Journal of Agricultural Sciences
Vol. 55, No. 2, 2010
Pages 195-215

DOI: 10.2298/JAS1002195S
UDC: 631.147
Review article

NATURAL PROCESS AND USE OF NATURAL MATTERS IN ORGANIC VITICULTURE

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Abstract: During recent years organic viticulture has been developing in the leading viticulture countries worldwide. The organic viticulture has been defined as the application of procedures of organic agriculture in view of increasing the production of top quality grape and wine. All the aspects of the organic viticulture such as cultivating and maintaining the soil, ground cover plants and weed control, balanced nutrition of grapevine, growing systems, disease and pest control are carried out in view of increasing the quality and health safety of wine and table varieties. When making a choice of a cultivar, there are two key factors: an economic indicator–market perspective and characteristics of a cultivar. Traditional varieties are in advantage in comparison to newly created ones, new preparations, improved computerised forecast models contribute to the efficient protection from disease and pests. New I.C./PIWI varieties must show tolerance to low winter temperatures and/or spring frosts, real commercial value through the quality of fruit, wine, juice or table grapes, tolerance to diseases and pests, balanced relationship between fruit and wood ripening. The aim of this paper is to present organic viticulture through integral agroecosystem and traditionally applied procedures in viticulture.

Key words: vineyard, *Vitis vinifera* L., soil maintenance, training system.

Introduction

Natural resources reflect life on our planet, but three main components such as air, water and soil have been polluted at unsuspected rate. The population worldwide has increased according to exponential function. During the period between 1990 and 2005, the world population increased from five and a half billion to six and a half billion people which is almost twenty percentage (De Žarden, 2006).

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In order to provide a quality life to such a great number of people, the existing environment must be preserved and protected. The terms ‘preservation’ and ‘protection’ include the acquired experience significant for our environment and forecasts/expectations of changes in far future along with conscientious and conscious monitoring of the process of production and processing of grapes, solid and liquid waste in wine industry. Today’s political and social issues, as well as the interest of researching organic viticulture reflect the fact that the European action plan incorporated in the national action plans that already exist, and it includes special research programmes for organic production (examples are: Germany: Federal Organic Farming Scheme BOEL; and Denmark: Danish Research Centre for Organic Farming DARCOF).

Organic viticulture has been developing in recent years in most EU member countries. It is still represented by a very low percentage, in average about 1.3% (Willer, 2008) in comparison to total surface under grapevine, and this percentage is expected to grow up to 5% in the near future. Grapes and wine are primary products, while vineyard pruning, stalks, marc (grape pressing: skin and seeds) can be categorised as secondary. These secondary products are precious material and may be used for composting, and edible oil may be produced by a special procedure as well as tannins and phenols from leaves and seeds that may be used in human medicine. Organic viticulture is defined as the application of the procedures of organic agriculture in view of producing top quality grapes and vine (Trioli and Hofmann, 2009). All the aspects of the organic viticulture such as canopy management, soil, diseases and pest control are conducted in view of increasing the quality and health safety of wine and table varieties.

Organic viticulture in the European Union is based on the Council Regulation (EC) 834/2007 containing the principles of organic production and general rules for production. The first steps in organic viticulture are made by Switzerland and Germany that invested great efforts in creating basic principles. At the very beginning, there was a great uncertainty with respect to the yield of grapes mostly due to downy mildew, which resulted in the stagnation of organic viticulture advancement. In 1977, the Association ‘Ecology and Agriculture’ (SOUL) organised the first meeting of the producers from Germany, France and Switzerland. The first standards for ecological grapes and wine of regional significance were established between 1983 and 1985 and were labelled as ‘produced organically’ (Willer, 2008). In Austria, private standards for organically produced wine were established in 1990, the National Federation for organic wine (FNIVAB) was established in France in 1998. Organic viticulture in Central and East Europe developed in early 1990. The first experiences in Serbia in the application of ecological preparations against downy mildew and powdery mildew date back to 1994 (Robotić et al., 1995).

A vine-grower with good monitoring skills represents a good base for understanding the complex of interactions that exist in a vineyard, around it and in nature. This understanding becomes a foundation for developing a system of organic production management. Some methods become a part of this system and may seem contradictory to conventional wisdom of growing numerous wine and table grape varieties. We know that the methods of organic production will improve natural resources, reduce potential pollution of air, water and soil, and in general contribute to human health through primary and secondary grape and vine products (Hofmann et al., 1995).

The objective of this paper is to present organic viticulture through an integral system of solar energy, nutrient in soil and water necessary to grapevine, with a final product being the reflection of terroir: a unique environmental whole (of hydrological conditions, soil, micro-climates) through traditionally applied procedures.

The significance of the increased number of plant and animal species in organic production

A conventional modern agriculture mostly contributed to the environmental protection crisis. Numerous researches confirmed the hypothesis that a decrease of number of species in agroecosystem results in the invasion of plant pests and parasites (Nicholls et al., 2008). Specialised harmful species usually survive in greater number in monoculture than in congregation communities of more numerous and various host plants (Andow, 1991). In a conventional production, a vineyard is treated as a monoculture endangered by different pests, parasites and weed species. Entomonofauna of grapevine is a various congregation of harmful and useful insects, predators, parasites and pests living in a close interaction with a climate, soil and vine (Altieri and Nicholls, 1999). The composition of the entomonofauna differs from region to region, however, in similar ecological conditions there are typical vine associated pests and typical vine associated predators. The researches of the role of predator species present in the European vineyards in reducing the population of economically important harmful insects such as flower thrips and berry moths were substantial. According to Robinson (1996), the most important issue in a sustainable agriculture is to maintain and/or expand biodiversity and the role that may be significant for the restoration of the ecological balance of agroecosystem in such a way to confirm a stabile production. Biodiversity acts differently on renewable processes and helps in agroecosystem through biological control, population regulation, source of natural enemies, pollination, nutrient cycling and disease suppression (Thies and Tscharntke, 1999). The organic system of growing should be a projection of nature in miniature (Zanetti et al., 2008). Owing to that, balance in agroecosystem is established and each participant contributes to its own preservation and the preservation of the whole. Or to put it more simply, in a community with the organic production there is no over-reproduction of one species at the cost of another, but there is enough space for the existence of every species and every unit. Such diversity may be established/incorporated in a vineyard and a stabile agroecosystem can be ensured. It is necessary to consider and understand what type of natural control is present and improve it.

The most favourable site and exposition of the terrain

Written data show that in Europe grapevine has been grown in river valleys, lake banks, sea coasts, at light slopes and moderately fertile soils as of the beginning of a new era until today (Galet, 2002). Vine has existed, developed for the full nineteen and a half centuries and the number of varieties has increased. It was a real organic production of grapes and wine in the full sense of today's term. Disease factors and harmful insects were brought from North America in the second half of the nineteenth century, having a negative impact on viticulture. The postulates that by that time were valid for a right choice of a site became even more significant. It was similar with the introduction and expansion of organic viticulture worldwide today. Most technical procedures that were refined in the organic viticulture originated in the conventional production (Willer and Zanoli, 2000). According to Tamm (1999), the producers of organic grapes and wine in Switzerland copied the best practices of the conventional production.

An ideal vineyard is lit by sunshine, with a continuous, moderate air circulation, soil of moderate fertility and good drainage characteristics (Vulić et al., 2004). The amount of sunlight falling on a vineyard depends on geographic latitude, season, time of day and cloud coverage. The intensity of sunlight expressed in photo-synthetic activity (PAR Photo-synthetically Active Radiation) during a day at full sunlight may be greater than 2000 $\mu Em^{-1}s^{-1}$, while in cloudy conditions it may drop below 300 $\mu Em^{-1}s^{-1}$. The leaves located in the centre of a vine canopies receive less than 10 $\mu Em^{-1}s^{-1}$ of sunlight, although the value above directly lit leaves remains 2000 $\mu Em^{-1}s^{-1}$. The reason for that is because grapevine leaves strongly absorb sunlight. Measurements showed that the first leaf in a shade under the leaf directly exposed to sunlight absorbed just 6% or 120 $\mu Em^{-1}s^{-1}$ (Smart and Robinson, 2008). Along with the light intensity, the quality of visible part of spectrum is also important: the proportion of red light (660 nm) to far red light (730 nm) declines in the canopy. The proportion of red light and far red light expressed through a phytochrome system acts on the synthesis of coloured matters in a berry. Along with variety, the microclimate of canopy and the applied viticulture practice result in differences in the composition and concentration of phenols (Downey et al., 2006). Phenols play a role of a natural sun shade in a berry and are an essential cofactor of colour improvement in grape and wine (Ristić et al., 2007; Downey et al., 2004; Spayd et al., 2002; Haselgrove et al., 2000). They are synthesised during the same process, as well as anthocyanins (Robinson and Davies, 2000). By means of simultaneous investigations in controlled and natural conditions, a group of scientists with Tarara et al. (2008) arrived at the conclusion that small deviations in sun radiation did not result in endangering the accumulation of total anthocyanins, but the combination of low light and high temperature when the total concentration of anthocyanins in a skin is reduced.

The precision in providing information at each moment and in each place give a new dimension to viticulture – precision viticulture (Proffitt et al., 2006). The first step in the application of precision viticulture is to recognise the variability in a vineyard, to determine the factors causing it as well as the possibilities of improvement. During the second phase, a great number of data is collected and processed on the basis of which we arrive at possible solutions. The assistance in choosing a site for vineyard is based on a three-dimensional modelling of soil, with the altitude, rock type or parent material, inclination, exposition of the terrain and it may be applied in small areas (Ferreiro-Armîan et al., 2006). The data combined with the registered coordinates of, for example, soil type, topography, direct sunlight radiation, and their local classification may be used for determining and regional zoning of viticulture significant factors, for example, favourable climate zone for varieties with late ripening or the zones with the best soil conditions (http://www.lwg.bayern.de/weinbau).

The most important prevention measures in the organic production are the measures for disease and pest prevention (Sivčev et al., 2010). A good viticulture practice tends to maintain moderate to low relative humidity of air in a vineyard during the vegetation. This is achieved by a correct choice of site (exposition, altitude) and row spacing, vine spacing, row orientation, training system, growth habit, balanced pruning, and maintaining soil in vineyard (Sivčev, 1998; Rombough, 2002; Sivčev et al., 2005). The requirements with respect to the selection of locality for a new vineyard for the organic production are similar to the ones when establishing a conventional production. A correctly selected site confirms the existence of healthy vine plants.

Maintaining soil and balanced nutrition of vine

The soil of a good structure enables the root to develop and penetrate to deeper layers for the purpose of providing water, nutrients and oxygen. Also, the soil of a good structure increases the number and diversity of organisms in the soil, decreases a development of harmful units and encourages the process of degradation of organic matters to minerals (Raičević et al., 2004). A well-balanced soil guarantees the survival of healthy plants – grapevine and its immediate surroundings. A sustainable organic mass is a leading factor for improving the structure and fertility of soil (Sivčev et al., 2006). The parts of the soil connected in such a way make a structural unity known as 'living aggregates' or 'clay-humus complex' which significantly limits: erosion, compactness of the soil through forming 'crust' and 'plough pans'. The organic matter also improves a water holding capacity of the soil, making water available to the plants and microfauna. A stable organic matter includes the energy and it represents a source of nutrients for soil microorganisms that degrade and transform the organic matter by normal metabolism (Wilkinson and Biala, 2001). A contemporary interpretation starts from a complex term 'soil management' which means the optimal use of its biomass. It includes a timely biodegradation with the maintenance and continuous creation of high quality humus (Suchde and Suchde, 2000). Epidermal cells of the vine root in rhizosphere make secretions and in such a way enrich the soil with carbon which has an additional impact on the biodiversity of microorganisms. The components of the root's escudate (amino acids, sugars, organic acids and polysaccharides) attract numerous parasites, pathogens and rhyzobacteria (PGPB) (Mc Gourty and Reganold, 2005). A higher amount of the accumulated humus provides the balance of elements available to all units of this unique community (White, 2003). The creation of a fertile soil is the basis for the organic system and provision of organic matter, and perhaps the most important factor for preserving the fertility of soil. It means that the biodiversity of microorganisms, plant nutrients, sustainable water capacity, stability of aggregates, control of soil erosion depend on the quality and quantity of the organic matter in the soil (Kandeler et al., 2005).

The organic viticulture is based on the living 'soil' sustainability of soil and preservation of its resources. The main sources of improvement and preservation of the soil fertility are: maintain or improve the contents of the organic matter/humus, increase the population and the activity of microorganisms through a good balance of microflora and fauna of the soil, maintain the stability of the aggregates of the soil structure, maintain the soil covered (occasionally or continuously) with plants in view of reducing erosion, enable the application of mechanisation and avoid the compression of the soil, enrich the soil with (macro and micro) nutrients (Hofmann et al., 1995; Boller et al., 1997; Bugg and Waddington, 1993). Organic viticulture and most of its techniques have a lot of novelties that may be applied in the conventional production (Fragoulis et al., 2009). In the first place it is the nutrition of the grapevine. The requirements of the grapevine regarding nutrients in the conventional production are comparatively modest and they depend on the yield and cultivar components. The preservation and improvement of the quality and productivity of the soil represent a basis for sustainable agriculture. The remains of the grapevine: fallen leaves, rejected young branches after pruning, rare fruit-clusters and/or berries, the remains of the root, aboveground and underground remains of weeds, secretions, remains of the animal origin represent the source of organic matter for heterotrophous microorganisms. Table 1 shows the supply of nutrients in 20 m^3 of compost which is sufficient for the vine when applied every second or third year, other than nitrogen. The calculation has been made on the basis of the average yield of grapes of 10 t/ha* and 2.7 t/ha* of the cane pruning weight or vegetative yield cutting (Biala, 2000). Nitrogen, being insufficient, may be compensated in the first place from the air since at the annual level it amounts to 30-50 kg/ha or through the mineralisation of spare humus in the soil.

Table 1. Availability and supply of nutrients in 20 m^3 volume of compost of the average quantity of biowaste of compost in comparison to vine requirements for nutrients.

Nutrient	Nutrient concentration (% dm)	Nutrients available to plants in kg/ha (Percentage of total)		Nutrient demand of grapevine* in kg/ha per year
		In first year	Within four year	
N	1.2	10-20 (10-15%)	approx. 50 (approx. 40%)	45-80
P_2O_5	0.7	20-30 (30-40%)	70 (100%)	16-23
K_2O	1.2	70-100 (65-85%)	120 (100%)	83-100
MgO	1.8	10-30 (5-15%)	?	10-151
CaO	6.0	sufficient	sufficient	15-40

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Hofmann (1998) states that the relationship of 1:4 between a vegetative yield cutting and the yield of grape is ideal. The researches included two sites with two most represented wine varieties of Riesling and Mueler-Thurgau in Germany. Biala (2000) took into account several results and showed the average value of the vegetative yield and grape yield obtained from Europe and Australia. Microorganisms present in the compost degrade organic matter and by its activity and enzymes created during these processes contribute to easier absorption of nutrients by vine and other plants.

The microbiological biomass leads to the improvement of natural fertility of soil, and plants are healthier and more tolerant to parasites and pests (Raičević et al., 2004). The compost has shown to have a positive effect not only on the vine growth, but on the quality of grapes as well. In the indirect way, the compost improved the humidity regime of the soil, prevented the stress due to the lack of water and reduced the level of amino acids in must, which according to Wagenitz (1995), may cause problems in fermentation and decrease a flavour of the wine.

A significant measure for increasing the contents of the organic matter is the cultivation of cover plants in a vineyard. We use the term ‘cover crops’ which is more extensive than “grass cover or green cover including” precisely only the varieties of the family *Poaceae* L. Cover crops in a vineyard prevent the soil from degradation caused by sunlight or erosion. The contribution can be also seen in the creation of numerous channels in the soil and the improvement of water and heat regime (Sivčev, 1988). The ecological quality of agroecosystem ‘vineyard’ is determined by the quality of cover crop and represents a whole. The strategy of a continuous green cover or alternative shift in Germany and Switzerland was first applied in the early nineties of the last century (Boller et al., 2004). The results of the research of the application of cover crop management in different viticulture areas ranged from contrary to very similar ones. It was also very important to align the differences in climate conditions and the types of soil and in that way take into account the possibilities of the application of a permanent or temporary cover crop in a vineyard. Cover crops should improve the soil structure and maintain humidity that should be continuously available to the root, enable a greater biological activity to earthworms and microorganisms as well as the availability of nutrients, both to them and to the vine, adjust the nutrition of vine to its growth and pruning measures, and by choosing a sowing time for the seeds encourage the fixation of nitrogen from the air (seeding herbs and nitrogen fixing plants) as well as to support and stabilise the fauna in a vineyard ecosystem (White, 2003). Among herbaceous species, excellent results were achieved with the species from the family of legumes, grasses and cabbage (*Leguminoseae*, *Gramineae* and *Brassicaceae*). Cover crops in a vineyard contribute to the expansion of biodiversity according to Robin (2006) and establish a favourable balance between the present pests, parasites, predators and natural enemies, which makes the base for the application of pest management. Darnell (2006) recommends a greater number of woody plants for planting near vineyards that are tolerant to drought and with the same objective: to increase biodiversity. Woody plants in the immediate vicinity of a vineyard are attractive, particularly at the time of nectar secretion when they attract useful parasites, predator populations and pests. The Regulation EC No 834/2007: Article 12 (b) stipulates that “the fertility and biological activity of the soil shall be maintained and increased by multi-annual crop rotation including legumes and other green manure crops”.

The presence of weeds among the rows is minimal due to the presence of temporary or permanent cover crops. Weeds are thus more represented in the rows and the application of chemical herbicides is forbidden in organic viticulture. Agricultural practices are recommended, as follows: mechanical removal or seeding plants with a very low potential of growth that leave mulch after cutting. Guerrini et al. (2008) recommend a biodegradable mulch film 'Mater-Bi®, Mater-Bi' being compostable plastic with waste plant material – biodegradable and compostable plastic that contains vegetable raw materials such as maize starch modified with biodegradable polyesters. A biodegradable film may reduce the increase of weeds during 12 months. A more rapid growth of the vine may be the result of a faster heating of the soil (black film), a better supply of water and reduced competition between the vine and weeds (Sivčev, 1985; Guerrini et al., (2008). The control of the vegetative increase in a vineyard reduces the effect caused by the competition between the vine and other plants with respect to water. Trioli and Hofmann (2009) see as one of the solutions for suppressing weeds in a row: alleolopatic relation between the plants. Some plants excrete certain chemicals that may prevent or significantly reduce germination and/or development of other plants. The most interesting among them are the species mouse ear hawkweed *Hieracium pilosella* and cheatgrass brome *Bromus tectorum* L. They are particularly interesting in arid climate conditions because they have semi-dormancy period during summer when the stress due to lack of water in vine is rather high.

Resistant and tolerant varieties and bases

All traditional varieties originating from the species *Vitis vinifera* L. are susceptible to fungal diseases that were brought to Europe from North America. The creation of the varieties tolerant to fungal diseases was initiated in France by the appearance of phylloxera *(Dactylosphaera vitifolli* Shim.*)* in Europe at the end of the 19th century. Since then, 126 years have passed and breeders from different European countries tried to combine the characteristics of resistant varieties, and these were the characteristics of the species originating in America and Asia with quality characteristics of traditional European varieties. Wine obtained from grapes of the first hybrids fell behind in quality, but later on, owing to hard work, new 'interspecific crossing' – I.C. brought certain novelties and improvement. The first hybrids were obtained by direct cross-breeding of the species originating from *Vitis vinifera* and the American species that is why they have a prefix 'direct'. (Stojanović and Toskić, 1948; Csizmazia, 1977; Eibach, 1994; Avramov et al., 1997; Boubals, 1994; Reisch and Pratt, 1996; Galet, 2000; Hajdu, 2000; Serot et al., 2001; Basler et al., 2002). The wish of the Europeans to preserve the varieties of noble vine with recognisable sensory characteristics of wine was very strong, and a quick solution was found in grafting. About half a century before such a dramatic event for Europe, the first data on the first selectioners were recorded in

North America. They selected wild forms of the vine and introduced it in a commercial production. One of the most important breeders was T.V. Munson from Denisson. He described in detail the varieties resulting from the species *V. labrusca* L.*, V. aestivalis* Michx.*, V. rotundifolia* Michx.*,* made over 60 new table varieties by cross-breeding with *V. cancdicans* Engelmann, *V. champini* Planchon, *V. lincecumi* Buckley, and pointed out the significance of complex cross-breeding and identified the optimal solution of tolerance to pests and diseases and the quality close to *vinifera* varieties (Munson, 1909). The varieties Concord (*V. labrusca* L.), Catawba and Izabela, (*labrusca-vinifera*) are the varieties that are still grown in the North American continent out of numerous species from that period. The vine selection centres in North America are numerous and adapted to given conditions: Cornell University in New York, University of Minesota, University of California-Davis, USDA-ARS Geneva, NY, USDA-ARS Parlier, CA, University of Georgia (muscadines), Florida A&M University (muscadines and florida bush grape, the University of Arkansas and University of Guelph Vineland, Ontario (Owens, 2008). Owing to that, the organic production of grapes was initiated with hybrids and the encouraging results contributed to the expansion of traditional *vinifera* varieties (http://www.ngr.ucdavis.edu/).

The share of hybrids, according to Galet (2002) versus the total surface under vine in France in 1958 accounted for almost 30% to drop to only 1.77% in 1999. In Europe, the work on selection was continuous and brought good results. France was followed by Italy and Germany, and according to the international catalogue, around 5,800 selected varieties were created as a result of interspecific crossing, which makes more than 30% of all varieties recorded in the data base (http://www.genres.de/db/vitis/vitis.htm).

Albert Seibel (1844-1936) was one of the most fruitful breeders. The main objective of the selection was to make a cultivar resistant to phylloxera, and he created more than 1,500 new varieties. The variety ‘Plantet’ known as ‘5455 Seibel’ was most frequently represented interspecies variety in the second half of the twentieth century. In 1999, there were around 2,070 ha in France (Galet, 2000), and in 2002, around 200 ha under this variety (Final report, 2003). However, the percentage of surfaces under hybrids in Europe was and remained low, and it is estimated to be 1-5% versus total surfaces under vine. Selectioners of vine rootstocks, a strong development of chemical industry and production of fungicides contributed to this all in view of preserving the varieties of noble vine. Recent researches pointed to the complexity of inheriting tolerance to fungal diseases and quality of grapes and thus to the selection processes. The published results Breider (1964) aroused vine growers and consumers: wine obtained from interspecies varieties contained components harmful for human health. This postulate is not scientifically based, and several scientists denied it by their results (Leuschner and Leuschner, 1966; Stoewsand et al., 1969). However, the connotation remained negative.

The selection programmes were redirected in many countries at the end of the sixties. Germany, Austria, Switzerland and Hungary continued with those programmes, and the Balkan countries joined them subsequently: Romania, Bulgaria, Greece and Serbia (http://www.sorte.minpolj.sr.gov.yu). Reverse cross-breeding with the varieties *Vitis vinifera* led to decrease and elimination of a ‘wild’ flavour and preservation of tolerance to diseases. Those new tolerant varieties actually were not ‘interspecies varieties’ because they carry a greatest genetic part of *Vitis vinifera*. Thus the cultivar Regent [Geilweilerhof 67-198-3: Diana (Silvaner x Muller-Thurgau) x Chamborcin)] was recorded in the Registry of varieties *Vitis* international variety catalogue http://www.genres.de/idb/vitis/vitis.htm as *Vitis vinifera* because in its genetic base it contains 87.5% of noble vine and 12.5% originating in ‘interspecific crossing’ – I.C. The abbreviation PIWIs originates from Germany (from the German expression ‘pilzwiderstandsfähig’ = apt to resist fungi) which denotes the varieties resistant to fungal diseases.

By comparing the data available in the collections worldwide, 3249 I.C. varieties or 56% of varieties account for newly made varieties (Final report, 2003). Growing interspecies varieties is one of the ways to reduce the application of pesticides in view of protecting the vine from pests and diseases. It is not real to expect that the whole organic production of grapes and wine will be based on interspecies varieties. It is envisaged that in 2020, the share of the organic production of grapes would account for between 5 and 20% in the world, and about 10% versus the total area under grapevine in Europe (Final report, 2003).

One of the principles of organic viticulture is the selection of varieties, species and rootstocks that are distinguished in terms of adaptability to climate conditions and general agricultural conditions. It is a good choice of local autochthonous (indigenous) varieties having a great inherited resistance to main patogens and pests (Trioli and Hofmann, 2009). The results of Borgo et al. (2009) point to great differences in susceptible to diseases among 210 monitored varieties and support the findings of Trioli and Hofmann (2009). In 2008, the conditions were favourable for the development of downy mildew and the ampelographic collection in two sites in the region of Veneto was not protected. The varieties of local significance such as Aglianico, Fiano, Refosco, Terrano, Riesling Renano were less damaged by downy mildew in comparison to the varieties Merlot, Negroamaro, Malvasia nera, Corvina, Cabernet franc and Pinot. Most of the species showed moderate susceptibility.

Table 2 shows the estimation of resistance of varieties that are usually grown in Austria, Switzerland and East Europe, according to Breeders’ data.

Table 2. Resistance - disease tolerant I.C./PIWI varieties.

Colour	Variety	Resistance *Peronospora*		Resistance *Oidium*		Resistance		
		Leaf	Grape	Leaf	Grape	Coulure	*Botrytis*	Cold
Red	Baco noir	good	good	good	good	---	---	---
Red	Baron	good	good	good	good	medium	---	---
Red	Cabernet Carbon	very good	very good	medium	medium	very low	---	---
Red	Cabernet Carol	very good	very good	good	good	very low	---	---
Red	Cabernet Cortis	very good	very good	good	good	low	---	---
Red	Cabernet Jura (VB 5-02)	very good	very good	very good	very good	---	very good	very good
Red	Cabertin (VB 91-26-17)	good	good	good	good	---	good	very good
Red	Chamborcin	good	good	good	good	medium	---	---
Red	Chancellor	very good	very good	very good	very good	low	---	---
Red	De Chaunac	medium	medium	medium	medium	medium	---	---
Red	Landal	medium	good	good	good	low	---	---
Red	Leon Millot	medium	good	good	very good	low	---	---
Red	Marchechal Foch	good	good	good	very good	low	---	---
Red	Monarch	good	good	medium	medium	low	---	---
Red	Pinotin	good	good	good	good	---	good	very good
Red	Plantet	good	good	good	good	---	---	---
Red	Prior	very good	very good	very good	very good	very low	---	---
Red	Regent	low	good	good	very good	medium	---	---
Red	Triumph von Elsass	---	---	---	---	very high	---	---
Red	VB 91-26-4	good	good	good	good	---	good	very good
Red	VB 91-26-5	good	good	good	good	---	---	good
White	Bianca	good	good	good	good	strong	---	---
White	Broner	good	good	good	medium	weak	---	---
White	Cabernet Blanc (VB 91-26-1)	good	good	good	good	---	good	good
White	Helios	medium	good	very good	very good	low	---	---
White	Johanniter	medium	good	good	very good	low	---	---
White	Merzling	medium	medium	medium	medium	medium	---	---
White	Orion	medium	medium	medium	medium	medium	---	---
White	Phoenix	very good	very good	very good	very good	medium	---	---
White	Saphira	medium	medium	good	good	low	---	---
White	Seyval blanc	medium	good	good	very good	low	---	---
White	Sirius	good	good	good	good	---	---	---
White	Solaris	medium	good	very good	good	low	---	---
White	Soleil blanc	good	very good	very good	very good	low	---	---
White	Staufer	good	good	good	good	medium	---	---
White	Vidal blanc	medium	good	very good	very good	low	---	---

Source: PIWI-International (http://www.piwi-international.org/index.htm)

The estimation has been determined in natural conditions and expressed in 5 levels: very low, low, medium, good and very good; --- no declaration available. When choosing varieties, two factors are important in general: economic indicator – market perspective and characteristics of varieties. Traditional varieties have an advantage over newly-made ones and new preparations, improved forecast models contribute to a more efficient protection from diseases and pests. New I.C./PIWI varieties must show tolerance to low winter temperatures, and/or spring frosts, a real commercial value through the quality of fruit, wine, juice or table grape, tolerance to pests and diseases, a balanced relationship between the ripening of fruits and vine plant. The estimation of resistance shown is the estimation of breeders themselves (Trioli and Hofmann, 2009). The estimation confirmed in field monitoring and made at five levels of resistance is more objective in a certain sense. However, the shown results, irrespective of how big they are, actually refer to a small number of varieties in some area.

The number of varieties grown worldwide amounts to around 1,100 varieties (http://www.vivc.bafz.de/index.php). The greatest areas under vine are covered by about forty wine varieties, and about 20 varieties cover 87% of vineyard regions in France. There are around thirty table varieties worldwide, including seedless ones. The list of varieties in Serbia is also extensive, with ten dominating varieties.

The organic production of grapes along with the indicated advantages contributes a lot to the improvement of biodiversity by introducing the varieties of local significance (Borgo et al., 2009) and interspecies varieties because they represent a source rich in genetic potential (This et al., 2006) in the production.

Pruning and training systems

A vineyard production potential depends on vine growing systems. Differences in the production surfaces of vine plants, arrangement of leaves and relationship of developed and young leaves, grapevine canopy are the result of a unique reaction between the structure of leaves and life environment of the vine. Those interactions contain specific physiological responses both by leaves and by external conditions. The leaf function is the result of both internal and external conditions during its development and growth (Baeza et al., 2005). Mesoclimate and microclimate of one training system in physiological sense is unique and it is difficult to compare it with the achieved results in some area. On the other hand, the unique requirements in all regions where vine is grown are to improve the quality of grapes and reduce production costs, costs of trellising system, and to adjust the production to the basic principles of canopy management from moderate to hot climate (Hunter and Archer, 2001a, b). There are recordings that pruning was performed in ancient vineyards in the Middle East, Greece and Rome (Winkler et al., 1974). Today, most training systems are faced with difficulties in regions where the systems were established (Reynolds and Vanden Heuvel, 2009). One of the first projects on the organic production of grapes [Forecología, Lehrmaterial für Ökologischen Weinbau, Leonardo da Vinci (ES/03/B/F/PP-149080)] started from the following issue with respect to protection of vine: to prune or not to prune vine. The answer may be found in the first growing systems: they were intended to keep the fruit from not touching the ground and thus facilitated the harvest (Winkler et al., 1974).

All the aspects relating to the growth of a vine plant, development, harvest, fruit composition may depend on modifications of the training system. The total yield and fruit composition vary and depend exclusively on photosynthetic activity of leaves. Numerous researches showed that the temperature of a leaf, light in the given conditions or environment, direction or age of leaves have a strong impact on photosynthesis (Poni and Intrieri, 2001). The interval between 7 to 14 cm^2 of total leaf surface per gramme of fruit is necessary for the achievement of a ripe fruit according to Howell (2001). By applying several training systems and different measures of green pruning, Dokoozlian and Kliewer (1995) found out that the proportion of a threshold of leaf area and the fruit mass depended on the relationship of exposure/non-exposure of leaves to direct sunlight, which is the reflection of a training system. Howell (2001) includes the data from different parts the world and varieties originating in North America and Europe and points out that the selection of a training system has a dominant influence on the level of a sustainable productivity of ripe grapes. A training system including a greater percentage of several years old vine plants has a favourable impact on the yield, size of a vine plant, fruit composition and resistance to winter hardiness during winter (Howell et al., 1987, 1991). The sphere that would be subject to greater attention than it was at the time when Howell (2001) published his work on a sustainable production of grapes and the proportion of increase/yield is the scenario on global heating. Howell (2001) states two reasons: extreme variability of meteorological indicators during a season and less possibilities for pest and disease control. The results of Vuković et al. (2009) and Jones et al. (2009) confirm Howell’s conclusions.

Smart and Robinson (2008) reviewed a microclimate of a vine plant through and numerous measurements confirmed most of the conclusions arrived at traditional viticulture regions. Thus the balance of a vine plant expressed through the yield of grapes and vine yield to pruning weight for *vinifera* varieties amounted to between 10 and 12 (Bravdo et al., 1985) or 5 and 10 (Smart and Robinson, 2008). Ravaz index between 12 and 22 did not have a negative effect on the yield of variety Cabernet Sauvignon at the beginning of fruit yield age, in the current year according to the results achieved by Vanden Heuvel et al. (2004). One of the novelties in the work of Smart and Robinson (2008) was a definition of vine yield. The term ‘vine yield’ means a series of processes that take place during the period of around 17 months before harvesting. All these processes are the reflection of a shade in a training system and may take place independently (Smart and Robinson, 2008). The formation of reproductive organs in grapevine is a complex phenomenon, and it takes place during two successive years and it is interrupted by bud break in the moderate climate zone. The success of a reproductive process in grapevine depends on available sugar, and other nutrients such as nitrogen may improve it (Duchêne et al., 2003). There are two crucial steps in the formation of reproductive organs in optimal conditions according to Lebon et al. (2008). The first step, a physiological status of a plant at the moment of the initiation of the primordial inflorescence is during summer preceding inflorescence and regulates the number of inflorescences that will develop the next year. The second step, the content of sugar in the whole plant at the time of bud break probably participates more in the control of number of flowers in each inflorescence. Irrespective of the number of inflorescences per plant and number of flowers per inflorescence, a fruit set remains a constant for the same variety when there is no stress during a development of reproductive organs. Female meiosis according to Lebon et al. (2008) must be identified as the third crucial element in the reproduction depending on the stress in living environment.

New researches contributed to a better understanding of the complexity of processes taking place on a vine plant. The absorption of light by leaves and fruits in ultra-microclimate is the result of a training system, it contributes to a good composition of a fruit and sensory characteristics of wine. According to Reynolds and Vanden Heuvel (2009), extensive researches of training systems should be directed to the optimisation of yield and quality of fruit. The training system includes the number of buds per vine to live after winter pruning. A rule established in certain climate conditions for a certain variety and base may be just partially applied in some other site or climate (Petrović et al., 2007).

General rules include three propositions and they are applied to organic and conventional production: the first refers to vine vigour, which is the number of buds left on the vine after pruning, and which increases yield and reduces vigour. The number of left buds, obtained by the research is arranged for the purpose of achieving ideal shoot size, yield, fruit quality, and vine health. It is well-known that an excess of vigour can compromise the quality potential of grape (Schneider et al., 1992). Vigour management is currently one of the major problems that are not simple to solve due to poor understanding of the physiological mechanisms involved (Corino and Caló, 2001). The second is for over cropped or small vine plants with weak growth, the objective is to leave fewer buds to obtain ideal shoot size, yield, fruit quality, and vine health. The third is for vine plants with perfect size shoots, good yield, high quality fruit, it is necessary not to change the number of buds as well as prunings. These vine plants will bear optimum tonnage and fruit quality while sustaining healthy vine plants for a long period of time (Mc Eachern and Sivcev, 2006).

Conclusion

The most important thing in a sustainable agriculture and thus in organic viticulture is to preserve, and/or expand biodiversity. The biodiversity through biological control, population regulation, expanded source of natural enemies, pollination, nutrient cycling and disease suppression assists in the restoration of agroecosystem. A good viticulture practice tends to maintain moderate to low relative humidity of air in a vineyard during the vegetation. The efficiency of preventive protection measures against pests and diseases is thus guaranteed. This is achieved by a correct choice of site (latitude, altitude, exposition) and the row spacing, vine spacing, row orientation, growth habit and training system, balanced pruning and maintaining soil in vineyard. The organic grape production should be used in case of traditional varieties and along with a good viticulture practice to include the preparations obtained from natural products and biological preparations, together with the preparations based on sulphur and copper. It is evident that the best choice is the choice of local autochthonous (indigenous) varieties because they have a great inherited resistance to main pathogens and pests. We arrive at the conclusion that the basic principle of organic viticulture is the choice of varieties, species and bases that are adapted to and that correspond to climate conditions and general agricultural conditions. Varieties resistant or tolerant to most frequent diseases in the area could be chosen if they are still in accordance with the production and market requirements.

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Received: February 16, 2010
Accepted: November 11, 2010

ORGANSKO VINOGRADARSTVO ZASNOVANO NA PRIRODNIM PROCESIMA I UPOTREBI PRIRODNIH MATERIJA

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R e z i m e

Organsko vinogradarstvo je u porastu poslednjih godina u vodećim vinogradarskim zemljama u svetu. Organsko vinogradarstvo definiše se kao primena postupaka organske poljoprivrede u cilju povećanja proizvodnje grožđa i vina najboljeg mogućeg kvaliteta. Svi aspekti u organskom vinogradarstvu kao što su obrada i održavanje zemljišta, pokrovne vrste u vinogradu i kontrola korova, izbalansirana ishrana vinove loze, sistemi gajenja i kontrola bolesti i štetočina se sprovode u cilju povećanja kvaliteta i zdravstevene bezbednosti vinskih i stonih sorti. Pri izboru sorti, ključna su dva faktora: ekonomski pokazatelj – perspektiva na tržištu i karakteristike sorti. Tradicionalne sorte su u prednosti u poređenju sa novostvorenim, nova sredstva za zaštitu, poboljšani modeli za prognozu doprinose efikasnijoj zaštiti od bolesti i štetočina. Nove I.C./PIWI sorte moraju da ispolje tolerantnost na niske zimske temperature i/ili prolećne mrazeve, realnu komercijalnu vrednost kroz kvalitet ploda, vina, soka ili stonog grožđa, tolerantnost na bolesti i štetočine, skladan odnos između sazrevanja plodova i drveta. Cilj ovog rada je da organsko vinogradarstvo prikaže kroz integralni agroekosistem i tradicionalne postupke u vinogradu.

Ključne reči: vinograd, *Vitis vinifera* L., održavanje zemljišta, sistem gajenja.

Primljeno: 16. februara 2010.
Odobreno: 11. novembra 2010.

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