different sections with knots forming the boundaries between the sections. Around the knots inconspicuous small leaves surrounding the stem as well as thin *roots* have formed. In between the knots the couch grass *rhizomes* are hollow (See 4.1 Elymus Repens “Couch Grass” or “Quack Grass” and Figure 1)

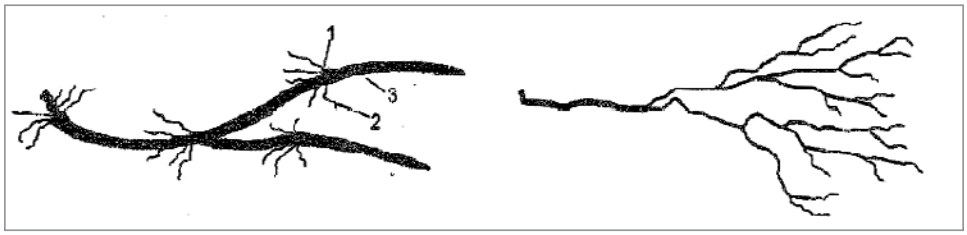


Figure 1: Schematic representation Of “Couch Grass” *rhizome* (left) with knots (1), *roots* (2) and leaves (3). “Orange Charmer” *root* (right).

4.0 Test Plant Growth

4.1 Plants

- **Pyracantha Coccinea**: “Orange Charmer” a woody ornamental plant species which under greenhouse conditions shows an all-year round growth suitable for the test.
- **Elymus Repens (aka Agropyron Repens)**: “Couch Grass or Quack Grass”, an indigenous grass with slow-growing *rhizomes*, a common weed species found on many roofs with a moderately aggressive rhizomatous growth habit and which also grows sufficiently all-year under the given testing conditions.

4.2 Classification of Plant Growth Coverage Performance

Plant growth coverage shall be visually evaluated monthly with the following scale:
Inadequate: <60% surface coverage

Moderate: 60–75% surface coverage

Adequate: >75% surface coverage

4.3 Plant Growth Coverage

Within 3 months of the onset of the test, plant growth coverage of the media shall be in excess of 60% of the surface, and there shall be evidence of new growth and plant *roots* or *rhizomes* shall be visible at the bottom of the control containers. Plant growth coverage shall remain dense (>75% surface coverage and a dense mat of *roots* or *rhizomes* at the bottom of the control containers) throughout the remainder of the test procedure (Figure 2). If <60% plant growth coverage is not attained after 3 months terminate and restart the test, or wait until 60–75% coverage is attained. The test duration shall be extended to account for the delay in achieving 60–75% coverage. This condition shall be noted in the test report. *Root* or *rhizome* surface coverage shall be determined using the methodology presented in Section 6.1.

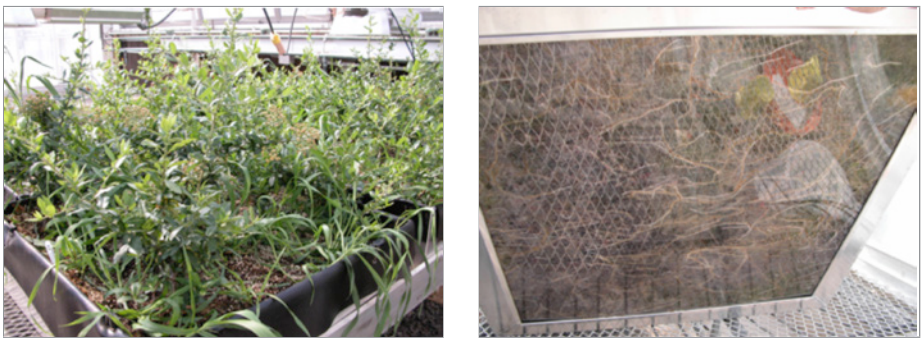


Figure 2: Adequate healthy plant growth (>75% coverage) in a trial container and dense root mat visible at the bottom of a control container.

Figure 3: Sample trial container. Note the interior metal fold to support the clear plexiglass base.

5.5 Root Barrier to be Tested

The *root barrier* shall be supplied and installed in the *trial containers* per the manufacturer's specifications and shall contain seams or joints as shown in Attachment 1 and Attachment 2. The *root barrier* shall be laid according to Section 5.11. Liquid coating *root barriers* shall be applied according to Section 5.11.1.

5.6 Growth Media

Growth media shall be a greenhouse or nursery product commercially available or composed onsite. When a commercial product is used the manufacturer and lot number shall be recorded. If composed onsite, the formulation shall be recorded. EC and pH will be measured using a standard saturated paste method. (See C5.6)

5.7 Fertilizer

Fertilization by liquid feed or slow release fertilizer with complete macro and micro-nutrients shall be used to encourage plant and *root* or *rhizome* growth. Fertilizer shall be applied at the low or moderate rate recommended by the fertilizer manufacturer for containers of the size used to maximize plant growth. Formulations and quantities of fertilizer applied shall be recorded and included in the final report. (See C5.7)

5.8 Irrigation

Plants shall be watered with good quality water suitable for greenhouse or nursery crop production. Plants shall be watered as needed based on local environmental conditions to maximize plant growth. Irrigation may be done by hand or by an automated system. In either case plants shall be allowed to dry between irrigation applications, and the *growth media* shall be thoroughly wetted with each irrigation application.

5.9 Samples and Information Provided by the Manufacturer

To ensure a clear identification of the tested product, the following information shall be provided by the manufacturer before the test is started: product name, material description, material standards, thickness, surface finish or structure, test certificates, year of manufacture, seaming or jointing procedures (e.g. spacing overlap, seaming technique, seaming agents, type of seam sealing, cover strips over seams, special corner and angle joints), and, if applicable, admixture of biocides (e.g. *root* inhibitors) with details regarding the concentration of the substances.

Maintain plants to aid in proper growth management. Pruning shall be kept to a minimum because excessive pruning will limit *root* growth. Pruning shall be done equally to both test and control plants. (C5.12)

Insufficient quack grass coverage (< 40% of the surface is covered) shall be improved by up to two units of repeat seeding or by dividing existing plants or adding additional *rhizome* plugs in the first three months of the test.

In case of pest attacks or plant diseases threatening the survival of the plants under testing, appropriate plant protection measures shall be carried out. Pesticide applications if necessary shall be kept to a minimum and the chemical class of the pesticides shall be carefully considered with the *root barrier* manufacturer to avoid the use of materials that might interact with the *root barrier* material.

5.13 Preparation and Installation of the Three Control Trial Containers
Control *trial containers* shall be prepared and installed as described in Section 5.0, but without the installation of the *root barrier* material.

6.0 Evaluations

6.1 Evaluation During Testing

See Section 5.12 for proper irrigation and plant management. Plant damage such as deformations of the leaves or changes of leaf color shall be noted.

Inspection of all *trial containers* (test and control containers) shall be made once a month. This observation shall include visual evaluation of plant cover, plant appearance, new growth, and *root* or *rhizome* surface growth coverage at the bottom of the control *trial containers*. (See 4.2). A digital photograph of all *trial containers* (base and plants) shall be taken during this inspection. (See C6.1)

A formal evaluation of the transparent base of the 6 test *trial containers* shall be conducted in intervals of 6 months to detect for visible *roots* or *rhizomes* penetration.

6.2 Premature Test Termination

During the test evaluations visible penetrations of *roots* or *rhizomes* into the *root barrier* to be tested is identified, the test shall be terminated. (See 4.6)

If during the test phase more than 25% of the plants are lost, the investigation shall be started anew, i.e., new plantings with new *growth media* shall be carried out.

6.3 Evaluation at the End of the Trial

6.3.1 Evaluation Procedure

Evaluation commences with a final monitoring of the growth performance of the plants. Above-ground plant biomass for test *trial container* and control *trial container* shall be compared per below instructions.

After the above ground biomass has been removed and evaluated the *trial containers* shall be turned upside down and the *growth media* and *root* or *rhizome* mass removed.

In a successful test the entire *growth media* mass will be completely bound together by *roots* or *rhizomes* and will come out of the test *trial container* as a single mass. *Root* or *rhizome* density at the bottom of the containers shall be evaluated when the boxes are dissambled. *Root* or *rhizome* density at the bottom of the test *trial containers* shall be visually compared with *root* or *rhizome* density of the control *trial containers*. Successful plant growth is indicated by a solid mat of *roots* or *rhizomes* at the bottom of the control *trial containers*. *Root* density at the bottom of the control *trial containers* of less than 80% observed indicates poor test conditions and the test shall be repeated.

After plant and *root* or *rhizome* evaluations, examine the *root barrier* material for *root* or *rhizome* adhesion or penetration. Wash with garden hose using gentle pressure to remove loose material. Examine remaining material to determine if *roots* or *rhizomes* have adhered to the surface of the *root barrier*. Examine under a 7x magnification microscope to determine if they are surface attached or have penetrated into the *root barrier*. *Root* or *rhizome* ingress or penetration into the *root barrier* shall be recorded in the test report. (See C6.3).

6.3.2 Test Field Evaluation

If more than 50 *roots* or *rhizomes* per container are found to have penetrated into but not through the *root barrier*, the evaluation on penetration shall be performed only on a section of the tested material. In this case, the evaluation shall cover at least 2 ft^2 (0.2 m^2) equivalent to about 20% of the *root barrier* covered with the *growth media*, and shall be performed in the area indicated in (Figure 5). The penetration of *roots* or *rhizomes* into the field of the evaluation area shall be recorded.

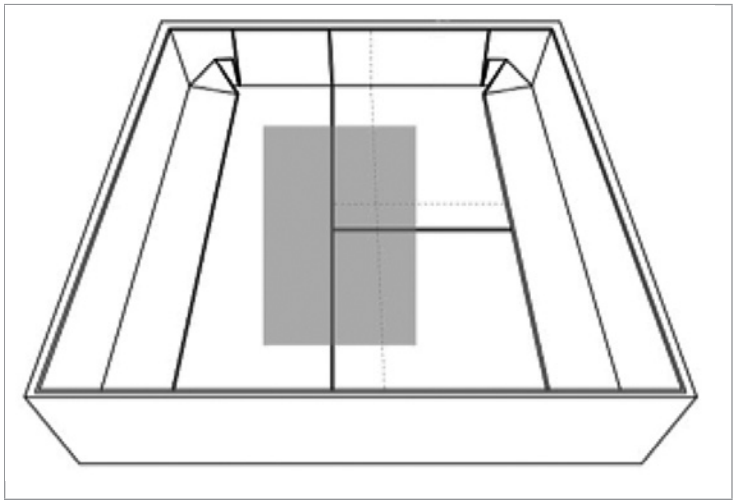


Figure 5: Evaluation of penetrations into the surface of the root barrier with >50 penetrations per receptacle.

6.3.3 Test Seam Evaluation

The penetration of *roots* or *rhizomes* into the overlap area of seams shall be recorded. For retention purposes, samples of the *root barrier* shall be taken. The samples shall be compared to the control samples stored at the initial stage of the testing. (See 5.1)

6.3.4 Failure Criteria

A *root barrier* is deemed to have failed if *roots* or *rhizomes* have penetrated through the *root barrier* or seams in the *root barrier* material and are visible at the bottom of the *trial container* (Figure 6).

Figure 6: Root penetration on backside of tested root barrier.

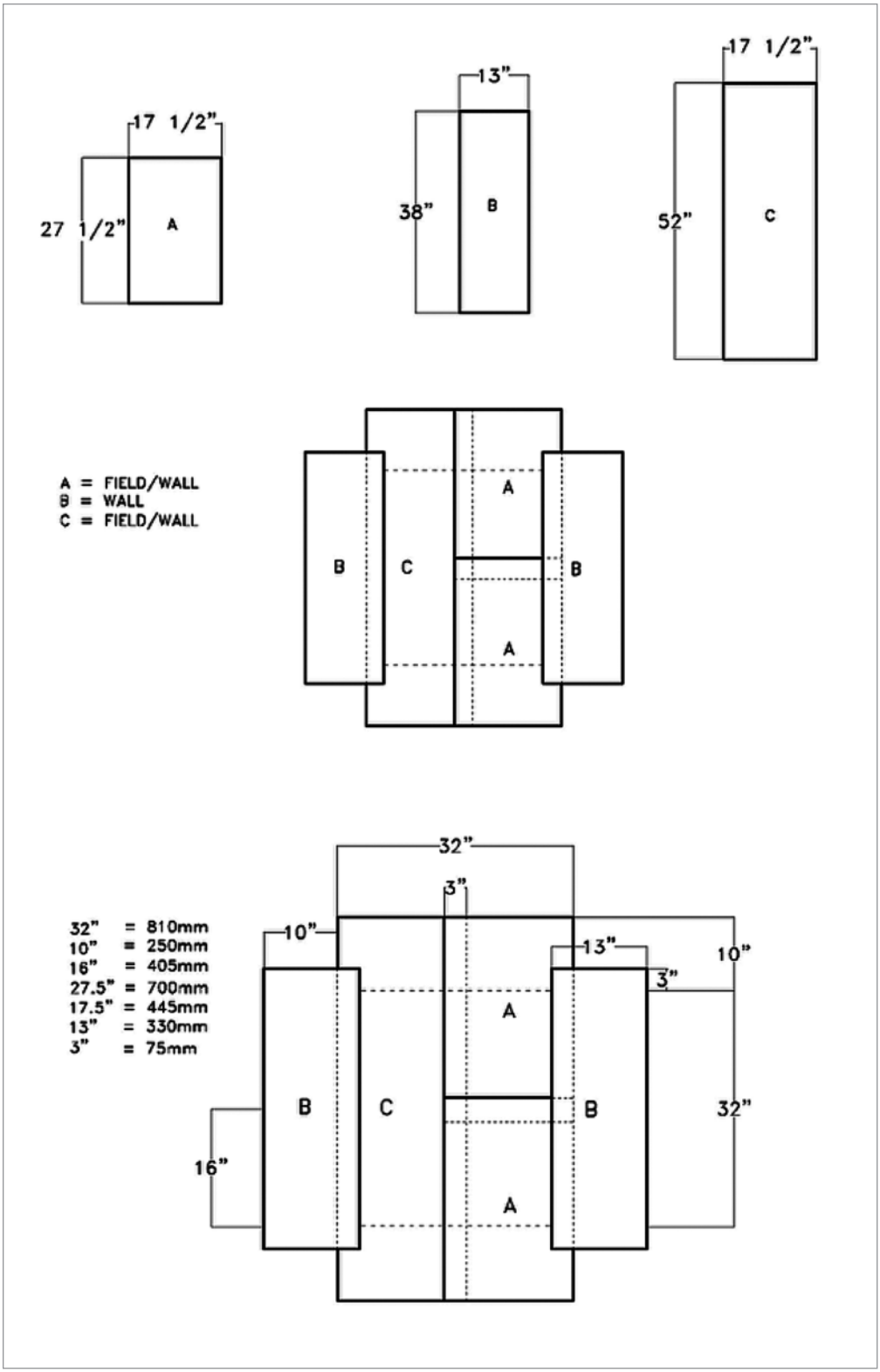
6.4 Test report

Upon termination of the trial, a complete test report shall be prepared. The report shall contain the following information:

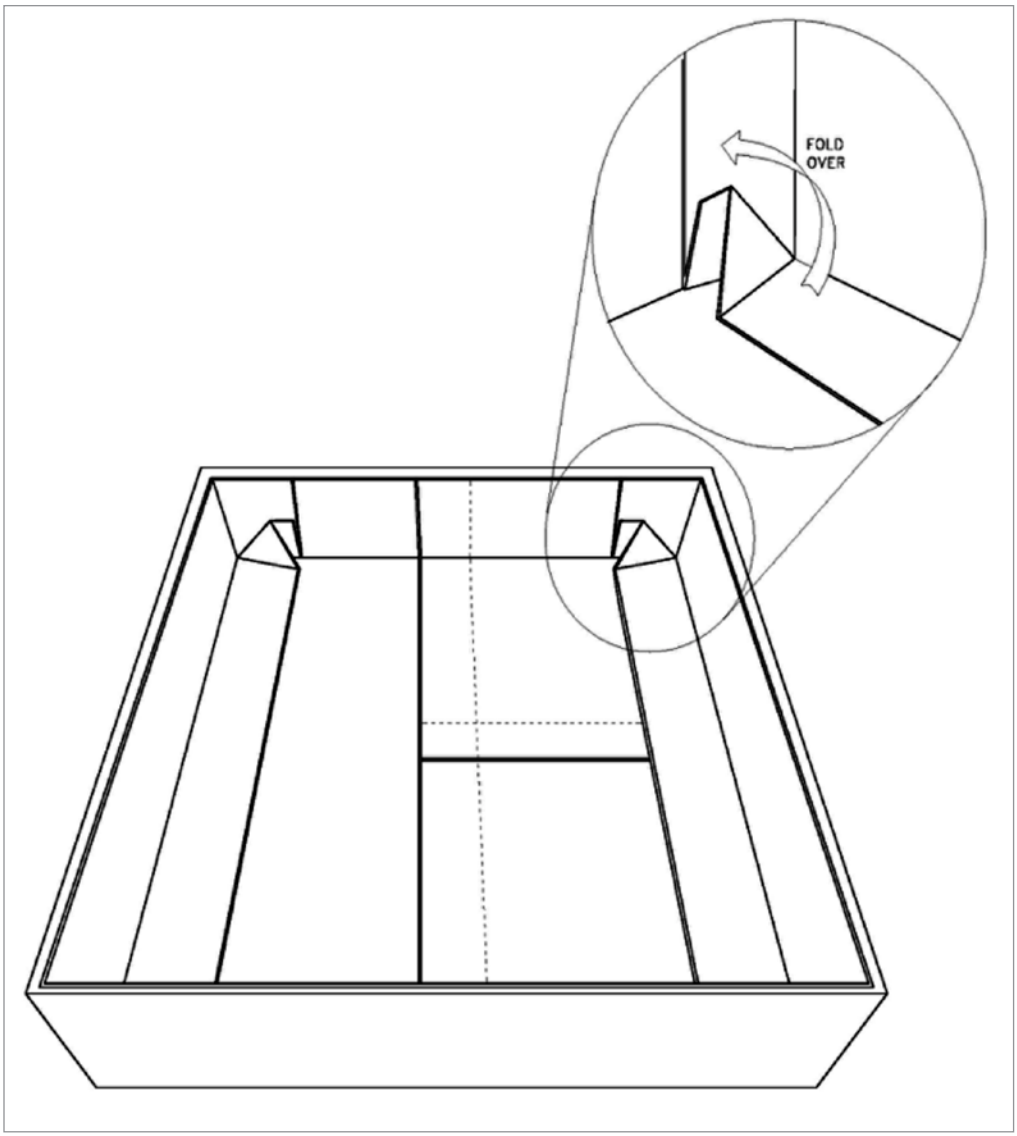
- Details provided by the manufacturer in relation to the *root barrier* under testing. (See 5.9);
- Description of the preparation of the *trial containers*; and
- All evaluation results in accordance with Section 6.0.

Attachments

Attachment 1: Layout of the seams in the root barrier to be tested



Attachment 2: Trial container corner detail



Commentary

This Commentary is not a part of ANSI/SPRI VR-1 Procedure for Investigating Resistance to *Root* or *Rhizome* Penetration on Vegetative Roofs. It is included as supplemental information.

This Commentary consists of explanatory and supplementary material designed to assist users in applying the recommended requirements. It is intended to create an understanding of the requirements through brief explanations of the reasoning employed in arriving at these requirements. The following wording shall be included in introduction to the Commentary: "The information contained in this Commentary is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, Commentary may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard."

The sections of this Commentary are numbered to correspond to sections of the standard to which they refer. Since it is not necessary to have supplementary material for every section in the standard itself, there may be gaps in the numbering in the Commentary.

C2.0 The goal of this test procedure is to maximize *root* or *rhizome* growth in contact with the *root barrier* being tested. The two moderately aggressive and vigorous plant species chosen represent a realistic threat to *root barrier* integrity when well grown. Plant growth procedures described in this test are intended to maximize *root* or *rhizome* growth.

C5.4 Larger containers may be used if the circumstances under which they are to be installed so require. For example, a larger *trial container* would be needed to evaluate seaming details as they would be installed in the field.

C5.6 Examples of commercially available *growth media* are Premier Horticulture Pro-Mix BX, Quebec, or other equivalent media. The substrate will require about 23 gal (88 L) per receptacle (taking into account a substrate supply via plant earth-clumps).

C5.7 An example of commercially available fertilizer is Osmacote Plus 15-9-12 with a release over 6 months.

C5.10 This corresponds to a substrate volume of 23 gal (88 L) for a receptacle of 32 in x 32 in (800 mm x 800 mm) It is advisable to place the receptacles on stands to facilitate *root* or *rhizome* penetration checks in regular intervals. Keep a minimum distance of 16 in (0.4 m) between and around the different receptacles.

C5.12 Pruning is limited to side shoots if they are an obstacle to using walkways. Excessive pruning will limit *root* or *rhizome* growth.

C6.1 To evaluate the *root* or *rhizome* surface growth coverage of the control *trial containers*, a digital photograph may be taken of the transparent base. The photograph can be processed at high contrast in order to highlight *root* or *rhizome* covered areas. The *root* or *rhizome* density as a percentage of total base area can be determined using appropriate image processing software.

C6.3 *Root* or *rhizome* adhesion is defined as *roots* or *rhizomes* that stick to the surface of a material or imperfections in the surface of a material that are not easily washed off with a low pressure water stream. This may include *roots* or *rhizomes* that have entered surface air bubbles or craters in the surface of a material but not progressed beyond the limits of the surface imperfection. *Root* or *rhizome* adhesion does not include *roots* or *rhizomes* that stick to the material because of surface erosion or other degradation of the material.

Not to be identified as *root* or *rhizome* penetration but may be noted in the test documentation are:

- Roots or *rhizomes* that have grown < 0.2 in (5 mm) on a root barrier which contain radicide substances, since here any root or *rhizome* banning effect can only act upon the root or *rhizome* in the root barrier.
- Roots or *rhizomes* that have penetrated seam sealing components (without damaging the sealed seam).