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Effects of rugose wood and GLRaV-1 on yield of cv. 'Refošk' grapevines^a

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ABSTRACT

The influences of rugose wood (RW) disease and grapevine leafroll associated Closterovirus 1 (GLRaV-1) on yield in grapevine cv. Refošk were studied. Both diseases were shown to reduce the yield. The grape quality expressed as sugar degree (°Oe) was higher in GLRaV-1 infected vines probably due to lower yield and consequent early ripeness. 18 % of plants with RW symptoms on the rootstock part of the vine have died 10 years after planting.

Key words: grapevine, selection, grapevine leafroll associated virus 1, rugose wood, yield.

IZVLEČEK

VPLIV BOLEZNI RAZBRAZDANJA LESA TER GLRaV-1 NA PRIDELEK SORTE 'REFOŠK'^b

Proučevan je bil vpliv boleznih razbrazdanja lesa ter virusnega zvijanja listov vinske trte (Grapevine leafroll associated Closterovirus 1, GLRaV-1) na pridelek sorte 'Refošk'. Tako GLRaV-1 kot bolezen razbrazdanja lesa vplivata na zmanjšanje pridelka. Kakovost grozdja, izražena v °Oe stopinjah sladkorja, je bila boljša pri trsih okuženih z GLRaV-1, verjetno tudi zaradi manjšega pridelka in posledično hitrejšega dozorevanja grozdja okuženih trsov. 18 % trsov z boleznijo razbrazdanja lesa, izraženo na podlagah okuženih trsov, je propadlo že 10 let po sajenju.

Ključne besede: vinska trta, selekcija, virusno zvijanje listov vinske trte 1, razbrazdanje lesa, pridelek.

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1 INTRODUCTION

Virus infections may cause significant negative consequences for the grapevine yield. The impact of virus infection is not easy to predict as the type and severity of symptoms vary with the virus, the variety, scion/rootstock combination, and the environmental conditions (Mannini et al., 1999; Walter and Martelli 1997).

Leafroll is an extremely widespread disease that induces typical and often intense symptoms in *V. vinifera*, but is latent in almost all American *Vitis* species and their hybrids. In European grapevine varieties, disease symptoms consist of downward rolling of leaf blades, accompanied by a reddish or yellowish discolouration of the interveinal tissues in red-berried and white-berried varieties, respectively. All leafroll-associated viruses (GLRaVs) belong to the family *Closteroviridae*. Heretofore, ten serologically different GLRaVs viruses have been described (Digiario et al., 1999; Boscia et al., 1995; Marteli, 2003). Although the number of newly discovered viruses is increasing, their impact on yield has not been evaluated for each individual virus. There are only the general reports describing the economic importance of the overall leafroll disease (Walter and Martelli, 1997). Knowing the impact of each individual virus on grapevines is very important when we are taking decision about the opportunity and the standards of sanitary selection (Martins and Carneiro, 1997). In case of GLRaV-3, all authors agreed that the leafroll disease caused yield losses due to a decrease in the plant vigor, sugar content of musts, and increase of titratable acidity. On the contrary, little is known about the influence of GLRaV-1.

Another very important graft transmissible disease is a rugose wood (RW) complex. RW designate a group of distinct disorders, mainly characterized by the development of pitting and grooving in the woody cylinder. The disease may be present as a latent stage on *Vitis vinifera* cultivars and only manifest itself following grafting on to American rootstocks. The severity of symptoms varies according to the variety of rootstock. RW wood has been reported from almost all grape-growing regions of the world.

Cultivar 'Refošk' is showing high RW and leafroll disease incidence. ELISA analysis and visual inspection of potential mother plants revealed 37 % GLRaV-1 positive and 15 % RW positive vines, respectively. These vines were included in a study to assess the impact of RW and GLRaV-1 on yield.

2 MATERIAL AND METHODS

Plant material: The trial was conducted in the 18 years old vineyard of cv. 'Refošk', located in Komen (Karst region of Western Slovenia). The planting materials were 76 blocks of potential mother plants of cv. 'Refošk' grafted on standard SO4 rootstock. Vines were trained on double Guyot with 25 buds/vine. The vineyard was permanently green covered.

GLRaV-1 was tested using antisera produced by Bioreba (Switzerland) in indirect standard DAS ELISA procedure (Clark and Adams, 1977). All of the 1680 vines from selection vineyard were visually inspected for rugose wood symptoms with unknown etiology.

Chemical analysis of grapes

In the vintage of 1998 the grape sugar, titratable acid, and the weight of 100 berries have been measured for each of the 76 potential elite group. We further measured the number of clusters per vine and the crop per vine for 181 plants. The data were statistically analyzed using STATGRAPHIC 5.0 software. Analysis of variance was used to test for significant differences among the means; furthermore, Sheffe's multiple range test was used to determine which means are significantly different.

3 RESULTS AND DISCUSSION

The chemical and yield analyses revealed that RW had no significant influence on sugar content and berry weight in fruits of cv. 'Refošk'. However, the total acid content is significantly higher in grapes of the vines showing no RW. The later, from a viticulturist point of view, means that these grapes are not ripe yet and are able to accumulate more sugar in a proper time as the diseased vines that show RW symptoms. During the process of ripening, the acid content is decreasing while the sugar content is increasing accordingly. Therefore, high acid content simply means that the ripening period has not ended (Figure 1). The number of clusters per vine and the cluster weight are significantly higher in vines showing no RW, resulting in a higher crop per vine. Notably, among vines, which showed pits on the rootstock, recognized as RW, 18 % of the vines died only eight years after planting, which is the first report of this kind of RW impact (Table 1). Reynolds et al. (1997) reported that Rupestris stem pitting, which is believed to be one of the components of the RW disease complex, had no major impact on grapevine growth and yield, but may advance fruit maturity in terms of titratable acidity and pH. The results of the present study confirmed some of these effects, but showed more pronounced damaging effects of RW on quality of grapes than reported previously.

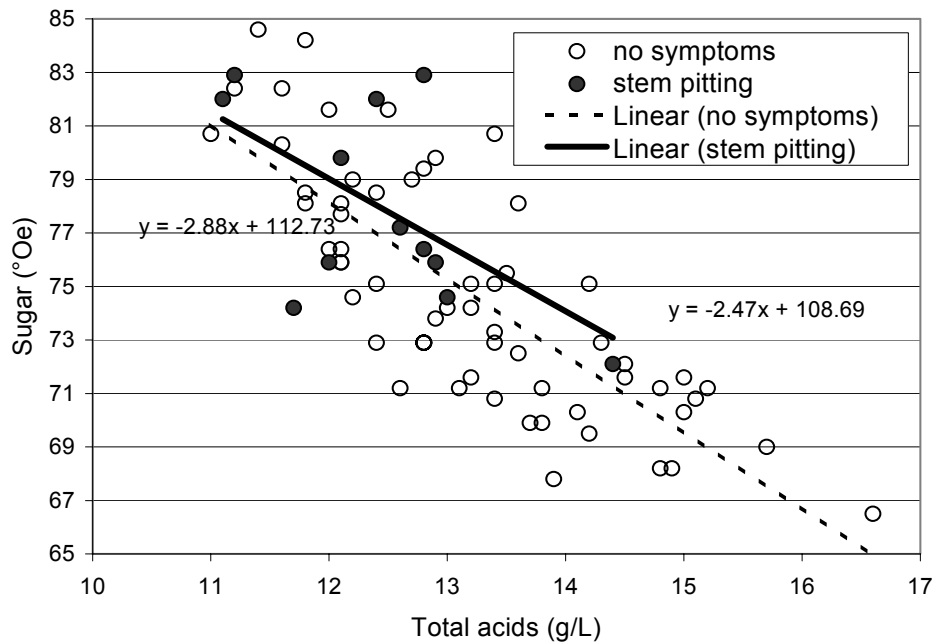


Figure 1: The influence of rugose wood disease upon the yield of cv. 'Refošk', Komen, Slovenia 1998.

Table 1: The influence of the rugose wood disease upon the yield of cv. 'Refošk', Komen, Slovenia 1998.

Rugose wood symptoms	Sugar (°Oe)	Titrateable acidity (g/L)	100 Berry weight (g)	% Dead vines	Yield/vine (kg)	Clusters /vine	1 Cluster weight (g)
No symptoms	74.7	13.3*	302.5*	2.14	7.91*	28.3*	275.5*
Symptoms on rootstock	77.7	12.2	293.4	17.85*	5.95	24.4	245.4
Symptom on scion	78.6	11.9	306.8	7.61	5.73	23.6	239.1

* - significant at the $p < 0.05$

Grapes of the cv. 'Refošk' vines, which tested positive for GLRaV-1, had significantly higher sugar degree and were lower in acids than vines, which were free of this virus (Figure 2). This results indicate that GLRaV-1 accelerates the grape ripening, which could also be associated with the lower number of clusters per vine and accordingly, with the lower crop per vine. Notably, the data showed no significant influence of the virus on berry and cluster weight, which are cultivar stable characteristics. In case of the GLRaV-1 infected plants, there is no significantly bigger record of dead vines (Table 2). The majority of previous reports describe mostly the effects of GLRaV-3. Cabaleiro et al. (1999) reported that the infection of healthy 'Albariño' vines with GLRaV-3 in the field diminishes the quality of the must, reducing sugar content and increasing acidity, and thereby reducing the value of the crop. Mannini et al. (1999) found the same results for vines infected simultaneously with GLRaV-1 and GVA, but not for vines infected only with GLRaV-1. The results of the present study show that the effects of the GLRaV-1 infection alone are different than those of the GLRaV-3 infection and GLRaV-1 / GVA mixed infection.

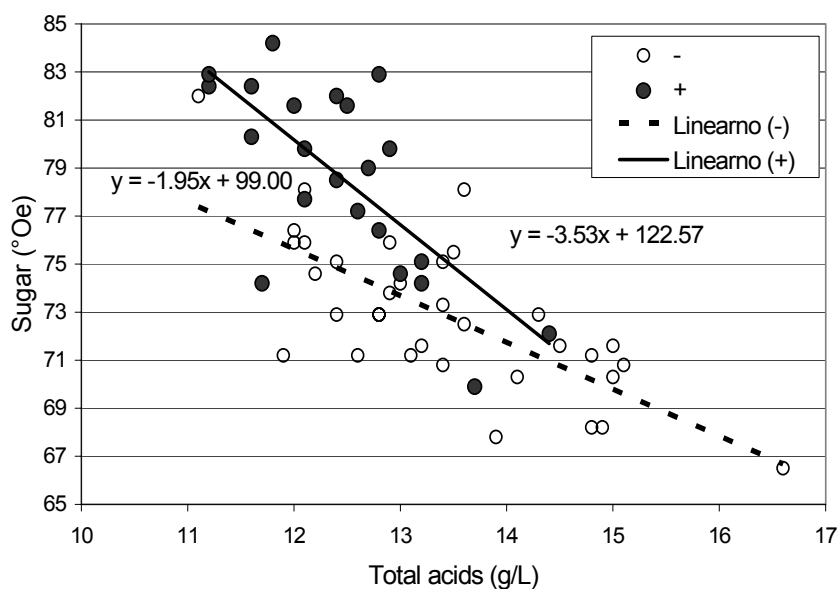


Figure 2: The influence of GLRaV-1 upon the yield of cv. 'Refošk', Komen, Slovenia 1998.

Table 2: The influence of GLRaV-1 upon the yield of cv. 'Refošk', Komen, Slovenia, 1998.

Virus status	Sugar (°Oe)	Titrateable acidity (g/L)	100 Berry weight (g)	% Dead vines	Yield/vine (kg)	Clusters /vine	1 Cluster weight (g)
GLRaV-1 (-)	73.0	13.5*	303.0	3.53	7.78*	28.8*	265.4
GLRaV-1 (+)	78.6*	12.3	304.1	8.59	5.11	20.4	247.2

* - significant at the $p < 0.05$

Furthermore, we assessed the grape yield loss per hectare (ha) per growing area, for diseased and healthy vines. The calculations were made from data obtained for the collection vineyard in 1998. We found out that the yield per hectare of the vineyard with 100 % of vines infected with GLRaV-1 would give 36 % less crop per hectare, and the yield in vineyard infected with RW disease would be decreased by 34 % (Table 3). Notably, the later would be mostly a direct consequence of the high incidence of dead vines.

Table 3: Calculations for yield per growing area in hectares (yield/ha) comparatively for diseased and healthy vines cv. 'Refošk', Komen, Slovenia, 1998.

Sanitary status	% of dead vines	Yield/vine (kg)	Planting density 3000 vines/ha	
			No. dead vines/ha	Yield/hectare (kg)
No rugose wood symptoms	2.51	7.91	75	23134
Rugose wood symptoms on rootstock	17.85	5.95	536	14662
Rugose wood symptoms on scion	7.61	5.73	228	15882
GLRaV-1 (-)	3.53	7.78	106	22516
GLRaV-1 (+)	8.57	5.11	258	14342

These data are comparable with data reported from Woodham et al (1984) who demonstrated that leafroll induced 35 % reductions of yield. Similarly reported of yield reduction due leafroll infection McCarty et al. (1989), Diagaro et al. (1999) and Garau et al. (1997).

According to Garau (1985) and Teliz et al. (1980) RW disease cause 20 % to 70 % crop losses, whereas Rynolds et al. (1997) reported that Rupestris stem pitting virus, which is considered to be component of RW complex, had no major impact on grapevine yield. The differences are expected since the rugose wood is complex disease and different viruses could be involved in.

The results indicate that GLRaV-1 alone has different influence on the yield than GLRaV-3, or GLRaV-1 in mixed infection with GVA. GLRaV-1 infection seems to improve the quality of the must, which was found to be only on the account of the high yield reduction. GLRaV-1 and RW were both shown to cause yield reduction in

cv. 'Refošk'. In case of RW, this is the first report where the yield loss was shown to be a direct consequence of dying of the vines.

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