

EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
ORGANISATION EUROPEENNE ET MEDITERRANEENNE POUR LA PROTECTION DES PLANTES
Summary sheet of validation data for a diagnostic test

The EPPO Standard PM 7/98 *Specific requirements for laboratories preparing accreditation for a plant pest diagnostic activity* describes how validation should be conducted. It also includes definitions of performance criteria.

Laboratory contact details	National Institute of Biology, Department of Biotechnology and Systems Biology Vecna pot 121, 1000 Ljubljana, Slovenia
Short description of the test	Detection of flavescence doree phytoplasma by LAMP in grapevine
Date, reference of the validation report	2015-11-26 - validation data included in Kogovšek P, Hodgetts J, Hall J, Prezelj N, Nikolic P, Mehle N, Lenarcic R, Rotter A, Dickinson M, Boonham N, Dermastia M, Ravnikar M (2015) LAMP assay and rapid sample preparation method for on-site detection of flavescence dorée phytoplasma in grapevine. <i>Plant Pathology</i> , 64, 286-296. Result of the test performance study: Euphresco GRAFDEPI2, WP4: Test performance study of the LAMP assays for the detection of BNp and FDp (Final report).
Validation process according to EPPO Standard PM7/98?	yes
Is the lab accredited for this test?	no
Was the validated data generated in the framework of a project?	
Description of the test	
Organism(s)	Grapevine flavescence dorée phytoplasma(PHY64)
Detection / identification	detection
Method(s)	Extraction Molecular Extraction DNA RNA Molecular LAMP
Method: Extraction	
Reference of the test description	
As or adapted from an EPPO diagnostic protocol	yes
EPPO Diagnostic Protocol name	PM 7/079 Grapevine flavescence dorée phytoplasma (version 2)
Other information	
Other details on the test	without DNA extraction = direct testing of crude homogenates (Kogovšek P, Hodgetts J, Hall J, Prezelj N, Nikolić P, Mehle N, Lenarčič R, Rotter A, Dickinson M, Boonham N, Dermastia M, Ravnikar M

	(2015) LAMP assay and rapid sample preparation method for on-site detection of flavescence dorée phytoplasma in grapevine. Plant Pathology, 64, 286-296)
Method: Molecular Extraction DNA RNA	
Reference of the test description	
As or adapted from an EPPO diagnostic protocol	yes
EPPO Diagnostic Protocol name	PM 7/079 Grapevine flavescence dorée phytoplasma (version 2)
Other information	
Other details on the test	with DNA extraction (Mehle, N., Nikolić, P., Rugar, M., Boben, J., Ravnikar, M., Dermastia, M. 2013. Automated DNA extraction for large numbers of plant samples. In: Dickinson, M. (ed.), Hodgetts, J. (ed.). Phytoplasma: methods and protocols, (Methods in Molecular Biology, vol. 938), (Springer Protocols). New York: Humana Press: 139-145.)
Method: Molecular LAMP	
Reference of the test description	
As or adapted from an EPPO diagnostic protocol	yes
EPPO Diagnostic Protocol name	PM 7/079 Grapevine flavescence dorée phytoplasma (version 2)
Name of the test	LAMP according to Kogovsek et al. (2015)
As or adapted from an IPPC diagnostic protocol	no
Other information	
Are the performance characteristics included in the EPPO diagnostic protocol?	yes
Performance Criteria :	
Organism 1.:	Grapevine flavescence dorée phytoplasma(PHYP64)
Analytical sensitivity	
What is smallest amount of target that can be detected reliably?	3 experiments with 8 serial dilutions of DNA were performed: maximum dilution of FDp DNA that was detected was 1:270, which corresponding to 9-27 copies of FDp DNA (maximum dilution of FDp DNA that was detected using real-time PCR (Hren et al., 2007) was 1:2430, which corresponding to 1-3 copies of FDp DNA). 3 experiments with at least 6 serial dilutions of plant homogenate were performed: maximum dilution of FDp infected homogenate that was detected was 1:81, which corresponding to 9-27 copies of FDp DNA (maximum dilution of FDp infected homogenate that was detected using real-time PCR (Hren et al., 2007) after DNA extraction (Mehle et al., 2013) was 1:729, which corresponding to 1-3 copies of FDp

	DNA).
Diagnostic sensitivity	
Proportion of infected/infested samples tested positive compared to results from the standard test, see appendix 2 of PM 7/98	Two options for LAMP testing was compared: testing of isolated DNA:100% (no. of targets analysed: 52 FDp infected samples (38 grapevine leaf vein, 8 Clematis vitalba, 3 Alnus glutinosa, 1 Scaphoideus titanus and 2 Orientus ishidae samples)) direct testing of crude homogenates: 100% (no. of targets analysed: 27 FDp infected grapevine samples) Additionally, in 2015 all official Slovenian grapevine samples were tested by LAMP (direct testing of crude homogenates) and by real-time PCR. Number of samples: 286 Number of FDp positive samples (samples positive for FDp with real-time PCR): 28 Diagnostic sensitivity: 100% (27 samples were clear positive with LAMP, while one sample was positive with LAMP only in one out of three parallels)
Standard test(s)	real time PCR (Hren et al., 2007) on DNA isolated according Mehle et al. (2013)
Analytical specificity - inclusivity	
Number of strains/populations of target organisms tested	65 FD isolates/ infected samples (FD70, FD-C, FD-D) and 2 EY-phytoplasma isolates (for details see Table 1 in Kogovšek et al., 2014) Additionally, 15 samples with targets (11 samples positive for FD phytoplasma, and 4 samples positive for phytoplasmas of 16SrV group) from the test performance study (Euphresco: Grafdepi) were analysed.
Specificity value	LAMP is specific to 16SrV phytoplasmas (e.g. FD, EY). Percentage of accurate results: 99% (fals negative results: 0%; fals positive results: 1.5%*) Additionally, In silico analysis shown high specificity to 16SrV phytoplasmas including FD. *One healthy grapevine sample and a DNA sample of Ca. P. fraxini (16SrVII; isolate: ASHY 2; origin: USA) from the test performance study (Euphresco: Grafdepi) were positive with LAMP.
Analytical specificity - exclusivity	
Number of non-target organisms tested	123 (phytoplasma DNA from other 16Sr groups, bacterial and fungal isolates and healthy hosts; for details see Table 1 in Kogovšek et al., 2015) Additionally, 9 samples with non-targets from the test performance study (Euphresco: Grafdepi) were analysed.
Specificity value	Cross reaction: Ca. P. fraxini (16SrVII)
Cross reacts with	Phytoplasma fraxini
Diagnostic Specificity	
Proportion of uninfected/uninfested samples (true negatives) testing negative compared to results from a standard test	100% (no. of non-targets analysed: 53 FDp non-infected samples (48 grapevines, 2 C. vitalba, 1 A. glutinosa, 1 O. ishidae and 1 S. titanus))

	Additionally, in 2015 all official Slovenian grapevine samples were tested by LAMP (direct testing of crude homogenates) and by real-time PCR. Number of samples: 286 Number of FDp negative samples (samples negative for FDp with real-time PCR): 258 (FD and BN negative: 50; FD negative, BN positive: 208) Diagnostic specificity: 100%
Specify the test(s)	real time PCR (Hren et al., 2007) on DNA isolated according Mehle et al. (2013)
Reproducibility	
Provide the calculated % of agreement for a given level of the pest (see PM 7/98)	High FDp conc. (3 samples with more than 729 copies of FDp DNA): 100% (3 pos/ 3 repeats) Medium FDp conc. (2 samples with 81-729 copies of FDp DNA): 100% (2 pos/ 2 repeats) Low FDp conc. (8 samples with less than 81 copies of FDp DNA): 100% (8 pos/ 8 repeats) No. of operators: 2 No. of devices: 2 No. of days: 2-9
Repeatability	
Provide the calculated % of agreement for a given level of the pest (see PM 7/98)	High FDp conc. (5 samples with more than 729 copies of FDp DNA): 100% (29 pos/ 29 repeats) Medium FDp conc. (4 samples with 81-729 copies of FDp DNA): 100% (12 pos/ 12 repeats) Low FDp conc. (8 samples with less than 81 copies of FDp DNA): 81% (22 pos/ 27 repeats)
Test performance study	
Test performance study?	yes
Brief details of the test performance study and its output. It available, link to published article/report	A test performance study (TPS) has been performed to validate this LAMP protocol in the frame of WP4 of Euphresco Grafdepi2 project. Note: in this TPS also LAMP assay for BNp detection (which was developed in the frame of WP 1 of Euphresco Grafdepi2 project and is not published yet) was included. Ten laboratories from the research and plant protection area from Europe and Australia participated in this TPS. Samples that were subject of this TPS: DNA samples (1 from FD-infected clematis, 3 from FD-infected grapevine plants, 4 from BN-infected grapevine plants, 1 from FD and BN infected grapevine plants, 6 from healthy grapevine plants, 1 sample of fungi DNA, 1 sample of bacterial DNA, 1 sterile nuclease free water) Results: No. of labs taking in account for evaluation: 10 No. of results: 179 (number of samples with a positive assigned value: 49; number of samples with a negative assigned value: 130) Rate of true positives: 100% Rate of true negatives: 97,7% Accuracy: 98,3% Additionally, LAMP FDp assay was compared with a Qualiplate/Hyris isothermal amplification assay for FD (code: IsoA.FD/80) by three laboratories. Results for Qualiplate/Hyris isothermal amplification assay: No. of labs taking in account for evaluation: 3 No. of results: 54 (number of samples with a positive assigned value: 15; number of samples with a negative assigned value: 39) Rate of true positives:

	100% Rate of true negatives: 97,4% Accuracy: 98,1% For details see final report (file is attached).
Other information	
Any other information considered useful	Selectivity: There was no impact observed of different hosts, grapevine cultivars or tissues on the test results (FD was confirmed using LAMP in 12 different grapevine cultivars, either in berries or leaf veins, and also in <i>C. vitalba</i> , <i>A. glutinosa</i> , <i>O. ishidae</i> and <i>S. titanus</i>).
The following complementary files are available online:	<ul style="list-style-type: none"> • Euphresco GRAFDEPI2, WP4: Test performance study of the LAMP assays for the detection of BNP and FDp (Final report) • Kogovsek et al. 2014

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