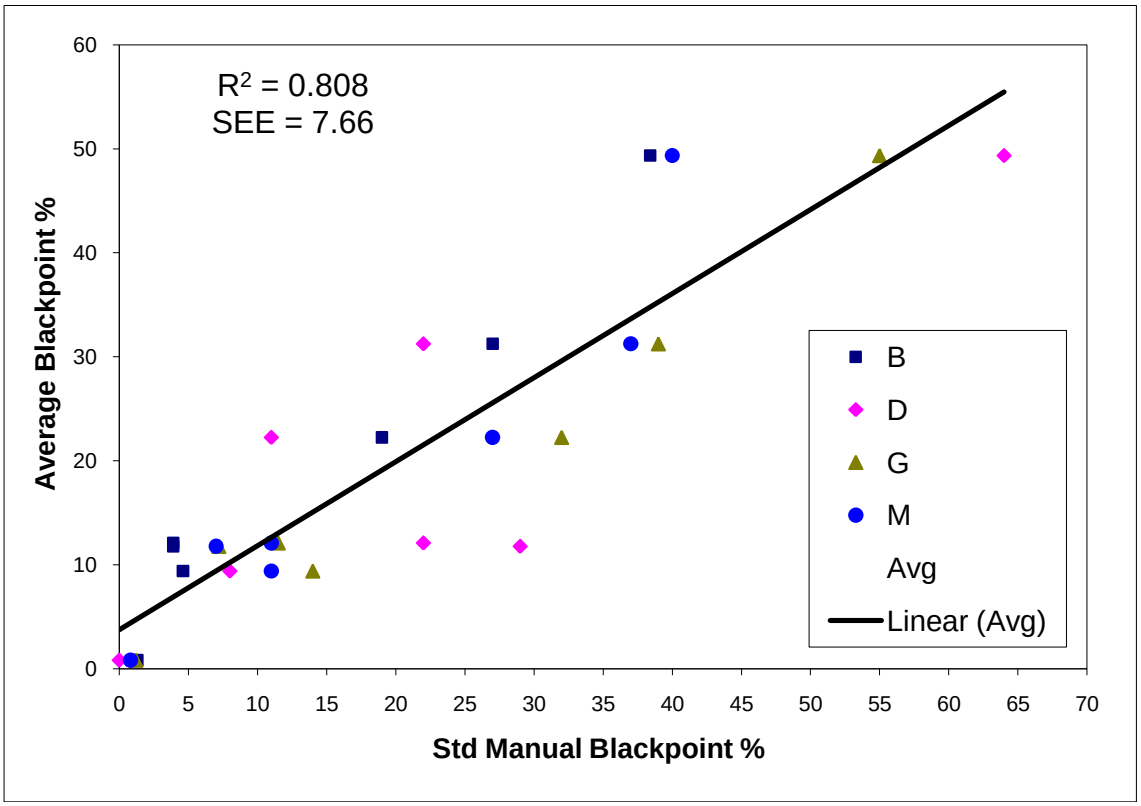


Figure 1: Four Manual Blackpoint Assessments of Seven Wheat Samples

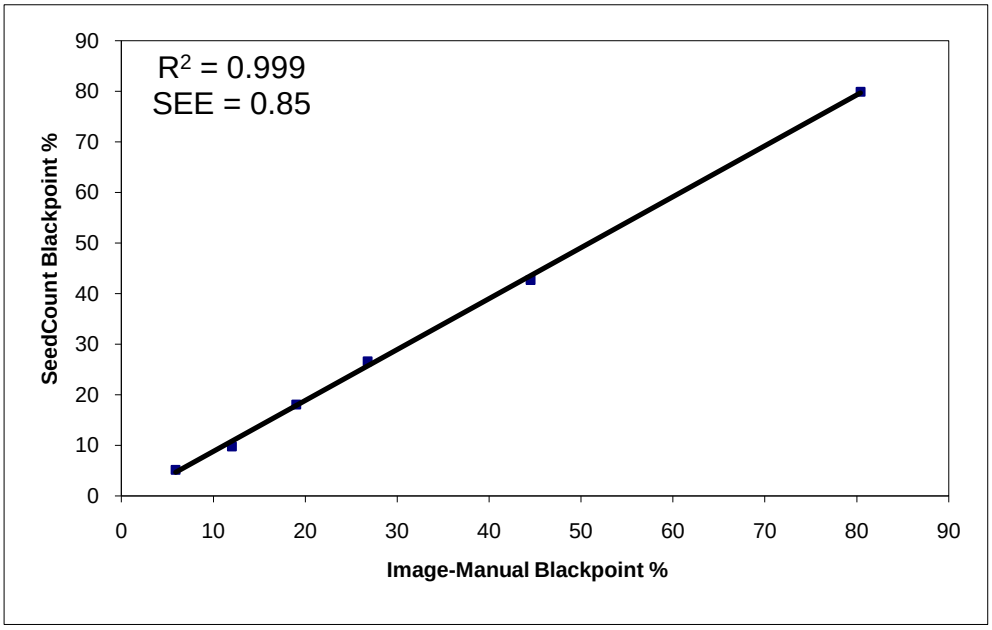
DIA Assessment

The DIA calibrations were made using a diagnostic version of the SeedCount software. The high R^2 correlation (0.999) and low Standard Error (0.85) shown in Figure 2 confirm the accuracy of the BPt module when compared on a shared image basis.

The robustness of the wheat calibration was then tested on a diverse validation set including white and red, vitreous and non-vitreous material (Figure 3). There was only a small drop in the correlations (R^2 = 0.983) for these wheats and a small improvement in SEE (0.66) compared to the calibration set. Each analysis took approximately one minute.

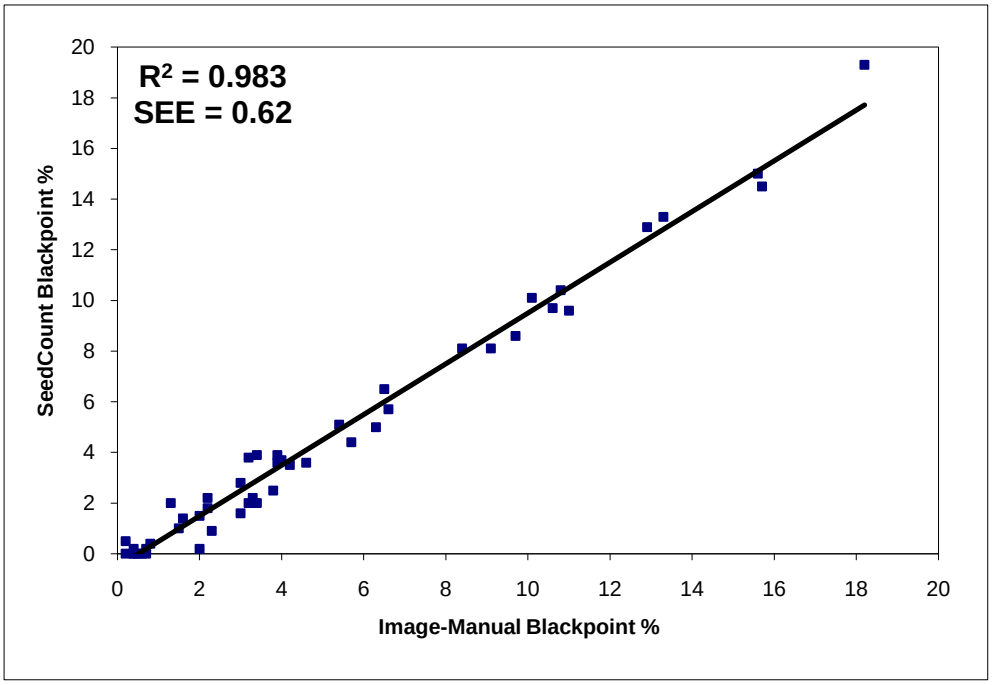
The wheat BPt assessments were more accurate than the barley blacktip assessments (not shown). This was due to the greater difficulty in identifying the kernel crease and the diffusing of the blacktip intensity caused by the barley husk.

Figure 2:



Wheat Blackpoint Calibration Accuracy

Figure 3:



Wheat Blackpoint Calibration Validation

The validation process was then extended to ensure that the calibration would hold its accuracy when used with another scanner (Figure 4). Each tray-full of kernels was used in both scanner systems without being disturbed to minimize sample distribution errors. The inter-scanner correlation slipped slightly to 0.996 and the SEE increased to 1.6, indicating a small decrease in accuracy with a change in scanners. This decrease can probably be further reduced by software improvements. Figure 4 indicates that the SEE decreases as the percent BP decreases, making the calibration portability greater near the critical five percent BP region.

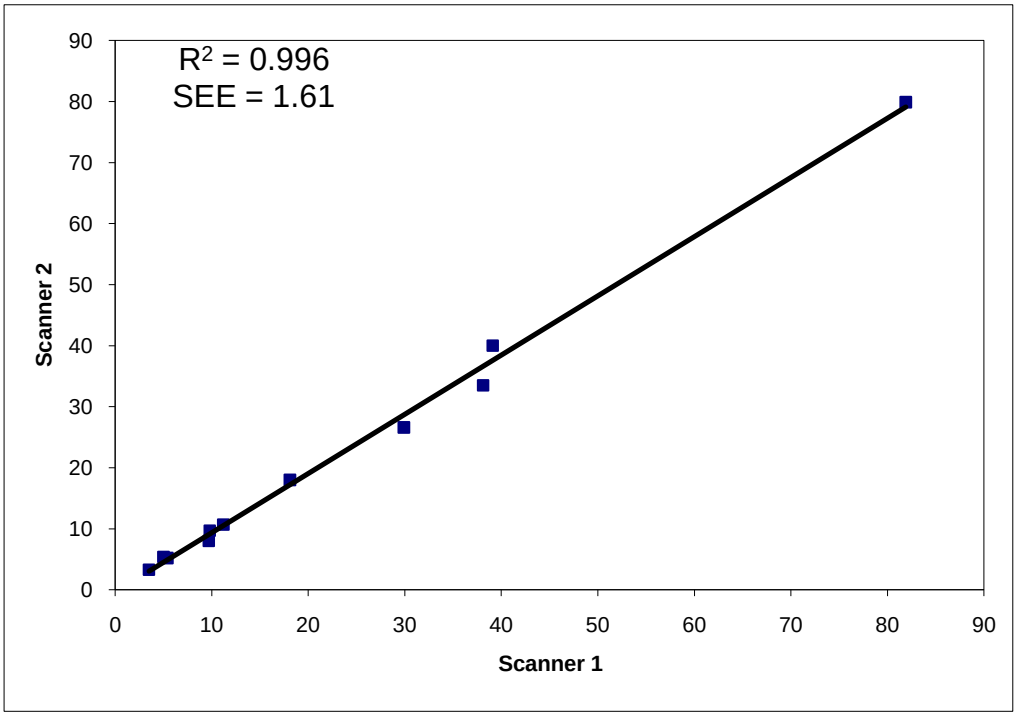


Figure 4: Inter-Scanner Calibration Portability

Conclusions

The DIA BPt assessments were more consistent than the fully manual assessments and the calibrations are reasonably portable across different scanners.

The SeedCount DIA system provided rapid and useful blackpoint assessments.

Acknowledgements

The authors thank Colin Wrigley, Daryl Mares, Helen Allen and John Dines for their assistance.

References

Armstrong, B., Weiss, M., Greig, R. I., Dines, J., Gooden, J., & Aldred, G. P. (2003). Paper presented at the Barley Technical Symposium/53rd Australian Cereal Chemistry Conf, Glenelg.

AWB Limited. (2002). Melbourne: AWB Limited.

Dexter, J. E., & Matsuo, R. R. (1982). *Cereal Chem, 59*, 63 - 69.

Johnsson, A. (2003). Hoganas: Foss Tecator.

Sulman, M., Fox, G., Osman, A., Inkerman, A., Williamson, P., & Michalowitz, M. (2001). Paper presented at the 10th Australian Barley Technical Symposium.