Evaluation of Two grapes Harvesting Machine with Horizontal and Vertical Shaking

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ABSTRACT

Here the research results are presented whit the aim of comparing two types of grape harvesting machines, one using horizontal shaking (SO) and another using vertical shaking (SV). Both machines have been tested for the mechanical harvesting of Trebbiano Romagnolo trained by Casarsa and by GDC. The attention was focused on the extent of the vibrations transferred from the shaker, on the effects on the products and on the plants and on the final features of the wine. The results have shown differences between the two grape harvesting machines and to a lesser extent between the adjustments used with each machine. The extent and the duration of the vibrations transmitted have affected the mistreatment on the vegetation, the harvest's characteristics and the results of the enological transformation. Thanks to a closer interaction between the plant and the machine, the vertical shaking system has allowed for an overall better performance.

Keywords: Mechanical grape harvesting, vibrations, wine producing characteristics, Italy.

1. INTRODUCTION

In Italy, mechanical harvesting is subject to criticism which influences its growth. In most cases there is an underlying fear of the negative effect of the harvest yields and the quality of the product. To completely understand the importance of these elements, it is helpful to know the beginnings and the development of two grape harvesting machines.

1. MATERIALS AND METHODS

The test were carried out on Trebbiano Romagnolo in two level and adjacent vineyards.

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One of them is cultivated in Casarsa by the trailed grape harvesting machine, horizontal shaking model *LS* of the *ERO* Firm, the other one, GDC cultivated, by the self-propelled grape harvesting machine with vertical shaking model *VT SC* of *Tanesini Technology*.
The *LS* grape harvesting machine with horizontal shaking (*SO*) was provided with a structure of a double series of curved poles of 1,3 m length whereas the *VT SC* grape harvesting machine was equipped with a star-shaped shaker with 6 inclined spokes operating only on support wire and on permanent cordon.
The two machines were driven with the proceeding speed the most suitable for test conditions: 1.6 km/h for the *SO* and 2.0 km/h for *SV*.
Using these speeds, 3 thesis were carried out varying only the shaking frequency: 500, 600 and 700 strokes/min for *SO* and 450, 500 and 550 strokes/min for *SV*. The thesis were repeated 3 times.
Each thesis was checked on three different aspects:

- number and intensity of the vibration transmitted from the grape harvesting machine to the vine and to its support was carried out with piezoelectric accelerometers mounted on different positions of the plant in the central part between every two supporting poles down the row;
- the influence of the mechanical harvest on the product and on the plants. The fallen grapes and the leaves expelled by the cleaning system were collected and measured from ground. The harvested product was subdivided to the solid fraction (bunches and grapes), that liquid (must) and that represented by foreign matter (leaves and vine shoots) (AA.VV., 1978). This measurement was done with hydro-sensitive paper applied in the productive phase, with the purpose of supplying an indication on the “hidden” loss;
- the final quality of the wine. The evaluations, triangular tests and 1 preference test (Ubigli, 1998) were done in each trained system, comparing the three models of mechanical harvesting with that of manual reference.

2. RESULTS AND DISCUSSION

2.1 Transmitted vibrations

Considering the thesis of the grape harvesting machine *SO* you can note how the rise of the shaker frequency implies a corresponding rise in the number and in the values of the transmitted accelerations.
In a particular way the peak accelerations rise (>1000 m/s^2), and pass from an incidence of 21% to that of 45%.
Instead, in the case of the *SV* grape harvesting machine the effect is highlighted only with the first shaker frequency rise and has prevalently interested the impulses of average intensity (500-1000 m/s^2).
The highest frequency (550 strokes/min) was less incisive than the preceding regulation, with a reduction in the number of impulses and of the top value (1340 versus 1785 m/s^2). This result is attributed to the elasticity of the support wire that, with higher frequency, can impede a regular transmission of impulses of the shaker. The solicitations to the vine shoot are much more reduced. If we consider a > 20 cm distance from cordon, the maximum values resulted to be more than halved.

Based on our machines accelerations comparison, we can note how the grape harvesting machine *SO*, that involves a great part of the vegetative wall during the shaking, generates a train of impulses of high entity with a high duration. Differently, the grape harvesting machine *SV*, that works on the support structure of the vineyard, transmits less intense accelerations and concentrated in a shorter time interval (Fig. 1).

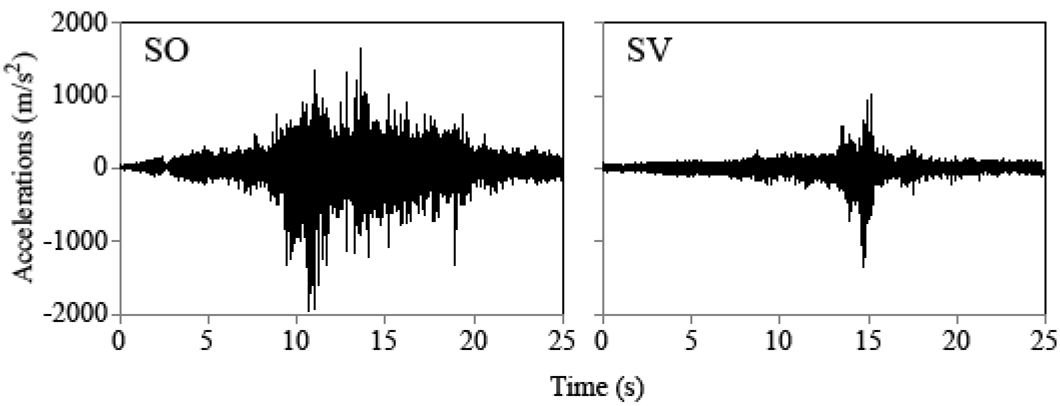

Figure 1. Trends acceleration by grape harvesting machine SO on the productive part during the intermediate regulations and by grape harvesting machine SV on the permanent cordon

Influence on the Product and on the Plants

The *SO* system, more direct, caused an increased mistreatment of the harvested product compared to *SV*, and has an averagely higher level of must (23.6% versus 9.6%). This result is shown even on the moisture of the hydro-sensitive paper applied to the leaves. The highest moisture recorded in the thesis with *SO* (on the average 82% versus 13%) indicates a higher value of hidden losses.

The *SO* system is also less efficient in the detachment of the product, showing with limited differences, a higher presence of grapes and shoots left on the plant. There are not substantial differences between the two shaking systems as for the loss on the ground.

The evaluation of utilized adjustments shows, for both machines, the tendency to improve the harvest yield when increasing the frequency of shaking. The differences appear to be limited and not significant (Table 1).

The different comportment of the machines also shows in surveys done on the leaves (Table 2). During harvesting, both machines tend to break off a percentage of leaves which increases with the rising frequency of shaking. The *SO* system appears to be stronger with a higher detachment (on average of 36% versus 28%) and it is particularly elevated in the highest frequency (55%). The detached leaves were found on the ground, for the most part expulsed from the pneumatic cleaning system, or in the harvested product. In both cases they represent a direct and important source of hidden losses, because they collected must on a large part of their surface.

Table 1. Percentage distribution of the product surveyed in the tesi

Thesis	Harvested product		Visible losses		
	solid	liquid	Bunches of grapes on plant	Small bunches on plant	Berries on ground
SO 500	71,8 a	22,0 b	2,4 d	3,6 d	0,2 a
SO 600	70,1 a	23,6 b	1,9 cd	3,3 cd	1,1 b
SO 700	70,5 a	25,3 b	0,2 a	2,9 bc	1,1 b
SV 450	84,7 b	10,4 a	1,7 c	2,4 ab	0,8 b
SV 500	86,4 b	9,7 a	1,1 b	2,0 a	0,8 b
SV 550	87,8 b	8,7 a	1,1 b	2,2 a	0,2 a

values followed by different letters within the same column differ statistically for $P \leq 0,05$.

Table 2. Percentage distribution of the leaves after the passage of the machines

Thesis		Leaves (%)	
	On plant	On ground	Harvested
SO 500	75,5 c	18,6 a	5,9 c
SO 600	70,3 bc	25,8 ab	3,9 b
SO 700	45,3 a	47,5 c	7,2 c
SV 450	75,1 c	23,5 ab	1,4 a
SV 500	71,9 bc	25,8 ab	2,3 ab
SV 550	67,7 b	30,6 b	1,7 a

values followed by different letters within the same column differ statistically for $P \leq 0,05$.

3.3 Sensorial Evaluation in obtained Wines

The triangular tests have shown, in each trained system, significant differences ($p \leq 0.05$) between all of the compared thesis. The only exception was found in Casarsa, where the manual harvest wasn’t different to the mechanical harvest carried out with the lower frequency of the shaker.

Some significant differences emerged in the preference test, where the low values (ranks), calculated from the summary of every wine taster’s grading, indicate the best wines (Fig. 2). Among the Casarsa thesis, the SO 600 was the least preferred thesis, followed by the SO 700. The manual harvesting and the mechanical harvesting at a lower frequency (SO 500), already similar to the triangular test, were much more appreciated.

In the thesis gathered in the GDC, those most appreciated were the SV 450 and the SV 500, even if the four wines didn’t have significant differences in their results. The low evaluation of the manual thesis can be attributed to the sanitary state of the grapes that presumably were penalized due to a longer harvesting time compared to that necessary for the mechanical harvest (4 h versus app. 0.4 h).

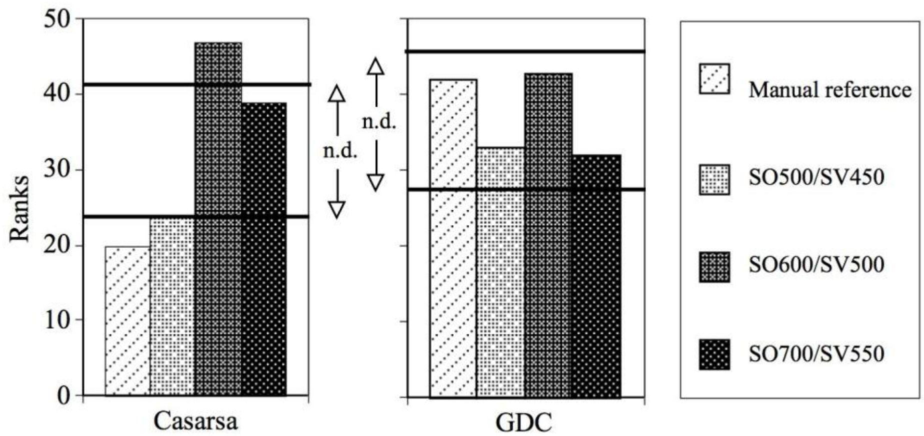

Figure 2. Kramer tests conducted among different techniques on the same vineyard. It is shown the interval of no difference (P ≤ 0.05).

4. CONCLUSIONS

The evaluation of the functional, operational and technological aspects of mechanical grape harvesting has highlighted important differences between the examined systems.

The correct regulation of the shaker, in *SO* harvest, appears to be fundamental for better transmitting suitable solicitations to produce a satisfactory detachment, without damaging the product or the vegetation. In every case the direct action of the machine always produced a certain quantity of grape juice and of defoliation of the plant, that represent the two main causes of quality and quantity losses of the harvest.

Differently, the best interaction between the machine and the plant of *SV* allows for better transmission of the vibrations and to avoid dangerous excesses due to an elevated frequency of the shaker. The *SV* harvesting machine produces less damage to the product and to the plant, and it is easier to regulate.

These results have been confirmed by the wine tasting as well. In the *SO* case the product shows qualitative similarities to the manual harvesting only in the thesis of low frequency of the shaker that provoked less damage. Instead, in the *SV* case the different regulations of the thresher didn't cause a decrease in the quality, which compares to the wine that was manually harvested.

Overall the results appear to be positive for the two harvesting systems. They can satisfy the different needs of vineyards concerning the costs of planting, the cultivation techniques and the professionalism of the operators.

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