Research Institute of Horticulture
at the Weihenstephan University of Applied Sciences
Institute of Horticulture

Test Report

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

Product name:

WOLFIN IB

Principal/Manufacturer:

Henkel AG & Co. KGaA
Standort Wächtersbach
Am Rosengarten 5
D-63607 Wächtersbach-Neudorf

The report compiles 32 pages and is only allowed to be used unabridged.
The report has a 10 years period of validity.

Date: 2008-08-10

Information given by the Henkel AG & Co. KGaA concerning data and characteristics of the flexible sheet WOLFIN IB

- **Product name:** WOLFIN IB
- **Intended use:** sealing of roof and building
- **Material code/type of material:** PVC-P-BV
- **Thickness of the sheeting (without lamination):** 1.5 mm
- **Product design/structure:** homogeneous PVC-P-BV
- **Supply form:** rolls
- **Manufacturing technique:** extrusion
- **Material standards / norms:** DIN 16730, DIN 16937
- **Test certificates:** e.g. DIN 16726, DIN 53387, DIN 53472, SIA 280
- **Year of manufacture:** 2006
- **Layer which is responsible for the function of root resistance:** complete membrane
- **Installation method at test site:**
  - Overlap: circa 50 mm
  - Joint technique: solvent welding and hot air welding
  - Jointing agent: Tetrahydrofuran
  - Type of joint seal: none
  - Cover strip over joints: none
  - Special corner joints: covering with the same material
- **Addition of root inhibition agents with details of concentration:** none

1 Problem task

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

In this test the resistance to root and rhizome damage of the sheet WOLFIN IB manufactured by the Henkel AG & Co. KGaA, Standort Wächtersbach, Am Rosengarten 5, D-63607 Wächtersbach-Neudorf, Germany, was determined.

2 Test facility and procedure

The 2 years lasting test was carried out in accordance with the „Method of testing resistance to root damage to flexible sheets and coatings of roof planting“ (FLL, 2002). The complete description of the FLL test procedure can be found in annex 3 of this report.

The test was carried out between August 2006 and August 2008 comprising 8 containers equipped with the sheet to be tested. Another 3 containers without sheet were serving as control that allows to compare the plant development in the different containers.

The sheet was cut, jointed and installed in the containers at the test site of the Institute of Horticulture, Weihenstephan University of Applied Science by the Henkel AG & Co. KGaA.

A check sample of the sheet was taken and stored at the testing institute.

The containers were installed in a climate-controlled glass house.

The test plant Pyracantha coccinea ‘Orange Charmer’, is a Firethorn variety with satisfying growth at the defined climatic conditions also during winter half year. The other test plant, Agropyron repens (Coach Grass), is forming rhizomes which can damage protection sheets as well as roots.

The FLL method involves all relevant elements of the method according to the European Standard EN 13948. Compared with EN 13948 the FLL method is more extensive and is considered to be more significant.

3 Data given by the manufacturer of the sheet

The 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 the Henkel AG & Co. KGaA concerning the sheet WOLFIN IB are listed on page 2 of this report.

4 Results

4.1 Plant development

The plants, Firethorn and Coach Grass, performed well during the whole test period. Growth of the test plants in the control containers (without sheet) was only slightly differing from plant growth in the test containers covered by the sheet WOLFIN IB. The required minimum vigorousness of Firethorn in the test containers (80 % of the average vigorousness of growth in the control containers) was clearly exceeded (97 to 106 %).

Coach Grass performed from the first interim evaluation (February 2007) during the whole test period a high to very high density of stand. At the periodic evaluations in the 8 test containers on average 70 to 79 % of the substrate surface was covered with Coach Grass (nominal value $\geq$ 40 %).

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

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

At the end of the test period (August 2008) the containers were emptied for a detailed check of the sheet WOLFIN IB for root or rhizome penetration and perforation.

The sheet (surface and joints) 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, 2002) a two years lasting test was carried out with the sheet WOLFIN IB.

The sheet WOLFIN IB (surface and joints) did not show any perforations or penetrations caused by roots and rhizomes after the 2 year test period.

The sheet WOLFIN IB is therefore considered to be root resistant and rhizome resistant to Coach Grass 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 WOLFIN IB can be regarded as being resistant to root penetrations according EN 13948 as well.

The results of the test relate only to the tested sheet WOLFIN IB with it’s defined material characteristics, applied jointing technique and manufacturing technique (s. page 2 of this report). An extension of the results to other sheets is not admissible.

Check samples of the tested sheet were taken and are stored at the Institute of Horticulture, Weihenstephan University of Applied Science.

The test report was compiled in August 2008. The report has a 10 years period of validity.

This report comprises 32 pages and is only allowed to be used unabridged.

Person responsible for the test and the report:
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Annex 1
Photos concerning the tested sheet WOLFIN IB (August 2008)

Figure 1: Sheet surface (detail)

Figure 2: Sheet surface (corner)

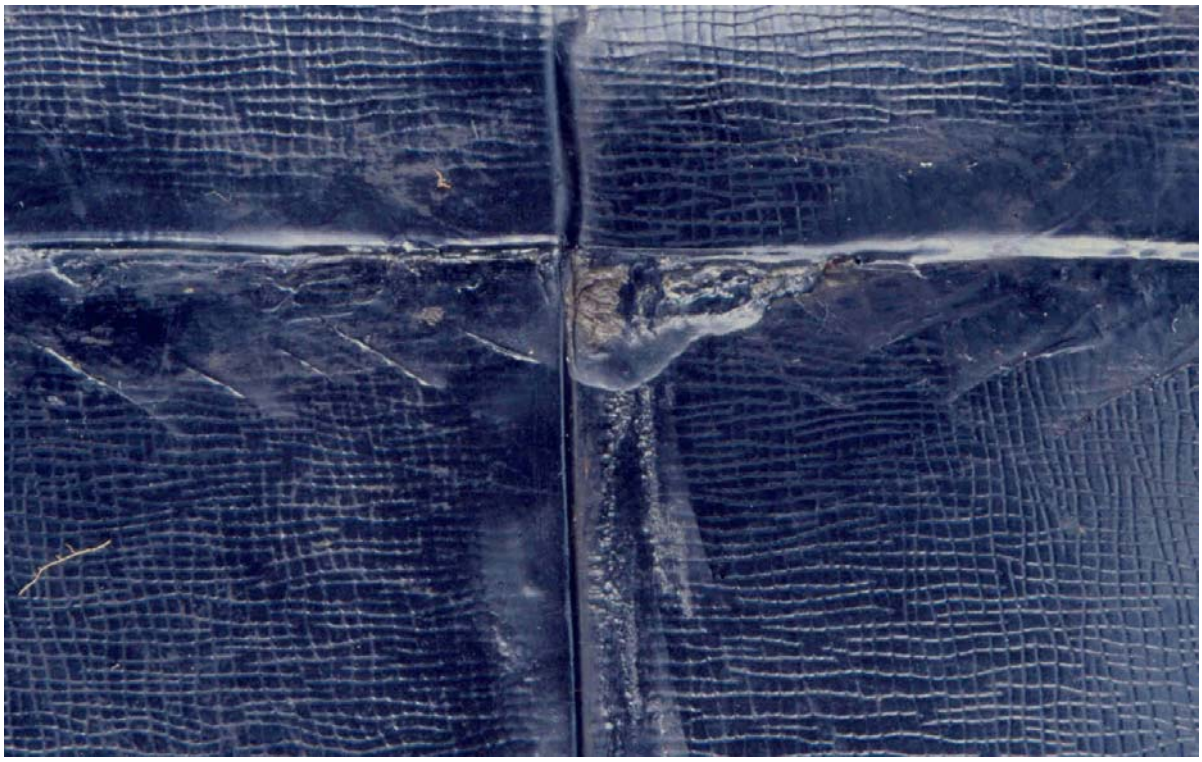

Figure 3: Sheet surface (T joint)

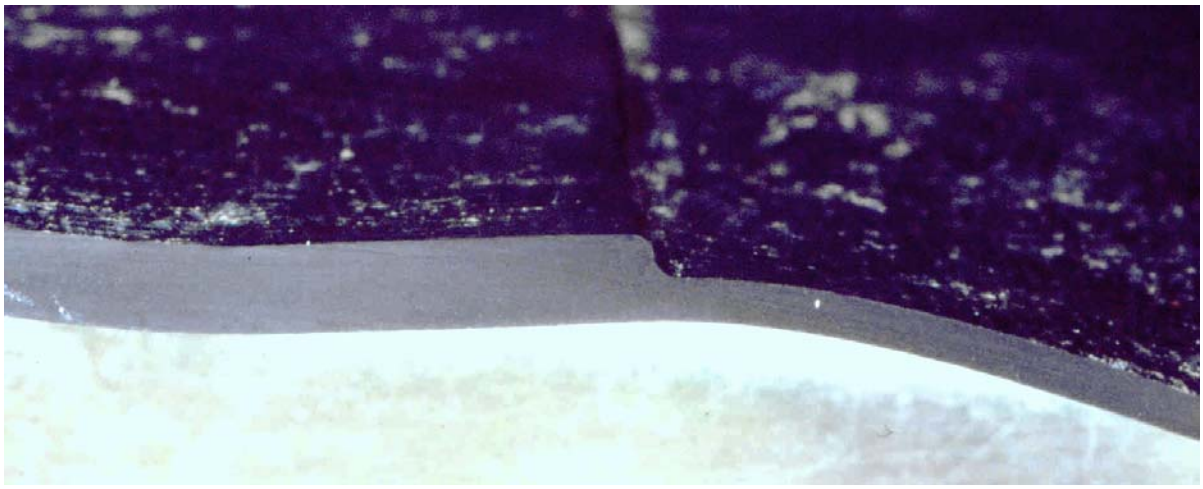

Figure 4: Cross-section of a joint of the sheet

Annex 2
Data on plant development

Table 1: Height and trunk diameter of Firethorn in 3 control containers

Cont. No.	Plant No.	February 2007		August 2007		February 2008		August 2008	
		∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm
1	**1**	1.4	225	1.4	255	1.7	295	2.2	335
	2	1.4	205	1.6	280	1.8	305	2.0	330
	3	1.4	190	1.6	200	1.8	255	2.1	365
	4	1.2	230	1.6	170	1.9	280	2.3	265
2	**1**	1.4	185	1.7	295	1.7	250	2.0	300
	2	1.4	180	1.6	180	2.0	300	2.3	280
	3	1.2	180	1.4	200	1.7	230	2.1	280
	4	1.4	230	1.5	230	1.9	230	2.1	285
3	**1**	1.2	205	1.5	205	1.6	200	1.9	270
	2	1.3	230	1.5	225	1.8	285	2.2	350
	3	1.2	200	1.4	215	1.8	320	2.2	275
	4	1.4	200	1.6	285	2.1	280	2.3	370

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

Table 2: Average height and trunk diameter of Firethorn in 3 control containers

Cont. No.	Plant No.	February 2007		August 2007		February 2008		August 2008	
		∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm
1- 3	**1-4**	1.32	205	1.53	228	1.82	269	2.14	309

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

Table 3: Height and trunk diameter of Firethorn in 8 test containers

Cont. No.	Plant No.	February 2007		August 2007		February 2008		August 2008	
		∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm
1	**1**	1.4	175	1.6	220	1.8	210	2.0	330
	2	1.3	200	1.6	245	1.7	255	1.9	290
	3	1.4	220	1.6	210	1.9	235	2.3	365
	4	1.3	195	1.7	240	1.8	265	2.2	335
2	**1**	1.3	210	1.5	225	1.7	240	2.1	305
	2	1.4	225	1.6	230	2.0	265	2.3	315
	3	1.3	195	1.6	255	1.8	180	2.0	305
	4	1.3	220	1.5	230	1.9	210	2.1	285
3	**1**	1.5	235	1.7	250	2.0	300	2.3	300
	2	1.3	205	1.6	195	1.8	215	2.1	275
	3	1.4	230	1.7	290	2.0	315	2.2	305
	4	1.4	210	1.6	225	1.8	185	2.2	350
4	**1**	1.4	180	1.5	235	1.8	215	2.1	295
	2	1.4	225	1.6	285	2.2	300	2.3	380
	3	1.3	200	1.5	270	1.7	250	2.0	320
	4	1.4	210	1.6	180	1.9	210	2.3	235
5	**1**	1.4	175	1.7	180	2.0	215	2.3	265
	2	1.2	245	1.4	240	1.6	250	1.8	285
	3	1.3	210	1.7	210	1.8	240	2.0	275
	4	1.3	220	1.6	300	1.7	275	2.1	335
6	**1**	1.4	250	1.6	270	1.8	265	2.1	275
	2	1.4	230	1.6	255	1.8	300	2.3	315
	3	1.4	195	1.5	210	1.8	290	2.3	265
	4	1.5	240	1.7	300	2.0	285	2.2	365
7	**1**	1.3	170	1.6	200	1.8	215	2.1	280
	2	1.4	240	1.6	215	1.8	240	2.0	350
	3	1.4	220	1.7	290	2.1	310	2.4	325
	4	1.3	195	1.5	240	1.7	265	2.1	310
8	**1**	1.4	170	1.6	220	1.7	255	1.8	330
	2	1.4	175	1.6	220	1.8	210	2.0	330
	3	1.3	200	1.6	245	1.7	255	1.9	290
	4	1.4	220	1.6	210	1.9	235	2.3	365

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

Table 4: Average height and trunk diameter of Firethorn in 8 test containers

Cont. No.	Plant No.	February 2007		August 2007		February 2008		August 2008	
		∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm
1-8	**1-4**	1.36	213	1.59	241	1.83	261	2.13	310

[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.	February 2007		August 2007		February 2008		August 2008	
		∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm	∅ cm[1)]	Height cm
1-8	**1-4**	103	104	104	106	101	97	100	100

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

Table 6: Classification of the stand density of Coach Grass in 3 control containers

Cont. No.	February 2007	August 2007	February 2008	August 2008
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1	65	75	75	80
2	65	60	60	65
3	65	75	80	80

Table 7: Average values of the stand density of Coach Grass in 3 control containers

Cont. No.	February 2007	August 2007	February 2008	August 2008
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1-3	63.3	71.2	71.2	75.0

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

Cont. No.	February 2007	August 2007	February 2008	August 2008
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1	70	75	75	75
2	75	80	80	70
3	70	80	85	85
4	65	70	85	70
5	65	65	60	65
6	75	75	85	75
7	70	70	80	85
8	70	80	70	70

Table 9: Average values of the stand density of Coach Grass in 8 test containers (nominal value: ≥ 40 %)

Cont. No.	February 2007	August 2007	February 2008	August 2008
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1-8	70.0	75.0	78.8	72.5