THE APPLICATION OF PRECISION FARMING PRINCIPLES ON THE QUANTITATIVE AND QUALITATIVE PARAMETERS OF APPLE PRODUCTION, IN THE VOINESTI-DAMBOVITA

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Abstract: *The aim of this study, is to establish and compare the quality and quantity parameters for apple production, in the Voinesti-Dambovita station, for Florina and Generos cultivars. It was established the influence of cultivar on the quality and quantity parameters, in the same pedogenetics conditions and the same applied technology, with the aim of classification of fruits in quality class. The fruit size, measured at diameter leads to their classification in "extra" class, according to standards market for fresh apples. Regarding the average weight of fruit was found that the values are covered by the specific parameters of cultivar, but not with the big differences. Therefore, based on these study, we established that the influence of cultivar is important but it is necessary to improve the technology for a better production.*

Key words: *apple, cultivar, precision farming, quality*

INTRODUCTION

Precision agriculture is a relatively new management practice for managing field variability. The first applications started at the early 1990's mainly in arable crops, but its application in tree plantations is still very limited mainly because farm mechanization and especially harvesting is still very expensive and the majority of fruits for fresh consumption are harvested manually.

The University of Florida has done important researches on citrus. For the yield mapping has been created an automatic system of yield calculation (Miller and Whitney, 1999, Whitney et al., 2001, Molin et al., 2007). Also, it was created a system in order to calculate the volume of the tree canopy by using ultrasonic devices (Zaman et al., 2006) and laser scanners (Tumboet al., 2001, Wei and Salyani, 2004). Moreover, Zaman et al. (2006) applied variable rate of nitrogen fertilizers on citrus and they found the there was a reduction of the production cost by 40%.

Zaman and Schuman (2006) created zones for dolomite application based on the organic matter of the soil and the NDVI value which extracted by aerial photographs. Schuman and Zaman (2003) created maps of the electric conductivity of the soil by using the induction method in order to identify the parts of the field which had problem with the water.

Many scientists have been developing systems for yield mapping in citrus (Annamalai and Lee 2003, Chinchuluun et al., 2007, Okamoto et al., 2007) and tangerines (Xujun et al. 2007) by using multispectral images.

In Spain, Lopez-Granados et al. (2004) studied the variation of the nutritive components at olive leaves and they found that only 3 and 17% of the field needed fertilizers during 1999 – 2000. Romo et al. (2007) created a management system for a field with olives using remote sensing. From the satellite images they created the maps with the NDVI values of the olive plantations, the biomass, the surface of the leaves and the nitrogen.

Bramley (2004) and Arno (2005) studied on vines the yield variability in different vineyards by using a harvest machine which had GPS system in order to make the yield mapping. Bramley (2005) studied the quality variability in vineyards from 1999 to 2002 and he found that there was spatial and time variability at the quality features of the vines.

In France, Tisseyre et al. (2001) and Ortega et al. (2003) applied precision agriculture on different vineyards. Taylor et al. (2005) compared the spatial variability of two vineyards in France and Australia. Acevedo-Opazo et al.(2007) created management zones of a vineyard by using the NDVI values.

Balastreire et al. (2002) and Sartori et al. (2007) developed an automatic yield mapping system on coffee crops. Queiroz et al. (2007) studied the spatial and time variability in quality of the coffee for two years in different fields. Shamsi et al. (2007) studied the spatial variability of yield and quality on date palms while Coates et al. (2007) applied chemicals in variable rates at fields with almond trees.

On apple plantations were used image interpretation from hyperspectral and multispectral camera in order to predict the number of fruits on trees and to create the yield map (Kim and Reid, 2004, Stajnko et al., 2004, Safren, 2006, Alchanatis et al., 2007).

In Greece, research of precision agriculture in tree plantations was initiated over the last five years.

Aggelopoulou et al (2010) studied the spatial and time variability of apple's quality and yield and created management zones by using MZA software. Tagarakis et al. (2006), Chatzinikos (2007) and Stamatiadis et al. (2007) studied the yield variability and the soil properties in vineyards. At Olive orchards yield mapping were made and soil properties were studied (Fountas et al. 2010), while in peach plantations variability and yield recording was carried out by Ampatzidis (2010).

In Romania, the application of precision agriculture has been studied in apple plantations to investigate yield and quality variability (Teodorescu 2007a, 2007b, 2009).

MATERIALS AND METHODS

We focused this study on Florina and Generos cultivars, with an age of trees of 8 years, grafted on MM 106. We study the following caracteristics: the size, the weight and the colour of fruits, for classification into the quality classes. The two cultivars are growing in the same pedogenetics conditions and have the same applied technology to better analyse the relevance of the spatial variability on yield and quality parameters. The study area is located in the Voinesti Valey, in the north of the Dambovita county. Generally, the harvesting begin in the first days of October, for both cultivars, when the apples reached the specific size and weight.

The Generos and Florina cultivars is geneticaly resistant to apple scab, very slightly sensitive to powdery mildew and fire blight. The number of works in the field and the treatements are reduced to half, because of these genetic resistence, ensuring a better environmental protection. Thus, the quality of fruits is better and the yield is more healthy.

The study made part of the bilateral project, between Romania and Greece, having the purpose to study and implement precision farming in both countries. The studied parameters were: analysis of soil parameters and mapping, analysis of crop parameters and crop mapping, analysis of quality aspects and yield mapping, creation of management zones, variable rate application, environmental assessment of precision agriculture in apples.

At the end of the project there will be an evaluation of the used techniques according to how safe for the environment are they and what is the profit of the farmers. Finally, for the farmer's profit estimation, the total cost of the inputs will be calculated and compared with the total cost of the outputs which will be occurred.

RESEARCH RESULTS

For all these measurements were calculated the averages. In the same time, the total yield was weighed to determine the correlations between quality parameters and yield.

The qualitative parameters were analysed in terms of weigt and size, for both cultivars.

The average weight of Generos and Florina fruits was determined using an electronic scale.

For Generos cultivar the values ranged between 160,8 and 227,2 g/fruit. The average value determined is 186.42 g/fruit.

For Florina cultivar the value ranged between 90.7 and 205.4 g/fruit. The average value determined is 143.68 g/fruit.

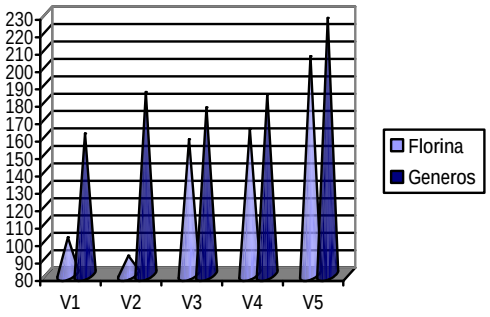

Figure 1 The average weight of cultivars, for all variants

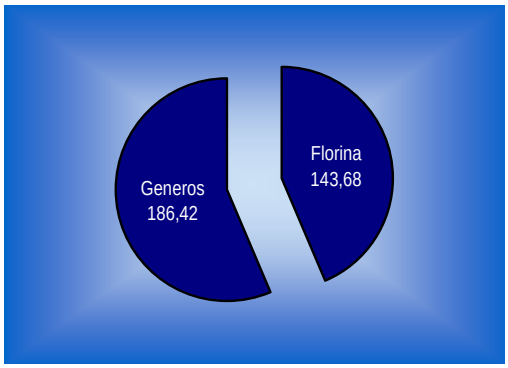

Figure 2 The average weight (g) of the two cultivars

The fruit size according to the diameter was recorded with a calibrator.

For Generos cultivar, the values were recorded between 72 and 85 mm, with an average of 77.8 mm.

For Florina cultivar, the values were determined between 60 and 85 mm, with an average of 70 mm.

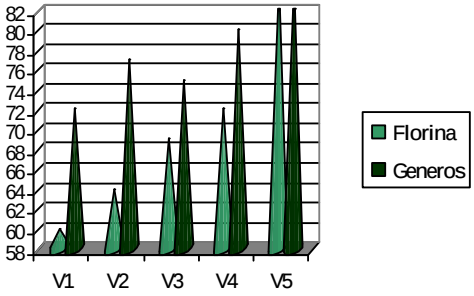

Figure 3 The average size of cultivars, for all variants

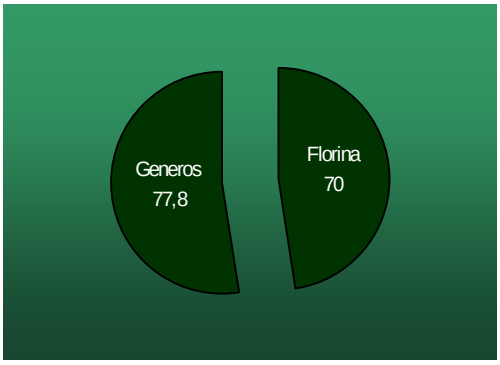

Figure 4 The average size (mm) of the two cultivars

In terms of quantitative parameters, the yield of each tree was harvested manually and individually placed in boxes.

For Generos cultivar, the values were recorded between 13 and 45 kg, with an average of 31 kg/tree.

For Florina cultivar, the values were determined between 9 and 28 kg, with an average of 17,8 kg/tree.

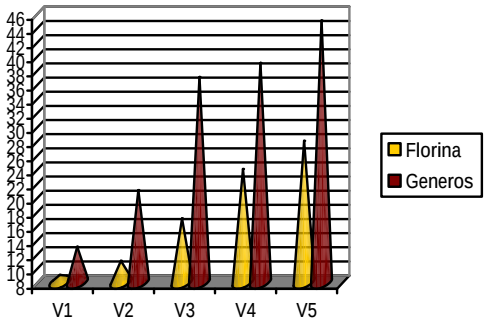

Figure 5 The average yield of cultivars (kg/tree), for all variants

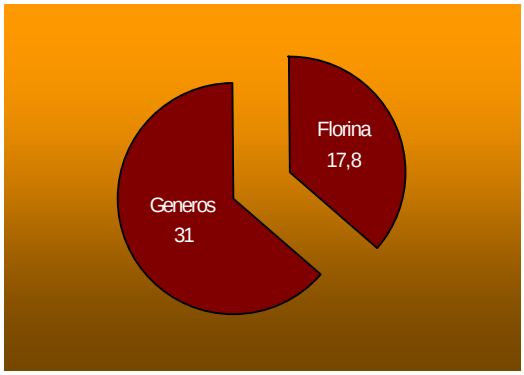

Figure 6 The average yield (kg/tree) of the two cultivars

CONCLUSIONS

The conclusions of this study are:

- the quality parameters are superiors at Generos cultivar than at Florina cultivar;
- the yield is significantly bigger at Generos cultivar than at Florina cultivar;
- spatial variability are significant in the study area;
- for both cultivars, yield is correlated with fruit qualities, such as weight and size;
- according to standards market for fresh apples, the fruit size measured at diameter (average fruit is 70 mm for Florina cultivar and 77,8 mm for Generos cultivar) leads to their classification in "extra" class.

Promoting the genetic resistance cultivars in the field is ensured a better protection of the environment and reduced costs with technology.

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REFERENCES

1. **ACEVEDO-OPAZO, C., TISSEYRE, B., GUILLAUME, S., OJEDA, H.,** 2007, Test of NDVI information for a relevant vineyard zoning related to vine water status, 6th European Conference on Precision Agriculture, Skiathos, Greece, pp. 547-554
2. **AGGELOPOULOU**, **K. D., WULFSOHN, D., FOUNTAS, S., GEMTOS, T. A., NANOS, G. D., BLACKMORE, S.,** 2010, Spatial variation in yield and quality in a small apple orchard, Precision agriculture Vol. 11 Issue 5, p538-556
3. **ALCHANATIS, V., SAFREN, O., LEVI, O., OSTROVSKY, V.,** 2007, Apple yield imaging using hyperspectral machine vision, 6th European Conference on Precision Agriculture, Skiathos, Greece, pp. 555-562
4. **AMPATZIDIS, I.,** 2010, PhD Thesis.
5. **ANNAMALAI, P., LEE, W.S.,** 2003, Citrus yield mapping system using machine vision, ASAE paper number 031002.
6. **ARNO, J., BORDES, X., RIBES-DASI, M., BLANCO, R., ROSELL, J.R., ESTEVE, J.,** 2005, Obtaining grape yield maps and analysis of within field variability in Raimat (Spain), 5th European Conference on Precision Agriculture, Upsala, Sweden, pp. 899-906.
7. **BALASTREIRE, L.A., SCHUELLER, J.K., AMARAL, J.R., LEAL, J.C.G, BAIO, F.H.R.,** 2002, Coffee Yield Mapping, ASAE Paper No 021166. St. Joseph, Michigan. ASAE

8. **BRAMLEY, R.G.V., HAMILTON, R.P.,** 2004, Understanding variability in winegrape production systems 1. Within vineyard variation in yield over several vintages, Australian Journal of Grape and Wine Research 10: 32-45
9. **BRAMLEY, R.G.V.**, 2005, Understanding variability in winegrape production systems 2. Within vineyard variation in quality over several vintages, Australian Journal of Grape and Wine Research 11 (1): 33-42
10. **COATES, R.W., SHAFII, M.S., UPADHYAYA, S.K., BROWNE, G.T.,** 2007, Site specific fumigant applicator for prevention of almond replant disease, ASBE Paper N 071080
11. **CHINCHULUUN, R., LEE, W. S., EHSANI, R.,** 2007, Citrus yield mapping system on a canopy shake and catch harvester, ASAE Annual Meeting 073050
12. **KIM, Y., REID, J.,** 2004, Apple yield mapping using a multispectral imaging sensor, International Scientific Conference on Agricultural Engineering (AgEng), Leuven, Belgium
13. **LOPEZ-GRANADOS, F., JURADO-EXPOSITO, M., ALAMO, S., GARCIA-TORRES, L,** 2004, Leaf nutrient spatial variability and site-specific fertilization maps within olive (*Olea europaea L*.) orchards, European Journal Agronomy 21: 209-222
14. **MILLER, W.M., WHITNEY J.D.,** 1999, Evaluation of weighing systems for citrus yield monitoring, Applied Engineering in Agriculture, 15(6): 609–614
15. **MOLIN, J.P., MASCARIN, L.S., POVH, F. P., AMARAL, J.R., OLIVEIRA, A.S.,** 2007, Proceedings of the 6th European Conference on Precision Agriculture, Skiathos, Greece. Poster Abstracts in CD
16. **OKAMOTO, H., LEE, W.S., KANE, K.,** 2007, Hyperspectral imaging for green citrus detection, Proceedings of the 6th European Conference on Precision Agriculture, Skiathos, Greece, Poster Abstracts in CD
17. **ORTEGA, R.A., ESSER, A., SANTIBANEZ, O.,** 2003, Spatial variability of wine grape yield and quality in Chilean vineyards: economic and environmental impacts, 4th European Conference on Precision Agriculture, Berlin, Germany, pp. 499-506
18. **QUEIROZ, D.M., ALVES, E.A., PINTO, F.A.C.**, 2007, Spatial and Temporal Variability of Coffee Quality, ASABE Paper, N. 071141
19. **ROMO, A., FRAILE, S., SANZ, J., CASANOVA, J-L.,** 2007, Management support for an olive- tree plantation through remote sensing, 6th European European Conference on Precision Agriculture, 3-6 June, Skiathos Greece, Poster Papers Proceedings in CD.
20. **SAFREN, O.,** 2006, Green apple yield mapping using hyperspectral machine vision, M.Sc Thesis, Ben-Guiron University of Negev, Faculty of Engineering Sciences, Department of Industria Engineering and Management, Israel
21. **SARTORI, S., FAVA, J.F.M., DOMINGUES, E.L., RIBEIRO FILHO, A.C., SHIRAISI, L.E.,** 2002, Mapping the spatial variability of coffee yield with mechanical harvester, Proceedings of the World Congress of Computers in agriculture and Natural Recourses. ASAE Publication Number 701P0301
22. **SHAMSI, M., MAZLOUMZADEH, S.M., BLACKMORE, S.,** 2007, Studyind yield variations using precision farming in date palm orchard, 6th European Conference on Precision Agriculture, Skiathos, Greece, Poster Abstracts in CD.
23. **SCHUMANN, A.W., ZAMAN, Q.U.,** 2003, Mapping water table depth by electromagnetic induction, Applied Engineering in Agriculture, 19(6): 675-688
24. **STAJNKO, D., LAKOTA M., HOEVAR, M.,** 2004, Estimation of number and diameter of apple fruits in an orchard during the growing season by thermal imaging, Computers and Electronics in Agriculture, 42: 31-42.

25. **STAMATIADIS, S., TASKOS, D., TSADILA, E., CHRISTOFIDES, C., TSADILAS, C., SCHEPERS, J.S.**, 2007, Proximal remote sensing. Technological advances and application in vineyards, 6th European Conference on Precision Agriculture, Skiathos, Greece, Poster abstracts in CD
26. **TAGARAKIS, A., CHATZINIKOS, A., FOUNTAS, S., GEMTOS, T.A.,** 2006, Deliniation of management zones in precision viticulture, HAICTA 2006 Conference, Volos, Greece, pp 547-554
27. **TAYLOR, J., TISSEYRE, B., BRAMLEY, R., REID, A.,** 2005, A comparison of the spatial variability of vineyard yield in European and Australian product systems, 5th European Conference on Precision Agriculture, Uppsala, Sweden, pp. 907-914
28. **TEODORESCU, G.,** 2009, Improvement of fruit quality using the precision horticulture in Romania, VIII International Symposium Frutic Chile, 2009
29. **TEODORESCU, G.,** 2007a, Precision Horticulture system – an opportunity for Romania, 6th European Conference on Precision Agriculture, Skiathos Greece, (CD), 2007
30. **TEODORESCU, G.,** 2007b, Improvement of fruit production and precision horticulture opportunities in Romania, Scientific volume, nr.50 Universitatea de Stiinte Agricole si Medicina veterinara Iasi, 2007, ISSN 1454-7414
31. **TISSEYERE, B., MAZZONI, C., ARDOIN, N., CLIPET., C.,** 2001, Yield and harvest quality measurement in precision viticulture- application for a selective vintage, 3rd European Conference on Precision Agriculture, Montpellier, France, pp. 133-138
32. **TUMBO, S.D., SALYANI, M., WHITNEY, J.D., WHEATON, T.A., MILLER, W.M.**, 2001, Laser, ultrasonic and manual measurements of citrus tree canopy volume, ASAE Paper N. 01-1068
33. **WEI, J., SALYANI, M.,** 2004, Development of a laser scanner for measuring tree canopy characteristics, ASAE Paper N 041168
34. **WHITNEY, J.D., LING, Q., MILLER, W.M., ADAIR WHEATON, T.,** 2001, A DGPS yield monitoring system for Florida citrus, Applied Engineering in Agriculture, 17(2): 115-119
35. **XUJUN, Y., SAKAI, K., MANAGO, M., ASADA, S., SASAO, A.,** 2007, Prediction of citrus yield from airborn hyperspectral imagery, Precision Agriculture, 8(3):111-125
36. **ZAMAN, Q., SCHUMAN, W.A.,** 2006, Nutrient management zones for citrus based on variation in soil properties and tree performance, Precision Agriculture 7: 45-63
37. **ZAMAN, Q., SCHUMAN, W.A., HOSTLER, H.K.,** 2006, Estimation of citrus fruit yield using ultrasonically-sensed tree size, Applied Engineering in Agriculture 22(1): 39-43