RESIDUAL COPPER QUANTIFICATION ON GRAPEVINE'S ORGANS

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Abstract:

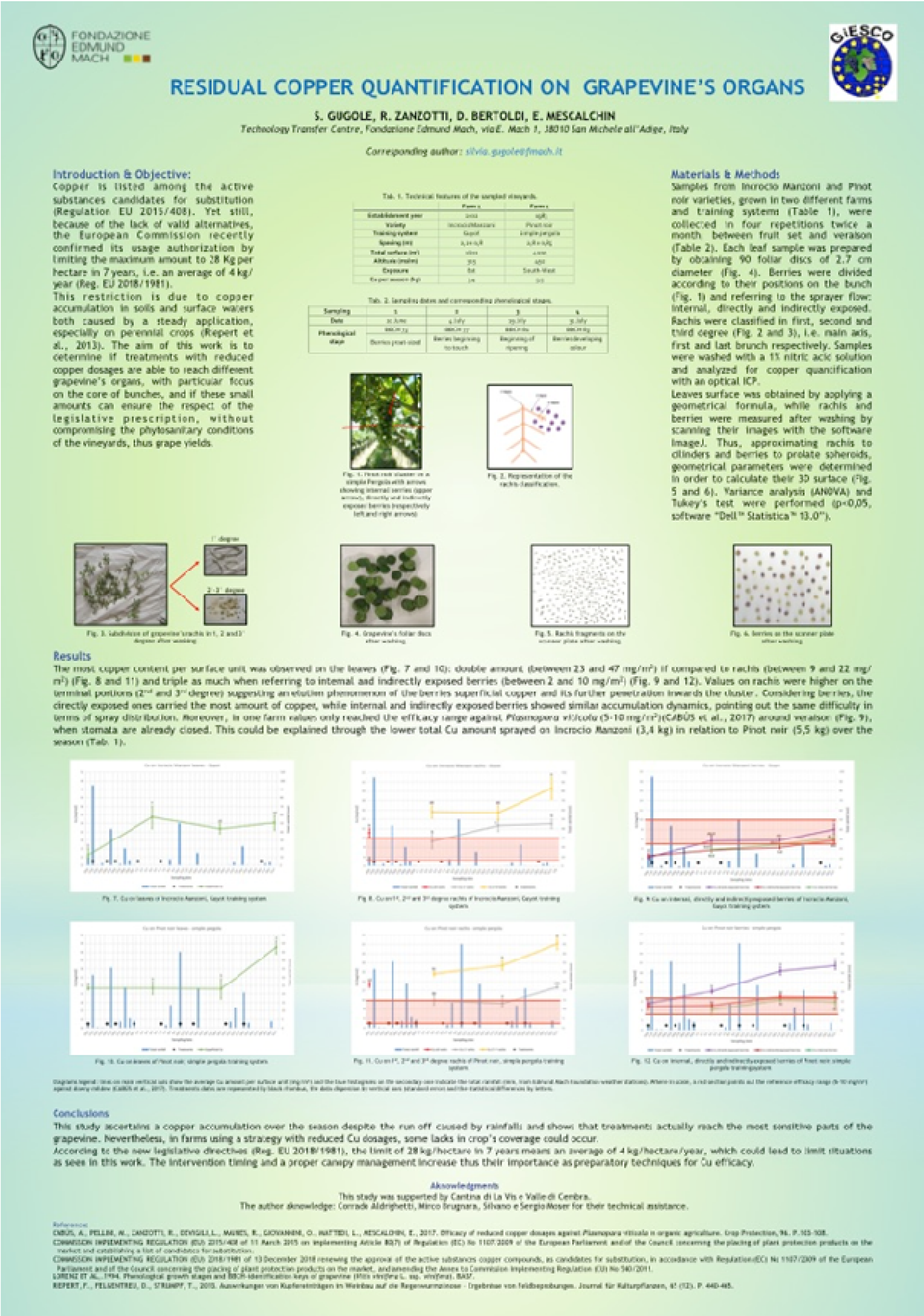
Context and purpose of the study – Copper is listed among the active substances candidates for substitution (Regulation EU 2015/408). Yet still, because of the lack of valid alternatives, the European Commission recently confirmed its usage authorization by limiting the maximum amount to 28 Kg per hectare in 7 years, i.e. an average of 4 kg/year (Reg. EU 2018/1981).This restriction is due to copper accumulation in soils and surface waters both caused by a steady application, especially on perennial crops (Riepert et al., 2013). The aim of this work is to determine if treatments with reduced copper dosages are able to reach different grapevine's organs, with particular focus on the core of bunches, and if these small amounts can ensure the respect of the legislative prescription, without compromising the phytosanitary conditions of the vineyards, thus grape yields.

Material and methods – Samples from Incrocio Manzoni and Pinot noir varieties, grown in two different farms and training systems, were collected in four repetitions twice a month, between fruit set and veraison. Each leaf sample was prepared by obtaining 90 foliar discs of 2.7 cm diameter. Berries were divided according to their positions on the bunch and referring to the sprayer flow: internal, directly and indirectly exposed. Rachis were classified in first, second and third degree, i.e. main axis, first and last brunch respectively. Samples were washed with a 1% nitric acid solution and analyzed for copper quantification with an optical ICP. Leaves surface was obtained by applying a geometrical formula, while rachis and berries were measured after washing by scanning their images with the software ImageJ. Thus, approximating rachis to cilinders and berries to prolate spheroids, geometrical parameters were determined in order to calculate their 3D surface. Variance analysis (ANOVA) and Tukey's test were performed ($p<0,05$, software "Dell™ Statistica™ 13.0").

Results – The most copper content per surface unit was observed on the leaves: double amount (between 23 and 47 mg/m^2) if compared to rachis (between 9 and 22 mg/m^2) and triple as much when referring to internal and indirectly exposed berries (between 2 and 10 mg/m^2). Values on rachis were higher on the terminal portions (2nd and 3rd degree) suggesting an elution phenomenon of the berries superficial copper and its further penetration inwards the cluster. Considering berries, the directly exposed ones carried the most amount of copper, while internal and indirectly exposed berries showed similar accumulation dynamics, pointing out the same difficulty in terms of spray distribution. Moreover, in one farm values only reached the efficacy range against *Plasmopora viticola* (5-10 mg/m^2)(CABÚS et al., 2017) around veraison, when stomata are already closed. This could be explained through the lower total Cu amount sprayed on Incrocio Manzoni (3,4 kg) in relation to Pinot noir (5,5 kg) over the season. This study ascertains a copper accumulation over the season despite the run off caused by rainfalls and shows that treatments actually reach the most sensitive parts of the grapevine. Nevertheless, in farms using a strategy with reduced Cu dosages, some lacks in crop's coverage could occur.According to the new legislative directives (Reg. EU 2018/1981), the limit of 28 kg/hectare in 7 years means an average of 4 kg/hectare/year, which could lead to limit situations as seen in this work. The intervention timing and a proper canopy management increase thus their importance as preparatory techniques for Cu efficacy.

Keywords: Grapevine, Organic viticulture, Copper, Treatments, Berries, Rachis, Leaves.

1. Introduction.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RESIDUAL COPPER QUANTIFICATION ON GRAPEVINE'S ORGANS
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Introduction & Objective:
Copper is listed among the active substances candidates for substitution (Regulation EU 2015/408). Yet still, because of the lack of valid alternatives, the European Commission recently confirmed its usage authorization by limiting the maximum amount to 28 Kg per hectare in 7 years, i.e. an average of 4 kg/year (Reg. EU 2018/1981).
This restriction is due to copper accumulation in soils and surface waters both caused by a steady application, especially on perennial crops (Repert et al., 2013). The aim of this work is to determine if treatments with reduced copper dosages are able to reach different grapevine's organs, with particular focus on the core of bunches, and if these small amounts can ensure the respect of the legislative prescription, without compromising the phytosanitary conditions of the vineyards, thus grape yields.
Tab. 1. Technical features of the sampled vineyards.
Tab. 2. Sampling dates and corresponding phenological stages.
Materials & Method:
Samples from Incrocio Manzoni and Pinot noir varieties, grown in two different farms and training systems (Table 1), were collected in four repetitions twice a month between fruit set and veraison (Table 2). Each leaf sample was prepared by obtaining 90 foliar discs of 2.7 cm diameter (Fig. 4). Berries were divided according to their positions on the bunch (Fig. 1) and referring to the sprayer flow: internal, directly and indirectly exposed. Rachis were classified in first, second and third degree (Fig. 2 and 3), i.e. main axis, first and last brunch respectively. Samples were washed with a 1% nitric acid solution and analyzed for copper quantification with an optical ICP.
Leaves surface was obtained by applying a geometrical formula, while rachis and berries were measured after washing by scanning their images with the software ImageJ. Thus, approximating rachis to cilinders and berries to prolate spheroids, geometrical parameters were determined in order to calculate their 3D surface (Fig. 5 and 6). Variance analysis (ANOVA) and Tukey's test were performed (p<0,05, software "Dell™ Statistica™ 13.0").
Fig. 3. Subdivision of grapevine's rachis in 1, 2 and 3° degree after washing
Fig. 4. Grapevine's foliar discs after washing
Fig. 5. Rachis fragments on the scanner plate after washing
Fig. 6. Berries on the scanner plate after washing
Results
The most copper content per surface unit was observed on the leaves (Fig. 7 and 10): double amount (between 23 and 47 mg/m²) if compared to rachis (between 9 and 22 mg/m²) (Fig. 8 and 11) and triple as much when referring to internal and indirectly exposed berries (between 2 and 10 mg/m²) (Fig. 9 and 12). Values on rachis were higher on the terminal portions (2nd and 3rd degree) suggesting an elution phenomenon of the berries superficial copper and its further penetration towards the cluster. Considering berries, the directly exposed ones carried the most amount of copper, while internal and indirectly exposed berries showed similar accumulation dynamics, pointing out the same difficulty in terms of spray distribution. Moreover, in one farm values only reached the efficacy range against Plasmopara viticola (5-10 mg/m²) (CABÚS et al., 2017) around veraison (Fig. 9), when stomata are already closed. This could be explained through the lower total Cu amount sprayed on Incrocio Manzoni (3,4 kg) in relation to Pinot noir (5,5 kg) over the season (Tab. 1).
Fig. 10. Cu on leaves of Pinot noir, simple pergola training system
Fig. 11. Cu on 1st, 2nd and 3rd degree rachis of Pinot noir, simple pergola training system
Fig. 12. Cu on internal, directly and indirectly exposed berries of Pinot noir simple pergola training system
Conclusions
This study ascertains a copper accumulation over the season despite the run off caused by rainfalls and shows that treatments actually reach the most sensitive parts of the grapevine. Nevertheless, in farms using a strategy with reduced Cu dosages, some lacks in crop's coverage could occur.
According to the new legislative directives (Reg. EU 2018/1981), the limit of 28 kg/hectare in 7 years means an average of 4 kg/hectare/year, which could lead to limit situations as seen in this work. The intervention timing and a proper canopy management increase thus their importance as preparatory techniques for Cu efficacy.
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