EFFECTS OF DIFFERENT FUNGICIDE TREATMENTS ON GRAPE, MUST AND WINE QUALITY

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SUMMARY

The aim of this study was to evaluate the effectiveness of natural products and low-rate copper formulations against grapevine downy mildew, in order to reduce or replace copper use in organic farming, and to assess the effects on the qualitative parameters of grape, must and wine of the different treatments.

The trial was carried out in an organic vineyard in accordance with the EPPO/OEPP guidelines. Plots were prepared, each containing 12 vine-plants and repeated four times in randomized blocks.

At harvest, representative grape samples were picked off from the plots treated with the different products: for each treatment, a random sub-sample was kept for analyses, the remaining part was processed to produce wine. Grapes, musts and wines were characterized for their food quality indices, as well as for their nutraceutical profiles and antioxidant activity. On must and wine, sugars, acidity and pH were determined according to official methods. On grape and wine, total polyphenol, flavonoid and hydroxycinnamic acid contents were determined by spectrophotometric analysis, as well as antioxidant activity tests. Organic acids and single polyphenols were also determined by HPLC.

The results of the trial, characterized by moderate infection pressure, indicate that all tested products guaranteed a satisfactory control of *Plasmopara viticola* although the alternatives to copper were not as effective as copper. Data evidence that grape quality and its oenological potential were not significantly influenced by applied treatments and that they did not significantly differ in comparison with the untreated control, only with an interesting significant negative correlation between proanthocyanidins level and the severity of disease on ripe berries.

The uniformity of data seems to evidence a general adaptation of plants to different treatment stresses, probably due both to low input of active ingredients and to moderate downy mildew infection.

Key words: copper, *Plasmopara viticola*, organic vineyard, phytochemicals, antioxidant compounds

INTRODUCTION

Copper is an essential natural micronutrient. It is involved in fundamental biological processes including photosynthesis and respiration (Van Assche and Clijsters, 1990; Harrison *et al*., 1999). However, high concentrations of copper can have deleterious effects due to its accumulation in the soil (Geoffrion, 1975; Fernandes and Henriques, 1991; Balsberg-Pahlson, 1989; Rhoads *et al*., 1989; Deluisa *et al*., 1996; Giller *et al*., 1998; Moolenaar and Beltrami, 1998; Brun *et al*., 2003; Scaglione *et al*., 2008). The level of copper found in the soil is increased when it is used to control plant diseases, specifically *Plasmopara viticola* (Berk. and M.A. Curtis) Berl. and De Toni.

Since the use of copper is incompatible with organic farming's philosophy of environmentally friendly farming the European Union fixed a ceiling of permitted copper quantities to a maximum of 6 kg per hectare per year in organic farming (Regulation EC 473/2002). The European

Commission plans to review copper authorisation, in the light of new developments and evidence, regarding a possible further restriction of allowable copper quantities and for possibly banning the use of copper in organic farming.
In order to find appropriate alternative solutions to copper, several research programs have been carried out (Tamm *et al*., 2003; Wang *et al*., 2004; La Torre *et al*., 2005; Thüerig *et al*., 2006; Sivčev *et al*., 2010) but at the moment, copper is still essential for the cultivation of a wide range of plants.
Grape berries and wine, are generally considered as healthy-promoting food products. Health benefits seem to be related to the presence of phenolic compounds which act as antioxidants or free radical scavengers (Sanchez-Moreno *et al*., 1999; Pratt, 1992). Moreover, the presence of phenolics can be considered as a quality index for grape, that can be subjected to variations in order to pre-harvest factors, such as fungal diseases (Mercier, 1997).
The purpose of this study was to evaluate the effectiveness against grapevine downy mildew of natural products and low-rate copper formulations. Besides evaluating the possibility of replacing or reducing the use of copper, our aim was also to assess the effect of the different treatments on the qualitative parameters of grape, must and wine.

MATERIALS AND METHODS

Experimental conditions

The field trial was carried out on grape (*Vitis vinifera* L.) in an organic vineyard near Rome (lat. 41.4°N, long. 12.3°E, 180 m a.s.l.). The cultivar tested was Malvasia di Candia, and the rootstock (44 years old) employed was Kober 5BB (*Vitis berlandieri* x *Vitis riparia*). The training system was "tendone", consisting of a continuous overhead canopy under which the bunches are disposed (Rana *et al*., 2004). Plots were prepared, each containing 12 vine-plants and repeated four times in randomized blocks. The distance between vines was 2.50 x 2.50 m. In order to avoid product drift from one plot to another, each plot was separated from its neighbour by a row of untreated plants. Cultural conditions were uniform in the experimental site and conformed to organic viticulture practices.
Products were applied with a pulled sprayer (Martignani K.W.H. electrostatic sprayer system) at a pressure of 1.5 bar. The plants were treated until near run-off. The test organism was *P. viticola*. The trial was carried out in accordance with to the EPPO/OEPP PP1/31 (3) guidelines (EPPO, 2004).

Environmental data

A weather station (Davis Instruments, model wireless) was placed in the trial site to record weather data: precipitation, air temperature, soil moisture at 20 cm and 40 cm deep, leaf wetness, solar radiation, relative humidity, soil temperature, and wind speed and direction. Data were acquired through the GSM modem that was on board the weather station for remote transmission to a WeatherLink software program.

Treatments

Table 1 reports commercial name, composition, active ingredient and rate of application of tested products. The products included new copper formulations with low metallic copper (Labicuper and Glutex CU 90) and natural substances (Biplantol, Sporatec, Myco-Sin VIN, BM-

608, Stimulase). The commercial products were used according to the manufacturer's information. The products were compared with an untreated control and a reference product containing copper (Standard).

Table 1. Commercial name of tested products, composition, active ingredient and rate of application

Treatment	Copper compounds	Composition	Active ingredient (%)	Rate of application (L/ha or %)
St[a]	Cuproxat SDI	Tribasic copper sulphate	15.2	3
	Bentoram	Copper hydroxide	10.0	2-3-4
1	Glutex CU 90	Copper hydroxide	9.0	4-4.25
2	Labicuper	Copper gluconate	8.0	2-2.5
3	Biplantol agrar Biplantol mycos V forte	Homeopathic preparation	-	1
4	BM-608	*Melaleuca alternifolia* essential oil	23.8	0.75
5	Myco-Sin VIN	Aluminium sulphate	75.0	0.5
6	Sporatec	Rosemary Oil - Clove Oil - Thyme Oil	18-10-10	1
7	Stimulase	Purified enzymes extracted from *Trichoderma* sp.	-	1

[a] Standard (Reference product)

Disease assessment

In order to evaluate the performance of the products, the response of the plants to downy mildew disease was analysed regularly at each growth stage (BBCH-identification keys of grapevine), following the developmental scale described by Lorenz *et al*. (1994). We scored 100 leaves and 100 bunches picked randomly from 10 central plants of each plot and estimated the percentage of affected organs (disease incidence) and the percentage areas of leaves and bunches showing disease symptoms (disease severity). Disease severity (infection degree, ID) was computed using a scale of nine classes (0-8) with the Townsend – Heuberger formula (Townsend-Heuberger, 1943):

$$ID\ (\%) = \Sigma^{i}{}_{1}(n_i \times v_i) \ / \ N \times V$$

where v_i is the damage class, n_i is the number in one class, N is the total number, V is the highest class, i is the number of classes.

The effectiveness of the products was calculated using Abbott's formula (Abbott, 1925):

$$\%\ \text{effectiveness} = [(I_c - I_t)/I_c] \times 100$$

where I_c is the disease incidence of the untreated control, I_t is the disease incidence of the treatment.

Observations for the presence of phytotoxic effects of all tested products were made after each spray on the shoots, leaves, bunches and flowers.

Chemical analysis of grape, must and wine

Just after harvest, grape samples (about 15 kg grape in quadruplicate for each treatment) have been taken to the laboratory and soon refrigerated to 3-5°C before successive treatments. An aliquot of 100 visually healthy berries have been randomly selected from each group, acidified with HCl 6N (0.2 ml in 100 g) and homogenized at 2-4°C in a waring blender in presence of a double volume of EtOH 50%. The mixture was centrifuged at 10000 × g at 4°C, the supernatant filtered on glass wool and stored at -20°C for further analyses. Extracts from grape have been analysed for the amount in the main hydroxy acids, such as tartaric and malic, as described by Lo Scalzo *et al*. (2007).
The remaining grape was subjected to winemaking according to conventional protocols, as described in Lo Scalzo *et al*. (2012). The main general quality parameter have been measured on must (sugar content, pH and titratable acidity) and on the final wine (alcohol amount, pH, titratable acidity, volatile acidity, tartaric and malic acids, glycerin), all measured by official methods of analyses (OIV, 1990).
Moreover, samples of grape extracts and wine were subjected to the measurement of the amount of their main phytochemicals: total polyphenols index, hydroxycinnamic acids (caftaric and coutaric acids) and flavonoids (catechin, epicatechin, quercetins and polymeric proanthocyanidins) after HPLC-FI chromatography as described in previous works (Lo Scalzo *et al*., 2007; Peng *et al*., 2001). Besides, two antioxidant assays have been performed to assess the biological activity of the samples, the scavenging of DPPH (Sanchez-Moreno *et al*., 1999) and the AAPH-crocin bleaching assay (Ordoudi and Tsimidou, 2006).

Statistical analysis

Data on disease incidence and disease severity were arcsine transformed.
Data obtained were subjected to statistical analysis using a parametric statistical method ANOVA and Tukey's test ($P < 0.05$) for quantitative variables (disease incidence). For ordinal variables (disease severity) individual antifungal activity differences of the products were compared by a Kruskal-Wallis test (a nonparametric test) with Dunn's *post hoc* test ($P < 0.05$).

Statistics were performed with GraphPad InStat version 3.00 for Windows.
The quality data were analysed by means of one-way ANOVA using the GLM procedure of SAS Institute software, version 9.2. The statistical differences of means were indicated by different letters according to Tukey's test ($P < 0.05$). The correlation between the amount of phytochemicals and the infection indexes of the last phenological stage on bunches was performed by simple linear regression test, using Microsoft Excel 2003 and confirmed with Statgraphics plus 5.0.

RESULTS

Environmental data

Figure 1 reports the environmental data (temperature, relative humidity, leaf wetness and rain) recorded in the organic vineyard where the field trials were carried out. The season of the trial was characterized by high spring rainfall, concentrated mainly in May, when there was 99.8 mm of rain. In June and August rainfall was average for that period, while in July and September rainfall was low.

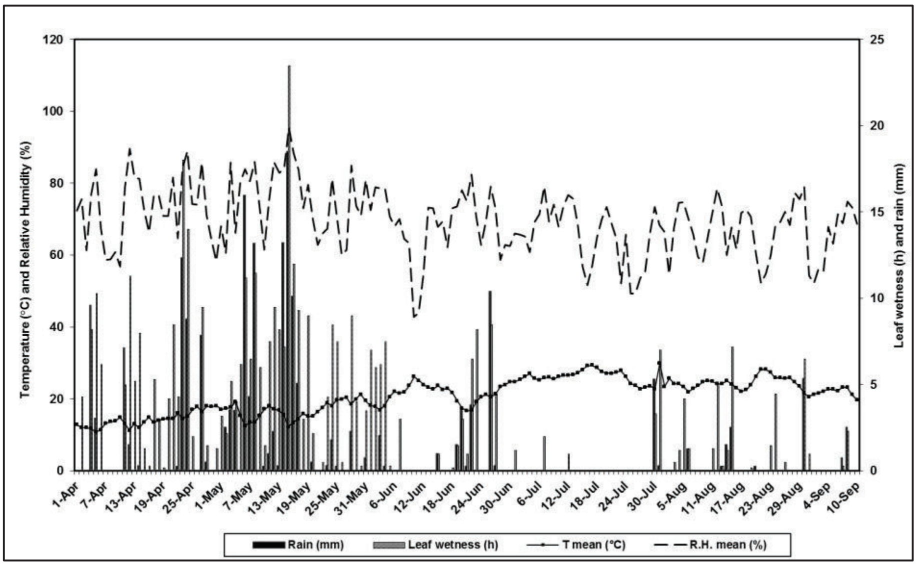

Figure 1. Climatic conditions registered during the trial

Effect of tested products on disease incidence and disease severity

The first oil-spots appeared on the 24th of May (BBCH 57-Inflorescences fully developed; flowers separating). With regard to the fruits, the first symptoms of grapevine downy mildew were observed on June 23rd (BBCH 75-Berries pea-sized, bunches hang). The phytosanitary situation did not show a particularly critical framework.

Table 2 reports the assessments of disease incidence and severity on leaves. For disease incidence, at harvest, all tested products gave a satisfactory protection against the disease and showed significant differences in comparison to the untreated control. Regarding disease severity, only Standard and Glutex Cu 90 showed significant differences in comparison to the untreated control.

Table 3 reports the assessments of disease incidence and severity on bunches. For disease incidence, at harvest, copper compounds (Standard, Glutex Cu 90 and Labicuper) showed significant differences in comparison to the untreated control. Regarding disease severity, only Standard and Glutex Cu 90 showed significant differences in comparison to the untreated control.

In conclusion, the best protection on leaves and bunches was achieved with copper compounds and all non-copper based alternative products where essentially equally effective at harvest.

Table 2. Disease incidence and severity of downy mildew infections on leaves.

Treatment	26/05/2010 (BBCH[a]- 57)			28/06/2010 (BBCH-75)			19/07/2010 (BBCH-77)			02/08/2010 (BBCH-81)			09/09/2010 (BBCH-89)		
	Disease Incidence[b] (%)	Disease Severity[c] (%)	Eff.[d] (%)	Disease Incidence (%)	Disease Severity (%)	Eff. (%)	Disease Incidence (%)	Disease Severity (%)	Eff. (%)	Disease Incidence (%)	Disease Severity (%)	Eff. (%)	Disease Incidence (%)	Disease Severity (%)	Eff. (%)
Control	2.00 ab	0.31 a	-	6.75 a	1.22 a	-	23.75 c	6.23 b	-	29.00 c	7.34 b	-	36.50 c	9.19 b	-
Standard	1.00 ab	0.13 a	50.0	4.00 a	0.56 a	40.7	9.75 a	1.63 a	58.9	11.50 a	1.94 a	60.3	16.00 a	2.75 a	56.2
Glutex Cu 90	0.00 a	0.00 a	100	4.75 a	0.72 a	29.6	10.50 a	1.88 ab	55.8	12.50 a	2.16 a	56.9	17.00 a	3.22 a	53.4
Labicuper	0.50 ab	0.09 a	75.0	4.25 a	0.72 a	37.0	14.25 ab	2.88 ab	40.0	16.00 ab	3.16 ab	44.8	20.75 ab	4.13 ab	43.2
Stimulase	1.00 ab	0.16 a	50.0	5.50 a	0.91 a	18.5	18.75 bc	4.16 ab	21.0	21.50 b	4.69 ab	25.9	27.75 b	6.13 ab	24.0
Mycosin Vin	1.25 ab	0.22 a	37.5	6.25 a	1.13 a	7.4	18.25 bc	4.19 ab	23.7	21.00 b	4.72 ab	27.6	26.50 b	5.91 ab	27.4
Sporatec	0.50 ab	0.06 a	75.0	5.50 a	0.94 a	18.5	18.50 bc	4.03 ab	22.1	20.75 b	4.47 ab	28.4	25.50 b	5.59 ab	28.8
Biplantol	2.50 b	0.50 a	-25.0	6.50 a	1.19 a	3.7	18.25 bc	4.47 ab	23.2	21.75 bc	5.09 ab	25.0	26.75 b	6.16 ab	26.7
BM-608	0.75 ab	0.09 a	62.5	5.75 a	1.00 a	14.8	17.00 bc	3.66 ab	28.4	19.75 b	4.25 ab	31.9	26.25 b	5.59 ab	30.1

[a] Phenological growth stages and BBCH-identifications keys of grapevine: 57 – Inflorescences fully developed, flowers separating; 75 – berries pea-sized, bunches hang; 77 – berries beginning to touch; 81 – beginning of ripening: berries begin to develop; 89 – berries ripe for harvest

[b] Values in the same column followed by same letter are not significantly different according to the Tukey test at $P < 0.05$

[c] Values in the same column followed by same letter are not significantly different according to the Kruskal-Wallis test followed by Dunn's multiple comparison test at $P < 0.05$

[d] Effectiveness of tested products

Table 3. Disease incidence and severity of downy mildew infections on bunches.

Treatment	28/06/2010 (BBCH[a]-75)			19/07/2010 (BBCH-77)			02/08/2010 (BBCH-81)			09/09/2010 (BBCH-89)		
	Disease Incidence[b] (%)	Disease Severity[c] (%)	Eff.[d] (%)	Disease Incidence (%)	Disease Severity (%)	Eff. (%)	Disease Incidence (%)	Disease Severity (%)	Eff. (%)	Disease Incidence (%)	Disease Severity (%)	Eff. (%)
Control	1.25 a	0.25 a	-	15.50 d	3.31 b	-	20.25 c	4.47 c	-	31.00 c	7.63 b	-
Standard	0.00 a	0.00 a	100	3.00 a	0.41 a	80.6	4.25 a	0.56 a	79.0	10.00 a	1.59 a	67.7
Glutex Cu 90	0.00 a	0.00 a	100	4.75 ab	0.72 ab	69.4	6.50 a	0.97 ab	67.9	12.75 ab	2.25 a	58.9
Labicuper	0.00 a	0.00 a	100	6.25 abc	0.97 ab	59.7	8.75 ab	1.41 abc	56.8	15.75 ab	3.09 ab	49.2
Stimulase	0.50 a	0.06 a	60.0	10.25 bcd	1.97 ab	33.9	13.50 bc	2.56 abc	33.3	20.50 bc	4.31 ab	33.9
Mycosin Vin	0.25 a	0.03 a	80.0	10.00 bcd	1.78 ab	35.5	13.75 bc	2.53 abc	32.1	21.25 bc	4.19 ab	31.5
Sporatec	0.50 a	0.09 a	60.0	11.75 cd	2.25 ab	24.2	15.25 bc	2.97 abc	24.7	22.25 bc	4.47 ab	28.2
Biplantol	0.75 a	0.16 a	40.0	12.50 cd	2.56 b	19.4	15.50 c	3.16 bc	23.5	21.50 bc	4.59 ab	30.7
BM-608	0.25 a	0.06 a	80.0	10.25 bcd	1.72 ab	33.9	14.00 bc	2.53 abc	30.9	22.75 bc	4.41 ab	26.6

[a] Phenological growth stages and BBCH-identifications keys of grapevine: 75 – berries pea-sized, bunches hang; 77 – berries beginning to touch; 81 – beginning of ripening: berries begin to develop; 89 – berries ripe for harvest

[b] Values in the same column followed by same letter are not significantly different according to the Tukey test at $P < 0.05$

[c] Values in the same column followed by same letter are not significantly different according to the Kruskal-Wallis test followed by Dunn's multiple comparison test at $P < 0.05$

[d] Effectiveness of tested product

Amount of copper provided with the treatments

Figure 2 shows the amount of metallic copper applied with the treatments. The total copper applied with reference product was approximately 6.3 kg/ha compared with about 0.99 kg/ha and 2.2 kg/ha for the Glutex Cu 90 and Labicuper formulations respectively.

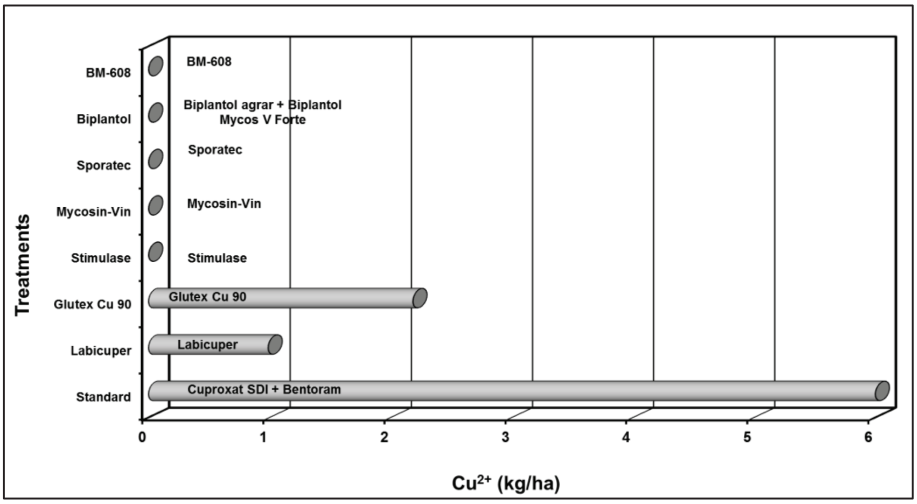

Figure 2. Amount of metallic copper applied with the treatments

Chemical analysis

The grape samples showed a significant difference only in the content of tartaric acid, while for the other parameters no significance was found. Low P values resulted from malic acid, total OH-cynnamics and proanthocyanidins (Table 4). The simple regression analysis *vs* the level of disease in the corresponding phenological stage of the sample gave noticeable results, with high negative values found for the level of proanthocyanidins, total polyphenols, catechin, crocin assay and *cis*-caftaric acid.

As regards the analysis on must samples (Table 5), the best variability, checked by the lowest P value, although not significant at $P < 0.05$, was found in the level of titratable acidity, also giving a negative correlation with the level of disease.

Again, the wine quality gave no significance in the response to the investigate products. The lowest P value was found for total flavonoids, crocin assay and total OH-cynnamics data (Table 5), but no significant correlation was found with the levels of disease for these data. On the other hand, high correlation was found for total polyphenols, with positive values and for volatile acidity, with negative ones (Table 5).

Table 4. Quality control of grape samples. All showed values are the average of four replicates. Numbers in the same column followed by different letters are significantly different according to the Tukey test at P < 0.05. GAE, gallic acid equivalents; CE, catechin equivalents; CAE, caffeic acid equivalents; QE, quercetin equivalents. In Crocin assay the data unit are given by trolox eq, a Vitamin E hydrosoluble analogue. The last two rows indicate the simple regression value (rxy) of each index *versus* the disease incidence and the disease severity taken on grape bunches at the last phenological stage (berry ripe for harvest, cfr Tables 2 and 3).

Treatment	Tartaric acid g/kg	Malic acid g/kg	Total polyphenols GAE mg/kg	Total flavonoids CE mg/kg	Total OH-cynnamics CAE mg/kg	Crocin assay Trolox eq mM	grapes DPPH assay GAE mM	Cis-caftaric CAE mg/kg	Trans-caftaric CAE mg/kg	Coutaric CAE mg/kg	Catechin mg/kg	Epicatechin mg/kg	Proanthocyanidins CE mg/kg	Quercetins QE mg/kg
Control	4.63 a	1.53	492	1200	49.1	1.24	8.46	1.43	39.4	4.59	36.0	6.67	109.9	25.65
Standard	3.57 ab	1.84	564	1311	55.0	1.49	9.23	1.79	45.0	5.79	48.2	8.00	174.5	31.85
Glutex Cu 90	4.19 ab	1.86	501	1172	48.8	1.51	7.91	1.57	39.7	8.48	44.8	7.50	129.1	23.37
Labicuper	3.99 ab	2.22	497	1126	43.3	1.64	7.56	1.40	33.5	4.77	38.8	7.93	125.6	21.50
Stimulase	4.80 a	2.17	477	1156	46.5	1.26	8.74	1.51	38.1	5.83	44.8	6.78	112.5	17.37
Mycosin Vin	4.18 ab	1.79	498	1138	49.6	1.60	7.13	1.60	43.2	5.65	38.8	7.83	105.1	25.57
Sporatec	3.88 ab	2.34	562	1220	47.8	1.62	7.83	1.64	39.6	6.00	51.7	9.01	113.1	25.46
Biplantol	2.80 b	2.07	518	1219	51.2	1.56	7.86	1.76	42.5	9.01	51.3	8.66	147.1	30.98
BM-608	4.20 ab	2.18	481	1150	48.0	1.81	7.08	1.52	40.0	8.53	45.7	8.02	102.1	19.00
Average	4.03	2.00	510	1188	48.8	1.53	7.98	1.58	40.1	6.52	44.5	7.82	124.3	24.53
min	2.80	1.53	477	1126	43.3	1.24	7.08	1.40	33.5	4.59	36.0	6.67	102.1	17.37
max	4.80	2.34	564	1311	55.0	1.81	9.23	1.79	45.0	9.01	51.7	9.01	174.5	31.85
Pr > F	0.035	0.109	0.735	0.782	0.265	0.759	0.517	0.483	0.442	0.472	0.543	0.913	0.224	0.732
vs incidence	0.310	-0.174	-0.376	-0.274	-0.223	-0.239	-0.243	-0.397	-0.130	-0.167	-0.309	-0.226	-0.673	-0.187
vs severity	0.318	-0.271	-0.369	-0.214	-0.194	-0.367	-0.122	-0.415	-0.148	-0.232	-0.365	-0.315	-0.592	-0.131

DISCUSSION

Under medium infection pressure all investigate products showed an effective control of *P. viticola*. The best results were obtained with copper compounds, which were all very effective. The alternatives to copper formulations were less effective than copper but showed an acceptable level of activity against grape downy mildew. Copper compounds (Glutex Cu 90 and Labicuper) were able to control *P. viticola* using a third (Glutex Cu 90) or a sixth (Labicuper) of the amount of copper in comparison with the Standard (Figure 2).

Grape, must and wine quality were evaluated to check possible actions of investigated products both on the berries composition and on the fermentation trend, but the evidence is that no significant action was found.

However, the approach regarding the correlation between the level of disease and the composition gave some interesting responses. Some high negative values, meaning a tendency to a lower index of disease when the level of the metabolite is high, have been found. Interestingly, the significant negative correlation values found for proanthocyanidins in grape (rxy = -0.67 *vs* incidence and -0.59 *vs* severity) is in accordance with the findings reviewed by Mercier (1997), indicating these molecules as protective against fungal diseases on plants.

Table 5. Quality control of must and wine samples. All showed values are the average of four replicates. Numbers in the same column followed by different letters are significantly different according to the Tukey test at $P<0.05$. GAE, gallic acid equivalents; CE, catechin equivalents; CAE, caffeic acid equivalents. In Crocin assay the data unit are given by trolox eq, a Vitamin E hydrosoluble analogue. The last two rows indicate the simple regression value (rxy) of each index *versus* the disease incidence and the disease severity taken on grape bunches at the last phenological stage (berry ripe for harvest, cfr Tables 2 and 3).

Treatment	must			wine											
	Glucose+ fructose g/L	Titratable acidity g/L	pH	Titratable acidity g/L	Volatile acidity g/L	pH	Alcohol % vol.	Glycerin g/L	Tartaric acid g/L	Malic acid g/L	Total polyphenols GAE mg/kg	Total flavonoids CE mg/kg	Total OH-cynnamics CAE mg/kg	Crocin assay Trolox eq mM	DPPH assay GAE mM
Control	170.1	6.04	3.25	7.31	0.37	3.19	10.41	5.73	3.41	1.00	183	527	33.0	0.47	5.27
Standard	171.9	6.72	3.28	7.51	0.38	3.21	10.44	6.14	3.33	1.09	174	541	33.8	0.87	6.57
Glutex Cu 90	169.8	6.25	3.25	7.57	0.43	3.20	10.56	5.91	3.46	1.05	160	497	30.7	0.50	6.57
Labicuper	167.8	6.35	3.28	7.43	0.40	3.24	10.52	5.36	3.21	1.30	155	483	28.3	0.56	4.99
Stimulase	167.6	6.39	3.26	7.34	0.37	3.20	10.30	6.16	3.48	1.17	167	505	28.6	0.86	7.66
Mycosin Vin	176.1	6.09	3.31	7.14	0.35	3.25	10.80	6.34	3.11	1.16	176	532	32.9	0.72	7.29
Sporatec	172.4	6.40	3.27	7.94	0.41	3.23	10.68	5.52	3.41	1.05	169	523	32.1	0.77	8.17
Biplantol	175.7	6.32	3.32	7.14	0.33	3.26	10.79	5.15	2.97	1.17	153	480	27.2	0.56	6.97
BM-608	167.1	6.88	3.25	7.58	0.35	3.21	10.33	5.68	3.32	1.22	177	522	32.2	0.83	7.23
Average	170.9	6.38	3.27	7.44	0.38	3.22	10.54	5.78	3.30	1.14	168	512	31.0	0.68	6.75
min	167.1	6.04	3.25	7.14	0.33	3.19	10.30	5.15	2.97	1.00	153	480	27.2	0.47	4.99
max	176.1	6.88	3.32	7.94	0.43	3.26	10.80	6.34	3.48	1.30	183	541	33.8	0.87	8.17
Pr > F	0.878	0.127	0.228	0.820	0.646	0.497	0.952	0.309	0.399	0.227	0.246	0.119	0.153	0.128	0.314
vs incidence	0.069	-0.388	-0.015	-0.261	-0.475	-0.037	-0.011	-0.219	-0.219	-0.071	0.488	0.100	0.036	-0.247	-0.017
vs severity	0.057	-0.479	-0.046	-0.311	-0.425	-0.100	-0.047	-0.152	-0.152	-0.021	0.485	0.130	0.077	-0.312	-0.129

ACKNOWLEDGEMENT

This study was conducted within the project “Protezione della Vite e delle Sementi in Agricoltura Biologica” funded by the Italian Ministry of Agriculture and Forestry. A special thank have to be given to the students of CRA-ENC of Velletri (Rome) that helped in the winemaking of the grape samples.

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