Evaluation risks of biomechanical overload during the manual vineyard pruning by using measured values of the effort

Camillieri D.[(1)], Conti A.[(1)], Longo D. [(1)], Rapisarda V.[(2)], Romano[(3)], Schillaci G.[(1)]
[(1)] *University of Catania. DiGeSA, Section of Mechanics and Mechanisation*
Via Santa Sofia, 100 – 95123 Catania, ITALY. Tel 0039 0957147512, Fax 0039 0957147600
Email corresponding Author: giampaolo.schillaci@unict.it
[(2)] *Occupational Medicine, Policlinico Universitario "G. Rodolico", via S. Sofia 78, 95100 Catania ITALY. Tel +39 095 7021 412,*
[(3)] *Agriculture Research Council – Agricultural Engineering Research Unit (CRA-ING); Laboratory of Treviglio, via Milano 43, 24047 Treviglio BG, ITALY. Tel/Fax 0039 0363 49603*

Abstract
Several analytical methods have been developed to determine and quantify the risk from exposure to biomechanical overload of the upper limbs. The subjective estimates of the force applied by the workers during the assessment of muscle-skeletal risk exposure in the vineyard manual pruning appear critical. Some recent research has been carried out using a sensorized scissor to obtain measures of the handling effort used, in place of the estimates expressed by the workers (Schillaci et al., 2010; Romano et al., 2010). This research proposes a preliminary study of an experimental methodology in order to replace subjective opinions with instrumental values obtained by using electromyography (EMG) in assessing the risk of muscle-skeletal overloading of the upper limbs during manual vineyard pruning.
The OCRA method (Colombini and Occhipinti, 1996, 2005) is the procedure recommended by the international standard (ISO 11228-3) for risk assessment from overload due to upper limbs repetitive movements. The Borg CR10 scale is usually used to evaluate the subjective perception of the strain in relation to the amount of the strain. In this research, we have used the results of laboratory tests that used EMG performed by a sample of pruners on different vine cultivators with different branch diameters and with different scissors. Using the surface EMG it was possible to highlight the actions taken by each muscles involved in the technical actions. The measurements of the EMG acquired were compared with the measurements of the MVC (maximum voluntary contraction) on the activity and the subject examined.
From the data processing recorded during the laboratory operations, represented by percentage of intensity compared to the relative MCV, a value was obtained for the strength for each muscle analyzed during the activity and for an intensity scale of the strength. The values of the "strength" acquired have been used to calculate the risk through the OCRA index. The results obtained were compared with the workers opinions about the subjective perception of the strain and with the results of previous research (Schillaci et al., 2010; Romano et al., 2010). The EMG tests have shown the involvement of the muscular districts involved giving new ideas about the risk assessment in pruning operations.

Keywords: OCRA Method, EMG, MCV

Introduction
There are several analytical methods developed to determine and quantify the risk from exposure to biomechanical overload of the upper limbs. They are often criticized because they are considered unsuitable to accurately quantify the exposure to the risk factors.

It appears critical the subjective estimate of the force applied by the workers during the assessment of muscle-skeletal risk exposure in the vineyard manual pruning. Some recent researches have been carried out using a sensorized scissor to obtain measures of the handle effort to be used in place of the estimates expressed by the workers *(Schillaci et al., 2010; Romano et al., 2010).*
This research proposes a preliminary study of an experimental methodology in order to replace the subjective opinions with instrumental values obtained using electromyography (EMG) in assessing the risk of muscle-skeletal overloading of the upper limbs during vineyard manual pruning.

Methods
The OCRA method *(Colombini and Occhipinti, 1996, 2005)* is the procedure recommended by the international standards EN 1005-5 and ISO 11228-3 for the risk assessment from overload due to upper limbs repetitive movements.
The Borg CR10 scale is usually used to evaluate the subjective perception of the strain in relation to the amount of the strain.
Furthermore, the OCRA methodology allows different procedures for the evaluation of the "strength" as an estimate of the external force by using dynamometers and the estimate of the internal force through the surface electromyography (EMG).
In this research, we have used the results of laboratory tests using EMG (*Romano et al., 2012*) performed by a sample of pruners on three different vine cultivars (*Cabernet, Merlot, Moscato*) with twodifferent diameters of the branches (<5 mm / 8-12mm) andwith two different scissors (*Fig. 1 and Fig. 2*).

Fig. 1 – Scissor F

Fig. 2 - Scissor W

Using the surface EMG it was possible to highlight the actions taken by each muscles involved in the technical actions.
The measurements of the EMG acquired were compared with the measurements of the MVC (maximum voluntary contraction) on the activity and subject examined.
From the data processing recorded during the laboratory operations, represented by percentage of intensity compared to the relative MCV, a value was obtained for the strength for each muscle analyzed during the activity and for an intensity scale of the strength. The values of the "strength" acquired have been used to calculate the risk through the OCRA index. The results obtained were compared with the workers opinions about the subjective

perception of the strain and with the results of previous research (*Schillaci et al., 2010; Romano et al., 2010*).
Limits to the present work include the fact that the values for the force exercised by the hand were derived from laboratory and not field trials and that these trials involved staff not used to carrying out the work.

Results
The table below (Tab. 1) shows the data processing obtained during the cutting tests as compared to their MVC percentage for different cultivars. On this specific occasion, since we wanted to try an experimental methodology, we have been working with only average values.

Tab. 1 – Level (%) with respect to MCV

Scissor F	**37.09**
Cabernet	**47.22**
diameters <5 mm	25.14
diameters 8÷12mm	69.29
Merlot	**31.29**
diameters <5 mm	22.16
diameters 8÷12mm	40.41
Moscato	**28.43**
diameters <5 mm	20.86
diameters 8÷12mm	36.00
Scissor W	**28.12**
Cabernet	**34.74**
diameters <5 mm	19.19
diameters 8÷12mm	50.29
Merlot	**24.78**
diameters <5 mm	15.37
diameters 8÷12mm	34.18
Moscato	**21.56**
diameters <5 mm	12.82
diameters 8÷12mm	30.31
Total	**32.60**

The values measured in the cutting trials were converted into Borg scores in relation to the average strains. Starting from the values obtained, we can get the Borg scores so that to calculate the risk of upper limb biomechanical overload via the OCRA method..The results are not conclusive, but at facevalue, it seems to be a strict connection with the results of previous study whereas values of stress obtained from laboratory tests using sensorized scissors (instead of the estimation expressed by operators) were used to calculate the OCRA index. (*Schillaci et al, 2010; Romano et al, 2010*).

Conclusions and perspectives

This research proposes a preliminary study of an experimental methodology in order to replace subjective opinions with instrumental values obtained by using electromyography (EMG) in assessing the risk of muscle-skeletal overloading of the upper limbs during manual vineyard pruning.
Finally, this research wants to become the starting point of the good practice of choosing a work tool from the beginning (in this case, a pair of pruning scissors) that meets the ergonomic criteria so that to reduce the ergonomic risk.

Acknowledgements

This work was carried out within the framework of the "INTRAC" project, funded by the Italian Ministry of Agriculture and Forestry. Authors also acknowledge Mr. Elia Premoli (CRA-ING, Laboratory of Treviglio) for his valuable help in setting up the experimental facility as well as the preparation of materials and the data collection.

References

Colombini D., Occhipinti E., Fanti M. 2005. *Il metodo OCRA per l'analisi e la prevenzione del rischio da movimenti ripetuti*. Collana Salute e lavoro, Franco Angeli Editore.

Romano E., Bonsignore R., Camillieri D., Caruso L., Conti A., Schillaci G. 2010. *Evaluation of Hand Forces During Manual Vine Branches Cutting*. International Conference Ragusa SHWA2010 - September 16-18, 2010 Ragusa Ibla Campus- Italy.

Romano E., Camillieri D., Longo D. , Rapisarda V., Schillaci G. 2012. *A clinical test to research objective values of effort during manual pruning.* International Conference RAGUSA SHWA2012 September 3-6 2012 Ragusa - Italy

Schillaci G., Balloni S., Bonsignore R., Camillieri D., Romano E. 2010. *Hand forces during manual vine branches cutting.* Atti su CD-Rom del Third International Congress on Mountain Viticulture, Castiglione di Sicilia (Italy), 12/14 maggio.

Schillaci G., Balloni S., Caruso L., Camillieri D. 2010. *Risk due to repetitive movements in manual vineyard pruning*. Atti su CD-Rom del Third International Congress on Mountain Viticulture, Castiglione di Sicilia (Italy), 12/14 maggio.

Schillaci G., Bonsignore R., Camillieri D., Romano E. 2010. *Assessment of the "Strain" Parameter in the Calculation of the Biomechanical Risk Index as Regards the Upper Limbs in Vineyard Manual Pruning.* International Conference Ragusa SHWA2010 - September 16-18, 2010 Ragusa Ibla Campus- Italy.