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We apologize for errors that could have arisen during the editing process despite our careful vigilance.

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PREFACE

18èmes Journées Internationales G*i*ESCO 2013, Porto, Portugal

PORTUGAL - Diversité, Patrimoine, Innovation

Le 18ème Symposium International G*i*ESCO 2013 (Groupe *international* d'Experts en Systèmes vitivinicoles pour la CoOpération) s'étend entre 7 et 11 Juillet, à la Faculté des Sciences de l'Université de Porto - Portugal, sous le Haut Patronage de Son Excellence Monsieur le Président de la République Portugaise. A ce événement sont associés l'OIV (Organisation Internationale de la Vigne et du Vin), le Rector de l'Université de Porto, l'Institut d'Agronomie - Université Technique de Lisbonne, l'Institut National de la Recherche Agronomique et Vétérinaire IP, la Fondation pour Science et Technologie, l'Institut de la Vigne et du Vin, IP, la Commission de la Viticulture de la Région des Vinhos Verdes, l'Institut des Vins du Douro et de Porto, IP, le ViniPortugal, la « Casa do Douro » et la "*Chaire UNESCO Culture et Traditions du Vin*".

Le grand succès auprès de la communauté scientifique se traduit par la présentation de plus de 220 articles scientifiques (orales et posters) d'environ 250 chercheurs et scientistes de 23 pays. Pendant quatre jours et neuf séances, seront abordés les sujets: Méthodologie et écophysiologie, Relations Hydriques; Viticulture de montagne et des régions chaudes; Environnement: climat et sol ; Système de culture, Rendement, Qualité ; Systèmes de Conduite; Nouveaux concepts et Technologies avancées en Viticulture, Viticulture Générale; Gestion des territoires. Viticulture durable; Académie de la Vigne et du Vin.

Cette réunion sera également l'occasion pour que les participants puissent connaitre les dernières avancées technologiques de l'industrie de la vigne et du vin Portugais et sa diversité, à travers des visites techniques dans la REGION DES VINHOS VERDES et la région de le HAUT DOURO VITICOLE, classé Patrimoine Mondial par l'UNESCO en 2001.

Dans ce colloque on désire aussi honorer le Prof. Rogério de Castro pour sa contribution à l'enseignement, de la Viticulture et de leur collaboration avec G*i*ESCO, raison pour laquelle ce jour et ouvert à la communauté scientifique et technique.

Saisissant l'occasion pour souhaiter la bienvenue à tous les participants, nous remercions à toutes les personnes impliquées dans l'organisation de cet événement, en particulier à Dra. Teresa Mota, Engª. Anabela Carneiro, à Engª. Susete Melo et Eng.º António Fonseca, les membres du Comité Organisateur et du Comité Scientifique par la révision des articles, ainsi que toutes les institutions et les entreprise que, d'une manière ou d'une autre, ont contribué à l'organisation de ce colloque.

Finalement, je remercie ma famille pour leur soutien.

Jorge B. Lacerda de Queiroz

Presidente da Comissão de Organização

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GRAPE COMPOSITION CHANGES DURING CONVERSION TO ORGANIC AND BIODYNAMIC CULTIVATION

VARIATIONS DANS LA COMPOSITION DU RAISINS PENDANT LA CONVERSION A LA VITICULTURE BIO ET BIODINAMIQUE

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SUMMARY

This study deals with the changes observed in the first year of conversion to organic and biodynamic cultivation in a vineyard growing Rhine Riesling and Pinot blanc grafted onto SO4 and trained using the simple pergola system in a hilly area in Trentino (Italy). Three farming methods were compared: conventional (CONV; chemical weeding under the rows, grass mowing between rows, mechanical topping and air-operated leaf removal, cluster thinning with gibberellic acid), organic (ORG; soil working under the rows, grass mowing between rows, rolling up the canopy along the furthest wire, air-operated leaf removal and hand fining) and biodynamic (BIOD; soil working under the rows, deep ripping between rows, side-shoot removal by hand, green manure in alternate rows, 2 soil treatments with horn manure 500, 3 leaf treatments with horn silicate 501).

The cluster weight, real fertility, yield/vine and Ravaz index were measured. Sugars, total acidity, pH, tartaric and malic acids, K and the assimilable nitrogen of grapes harvested from 10 parcels for each variety at ripeness were measured. In both varieties, BIOD farming showed a higher cluster weight, yield/vine and Ravaz index, while the differences between ORG and CONV were significant in terms of cluster compactness in both varieties and cluster weight and botrytis attack only in the case of Riesling. As regards grape composition, technologically speaking the main differences observed were in pH - slightly lower in the ORG and BIOD plots - and above all in yeast assimilable nitrogen (YAN), while no statistically significant differences were found for °Brix. ORG and BIOD grapes had half the YAN content of the CONV grapes.

RÉSUMÉ

Le travail concerne les changements observés au cours de la première année de conversion d'un vignoble de Riesling et de Pinot blanc greffés sur SO4 et conduit en pergola simple dans une zone de colline en Trentino (Italie). Trois méthodes de gestion ont été comparées: conventionnelle (CONV; désherbage chimique sur rang, enherbement entre les rangs, rognage mécanique et effeuillage avec effeuilleuse pneumatique, eclarissage avec acide gibbérellique –GA_3), biologique (ORG;, enherbement entre les rangs, enroulement des sarments sur le fil du haut, effeuillages mécanique et manuel) et biodynamique (BIOD; travail du sol en intercep, travail profond et engrais vert un rang sur deux, élimination manuelle des entrecoeurs, 2 interventions au sol avec 500 –buse de corne- e 3 interventions sur la végétation avec 501 – silice de corne.

Le poids des grappes, la fertilité réelle, la production par vigne et le rapport de Ravaz ont été déterminés. Au moment de la maturité des grappes, les sucres, l'acidité totale, le pH, l'acide tartrique et l'acide malique, le potassium et l'azote assimilable ont été relevés dans 10 parcelles par variété. Dans les deux variétés, la gestion biodynamique a montré un poids majeur des grappes, une production par vigne et l'indice de Ravaz plus elevés. Les différences entre la gestion biologique et la conventionelle ont été significatives pour la compacité des grappes sur les deux variétés et pour le poids des grappes et la présence de botrytis seulement sur le Riesling. Par rapport à la composition du raisin les différences plus importantes ont été observées pour le pH, légèrement plus bas dans les parcelles biologique et biodynamique, et en particulier pour l'azote promptement assimilable (APA) tandis que des diffèrences significatives n'ont pas été trouvées pour °Brix. Les raisins biologiques et biodinamiques ont révelé des contenus en APA réduits de moitié par rapport aux raisins traditionnels.

Keywords: organic, biodynamic, vineyard management, grape composition, yeast assimilable nitrogen
Mots clés: viticulture biologique, biodynamique, gestion du vignoble, composition du raisin, azote promptement assimilable

INTRODUCTION

Organic viticulture in Italia has been increasing in the last few years. In 2012, 52,812 hectares were cultivated using organic farming methods, according to surveys carried out (CE 889/2008 regulations). The increase as compared to the previous year was 1%, while the increase was 55.9% in comparison to 2005 and 69% in comparison to 2000 (official source: www.sinab.it). This data takes into consideration the total surface area already certified and areas undergoing conversion. It is more difficult to estimate the surface area of vineyards cultivated using the biodynamic method, as not all the vineyards using this system also adopt specific certification for biodynamic farming (Demeter or others), in addition organic certification. At all events, interest in this type of cultivation is increasing continuously.

The conversion process to organic and biodynamic grape-growing is lengthy and - if pesticide residues are excluded - the short-term effects on the composition of grapes and relative wines have not been fully explained. The effects of these cultivation systems on the quality of wine have already been the object of some studies (Dupin *et al*. 2000; Ross *et al*. 2009), but experimental *ad hoc* studies making it possible to compare three types of management systems - integrated, organic and biodynamic - are limited. This justifies the present work.

MATERIALS AND METHODS

Experimentation was begun in autumn 2011 in a hillside vineyard (280 m a.s.l.) belonging to the Fondazione E. Mach in San Michele all'Adige (Trentino, north-eastern Italy), adopting the simple Trentino pergola training system (2.8 x 0.5 m). The vineyard (1.83 ha) is cultivated with Pinot blanc (PB, 9600 sq. m, clones LB 16 and LB 18) and Rhine Riesling (RR, 8700 sq. m, clones 198-10 GM and 239-25 GM) both grafted onto SO4. For each variety, the experimentation took place on 10 parcels for management system (Table 1). The agronomic procedures applied in the experimentation and described below reflect what generally takes place in the process of conversion from conventional farming to organic or biodynamic farming in Trentino.

Conventional farming

The CONV system took place with chemical weeding under the rows, grass mowing between rows and fertilisation in spring (24 units of nitrogen/ha) with complex 12-12-17 fertiliser. Three chemical thinning treatments were carried out on PB, two with gibberellic acid (GA) 2,2 g/hl + naphthaleneacetic acid (NAA) 4,5 g/hl (3 and 17/5/2012) and one with only GA 1,4 g/hl (26/5/2012). Two chemical thinning treatments were carried out on RR with GA + NAA, using the same dosage adopted for PB (8 and 17/5/2012). 6 hl/ha were used for these treatments. Control of the vegetation took place with basal leaf removal using a pneumatic leaf remover (5/6/2012) and mechanical topping (16/7/2012). 12 treatments (from 28/4/2012) using 12 fungicides were carried out while no insecticide was used as sexual confusion against the grapevine moth was applied.

Organic farming

With the organic system (ORG) control of grass under the rows was carried out using mechanical means (Tournesol, Pellenc) on 2/7/2012, whereas between rows it was managed as for the previous system. No fertilisation was carried out in spring, 12 treatments were carried out using exclusively copper and sulphur. Leaf removal, carried out in the same period as for the previous system, involved the complete elimination of the leaves in the bunch area, in order to obtain a reduction in the compactness of the bunch. The ends of the shoots were not topped but rolled along the last wire of the pergola.

Biodynamic farming

For the biodynamic (BIOD) system, horn manure 500 was used three times (twice in spring, once in autumn) along with horn silicate 501 (once in May and twice in June) and autumn spring green manuring was carried out on alternate rows. The mixture was made up of graminaceous, leguminous and cruciferous plants. Weed control along the rows and pest control took place using the same methods adopted for the ORG system. To substitute topping, the vine shoots were rolled around the last wire of the pergola and basal leaf removal was substituted with elimination of the side shoots along the proximal and central part of the shoots.

Agronomical, chemical and statistical analysis

The following tests were carried out at the time of picking (PB, 3/9/2012; RR, 13/9/2012): assessment of the health and compactness of the bunch, yield per vine, average weight of bunch, fertility. The Ravaz index was determined at pruning time. The data for individual plants were used for statistical processing of the Ravaz index and the fertility index. At technological ripeness, thirty grape samples were harvested for each variety, ten for each type of farming (conventional, organic and biodynamic). Clusters affected by botrytis were not collected. The grapes were pressed, filtered on cotton wool, and analysed for the basic composition of the juice using a FT-IR Spectrometer (Grapescan 2000, FOSS, Hillerød, Denmark). Statistical analysis was performed with Statistica 9.0 (Statsoft Inc., Tulsa, OK), applying the Tukey HSD test ($p<0.05$) and using a univariate approach for each individual variety and type of farming as the source of variance.

RESULTS AND DISCUSSION

Agronomical results

The results of observations related to viticulture and yield are given in Table I. It is possible to note a higher yield per plant in biodynamic systems, determined in both varieties by a higher average weight per bunch. The number of vine shoots, the number of bunches and fertility were not significantly different. The Ravaz index is significantly higher with the BIOD system in both varieties as compared to the CONV system and in RR alone in comparison with the ORG system. The suspension of chemical weeding following the abandoning of conventional management systems

Table I Comparison of average agronomical and yield data at harvest, displayed by variety and type of farming. The same letter for the variety indicates no significant difference in content (Tukey HSD test, p<0.05).

Comparaison des données agronomiques et des rendements à la vendange par variété et par gestion. Même lettre par variété indiquent l'absence de résultats significativement différents (test Tukey HSD, p <0,05).

	Pinot Blanc			Rhine Riesling		
	CONV (N=10)	ORG (N=10)	BIOD (N=10)	CONV (N=10)	ORG (N=10)	BIOD (N=10)
First leaf unfolded (BBCH 11)	10/4/2012			16/4/2012		
Harvest date	3/9/2012			13/9/2012		
N° of vines	1881	1856	2043	1734	1677	1664
Area (sq. m)	2663	2598	2860	2428	2348	2330
Shoots/vine	10.3 ns	10.4 ns	9.9 ns	10.0 ns	9.3 ns	9.2 ns
Clusters/vine	14.0 ns	15.6 ns	14.4 ns	18.3 ns	16.8 ns	18.0 ns
Yield/vine (kg)	1.58 b	1.78 ab	1.94 a	1.47 b	1.51 b	1.77 a
Cluster weight (g)	113 b	113 b	133 a	81 c	91 b	99 a
Clusters/shoots	1.35 ns	1.49 ns	1.51 ns	1.84 ns	1.82 ns	1.98 ns
Pruning weight/vine (kg)	0.32 ns	0.31 ns	0.28 ns	0.37 a	0.32 ab	0.30 b
Ravaz index	5.76 b	6.54 ab	7.90 a	4.45 b	5.46 b	6.69 a
Compact clusters %	16.3 b	66.3 a	66.7 a	31.3 b	46.7 a	42.2 ab
Frequency of Botrytis %	0 ns	0 ns	0 ns	26 b	38 a	40 a
Severity of Botrytis %	0 ns	0 ns	0 ns	2.6 b	3.9 ab	6.4 a

led to changes in terms of yield. With the RR this was translated into a significant increase in the weight of the bunch with the ORG and BIOD systems, and in the yield per plant in relation to the BIOD system alone. In the case of PB, the 2 parameters mentioned were only significantly higher in the case of the BIOD system. With this variety drastic early leaf removal, only carried out in the case of ORG, led to a reduction in bunch weight. With the CONV system, chemical thinning led to a reduction in compact bunches, significant as compared to the ORG system for both varieties, and in PB alone as compared to the BIOD system. The carrying out of autumn-spring green manuring with the BIOD system did not lead to an increase in the vigour of the vegetation. Pruning weight was lower in both varieties, while only reaching a significant level as compared to the CONV system in the case of RR. For this variety the nitrogen added with the CONV system significantly increased vigour as compared to the BIOD system, but not as compared to the ORG system, which received no fertiliser and was not subjected to green manuring. In PB there were no significant effects on vigour which could be attributed to the presence of green manure or nitrogen fertilisation.

With the conditions in the trial year, characterised by the relatively scarce presence of rot, the health of the bunches was excellent in PB for all management systems. In RR, the management of botrytis was more problematical with the ORG and BIOD systems as compared to the CONV system.

Grape composition

Figure 1 shows the distribution of the basic composition data of must and the statistical significance of the differences between management methods measured within each variety. No differences emerged for any variety in relation to total suspended solids, while differences between management methods in terms of total acidity and pH were noted in the case of both PB and RR. Specifically, as regards pH, the trends were coherent in the 2 varieties, with the expected lowest levels in the case of RR. The BIOD and ORG systems, which could not be statistically differentiated, showed significantly lower levels than the CONV system. Potassium, tartaric acid and malic acid were shown to be significantly higher with the CONV system as compared to the other two only in the case of the PB variety, whereas no differences were observed in RR.

As regards yeast assimilable nitrogen (YAN), relatively low levels were observed, almost always <150mg/L, with the sole exception of PB CONV. The BIOD system was always significantly lower than CONV, whereas the ORG system, although it always had average levels lower than the CONV system in both varieties, was statistically differentiated from the latter only in the case of PB. In PB, YAN from amino acid – although higher than that from ammonia – is present in a lower percentage in the CONV system as compared to the other two. The differences observed in terms of higher total YAN values with the CONV system

may also have significant sensorial repercussions on the wines. Indeed, a difference of more than 100 mg/L in YAN between the systems is capable of influencing fermentative production by the yeasts

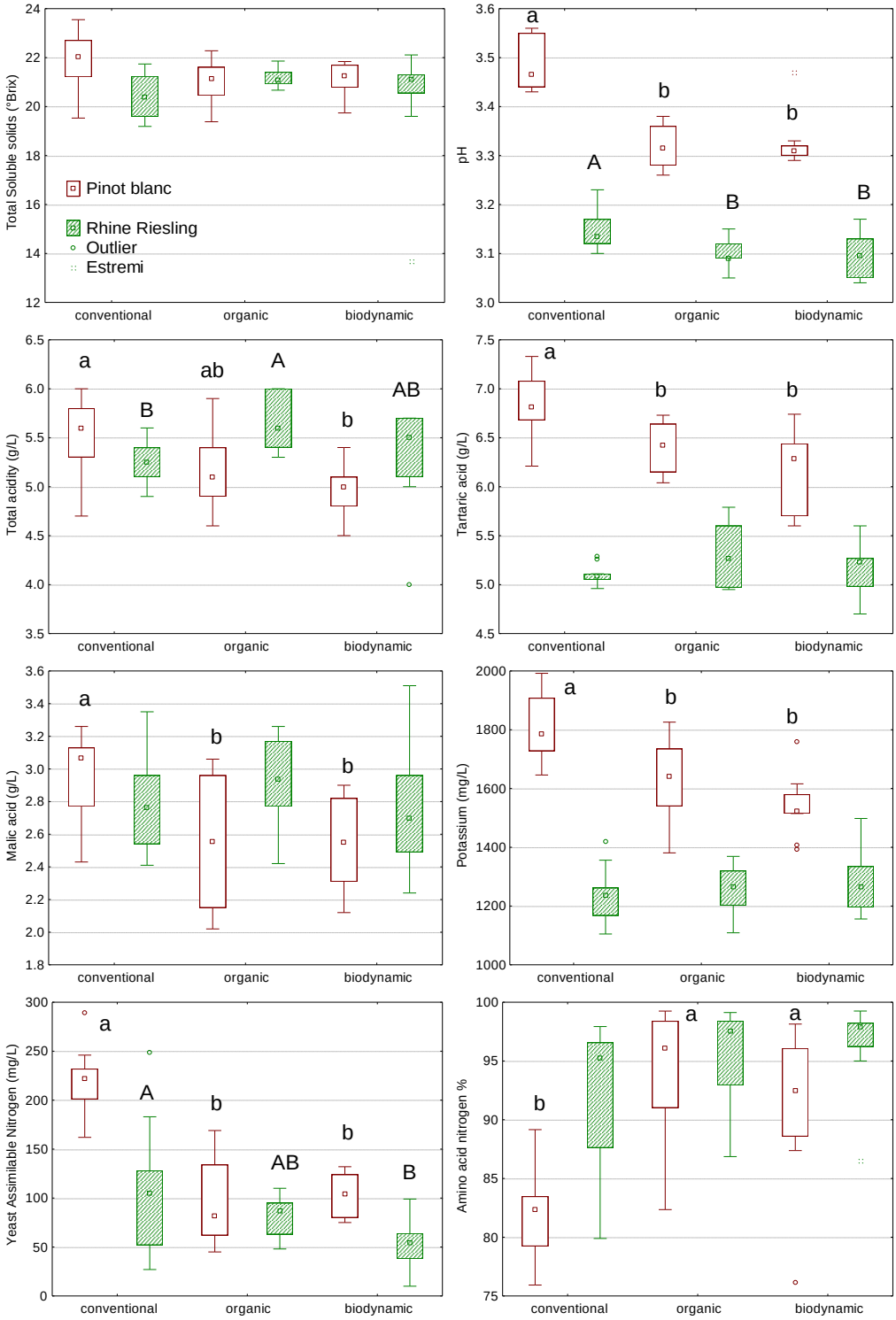

Figure 1 - Statistical distribution (median, 25th and 75th percentile, min-max, outliers and extremes) of grape composition parameters by variety and type of farming. The same letter (or no letter) for the variety indicates no significant difference in content (Tukey HSD test, $p<0.05$). Lower cases and capital letters refer to Pinot blanc and Rhine Riesling respectively.

Distribution statistique (médiane, 25eme et 75eme percentile, min-max, outliers et extrêmes) des paramètres de composition de raisin par variété et par gestion. Mêmes lettres (ou aucune lettre) par variété indiquent l'absence de résultats significativement différents (test Tukey HSD, p<0,05). Minuscules et majuscules sont référées au Pinot blanc e Riesling du Rhin, respectivement.

of fatty acid ethyl esters and acetates of higher alcohols, compounds responsible for the fruity notes of white wines (Nicolini *et al*. 2000), as well as of sulphur off-flavours. In effect, a reduced presence of YAN in ORG/BIOD farming had already been occasionally noted in Trentino in previous years, although not supported by statistical data. Specifically, observation of Pinot gris and Chardonnay in 2010-2012 would seem to confirm the tendency noted in this study, whereas no differences were observed in Gewürztraminer. One explanation for the reduction of YAN noted in BIOD juice could be the deep digging of the soil (50 cm) taking place with this system alone, to prepare for green manuring. This procedure could have caused partial destruction of the vine root system, which represents an important reserve of nitrogen for the reproductive and vegetative organs of the plant (Roubelakis-Angelakis and Kliewer, 1992). Another hypothesis is linked to the different shoot management adopted with the different methods. Topping of vine shoots was only carried out with the CONV system, whereas in the other two cases the shoots were rolled around the wire. The lack of topping led to fewer side shoots and a higher average age of the upper leaves with the ORG and BIOD systems, perhaps reducing the efficiency of the leaf system during the maturing of the grape bunches (Wermelinger and Koblet, 1990; Wermelinger, 1991). Although grapes clearly attacked by botrytis were not picked, the possible influence of botrytis in reducing YAN (Rapp, 1989) for the ORG and BIOD systems cannot be excluded, at least for RR.

CONCLUSIONS

It is clearly not possible to arrive at conclusive indications as regards conversion to ORG or BIOD farming after a single year, but some aspects worthy of further investigation over a longer period emerged. In general, the BIOD system showed a higher yield and bunch weight, a higher Ravaz index and a pruning weight tending to be lower than for the CONV system. With both the ORG and BIOD systems there was a larger percentage of compact bunches and a higher incidence of botrytis. The number of vine shoots and of bunches and fertility did not differ in the 3 systems.

As regards the composition of juice, the maintenance of lower pH levels with the BIOD and ORG systems in the face of insignificant changes in total soluble solids is particularly interesting. These levels can favour microbiological control of the fermentation and hydrolysis of the glycosylated aroma precursors during the wine ageing. On the other hand, some worries arise as regards these management methods in relation to the significant reduction in YAN, particularly for the consequences on winemaking.

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