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Test Report

Determination of resistance to root damage to flexible sheets and coatings for roof planting according to FLL (2002)

Product name

NOVOPROOF® DA-P

Principal/Manufacturer

DURAPROOF technologies GmbH

Eisenbahnstraße 24

D-66687 Wadern-Büschfeld

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

The report has a 15 years period of validity.

Date: 20-11-2003

Information given by DURAPROOF technologies GmbH concerning data and characteristics of the flexible sheet NOVOPROOF® DA-P

- **Product name:** NOVOPROOF® DA-P
- **Intended use:** Waterproofing membrane
- **Material code/type of material:** EPDM
- **Thickness of the sheet (without lamination):** 1.3 mm
- **Product design/structure:** Single layer EPDM
- **Supply form:** Rolls of membrane or prefabricated units
- **Manufacturing technique:** Vulcanisation
- **Material standards / norms:** DIN 7864, Teil 1 (EN 13956, EN 13967)
- **Test certificates:** e.g. DIN 7864, Teil 1; DIN 4102, Teil 7; DIN 1055 (DIN EN 13501-1, Zertifikat WPK 1213-CPD-022, Zertifikat WPK 1213-CPD-023)
- **Year of manufacture:** 1999
- **Installation method at the test site:**
  - Overlap: 40 mm
  - Jointing technique: Thermofast® hot air welding
  - Jointing agent: None
  - Type of joint seal: None
  - Wall corner joint reinforcing: None (folded corners)
- **Addition of root inhibition agents with details of concentration:** None

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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 NOVOPROOF® DA-P manufactured by DURAPROOF technologies GmbH, 66687 Wadern-Büschfeld, Germany 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, 2002). The complete description of the FLL test procedure can be found in annex 3 of this report. The test was carried out between October 2001 and November 2003 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 DURAPROOF technologies GmbH 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.

Deviating from the FLL method no wall corner joints were fabricated. Instead of hat the EPDM membrane was folded in the wall corners (Fig. 1 and 2). As this is common practice concerning the installation of an EPDM membrane the deviation from the FLL method was accepted.

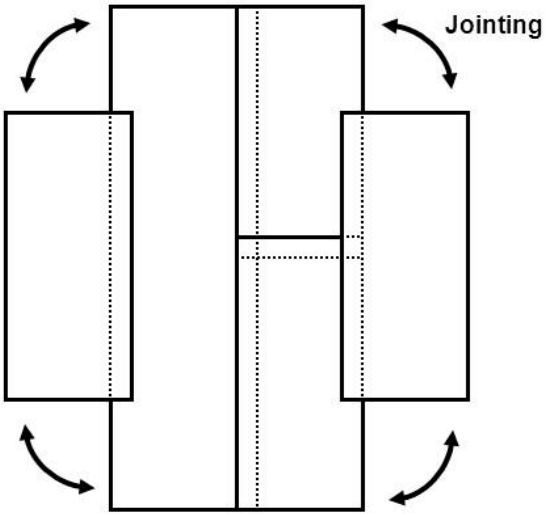

Figure 1: Wall corner joints according to FLL method

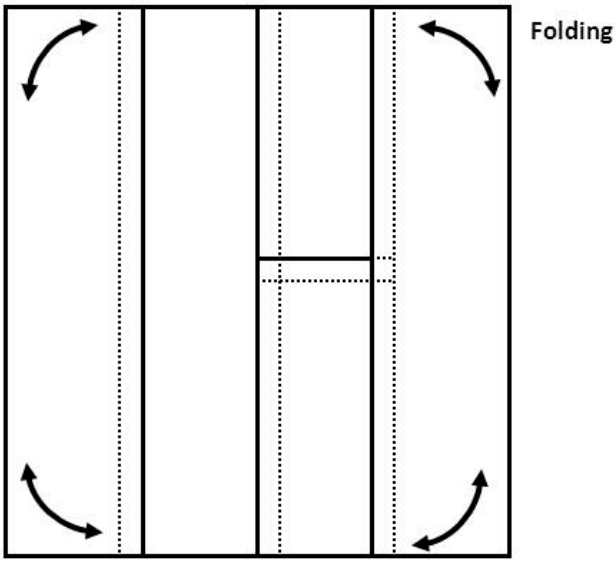

Figure 2: Folded EPDM membrane in the wall corners

3 Data given by the manufacturer of the sheet

The FLL test of resistance to 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 DURAPROOF technologies GmbH concerning the sheet NOVOPROOF® DA-P 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 NOVOPROOF® DA-P. 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 - 114 %).

Couch Grass performed from the first interim evaluation (April 2002) during the whole test period a high density of stand. At the periodic evaluations in the 8 test containers on average 71.3 to 93.8 % 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 (November 2003) the containers were emptied for a detailed check of the sheet NOVOPROOF® DA-P for root or rhizome penetration and perforation.

The flexible sheet NOVOPROOF® DA-P did not show any perforations or penetrations caused by roots or rhizomes after the 2 year test period (see figures 3-6 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 year-long test was carried out from October 2001 to November 2003 with the sheet NOVOPROOF® DA-P manufactured by DURAPROOF technologies GmbH, 66687 Wadern-Büschfeld, Germany.

The flexible sheet NOVOPROOF® DA-P did not show any perforations or penetrations caused by roots or rhizomes after the 2 year test period. The sheet NOVOPROOF® DA-P 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 NOVOPROOF® DA-P 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 November 2003 with a 10 years period of validity. Considering the actual FLL guidelines (2008) the period of validity was extended for 5 years in November 2013. Therefore the test report is valid until November 2018.

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

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

20-11-2013 

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Annex 1
Photos concerning the tested sheet NOVOPROOF® DA-P (November 2013)

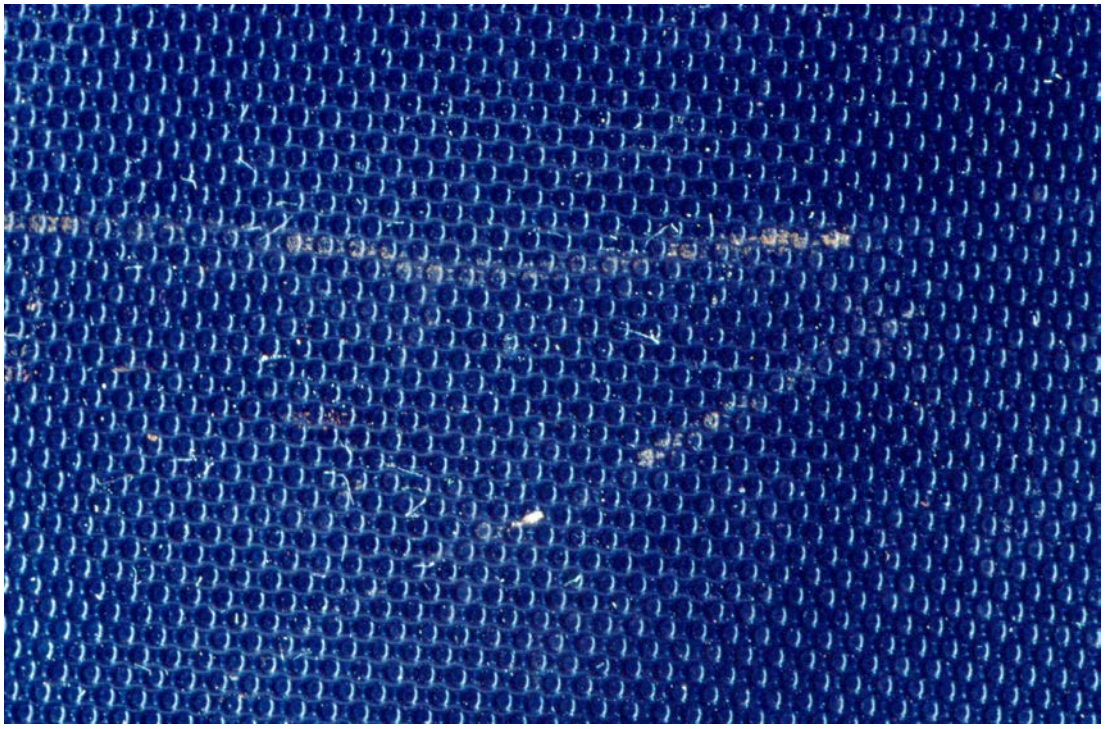

Figure 3: Sheet surface (Detail)

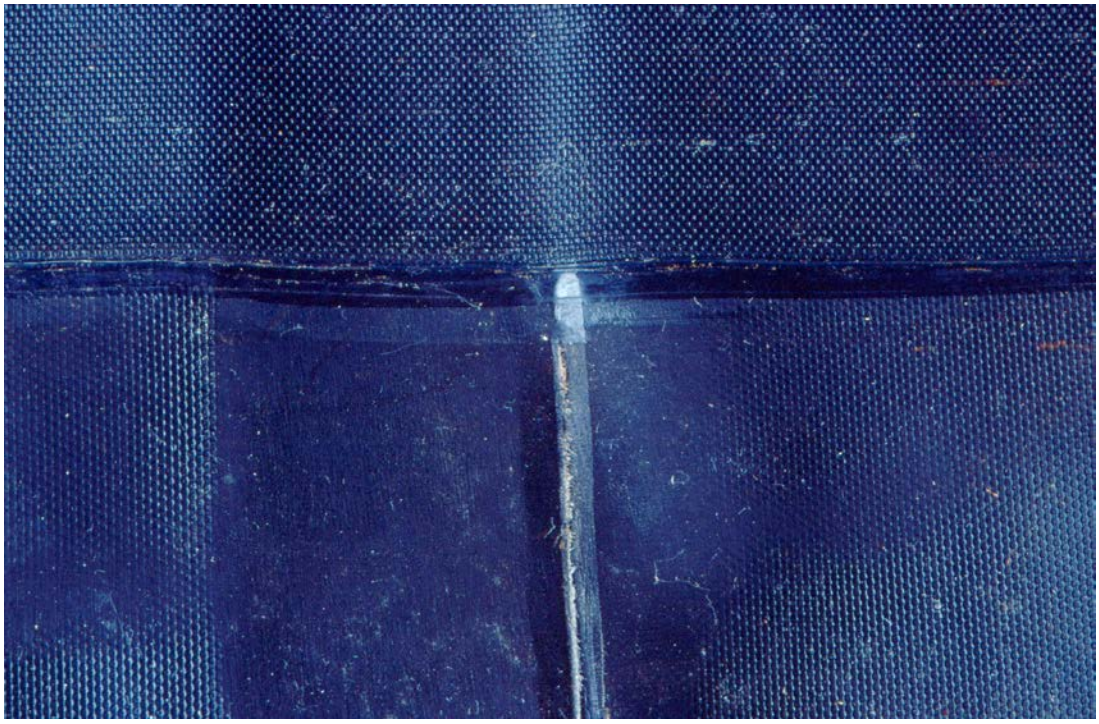

Figure 4: Sheet surface with T joint

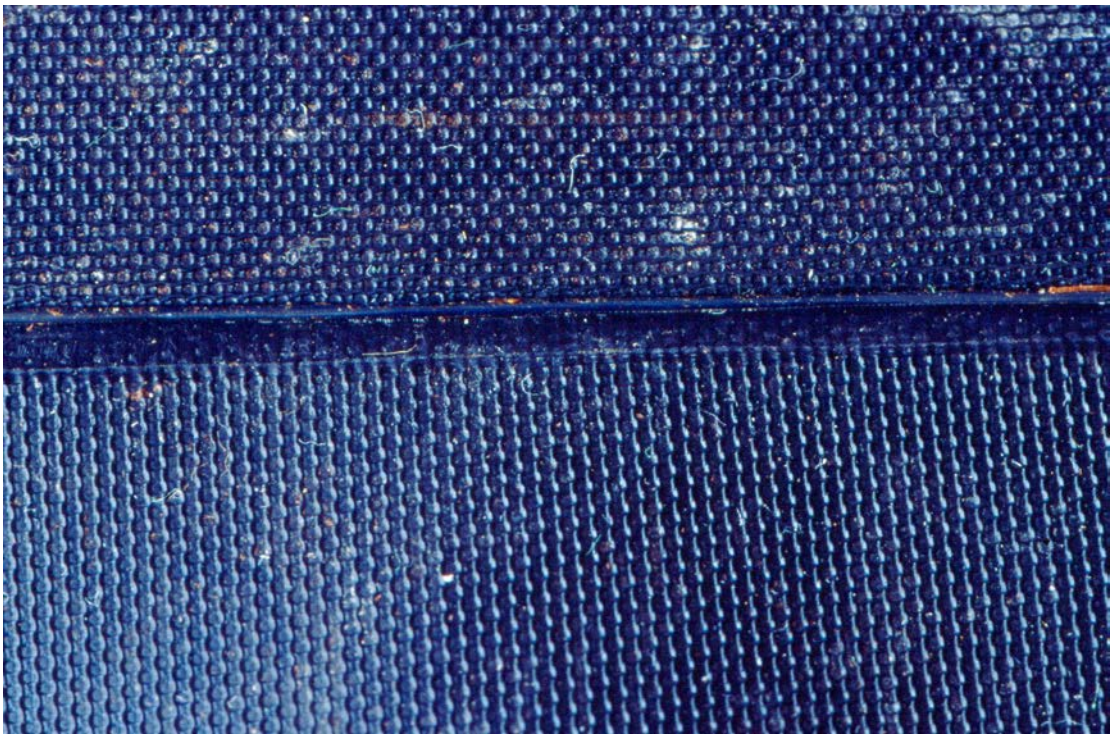

Figure 5: Sheet surface with joint

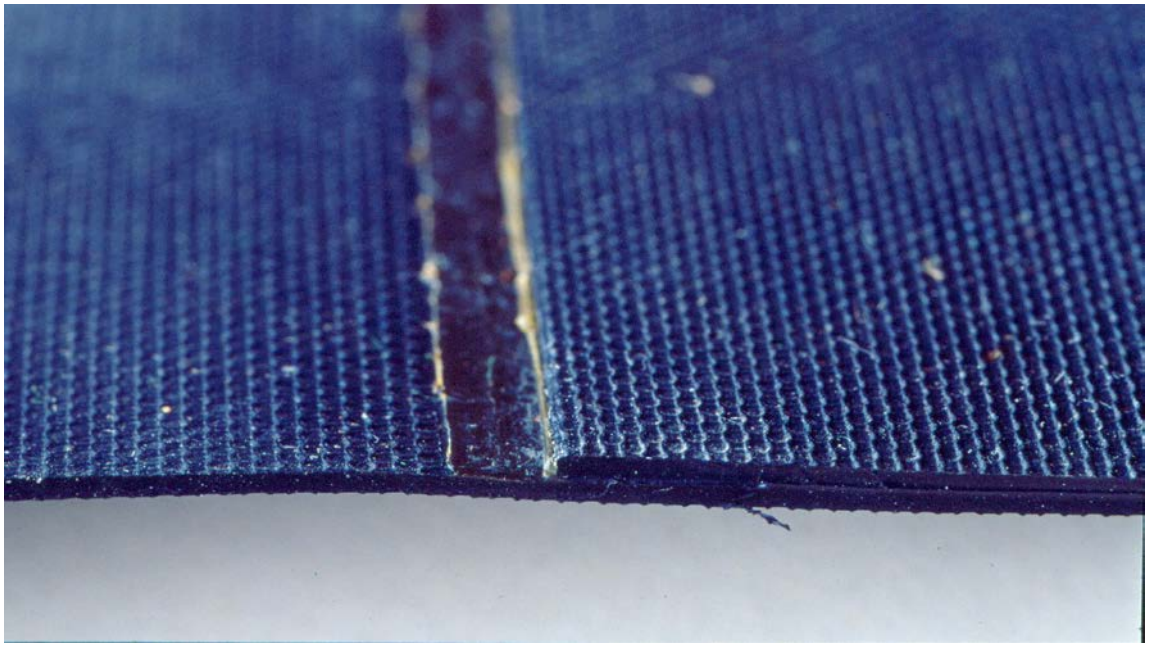

Figure 6: Cross-section of a joint of the sheet

Annex 2
Data on plant development

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

Cont. No.	Plant No.	April 2002		October 2002		April 2003		October 2003	
		Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm
1	**1**	1.3	220	1.5	245	1.7	255	2.2	295
	2	1.3	230	1.6	285	1.8	280	2.3	310
	3	1.4	200	1.6	250	1.7	265	2.1	300
	4	1.3	195	1.6	290	1.8	290	2.3	335
2	**1**	1.2	220	1.4	245	1.6	260	1.9	275
	2	1.4	230	1.6	255	1.8	300	2.3	315
	3	1.3	195	1.5	240	1.7	265	2.1	310
	4	1.4	170	1.6	220	1.7	255	1.8	330
3	**1**	1.3	210	1.4	210	1.8	270	2.2	265
	2	1.4	175	1.7	180	2.0	215	2.3	215
	3	1.2	245	1.4	240	1.6	250	1.8	285
	4	1.3	210	1.7	210	1.8	240	2.0	275
4	**1**	1.4	200	1.6	255	1.9	275	2.4	365
	2	1.3	170	1.6	200	1.8	215	2.1	280
	3	1.2	150	5.0	220	1.8	210	2.2	280
	4	1.3	200	1.6	245	1.7	245	1.9	290
5	**1**	1.4	240	1.6	215	1.8	240	2.3	350
	2	1.4	220	1.6	210	1.9	235	2.3	365
	3	1.3	195	1.7	240	1.9	265	2.2	335
	4	1.3	210	1.5	225	1.7	240	2.1	305
6	**1**	1.4	225	1.6	230	1.9	265	2.3	315
	2	1.3	195	1.6	255	1.8	180	2.0	300
	3	1.3	220	1.5	215	1.9	210	2.2	285
	4	1.2	185	1.5	200	1.7	245	1.9	260
7	**1**	1.3	170	1.6	195	1.8	215	2.1	275
	2	1.4	230	1.7	290	2.0	315	2.4	385
	3	1.4	210	1.6	225	1.8	185	2.2	350
	4	1.2	180	1.5	235	1.8	215	2.1	275
8	**1**	1.4	225	1.6	285	2.1	300	2.5	395
	2	1.3	200	1.5	270	1.7	250	2.0	300
	3	1.4	210	1.6	180	1.9	200	2.3	235
	4	1.2	200	1.5	245	1.7	195	1.9	220

[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.	April 2002		October 2002		April 2003		October 2003	
		Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm
1-8	1-4	1.32	204.2	1.67	234.5	1.80	245.2	2.15	302.3

[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.	April 2002		October 2002		April 2003		October 2003	
		Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm
1	1	1.3	220	1.4	155	1.8	150	2.2	300
	2	1.4	205	1.6	255	1.8	205	2.0	330
	3	1.4	230	1.5	215	1.9	230	2.1	285
	4	1.2	205	1.5	205	1.6	200	1.9	270
2	1	1.4	190	1.6	195	1.8	255	2.1	275
	2	1.4	230	1.6	170	1.9	280	2.3	265
	3	1.3	225	1.5	225	1.8	185	2.2	350
	4	1.2	200	1.4	215	1.8	215	2.2	275
3	1	1.4	200	1.6	285	2.1	280	2.3	370
	2	1.4	185	1.7	155	1.7	250	2.0	300
	3	1.4	180	1.6	180	2.0	200	2.3	235
	4	1.2	175	1.4	200	1.7	230	2.1	280

[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.	April 2002		October 2002		April 2003		October 2003	
		Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm	Ø cm[1)]	Height cm
1- 3	1-4	1.33	203.8	1.53	204.6	1.83	223.3	2.14	294.6

[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.	April 2002		October 2002		April 2003		October 2003	
		Ø %	Height %	Ø %	Height %	Ø %	Height %	Ø %	Height %
1-8	1-4	99	100	109	114	98	110	100	103

[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.	April 2002	October 2002	April 2003	October 2003
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1	75	80	90	100
2	75	80	90	90
3	65	85	95	100
4	70	75	85	85
5	70	85	90	90
6	65	80	95	90
7	80	85	90	95
8	70	80	80	100

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

Cont. No.	April 2002	October 2002	April 2003	October 2003
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1-8	71.3	81.3	89.4	93.8

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

Cont. No.	April 2002	October 2002	April 2003	October 2003
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1	65	80	90	95
2	75	85	90	100
3	65	85	90	95

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

Cont. No.	April 2002	October 2002	April 2003	October 2003
	stand density (in %)	stand density (in %)	stand density (in %)	stand density (in %)
1-3	68.3	83.3	90.0	96.7