AN EVALUATION OF THE GRAPE VINE GROWTH AFTER DEEP COMPOST INCORPORATION

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Abstract
Experiments were set up in vineyards in two different locations, Lednice and Velké Bílovice, in order to verify the effect of compost and compost enriched with Lignohumax applied to the areas around trunks on vine growth. The compost rates applied in autumn 2017 were 30 $t \cdot ha^{-1}$. The purpose of the initial measurements was to compare the length of new shoots, indicating a predominantly positive effect in relation to the application of compost. At the Lednice site, the length of shoots was 8-16% longer in the fertilised variant, while at the Velké Bílovice site it was 4-10% longer compared to the unfertilised control variant. The applied compost also had a positive effect on soil moisture.

Key words: *Lignohumax; soil moisture; shoot length; viticulture; Vitis vinifera.*

INTRODUCTION

Most wine-growing areas in Europe are currently facing a lack of rainfall and only 10% of vineyards are equipped with supplementary irrigation (*Costa et al., 2016*). The increasing scarcity of water is becoming an ever-growing problem for vines, even in relatively cooler and wetter European countries such as Austria, Germany, Luxembourg, Czech Republic etc. (*Santos et al., 2020*). This is probably caused by the increase in daily temperatures over recent years, which has been accompanied by more extreme weather events such as heat waves, long periods of drought, etc. (*Fraga et al., 2020*). The lack of water, combined with high temperatures during the growing season, may be the main limiting factor for the growth of shoots on vines and the production of grapes (*Chacón-Vozmediano et al., 2020*). In the long term, this condition leads to a general weakening of the growth of vines, which may result in their drying out. Another problem is the limited production of above-ground biomass, especially of shoots. Once they have matured, they are used to shape the vines and form canes in the following year (*Gambetta et al., 2020*). Therefore, in practice, it is very important to focus on ways of increasing water availability and limiting potential water stress in vines during the growing season without the use of supplementary irrigation (*Ramos & Martínez de Toda, 2020*). In this respect, innovative agrotechnical interventions that provide the desired effect, are easy to implement and economically viable can be considered promising solutions (*Yang et al., 2021*).

One such promising solution in this context is the application of organic fertilisers to the soil profile in the spacing between vineyard rows. It is generally known that organic matter plays an indisputable role in improving the physical and chemical properties of soil, including improving its retention capacity (*Nardi et al., 2002*). Especially in older plantings (typically over 25 years old), we see a significant deficit of organic matter in soil. This is a consequence of the cultivation itself, which depletes the soil of organic matter, as well as the more difficult application and incorporation of organic fertilisers, and their unavailability due to the decline in livestock farming (*Hudetzová, 2021*).

For that reason, viticulture is addressing issues related to the replacement of traditional organic fertilisers, such as manure, new types of fertilisers (compost), digestates, green manure (*Chou & Vanden Heuvel, 2019*), etc. The advantage of quality compost is its favourable composition and relatively wide availability in terms of quantity and price (*Pessina et al., 2019*).

In vineyards, traditional fertilisers as well as new types of fertilisers face the same problems associated with their application. Existing systems apply compost to the surface of the fertilised spacing between rows, followed by incorporating it shallowly below the soil surface (*Burg et al., 2021*). Other application methods are also being tested, e.g. application in a furrow pre-ploughed in parallel with the treated rows where the applied compost reaches a deeper depth where roots with the capacity to actively take up water and nutrients are distributed (*Gaiotti et al., 2017*). Another positive effect of this method of application is related to the acidification of the soil, the creation of a drain groove for water and air exchange,

the partial removal of soil compaction in trackways, and the disruption of the root system with subsequent regeneration and renewal (*Burg et al., 2021*).
The aim of this paper is to evaluate the effect of deep compost application in the areas around trunks of fertile vines on soil moisture and the growth of vines expressed by the length of shoots.

MATERIALS AND METHODS

The characteristics of the experimental site
Experimental measurements were carried out in between 2018 and 2020 in two locations in the Moravia viticulture region that differ in paedological and micro-climate properties, under the wine-growing conditions of the Czech Republic.

Lednice Experimental Site (Mikulov´s subregion)
With coordinates of 48° 47’ 30’’ north latitude and 16° 47’ 56’’ east longitude, the area of interest is located in a vineyard southwest of the Lednice village (Na Valtické vineyard track). For the needs of measuring meteorological data (monthly precipitation and temperature) a meteorological station with remote data transmission (AMET, Velké Bílovice, Czech Republic) was installed at the experimental sites. The measured values of precipitation and temperature during the monitored years at the Lednice site are shown in Fig. 1.
The predominant soil types are modal chernozem and carbonate chernozem; the parent substrate is loess. The Sauvignon Blanc variety is planted in the vineyard, grafted on the rootstock Kober 5BB, and shrubs are cultivated using high-culture training with a cut to a single cane. The support structure formed of steel columns reaches a height of 1.8 m. The plantation was established in 2012; shrubs are planted in a clutch of 2.5x1.0 m.

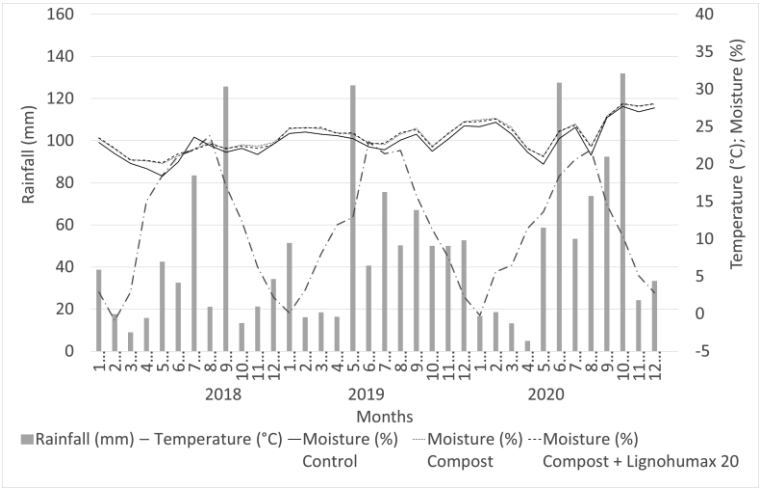

Fig. 1 Average month temperature rainfall and soil moisture under variant in Lednice

Velké Bílovice Experimental Site (Velkopavlovic´s subregion)
With coordinates of 48° 52’ 59” north latitude and 16° 53’ 5’’ east longitude, the area of interest is located northwest from the Velké Bílovice village (Úlehle vineyard track). The measured values of precipitation and temperature during the monitored years at the Velké Bílovice site are shown in Fig. 2.
The predominant types of soil are chernozem and pelic chernozem; the parent substrate is loess. The soil is slitty; this is moderately heavy skeletonless soil, a very deep soil with a mainly favourable water regime. The vineyard is planted with a variety of Pinot Gris, grafted on the rootstock SO4, and shrubs are cultivated using high-culture training with a cut to a single cane. The plantation was established in 2007; shrubs are planted in a clutch of 2.7×1.0 m.

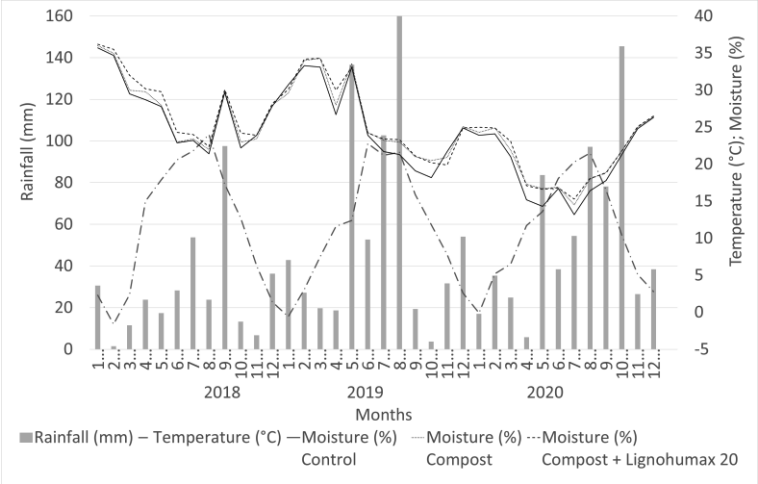

Fig. 2 Average month temperature rainfall and soil moisture under variant in Velké Bílovice

Compost characteristics and experimental variants
The applied compost was made from biologically degradable garden waste. The main components were grass cuttings, vegetable and fruit waste, wood chips and grain straw. The input raw materials were composted in strip bases triangular profiles and a base widths of 1.5 m. In terms of composition, the applied compost met the requirements of the CSN 46 5735 – Composting standard. In Tab. 1 are the average values of selected parameters of the compost applied in the vineyards in year 2017. The compost was applied to the cultivated in-rows using a specially designed prototype of a device for deep placement of compost in the spacing between vineyard rows. The embedment depth varied between 0.25–0.30 m.

Tab. 1 Selected physical and chemical parameters of the applied compost

Parameter	K	Mg	P	Ca	Dry matter	N_C	C_{OX}	pH_{KCL}
	$mg \cdot kg^{-1}$	$mg \cdot kg^{-1}$	$mg \cdot kg^{-1}$	$mg \cdot kg^{-1}$	(%)	(%)	(%)	
Value	4256±240	1190±57	608±64	7605±282	67.85±1.63	0.87±0.08	4.01±1.13	7.05±0.07

The experiment was based on the following variants:
Variant I – control without compost
Variant II – compost (dose of 30 $t \cdot ha^{-1}$)
Variant III – compost (30 $t \cdot ha^{-1}$) + Lignohumax 20 (0,4 $l \cdot ha^{-1}$)

Each variant was based on the method of random blocks of 100 m length in three repetitions. The applied dose of compost was 30 $t \cdot ha^{-1}$. Lignohumax 20 (Agrostim Biotechnologieprodukte, Saxony, Germany) was added to Variant III. This is a concentrated water solution produced by the hydrolytic-oxidation degradation of technical lignosulphonates made up of a mixture of humic and fulvic acids, including their salts. The application of Lignohumax increases the usage of nutrients contained in the soil, supports the development of the root system.

Evaluation of the soil moisture
Soil moisture was measured using "VIRRIB" (AMET, Velké Bílovice, Czech Republic) volumetric soil moisture sensors. These are mechanical sensors with a circular design, with a diameter of 280 mm, which were located at a depth of 0.1 m. Soil humidity was recorded to Datalogger, every day at regular fifteen-minute intervals.

Evaluation of the length of shoots
The length of shoots was assessed at regular weekly intervals, using a non-destructive method, from the beginning of the growing season until the first pollination. For taking the measurements, 3 vines were randomly selected for each of the treatments, leaving 8 annual shoots. The length of each shoot was then

measured using a caliper from the base towards the growing point. The measurements were then averaged.

Statistical analysis
Results were reported as averages and standard deviations at a significance level of α= 0.05. The software package Statistica 12.0 (StatSoft Inc., Tulsa, OK, USA) were used.

RESULTS AND DISCUSSION

Fig. 1 and 2 show the evolution of the volume of moisture in the soil during the monitored period. The results show a positive effect of applied compost on soil moisture values compared to the unfertilised control variant. Moisture values at the Lednice site were higher each year by 1–3%, while at the Velké Bílovice site they were 2–4%. *Perez-Alvarez, Garcia-Escudero, & Peregrina (2015)* states that soil moisture conditions can impact subsequent plant growth and nutrition by effecting soil nutrient availability. Also, *Cavagnaro (2016)* and *Burger et al., (2005)* states that soil moisture impact on nutrient availability and cycle may be particularly important for systems where organic matter is the dominant nutrient source. This is caused by the nutrient cycle and release from organic matter sources being largely a microbially mediated process and the activity of soil microbes is strongly dependent on soil moisture. When compost is incorporated into the soil, it is mineralised, which ensures a sustained release of available nutrients that can be more readily available to plants (*D'Hose et al., 2004*). *Meissner et al., (2019)* also states that a sufficient supply of soil organic matter can significantly reduce competition for water and nutrients between vines under hot and dry conditions, especially when it occurs at sensitive stages (e.g. when flowering and building berries), which has a positive effect on vine growth and grape yield.
Fig. 3 show the lengths of the shoots at the Lednice site and Fig. 4 at the Velké Bílovice site. The growth rate of vine shoots is mainly influenced by temperature and soil moisture (*Pavloušek, 2011*).
Overall, the graphs generated at both sites show a shorter length of shoots in the unfertilised control variant. For the variant using compost and compost in combination with lignohumate, the lengths of shoots were greater. *Pavloušek (2011)* states that high temperatures cause the mobilisation of substances stored in the root system, the production of auxins, and an intense and rapid growth of annuals. The problem of evaluating the growth of shoots in relation to the application of composts of different origin, applied on the surface and at depth, was addressed, for example, by *Gaiotti et al., (2017)*. The results of his experiments performed between 2009 and 2013 on the Cabernet Sauvignon varietal show that compost has a conclusive effect on the vegetative growth of vines compared to a control unfertilised variant. The length of shoots in the experiment variant with a fertiliser exceeded the control variant by more than 50%. *Nardi et al., (2002)* state that in order to optimise production, it is necessary to find a balanced relationship between vegetative growth and vine fertility and the yield of grapes produced. Measurements in this context were taken by *Arrobas et al., (2022)*, who applied compost from municipal waste at a quantity of 20 tonnes per hectare in the vineyard. The cumulative grape yield increased by 28% over the three-year period in the experimental plot.

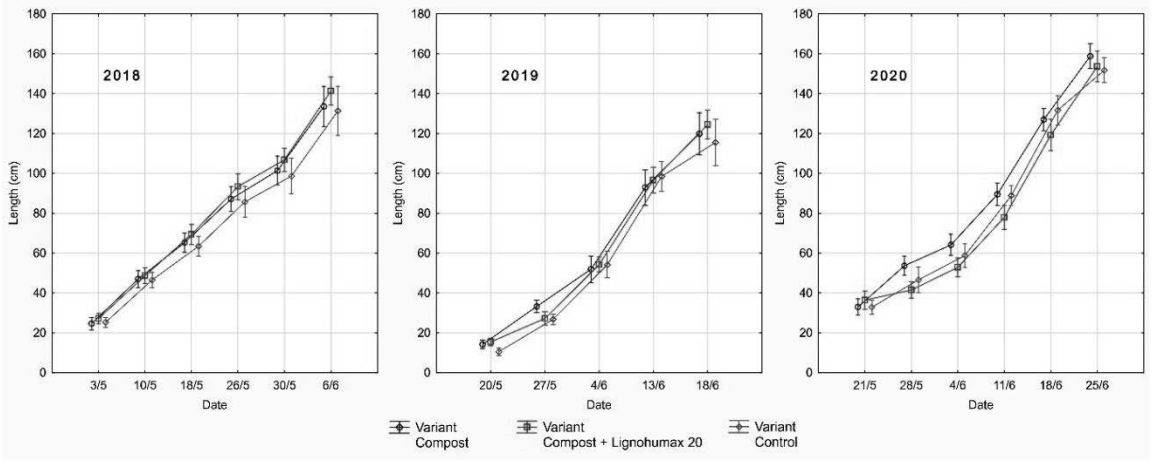

Fig. 3 Average lengths of the shoots at the Lednice site (2018-2020)

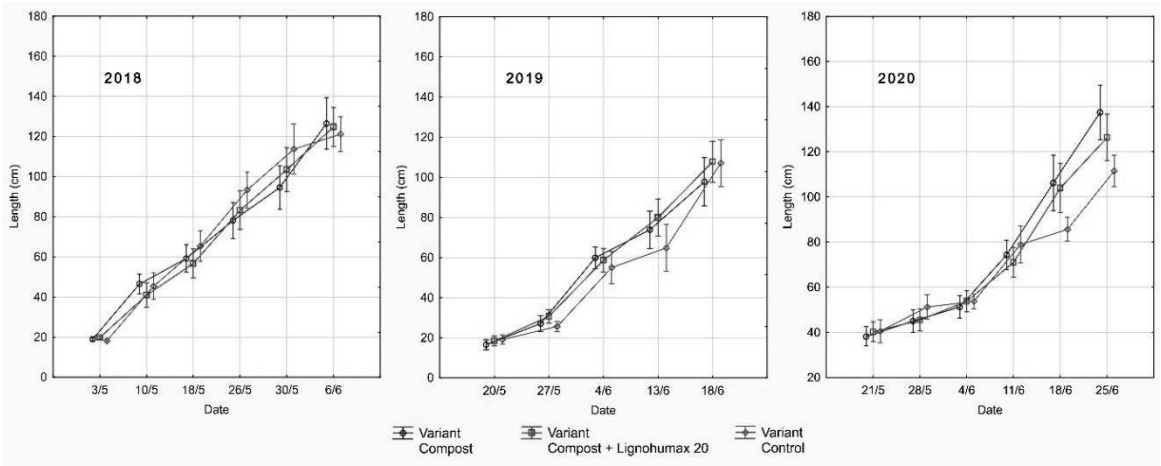

Fig. 4 Average lengths of the shoots at the Velké Bílovice site (2018-2020)

CONCLUSIONS

The results of the measurements taken over a three-year period indicate a positive effect of the deep application of compost to the area around trunks, which is reflected in increased soil moisture and more substantial growth of vine shoots. The wider implications and effects of this method of applying fertiliser will need to be verified over a longer term. Based on the results to date, the deep application of compost in vineyards can be recommended as an important agronomic intervention associated with the enhancement of sustainable viticulture aspects. In terms of future research activities, it would be advisable to focus more attention on variant verification of applied compost rates, verification of the possibility of adding soil improvers, expansion of the evaluation with emphasis on the assessment of vine nutrition, and yield and grape quality parameters in a wider range of grape varietals.

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