Vineyard Pruning Residue Mulcher: A natural Resource Management Machinery

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Pruning is one of the important operations for vineyards. As discussed already it generally done by selectively removing unsuitable or extraneous spurs, while retaining an adequate number of good spurs to produce fruitful shoots in the coming season, and to produce healthy shoots from which a good fruiting cane can be selected for next pruning. Pruning can produce residue in the range of 0.45 to 1.34 kg per plant (1850–5360 kg ha^{-1}) depending on variety of grape, age, climate and other agronomical conditions (Manzone *et al.* 2016, Cetin et al. 2011, Velazquez-Marti et al. 2011, Giacomo and Taglieri, 2009, and Brito et al., 2014). These pruning generally burned or composted in the same field worldwide. Since the pruning residue is good source of energy, it is also considered to collect and use directly or after densification or after conversion to biofuel.

Traditional methods of grape pruning residue management

Burning is easy and old method to dispose the pruning and, prevent the pathogen spread from infected cut pruning to the healthy shoot and enrich the soil with minerals (Adamchuk, 2016). Most of the owners of vineyards collect the pruning residue manually and burn it openly by making pile outside the orchard (Fig.1 a). In some areas of Europe mostly in France and Spain, pruning waste is used to burn simultaneously during pruning operation using conventionally popular wheelbarrows (Fig.1 b) made up of old oil barrel to prevent it from dropping on the ground and save the time of collection (Evineyard, 2018). After combustion, ash produced is in the range of 2.4% to 4.2 % (Nasser et al. 2014) which is potential mineral rich source of mainly Ca, Si, Cl, Mg, Al, K, P oxides (Fernandez-Puratich et al. 2015). However, it creates environmental issues attributed to harmful emissions from open burning of residue. If burnt immediately after pruning, pruning residue emittes about 131 g/kg (db) carbon mono oxide (CO), 25.2 to 40.3 g/kg (db) particulate matter, 5.3 g/kg (db) of Nitrogen oxides (Nox), and other harmful emissions, while the quantity may alter depending on moisture content (Pizzi et al. 2018). In recent years, due to environmental regulation and strict rules related to open burning of pruning residue have diverted many growers to alternate sustainable management.

Fig.1: a) Open burning of grape vine pruning residue (Lutz, 2017), b) On the go burning of pruning residue using traditional equipment during pruning activity (Photo Source: www.evineyardapp.com, 2018)

Mulching and incorporating into soil

Since grape vine canes of irregular size are generally left scattered on inter row area, it becomes obstacle for intercropping and other operations. This residue can be used as organic mulching for cover crops which eventually get decompose releasing nutrients into soil.

Pick-Up Wood Choppers (Adamchuk *et al.* 2016)**:** (Fig.2 a)

Working principle: This machine collects pruned grape vine residue from ground using pick-up attachment, and convey the material to the machine's chopping chamber and then spread chopped material of average size of 4.8 cm on the ground from rear end of machine.

Power consumption: 15 kW

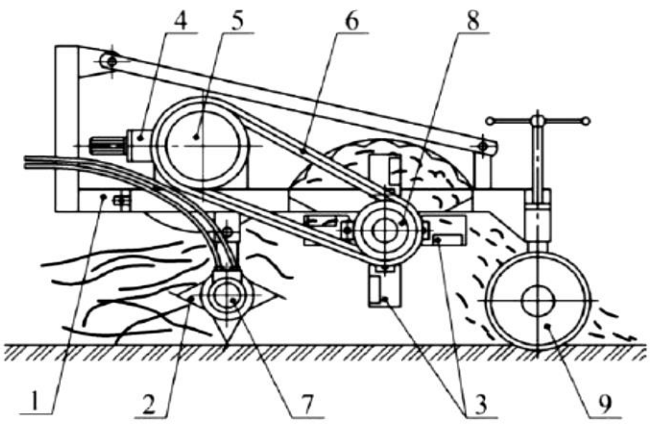

Fig. 2: Schematic of the grape vine pruning residue pick up chopper (1-frame; 2-pick-up system; 3-chopping chamber; 4,5-drive and intermediate gear; 6-belt; 7- hydraulic motor; 8- clutch for chopping unit; 9-gauge wheel) (Adamchuk, 2016).

Components and its function

- ❖ The frame (1) on the chopper is a welded assembly that is fabricated from rectangular tubes and channel beams.
- ❖ The front of the frame features a rigidly-fixed standard three-point linkage for hinging to the aggregating tractor.
- ❖ The collecting unit (2) consists of a tubular shaft with welded rods which are installed on the lower part of the frame (1) with the use of telescopic struts, which allow adjustments to be made in the vertical position of the collecting unit in steps to a total of 200 mm by repositioning the locking pins.
- ❖ The chopper drum with chopping blades (3) consists of a tubular shaft, to which clevis lugs made from angled sections are welded.
- ❖ In the clevis lugs, two types of chopping blade are installed so that they pivot: straight blades and L-shaped blades.
- ❖ The chopper drum shaft rotates on two bearing supports which are attached to the frame (Fig. 2).
- ❖ The actuation of the chopper drum is provided by the aggregating tractor's PTO shaft (at 540 rpm) which drives the step-up gear (4), and then the intermediate gear (5), the belt transmission (6), and the free-wheel clutch (8).
- ❖ The last item is mounted directly onto the shank of the chopper drum.
- ❖ The described chopper design utilizes a single-stage step-up bevel gear (with four positions) that increases the speed of rotation at a gear ratio of 2.4.
- ❖ The other end of the shaft of the intermediate gear (5) features the attached greater pulley for the V-belt transmission (6).
- ❖ The pick-up unit (2) is driven by the hydraulic motor (7) which is mounted onto the collecting unit's support bracket and is connected by pipelines to the aggregating tractor's hydraulic system.
- ❖ Two supporting gauge wheels (9) provide for the adjustment of the positioning of the frame (1) in relation to the soil's surface, depending on the height of the windrow of pruned grape vine canes or fruit tree branches and twigs.

Commercially available machines:

KUHN TRP-175 grape vine cane shredder

- ❖ This pick up the residue and grind into 14 mm size using hammer mill with the power consumption of 29 kW.
- ❖ **Pick up attachments** can be rake type equipment or rotor type equipment (Adamchuk, 2016). KUNH also have a different models of shredders (Model VK-95,115,135,155)
- ❖ **Row spacing**: Different row spacing from 925 to 1525 mm
- ❖ **Offset distance**: 225 to 2025 mm (KUHN, 2018).
- ❖ Rotor type equipment can be drums with fingers or belts with spikes.

A reversible blades mulcher (Fig.2 b) is also available commercially for front and rear mounting with tractors of 90 to 140 hp. It has hydraulically powered pick up roller designed for pruning waste up to 5 cm in diameter (Zanon, 2018,p:1-2).

Table 1: Operational feature of the shredder machine and TRP -175 shredder (KUHN)

Sr. No.	Parameter	TRP -175 shredder (KUHN)
1	Field capacity (ha/h)	1.43
2	Operational travel speed (m/s)	1.24
3	Effective width (mm)	1,750
4	Weight (kg)	950
5	Diameter of collecting drum at rod ends (mm)	350
6	Type of wood chopper drum	Hammers
7	Diameter of wood chopper drum (mm)	465
8	Revolution rate of wood chopper drum (rpm)	1960
9	Number of blades/hammers (pcs)	28
10	Power consumption (kW hp-1)	49/67

TLK reversible blades mulcher (Zanon Machine Agricole)

The TLK reversible mulcher is designed for front or rear mounting on high power tractors (70-120 hp), and incorporates a pick-up roller for feeding waste material into the machine. The TRK is ideal for shredding pruning waste up to 5/6 cm in diameter and can be used over all kinds of terrain, including stony ground. It boasts a robust steel frame and an electronically balanced rotor mounted on fully enclosed, self- aligning bearings.

The TRK features blades arranged in six self-covering rows, high strength steel pick-up rollers and an oil bath gearbox with double freewheel. Possibility of working with both directions of the PTO (specify whether 540 or 1000 rpm).

Parts and components

- Gearbox with double freewheel clutch PTO
- Rotor with helical cutting system
- 3-point linkage fixed
- Cutting system with blade and counter-blade crossing
  Fixed skids
- Fixed steel wheels
- Hydraulically powered double pick-up roller
- Opening hood (for inspection only)
- Protective equipment as per EC safety rules

Fig. 3: TLK reversible blades mulcher (Zanon, 2018)

After a chopping operation, to enhance the in situ decomposition, couple of passes of disc harrow or rotavator to mix and pulverize the chopped residue into soil are generally performed. Some rotavators are commercially available with chopper attachment can be used directly for disposal of grape vine pruning waste into field.

Conclusion

Burning of vineyard residue is seeking attention due to environmental and health issues caused by its harmful emissions. Pruning residue utilization for mulching is much followed as an organic farming to conserve the nutrients in the pruning biomass and soil moisture. Also, this mulching reduces weed infestation reducing the nutrient and water intake and eliminating weeding operation. New principles of pruning crushers can be designed for reduction in power requirement can be point of research for energy efficient vineyard mulching.s

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