EFFECTS OF DIFFERENT BUD DENSITY ON THE MYCORRHIZAL COLONISATION OF GRAPEVINE IN THE KUNSÁG WINE REGION

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ABSTRACT

Mycorrhizal symbiosis has an important role for the grape: it helps the water - and nutrient uptake, as well as the avoidance of biotic and abiotic stresses. During our investigation carried out on stocks grown in Szigetcsép (Kunság wine region), we studied the effects of different bud load on the degree of mycorrhizal colonisation. The vineyard (Gál Vineyard and Winery in Szigetcsép) is on sandy soil with low nutrient content, thus the mycorrhizal colonisation have a great importance in this area. For the estimation of endomycorrhizal colonisation, fine roots of the grape cultivar 'Kékfrankos' were stained with anilin-blue, and investigated under light microscope. Our results show significant difference of the mycorrhizal colonisation in our experiments, however, further studies are needed in other wine regions for general conclusions to be drawn.

Keywords: endomycorrhiza, grape, bud load

INTRODUCTION

Mycorrhizal symbiosis, namely the mutualistic interaction between a fungus and the root of a vascular plant, is also formed by the grape among a variety of other species. This symbiosis is necessary for the optimal and healthy development of the plants.

The mycorrhiza forming ability of grape was first recorded by Stahl in 1900 (POSSINGHAM and OBBINK, 1971). Grape establishes endomycorrhizal interaction, i.e. the hyphae penetrate the cell wall of the root cells, and invaginate the cell membrane. Within the cells of the host plant, a dichotomously-branching hyphal endings, so-called arbuscules and storage hyphal endings (vesicles) develop. The establishment of arbuscules considerably increases the nutrient translocation surface (interface) between the hypha and the root cell, so it facilitates the transfer of nutrients between them (SCHREINER, 2005). Therefore, the effectiveness of the endomycorrhizal interaction is revealed by not the degree of the colonization (i.e. the number of the hypha living within the roots), but the number of arbuscules observed in the colonized root fragments (PINKERTON et al., 2004, SCHREINER 2005). However, the nutrient uptake of mycorrhizal plants is also influenced by the soil characteristics, the soil cultivation method and the nutrient supply. Especially in case of nutrient deficiency and poor soil condition, is mycorrhizal colonization of considerable importance (RYAN and GRAHAM 2002).

In case of sufficient phosphorous supply, the carbohydrate demand of the mycorrhiza is not proportional to the benefits offered by the fungus. Therefore, the degree of mycorrhizal colonization is lower here compared to the soils with phosphorous deficiency (BAUMGARTNER, 2003). The yield also considerably influences the arbuscule number: in

an investigation on the rootstock effect, the varieties with lower yield (e.g. 101-14 Mgt) proved to have more arbuscules (thus more intensely functioning mycorrhizae) than those with higher yields (e.g. Teleki-Fuhr SO4). The latter kinds of rootstocks use usually more carbohydrates to yield ripening, so there are fewer carbohydrates available for the mycorrhizal fungus (SCHREINER, 2003). Intensive defoliation reduced the number of arbuscules, in parallel with the decreased level of carbohydrate assimilation (PINKERTON et al., 2004).

MATERIALS AND METHODS

The Kunság wine region – where Szigetcsép is located – is the largest wine region of Hungary. Similarly to the whole wine region, the area is covered with sandy soil; the climate is continental with hard colds in the winter and also in early spring. The summer is usually hot, with drought periods.

The experiment was carried out in the Gál Vineyards and Winery. The investigated variety was Kékfrankos, grafted on Teleki 5 C rootstocks. The samples were collected from vines with two several bud loads (low bud load: 4 bud/m^2; high bud load: 11 bud/m^2). After two vegetation periods, in the autumn and winter of 2010-2011, the bud load was unified: 8 bud/m^2 in each row, according to the practice of the company.

During the autumn of 2010 and the spring of 2011, 16 samples were taken per every treatment. The root samples were cleaned and conserved in ethanol (70%). The samples were cut in 1 cm pieces. 30 samples per treatment were stained with anilin-blue, and investigated under light microscope according to the method of MCGONIGLE (1990) and SCHREINER (2003). If in the sample arbusculum, vesiculum, or hypha was found, we counted it as colonised. Moreover, we counted the number of the arbuscules, and subsequently we determined the arbuscular % of the samples. Leaf element content was analyzed in the labor of Corvinus University of Budapest, Research Institute for Viticulture and Oneology, Kecskemét. Data were analyzed by One-way-Anova, using Pasw Statistics 18.

RESULTS AND DISCUSSION

In case of the 11bud/m^2 load, in 2010, the number of arbuscules was significantly lower than in case of the 4bud/m^2 load (*Figure 1*). Our results agree with the observations of SCHREINER (2003): when the stocks were loaded to a heavier extend, they used more assimilate to supply the bunches and to develop a larger canopy, so there was less carbohydrates available for the mycobiont. The results of GÁL (2011) at the same study area showed, that the average yield was 2, 16 kg/m^2 in case of the 4 bud/m^2 load, and 4, 59 kg/m^2 in case of the 11 bud/m^2 load. In the same time, the results of the leaf analyses (*Table 1*) did not show any significant differences between the treatments, so the differing colonization level could not be caused by the different element content of the leaves. The minor load could be more advantageous for the grape, because the water and nutrient use was presumably equal, therefore the colonization of roots was more intense.

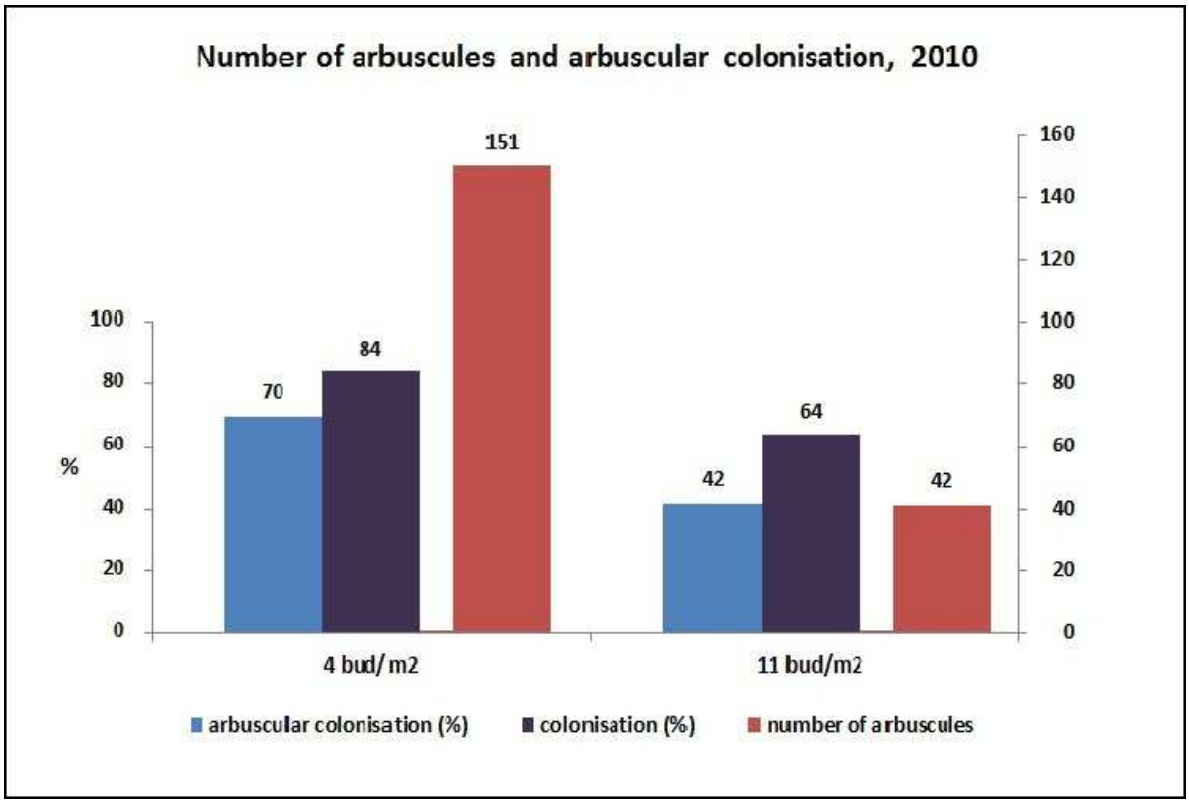

Figure 1. The effect of bud load on the mycorrhizal colonisation of Kékrankos variety (Szigetcsép, 2010)

Table1. Leaf element content of the grapes with different bud load (Gál, 2011)

Nutrient	4 bud/m^2		11 bud/m^2	
m/m %	2009	2010	2009	2010
N	1,74	1,98	1,70	1,94
P	0,13	0,139	0,109	0,129
K	1,02	1,36	0,897	1,04
Ca	4,11	2,77	4,41	2,96
Mg	0,361	0,285	0,346	0,287

In the next season, the bud load of the grapes was uniformly adjusted to 8 bud/m^2. This means that in the year of 2011, on those stocks where the bud load was previously 4 bud/m^2, the load was doubled, while in case of the other treatment, the load was somewhat reduced. On the stocks of each treatment we counted more arbuscules and observed higher % of colonization in spring, than in the autumn, similarly to the results of SCHREINER-LINDERMANN (2005). In the two vegetation periods, the overloaded stocks may have

utilized the majority of their stored nutrients, which is important for the grape. Consequently, the reason for the elevated number of the arbuscules might be the fact that the modified bud load increased the need of a more intensely working endomycorrhizal interaction. Since the excess of transport between the mutualistic partners is revealed by the area of the interface (SCHREINER, 2005), this led to the formation of more arbuscules within the roots. The mentioned problem would be especially important in an arid soil deficient in nutrients, where endomycorrhiza have a more significant role for the host plants (RYAN and GRAHAM, 2002).

All the mentioned effects are more pronounced in case of the previously more intensely loaded (11 bud/m^2) stocks. On these, both the arbuscular colonization and the number of arbuscules was almost the double that of the other (previously 8 bud/m^2) treatment (*Figure 2*). Besides, the number of arbuscules in the 11 bud/m^2 treatment was significantly different between 2010 and 2011. Nevertheless, the difference between the endomycorrhizal colonisation of the two treatments decreased, thus we can observe a tendency toward an equalized endomycorrhizal status as a result of unifying the bud load. However, in spring the colonization level of the formerly to 4 bud / m^2 loaded stocks was still higher.

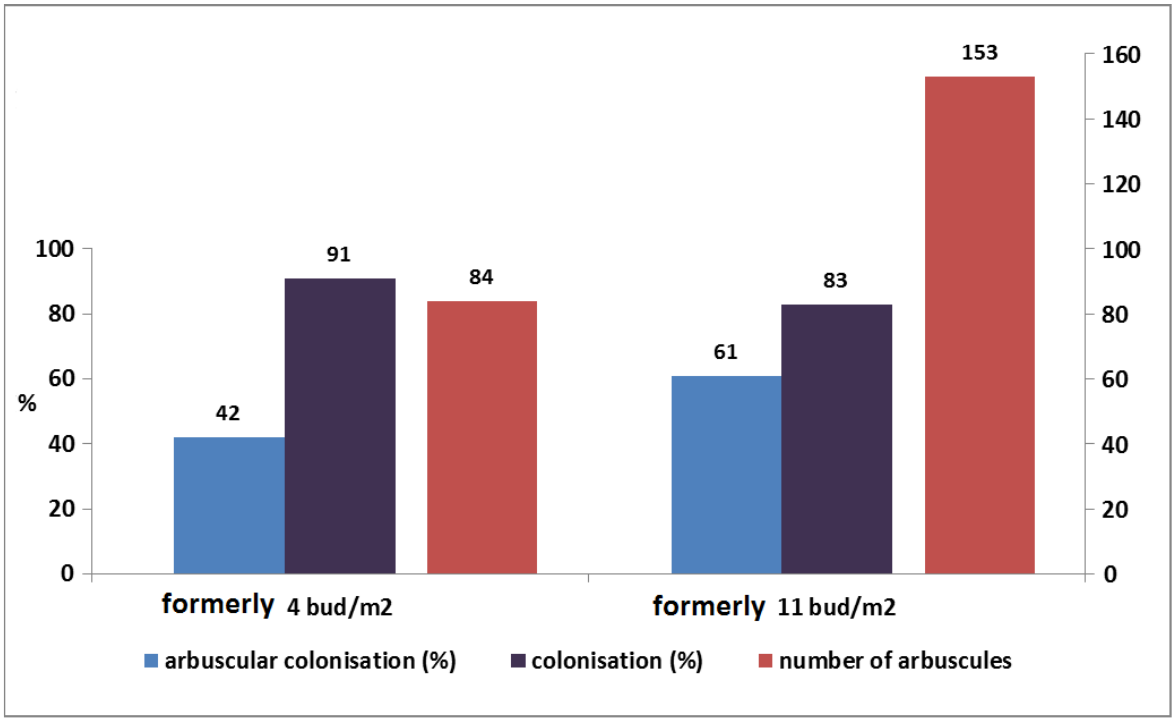

Figure 2. Mycorrhizal colonisation of following unifying bud load to 8 bud/m^2 2011.

Our results on Kékfrankos grape variety show that the enhancing of the bud load leads to the decrease of mycorrhizal colonization. This is in accordance with other researchers results, who have also found that the rootstocks of higher yield had less intensely colonized roots in terms of the arbuscule number, while in case of the varieties of lower yields, higher arbuscule proportion was observed (SCHREINER, 2003). Root colonization may also

be affected by intense defoliation, because it results decreased carbohydrate assimilation and lower arbuscules number (PINKERTON et al., 2004).

This phenomenon was observed not only in the investigation on the bud load effect, but also in the samples which were taken after the subsequent pruning, where we found significantly different arbuscule numbers in case of the 11 bud/m^2 load treatments. The difference was manifested in the higher degree of colonization too, but in accordance with the results of SCHREINER (2005), the change in the number of arbuscules was significantly higher.

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