Industry allocated project number	PHI allocated project number

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FINAL REPORT
(2016)

1. PROGRAMME AND PROJECT LEADER INFORMATION

	Research Organisation Programme leader	ARC Research Team Manager	Project leader
Title, initials, surname	Prof B Ndimba	Ms R Carstens	Dr Francois Halleen
Present position	Senior Research Manager	Acting Research Leader: Plant Protection	Specialist Researcher
Organisation, department	ARC Infruitec-Nietvoorbij Private Bag X5026 Stellenbosch 7599	ARC Infruitec-Nietvoorbij Private Bag X5026 Stellenbosch 7599	ARC Infruitec-Nietvoorbij Private Bag X5026 Stellenbosch 7599
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2. PROJECT INFORMATION

Research Organisation Project number	WW06/42 (000274)
Project title	Investigation into the cause of rootstock necrosis in grapevine nurseries.
Short title	Rootstock necrosis

Fruit kind(s)	Wine grapes		
Start date (mm/yyyy)	01/04/2012	**End date** (mm/yyyy)	31/03/2016

Key words	Rootstock necrosis, nursery vines

Approved by Research Organisation Programme leader (tick box) ✓

3. EXECUTIVE SUMMARY

Objectives & Rationale

Rootstock necrosis of grafted nursery vines (i.e. dead zones primarily at the base of rootstocks) has been identified in several Vine Improvement Association (VIA) reports as a major cause of rejections in grapevine nurseries. The objectives of this project would therefore be:

(1) to determine which fungi or fungal complexes are associated with rootstock necrosis;
(2) to determine whether these infections are the cause of the symptoms or if other factors predispose the rootstocks to fungal infections;
(3) to graft rootstock cuttings with discolorations on one side in order to determine whether this is the cause of the symptoms observed.

Methods

Surveys were conducted in grapevine nurseries by collecting nursery vines with typical symptoms. Fungal isolations were conducted in the laboratory to determine if specific pathogens could be associated with these symptoms. Other factors that could contribute to the development of these specific symptoms were also investigated. Consequently, dormant rootstock shoots which are used as grafting material were also included in the study. Field trials were also conducted to see whether these specific symptoms could be recreated and which factors contribute to symptom development.

Key Results

The most affected rootstocks included Ramsey, Richter 110, US8-7, followed by Paulsen 1103, Ruggeri 140, Richter 99, 143B Mgt, 101-14 Mgt and SO_4. Rootstocks cuttings with discolorations on the one side that are used as grafting material was identified as a possible predisposing factor. Several grapevine trunk disease pathogens were isolated from both of these types of material. However, based on the knowledge of the pathogens isolated and the symptoms they are associated with, it is highly unlikely that any of these pathogens are the primary cause of these specific symptoms and that they merely infect plant material that was predisposed by other factors. Rootstock cuttings with discolorations on the one side and rootstocks from grafted vines with necrotic lesions at the base were traced back to several sources. Field trials were conducted with rootstock material from one of these sources. At the end of the nursery season typical rootstock necrosis (dead parts at the base of rootstocks) with no root formation on one side was observed in all three combinations. Discolorations in or on the one side of the rootstock prior to grafting was not a prerequisite as only 18.2% of such vines developed necrosis (typical symptoms). The only other observation that stood out was the position of the basal bud/side-shoot where 64% of the rootstocks with rootstock necrosis had basal buds 5-20 cm away from the base of the rootstock

Conclusion/Discussion

It is **recommended** that nurseries adhere to the physical requirements for plant material (Vine Improvement Association) to ensure that a node is within 15 mm of the base of each rootstock. Rootstock cuttings with internal discolorations should not be grafted as these cuttings will most likely die in the nursery contributing to the low percentage certifiable vines produced in local nurseries.

4. PROBLEM IDENTIFICATION AND OBJECTIVES

Rootstock necrosis of grafted nursery vines (i.e. dead zones primarily at the base of rootstocks) has been identified in several Vine Improvement Association reports as a major cause of rejections in grapevine nurseries. During the 2007/2008 season 53 graft combinations at 20 nurseries were rejected as a result of this phenomenon. This constitutes 49% of all the rejections and is therefore of great concern to grapevine nurseries. Furthermore, these necrotic lesions can also occur away from the basal end which is not easily detected during the certification process. This would most definitely lead to premature dieback of grapevines once established in new vineyards. A preliminary study found several grapevine trunk disease pathogens associated with this necrosis, but the project was terminated before any conclusions could be drawn. The objectives of this project would therefore be:

(1) to determine which fungi or fungal complexes are associated with rootstock necrosis;
(2) to determine whether these infections are the cause of the symptoms or if other factors predispose the rootstocks to fungal infections;
(3) to graft rootstock cuttings with discolorations on one side in order to determine whether this is the cause of the symptoms observed.

5. DETAILED REPORT

a. PERFORMANCE CHART (for the duration of the project)

Milestone	Target Date	Extension Date	Date completed
To determine which fungi or fungal complexes are associated with rootstock necrosis *Isolations from symptomatic cuttings* *Isolations from rejected grafted vines* *Identify fungal pathogens* *Analyse data and attempt to identify mother block sources*	 May 2013 June 2013 Oct 2013 April 2014		 June 2013 June 2013 Oct 2013 April 2014
To determine if other factors predispose the rootstocks to fungal infections.	March 2014		March 2014
Field trials to determine if typical rootstock necrosis symptoms could be recreated and which factors contribute to this phenomenon. *Establish trial* *Monitor* *Uplift vines* *Evaluation* *Analyse data*		 Oct 2015 May 2016 June 2016 June 2015 July 2015	 Oct 2015 May 2016 June 2016 June 2015 July 2015
Final Report		Dec 2015	Aug 2016
6. Journal publication(s) – final milestone *WineLand article* *SAJEV*	 June 2017 June 2017		

b) WORKPLAN (MATERIALS AND METHODS)

Collection of symptomatic dormant rootstock cuttings
Rootstock cuttings, representing different rootstock cultivars and clones (US 8-7, 101-14 Mgt, Richter 110, etc) that exhibit necrotic lesions will be examined externally and the observed symptoms photographed.

Collection of rejected dormant grafted nursery vines
Grafted vines rejected due to necrotic lesions will be examined externally and the observed symptoms photographed. If possible the origin of the lesions will be determined (i.e. whether it originates from de-budding sites). These collections will be made in collaboration with BG Plant Inspection Consultants.

Isolations from dormant cuttings and grafted vines
Subsequent to external examination, dormant rootstock cuttings and vines will be cut in smaller sections before isolations can be made. Transverse sections will be made through the necrotic lesions and examined for any internal wood necrosis symptoms and photographed. The selected sections will be triple sterilised by immersion into 70% ethanol for 30 s, 1 min in 0.35% NaOCl and again for 30 s in 70% ethanol. After sterilisation, sections will be split longitudinally and 4 pieces of tissue will be removed aseptically from the edge of each symptom type and plated out onto potato dextrose agar (PDA, Biolab, Midrand, Johannesburg) amended with streptomycin sulphate (40 mg/L) to reduce bacterial growth. Isolations will also be made from asymptomatic tissue adjacent to the lesions to determine the possible presence of latent pathogen infection. All isolations will be done under sterile conditions in a laminar flow cabinet. After isolation, dishes will be incubated at ± 25 °C for 4 weeks.

Identification of fungal pathogens
Fungal growth on the dishes will be carefully monitored and identified where possible. Other fungi growing from the tissue pieces will be sub cultured through hyphal tipping onto fresh PDA dishes for later identification. All the cultures will be identified to genus, and where possible, to species level based on morphological characteristics. Fungi belonging to potentially pathogenic genera will be identified to species level based on molecular and morphological characteristics (Mostert *et al*., 2006; van Niekerk *et al*., 2004, 2005). These cultures will be stored in sterile water and on PDA slants. Infection studies on selected rootstock cultivars will have to be conducted with selected species of which the pathogen status is unknown.

Nursery trials
Rootstocks with discolorations on the one side were collected from nurseries in 2014, grafted and planted to determine whether this is the cause of the problem. During the 2015 season, rootstocks were categorized and labelled before grafting which allowed for more observations. Discolorations on the one side of the rootstock or in the rootstocks was only one of several considerations that were noted. Other factors included whether the basal bud was removed or not, the size of the wound, visible “infections” or not, the size of the basal side shoot that was removed, visible symptoms, tears resulting from bud/shoot removal or any other physical injuries, the position of these wounds/tears/injuries in relation to other wounds and the basal end, rootstock thickness (thin, average or thick) and shape of rootstocks [flat on one side or more round (Van der Westhuizen, 1981)]. During the 2015 season US8-7 (UC274A) rootstocks from an identified source (Source 3, Table 1) were grafted by a commercial nursery in three combinations with Sauvignon blanc (SB316G), Cabernet Sauvignon (CS169B) and Shiraz (SH1C). Due to the magnitude of variables, a statistical trial could not be laid out. The trial was evaluated in May 2016 when the vines were uplifted. The vines were then inspected for typical rootstock necrosis symptoms.

c) RESULTS AND DISCUSSION

Grafted vines:
During the 2013 season, 134 graft combinations with typical symptoms were obtained from nurseries (38 in 2012). The most affected rootstocks included Ramsey [mostly clones SC18AB and SC18AE], Richter 110, US8-7, followed by Paulsen 1103, Ruggeri 140, Richter 99, 143B Mgt, 101-14 Mgt and SO_4. Affected vines don't have roots on one side and is characterised by a lesion ("dead" zone) which start at the base of the vine running down the rootstock in the direction of the graft union. These lesions differ in length from 20-250mm. Transverse sections were made through these necrotic lesions and isolations were made from affected material in order to identify pathogens associated with these lesions. Pathogens isolated include species associated with Black foot disease, namely *Campylocarpon fasciculare, Campylocarpon pseudofasciculare, Cylindrocarpon pauciseptatum, Ilyonectria liriodendri, Ilyonectria macrodidyma, Ilyonectria novozelandica* and *Ilyonectria torresensis*. Other pathogens include *Phaeomoniella chlamydopsora*, *Phaeoacremonium* spp., *Cadophora luteo-olivacea*, *Pleurostomophora richardsiae* (Petri disease), *Phomopsis* spp. (Phomopsis dieback and cane spot), as well as *Botryosphaeria* spp. (Bot canker and dieback).

The most frequently isolated pathogens from the 1050 grafted vines analysed during the 2013 season include species within the "*Cylindrocarpon"* complex (59.0%), followed by Botryosphaeriaceae (7.1%), *Phomopsis* (3.8%), *Phaeomoniella chlamydospora* (3.4%), *Phaeoacremonium* spp. (2.4%) and *Pleurostomophora richardsiae* (1.5%). The *"Cylindrocarpon"* complex was represented by *Ilyonectria macrodidyma* (isolated from 34.2% of the total number of vines investigated), *Campylocarpon fasciculare* (13.6%), *Cylindrocarpon pauciseptatum* (5.0%)*, Neonectria radicicola* (4.0%), *Ilyonectria liriodendri* (2.9%)*, Ilyonectria alcacerensis* (1.3%), *Ilyonectria crassa* (0.6%) and *Ilyonectria estremocensis* (0.1%). Seven percent of plants from which *Cylindrocarpon* was isolated, contained two "Cylindrocarpon" species within the same plant. Botryosphaeriaceae species include *Lasiodiplodia theobromae*, *Neofusicoccum australe*, *N. parvum* (the two most pathogenic species previously identified from South African grapevines), *N. vitifusiforme*, *Diplodia mutila*, *D. seriata*, *D. pseudoseriata* and *Macrophomina phaseolina*. Phomopsis species include *Diaporthe ampelina* (the new name for "*Phomopsis viticola*"), *Diap. novum*, *Diap. ambigua, Diap. endophytica, Diap. theicola, Diap. amygdali* and an unknown *Diaporthe sp.* This is the first report of *Diap. novum* on *Vitis* and has only been found on South African rooibos. *Diap. endophytica* is only known from soybean seeds and tree leaves from Brazil.

Rootstock cuttings:
Twenty-five rootstock batches with discoloration on one side of the rootstock were also investigated during the 2013 season (34 in 2012). This was observed mostly on Ramsey (14), especially clone SC18AE (10), followed by Richter 110 (4), US8-7 (3), Richter 99 (2), 143B Mgt (1) and Paulsen 1103 (1). Pathogens isolated during the 2012 season include *Cadophora luteo-olivacea, Phaeoacremonium spp., Phaeomoniella chlamydopsora,* as well as *Phomopsis* and Botryosphaeriaceae species. The Bot species were identified as *Neofusicoccum australe*, *N. parvum*, as well as *Diplodia seriata* and *N. mediterraneum*, the latter isolated from South African grapevines (101-14 Mgt) for the first time. Botryosphaeriaceae (16.7%) and *Phomopsis* (13.6%) species were the pathogens most frequently isolated from the 132 shoots analysed during the 2013 season, followed by *Cadophora luteo-olivacea* (1.5%)*, Phaeoacremonium aleophilum* (0.8%) and an unknown *Eutypella* sp. (0.8%). The most frequently isolated Botryosphaeriaceae included *Diplodia seriata* (6.8%), *Neofusicoccum australe (*4.5%)*,* Unidentified Bots (4.5%), *Macrophomina phaseolina* (0.8%) and *Aplosporella aquifolii* (0.8%). Phomopsis species included *Diap. novum* (3.4%)., *Diap. ambigua* (3.0%)*., Diap. infecunda* (2.3%)*., Diaporthe sp.* (2.3%)*, Diap. endophytica* (0.8%), *Diap. neotheicola* (0.8%)*, Diap. longicolla* (0.8%). *Diap. infecunda* and *Diap. longicolla* has not been isolated from any host in South Africa and also not from *Vitis* anywhere in the world.

Origin of affected propagation material:
US8-7 UC274A is used as an example (Table 1) to show how the rootstock cuttings with discolorations and dormant grafted vines with necrotic lesions at the base of the rootstocks were analysed to determine whether affected rootstocks could be traced back to the same origin or whether any other conclusion could be drawn. For example, US8-7 rootstock cuttings from the same origin (Source 1; indicated in yellow in Table 1) were found during 2012 and 2013 with discolorations. A Pinotage graft combination with basal necrosis were found in 2013 where US8-7 rootstocks from the same origin were used. US8-7 rootstock cuttings (Source 3; indicated in purple in Table 1) were found during 2012 with discolorations. Several graft combinations were found in 2013 with necrotic lesions at the base of the rootstocks from the same source (Source 3). Affected rootstock cuttings from Source 2 were found during 2012 and 2013 and also in two graft combinations during 2012 (indicated in green in Table 1). According to these observations it is therefore possible that rootstock cuttings with discolorations on one side might be associated with the necrotic lesions observed in grafted vines.

Rootstocks from the same origin (i.e. Source 3) grafted by the same nursery (nursery 2) to different scions (i.e. Merlot or Chardonnay) show the same symptoms.

Rootstocks from the same origin (i.e. Source 3) grafted by the same nursery (nursery 4) to different scions (i.e. Chardonnay, Wit Muskadel, Petit Verdot, Shiraz, Grenache Noir, Melody) show the same symptoms.

Rootstocks from the same origin (i.e. Source 6) grafted by the same nursery (nursery 2) to different scions (i.e. Chardonnay, Colombar, Muscat d'Al, Chenin blanc) show the same symptoms.

Rootstocks from the same origin (i.e. Source 14) grafted by the same nursery (nursery 4) to different scions (i.e. Cabernet Sauvignon, Sugra19, Desert Dawn) show the same symptoms.

Rootstocks from the same origin (i.e. Source 3) grafted by the different nurseries (nurseries 2 and 4) using the same scions (i.e. Chardonnay) show the same symptoms.

Rootstocks from the same origin (i.e. Source 3) grafted by the different nurseries (nurseries 2 and 4) using different scions (i.e. Chardonnay and Merlot) show the same symptoms.

Rootstocks from the same origin (i.e. Source 6) grafted by the same nursery (nursery 2) show the same symptoms in two different seasons.

During 2013 35% of the affected US 8/7 rootstocks (form grafted vines) came from Source 3, 14% from Source 6 and 11% from Source 14.

Table 1. US8-7 (UC274A) rootstocks with discolorations on one side and grafted nursery vines with necrotic lesions at the base of the rootstock that were analysed during 2012 and 2013.

Rootstock shoot or Grafted vine	*Year*	*Scion*	*Nursery**	*Rootstock Source***
Rootstock	2012	-	-	1
		-	-	2
		-	-	3
		-	-	4
Grafted vine	2012	Shiraz	1	5
		Merlot	2	6
		Shiraz	2	6
		Shiraz	2	7
		Colombar	2	7
		Cabernet Sauvignon	2	7
		Zante Korente	2	6
		Ruby Cabernet	3	2
		Grenache Noir	3	2
Rootstock	2013	-	-	2
		-	-	8
		-	-	1
Grafted	2013	Chardonnay	4	3
		Chardonnay	4	3
		Merlot	2	3
		Chardonnay	2	3
		Shiraz	2	9
		Chardonnay	2	6
		Wit Muskadel	4	3
		Chenin blanc	2	10
		Colombar	2	6
		Chenin blanc	2	11
		Chenin blanc	2	12
		Pinotage	3	1
		Morio Muscat	3	?
		Crimson S	2	13
		Sugra19	4	14
		Desert Dawn	4	14
		Ruby Cabernet	2	15
		Muscat d'Al	2	6
		Chenin blanc	2	6
		Petit Verdot	4	3
		Cabernet Sauvignon	4	14
		Ruby Cabernet	4	3
		Sauvignon blanc	2	15
		Shiraz	4	3
		Grenache Noir	4	3
		Melody	4	3
		Chenin blanc	2	16
		Pinotage	2	17
		Merlot	2	18

*Nursery = where the grafted vines were planted and from which the dormant grafted vines were obtained from

**Rootstock Source = mother block or origin of the rootstocks

Nursery trials

The 2014 trial failed mainly because the extent of the discoloration was not taken into account, and most of the plants died. During the 2015 season, rootstocks were categorized and labelled before grafting which allowed for more observations. At the end of the nursery season typical rootstock necrosis (dead parts at the base of rootstocks) with no root formation on one side was observed in all three combinations (Figure 1). These symptoms correlate with the symptoms previously observed during the surveys. In the US8-7 / SB316O combination, 1.9% of the plants developed typical symptoms, whereas it was 3.1% and 9.6% in the US8-7 / SB316G and US8-7 / SH1C combinations, respectively. Discolorations in or on the one side of the rootstock prior to grafting was not a prerequisite for symptom development as only 18.2% of such vines developed necrosis (typical symptoms). Instead, plants with discolorations in the rootstock or on one side of the rootstock had a high mortality rate in the nursery, especially in the US8-7 / SB316G and US8-7 / SH1C combinations where 63% and 63.8%, respectively, of such plants died shortly after planting or within the 7 months in the nursery. This could also explain the failure of the 2014 trial where only rootstocks with discolorations were used in the experiment. The only other observation that stood out was the position of the basal bud/side-shoot where 64% of the rootstocks with rootstock necrosis had basal buds 5-20 cm away from the base of the rootstock. The traditional recommendation is to cut rootstocks 5 mm below the basal node (Van der Westhuizen, 1981), although the "Physical requirements for plant material" of the Vine Improvement Association state that "A node shall occur within 15 mm of the base of each such shoot."

Figure 1. Examples of rootstock necrosis observed in US8-7 rootstocks during the 2015/16 nursery trial. Note the brown/black necrosis on the one side of the rootstock, no root formation on the one side, and internal brown/black necrosis from the base of the rootstock.

Figure 1 (continue).

d) CONCLUSIONS

During the 2013 season grapevine trunk disease pathogens were isolated from 31% (29% in 2012) of the rootstocks cuttings with discoloration and from 71% (36% in 2012) of grafted vines with necrotic lesions along one side. Pathogens within the "*Cylindrocarpon"* disease complex were frequently isolated (59.0%) from grafted vines with necrotic lesions, especially during the 2013 season. These pathogens cause black foot disease, which include root necrosis, as well as rootstock discolorations which sometimes can be seen as a brown to purple-brown necrosis from the pith to the bark in a cross section. However, none of these symptoms are typical of

those associated with the current problem where a sunken, wedge-shaped lesion is observed running along the base of the rootstock with its widest point at the bottom. Previous studies (WW06/25) have shown that black foot disease pathogens infect newly planted grafted nursery vines from nursery soils shortly after planting. Black foot disease pathogens are also known as opportunist and therefore will infect weakened plant tissue if given the opportunity. It is highly unlikely that black foot disease pathogens are the cause of these specific symptoms and that they merely infect plant material that was predisposed by other factors. Although the pathogen status of many of the other fungal species isolated is unknown, it is also highly unlikely that they are the cause of these specific symptoms, not only due to the relatively low isolation numbers, but also due to the fact that they were only associated with certain batches.

Four rootstocks (Ramsey, US8-7, Richter 110 and Paulsen 1103) were consistently associated with these symptoms, collectively contributing to 85% of the symptoms observed on grafted vines in 2013 (85% in 2012). Some people are of the opinion that the discolorations sometimes observed on one side of rootstock cuttings are responsible for the symptoms observed on dormant grafted vines. Discolorations observed on one side of rootstock cuttings were most consistently associated with Ramsey and US8-7 (68% in 2013 and 59% in 2012). The cause of these discolorations is the subject of much debate, many people believing it is the cause of sunburn. A further debate is whether it is direct sunburn, or whether the shoots are exposed to rocks that warm up. Another problem is the fact that the discolorations are not continuous throughout the entire length of the cane and it is therefore possible that it might not be seen when cutting rootstock canes into cuttings destined for grafting. Skilled workers with many years of experience usually throw these shoots out and will therefore not affect the grafting process.

US8-7 rootstocks with discolorations on the one side, as well as several other factors, were obtained from one of the identified sources. They we grafted and followed through the nursery process in order to determine whether this is the cause of the problem or not. Only a low percentage of such vines developed typical symptoms, instead, a high percentage died. Typical symptoms were more associated with the position of the basal bud.

It is **recommended** that nurseries adhere to the physical requirements for plant material (Vine Improvement Association) to ensure that a node is within 15 mm of the base of each rootstock. Rootstock cuttings with internal discolorations should not be grafted as these cuttings will most likely die in the nursery contributing to the low percentage certifiable vines produced in local nurseries.

Literature cited

Mostert, L., Groenewald, J.Z., Gams, W. and Summerbell, R. and Crous, P.W. 2006. Taxonomy and pathology of *Togninia* (Diaporthales) and its *Phaeoacremonium* anamorphs. Studies in Mycology 54: 1–115.

Van der Westhuizen, J.H. 1981. Voortplanting. In: Wingerdbou in Suid Afrika. Trio-Rand/S.A.Litho, Old Millweg, N'dabeni. pp. 141-168.

Van Niekerk, J.M., Crous, P.W., Groenewald, J.Z., Fourie, P.H. and Halleen, F. 2004a. DNA phylogeny, morphology and pathogenicity of *Botryosphaeria* species on grapevines. Mycologia 96: 781–798.

Van Niekerk, J.M., Groenewald, J.Z., Farr, D.F., Fourie, P.H., Halleen, F. and Crous, P.W. 2005. Reassessment of *Phomopsis* species on grapevine. Australasian Plant Pathology 34: 27–39.

1. ACCUMULATED OUTPUTS

List ALL the outputs from the start of the project. The year of each output must also be indicated.

a) TECHNOLOGY DEVELOPED, PRODUCTS AND PATENTS

A better understanding of the factors contributing to rootstock necrosis.

b) SUGGESTIONS FOR TECHNOLOGY TRANSFER

Nurseries must ensure that grafting is done according to recommendations, specifically with regards to the physical standards (i.e. position of the basal node) as described by the Vine Improvement Association.

c) HUMAN RESOURCES DEVELOPMENT/TRAINING

Complete the following table, adding more lines if necessary.

Student Name and Surname	Student Nationality	Degree (e.g. MSc Agric, MComm)	Level of studies in final year of project	Graduation date	Total cost to industry throughout the project
Honours students					
Masters Students					
Shaun Langenhoven	SA	MSc		March 2017	R0
PhD students					
Postdocs					
Dr Michael Bester	SA	n/a			R0
Support Personnel (not a requirement for HORTGRO Science)					
Palesa Lesuth	SA	MTech		Dec 2016	R0

PERSONS PARTICIPATING IN THE PROJECT (Excluding students)

Initials & Surname	Highest Qualification	Degree/ Diploma registered for	Race (1)	Gender (2)	Institution & Department	Position (3)	Cost to Project R
Halleen, F.	PhD Agric		W	M	ARC Infruitec-Nietv. (Plant Protection)	PL	
Mostert, L.	PhD Agric		W	F	University of Stellenbosch (Dep. Plant Pathology)	Coll	
Lesuthu, P.	B. Tech	MTech	B	F	ARC Infruitec-Nietv. (Plant Protection)	TA	
Vermeulen, C.	Matric		W	F	ARC Infruitec-Nietv. (Plant Protection)	RA	
Marais, J.	Matric		W	F	ARC Infruitec-Nietv. (Plant Protection)	RA	
Marais, D.	Matric		W	M	ARC Infruitec-Nietv. (Plant Protection)	RA	

(1)Race B = African, Coloured or Indian
W = White

(2)Gender F = Female
M = Male

(3)Position Co = Co-worker (other researcher at your institution)
Coll = Collaborator (participating researcher that does not receive funding for this project from industry)
PF = Post-doctoral fellow
PL = Project leader
RA = Research assistant
TA = Technical assistant/ technician

d) PUBLICATIONS (POPULAR, PRESS RELEASES, SEMI-SCIENTIFIC, SCIENTIFIC)

None to date.

e) PRESENTATIONS/PAPERS DELIVERED

Papers delivered at conferences:

Halleen, F. Investigation into the cause of rootstock necrosis in grapevine nurseries. 35th SASEV Conference (13-15 November 2013, Somerset West)

Halleen, F. Resistance and soilborne plant diseases. Grapevines – are we making progress? 23rd Soilborne Plant Diseases Symposium (18 & 19 Sept. 2013, Stellenbosch).

Langenhoeven, S., Halleen, F. & Mostert, L. Detection and quantification of soil borne pathogens in grapevine nurseries. 36th SASEV Conference (12-14 November 2014, Somerset West)

2. BUDGET

TOTAL COST SUMMARY OF THE PROJECT

YEAR	CFPA	DFTS	Deciduous	SATI	Winetech	THRIP	OTHER	TOTAL
2012/2013					133049		138479	271528
2013/2014					143693		149557	293250
2014/2015					155188		161521	316709
2015/2016					155188		161521	316709
Total					587118		611078	**1198196**

EVALUATION BY INDUSTRY

This section is for office use only

Project number	WW06/42 (000274)

Project name	Investigation into the cause of rootstock necrosis in grapevine nurseries.

Name of Sub-Committee*	Plant Protection

Comments on project

Committee's recommendation (Review panel in the case of PHI)

- Accepted. ☐
- Accepted provisionally if the sub-committee's comments are also addressed. Resubmit this final report by_____ ☐
- Unacceptable. Must resubmit final report. ☐

Chairperson_____ Date_____

*SUB-COMMITTEES

Winetech
Viticulture: Cultivation; Soil Science; Plant Biotechnology; Plant Protection; Plant Improvement;
Oenology: Vinification Technology; Bottling, Packaging and Distribution; Environmental Impact; Brandy and Distilling; Microbiology

Deciduous Fruit
Technical Advisory Committees: Post-Harvest; Crop Production; Crop Protection; Technology Transfer
Peer Work Groups: Post-Harvest; Horticulture; Soil Science; Breeding and Evaluation; Pathology; Entomology