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IMAGE ANALYSIS OF ORNAMENTALS, WITH EMPHASIS TO ROSE AND ALSTROEMERIA

Document prepared by an expert from the Netherlands

Calibration

1. In the past years, experts of the Netherlands have tried to develop a method to quantify colour and patterns of flowers for application in variety research.

2. A lot of attention was aimed at spectral imaging, where, by means of an imaging spectrograph, wavelength specific reflectance of ornamentals was measured in an image forming (2D) way. Conclusions were that:

- it is possible to record reproducible colour images over years. Therefore a digital reference collection of ornamentals like roses seems possible
- flowers can be compared in a quantitative way using colour (variation)
- colour can be treated as a quantitative trait and statistical analysis is possible using the UPOV COY-D method
- it is possible to correct for year effects by using a standard set of reference varieties over years.
- many varieties of rose could be declared distinct using the spectral images

3. A major drawback for practical application in variety testing is the complexity and time-consumption of the recording and calibration method.

4. Therefore it was investigated whether standard digital cameras could be used instead of spectral cameras. During the last year, a calibration protocol was developed to correct for differences between light sources and camera specifics, using specific colour charts and calibration software based on ICC-colour profiles.

5. To use colour in a quantitative way, we convert the RGB (red, green, blue) colour values to a colour space which is more suitable for measuring colour distance. The so-called CIE-L*a*b* colour space is commonly used for this. Colour distance is then defined as the square root of the Euclidean distance: $\Delta E = \sqrt{L^2 + a^2 + b^2}$.

6. Figure 1 shows the importance of good calibration to reduce colour differences due to different recording situations.

Conclusions calibration

7. Using the developed protocol, it appears possible to correct for differences in camera and lighting conditions. This calibration led to a limited loss in the range of colours (colour gamut). Furthermore, the colours present in a digital image covered a considerable larger range (gamut) than could be represented on a monitor or print.

8. It could be concluded that the colour differences found between a set of colour patches using a calibrated digital colour camera (like NIKON D1X) and the more elaborate spectral imaging equipment were similar under normal conditions, hence a digital colour camera seems sufficient.

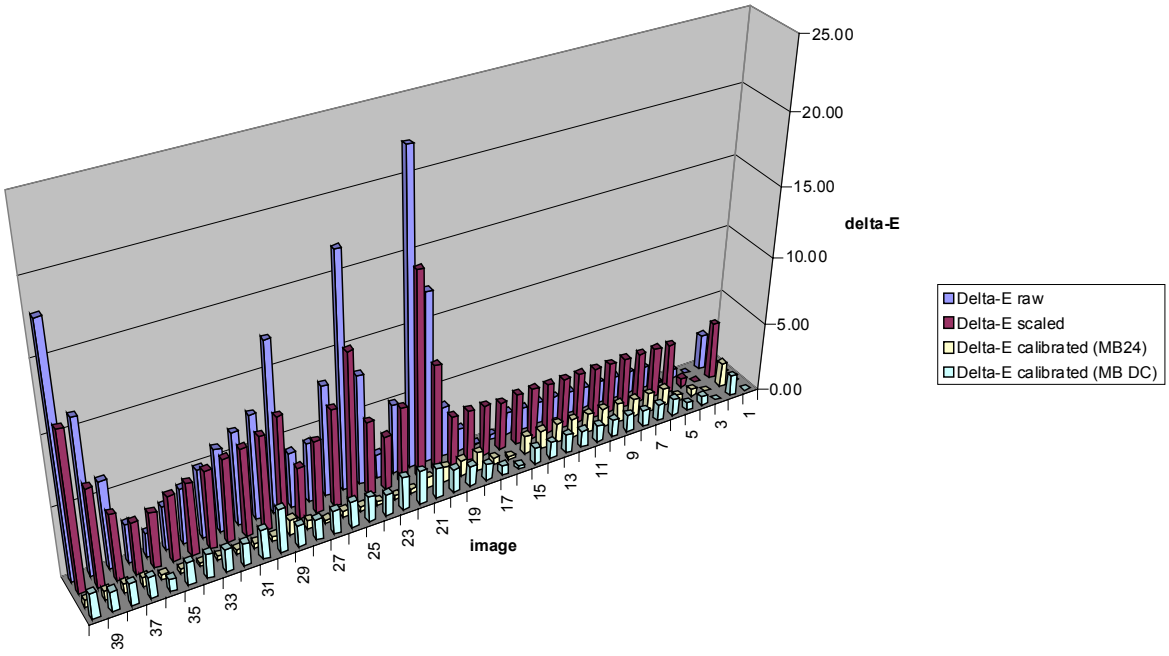


Figure 1: Under 40 different conditions (shutter time, light source, aperture, white balance) colour patches of colour charts are recorded. Measured is the distance between the original and the measured colour expressed as DeltaE. Under 40 different conditions the distance between the true and measured colour values of a set of colour patches is given. The back row shows raw data, the second last row when only intensity scaling is applied. The first two rows show the results of two different types of calibration.

Measuring colour and striping patterns of Alstroemeria flowers

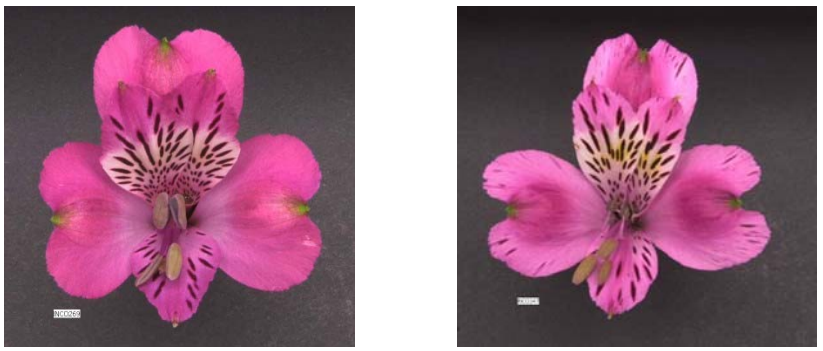
9. Besides being able to quantify colour and determine colour differences of flowers, we also investigated the possibility to quantify patterns like striping in Alstroemeria. Therefore the following protocol was developed for Alstroemeria:

1. image recording using standard lighting and background
2. image calibration (using ICC-profiles/ colour charts)
3. conversion of RGB-images to CIE-L*a*b*-images
4. segmentation of background and flower (Canny edge detection + watershed operator)
5. detection of striping pattern using set of morphological operations (max-min)
6. extraction of 9 colour features of non-striped area: average L*, a*, b*, standard deviation of L*,a*,b*, pair wise correlation of L*,a* and b*
7. extraction of 8 stripe related features: number of stripes, total area of stripes, average length, width and shape-factor of stripes, average colour (L*a*b*) of stripes
8. pair wise comparison of varieties using the 5% LSD (Least Significant Difference) as yardstick for the various features.

10. In Figure 2 the detection of the striping (step 5) is shown in blue overlay for a limited set of varieties. In total 392 varieties were processed. For most varieties no replications were available. The LSD was established on a set of 25 varieties in 4 replications.

Figure 2: the stripes of Alstroemeria flowers automatically detected are shown in blue overlay.

11. Using a procedure called MOSTSIMILAR in Genstat, we were able to find which varieties differed more than at least one yardstick (LSD-5%) for at least one of the 17 features examined. In total 377 of the 392 varieties were found to be unique using this method. The remaining 15 varieties did not differ enough from at least one other variety. In figure 3, images of the five pairs of varieties are shown which were found not to be different. As it can clearly be seen, these flowers are indeed rather similar in colour and striping. In figure 4, the remaining five similar yellow varieties are shown.


inco269 and inco347


inco325 and inco326


inco435 and inco668

inco446 and inco596

inco579 and inco580

Figure 3: the 5 pairs of varieties which were not distinct using the 17 image analysis features.

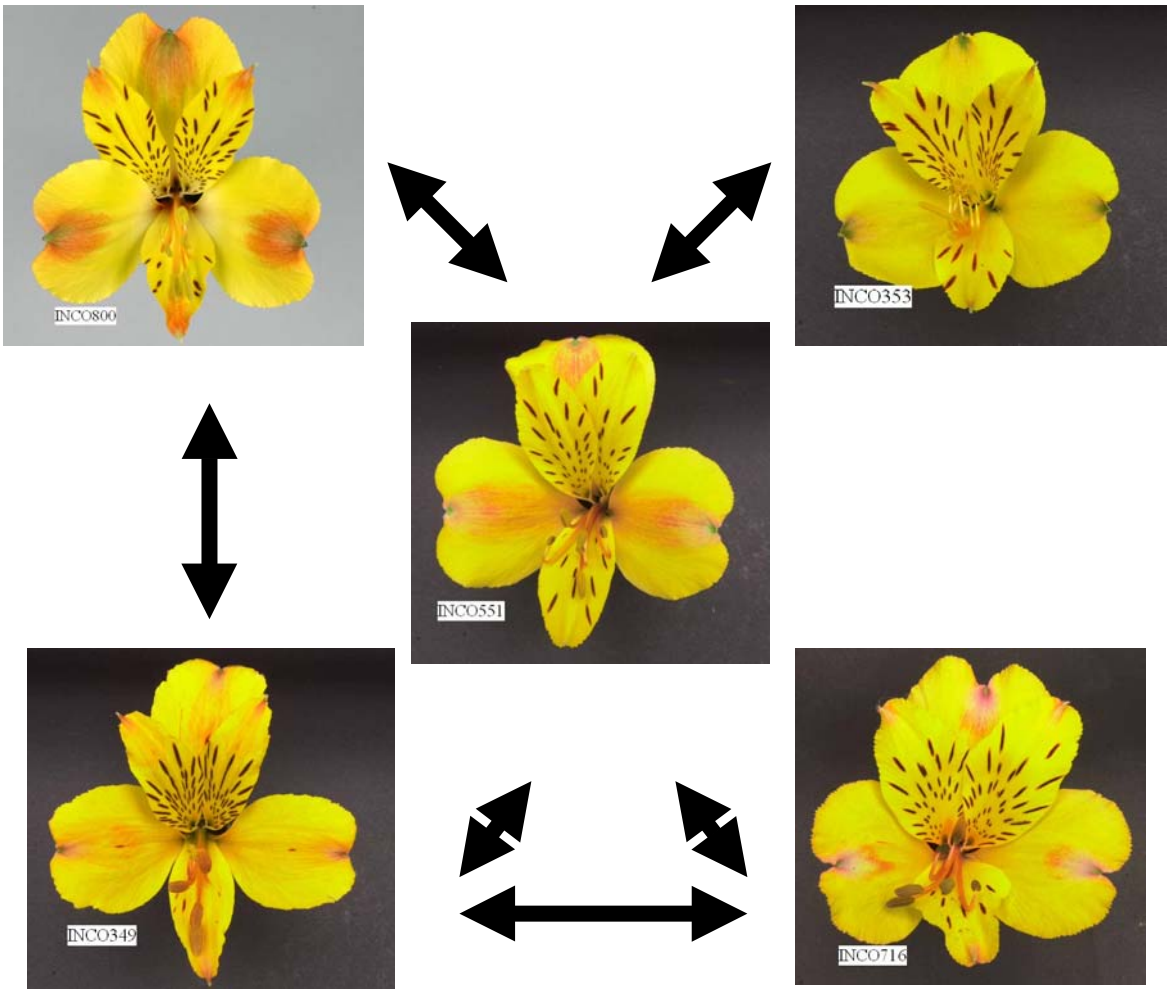


Figure 4. Arrows indicate which flowers are not significantly distinct using the 17 image analysis features.

Conclusions Alstroemeria striping

- Fully automatic analysis on a large dataset of Alstroemeria varieties worked well in most cases. Only in situations where the flower touched the border of the image, or when an inadequate background was used (white flowers on a light-grey background, with some shadow), the segmentation of background and flower could not be done automatically.
- Furthermore, the automatic segmentation of the stripes worked well.
- Most important features are average colour (L*a*b*) of flower and stripes, number of stripes and length/width ratio of stripes.
- Using an LSD of 5% for the 17 features described, 377 of 392 were declared distinct.
- Although the results are very promising, the current dataset was not fully suitable for automatic analysis and application of COY-D like procedures, since there were no replicates available for most varieties. Therefore conclusions were drawn on an

estimate of the standard deviation on a limited set (25) of varieties. For a good application of the described method, more flowers per variety should be recorded.

Overall remarks

12. The proposed method shows potential to use a digital reference collection of ornamentals for variety testing in accordance with UPOV-testing methods (COY-D). Differences between recordings can be corrected by calibration, hence limiting the effect of lighting conditions and camera specifics. Differences due to growing conditions, either because of a different test location (member states) or different growing season (year) are still present. This is a situation comparable with many other species and can be handled likewise: using a set of reference varieties recorded over years and at the different locations, the main additive effect of these factors can be eliminated statistically.

13. It would be very interesting to study if the above described procedure of recording, calibration and image analysis could be applied to a large set of ornamentals and be introduced as a standard UPOV method.

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