HOCHSCHULE
WEIHENSTEPHAN-TRIESDORF
UNIVERSITY OF APPLIED SCIENCES

Test Report

Determination of resistance to root damage to flexible sheets and coatings for roof planting according to FLL (2008)

Product name

Protan SE 1,6 Titanium +

Principal/Manufacturer

Protan AS
P. O. Box 420
Brakerøya
3002 Drammen
Norway

The report comprises 34 pages and is only allowed to be used unabridged.

The report has a 10 years period of validity.

Date: 19-09-2013

Information given by Protan AS concerning data and characteristics of the flexible sheet Protan SE 1,6 Titanium+

- **Product name:** Protan SE 1,6 Titanium +
- **Intended use:** Extensive Green roofs
- **Material code/type of material:** PVC-P
- **Thickness of the sheet (without lamination):** 1.6 mm
- **Product design/structure:** PVC-P with a core of polyester textile
- **Supply form:** Rolls of membrane or prefabricated units.
- **Manufacturing technique:** Calandering and coating
- **Material standards / norms:** EN 13956
- **Test certificates:** SINTEF Approval 2010, ATG13/2679
- **Year of manufacture:** 2011
- **Installation method at the test site:**
  - Overlap: 40-130 mm
  - Jointing technique: Hot air welding
  - Jointing agent: None
  - Type of joint seal: None
  - Wall corner joint reinforcing: None
- **Addition of root inhibition agents with details of concentration:**

  Fungicide, 0.5 %

1 Problem task

In order to prevent damage, protection sheets and coatings are required to perform permanent resistance against penetration or perforation by plant roots and plant rhizomes (subterranean sprouts).

It is well known that rhizomes as well as roots may damage protection sheets and coatings. So, methods on testing protection sheets and coatings should consider both roots and rhizomes. Using Couch Grass (*Agropyron repens*) besides Firethorn (*Pyracantha coccinea*) as test plants, the long-established and approved FLL method takes rhizomes into account. According to the European standard EN 13948, which is derived from the FLL method, the test is being carried out without Couch Grass. Consequently, no impact of rhizomes can be detected. Thus the FLL method is more extensive and is considered to be more significant compared with EN 13948. In this test the resistance to root and rhizome damage of the sheet Protan SE 1,6 Titanium + manufactured by Protan AS, P. O. Box 420, Brakerøya, 3002 Drammen, Norway was determined according to FLL method.

2 Test facility and procedure

The 2 year-long test was carried out in accordance with the "Method of testing resistance to root damage to flexible sheets and coatings of roof planting" (FLL, 2008). The complete description of the FLL test procedure can be found in annex 3 of this report. The test was carried out between September 2011 and September 2013 comprising 8 containers equipped with the sheet to be tested. Another 2 containers without sheet were serving as control that allows to compare the plant development in the different containers. The sheet was installed at the test site of the Institute of Horticulture, University of Applied Sciences Weihenstephan-Triesdorf by Protan AS in accordance with the requirements. A reference sample of the sheet was taken and stored at the test institute. The final inspection included the noting of any root and rhizome penetration into and through the sheet.

3 Data given by the manufacturer of the sheet

The FLL test of resistance against root perforation refers to the data and material characteristics of the tested sheet and to the applied jointing and manufacturing technique. The data given by Protan AS concerning the sheet Protan SE 1,6 Titanium + are listed on page 2 of this report.

4 Results

4.1 Plant development

The plants, Firethorn and Couch Grass, performed well during the whole test period. Growth of the test plants in the control containers (without sheet) was on average not much differing from plant growth in the test containers covered by the sheet Protan SE 1,6 Titanium +. The required minimum vigorousness of Firethorn in the test containers (80 % of the average vigorousness of growth in the control containers) was clearly exceeded (98 - 110 %).

Couch Grass performed from the first interim evaluation (March 2012) during the whole test period a high density of stand. At the periodic evaluations in the 8 test containers on average 59 to 68 % of the substrate surface was covered with Couch Grass (nominal value ≥ 40 %).

Detailed information concerning vigorousness of growth is given in annex 2.

4.2 Penetration and perforation of roots and rhizomes at the end of test period

At the end of the test period (September 2013) the containers were emptied for a detailed check of the sheet Protan SE 1,6 Titanium + for root or rhizome penetration and perforation.

The flexible sheet Protan SE 1,6 Titanium + did not show any perforations or penetrations caused by roots or rhizomes after the 2 year test period (see photos in annex 1).

5 Summary

In accordance with the "Method of testing resistance to root damage to flexible sheets and coatings for roof planting" (FLL, 2008) a two year-long test was carried out from September 2011 to September 2013 with the sheet Protan SE 1,6 Titanium + manufactured by Protan AS, P. O. Box 420, Brakerøya, 3002 Drammen, Norway.

The flexible sheet Protan SE 1,6 Titanium + did not show any perforations or penetrations caused by roots or rhizomes after the 2 year test period.

The sheet Protan SE 1,6 Titanium + is therefore considered to be resistant to roots and to Couch Grass rhizomes according to FLL standard.

The FLL method involves all relevant elements of the method according to the European Standard EN 13948. Furthermore the FLL method is more extensive and is considered to be more significant among experts. So from the technical point of view the tested sheet Protan SE 1,6 Titanium + can be regarded as being resistant to root penetrations according EN 13948 as well.

The test on root resistance relates to the data and material characteristics as well as the applied jointing technique and manufacturing technique described on page 2 of this report. Reference samples of the tested sheet were taken and are stored at the Institute of Horticulture, University of Applied Science Weihenstephan-Triesdorf.

The test report was compiled in September 2013. The report has a 10 years period of validity. The report comprises 34 pages.

Person responsible for the test and the report: Dipl.-Ing. (FH) M. Jauch

19-09-2013 

University of Applied Sciences Weihenstephan-Triesdorf,
Institute of Horticulture, Am Staudengarten 14, D-85354 Freising
Tel.: +49 (0) 8161 / 71-4413, Fax: +49 (0) 8161 / 71-3348
E-Mail: martin.jauch@fh-weihenstephan.de

HOCHSCHULE
WEIHENSTEPHAN-TRIESDORF
UNIVERSITY OF APPLIED SCIENCES

Annex 1
Photos concerning the tested sheet Protan SE 1,6 Titanium + (Sept. 2013)

Figure 1: Sheet surface with joints

Figure 2: Sheet surface with corner

Figure 3: Sheet surface with joint (detail)

Figure 4: Sheet surface with T joint (detail)

Figure 5: Cross-section of a joint of the sheet (detail)

Annex 2
Data on plant development

Table 1: Height and trunk diameter of Firethorn in 8 test containers

Cont. No.	Plant No.	March 2012		Sept. 2012		March 2013		Sept. 2013	
		Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm
1	**1**	1.6	215	1.8	225	2.0	230	2.3	330
	2	1.6	225	1.7	295	1.9	320	2.2	330
	3	1.6	215	1.7	255	1.9	270	2.1	330
	4	1.7	220	1.8	245	2.1	255	2.4	355
2	**1**	1.6	210	1.8	270	2.1	265	2.3	335
	2	1.6	185	1.9	265	2.1	245	2.4	335
	3	1.6	190	1.8	240	2.2	245	2.4	335
	4	1.7	220	1.8	260	2.0	330	2.2	355
3	**1**	1.6	180	1.8	210	2.1	245	2.4	335
	2	1.6	215	1.7	250	1.9	310	2.1	365
	3	1.6	205	1.7	250	1.9	315	2.1	340
	4	1.5	155	1.7	250	2.0	240	2.2	385
4	**1**	1.6	195	1.7	265	2.0	275	2.1	325
	2	1.7	220	1.8	260	2.0	330	2.1	355
	3	1.6	180	1.8	210	2.1	245	2.3	335
	4	1.6	220	1.8	280	2.0	295	2.2	325
5	**1**	1.5	190	1.6	240	1.8	245	2.1	335
	2	1.6	205	1.7	270	2.0	295	2.1	335
	3	1.7	200	1.8	270	2.0	290	2.2	355
	4	1.6	215	1.6	240	1.8	300	1.8	390
6	**1**	1.5	215	1.7	255	2.0	310	2.2	345
	2	1.5	200	1.6	225	1.8	245	1.9	375
	3	1.5	235	1.7	320	1.8	325	2.0	335
	4	1.6	200	1.8	285	1.8	310	2.0	375
7	**1**	1.5	225	1.6	245	1.8	280	1.9	355
	2	1.6	215	1.7	250	1.9	310	2.1	365
	3	1.6	205	1.7	280	1.8	305	1.9	345
	4	1.5	200	1.6	305	1.8	295	2.0	320
8	**1**	1.7	235	1.9	275	2.1	290	2.3	375
	2	1.6	225	1.7	260	1.9	295	2.1	340
	3	1.7	205	1.8	245	1.9	270	1.9	375
	4	1.7	225	1.9	270	2.1	265	2.2	375

[1)] Trunk diameter measured at 20 cm above substrate surface

Table 2: Average height and trunk diameter of Firethorn in 8 test containers

Cont. No.	Plant No.	March 2012		Sept. 2012		March 2013		Sept. 2013	
		Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm
1-8	1-4	1.61	207.8	1.74	258.5	1.96	283.8	2.14	348.9

[1)] Trunk diameter measured at 20 cm above substrate surface

Table 3: Height and trunk diameter of Firethorn in 3 control containers

Cont. No.	Plant No.	March 2012		Sept. 2012		March 2013		Sept. 2013	
		Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm
1	1	1.6	180	1.8	240	2.0	270	2.2	350
	2	1.6	205	1.7	245	2.0	270	2.1	380
	3	1.6	185	1.9	220	2.1	260	2.3	335
	4	1.7	215	1.8	250	2.1	295	2.3	335
2	1	1.8	200	1.8	240	1.9	295	2.0	345
	2	1.5	195	1.6	240	1.8	290	2.0	350
	3	1.8	210	2.0	210	2.1	270	2.3	370
	4	1.7	190	1.8	235	2.0	275	2.1	335
3	1	1.7	200	1.8	215	2.0	270	2.1	345
	2	1.5	210	1.6	225	1.9	270	2.0	340
	3	1.7	215	1.8	230	2.0	315	2.2	365
	4	1.5	220	1.7	265	1.9	305	2.0	340

[1)] Trunk diameter measured at 20 cm above substrate surface

Table 4: Average height and trunk diameter of Firethorn in 3 control containers

Cont. No.	Plant No.	March 2012		Sept. 2012		March 2013		Sept. 2013	
		Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm
1- 3	1-4	1.64	202.1	1.78	234.6	1.98	282.1	2.13	349.2

[1)] Trunk diameter measured at 20 cm above substrate surface

Table 5: Average values of height and trunk diameter of Firethorn in 8 test containers related to the values of the plants in 3 control containers (data in %, nominal value: ≥ 80 %)

Cont. No.	Plant No.	March 2012		Sept. 2012		March 2013		Sept. 2013	
		Ø %	Height %	Ø %	Height %	Ø %	Height %	Ø %	Height %
1-8	1-4	98	103	98	110	99	101	100	100

[1)] Trunk diameter measured at 20 cm above substrate surface

Table 6: Classification of the stand density of Couch Grass in 8 test containers

Cont. No.	March 2012	Sept. 2012	March 2013	Sept. 2013
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1	60	70	70	70
2	60	70	60	70
3	60	70	70	70
4	50	60	70	60
5	60	60	70	60
6	50	60	70	70
7	60	70	70	70
8	60	60	70	70

Table 7: Average values of the stand density of Couch Grass in 8 test containers (nominal value: ≥ 40 %)

Cont. No.	March 2012	Sept. 2012	March 2013	Sept. 2013
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1-8	58.9	65.0	68.3	67.5

Table 8: Classification of the stand density of Couch Grass in 3 control containers

Cont. No.	March 2012	Sept. 2012	March 2013	Sept. 2013
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1	60	70	70	70
2	60	70	60	70
3	50	60	60	70

Table 9: Average values of the stand density of Couch Grass in 3 control containers

Cont. No.	March 2012	Sept. 2012	March 2013	Sept. 2013
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1-3	56.7	66.7	63.3	70.0