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Changes in Soil Structure and Water Resistance of Soil Aggregates after the Application of Wine Marc Compost

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Abstract: The effect of incorporated grape marc compost on the development of soil structure and water resistance of soil aggregates is monitored in two experimental sites, namely on arable land and in a small plot trial since 2012. Climatic and soil conditions of both localities are different. The obtained results indicated that the application of higher doses of grape marc compost into the soil showed a positive effect both on the soil structure and the water resistance of soil aggregates.

Key words: compost; soil structure; wine marc; soil aggregates

1. Introduction

The use of organic materials enhancing properties of soil is a traditional method that enables to improve its physicochemical properties, structure, temperature and humidity on the one side and to increase the content of nutrients that are necessary for the growth and development of plants on the other. The application of organic materials into the soil may cause changes in soil microflora and soil microfauna that involve also a very extensive and very diverse group of nematodes [1].

It was found out that composts made of separated manure or wine marc inhibit the occurrence of galls (cecidia) on tomato roots that are caused by pathogenic nematodes of the species *Meloidogyne javanica*. Results published by Oaka Y. and Yermiyahu U. (2002) [2] indicated that a high concentration of oxygen in soil and a high electrical conductivity of soil aggregates contributed to the capacity of these composts to inhibit and/or kill nematodes.

Brown S. and Cotton M. (2011) [3] quantified positive effects of compost application into cultivated soils. They found out that — as compared with control — the application of compost resulted in a threefold increase in the content of soil organic nitrogen and in a twofold increase in the soil microbial activity. The process of composting is a conventional method how to liquidate organic wastes. If we want to reach a balance in properties of the final product of composting (e.g., its good physicochemical properties, capacity to inhibit and/or suppress phytopathogens, good degree of humification etc.), it is necessary to use for making such composts different source materials [4]. It was also found out that on non-permeable clayey subsoil a greater depth of the compost application into the soil improved the runoff and reduced the degree of waterlogging while on more permeable clayey subsoils this method of compost application extended the period of draught, above all in deeper soil layers [5].

2. Material and Methods

Since 2012, changes in soil properties after the application of compost made of grape marc and some additive components were monitored in several selected localities. Compost was made in a closed

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composting plant EWA in the town Albrechtice (Photo 1). Samples used for the evaluation of soil properties were collected at the beginning and to the end of the growing season.

Estimations of soil structure and water stability of soil aggregates were performed in the pedological laboratory of the Research Institute for Fodder Crops in Troubsko. Soil structure was assessed by sieving dry soil through sieves with the mesh size of 0.25; 0.5; 2. 5; 10 and 20 mm. Soil samples were taken always in three replications from two different depths, viz. 0-0.15 and 0.15-0.30 m. Each structural fraction was separately weighed and converted to percentages. The evaluation itself was performed on the base of calculated coefficients of structurality that expressed the relationship between structural elements of agronomic value (0.25-10 mm) and those of a lower value (>10 and < 0.25 mm). The water stability of soil aggregates was assessed using the method of wet sieving [6]. In individual soil samples, percentages of stable soil aggregates (i.e., those that were not destroyed by water) were calculated using a special formula. Soil was sampled in two replications again in two different depths, viz. 0-0.15 and 0.15-0.30 m. The content of water in soil (expressed as its percentage by weigth — wt%) was estimated in three replications by means of gravimetry in depths of 0-0.10; 0.10-0.20 and 0.20-0.30 m.

Experiments were established in two different localities, i.e., in Troubsko (a small-plot experiment) and in Rakvice (a field experiment).

Photo 1 Fermenter EWA – Closed Composting Plant

2.1 Soil and Climatic Conditions

A) The small-plot experiment in Troubsko (district Brno-County): This locality is situated in a sugar-beet-growing region and is classified as mildly warm and mildly dry. Its altitude is about 333 m above sea level. The soil is classified as a chernozem developed on the loessial subsoil with the loamy to clayey-loamy texture. The long-term annual sum of precipitations is 547 mm (of this, 344 mm occur within the growing season). The long-term average annual temperature is 8.4°C (within the growing season, the average temperature is 14.8°C). The plot is situated on flatland.

B) The field experiment in Rakvice (district Břeclav): This locality is situated in a maize-growing region and is classified as very warm and dry. Its altitude is about 164 m above sea level. The soil is classified as pellic chernozem (vertisol) that developed on very heavy substrates (clays, marls, Carpathian flysch and tertiary sediments). These soils are classified as heavy to very heavy with a lighter ploughing horizon; here and there they contain admixtures of 10% gravel and are prone to a surface waterlogging. The plot is akso situated on flatland.

Variants of wine marc application:

Troubsko

Variant 1–Control, without compost

Variant 2–50 t/ha

Rakvice

Variant 1–Control, without compost

Variant 2–50 t/ha

Variant 3–100 t/ha

3. Results and Discussion

Structural data assessed within the framework of the small-plot experiment established in Troubsko in Variant 1 and in Variant 2 by means of the coefficient of structurality are presented in Fig. 1. The obtained results indicated that in the second year of this experiment, the soil structure improved in both soil layers and in both variants. In Variant 2, the improvement of soil structure was the most marked in the surface soil layer, i.e., in the depth of 0-0.15 m.

Structural data about soils in Rakvice are presented in Fig. 2. As far as values of the coeffiucient of structurality are concerned, in this locality the soil texture is not so good as in Troubsko. It was found out that in all variants its values in the upper soil layer were higher than 1; in the bottom soil layer they were higher than 3 only in Variant 3 (i.e., with the maximum dose of grape marc compost). In average, the highest values of the coefficient of structuraliy were recorded in variants with the highest dose of compost in both years. In 2013, there was a decrease in structural values (probably due to a dry summer season; in this year there were no rainfalls for 2.5 months so that the decomposition of applied compost was not possible and did not take place). Because of the compactness of soil, the applied compost caused a transient deterioration of soil structure. In spite of this, however, a better soil structure was observed in the deeper soil layer.

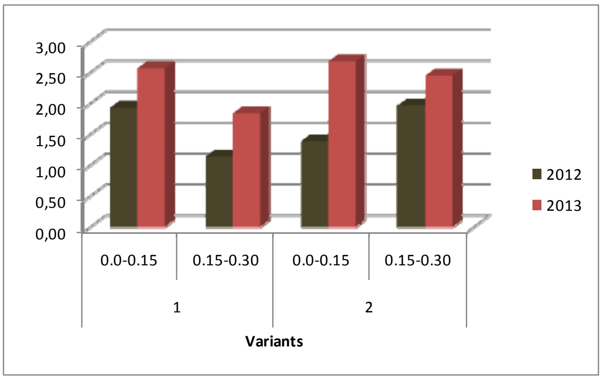

Fig. 1 Soil structure in Different Variants with Applied Grape Marc Compost (Troubsko, 2012-2013)

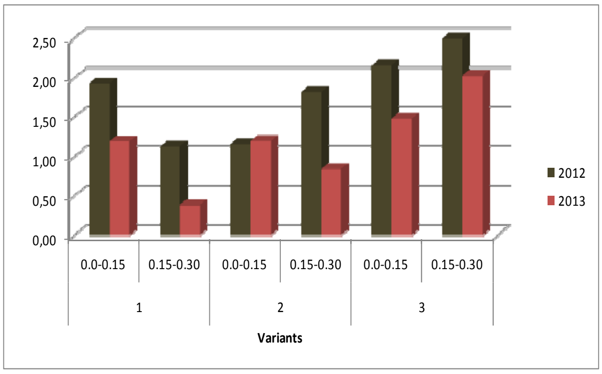

Fig. 2 Soil Structure in Different Variants with Applied Grape Marc Compost (Rakvice, 2012-2013)

As far as the stability of soil structure within the soil profile was concerned, there were differences caused by changing contents of organic matter and by presence of different forms of calcium carbonate, iron oxides, clay particles and pH_{KCl} [7, 8].

The water resistance of soil aggregates was estimated only once in the course of the growing season, viz. to the end of August. This was sufficient to evaluate this soil property.

In Troubsko, the measured values of water stability were at a medium level in both years (Table 1). In Variant 2, the recorded values were slightly higher. Also in this locality a decrease in the water resistance of soil aggregates in deeper sampling layers was obvious.

Results obtained in the field experiment are presented in Table 2. As one can see, higher values were recorded in Variant 3. Values of water resistance were better than those recorded in Troubsko. In 2012, differences between individual experimental variants were great while no significant differences were found out in 2013. A better stability of soil aggregates was observed in the deeper soil layer; this finding was correlated with values of soil structure. Author [9] observed that the application of organic material (e.g., straw) increased the stability of soil aggregates and, thus, also improved the soil structure.

In the small-plot experiment in Troubsko (Table 3), contents of soil moisture were similar in both variants in 2012 while in 2013 higher levels were recorded in Variant 2. Higher levels of soil moisture were recorded in the upper soil layer in both variants and in both experimental years.

Table 1 Water Stability of Soil Aggregates in Different Variants with Applied Grape Marc Compost — Troubsko, 2012-2013

Variants	Soil depth (m)	Years	
		2012	2013
1	0.0-0.15	22.32	28.74
	0.15-0.30	15.81	29.54
	mean	19.07	29.14
2	0.0-0.15	24.29	39.06
	0.15-0.30	21.44	27.82
	mean	22.87	33.44

Table 2 Water Stability of Soil Aggregates in Different Variants with Grape Marc Compost — Rakvice, 2012-2013

Variants	Soil depth (m)	Years	
		2012	2013
1	0.0-0.15	30.93	40.73
	0.15-0.30	31.38	47.66
	mean	31.16	44.20
2	0.0-0.15	46.89	36.29
	0.15-0.30	38.33	48.22
	mean	42.61	42.25
3	0.0-0.15	52.45	39.56
	0.15-0.30	53.14	48.92
	mean	52.79	44.24

Table 3 Soil Moisture in Different Variants with Grape Marc Compost — Troubsko, 2012-2013

Variants	Soil depth (m)	Years	
		2012	2013
		%wt.	
1	0.0-0.10	22.55	19.23
	0.10-0.20	12.72	18.72
	0.20-0.30	11.71	18.45
	mean	15.66	18.80
2	0.0-0.10	22.14	21.96
	0.10-0.20	13.03	19.97
	0.20-0.30	12.37	18.61
	mean	15.85	20.18

Table 4 Soil Moisture in Different Variants with Grape Marc Compost — Rakvice, 2012-2013

Variants	Soil depth (m)	Years	
		2012	2013
		%wt.	
1	0.0-0.10	21.70	19.82
	0.10-0.20	18.11	19.58
	0.20-0.30	16.97	18.02
	mean	18.93	19.14
2	0.0-0.10	21.34	21.03
	0.10-0.20	21.16	20.19
	0.20-0.30	21.42	19.04
	mean	21.31	20.08
3	0.0-0.10	21.10	20.90
	0.10-0.20	21.32	20.04
	0.20-0.30	22.44	19.27
	mean	21.62	20.07

In Rakvice, the content of water in soil was determined by means of gravimetry performed immediately after the sampling (Table 4). As one can see, higher soil humidity was recorded in variants with applied grape marc compost in both experimental years. In all variants under study, a higher content of soil moisture was recorded always in the upper soil layer. Another author [10] found out that compost application into the soil increased generally its water retention capacity. In sandy-loamy soils, the hydraulic conductivity of soil showed a tendency to decrease while in clay and clay-loamy soils the application of compost induced an enlargement of soil pores and, thus, increased their hydraulic conductivity.

4. Conclusions

Basing on obtained results it is possible to conclude that the effect of applied grape marc compost was more and more obvious, above all in the locality Troubsko. The applied compost improved soil properties, i.e., its structure, water resistance and content of soil moisture. In the locality Rakvice, a better soil structure was recorded only in the upper soil layer and in the second experimental year. The water stability of soil aggregates was positively influenced by ccmpost application. In variants with applied compost, the content of soil moisture was also higher. These results were influenced not only by a great variability of climatic conditions that existed in 2013 but also by a too shallow application of grape marc compost.

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References

[1] Renco M., Organic amendments of soil as useful tools of plant parasitic nematodes control, *Helminthologia* 50 (2013) (1) 3-14.

[2] Oaka Y. and Yermiyahu U., Suppressive effects of composts against the root-knot nematode Meloidogyne javanica on tomato, *Nematology* 4 (2002) 891-898.

[3] Brown S. and Cotton M., Changes in soil properties and carbon content following compost application: Results of

on-farm sampling, *Compost Science and Utilization* 19 (2011) (2) 87-96.

[4] Moral R., Paredes C., Bustamante M. A., Marhuenda-Ega F. and Bernal M. P., Utilisation of manure compost by high-value crops: Safety and environmental challenges, *Bioresource Technology* 100 (2009) 5454-5460.

[5] Whelan A., Kechavarzi C., Coulon F., Sakrabani R. and Lord R., Influence of compost amendments on the hydraulic functioning of brownfield soils, *Soil Use and Management* 29 (2013) (2) 260-270.

[6] Kandeler E., Aggregate stability, in: Schiner et al. (Eds.), *Methods in Soil Biology*, Berlin, Springer-Verlag, 1996, pp. 390-395.

[7] Kodešová R., Rohošková M. and Žigová A., Comparison of aggregate stability within six soil profiles under conventional tillage using various laboratory tests, *Biologia, Section Botany* 64 (2009) (3) 550-554.

[8] Annabi M., Houot S., Francou C., Poitrenaud M. and Le Bissonnais Y., Soil aggregate stability improvement with urban composts of different maturities, *Soil Sci. Soc. Am. J.* 71 (2007) (2) 413-423.

[9] Zhang P., Wei T., Jia Z., Han Q., Ren X. and Li Y., Effects of straw incorporation on soil organic matter and soil water-stable aggregates content in semiarid regions of northwest china, *PLoS One* 9 (2014) (3).

[10] Raviv M., Medina S., Krasnovsky A. and Ziadna H., Organic matter and nitrogen conservation in manure compost for organic agriculture, *Compost Science and Utilization* 12 (2004) (1) 6-10.