THE EVALUATION OF GREENERY COVER INFLUENCE ON THE SOIL COMPACTION IN THE INTER-ROWS OF GRAPEVINE

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Abstract: This paper focuses on the evaluation of penetrometer measurements carried out in the years 2015–2017, in the area of South Moravia, on the side called Popice/Gotberg with degraded black soil and different greenery. Four mixtures with varied species composition and work designation – Yearling mixture, Perennial mixture–diverse, Perennial mixture-dry and Yearling mixture-pollinators were used for the planting of the experimental vineyard. Penetrometer measurements were conducted using a manual penetrometer “Eijkelkamp P1.25”. The measurements were made in the space between the intervals at depths of 100–300 mm. The water content in the soil at time of measurement, expressed in weight percent, was determined by the gravimetric method. The obtained results show that the highest average values of soil penetrometric resistance were measured in the year when experiment began (2015) and were in the range of 2.27–2.48 MPa. Thanks to the evaluated variants of the greenery, the penetrometric soil resistance was reduced to 0.91–1.06 MPa over the next two years. The largest decrease of soil resistance was obvious at the variant A (yearling mix 58.8%) as well as the variant B (perennial mixture varied 56.7%). Based on the results obtained, these mixtures can be recommended for wine-growing practice and, at the same time, they might be used as a preventive and corrective tool for solving problems with soil compaction.

Key Words: grapevine, vegetation cover, soil compaction, penetrometers, penetration resistance

INTRODUCTION

Cropping systems in viniculture are increasingly focusing on technologies using greenery cover in between rows of vines. A suitable solution is the use of grassland systems with the use of diverse species of plant mixtures, which are the main tool in maintaining soil fertility and partially also the tool of quality management in viniculture (Linares et al. 2014).

Vegetation cover fulfils the whole range of significant functions. An important role is represented by the ability to dampen travel of mechanization vehicles and protection of soil against erosion effects (Göblyös et al. 2011, Ferrero et al. 2005, Boone and Veen 1994, Šimon and Lhotský 1989). From the perspective of ensuring good soil properties, legume or legume-cereal mixtures appear to be highly beneficial. The most valued are especially fabaceous plants of the family Fabaceae. It is a huge family, which contains of variety of plants, of which the most important are legumes (beans, peas, broad bean, etc.), and after them follow fodder crops (clover, alfalfa, etc.). These plants can produce a very rich root system, which may penetrate to a greater depth, in many cases up to 3 m (Judit et al. 2011). Due to the higher content of humus caused by the activity of microorganisms, there is simultaneously improved the soil structure and the retention capacity of soil is increased as well (Bauer et al. 2004). Similar to that, King and Berry (2005) state that greenery cover in the inter-rows of grapevine, especially in organic farming due to cover crops, might be able to enhance soil microbial activity, fertility and soil structure. The greenery cover in the inter-rows of grapevine reduces the need for frequent soil tillage in agroecosystems. It protects the soil like an umbrella from heavy rainstorms, thus considerably reduces erosion (Varga et al. 2007, Rinaldi et al. 2000). A key role is played by the type and density of vegetation, which influence the effective hydraulic conductivity (Zhang et al. 1995).
The objective of the work was to evaluate the influence of vegetation cover in various species composition on the penetrometric resistance of soil in selected vineyards in area conditions in the South Moravia.

MATERIAL AND METHODS

Experimental Site

Experimental measurements were carried out in the years 2015–2017 at site Popice/Gotberg. The basic geographical and soil characteristics is claimed as black soil on loess, sandy-loam to loamy-sandy sediment. Influenced by the anthropogenic activity (terracing of vineyard). The region - the outer Carpathians and The Pieniny Klippen Belt, coordinates 48°56´06,0´´ North Latitude 16°41´20,0´´ East Longitude, soil typology: CEc: CECp – carbonate black soil (pellic).

Equipment and Soil Penetration Resistance Measuring Methods

Soil penetration resistance in individual layers in the soil horizon was measured by the penetrometer type “Eijkelkamp P1.25” (Eijkelkamp Agrisearch Equipment, Netherlands). The device consists of a measuring needle tip, tensometric load cell sensor, optical sensor for depth measuring and electronics evaluation with a microprocessor and battery. Actual penetrometer measurements were performed in the area between the rows of vines with the evaluated variants of vegetation cover. For each experimental variant, there were 30 measurements carried out in the depth range 100–200, 200–300 and 300–400 mm. The measured values were corrected based on the determined soil humidity according to Lhotský (2000). The water content in percentage of weight in soil was determined by the gravimetric method.

Experimental Variants of Vegetation Cover

At the site, there were evaluated 4 variants of vegetation cover. The species composition is stated in Table 1.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Working designation of the mixture</th>
<th>Species composition (% representation of species in the mixture)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Yearling mixture</td>
<td>Lolium multiflorum (25%), Phalaris canariensis (15%), Phacelia congesta (5%), Phacelia tanacetifolia (5%), Trifolium alexandrinum (10%), Camelina sativa (10%), Fogopyrum esculentum (5%), Sinapis arvensis (5%), Trifolium resupinatum (10%), Lotus ornithopodioides (5%), Trifolium campestre (5%)</td>
</tr>
<tr>
<td>B</td>
<td>Perennial mixture - diverse</td>
<td>Festuca ovina (20%), Festuca rubra (10%), Festuca arundinacea (10%), Trifolium repens (5%), Medicago lupulina (15%), Trifolium pannonicum (5%), Lotus corniculatus (5%), Onobrychis vicifolia (10%), Securigera varia (5 %), Anthyllis vulneraria (15%)</td>
</tr>
<tr>
<td>C</td>
<td>Perennial mixture - dry</td>
<td>Festuca ovina (40%), Trifolium repens (20%), Festuca rubra (20%), Medicago lupulina (20%)</td>
</tr>
<tr>
<td>D</td>
<td>Yearling mixture - pollinators</td>
<td>Fogopyrum esculentum (30%), Phacelia congesta &quot;Fiona&quot; (20%), Calendula officinalis (20%), Camelina sativa (10%), Phalaris canariensis (10%), Lolium multiflorum (10%)</td>
</tr>
</tbody>
</table>

Statistical Analysis

Results were reported as means and standard deviation. Analysis of variance (ANOVA) and Tukey’s honestly significant difference (HSD) tests were conducted to determine the differences among which means that the statistical significance was declared at p ≤ 0.05. These statistical evaluation methods were applied using the computer software package “Statistica 12.0” (StatSoft Inc., USA).
RESULTS AND DISCUSSION

In the Table 2 are written average values of penetrometric soil resistance, which have been measured at the test point in three years period. The soil humidity at the time of measurement was 10.5% of its weight (2015); 16.9% of its weight (2016) and 12.8% of its weight (2017).

Table 2 Average values of penetrometric resistance of soil

<table>
<thead>
<tr>
<th>The depth of the soil horizon (mm)</th>
<th>Year</th>
<th>Variant of mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>100–200</td>
<td>2015</td>
<td>1.56 ± 0.50a</td>
</tr>
<tr>
<td></td>
<td>2016</td>
<td>1.35 ± 0.06ab</td>
</tr>
<tr>
<td></td>
<td>2017</td>
<td>1.17 ± 0.29a</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>2.90 ± 0.29c</td>
</tr>
<tr>
<td>200–300</td>
<td>2016</td>
<td>1.29 ± 0.03a</td>
</tr>
<tr>
<td></td>
<td>2017</td>
<td>1.53 ± 0.35a</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>3.00 ± 0.22a</td>
</tr>
<tr>
<td>300–400</td>
<td>2016</td>
<td>1.34 ± 0.09c</td>
</tr>
<tr>
<td></td>
<td>2017</td>
<td>1.68 ± 0.42a</td>
</tr>
</tbody>
</table>

Legend: Mean ± SD of three determinations, means in rows, not followed by a common letter are significantly different according to Tukey's multiple range test (P < 0.05).

As it can be seen from the values of penetrometric resistance and statistical analyses, there are statistically significant differences between the depths of the soil profile and the evaluated variants of plant mixtures in many cases. In overall, the highest values of soil penetrometric resistance were measured in 2015, shortly after the experiment was established. By comparing these average values with critical values, which are stated for example by Dijck (2002) or Arshad et al. (1996), the soil is most compacted at a depth of 200–400 mm where it reaches a level corresponding to the high compaction. It can be assumed that the reduction of soil compaction over three-year period may be affected by the roots of the plant community, while these roots mostly interfere the soil at a depth of 300–400 mm. Because of these facts, in the recent years, the attention has been focused primarily on the use of various herbal mixtures, which are deliberately introduced in between rows of vines (Escalona et al. 2003).

Figure 1 Comparison of the influence of greenery on the penetrometric resistance (2015–2017)

Legend: Vertical columns indicate 0.95 confidence intervals
Zanathy (2006) describes the high level of soil compaction at those vineyards at which the mechanical soil management is being done. Ramos and Martinez-Casanovas (2006) state, that the alternative soil management techniques which use grassing of the soil surface, such as applying different cover materials on the soil surface, can help to sustain a favourable water balance, soil structure and to lower soil consolidation. Other scientists like Fischer et al. (2014), Peacock (1999), Schuch and Jordan (1981), Gradwell (1968) as well describe the positive effect of vegetation cover on maintaining favourable soil structure, which helps to reduce the extent of soil compaction.

The overall evaluation of the average values of penetrometric soil resistance presented in Figure 1 clearly prove that each variant of plant mixtures has the positive effect of on soil resistance reduction.

The most significant decrease was observed in the variant A (Yearling Mix) and variant B (Perennial mixture - diverse). The penetrometric evaluation of soil compaction in cultivated and grassed rows between the vines in California was studied by Smith et al. (2008) as well. The results of their work confirm (in the longer term) the positive influence of vegetation covered soil on the reduction of soil compaction.

CONCLUSION

In the years 2015–2017, there were carried out experimental measurements in the area of South Moravia focused on the issue of influence of vegetation cover in between rows of vines on reduction of soil compaction. The measurements were carried out at site called Popice/Gotberg. 4 variants of vegetation cover with varied species composition were evaluated with the working designation yearling mixture, perennial mixture – diverse, perennial mixture – dry and yearling mixture – pollinators. The measured values of penetrometric soil resistance show, that the biggest reduction of soil density happened in the area between the vineyards by variant A – yearling mixture (58.8%) as well as the variant B – perennial mixture – diverse (56.7%). Both variants of greening have a major influence on reduction of penetrometric resistance of soil and their sowing in between rows of vines can be especially/particularly recommended as a corrective measure restricting soil compaction.

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REFERENCES


