Latest Experiments with GDV Technique in Agronomy

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Abstract

We have recorded coronas of ripe apples as a follow up to last year's study [6]. The results indicate that we are unable to detect differences between organically and conventionally grown apples of very similar standard quality. We are, however, able to pick up differences between plants grown using different fertilization schemes.

1 Introduction

It was demonstrated that Crown-TV Kirlian camera and GDV technique [1] can provide useful information for some problems in agronomy, i.e. distinguishing healthy from stressed or infected plants or differentiating between distinct varieties of the same family of plants [3, 6]. In our previous studies we tried using the GDV technology also for differentiating organically from conventionally grown apple trees. To this end we performed one experiment which turned out negative [6]. However, since the experiment's setup was not optimal and the problem is very interesting for the agronomists we decided to repeat it. We were also interested in whether we can use the data the technique provides for distinguishing apples grown in different long-term nutrition schemes.

In chapter 2 we describe the background of the experiments performed and the data collected. Chapter 3 shortly describes the experimental setup. Chapter 4 presents the results of the analysis. At the end we give our conclusions and some ideas for further work.

2 Experiments and their goals

The experiments were carried out in cooperation with the Swiss based Research Institute of Organic Agriculture (FiBL) under the supervision of Dr. Franco Weibel, Head of Department for Crop Production and Crop Quality. They took place in October 2002. Two experiments dealt with differentiating organically grown apples from conventionally grown ones and were performed as a follow up to a similar experiment performed in 2001 [6]. The apples measured (variety Idared) in these two trials originated from neighbouring fruit farms (one organic and one conventional) and from a system comparison experiment (organic/conventional) at the Swiss Federal Research Station (RAC) at Fougères. The third experiment was designed to investigate whether we can measure the effect of different fertilization methods by analyzing the corona images of apples grown in a long-term tree nutrition experiment. For this experiment we recorded 30 apples for each of five different fertilization methods, here denoted as v2, v3, v4, v5 and v10. This gave us a total of 150 samples.

For each recorded apple we also assessed the most important standard quality parameters for fruit: flesh firmness by a penetrometer, sugar content with a refractometer and acidity by titration; additionally we made a simple taste-test, giving points from 1 (very poor) to 5 (very good) by the same personnel who carried out the sample preparation and the GDV measurements.

Apples measured in the third experiment were taken from the KOB trial [7] performed by Franco Weibel and Andi Schmid at the Vogt organic farm in Remigen, AG, Switzerland. The apples are all of the same variety (Topaz), the only difference between them is the fertilization treatment they receive. Treatments taken under our observation were:

- v2: negative control, without compost, with PKCaMg addition;
- v3: fertilized with compost;
- v4: fertilized with compost of same raw material as v3, but made by a bio-dynamic recipe; no bio-dynamic preparations added during vegetation;
- v5: same as v4, except with bio-dynamic preparations added during vegetation three times per year on soil (bd 500) and on leaves (bd 501);
- v10: positive control, without compost, soil and leaf fertilizers applied, closest variant to conventional fertilization.

Specific information about the experiments is given in Table 1.

Problem	object	#ranges	#instances	#classes	majority class
conventional vs organic	ripe apple	4	80	2	50
conventional vs organic	ripe apple	4	60	2	50
fertilization method	ripe apple	4	150	5	20

Table 1 Main characteristics of the experiments

3 Experimental design

All the experiments were performed in a similar fashion. We first recorded the images of selected fruits with the Crown-TV camera using our recording methodology which is described in [5]. For the purposes of analysis and differentiation we have described the obtained images with numerical parameters with the use of GDV Assistant program [4, 5]. Each sample was described with a set of numerical parameters described in [4]. Differentiation was then attempted with See5 software [2]. Potential statistical analysis of the data was done with Microsoft Excel.

Unless specified otherwise the results were obtained using default settings of See5. Other settings were tried but did not give much improvement, if any. Testing method used was leave-one-out testing where number of samples was less than 100, otherwise 10-fold cross validation was used.

4 Results of the analysis

Both experiments dealing with differentiation of organically grown apples from conventionally grown ones turned out negative. Counting a similar experiment conducted in 2001, this means that all three experiments dealing with this type of differentiation were nega-

tive. It has to be noted, however, that in these trials standard quality parameters did not differentiate the samples either. On the basis of these experiments we probably have to conclude that Crown-TV is unable to provide us with complementary or organic-specific information in addition to what can be assessed by standard quality parameters.

Classification attempts with See5 for the fertilization experiment were also negative. However, in this experiment we would be satisfied with a less powerful result of differentiating between groups and not necessarily classifying each sample into its group. Therefore the question was whether there is a difference in any of the GDV parameters between one fertilization method from the other. To find this out we performed statistical t-tests for all GDV parameters on all pairs of fertilization methods. Results were positive for parameters area, noise and brightness deviation and are shown in Table 2.

Numbers in Table 2 represent probabilities that the two groups of samples come from the same population according to the observed GDV parameter. For example, value 0.0531 in the fourth row of the third column means that there is 5.31% probability that groups v2 and v5 come from the same population. The probabilities that are lower than 5% (a statistical standard) are highlighted with a bold font. For these cases we can claim that observed GDV parameter(s) point out the differences between the groups and therefore show differences between fertilization methods. In Table 2 we included only GDV parameters that showed such differences.

5 Conclusions

Experiments described in this paper suggest that we are not able to find complementary information to distinguish organically from conventionally grown plants if we observe fruit of very similar standard quality. We are, however, able to point out differences between plants grown using distinct nutrition schemes.

In retrospective, if we take a closer look at all the experiments using GDV technology in agronomy we conducted over the past three years the following conclusions can be given. For some

TTesting	pair	area	noise	br.dev
	v2 vs v3	**0.0000**	**0.0000**	**0.0009**
	v2 vs v4	**0.0074**	**0.0000**	0.6455
	v2 vs v5	0.0531	**0.0013**	0.1898
	v2 vs v10	0.0675	0.1216	0.4040
	v3 vs v4	**0.0105**	**0.0349**	**0.0056**
	v3 vs v5	**0.0002**	**0.0000**	**0.0207**
	v3 vs v10	**0.0009**	**0.0000**	**0.0001**
	v4 vs v5	0.2293	**0.0002**	0.4442
	v4 vs v10	0.3435	**0.0000**	0.2150
	v5 vs v10	0.9077	**0.0442**	**0.0338**

Table 2 Results of t-tests for positive GDV parameters

problems GDV technique can provide us with additional information and can be used alongside standard agronomical indicators. Recording methodology that proved quite stable and reliable was developed and extensively tested. Software for analysis of recorded coronas was developed and proved easier to use and analytically at least on par with previously existing software and in some cases also significantly better.

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References

[1] Korotkov, K. (1998) *Aura and Consciousness*, St.Petersburg, Russia: State Editing & Publishing Unit "Kultura".

[2] Quinlan, J.R. (1993) *C4.5 Programs for Machine Learning*, Morgan Kaufmann.

[3] Skocaj, D., Kononenko, I., Tomažic, I., Korošec-Koruza, Z. (2000) Classification of grapevine cultivars using Kirlian camera and machine learning, *Res. Rep. Biot. fac. UL - Agriculture* - ISSN 1408-340X, 75(1)133-138.

[4] Sadikov, A. (2002) *Computer visualization, parameterization and analysis of images of electrical gas discharge (in Slovene)*, M.Sc. Thesis, University of Ljubljana, Faculty of Computer and Information Science, Ljubljana, Slovenia.

[5] Sadikov, A., Kononenko, I., Weibel, F.P. (2003) Analyzing Coronas of Fruits and Leaves, In: K. Korotkov (ed.) *Science, Information, Spirit: Study with GDV Bioelectrography* (in press)

[6] Sadikov, A., Kononenko, I. (2002) Information Stored in Coronas of Fruits and Leaves, *Proc. New Science of Consciousness*, Ljubljana, pp 222-225.

[7] Weibel, F.P. (2001) *Internal FiBL Report*.