Organic amendments application to soil of mechanically pruned vineyards: effects on yield and grape composition of cv. 'Syrah' (Vitis vinifera L.)

Manuel Botelho*[1], Amândio Cruz[1], Elsa Borges da Silva[2], António Mexia[1], Jorge Ricardo-da-Silva[1], Rogério de Castro[1], Henrique Ribeiro[1]

1 LEAF, Linking Landscape, Environment, Agriculture and Food, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa
2 CEF, Forest Research Center, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa
Correspondin author: mbotelho@isa.ulisboa.pt

INTRODUCTION

. In Europe, vineyard is one of the agricultural ecosystems with the lowest carbon content in the soil and the one with the highest risk of erosion.
. The decrease of carbon content in vineyard soils is intensified in Mediterranean regions, due to climatic conditions, which will worsen with the expected climate changes.
. In a climate change scenario, Mediterranean viticulture is facing serious risks and adaptation measures are needed.
. Organic fertilization of soil is highlighted, because organic matter plays a fundamental role in long-term soil conservation and/or restoration by sustaining its fertility.
. Available sources of organic matter are increasing, such as composted municipal solid waste, which, if used in agriculture, can improve the physical properties of the soil and provide essential nutrients to plants.

AIM

The aim of this work is to evaluate the effects of the application of organic amendments on mechanically pruned vineyards, in order to increase yield and prevent excessive vigour loss.

MATERIAL AND METHODS

Period - 2012 to 2015; Sites – Quinta do Côro (QC) in Tejo Wine Region and Quinta do Gradil (QG) in Lisboa Wine Region;
Variety – Syrah; Rootstock – 99R (QC) and 1103P (QG); Spacing - 1.0m x 2.5m (QC) and 1.0m x 2.6m (QG); Planting Year – 1999 (QC) and 2005 (QG);
Pruning system - The cordon was 70cm height and **box pruned**.

The studied factor is the organic amendment and three treatments were imposed in a randomized complete block design, with three blocks of 48 vines in each trial field:
. Ctrl – no application of organic amendment neither fertilizer;
. MSWC – application of 16400 kg/ha/year of municipal solid waste compost;
. Manure – application of 24800 kg/ha/year of cattle manure.

In order to determine yield components, the number of clusters per vine and their weight were assessed at harvest in 36 vines per treatment. During pruning, in the same 36 vines, the number of canes per vine and their weight was measured. The dry matter production was calculated as proposed by Carbonneau and Cargnello (2003): DMP = 0.2 * yield + 0.5 * pruning weight. The grape composition was assessed by the laboratorial analysis of 6 samples of 100 berries per treatment. Statistical analysis was done, using the software Satistix 9, by one-way analysis of variance (ANOVA), using the general linear model, and F test. Since the experimental site interaction with the organic amendment was never significant, its values are not presented.

RESULTS

Organic amendments increased the number of clusters per vine (table 1) since year 3 and cluster weight since the year 2 and, in result, yield has been higher in these treatments since the second year of the experiment.

Table 1. Yield components of Syrah vines subjected to the application of municipal solid waste compost (MSWC) and cattle manure (Manure). A control (Ctrl) with no application of organic amendments was considered. Data are means of 36 vines from both experimental sites. The interaction between organic amendments and experimental site was never significant.

	Clusters per Vine				Cluster Weight (g)				Yield (t/ha)			
Year	1	2	3	4	1	2	3	4	1	2	3	4
Ctrl	54	68	64 b	68 b	90	61 b	88 b	70 b	19	17 c	23 b	19 b
MSWC	59	67	78 a	86 a	99	76 a	101 ab	86 a	22	20 b	32 a	29 a
Manure	61	71	75 a	88 a	100	84 a	104 a	85 a	24	24 a	32 a	29 a
Sig.	*n.s.*	*n.s.*	**	**	*n.s.*	**	*	*	*n.s*	***	**	*

Note: Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% (*), 1% (**) and 0,1% (***) by F test.

Vine growth (table 2) was less affected by the organic amendments than yield components. The number of shoots per vine was not significantly different between treatments, in any year, but, in an overall analysis, there is a significant difference between Ctrl and the other two treatments. The pruning weight per vine was increased by Manure, when compared to Ctrl, in years 2 and 3, while MSWC had an intermediate behaviour.

Table 2. Vegetative Growth of Syrah vines subjected to the application of municipal solid waste compost (MSWC) and cattle manure (Manure). A control (Ctrl) with no application of organic amendments was considered. Data are means of 36 vines from both experimental sites. The interaction between pruning and experimental site was never significant.

	Shoots per vine				Shoot weight (g)				Pruning weight (kg/vine)			
Year	1	2	3	4	1	2	3	4	1	2	3	4
Ctrl	26	32	34	32	25	18 b	21	15	0.66	0.61 b	0.71 b	0.48
MSWC	27	34	37	36	26	21 ab	22	19	0.71	0.74 ab	0.84 ab	0.70
Manure	27	34	38	38	29	23 a	24	17	0.76	0.79 a	0.89 a	0.60
Sig.	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*	*n.s*	*n.s*	*n.s.*	*	*	*n.s.*

Note: Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% (*), 1% (**) and 0,1% (***) by F test.

The dry matter production (table 3) was increased by both organic amendments, showing an increase in vine capacity. Ravaz index (table 3) was also increased by organic amendments, showing that the higher carbohydrate production was directed preferably to reproductive growth, instead of vegetative growth.

Table 3. Annual dry matter production of Syrah vines subjected to the application of municipal solid waste compost (MSWC) and cattle manure (Manure). A control (Ctrl) with no application of organic amendments was considered. Data are means of 36 vines from both experimental sites. The interaction between pruning and experimental site was never significant.

	Dry Matter Production (t/ha)				Ravaz Index			
Year	1	2	3	4	1	2	3	4
CTRL	5.14	4.52 b	5.90 b	4.67 b	7.62	8.31	8.83 b	10.45 b
MSWC	5.60	5.49 a	7.99 a	7.18 a	8.01	7.99	11.39 a	11.18 ab
Manure	6.36	6.31 a	8.05 a	7.06 a	8.02	8.88	10.00 a	12.72 a
Sig.	*n.s.*	***	**	*	*n.s.*	*n.s.*	*	*

Note: Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% (*), 1% (**) and 0,1% (***) by F test.

With exception of PAC in the year 3, grape composition was not significantly affected by the application of organic amendments to soil. In the third year of the trial, PAC decreased with the application of MSWC and Manure.

Table 4. Grape composition of Syrah vines subjected to the application of municipal solid waste compost (MSWC) and cattle manure (Manure). A control (Ctrl) with no application of organic amendments was considered. Data are means of six 100-berries samples from both experimental sites. The interaction between pruning and experimental site was never significant.

	PAC (% vol.)		pH		Total acidity (g/L)		Anthocyanins (mg/l)		Total Phenols	
Year	2	3	2	3	2	3	2	3	2	3
CTRL	13.9	12.6 a	3.46	3.38	5.25	5.48	1626	934	62	36
MSWC	13.4	11.9 b	3.44	3.45	5.19	5.70	1461	903	54	34
Manure	13.2	11.9 b	3.42	3.37	5.25	5.85	1407	946	50	37
Sig.	*n.s.*	*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*

Note: Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% (*), 1% (**) and 0,1% (***) by F test.
PAC – Probable alcoholic content.

CONCLUSION

1. The application of organic amendments to soil has enhanced productivity without reduction of vegetative growth.
2. The dry matter production was higher and the carbohydrates gain was preferably directed to reproductive growth.
3. Despite the increase in productivity, the grape composition in treatments with organic amendments was not different from Ctrl, except when yield exceeded a certain level and led to a delay in ripening.

MSWC and Manure improved yield without significant quality loss, proving to be good options for increase vineyard profitability. Since cattle manure is becoming less available, MSWC seems to be a good option for increasing soil organic matter and fertilize vineyards.

ACKNOWLEDGEMENTS

Research funded by PDR2020 (Measure 1.0.1/2016, partnership nº82, initiative 164), FCT (UID/AGR/04129/2013) and Caixa Geral de Depósitos and Instituto Superior de Agronomia / Universidade de Lisboa (doctoral grant to Manuel Botelho).