WINETWORK
European Knowledge Transfer

TECHNICAL DATA SHEET

GOOD PRUNING PRACTICES

Pruning wounds represent a significant point of entry to grapevine trunk diseases fungi, while pruning debris and symptomatic vines are a source of fungal inoculum. Implementation of preventative control strategies needs to be adopted early after vineyard establishment but winegrowers mainly start to conduct control strategies after grapevine trunk diseases' leaf symptoms appearance.

Network for the exchange and transfer of innovative knowledge between European wine growing regions

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Factors related to pruning that may influence grapevine trunk diseases development

Factors related to pruning such as training system, weather condition during pruning period, number and size of pruning wounds, location and aggregation of pruning wounds, cane and spur length, wound protection, wound age, late seasonal pruning, pruning debris management contribute to the incidence of wound infections and grapevine trunk diseases (GTD) development.

Impact of training system on GTD incidence and severity has been observed in different winegrowing regions but the **available information is partial or contradictory**. Some authors state that different training systems and pruning methods increase the risk of inner wood necrosis development and perennial wood infection with fungi related to these diseases, but the research was conducted in different vineyards and these conditions would have an impact on research results. Differences in Esca incidence are observed depending on the training system, corresponding to 15-20% on Guyot double, 10-25% on Guyot simple, 0-5% gobelet or Robat, and 0-1% on cordon training system. Moreover, changes in cultural practices in Tuscany, such as replacement of cordon with Guyot training system, led to an increase of Esca disease. A correlation of Esca leaf symptoms incidence with cane length on Guyot training system was evaluated in the winegrowing area of Bordeaux, results indicate that **symptoms incidence was higher on Guyot-trained** vines with shorter cane length. Development of Eutypa dieback foliar symptoms is higher on spur pruned vines in comparison to cane pruned, but lower death rate than on cane pruned vines (Fig. 1). On Fig. 1 can be observed that cane pruned vines have numerous grouped wounds on upper part of grapevine trunk, while spur pruned vines have a greater total wound surface.

Pruning wounds represent a point of entry to vascular grapevine pathogens, such as fungi implicated in GTD, which are able to overcome grapevine defence mechanism due to their virulence characteristics. **Large and numerous pruning wounds**, usually frequent on older vines or vines that had

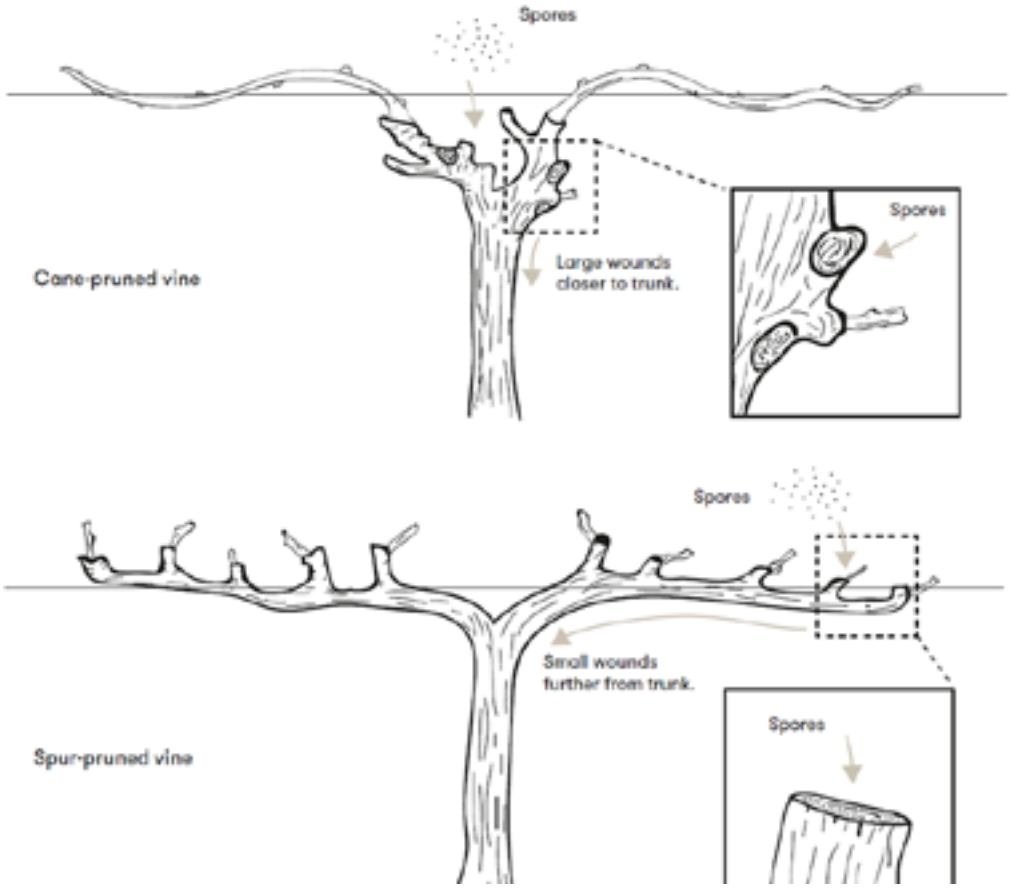

Figure 1: Correlation of grapevine training systems with GTD infection. (Sosnowski, 2016)

been retrained in a different training system, **provide an important point of entry to fungi** due to greater total wound surface area where spores can land and induce infection.
Spread pattern of GTD fungi in vineyard is connected with the distribution of infected vines, where newly symptomatic vines are usually located close to previously infected vines. Some fungal inoculum is transmitted to pruning wounds with pruning shears from infected vines, but the inoculum concentration transmitted with pruning shears is **insignificant**.

Pruning period: wheather condition

To choose the most appropriate pruning period it is necessary to consider different factors such as: **specific climatic conditions** in the concerned winegrowing region, different **life cycles of GTD pathogens**, spore release and wound infection susceptibility depending on the weather conditions, pathogen virulence.

It has been reported that incidence and type of symptoms of different GTD vary greatly between regions. This indicates that **rainfall** and **temperature influence not only the distribution of pathogens but also the symptomatology** of the pathogens in a climatic region. Furthermore, it was observed that the pathogens overlapped in terms of symptomatology, making symptom-based diagnosis of these diseases and their causal organisms unreliable. Therefore, management strategies for the different pathogens in a specific region should be aimed at the whole complex of trunk disease pathogens.

Botryosphaeria dieback, a GTD caused by numerous fungi belonging to *Botryosphaeriaceae* family, is spread within the vineyard by **airborne inoculum**, especially during rainfall or during overhead sprinkler irrigation. Aerial inoculum was observed during winter in California, while it was mainly detected during the vegetative period in France. Because of this, in California, the wound susceptibility is higher when vines are pruned in dormant season and lower when vines are pruned in early March. On the contrary, in France, it was found that the wound susceptibility is higher after bleeding (mean temperature > 10°C).

Eutypa dieback, a GTD caused mainly by *E. lata*, is frequently found in vineyards that receive more than 250 mm of rainfall per year, due to spore release throughout the entire year and spore dissemination with each rainfall > 0.5 mm. Spores are released in the frame of 2-3 h after the onset of rain and stops 24 h after the rain stops. The fungi penetrates into the plant **through pruning wounds** (spore germinate into the wound), and it was found that the wound susceptibility is higher when vines are pruned early in dormant season and lower when are pruned later in the dormant season.

Esca complex, a GTD caused by numerous fungi that belong to different taxonomical classification, has a lifecycle that differs depending on the fungi species present within the vineyard. Spore release of *Phaeomoniella chlamydospora* is **correlated to rainfall**, while for *Phaeoacremonium minimum* occurs during the vegetative period without any link to rainfall. The infection of pruning wounds by *Pa. chlamydospora* decreased from 75% to 10% when inoculation occurred 12 weeks after pruning.

Pruning grapevines during dry weather is critical because fungal airborne inoculum is significantly lower at that period. Late pruning in the dormant season (as close as possible to bud break) is a recommended cultural practice since pruning wounds heal faster with high degree-day temperatures. Recent studies indicate that the rate of natural infection of pruning wounds is lower following early pruning (autumn) than following late pruning (winter). The susceptibility of the wounds is mainly influenced by the relative humidity and rainfall periods.

Weather conditions are significant for release and dispersal of fungal species implied in grapevine trunk diseases, therefore pruning should be conducted during dry periods.

IFV Alsace

Management of pruning debris and other sources of fungal inoculum

The source of inoculum of GTD fungi can be found on vines that display wood and/or foliar symptoms and other crops like orchards cultivated near vineyards. Fungal inoculum can be found on **necrotic stems, leaves, desiccated bunches, under the bark of perennial wood** (trunk, cordon), **dead wood** and **pruning debris** of grapevine and it represents a potential source of new infections in vineyard. In order to remove the source of infection different practices are applied in European vineyards, the most common applied by winegrowers are mechanical grinding followed by incorporation in soil, burning, mechanical grinding followed by composting, extirpation of symptomatic and/or dead vines. Often, there are concerns on the impact of those practices in fungal eradication and prevention of fungal dispersal.

It is estimated that **pruning debris** is a **potential source** of **Botryosphaeria dieback** fungi for **42 months**, but infective inoculum decreased significantly after 24 months and spores viability was reduced to 44%.
Pruning debris and other grapevine fragments may be reintroduced in vineyard after a process of mechanical grinding and composting since this procedures eliminate the GTD fungi, if applied adequately, and do not pose a risk of vineyard recontamination with Eutypa dieback, Esca or Botryosphaeria dieback.

Mechanical grinding and composting on 40 – 50°C for a period of **six months eradicated successfully GTD fungi** (compost made from 140 m^3 pruned and grounded vine material, 125 m3 sheep manure, 60 m^3 of stalks and garden residues like grass and leaves). Additionally, some GTD fungi that induce **Esca disease** (*Pa. chlamydospora* and *P. aleophilum*) **were not isolated from grapevine fragments after grinding**, the authors assume that grinding favoured the activity of saprophyte fungi that grow more rapidly than those GTD species, but precise scientific data that confirms this finding is still missing.

Protection of pruning wounds

Adoption of preventative control methods oriented to GTD management early after vineyard establishment is critical. Infection rate in a longer period of time is significantly lower if a control strategy, with control efficiency of 75% pruning wounds, is regularly applied 3 to 5 years after vineyard establishment. Results presented in Fig. 2 indicate potential efficiency of practices such as late pruning, double pruning and pruning wound protection (mastic or spray application). Preventive disease management, if implemented early after vineyard establishment will minimize disease development and additional costs of cultural practices like trunk renewal or replacing vines later in production.

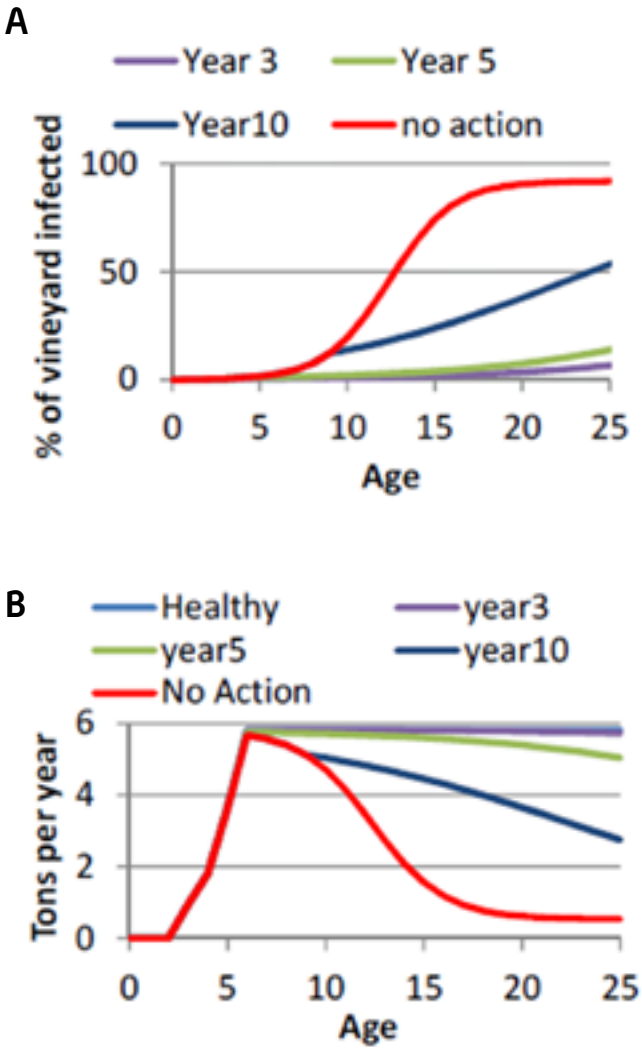

Fig. 2 A) Infection rate with no action and 75% disease control efficiency. B) Yield per acre for healthy, no action implemented, and 75% disease control efficiency (Baumgartner et al., 2014).

It is significant to remember that wounds remain **potential infection pathways** to fungi for a long period of time and protection of both **new and old pruning wounds** is required to limit disease establishment on yearly basis. Pruning wound protection is oriented to biological or chemical fungicides, both applied as prevention, posing different critical points to consider in disease management.

As a preventive measure applied in grapevine trunk diseases management in vineyards, protection of pruning wounds is an essential step.

One of the major limits of **chemical fungicides** is the narrow period of residual activity. Pruning is usually conducted early in the season since organization of work and weather conditions require a longer period of time and it is unlikely to achieve efficiency that lasts from 1 to 2 months. Some chemical fungicides have been reported to be efficient even after 3 weeks post treatment application and when needed more than one treatment may be applied. Application of pruning wound protection is achieved with **sprayed formulations** or **paintbrush applications** of fungicides. Sprayed formulations are more practical, time and cost effective but they are easily washed off by rainfall.

Biological control agents (e.g. *Trichoderma spp.*) and **natural molecules** (e.g. chitosan) have been reported efficient in pruning wound protection, in addition biological agents (BCA) are able to actively **colonize pruning wounds up to 8 months**. Treatments with BCA 6 hours after pruning, either early or late pruning, resulted in high wound colonization with Trichoderma spp. even if weather conditions and physiological state of grapevine were different at that vegetative state.

Once the disease is established it is difficult to implement a successful eradication as a result of limited efficiency of available control strategies. The development of some GTD can have two forms – chronic and apoplectic. Consequently, even if infections primarily occur through pruning wounds on upper parts of grapevine, GTD fungi progress overtime leads to colonization of more distant perennial parts of grapevine, such as trunk (Fig. 3).

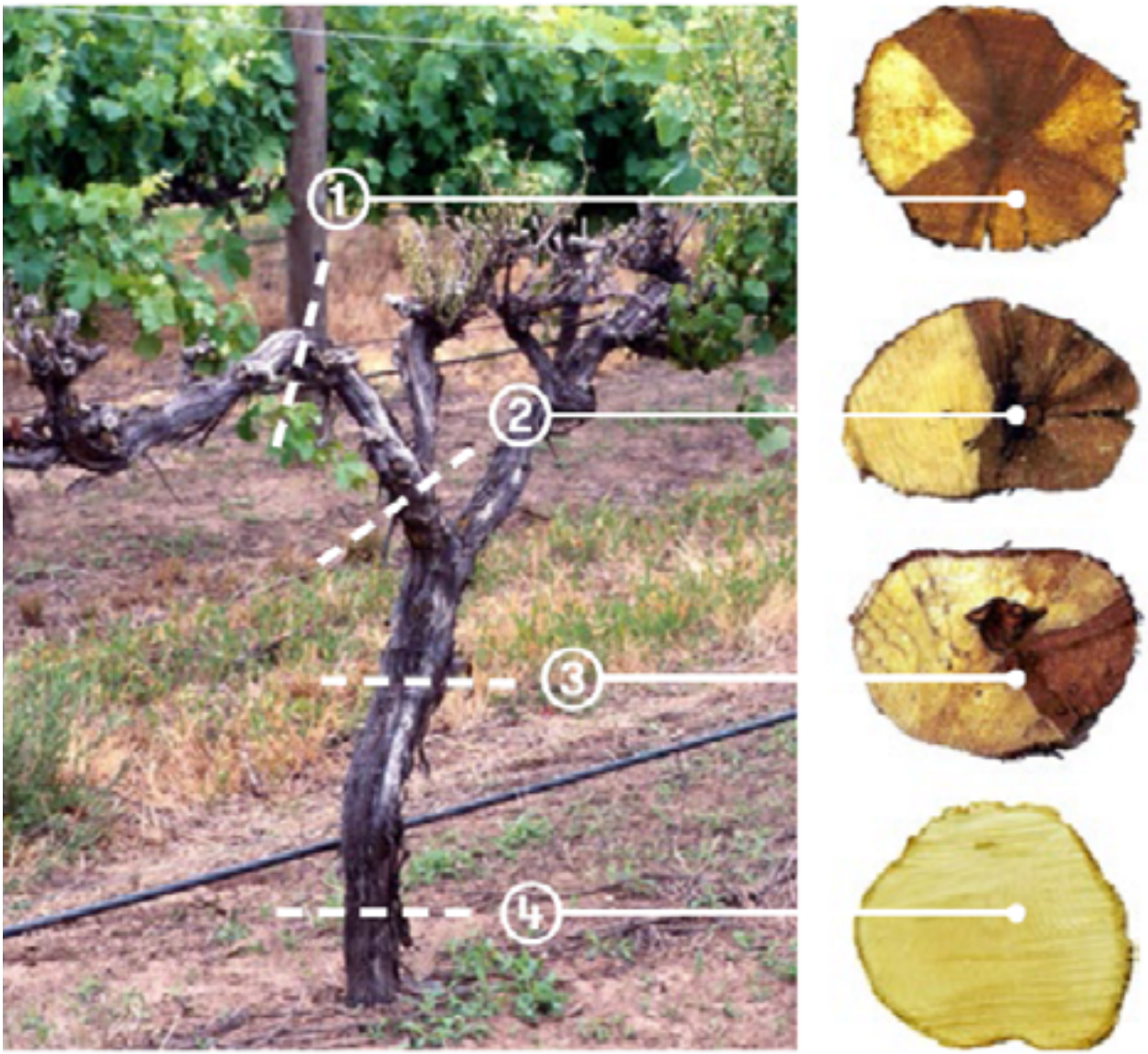

Figure 3: Potential progression of GTD fungi from cordon into basal parts of the trunk. (1-3: symptomatic wood, 4: asymptomatic wood), (Sosnowski, 2016).

Innovative/alternative aspects

1- Pruning Guyot-Poussard

The diameter of the pruning wound may be correlated with a 1.5 times longer necrosis on pruned spur or cane located near perennial wood (Fig. 4). Large wounds near perennial parts of grapevine cordon and/or trunk induce wood necrosis that potentially lead to **higher infection rates** and **deterioration of sap flux**. Moreover, deterioration of grapevine sap flux increases disease negative impact due to higher stress in grapevine physiology. Symptoms incidence and severity is increased, and apoplectic forms may be more frequent on those vines.

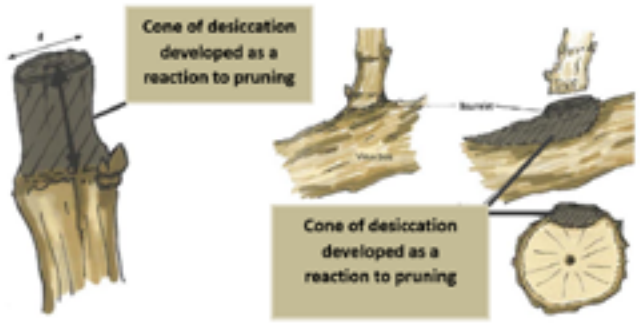

Figure 4: Correlation between pruning wounds and necrosis development. (Crespy, 2006)

Pruning in regard with sap flux was adopted by Lafon (1927) from a pruning system used in France, and later named **Guyot-Poussard** according to its developer. The main principle of this pruning system is **maintenance of the same sap route** from one year to another with pruning that positions wounds only on the upper part of the cordon (Fig. 5). Guyot-Poussard pruning contributes to the small size and low number of pruning wounds. Some pruning systems require retraining and a return cut, common in older vineyards, which could be avoided with this method of pruning. Moreover, wounds on older wood, common on retrained vines, are reported to be less resistant to GTD fungi infection than wounds on 1-year old wood. I**mpact of Guyot-Poussard on reduction of GTD incidence and severity needs to be scientifically validated** and current information is based only on hypothesis.

2- Double pruning

Double pruning is a modification of late pruning and recently it has been implemented in preventative management of GTD in spur-pruned vineyards. This practice is not applicable in cane pruned vineyards, but in spur pruned vineyards is an efficient practice to delay pruning until March and reduce infection rate of GTD pathogens.

Double pruning involves two operations that may be divided into pre-pruning and pruning. Pre-pruning consists of **non-selective mechanical pruning**, on uniform height of approximately 30 - 45 cm above spur, a **second cut to form the desired pruning system** is conducted later in the season, usually as close as possible to bud brake (Fig. 6). Pruning techniques that preserve longer length of two-year old cane above the upper winter bud reduce the infection of grapevine perennial wood located on cordon and/or trunk, due to limited yearly progress of GTD fungi. An economic evaluation estimates double pruning as highly cost practice in comparison with late pruning, while the efficiency of both practices is similar.

Figure 5: Grapevine pruning system Guyot-Poussard. (http://simonitesirch.com)

Figure 6: Mechanical pre-pruning (left), manual spur pruning (right) (IFV South-West)

3- Minimal pruning

Minimal pruning consists of almost no pruning and recently it has been considered as a cultural practice with a potential to reduce the infection rate of pruning wounds with GTD fungi. While this system reduces labour costs of pruning, it is also related with high productions and lower grape quality.
Minimally pruned vines, in comparison with spur-pruned vines, have lower: wood necrosis, Esca disease incidence (leaf symptoms), variability in fungal community and incidence of virulent fungal trunk pathogens. A research related to the impact of pruning systems on Eutypa dieback indicated that disease incidence and severity are lower on minimally pruned vines when compared to spur pruned vines.

Minimal pruning- IFV South-West

Summary – Critical points

Reduce fungal infective inoculum

- **Remove sources of infection prior pruning** (extirpation of symptomatic and dead vines)
- Prune grapevines during **dry weather**
- **Remove pruning debris as soon as possible** (pruning debris mulching, compost, etc.)
- **Avoid** depositing of pruning debris and/or dead vines in areas approximate to the vineyard

Minimize new infections

- **Preventative disease management**, implemented prior symptom development, is essential for a long-term productive vineyard
- Fungicides (biological and chemical) are efficient only as preventative treatments that limit new infections
- **Minimize the number of wounds** on grapevine in general (damage due to mechanical harvest, mechanical sucker removal, mechanical pruning, freeze damage, etc.)
- **Minimize the number and size of new pruning wounds**
- "Return cut" if needed should be done with the help of a longer 2-year-old cane to prevent large wounds
- **Increase spur/cane length** of pruned vines in order to minimize fungal penetration into perennial wood
- Consecutive pruning of symptomatic and asymptomatic vines is allowed due to irrelevant fungal inoculum transmission with pruning shears
- Pruning shears disinfection is a good hygiene practice, but **not of key importance to limit GTD spread**
- Implement double pruning, if not applicable replace with early/late pruning
- Implement **early/late pruning** to minimize new

Good pruning practices

- Coordination of work to minimize new infections - **short period of time between pruning and pruning wound protection** is crucial
- **Preventive protection of pruning wounds** (physical, biological, chemical) in a short interval after pruning
- Adjustment of nozzles on pruning wound zone to achieve better cover with fungicides (biological/chemical)
- Application of fungicides (biological and chemical) on pruning wounds with high volumes of water
- Clean properly tank of the sprayer prior application of *Trichoderma spp.* in order to avoid residual impact of chemical fungicides on this microorganism (remember: Trichoderma are a group of fungi and chemical fungicides have a negative impact on their activity!)

Collective disease management

- Application of a single control method in GTD management has only partial efficiency, **implementation of more methods** in disease management is essential.

Potential limitations

- Technical knowledge
- Lack of equipment that contributes to high efficiency (compost facility, trimmer for mechanical pruning, etc.)
- Availability of mastics and fungicides (biological and chemical) on the national market
- Cost-efficiency related to practice efficiency and product value

Good pruning

IPTPO (K. Diklić)

IPTPO (K. Diklić)

Wrong pruning

IPTPO (K. Diklić)

Large wounds and pruning cuts near perennial parts of grapevine cordon and/or trunk induce wood necrosis and potentially lead to **higher infection rates** with some species of GTD fungi.

IPTPO (K. Diklić)

More information

www.winetwork-data.eu

Video clips

1.Grapevine trunk diseases epidemiology and symptoms (presentation by V. Mondello)

Technical datasheets– more technical details available in:

- Pruning in regard with sap flux

TECHNICAL AND SCIENTIFIC LITERATURE:

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