United States Department of Agriculture

Bulb Preclearance Program

Identification Manual




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When using pesticies, read and follow all label instructions.

First Edition Issued 2011

Bulb Identification

Figures

Bulb Identification

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Bulb Identification

Acknowledgements

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Photographs were also obtained from the library of the late J. Heuperman.

Chapter

1

Introduction

Contents

Purpose

This Bulb Indentification Manual is intended as a reference for officers who will inspect bulbs for shipment to North America.

Scope

This is **not** an encyclopedic account of all the bulbs (including corms, rhizomes, and tubers) and perennials covered by the preclearance program. Out of more than 300 genera that are in the program, only about 70 most important ones in terms of volume are included in this manual. Many were selected to show the great diversity of the material exported through the program.

The pests and diseases described for each genus are only those that are currently being intercepted by the Dutch inspection services and the preclearance team. They are categorized into three groups:

Table 1-1 Categories of Pests and Diseases

Common Pests	Those that are commonly intercepted
Rare Pests	Those that are intercepted only once or twice a season
Other Pests	Those that are intercepted less frequently

The term “pest” here includes insect pests, diseases, physiological disorders and any other reason for phytosanitary rejection. Most of the insect pests that attack the plant during the growing season are **not** included as they are eliminated during washing. Furthermore, many pests and diseases are culled out by the exporter and are never seen during the phytosanitary inspections. These are **not** included in this manual. It is also important to note that because of improved horticultural practices, many pests and diseases that were common 20 years ago are **never** seen today.

Conventions

Conventions are established by custom and are widely recognized and accepted. Major conventions used in MU manuals follow.

Advisories

Advisories are use throughout MU manuals to bring important information to the user’s attention. Please carefully review each advisory. The definitions coincide with the American National Standards Institute (ANSI) with the goal of making the warnings easy to recognize and understand, thus limiting the human and dollar cost of foreseeable errors and accidents,[1] and are in the format shown below.

NOTICE

CAUTION

WARNING

1 TCIF Guideline, *Admonishments (Safety-Related Warning Message)*, TCIF-99-021 Issue 1, p.4

DANGER

Two significant changes in current warning messages are as follows:

- CAUTION, WARNING, and DANGER should now be used **only** for risks to personal safety, (in compliance with ANSI and the Occupational Safety and Health Administration (OSHA))
- Presentation has been standardized around the colors and symbols prescribed by ISO and the layouts and typography prescribed by ANSI[2]

Boldface

Boldface type is used to emphasize important words throughout MU manuals. These words include, but are not limited to: **cannot, do not, does not, except, lacks, must, neither, never, nor, not, only, other than**.

Bullets

Bulleted lists indicate that there is **no** order of priority to the information being listed. Bulleted lists should always be in alphabetical order.

Change Bar

A black change bar is used to indicate a change appearing on a revised page. Unfortunately, change bars do not always appear when text is merely deleted.

Chapters

This manual contains the following chapters:

1. Chapter 1: Introduction
2. Chapter 2: Corms
3. Chapter 3: Perennials
4. Chapter 4: Rhizomes
5. Chapter 5: True Bulbs
6. Chapter 6: Tubers
7. Chapter 7: Glossary
8. Index

Contents

Every chapter has a table of contents listing only the first- and second-level headings within the chapter.

2 *Id.*

Control Data

Control data is located at the top and bottom of each page to help manual users keep track of where they are in the manual ad to be aware of updates to specific chapters, appendixes, etc. At the top of each page is the chapter title and first-level heading for that page. At the bottom of each page is the transmittal number (month/year-issue or edition number), manual title, and page number.

Examples

Examples are used to clarify a point by applying it to a real-world situation. Examples always appear in a box as a means of visually separating them from the other information contained on the page.

EXAMPLE Examples are graphically placed boxes within the text as a means of visually separating information from other infromation contained on the page. MU examples always appear in a box like this.

Footnotes

Footnotes comment on or cite a reference to text and are referenced by a number. The footnotes used in MU manuals include general text footnotes, figure footnotes, and table footnotes.

General text footnotes are located at the bottom of the page after a thin green line half the width of the page and flow numerically throughout a chapter.

When space allows, figure and table footnotes are located directly below the associated figure or table. However, multipage figures and tables, or figures and tables covering the entire length of a page **cannot** accommodate footnote numbers and footnote text on the same page. If a table or figure continues beyond one page, the associated footnotes will appear on the page following **the end** of the figure or table. Each table's footnotes are individually numbered, e.g., a chapter may have three tables and within each table is a single footnote, then each footnote will be indicated with the number 1.

Heading Levels

Within each chapter there are four heading levels. The first-level heading is indicated by a horizontal line across both the left and right columns with the heading language across the left and right columns directly underneath. The body text after a first-level heading is located inside the margined text area, one line after the heading language. The second- and third-level headings are inside the margined text area with the body of text following underneath. The fourth-level heading is inside the margined text area followed by a period and leading into the text.

Hyperlinks to Tables, Figures, and Headings

Tables, figures, and headings are cross-referenced in the body of the manual and are in hyptertext (blue) font.

EXAMPLE See Reporting Problems With or Suggestions For the Manuals to determine where to report report problems with the manual.

Indentions

MU manuals indent content information, lengthy quotes, and entry requirements summarized from the Code of Federal Regulations (CFRs), import permits, or policies.

Italics

The following items are italicized throughout MU manuals.

- Cross-references to headings and figure/table titles
- Publication names
- Scientific names of commodities

Numbering Scheme

A two-level or three-level numbering scheme is used in MU manuals. In two-level numbering, the first number represents the chapter and the second number represents the page, table, or figure number. In three-level numbering, the first number represents the chapter, the second number represents the section, and the third number represents the page, table, or figure number. Dashes are used in page numbering to differentiate page numbers from decimal points.

Transmittal Number

The transmittal number contains the month, year, and consecutively issued number (beginning with -01 for the first edition and increasing consecutively for each update to the chapter or section). The transmittal number is only changed when the specific front matter, chapter, section, or back matter is updated. If no changes are made to a specific chapter or section, the transmittal number for that chapter or section remains unchanged. The transmittal number only changes for the entire manual when a new edition is issued or changes are made to the entire manual.

EXAMPLE 06/2011-01 is the transmittal number for this update and is located in the control data in the footer area of the pages in this volume.

06 is the month the manual/update was issued.
2011 is the year the manual/update was issued.
01 is the manuals edition number (the original edition).

Using the Manuals

Review the TOC of a manual to get a feel for the scope of covered material. Use the TOC in each chapter (miniTOC) to find the needed information. If the TOC or miniTOC are **not** specific enough, turn to the index to find the topic and corresponding page number.

Reporting Problems With or Suggestions For the Manuals

MU manuals provide users with information to determine where to report problems, disagreements, or improvements that directly affect the contents of a manual. An example follows:

Table 1-2 Procedures to Report a Problem with a Manual

If you:	Then:
Are **not** able to access the online manual	CONTACT Josie Cooley by email at josie.cooley@aphis.usda.gov
Have a situation that requires an immediate response regarding a procedure	
Have a suggestion for improving the formatting of the content (design, layout, composition), grammar, or spelling	

Manual Updates

The online manuals attempt to capture the most up-to-date information. Most MU manuals are electronically issued on the APHIS Web site.

Chapter

2

Corms

Contents

Introduction

This section provides descriptions, photographs, inspection procedures, and major pests of a variety of genera of corms. Corms are underground, upright, enlarged stems that are topped with buds. They are 80–100 percent covered with a tunic which are the remains of the old leaf bases, and have nodes with axillary buds.

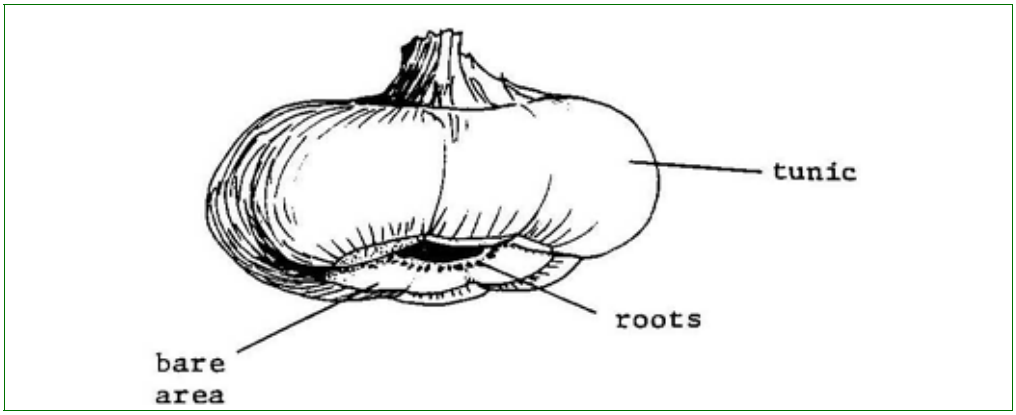


Figure 2-1 Corm Sketch

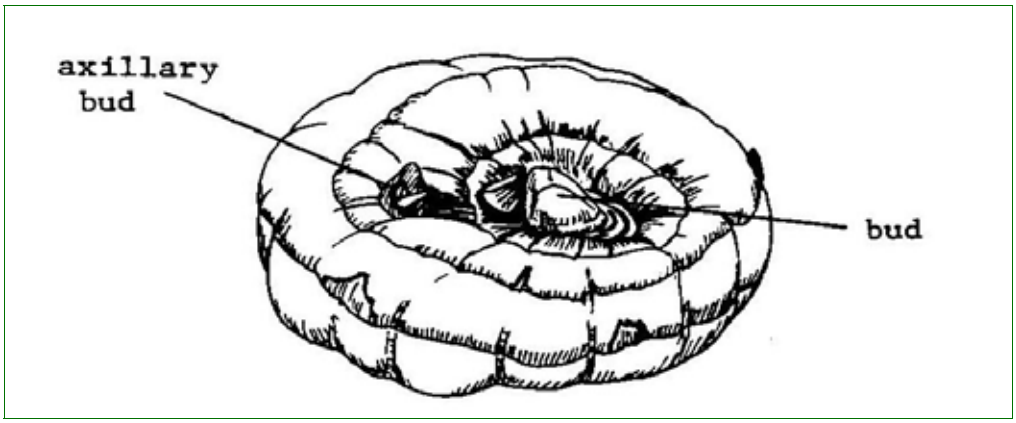


Figure 2-2 Corm with Tunic Removed

When a corm starts to grow, the bud expands and new roots emerge from the base of the bud (Stage 1). Nutrients are taken up from the old corm to supplement the growth of the new corm on top of the old one (Stage 2). The old corm shrivels and becomes a mummy. Occasionally, this mummy will remain attached to the corm that is presented for shipment. In gladiolus, root-like structures emerge from the base and expand to form tiny new corms or cormlets (Stage 3).

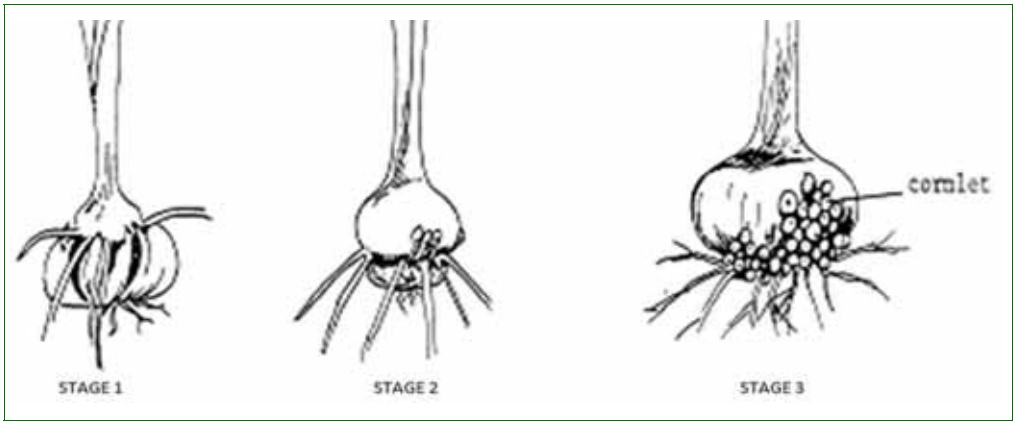


Figure 2-3 Stages of Development of *Gladiolus* Corm

The information in this chapter includes the pest risk rating for each bulb. The ratings are:

Table 2-1 Pest Risk Ratings for Corms

Pest Risk	Rating
1-2	Very low risk. Verify the genus in the shipment. Inspect if time is available
3-4	Low risk. Inspect if time is available
5-6	Moderate risk. Provide normal inspection
7-8	High risk. Inspect thoroughly
9-10	Very high risk. Inspect very thoroughly

Identification Procedure

Determine the length of the corm you are identifying. Compare it with the photographs in this chapter and select the description that fits your corm. Each description includes inspection procedures and pests of concern.

Acidanthera (*Gladiolus callicanthus*)

Acidanthera produces a small to medium sized corm with a pinkish-beige, papery tunic with reticulations on the top half. The corm is conical shaped, often with a slight twist, and the tip slightly off-center. The flesh of the corm is cream colored with yellow node lines.

Source: USDA-APHIS

Figure 2-4 ***Acidanthera***

Pest Risk Rating

The pest risk rating for *Acidanthera* is 2–3.

Similar Looking Corms

Freesia show **no** reticulation on the tunic, and it is thinner and smaller.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal corms for inspection.
3. Peel tunic back and look at flesh.

Pests

Common Pests

None

Rare Pests

Fusarium. Symptoms: Attacks the basal plate, causes depressed sunken lesions forming concentric rings.

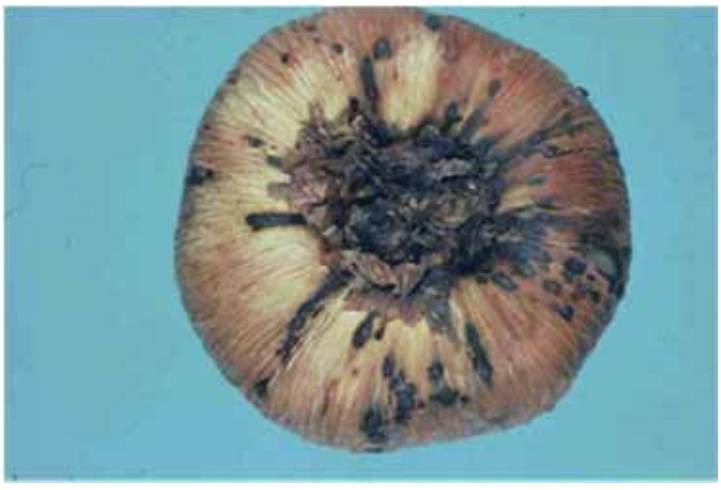
No photo available.

Other Pests

Botrytis. Symptoms: Pinpoint brown spots that radiate into the flesh, and will also infect areas besides the basal plate.

No photo available.

Stromatinia gladioli. Symptoms: Brown lesions with black sclerotia on the tunic. On the corm surface, lesions become sunken and usually turn black with slightly raised margins.



Source: PPO

Figure 2-5 *Stromatinia gladioli* on *Acidanthera*

Babiana

Babiana are small, globose or teardrop shaped corms with a very small basal plate. The tunic is tough and fibrous, sometimes netted, longer than the corm itself and with a bronze sheen. There are splits along the veins.

Source: USDA-APHIS

Figure 2-6 ***Babiana***

Pest Risk Rating

The pest risk rating for *Babiana* is 2–3.

Similar Looking Corms

Because of its long, fibrous, bronzy tunic, *Babiana* corms are very distinctive. *Crocosmia* corms also have tunics that are longer than the corm itself, but the tunic of *Babiana* is softer than that of *Crocosmia*. *Crocosmia* corms usually bear persistent roots, whereas *Babiana* corms do **not**.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal corms for inspection.
3. Remove tunic and examine flesh.

Pests

Common Pests

None

Rare Pests

Fusarium. Symptoms: Attacks the basal plate area causing depressed, sunken lesions that form concentric rings.

No photo available.

Other Pests

Thrips. Symptoms: Fresh symptoms: sticky, mildly brown coloration, usually around the internodes.

No photo available.

Brodiaea

Brodiaea corms are 0.5–0.75 inches (13–20 mm) in height and subglobose or broadly teardrop in shape. The corm is often asymmetrical due to the formation of cormlets and tends to angles on the sides. The tunic is cream colored, silvery-tan, grayish, or brown and fibrous with net-like at the base. The corm flesh is white and smooth. Many species formerly included in *Brodiaea* have been transferred to other genera, including *Ipheion* and *Triteleia.*

Source: USDA-APHIS

Figure 2-7 Brodiaea

Pest Risk Rating

The pest risk rating for *Brodiaea* is 3.

Similar Looking Corms

Crocus is similar in size and shape.

Ixia has a tunic which is completely fibrous and woven, with flesh that is red to purple in color.

Sparaxis tunics are fibrous, with an open weave pattern. The skins or tunics are white.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal corms for inspection.
3. Peel off the tunic and examine the flesh.

Pests

Common Pests

None

Rare Pests

Fusarium. Symptoms: Attacks at the base causing depressed, sunken lesions that form concentric rings.

No photo available

Mechanical Injury. Symptoms: Causes small, shallow, dry callus that can be flicked off with a knife blade. Strictly a quality issue.

No photo available.

Rhodococcus fascians. Symptoms: Attacks at the base or where scales attach, causing small, thin, fan-like, fasciated scales or very small deformed bulblets. The variety 'Queen Fabiola' is especially susceptible.

Source: nVWA

Figure 2-8 *Rhodococcus fascians* on *Brodiaea*

Other Pests

None

Colchicum

Colchicum corms are very distinctive. It can be up to 3 inches (76 mm) or more in length, irregularly-shaped, convex on one side and flat on the other, with a foot-like projection from the base. The edge of the corm covering the foot is scalloped or fringed. The tunic is brown and leathery when mature and extends above the body of the corm to form a neck. The main corm has two small cormlets attached to it. One cormlet is attached to the foot, the other to the side of the main corm. The main corm has channels or grooves to receive the growing shoots of the small cormlets

Source: USDA-APHIS

Figure 2-9 ***Colchicum***

Pest Risk Rating

Colchicum has a pest risk rating of 5–6.

Similar Looking Corms

There are **no** corms that resemble *Colchicum*.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal corms for inspection.

3. Examine tunics for disease symptoms.
4. Remove tunics and examine corm flesh.
5. Squeeze and examine basal plate

Pests

Common Pests

None

Rare Pests

Fusarium. Symptoms: Brown rot with distinct margins and accompanied by a musty, sour odor; usually basal. The left photo shows infection beginning at the sides of the corm. The right photo shows basal infections.

Source: (left photo) BKD; (right photo) USDA-APHIS

Figure 2-10 *Fusarium* on *Colchicum*

Other Pests

Ditylenchus detructor. Symptoms: Brown discoloration and streaking from the base of the corm. Basal plate eventually disintegrates, creating a depression at the base of the corm. Note the sunken base of the corm on the left in Figure 2-11.

Source: BKD

Figure 2-11 *Ditylenchus destructor* on *Colchicum*.

Urocystis colchici. Symptoms: Raised black sori on the outer surface of the tunic.

Source: PPO

Figure 2-12 *Urocystis colchici* on *Colchicum*

Uromyces colchici. Symptoms: Rust colored spores forming ring-like areas with sori present only on the inside surface of tunics.

No photo available.

Crocosmia

Crocosmia corms are globose, conical, or somewhat flattened and discoid in shape, 1–1.5 inches (25–38 mm) in diameter and up to 1.5 inches (38 mm) in height, with grayish-brown, coarse, fibrous tunic that is normally longer than the corm and persistent fibrous roots. A hard remnant of the previous year's growth often remains at the base of the corm. With the tunic removed, the corm has prominent nodes.

Source: USDA-APHIS

Figure 2-13 *Crocosmia*

Pest Risk Rating

Crososmia has a pest risk rating of 5.

Similar Looking Corms

Almost identical to *Montbretia*, which is **not** included in this manual. The corms of some varieties resemble those of *Gladiolus*.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select any abnormal corms for inspection.

3. Remove tunics and examine corm flesh and basal plate for disease symptoms.

Pests

Common Pests

None

Rare Pests

Fusarium. Symptoms: Black lesions at the nodes of the corm, resulting from the fungus entering the corm through the leaves. In cross-section of the corm, the infected vascular bundles radiating from the core are discolored and dark lesions are evident.

Source: BKD

Figure 2-14 *Fusarium* on *Crocosmia*[1]

1 Left photo: Note dark scab-like lesions along nodes of the corms. Right photo: Note discolored vascular bundles radiating from the core and brownish spotting of the corm.

Source: USDA-APHIS

Figure 2-15 ***Penicillium gladioli*** **on** ***Crocosmia***

Other Pests

Botrytis. Symptoms: Circular lesions penetrating into the flesh.

No photo available

Crocus

Crocus is a pear-shaped to globose or subglobose corm 0.5–1.2 inches (12–30 mm) in diameter and symmetrical or irregular in outline. The tunic is brown, fibrous, and coarsely or finely reticulate, netted or cloth-like, and membranous, papery, silky, or shell-like with overlapping scales. Some have annulate tunics that break up into rings around the corm, while others have tunics with longitudinal fibers. The interior of the corm is white and firm.

Source: USDA-APHIS

Figure 2-16 ***Crocus***

Pest Risk Rating

Crocus has a pest risk rating of 7–8.

Similar Looking Corms

The corms of different varieties of *Crocus* may resemble those of small *Gladiolus*.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal corms for inspection.
3. Examine the tunics for disease symptoms.

4. Examine for disease and especially the basal plate for nematode symptoms.
5. Examine corm flesh for disease symptoms.

Pests

Common Pests

Mechanical Damage. Symptoms: Abrasions, scars, discoloration due to damage sustained during harvest or during processing. A quality, non-quarantine issue. Purple coloration is normal for some varieties of this species.

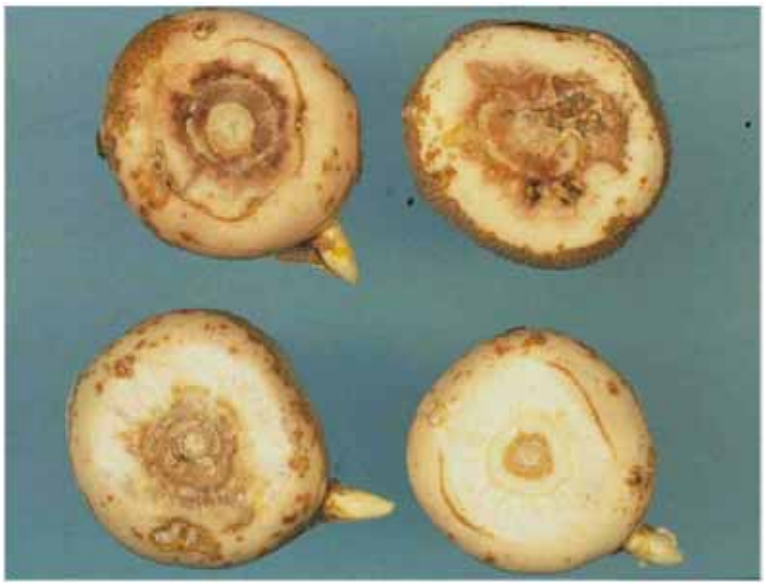
Source: USDA-APHIS

Figure 2-17 Mechanical Damage on *Crocus* [1]

1 Top row shows scarring on thin-tunic Crocus vernus. The bottom row shows damage on C. chrysanthus. This species has thicker tunic and damage occurs where the tunic has been removed during harvest/processing.

Rare Pests

Aphelenchoides subtenuis. Symptoms: Damage concentrated around rootlets. Swollen, raised basal plate with discoloration spreading outward.



Source: PPO

Figure 2-18 *Aphelenchoides subtenuis* on *Crocus* [1]

1 Bottom right specimen is healthy. Note characteristic streaking from the basal plate in the other three specimens.

Ditylenchus destructor. Symptoms: Extensive core rotting of the corm flesh. Starts at the base and spreads outward as a discoloration and upward through the core.

Source: T. Overdevest

Figure 2-19 *Ditylenchus destructor* on *Crocus* [1]

1 Note discoloration spreading from the basal plate.

Fusarium. Symptoms: Depressed chocolate brown to blackish lesions with white mycelia, usually around the basal plate.

Source: (left photo) PPO; (right photo) nVWA

Figure 2-20 *Fusarium oxysporum* on *Crocus*

Penicillium gladioli. Symptoms: Blue-green mold, usually secondary on damaged areas.

Source: USDA-APHIS

Figure 2-21 *Penicillium gladioli* on *Crocus*

Other Pests

Aphids. Symptoms: Usually with autumn flowering species. Emerging shoots can be sticky. Old aphid skins may be present.

No photo available

Botrytis croci. Symptoms: Dry rot with large sclerotia, especially along the nodes and penetrating the corm flesh.

Source: PPO

Figure 2-22 *Botrytis croci* on *Crocus*

Stromatinia gladioli. Symptoms: Brown to black, more or less circular lesions usually along the nodes, becoming sunken and often running together. Infected corm often becomes mummified and black.

Source: PPO

Figure 2-23 *Stromatinia gladioli* on *Crocus*

Urocystis gladiolicola. Symptoms: Conspicuously raised black sori penetrating into the flesh.

Source: PPO

Figure 2-24 *Urocystis gladiolicola* on *Crocus*

Uromyces croci. Symptoms: Lesions forming on the surface of the corm under the tunic and penetrating into the interior. Occasionally, the infection may originate at the base of the corm.

Source: PPO

Figure 2-25 *Uromyces croci* on *Crocus*

Freesia

Freesia corms are variable in shape and size depending on variety. In some varieties they are conical or ovoid, often with the tip bent to one side. In other varieties they could be almost oblong, somewhat flattened, nearly barrel-shaped or globose. The fibrous tunic may be brownish or dirty-whitish with thin, diamond-shaped reticulations on the upper 1/2 to 3/4 of the corm. The basal plate is very small.

Source: USDA-APHIS

Figure 2-26 ***Freesia***

Pest Risk Rating

Freesia has a pest risk rating of 7.

Similar Looking Corms

Freesia corms are similar to *Acidanthera* and *Gladiolus*; however, *Freesia* corms are generally more slender and smaller. The corms of some varieties resemble those of *Gladiolus nanus*.

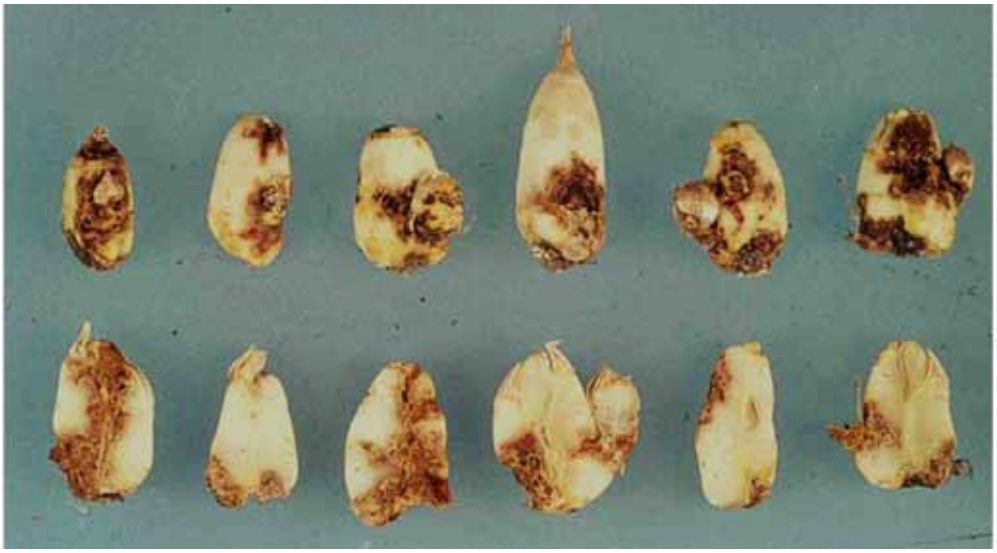
Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal corms for inspection.
3. Remove tunic and examine corm flesh for disease and nematode symptoms.

Pests

Common Pests

Fusarium. Symptoms: Brown black discoloration of the core. Infection is **not** restricted to base of corm. Superficial *Fusarium*-like symptoms often occur but the infections do **not** always affect the core of the corm. The causal agent may be another pathogen and *Fusarium* may or may **not** be present. Corms with these symptoms must be sent to the lab for determination.



Source: PPO

Figure 2-27 Fusarium on *Freesia* [1]

1 Top row: characteristic symptoms of *Fusarium*. Bottom row: longitudinal sections of corms show internal damage caused by *Fusarium*.

Source: USDA-APHIS

Figure 2-28 *Fusarium* Infection[1]

1 *Fusarium* infection in this variety of *Freesia* is characterized by distinct reddish-purple margins

Source: USDA-APHIS

Figure 2-29 Symptoms in *Freesia* That May or May Not Be Those of *Fusarium*

Rare Pests

Aspergillus. Symptoms: Black mold. Usually secondary on damaged areas.

Source: USDA-APHIS

Figure 2-30 *Aspergillus* on *Freesia*

Pseudokirkstip. Symptoms: Black spotting, bubbled surface of the corm with lesions in the interior. Symptoms are very similar to Cucumber Mosaic Virus and specimens must be sent to the laboratory for determination.

No photo available.

Other Pests

Erwinia chrysanthemi. Symptoms: Soft, mushy corms, deteriorating quickly; often with a foul odor.

Source: USDA-APHIS

Figure 2-31 *Erwinia* on *Freesia*

Penicillium. Symptoms: Blue-green mold.

No photo available.

Rhodococcus fascians. Symptoms: Fasciations at the base of the corm. In Figure 2-32, white scars near the base of the corm are due to mechanical damage.

Source: BKD

Figure 2-32 *Rhodococcus fascians* on *Freesia*

Stromatinia gladioli. Symptoms: Brown to black somewhat circular lesions usually along nodes, becoming sunken and often running together.

Source: PPO

Figure 2-33 *Stromatinia gladioli* on *Freesia*

Thrips. Symptoms: Reddish or dark yellow speckling (russeting) of corm flesh. Live insects should be present.

Source: J. Heuperman

Figure 2-34 Thrips on *Freesia*

Gladiolus

Gladiolus corms can be ovoid, globose or depressed globose, or somewhat conical in shape. They are usually medium sized, 1.5 inches (38 mm) in length and 2–2.5 inches (64 mm) in diameter, but small varieties can be 1 inch (25 mm) in length and 1.5 inches (38 mm) in diameter. The basal plate is fairly large. *Gladiolus* tunic and corm vary in color from medium brown to red or purple. The tunic can be papery to firm, and coarsely or softly fibrous. Small flowering species sometimes lack tunics.

Source: USDA-APHIS

Figure 2-35 ***Gladiolus***

Pest Risk Rating

The pest risk rating for *Gladiolus* is 9–10.

Similar Looking Corms

Acidanthera is similar but has a different shape and tunic.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal corms for inspection.
3. Examine stem remnants for disease symptoms.
4. Examine corm flesh, especially around the basal plate, for insects, nematodes, and disease symptoms.
5. If the corm has broken dormancy, examine any growing points for aphids.

Pests

Common Pests

Botrytis. Symptoms: Slightly sunken, round, straw-colored to dark brown spots on any part of the corm, usually penetrating to the core. In other instances, decay can be general, varying in texture from soft and spongy to fibrous and firm and affecting significant portions of the corm. In advanced stages, corm is either a dark mass with pockets of whitish mycelia and black sclerotia, or hard and mummified.

Source: (top photo) PPO; (bottom photo) USDA-APHIS

Figure 2-36 *Botrytis* on *Gladiolus*

Fusarium oxysporum. Symptoms: Dry, tan to blackish, depressed lesions often forming concentric rings as the infection expands. White to pink mycelia may be present. In some instances, only a few small lesions occur on surface, but the infection follows the vascular bundles into the core. In other instances, the lesions are larger and the rotted tissue may extend completely through the corm. Occasionally, dry-rot lesions occur only at the basal portion of the corm and do not penetrate into the core. Corm eventually becomes mummified during storage. In the top photo in Figure 2-37, the corm on the bottom right has become blackened and completely mummified. The bottom photo shows basal infection of *Fusarium*. Note the concentric growth rings of infection on the left corm.

Source: USDA-APHIS

Figure 2-37 *Fusarium oxysporum* on *Gladiolus*

Mechanical damage. Symptoms: Scarring and abrasions due to injury suffered during harvest and processing. This is a quality, **not** a quarantine issue. Secondary *Penicillium* may occur.

Source: USDA-APHIS

Figure 2-38 Mechanical Damage on *Gladiolus*

Penicillium gladioli. Symptoms: Reddish-brown, sunken but superficial lesions often accompanied by blue-green mold with cream-colored sclerotia. Corm eventually becomes mummified during storage. A secondary infection on bruised or injured corms.

Source: USDA-APHIS

Figure 2-39 *Penicillium gladioli* on *Gladiolus*

Thrips. Symptoms: Brownish discoloration (russeting) usually at the internodes. If the infestation is recent, the affected areas would be somewhat sticky. In the photo below, the corm on the right is totally symptomatic. Except at the apex, bands of russeting are well-developed on the other two corms.

Source: USDA-APHIS

Figure 2-40 Thrip damage on *Gladiolus*

Rare Pests

Curvularia trifolii. Symptoms: Very irregular, depressed, brown to black lesions. Corms may develop a dark brown corky core rot.

Source: nVWA

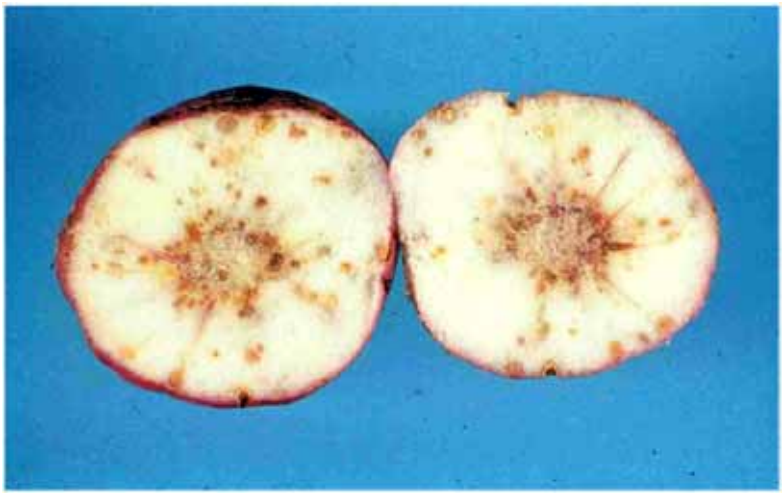
Figure 2-41 *Curvularia trifolii* on *Gladiolus*

Frost Damage. Symptoms: Corm becomes soft, spongy, and discolored. The photo below shows the top view of the corm on the left, and a cross-section on the right.

Source: USDA-APHIS

Figure 2-42 Frost Damage on *Gladiolus*

Kirkstip. Symptoms: Black scabs on the exterior and small lesions on the interior of the corm. The photo below is a cross-section of a corm showing interior lesions.



Source: PPO

Figure 2-43 Kirkstip on *Gladiolus*

Rhizoctonia violaceae. Symptoms: Infections begin at the base of the corm, accompanied by reddish to dark violet mycelia.

Source: BKD

Figure 2-44 *Rhizoctonia violaceae* on *Gladiolus*

Septoria gladioli. Symptoms: Water-soaked reddish brown to brownish black lesions becoming irregular, depressed, and black with definite margins but not penetrating the corm flesh. Many small lesions may coalesce into larger lesions. There may be tiny black sclerotia on the tunic, but normally the tunic must be removed to see the symptoms. Corm frequently becomes mummified during storage. Symptoms are similar to those of *Stromatinia gladioli*.

Source: nVWA

Figure 2-45 *Septoria gladioli* on *Gladiolus*

Other Pests

Aphids. Symptoms: If infestations are fresh, the corms may be sticky; live insects must be found.

No photo available.

Ditylenchus destructor. Symptoms: Extended brown streaks radiating from the base. The top photo below shows the apex and base of the corm. Note dark streaking radiating from the basal plate. The bottom photo shows a cross-section of the corm.

Source: BKD

Figure 2-46 *Ditylenchus destructor* on *Gladiolus nanus*

Meloidogyne. Symptoms: Swellings around the basal plate. Arrows in the photo below point to the characteristic abnormal swellings.

Source: PPO

Figure 2-47 *Meloidogyne* on *Gladiolus*

Pseudomonas gladioli. Symptoms: Pale yellow, water-soaked circular lesions eventually becoming sunken and turning brown or nearly black and scab-like with a lacquered appearance.

Source: nVWA

Figure 2-48 *Pseudomonas gladioli* on *Gladiolus*

Pseudomonas marginata. Symptoms: Dark, water-soaked lesions becoming dark brown, more or less circular and depressed and scab-like with elevated margins. Tunic often cracking longitudinally and developing oval to elongated dark brown spots. In the photo below, notice the characteristic scabs with raised margins.

Source: BKD

Figure 2-49 *Pseudomonas marginata* on *Gladiolus*

Rhodococcus fascians. Symptoms: Small, thin, fan-like, fasciated scales at the base of the corm

Source: PPO

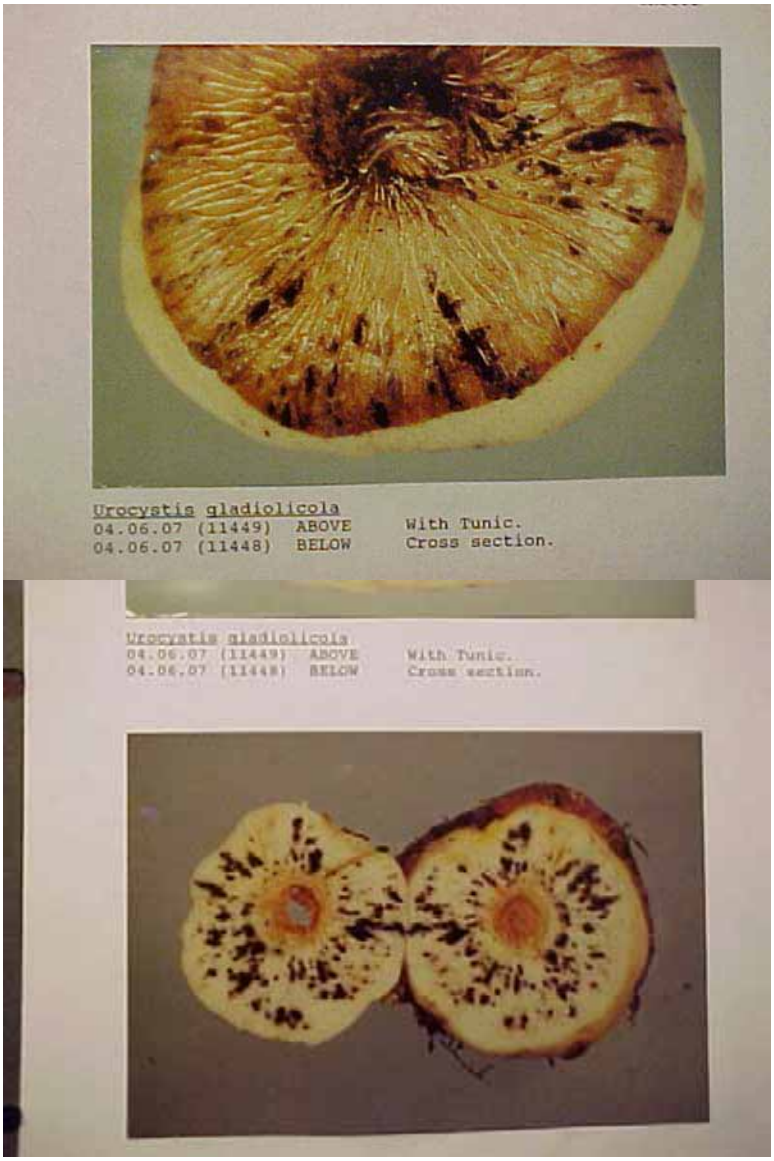
Figure 2-50 *Rhodococcus fascians* on *Gladiolus*

Stromatinia gladioli. Symptoms: Small, hard, black sclerotia on the tunic. Brown to black, somewhat circular lesions on the corm surface, especially along the nodes, becoming sunken, often merging into large irregular areas and usually turning black with slightly raised margins. Decayed tissue is corky and corms often become mummified in storage.

Source: USDA-APHIS

Figure 2-51 *Stromatinia gladioli* on *Gladiolus*

Urocystis gladiolicola. Symptoms: Yellowish welts on exterior of corm, exposing minute, raised, gray to black dots or black sori; with dark lesions on the interior. Dwarf varieties are particularly susceptible.



Source: J. Heuperman

Figure 2-52 *Urocystis gladiolicola* on *Gladiolus*

Ixia

Ixia corms are globose to teardrop-shaped, very irregular, and may be flattened at odd angles to the central axis. The tunic is medium-brown, with fine to moderately coarse netted fibers. A large lump of last year's dried up corm may be present at the base of the corm. The central bud and sprouts are red. The interior of the corm is red or purple. This is the only corm with red to purple flesh.

Source: USDA-APHIS

Figure 2-53 ***Ixia***

Pest Risk Rating

The pest risk rating for *Ixia* is 3–4.

Similar Looking Corms

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select any abnormal corms for inspection.

3. Remove tunic, examine corm flesh and basal plate for disease symptoms.

Pests

Common Pests

None

Rare Pests

Fusarium oxysporum. Symptoms: Brown rot, usually beginning at the base of the corm.

No photo available.

Other Pests.

Sclerotium gladioli. symptoms: Dark corky lesions.

No photo available.

Sparaxis

Sparaxis are globose to conical or ovoid corms, 0.75 inches (20 mm) tall. The tunic is shiny, white to cream-colored or dirty-white, and very fibrous with a woven, net-like appearance. There can be a spike-like stem and a flattened plate-like structure at the base of the corm. This plate is the remains of the roots produced during the growing season, and can easily be removed. The interior of the corm is white to cream in color. There are very few problems associated with *Sparaxis*.

Source: USDA-APHIS

Figure 2-54 *Sparaxis*

Pest Risk Rating

The pest risk rating for *Sparaxis* is 3.

Similar Looking Corms

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select any abnormal corms for inspection.
3. Remove tunics and examine corm flesh and basal plate for disease symptoms.

Pests

Common Pests

None

Rare Pests

None

Other Pests

Aphids. Symptoms: No definite symptoms; live insects must be found.

No photo available.

Pseudomonas marginata. Symptoms: Dark, water-soaked lesions, becoming dark brown and more or less circular, depressed and scab-like with elevated margins. Tunic often cracking longitudinally and developing oval to elongated dark brown spots.

No photo available.

Chapter

3

Perennials

Contents

Introduction

This section includes some of the perennials included in the approved list of bulbs in the Preclearance Program.

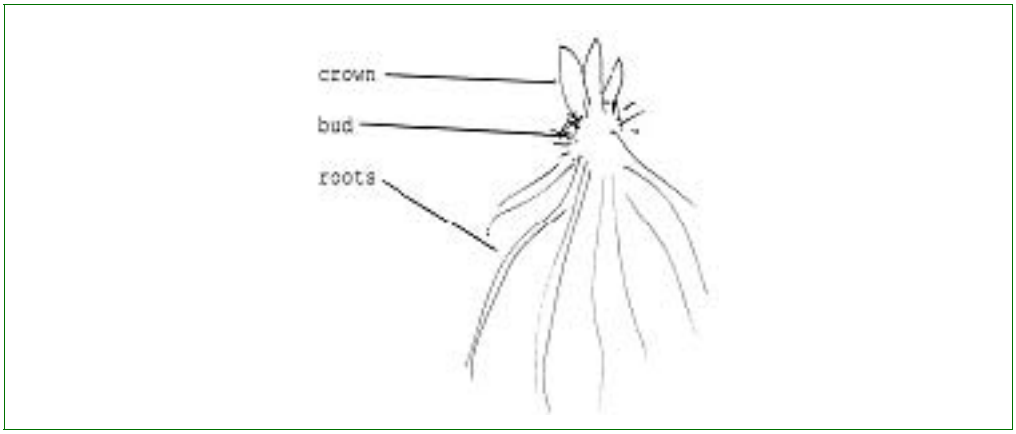


Figure 3-1 Sketch of a Common Perennial, Grass

Some of these perennials are actually tubers and tuberous roots, rhizomes, or corms. Look at the pictures of the perennials and select the picture and description that fits your specimen. Soil or growing media can be a problem, especially if the plants were started from “plugs” or “jiffy pots,” or if the roots are otherwise tightly bound. Weeds can also be tangled up in the roots. All weeds, **no** matter how cosmopolitan, are prohibited. In addition, be on the lookout for perennials that are breaking dormancy. Any green parts over 2 inches, or any fully expanded leaves even if smaller than 2 inches, are prohibited. Soil, weeds, and root knot nematode (*Meloidogyne*) are the most common reasons for rejections for perennials.

Source: USDA-APHIS

Figure 3-2 Growing Media and Weeds in Perennials[1] [2]

1 Left photo: *Dicentra spectabilis* with growing media trapped between roots. Note how tightly bound the roots are.

2 Right photo: *Veronica* with weeds tangled in the roots.

The information in this chapter includes the pest risk rating for each bulb. The ratings are:

Table 3-1 Pest Risk Ratings for Perennials

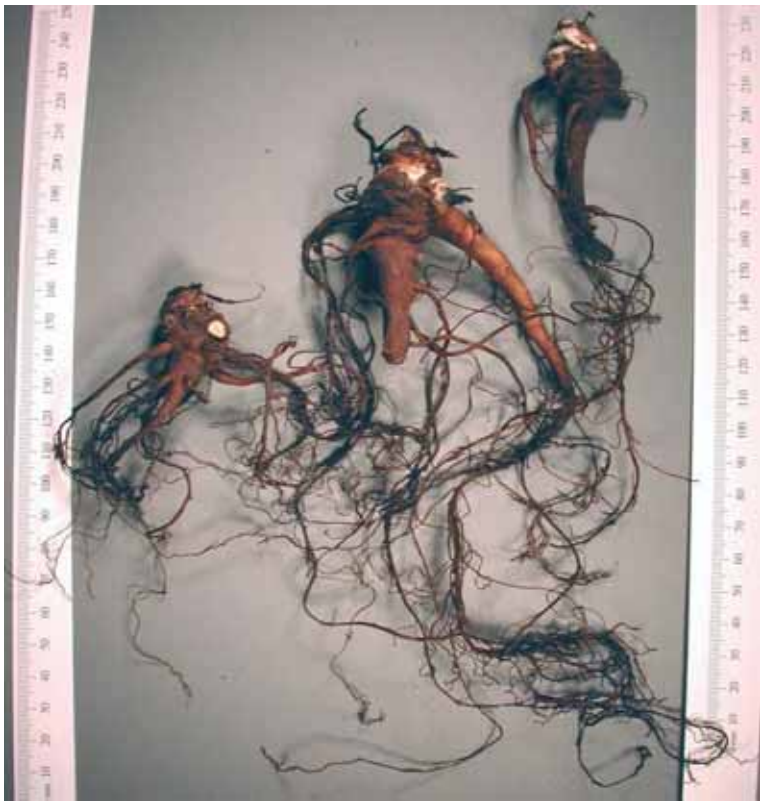
Pest Risk	Rating
1–2	Very low risk. Verify the genus in the shipment. Inspect if time is available
3–4	Low risk. Inspect if time is available.
5–6	Moderate risk. Provide normal inspection.
7–8	High risk. Inspect thoroughly.
9–10	Very high risk. Inspect very thoroughly.

Identification Procedure

Determine the length of the perennial you are identifying. Compare it with the photographs in this chapter and select the description that fits your perennial. Each description includes inspection procedures and pests of concern.

Aconitum

Aconitum can have roots that are fibrous, tuberous, or rhizomatous. The most common ones in the Netherlands have a dark brown tuberous tap root with a number of thick secondary roots with long slender tips. The bud is broadly joined to the crown.



Source: USDA-APHIS

Figure 3-3 ***Aconitum***

Pest Risk Rating

The pest risk rating for *Aconitum* is 5–6.

Similar Looking Perennials

Other tap-rooted perennials are similar, but *Aconitum* has characteristically long and slender root tips.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for proof of hot water treatment.

3. Look for soil contamination and select abnormal plants for inspection.
4. Inspect the leaf scales, buds, fleshy roots, and small fine roots, if present. Look for borers, fungal infections, and nematodes.

Pests

Common Pests

Meloidogyne hapla. Symptoms: Galls and swellings on slender ends of secondary roots and on rootlets.

Source: USDA-APHIS

Figure 3-4 *Meloidogyne* on *Aconitum*

Rare Pests

None

Other Pests

Aphelenchoides. Symptoms: Blackened leaf bases. Samples must be sent to the laboratory for confirmation.

Source: PPO

Figure 3-5 *Aphelenchoides* on *Aconitum*[1]

1 Note blackened apices of the leaf bases.

Sclerotium rolfsii var. Delphinii. Symptoms: White mycelia and black sclerotia.

No photo available

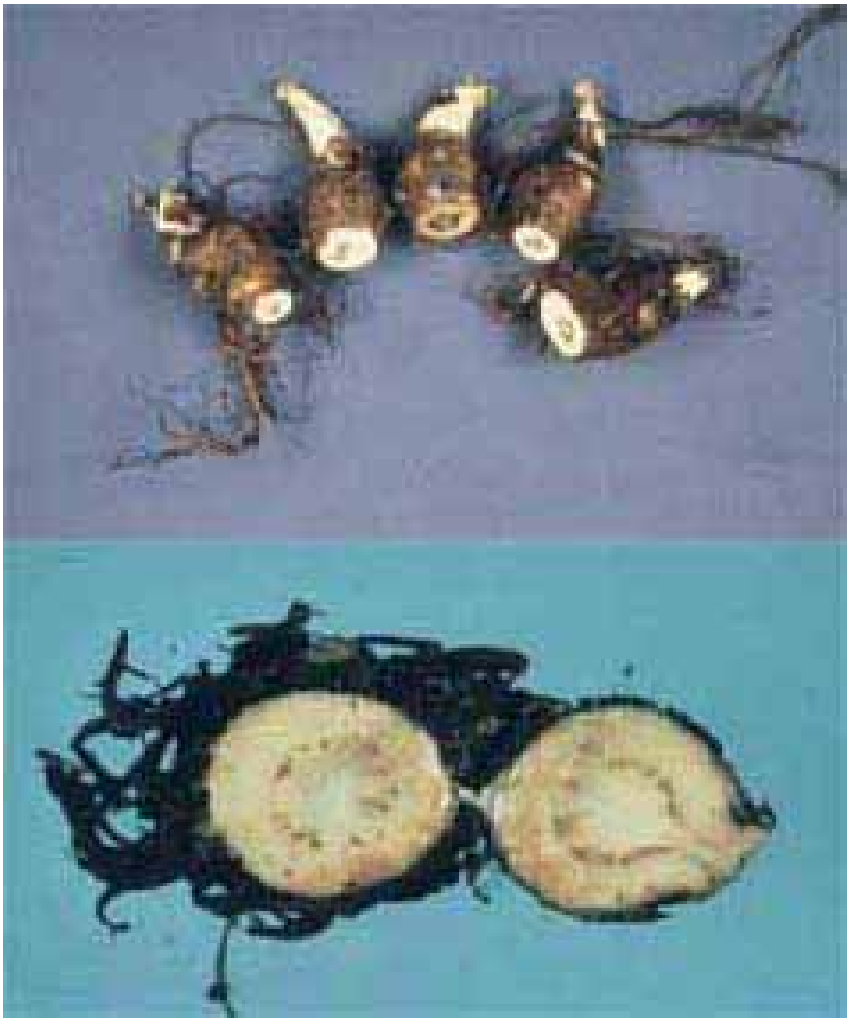
Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Storage Rot. Symptoms: Wet rot.

No photo available.

Verticillium albo-atrum. Symptoms: Discoloration of vascular bundles.



Source: PPO

Figure 3-6 *Verticillium* on *Aconitum*

Treatment

Dutch export regulations require the following mandatory hot water treatment for *Aconitum* to control leaf nematodes (*Aphelenchoides ritzemabosi*):

In 1 hour, heat the perennial to 43.5 °C and hold for 1 hour. Then cool quickly in cold water treated with Thiram (TMTD).

Treatments are performed by growers and exporters under the supervision of nVWA, Naktuinbouw, or BKD.

Agapanthus

Agapanthus plants have thick rhizomatous rootstocks with fleshy leaf bases and thick, spaghetti-like roots. The root crown is topped with a bud and long, fibrous remnants of old leaves and papery remnants of old flower stalks. Very few phytosanitary problems are associated with *Agapanthus*.

Source: USDA-APHIS

Figure 3-7 ***Agapanthus***

Pest Risk Rating

The pest risk rating for *Agapanthus* is 3.

Similar Looking Perennials

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.

3. Inspect the buds, dried remnants, fleshy roots, and small fine roots, if present. Look for borers and nematodes.

Pests

Common Pests
None

Rare Pests
None

Other Pests.
Meloidogyne hapla. Symptoms: Galls and swellings on roots.

No photo available.

Anemone

Anemone plants have root stocks usually consisting of congested, slender, spidery, dark brown to black rhizomes with wiry roots and numerous long, slender stems with persister fibrous leaf bases. Numerous small, vegetative buds and a few sprouts may occur along the roots and rhizomes. When just emerging, these buds can be mistaken for root galls of *Meloidogyne*.

Source: USDA-APHIS

Figure 3-8 ***Anemone japonica***[1]

1 Right photo shows buds and stolons emerging from primary roots.

Pest Risk Rating

The pest risk rating for *Anemone* is 6.

Similar Looking Perennials

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.

3. Inspect the root crown and rooting system.

Pests

Common Pests

Meloidogyne hapla. Symptoms: Galls and swellings on roots and abnormal root growth.

Source: G. v. Grinsven

Figure 3-9 *Meloidogyne hapla* on *Anemone* [1]

1 Note abnormally branched root system

Rare Pests

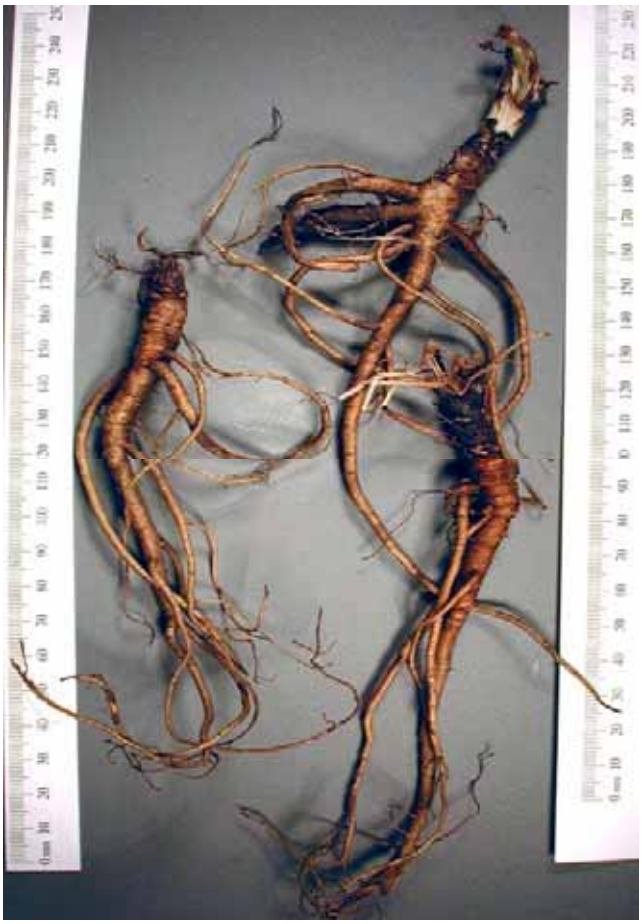
None

Other Pests

None

Aquilegia

Aquilegia has a carrot-like taproot with few thick, long side roots.



Source: USDA-APHIS

Figure 3-10 ***Aquilegia***

Pest Risk Rating

The pest risk rating for *Aquilegia* is 4–5.

Similar Looking Perennials

Eryngium, *Aconitum*, and other tap-rooted perennials are similar to *Aquilegia*.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.

3. Inspect the fleshy roots, and small fine roots. Look for borers and nematodes.

Pests

Common Pests

None

Rare Pests

Meloidogyne hapla. Symptoms: Galls and swellings on roots.

No photo available.

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Other Pests

None

Aruncus

Aruncus root crowns are usually compact, with dormant buds and strong primary roots with numerous fine secondary roots. Depending on species, the root crown can become woods and rhizomatous. Sometimes propagated by "plugs" and the dense tangle of roots may trap growing media.

Growing media is **not** allowed in the program, so consignments contaminated with media should be refused. Generally, **no** amount of washing will remove the trapped media. This is a common problem with perennials propagated in this manner.

Source: USDA-APHIS

Figure 3-11 *Aruncus*[1] [2]

1 Top photo: Specimen on the left was propagated from a cutting and kept in a small pot or "plug" where roots became pot-bound, trapping growing media.

2 Bottom photo: Close-up of root ball with trapped growing media (peat).

Pest Risk Rating

The pest risk rating for *Aruncus* is 6.

Similar Looking Perennials

Aruncus plants resemble many other fine-rooted perennials.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root system. Plants that have been grown in “plugs” or “jiffy pots” often have pot-bound roots that trap growing media. Also check for nematodes.

Pests

Common Pests

Meloidogyne hapla. Symptoms: Galls and swellings on roots. The galls often cause a proliferation of abnormal, slender roots.

Source: USDA-APHIS

Figure 3-12 *Meloidogyne hapla* on *Aruncus*

Source: USDA-APHIS

Figure 3-13 *Meloidogyne hapla* on *Aruncus*

Rare Pests

None

Other Pests

None

Astrantia

Astrantia has black, somewhat brittle roots and usually woody root crowns with persistent tan fibers of old leaves surrounding a prominent bud.

Source: USDA-APHIS

Figure 3-14 ***Astrantia major***

Pest Risk Rating

The pest risk rating for *Astrantia* is 6.

Similar Looking Perennials

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root system. Look for nematodes.

Pests

Common Pests

Meloidogyne hapla. Symptoms: Swellings and galls throughout the root system. Infected root tips may become swollen.

Source: USDA-APHIS

Figure 3-15 *Meloidogyne hapla* on *Astrantia*

Rare Pests

None

Other Pests

None

Campanula

Campanula plants have thick, succulent whitish to cream-colored roots and root crowns that are somewhat woody. Primary roots resemble short, fat spaghetti. Fibers of old roots may be present at the base of the crown.

Source: USDA-APHIS

Figure 3-16 ***Campanula***

Pest Risk Rating

The pest risk rating for *Campanula* is 5.

Similar Looking Perennials

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root system. The dense roots may trap soil or growing media. Look for fungal infections and nematodes.

Pests

Common Pests

Meloidogyne hapla. Symptoms: Proliferation of very small roots with small knobby swellings or galls.

Source: USDA-APHIS

Figure 3-17 *Meloidogyne* on *Campanula lactiflora* 'Pouffe'[1]

1 Note proliferation of very small roots with small knots.

Rare Pests

None

Other Pests

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Rhodococcus fascians. Symptoms: Fasciations at root crown.

Source: USDA-APHIS

Figure 3-18 *Campanula lactiflora* 'Pouffe' with *Rhodococcus fascians*[1]

1 This specimen is also heavily infected with *Meloidogyne*.

Dicentra

Two species are exported through the preclearance program. *Dicentra spectabilis* has a woody rootstock and stem and white or yellowish, stout, fleshy roots that are brittle and bruise easily. A few fine roots may be attached to the fleshy roots. *Dicentra formosa*, on the other hand, has numerous finer, spaghetti-like roots and prominent buds with persistent pinkish or green leaf bases. Both species are commonly found with growing media trapped within the root systems.

Source: USDA-APHIS

Figure 3-19 *Dicentra spectabilis* (left); *Dicentra formosa* (right)

Pest Risk Rating

The pest risk rating for *Dicentra* is 6–7.

Similar Looking Perennials

Dicentra spectabilis is quite distinct, but *D. formosa* may resemble other perennials with prominent buds and a dense root system.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination; common to both species.
3. Select abnormal plants for inspection.

Pests

Common Pests

None

Rare Pests

Penicillium. Symptoms: Blue-green mold, usually the result of poor storage conditions.

Source: USDA-APHIS

Figure 3-20 *Penicillium* on *Dicentra stabilis*

Storage Rot. Symptoms: Soft brown rot affecting the entire plant.

Source: USDA-APHIS

Figure 3-21 *Dicentra formosa* with Storage Rot[1]

1 Sample on the left is healthy; samples on the right are affected with storage rot.

Other Pests

Meloidogyne hapla. Symptoms: Swellings and galls on smaller roots.

No photo available.

Echinacea

Echinacea plants usually have a woody root crown often with several elongated buds and fibrous, cream-colored roots.

Source: USDA-APHIS

Figure 3-22 *Echinacea* 'Sunrise'

Pest Risk Rating

The pest risk rating for *Echinacea* is 6.

Similar Looking Perennials

Echinacea resembles other perennials with prominent buds at the root crown and cream-colored, fibrous roots.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and roots. Look for nematodes. The dense tangle of roots just below the root crown may trap growing media.

Pests

Common Pests

None

Rare Pests

Meloidogyne. Symptoms: Swellings and galls throughout the root system.

No photo available.

Rhodococcus. Symptoms: Fasciations at root crown.

Source: USDA-APHIS

Figure 3-23 *Rhodococcus* on *Echinacea* 'Mango Meadowbrite'

Other Pests

None

Epimedium

Epimedium plants are characterized by mats of fibrous, kinky, brittle roots attached to knobby, reddish-brown rhizomes. The rhizomes on some varieties resemble small, knobby, multi-branched sticks. Other varieties have root crowns with pinkish apical buds. Remnants of the previous years' inflorescences are often present. *Epimedium* is one of the few perennials that is not affected by *Meloidogyne*.

Source: USDA-APHIS

Figure 3-24 *Epimedium perralchium* cv. *Frohn Leitneri*

Source: USDA-APHIS

Figure 3-25 ***Epimedium youngianum***

Pest Risk Rating

The pest risk rating for *Epimedium* is 6.

Similar Looking Perennials

Other fibrous-rooted perennials are similar to *Epimedium*.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and small roots. The dense mass of fine roots in some varieties can trap growing media. Look for nematodes.

Pests

Common Pests

None

Rare Pests

Pratylenchus penetrans. Symptoms: Small, subtle warts on roots, especially a the tips. Samples must be sent to the laboratory for confirmation.

Source: USDA-APHIS

Figure 3-26 *Epimedium* with *Pratylenchus penetrans*

Source: USDA-APHIS

Figure 3-27 *Epimedium youngianum* with *Pratylenchus penetrans*[1]

1 Photo shows close-up of characteristic warts at root tips.

Other Pests

None

Eremurus

Eremurus is very distinctive. It has a stout root crown with a prominent central bud surrounded by long, persistent fibers and thick fleshy roots that may be up to 6 inches (15 cm) or more in length, causing it to resemble an octopus. The bud is covered with tightly fitting papery skin and may be accompanied by a stump from last year's flower stalk.

Source: USDA-APHIS

Figure 3-28 ***Eremurus***

Pest Risk Rating

The pest risk rating for *Eremurus* is 3–4.

Similar Looking Perennials

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.

3. Cut apex of bud scale. A brown ring indicates the presence of *Aphelenchoides*.

Pests

Common Pests

None

Rare Pests

Storage Rot. Symptoms: Soft wet rot and discoloration of the central core.

Source: USDA-APHIS

Figure 3-29 Storage Rot on *Eremurus*

Other Pests

Aphelenchoides ritsema-bosi. Symptoms: Brown discoloration of leaf scale, indicated by a brown ring.

No photo available.

Pratylenchus. Symptoms: Reddish or dark brown lesions on roots.

No photo available.

Eryngium

Eryngium plants have parsnip-like tap roots with thick side roots and smaller tertiary roots. Persistent fibers are often present at the root crown. There are very few problems with *Eryngium*.

Source: USDA-APHIS

Figure 3-30 ***Eryngium***

Pest Risk Rating

The pest risk rating for *Eryngium* is 3–4.

Similar Looking Perennials

Aquilegia is similar.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the buds and roots. Look for nematodes and bacterial and fungal infections.

Pests

Common Pests

None

Rare Pests

Meloidogyne hapla. Symptoms: Swellings and galls on secondary roots.

Source: USDA-APHIS

Figure 3-31 *Meloidogyne* on *Eryngium alpinum*

Other Pests

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Geranium

Geranium plants vary considerably. Some have knobby, twig-like pink to reddish-brown rhizomatous, stoloniferous, or tuberous roots with relatively few smaller roots, while others have an abundance of fibrous roots. There are usually numerous buds and fibrous remains of old leaves at the root crown. Some varieties are propagated in plugs resulting in a dense tangle of roots that may trap growing media. The most common causes for rejection in *Geranium* are soil (growing media) and *Meloidogyne*. Occasionally, the plants may have fully expanded leaves when presented for inspection. These lots should be rejected and reconditioned.

Source: USDA-APHIS

Figure 3-32 Two Types of *Geranium*

Pest Risk Rating

The pest risk rating for *Geranium* is 7–8.

Similar Looking Perennials

Other fibrous-rooted perennials are similar to *Geranium*.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and smaller roots. The thick masses of roots in some varieties can trap soil or growing media. Look for nematodes, fungal, and bacterial infections.

Pests

Common Pests

Meloidogyne. Symptoms: Swellings and galls throughout the root system. Galls are often accompanied by an abnormal proliferation of small lateral roots.

Source: USDA-APHIS

Figure 3-33 *Meloidogyne* on Three Different Varieties of *Geranium*[1]

1 Swellings are much more numerous on the center specimen in the photo.

Rare Pests

Rhodococcus fascians. Symptoms: Fasciations at the root crown.

Source: USDA-APHIS

Figure 3-34 *Rhodococcus* on *Geranium*[1]

1 Center specimen is severely infected. Specimen on the right is healthy. Fibers hide the fasciations on the specimen on the left.

In some species, *Rhodococcus*-like galling may occur along the rhizomes. These proliferations of sprouts may or may not be caused by infections of *Rhodococcus*. Samples must be sent to the laboratory for identification.

Source: USDA-APHIS

Figure 3-35 *Geranium sanguineum* with Anomalous Galling on Rhizomatous Roots

Other Pests

Phytophthora cinnamomi. Symptoms: Brown to black wet rot.

No photo available.

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Heuchera

Heuchera are compact plants with stout basal stems, persistent pink leaf bases and a strong root system. *Heuchera* is another plant that can be propagated in "plugs" or "jiffy pots." The most common causes for rejections in *Heuchera* are soil (growing media) and *Meloidogyne*.

Source: USDA-APHIS

Figure 3-36 ***Heuchera***

Pest Risk Rating

The pest risk rating for *Heuchera* is 6–7.

Similar Looking Perennials

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and root system. If the roots are densely tangled just below the root crown, inspect for trapped growing media. Look for nematodes and bacterial infections.

Pests

Common Pests

Meloidogyne hapla. Symptoms: Swellings and galls on roots. Galls are frequently accompanied by a proliferation of very small rootlets.

Source: USDA-APHIS

Figure 3-37 *Heuchera* 'Plum Pudding' with *Meloidogyne hapla*[1]

1 Left photo: Note proliferation of very small roots with root knots just below the root crown. Right photo: Close-up of root mass with abundance of root knots.

Source: USDA-APHIS

Figure 3-38 Close-up of Swellings Caused by *Meloidogyne hapla* and Proliferation of Abnormal, Fine Rootlets

Rare Pests

None

Other Pests

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Rhodococcus fascians. Symptoms: Fasciations at the root crown.

No photo available.

Hosta

Hosta plants have spaghetti-like roots with numerous side roots. The crown has conical buds and fibers from old leaves. At one time, *Meloidogyne* was common in *Hosta*, but it is rarely seen now. Today, weeds and soil are the most common reasons for rejections.

Source: USDA-APHIS

Figure 3-39 *Hosta*

Pest Risk Rating

The pest risk rating for *Hosta* is 6.

Similar Looking Perennials

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the buds and small fine roots. Look for nematodes and fungal infections.

Pests

Common Pests

None

Rare Pests

Meloidogyne. Symptoms: Swellings and galls throughout the root system. Occasionally, there may be little or no gall formation, but the root tips may be infected, causing stunting, a proliferation of side roots and a bushy root system.

Source: G. v. Grinsven

Figure 3-40 *Meloidogyne* Infection Causing Swollen Root Tips and Densely Bushy Root System

Source: USDA-APHIS

Figure 3-41 Stunted Root Tips and Abnormal Root Growth Caused by *Meloidogyne*

Storage Rot. Symptoms: Wet rot of the root crown and bud, spreading into the roots.

Source: USDA-APHIS

Figure 3-42 Storage Rot on *Hosta* with Early *Botrytis* Infection on Roots and Apex

Other Pests

Botrytis. Symptoms: White or grayish mold. This is a rare problem, normally due to improper storage.

Source: USDA-APHIS

Figure 3-43 *Botrytis* Infection on *Hosta* Roots

Pratylenchus. Symptoms: Dark, linear, necrotic lesions on roots, followed by general decay.

Source: G. v. Grinsven

Figure 3-44 *Pratylenchus penetrans* on *Hosta*

Incarvillea

Incarvillea are 6–8 inches in length. The plant has a very distinctive shape characterized by a cluster of light brown, fleshy, brittle roots topped with a corky, thick stem. The stem has small side buds that resemble warts. The roots are dotted with knobby projections. *Incarvillea* are shipped in winter.

Source: USDA-APHIS

Figure 3-45 ***Incarvillea***

Pest Risk Rating

The pest risk rating for *Incarvillea* is 2–3.

Similar Looking Perennials

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and fleshy roots. Look for fungal and bacterial infections.

Pests

Common Pests

None

Rare Pests

Phytophthora cactorum. Symptoms: Dark brown to purplish discoloration and rotting mainly on the tuberous roots, but also at the stem.

Source: PPO

Figure 3-46 *Phytophthora* sp. on *Incarvillea*

Source: PPO

Figure 3-47 *Phytophthora* sp. on *Incarvillea* Showing Longitudinal Sections of Infected Roots

Other Pests

Agrobacterium tumefasciens. Symptoms: Smooth cankers, usually at the root crown.

No photo available.

Rhodococcus fascians. Symptoms: Fasciations, usually at the root crown.

No photo available.

Liatris

Liatris is a plump, knobby, dark brown corm. The crown has small blade-like buds and distinctive circular, undulating ridges that expand outward from the center. The base of the corm may have short, worm-like new roots and/or fine fibers of old roots.

Source: USDA-APHIS

Figure 3-48 ***Liatris***

Pest Risk Rating

The pest risk rating for *Liatris* is 5–6.

Similar Looking Perennials

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the corms and small fine roots, if present. Cut off small pieces of the corms and examine the vascular areas.

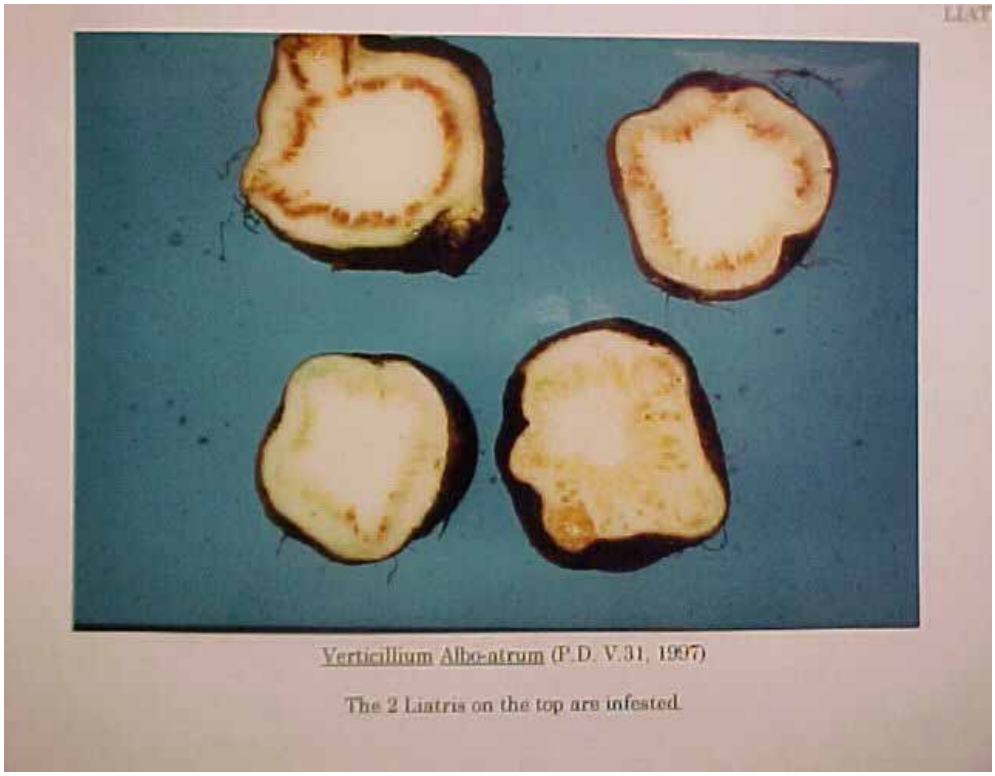
Pests

Common Pests

None

Rare Pests

Verticillium. Symptoms: Dark brown discoloration of the vascular bundles.



Source: J. Heuperman

Figure 3-49 *Verticillium* on *Liatris*

Other Pests

Botrytis. Symptoms: Wet decay and gray mold.

Source: BKD

Figure 3-50 *Botrytis* on *Liatris* with White/Gray Mycelium

Ditylenchus destructor (only L. calilepsis). Symptoms: Discoloration of core.

Source: PPO

Figure 3-51 *Ditylenchus destructor* on *Liatris calilepsis*[1]

1 In the top left sample (cross section) the infection has **not** yet affected the core. In the samples on the right (longitudinal section) and bottom (cross section) the infection has already affected the core.

Ligularia

Ligularia has a root crown with long persistent fibers of the old leaves and masses of long, thick spaghetti-like roots and few secondary roots. Remnants of the previous years' stem may be present.

Source: USDA-APHIS

Figure 3-52 *Ligularia*

Pest Risk Rating

The pest risk rating for *Ligularia* is 5–6.

Similar Looking Perennials

Ligularia is similar to other perennials with long, spaghetti-like roots.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown, fleshy roots, and small fine roots, if present. Look for nematodes and fungal infections.

Pests

Common Pests

Meloidogyne. Symptoms: Galls and swellings on smaller roots.

Source: USDA-APHIS

Figure 3-53 *Meloidogyne* on *Ligularia*

Source: USDA-APHIS

Figure 3-54 *Meloidogyne* on *Ligularia*

Rare Pests

None

Other Pests

Botrytis. Symptoms: Brown, wet rot of the root crown, and gray mold.

Source: USDA-APHIS

Figure 3-55 Early Stages of *Botrytis* Rot on *Ligularia*

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Papaver

Papaver has a woody root crown or stem and long, brown, brittle tap roots with few thick, secondary roots. In older plants, the roots near the crown are woody. The crown area is distinct with a tuft of new growth and old debris.

Source: USDA-APHIS

Figure 3-56 ***Papaver***

Pest Risk Rating

The pest risk rating for *Papaver* is 4–5.

Similar Looking Perennials

Papaver is similar to other tap-rooted perennials.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown, fleshy roots, and small fine roots, if present.

Pests

Common Pests

None

Rare Pests

Storage Rot. Symptoms: Wet rot usually affecting damaged areas and spreading through the root crown and into the roots. Caused by mechanical injury and poor storage conditions.

Source: USDA-APHIS

Figure 3-57 Storage Rot on *Papaver*[1]

1 Photo: Note unidentified secondary fungus on decaying tissue.

Other Pests

Agrobacterium tumefasciens. Symptoms: Smooth galls at root crown.

Source: G. v. Grinsven

Figure 3-58 *Agrobacterium tumefasciens* on *Papaver*

Meloidogyne. Symptoms: Galls and swellings on smaller roots.

Source: G. v. Grinsven

Figure 3-59 *Meloidogyne hapla* on Roots of *Papaver*

Phlox

Phlox is characterized by its strong stems and fibrous, whitish roots. This is another plant that can be propagated in plugs or jiffy pots.

Source: USDA-APHIS

Figure 3-60 *Phlox*

Pest Risk Rating

The pest risk rating for *Phlox* is 6–7.

Similar Looking Perennials

Phlox resembles most other perennials with strong stems and fibrous roots.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and small fine roots. If roots are tightly tangled, check for growing media. Look for nematodes and bacterial infections.

Pests

Common Pests

None

Rare Pests

Meloidogyne. Symptoms: Galls and swellings on roots. Galls are frequently accompanied by a proliferation of small rootlets. Occasionally, mixed infections of *Meloidogyne* and *Pratylenchus* occur on the same plant. Samples must be sent to the laboratory for confirmation.

Source: USDA-APHIS

Figure 3-61 *Meloidogyne* on *Phlox*[1]

1 Symptoms are not always apparent. Note swellings associated with a profusion of small roots along primary roots.

Source: USDA-APHIS

Figure 3-62 *Meloidogyne* on *Phlox*[1]

1 Top photo: Subtle swellings along primary roots and associated rootlets. Bottom photo: More typical symptoms of *Meloidogyne*.

Pratylenchus. Symptoms: Swellings on roots. Typical reddish lesions may or may **not** be present. Symptoms are similar to those of *Meloidogyne* or even *Rhodococcus*. Samples must be sent to the laboratory for confirmation.

Source: USDA-APHIS

Figure 3-63 *Pratylenchus penetrans* on *Phlox*

Rhodococcus fascians. Symptoms: Fasciations, usually at the root crown, but may also occur among the roots.

Source: USDA-APHIS

Figure 3-64 *Rhodococcus fascians* on *Phlox*

Other Pests

None

Platycodon

Platycodon is a plant with cream-colored or whitish carrot-like roots, about 6 inches long, with numerous smaller roots. The thick roots are frequently branched and may resemble ginseng roots. The crown is sometimes topped with a few small pinkish buds. *Platycodon* is **not** susceptible to *Meloidogyne*.

Source: USDA-APHIS

Figure 3-65 ***Platycodon***

Pest Risk Rating

The pest risk rating for *Platycodon* is 4–5.

Similar Looking Perennials

Platycodon is similar to other tap-rooted perennials.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and small fine roots, as well as the tap roots. Growing media may be trapped between thick succulent roots.

Pests

Common Pests

None

Rare Pests

None

Other Pests

Botrytis cineria. Symptoms: Brown wet decay and gray mold.

No photo available.

Storage Rot (Soft Rot). Symptoms: Soft, wet, progressive rot.

Source: G. v. Grinsven

Figure 3-66 Storage Rot on *Platycodon*

Pulmonaria

The rootstock of *Pulmonaria* is woody with few to numerous short upright stems with an apical and several axillary buds with pinkish sheaths. The primary roots are long and spaghetti-like and bear numerous fine secondary roots.

Source: USDA-APHIS

Figure 3-67 ***Pulmonaria***

Pest Risk Rating

The pest risk rating for *Pulmonaria* is 5.

Similar Looking Perennials

Dicentra formosa is similar, but the rootstock is **not** as woody as that of *Pulmonaria*, and it lacks the abundance of secondary and tertiary roots. *Salvia* is similar because it can also have numerous buds on the root crown. It is **not** as woody as *Pulmonaria* and it has many more secondary and tertiary roots.

Inspection Procedures

1. Check consignment and verify lot.

2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the buds and roots. Look for nematodes, and bacterial and fungal infections.

Pests

Common Pests

None

Rare Pests

Meloidogyne hapla. Symptoms: Swellings and galls on roots.

Source: USDA-APHIS

Figure 3-68 *Meloidogyne* on *Pulmonaria*

Other Pests

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Rudbeckia

Rudbeckia plants have woody rootstocks and strong, almost woody stems. The primary roots are whitish to tan in color, straight, and bear very few secondary roots.

Source: USDA-APHIS

Figure 3-69 *Rudbeckia*

Pest Risk Rating

The pest risk rating for *Rudbeckia* is 4.

Similar Looking Perennials

Tradescantia is similar, but **not** as woody as *Rudbeckia*.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the buds and roots. Look for nematodes, and bacterial and fungal infections.

Pests

Common Pests

None

Rare Pests

Meloidogyne hapla. Symptoms: Swellings and galls on roots.

No photo available.

Other Pests

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Salvia

Salvia plants have a root crown with many pinkish buds and often with remnants of the old stems. The root system can be dense with numerous fine secondary and tertiary roots. Some species have rhizomatous or tuberous rootstocks. *Salvia* is sometimes propagated in plugs or jiffy pots.

Source: USDA-APHIS

Figure 3-70 *Salvia nemorosa* 'Sensation' (left); *Salvia pratensis* 'Madeline' (right)

Pest Risk Rating

The pest risk rating for *Salvia* is 6–7.

Similar Looking Perennials

Pulmonaria is similar, but the rootstock is much woodier than that of *Salvia*. *Salvia* has many more secondary and tertiary roots than *Pulmonaria*.

Inspection Procedures

1. Check consignment and verify lot.

2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and small roots. If roots are tightly tangled, check for growing media. Look for nematodes.

Pests

Common Pests

None

Rare Pests

Meloidogyne. Symptoms: Galls and swellings on smaller roots.

No photo available.

Other Pests

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Tradescantia

Tradescantia rhizomes are jointed, resembling small bamboo. The roots are spaghetti-like with very few smaller roots. The buds are pointed and slender. *Tradescantia* is not affected by *Meloidogyne*.

Source: USDA-APHIS

Figure 3-71 *Tradescantia*

Pest Risk Rating

The pest risk rating for *Tradescantia* is 3–4.

Similar Looking Perennials

Rudbeckia is similar, but more woody.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and roots. Look for nematodes.

Pests

Common Pests
None

Rare Pests
None

Other Pests
Frost Damage: Symptoms:

No photo available.

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Veronica

Veronica plants have strong, nearly woody root crowns, strong upright stems, prominent buds, and a fibrous root system with long primary roots and an abundance of secondary roots.

Source: USDA-APHIS

Figure 3-72 *Veronica*

Pest Risk Rating

The pest risk rating for *Veronica* is 6–7.

Similar Looking Perennials

Rudbeckia is similar, but more woody, and the primary roots have fewer secondary roots.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal plants for inspection.
3. Inspect the root crown and roots. Look for nematodes.

Pests

Common Pests

Meloidogyne. Symptoms: Galls and swellings on roots. The galls are often accompanied by a proliferation of small lateral roots.

Source: USDA-APHIS

Figure 3-73 *Meloidogyne* on *Veronica*

Rare Pests

Rhodococcus. Symptoms: Fasciations at root crown and among roots.

Source: USDA-APHIS

Figure 3-74 *Rhodococcus fascians* on *Veronica*

Other Pests

Frost Damage. Symptoms:

No photo available.

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Chapter

4

Rhizomes

Contents

Introduction

Rhizomes are swollen horizontal stems that grow along or below the surface of the ground. They have nodes and internodes and the tips of the stems have large buds, often covered with scale-like leaves. When rhizomes grow, the terminal buds expand and produce new horizontal stems.

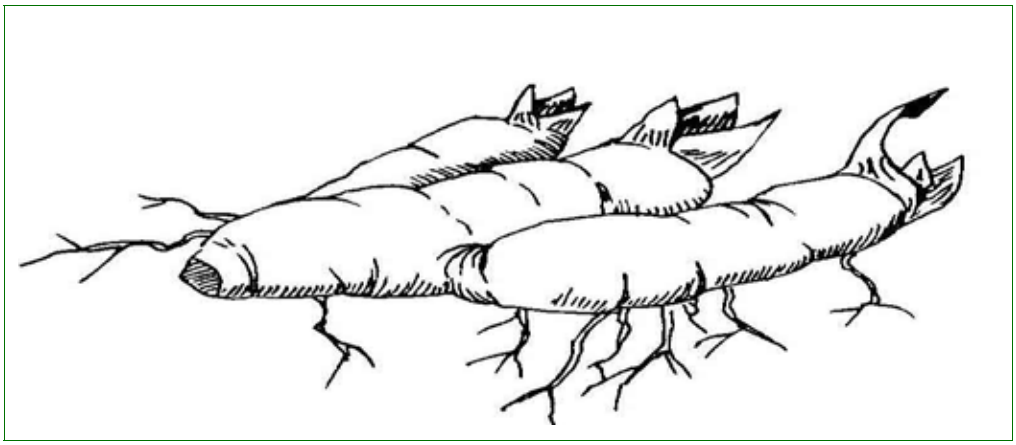


Figure 4-1 *Iris* Rhizome Sketch

The information in this chapter includes the pest risk rating for each bulb. The ratings are:

Table 4-1 Pest Risk Ratings for Rhizomes

Pest Risk	Rating
1–2	Very low risk. Verify the genus in the shipment. Inspect if time is available.
3–4	Low risk. Inspect if time is available.
5–6	Moderate risk. Provide normal inspection.
7–8	High risk. Inspect thoroughly.
9–10	Very high risk. Inspect very thoroughly.

Identification Procedure

Determine the length of the rhizome you are identifying. Compare it with the photographs in this chapter and select the description that fits your rhizome. Each description includes inspection procedures and pests of concern.

Astilbe

Astilbe rhizomes are woody and are usually covered with black or dark brown wool and dense mats of fibrous black or brown roots. Buds are covered with reddish-brown wool. If they have gone through the required hot water treatment recently, the wool on they buds will be black. If the plants have had time to grow after treatment, the buds will be reddish. Soil, growing media or weeds may be trapped in the dense mat of roots.

Source: USDA-APHIS

Figure 4-2 ***Astilbe***

Pest Risk Rating

The pest risk rating for *Astilbe* is 7.

Similar Looking Rhizomes

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for a paper with a Dutch stamp indicating that hot water treatment was done.
3. If such a document is **not** present, REFUSE TO INSPECT.

4. Look for soil contamination by breaking apart the root mass.
5. Select abnormal specimens for inspection.
6. Check roots for nematodes.

Pests

Common Pests

Meloidogyne. Symptoms: Swellings and galls on roots.

Source: USDA-APHIS

Figure 4-3 *Meloidogyne* on *Astilbe*

Rare Pests

None

Other Pests

None

Treatment

Dutch export regulations require the following mandatory hot water treatment for *Astilbe* to control leaf nematodes (*Aphelenchoides ritzemabosi*):

In 1 hour, heat the rhizome to 43.5 C and hold for 1 hour. Then cool quickly in cold water treated with Thiram (TMTD).

Treatments are performed by growers and exporters under the supervision of nVWA, Naktuinbouw or BKD.

Canna

Canna rhizomes are branched, fleshy, stout, 1–1.5 inches (25–38 mm) thick and 3–4 inches (76–102 mm) long, and have distinct nodes with the remains of papery leaf bases. There is a large bud on the tip of each branch, and roots may be attached anywhere along the rhizome. The bud is often sheathed by the basal remnants of the previous year's leaf.

Source: USDA-APHIS

Figure 4-4 ***Canna***

Pest Risk Rating

The pest risk rating for *Canna* is 3.

Similar Looking Rhizomes

Rhizomes of *Iris germanica* are similar but are more flattened and roots come directly from the bottom of the rhizome.

Inspection Procedures

1. Check small roots for nematodes.
2. Look at brown, necrotic buds for *Ditylanchus destructor*.
3. Look for soil contamination, especially under the leaf sheaths.

Pests

Common Pests

None

Rare Pests

Botrytis cineria. Symptoms: Soft, water-soaked areas becoming tan-colored when dry.

Source: PPO

Figure 4-5 *Botrytis cineria* on *Canna*

Other Pests

Ditylenchus destructor. Symptoms: Brown, necrotic buds.

No photo available.

Meloidogyne. Symptoms: Galls and swellings on small roots.

No photo available.

Convallaria

The rootstock of *Convallaria* is a horizontal rhizome with conspicuous buds (pips) and long fibrous roots. The buds are occasionally connected to each other by stolons. *Convallaria* are shipped during the winter.

Source: USDA-APHIS

Figure 4-6 ***Convallaria majalis***

Pest Risk Rating

The pest risk rating for *Convallaria* is 5.

Similar Looking Rhizomes

There are none.

Inspection Procedures

1. Look for soil and weeds.
2. Look for red lesions on roots.

Pests

Common Pests

None

Rare Pests

Pratylenchus. Symptoms: Red lesions, becoming dark brown to black, on roots and rhizomes. Heavy infestations will result in secondary rotting.

Source: G. v. Grinsven

Figure 4-7 *Convallaria* with *Pratylenchus convallariae*

Other Pests

None

Hemerocallis

Hemerocallis has short rhizomes with leafy buds or eyes and thick, succulent, yellowish-brown roots, often with tuber-like swellings. The fibrous remains of old leaves may be seen at the base of the buds. *Hemerocallis* is shipped in the winter.

Source: USDA-APHIS

Figure 4-8 ***Hemerocallis***

Pest Risk Rating

The pest risk rating for *Hemerocallis* is 2–3.

Similar Looking Rhizomes

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Make sure leaf bases are **no** more than 2 inches long.
3. Look for soil contamination.

4. Select specimens for inspection, especially those that look different from the rest.
5. Examine buds and roots for evidence of borers, diseases, and nematodes.

Pests

Common Pests

None

Rare Pests

Meloidogyne hapla. Symptoms: Galls and swellings on roots.

No photo available.

Pratylenchus. Symptoms: Dark depressed lesions on roots.

Source: G. v. Grinsven

Figure 4-9 *Pratylenchus penetrans* on *Hemerocallis*

Other Pests

None

Iris (mostly Iris germanica, I. pseudacorus, I. siberica, and I. ensata)

Iris rhizomes can be short and stout and somewhat flattened, up to 1.5 inches (38 mm) in diameter and up to 3–4 inches (76–102 mm) long, slender, and very short or long, slender and stoloniferous. They are usually horizontal and clump-forming, but in some species they are vertically oriented. Nodes may be indistinct, and fibrous or papery remains of old leaves may be present near the buds. The buds are leafy with **no** papery covering. The roots are often wiry. In *Iris germanica* and its cultivars, the roots are attached to the bottom of the rhizome and do **not** break off easily.

Source: USDA-APHIS

Figure 4-10 *Iris germanica* (left), *Iris siberica* (right)

Pest Risk Rating

Iris has a pest risk rating of 3–4.

Similar Looking Rhizomes

Canna rhizomes resemble those of *Iris germanica*. Remains of leaves may be present on most of the *Canna* rhizome. Leaf remnants on *Iris* occur only near the buds.

Inspection Procedures

1. Look for soil.
2. Smell for bacterial soft rot, *Erwinia*. The rhizome will have a bad odor if rot is present. It is very rare and only occurs in *Iris germanica*.
3. Look for nematodes on roots.

Pests

Common Pests

None

Rare Pests

Pratylenchus. Symptoms: Reddish to brown lesions on roots, followed by general decay.

Source: G. v. Grinsven

Figure 4-11 *Pratylenchus penetrans* on *Iris*[1]

1 Left photo: *Iris ensata*. Right photo: *Iris setosa*.

Other Pests

None

Paeonia

Paeonia has woody, flesh-colored to dark brown or blackish rhizomes and thick tuberous roots with a few or **no** fibrous roots.

Source: USDA-APHIS

Figure 4-12 Two Varieties of *Paeonia*

Pest Risk Rating

The pest risk rating for *Paeonia* is 5–6.

Similar Looking Rhizomes

There are none.

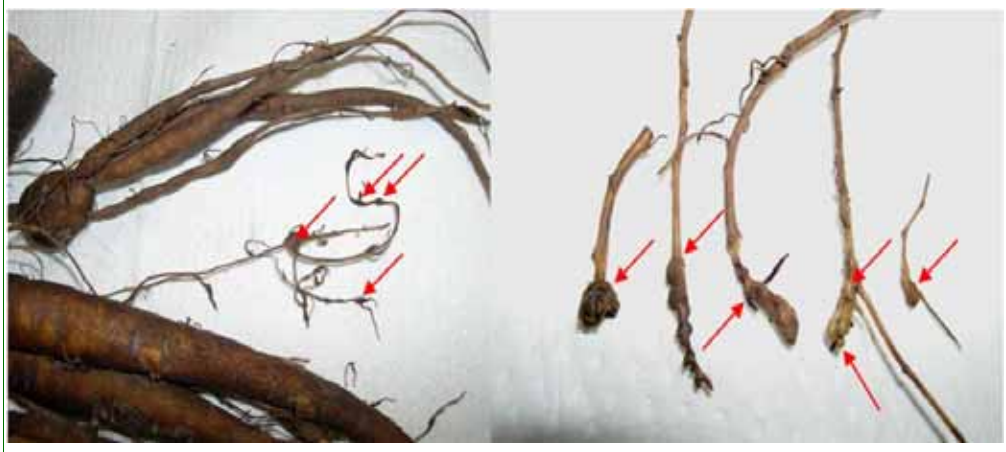
Inspection Procedures

1. Check consignment and verify lot.
2. Check for proof of hot water treatment.
3. Look for soil contamination and select abnormal plants for inspection.

Pests

Common Pests

Meloidogyne. Symptoms: Swellings and galls, mostly on secondary roots.

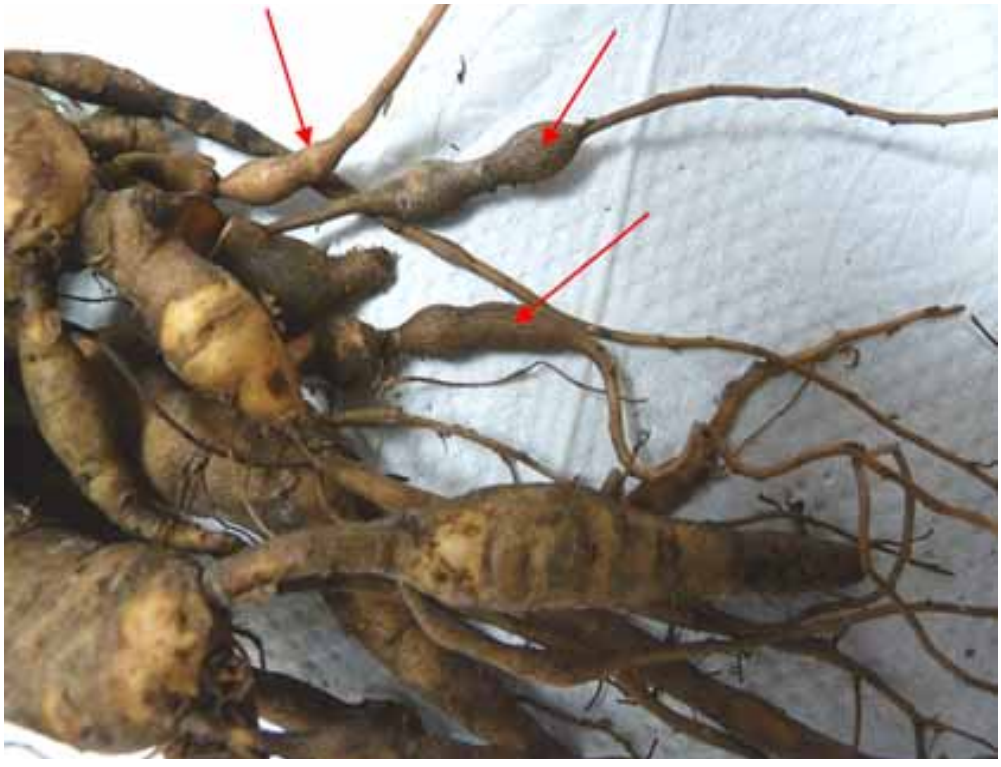


Source: USDA-APHIS

Figure 4-13 *Meloidogyne* on *Paeonia*[1] [2]

1 Left photo: typical symptoms of *Meloidogyne*.

2 Right photo: examples of swellings that are **not** *Meloidogyne*. Note that these swellings are irregular in shape and sometimes off to one side of the rootlet. Such features are common on some varieties of *P. officianalis* (“farmer’s peonies”).



Source: USDA-APHIS

Figure 4-14 Swellings on *Paeonia* Roots[1]

1 Example of large swellings on the roots of some varieties of *Paeonia*. These tuber-like swellings are **not** symptoms of *Meloidogyne*.

Rare Pests

Penicillium. Symptoms: Blue-green mold. This is normally only a storage problem.

Source: USDA-APHIS

Figure 4-15 *Penicillium* on *Paeonia*

Other Pests

Botrytis paeoniae. Symptoms: Black sclerotia imbedded in old stems.

No photo available.

Rhodococcus fascians. Symptoms: Fasciations at root crown.

Source: G. v. Grinsven

Figure 4-16 *Paeonia* with *Rhodococcus fascians*

Treatment

Dutch export regulations require the following mandatory hot water treatment for *Paeonia* to control leaf nematodes (*Aphelenchoides ritzemabosi*):

In 1 hour, heat the rhizome to 43.5 C and hold for 1 hour. Then cool quickly in cold water treated with Thiram (TMTD).

Treatments are performed by growers and exporters under the supervision of nVWA, Naktuinbouw or BKD.

Zantedeschia

The genus *Zantedeschia* consists of eight species over two sections, *Zantedeschia* and *Aestivae*. *Zantedeschia* has rhizomes, rhizomatous tubers or discoid tubers. *Zantedeschia aethiopica* and other species in Section *Zantedeschia* have rhizomatous tubers that are more or less elongate. Species in Section *Aestivae* such as *Z. rehmannii*, *Z. elliotiana*, and *Z. albomaculata* and their hybrids have discoid tubers with up to seven knobby daughter "bulblets." The major problem for *Zantedeschia* is soil.

Source: USDA-APHIS

Figure 4-17 *Zantedeschia*[1] [2]

1 Top left and right photos show examples of discoid tubers of *Zantedeschia* Section *Astivae*.

2 Bottom left photo is a rhizomatous tuber of *Zantedeschia aethiopica*.

Pest Risk Rating

The pest risk rating for *Zantedeschia* is 3.

Similar Looking Rhizomes

Arum (tuber) may or may **not** have side "bulblets."

Inspection Procedures

1. Select abnormal rhizomes for inspection.
2. Check for softness.
3. Check for soil.

Pests

Common Pests

None

Rare Pests

Erwinia carotovora. Symptoms: Soft brown rot with fetid odor. Species in Section *Aestivae* are more susceptible to *Erwinia* than those in Section *Zantedeschia*. *Erwinia* is normally culled out by the exporter before the preclearance inspections and is rarely intercepted.

Source: USDA-APHIS

Figure 4-18 *Erwinia carotovora* on *Zantedeschia*[1]

1 Two examples of *Erwinia carotovora* on *Zantedeschia*. Left photo shows fresh infection with mushy tissue. Right photo shows old infection with brown, dried tissue.

Other Pests

Rhizoglyphus. Symptoms: A secondary pest in decaying tissue.

No photo available.

Chapter

5

True Bulbs

Contents

Introduction

True bulbs are underground, upright stems with fleshy modified leaves. The leaves can be layered around each other with the outer leaves often drying out (the tunic). These are known as tunicated bulbs. An onion, cut in cross sections, will show concentric rings where the leaves wrap around each other.

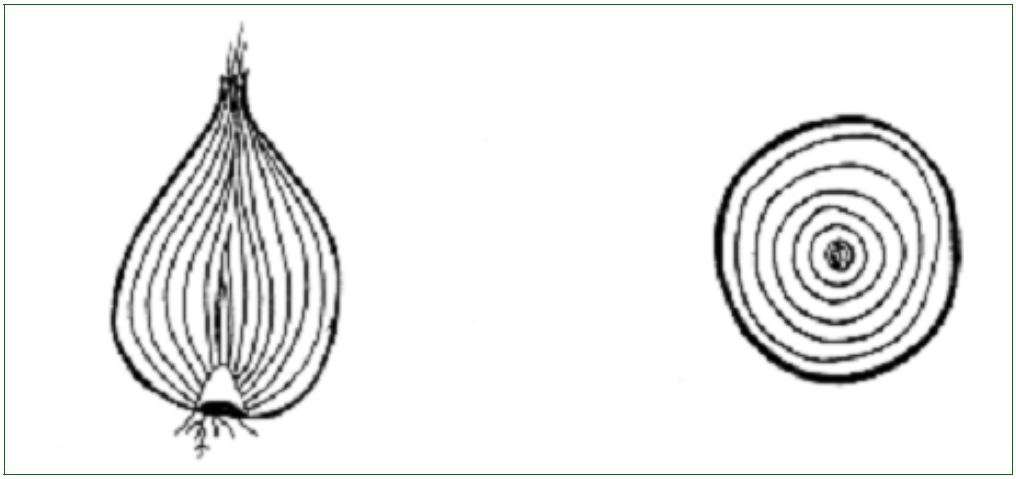


Figure 5-1 Sketch of a Lateral View and a Cross Sectional View of a True Bulb

In some true bulbs the fleshy leaves overlap each other and do **not** encircle the central bud or each other. Such bulbs are known as scaly bulbs. A lily is an example of this type of bulb.

Figure 5-2 Sketch of a True Bulb, the Lily

When a true bulb starts to grow, roots usually emerge from the base of the bulb. The central bud sends up new leaves. The leaves collect food which is then stored in the bases of the growing leaves. This storage area, located in the bulb, expands. The outer leaf bases do **not** send up leaves. They dry up to form a protective papery covering (tunic).

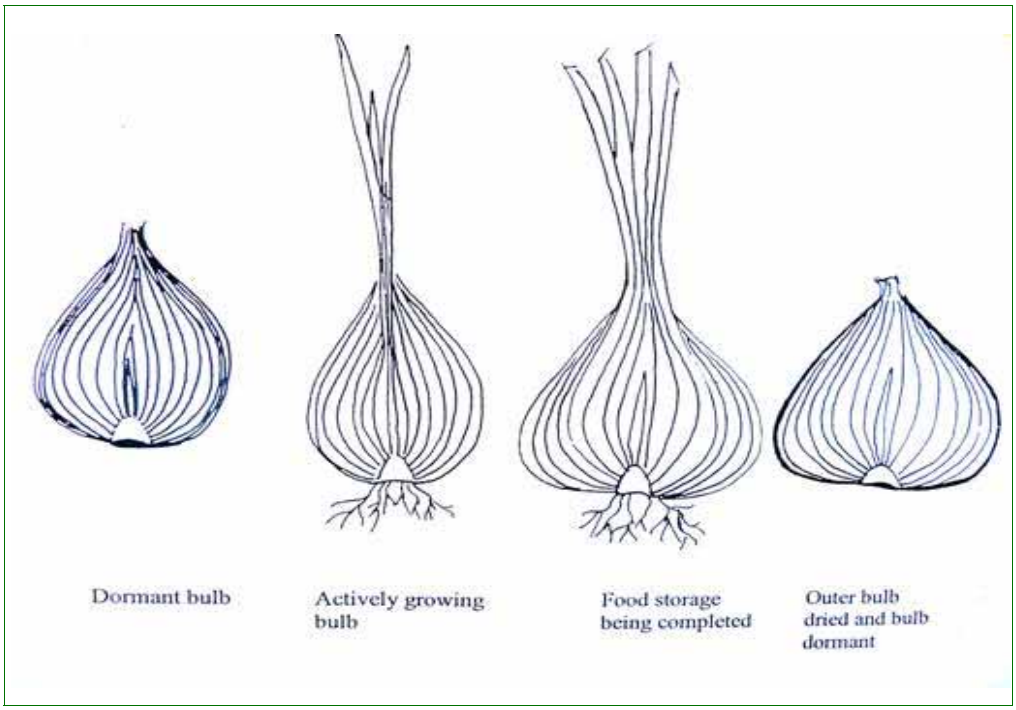


Figure 5-3 Steps in the Life Cycle of a True Bulb

The information in this chapter includes the pest risk rating for each bulb. The ratings are:

Table 5-1 Pest Risk Ratings for True Bulbs

Pest Risk	Rating
1–2	Very low risk. Verify the genus in the shipment. Inspect if time is available.
3–4	Low risk. Inspect if time is available.
5–6	Moderate risk. Provide normal inspection.
7–8	High risk. Inspect thoroughly.
9–10	Very high risk. Inspect very thoroughly.

Identification Procedure

Determine the length of the bulb you are identifying. Compare it with the photographs in this chapter and select the description that fits your bulb. Each description includes inspection procedures and pests of concern.

Allium (flowering onion)

Allium bulbs are highly variable in size and shape depending on species and variety, but are generally broadly teardrop-shaped to globose, often very symmetrical, usually with a prominent apex. The tunic is papery or hard and shell-like, and often shiny. The bulb has a small root plate. In cross-section the bulb has few concentric rings. When cut, the bulb emits an onion-like odor, and the consistency of the moisture in the bulb may vary from liquid to viscous.

Source: USDA-APHIS

Figure 5-4 *Allium* (top to bottom): *Allium karataviense*; *A. sphaerocephalon*; *A. moly*; *A. neapolitanum*

Pest Risk Rating

The pest risk rating for *Allium* is 6–7.

Similar Looking Bulbs

Small species and varieties of *Allium* are similar in size and shape to many small bulbs, such as some varieties of *Chionodoxa*, *Ornithogalum*, and *Puschkinia*; however, they can be distinguished by their often shiny white tunic and onion-like scent when cut. Medium and large bulbed *Allium* are fairly distinctive.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal bulbs for inspection.
3. Peel back loose skin and examine the base of the bulb for brown streaking. The single streak or many streaks in the bands may spread from the base into the top of the bulb. Tweeze the damaged area in a dish of water to extract nematodes.
4. Look for aphids, mites, thrips, and signs of other pests or diseases.

Pests

Common Pests

Fusarium oxysporum. Symptoms: Rotting and discoloration usually beginning at the basal plate and proceeding upward towards apex of the bulb.

Source: (left photo) PPO; (right photo) USDA-APHIS

Figure 5-5 *Fusarium oxysporum* on *Allium*

Mechanical injury. Symptoms: Scarring and abrasions due to damage sustained during harvest and cleaning. Mechanical injury is the most common disorder in *Allium*.

Source: USDA-APHIS

Figure 5-6 Mechanical Damage on Different Varieties of *Allium*

source: USDA-APHIS

Figure 5-7 Mechanical Damage on *Allium moly*[1]

1 Mechanical damage on *Allium moly*. The left bulb shows the tunic intact; bulbs to the right show progressive degeneration of the bulbs (tunics removed) due to injury. Bulb on extreme right has become totally discolored and shrunken. Symptoms can be mistaken for *Fusarium*.

Penicillium. Symptoms: Blue-green mold.

Source: USDA-APHIS

Figure 5-8 *Penicillium* on *Allium*

Rare Pests

Aphelenchoides subtenuis. Symptoms: Discoloration at basal plate, streaking upward; eventually the basal portion of the bulb becomes sunken but **not** soft. Diseases tissue turns grayish but **not** brown, as in *Ditylenchus*. Note characteristic shrinking of the base of the bulbs. Bulb in the top right photo has a secondary infection of *Penicillium*.

Source: (top left) PPO; (top right) BKD; (bottom) USDA-APHIS

Figure 5-9 *Aphelencoides subtenuis* on *Allium*

Aspergillus. Symptoms: Black mold.

Source: USDA-APHIS

Figure 5-10 *Aspergillus* on *Allium moly*

Other Pests

Aceria tulipae. Symptoms: Reddish russeting of the bulb.

Source: BKD

Figure 5-11 *Aceria tulipae* Symptoms on *Allium*

Aphids. Symptoms: **No** definite symptoms, live insects must be found.

No photo available.

Botrytis. Symptoms: Gray mycelia with black sclerotia.

No photo available.

Ditylenchus dipsaci. Symptoms: Discoloration of leaf scales, forming brown rings in cross section of the bulb. Discoloration at the basal plate, streaking towards apex. Basal area becomes soft.

Source: BKD

Figure 5-12 *Ditylenchus dipsaci* on *Allium*

Erwinia. Symptoms: Soft rot of bulb.

No photo available.

Gummosis. Symptoms: Clear or resin-like exudate. Often a reaction to injury. Note scarring due to mechanical injury.

Source: USDA-APHIS

Figure 5-13 *Gummosis* on *Allium*

Sclerotium cepivorum. Symptoms: White fluffy mycelia and masses of black sclerotia at the base of the bulb.

Source: PPO

Figure 5-14 *Sclerotium cepivorum* on *Allium*

Thrips. Symptoms: Russeting of leaf scales.

No photo available.

Camassia

The bulbs of *Camassia* vary in size and shape depending on species. Bulbs are 1–2.25 inches (2.5–5.8 cm) tall and 1–2.25 inches (2.5–6.2 cm) wide. Generally, they are irregularly broadly teardrop in shape and often flattened on one side, with thin, papery dark brown tunic and a prominent basal plate. The tunic is often partially removed during post-harvest handling and the white inner scales are frequently marked by brown discolorations due to mechanical damage. The bulbs can be symmetrical or somewhat flattened on one or two sides. There are **no** serious problems with *Camassia*.

Source: USDA-APHIS

Figure 5-15 ***Camassia leichtlinii***

Pest Risk Rating

The pest risk rating for *Camassia* is 3.

Similar Looking Bulbs

There are none.

Inspection Procedures

1. Check consignment and verify lot.

2. Look for soil contamination and select any abnormal bulbs for inspection.
3. Examine inner and outer scales for major pests.

Pests

Common Pests

None

Rare Pests

Ditylenchus destructor. Symptoms: Brown dry decay around roots. In cross section, the symptoms resemble those of a mild and dry *Fusarium* infection. Unlike in most other bulbs, there are **no** discolored concentric rings.

Source: BKD

Figure 5-16 *Camassia* with *Ditylenchus destructor*[1] [2]

1 Left photo: Infection of *D. destructor* on the right side of the basal plate.

2 Right photo: Longitudinal section of bulb showing *Ditylenchus* symptoms that resemble those of *Fusarium*.

Other Pests

None

Chionodoxa

Chionodoxa bulbs are small, symmetrical, nearly globose to teardrop-shaped bulbs, about 1/2–1 inch (1.27–2.5 cm) in diameter, often with a pointed apex and a large basal plate. The tunic is whitish to cream-colored or brownish and papery. Fleshy leaf scales may have purple spots on damaged areas. A cross-section of the bulb reveals yellow material between the leaf scales and at the core of the bulb.

Source: USDA-APHIS

Figure 5-17 ***Chionodoxa***

Pest Risk Rating

The pest risk rating for *Chionodoxa* is 5.

Similar Looking Bulbs

Chionodoxa bulbs may resemble those of *Ornithogalum*, *Puschkinia*, or some varieties of *Allium*.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal bulbs for inspection.
3. Cut the tip of the bulb off in a small cross-section to check for nematodes. The death of the growing tip of the bulb leaves a hard black, dry material in the core of the bulb.

Pests

Common Pests

Penicillium. Symptoms: Blue-green mold, especially on damaged areas. This is normally a storage problem.

Source: USDA-APHIS

Figure 5-18 *Penicillium* on *Chionodoxa*

Rare Pests

None

Other Pests

Aphelenchoides. Symptoms: Discoloration and streaking at the base of the bulb.

No photo available.

Ditylenchus dipsaci. Symptoms: Discoloration of leaf scales, forming brown rings in cross section of the bulb. Discoloration at the basal plate, streaking upwards toward the apex. Eventually, the base of the bulb begins to shrink and crack at the basal plate. Note the cracking at the base of the bulb in Figure 5-19.

Source: BKD

Figure 5-19 *Ditylenchus dipsaci* on *Chionodoxa*

Fritillaria

Fritillaria bulbs vary in size and shape depending on species. The bulbs of smaller species consist of two to three fat, large storage leaves. Bulbs of larger species have a thick donut-shaped outer scale and three to four thick inner leaf scales. *Fritillaria* bulbs lack papery tunics, are white to yellow in color, and emit a peculiar odor. In some species, there is a a prominent “flower stalk hole” at the center of the bulb. There is **no** tunic, so mechanical damage can be a serious problem.

Source: USDA-APHIS

Figure 5-20 *Fritillaria imperialis* (top left); *F. uva vulpis* (top right); *F. meleagris* (bottom)

Pest Risk Rating

The pest risk rating for *Fritillaria* is 4.

Similar Looking Bulbs

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination, particularly in the cavity at the center of the bulb, and select abnormal bulbs for inspection.
3. Examine outer scales for disease.

Pests

Common Pests

Fusarium. Symptoms: Infections usually begin at the base of the bulb, spreading into the core. Infected areas are often edged with distinct roundish or lobe-like brown margins, and often characterized by concentric “growth rings.”

Source: (top photo) PPO; (bottom photo) USDA-APHIS

Figure 5-21 *Fusarium* on *F. meleagris* (top)[1] and *F. imperialis* (bottom)[2]

1 Top photo: *Fusarium* on *F. meleagris*.

2 Bottom photo: basal infection of *Fusarium* on *F. imperialis*. Note concentric growth rings.

Mechanical damage. Symptoms: The fleshy outer scales of *Fritillaria* are easily bruised or damaged. Superficial scars and lesions are often mistaken for *Fusarium*, but damaged areas lack the characteristic margins and concentric "growth rings."

Source: USDA-APHIS

Figure 5-22 Mechanical Damage on *Fritillaria imperialis*

Rare Pests

Penicillium. Symptoms: Blue-green mold on damaged outer scales.

Source: USDA-APHIS

Figure 5-23 *Penicillium* on *Fritillaria uva vulpis*

Other Pests

Sclerotinia bulborum. Symptoms: Infected areas with masses of gray or white mycelia and black sclerotia.

No photo available.

Galanthus

The bulbs of *Galanthus* are teardrop-shaped with a broad basal plate and slightly asymmetrical due to the development of daughter bulbs. The tunic is often glossy, dark to medium brown, with prominent veins. Leaf scars are visible on the apex of the outer leaf scales of the bulb.

Source: USDA-APHIS

Figure 5-24 *Galanthus nivalis* (top); *G. elwesii* (middle); *G. woronowi* (bottom)

Pest Risk Rating

The pest risk rating for *Galanthus* is 4.

Similar Looking Bulbs

Galanthus may resemble some varieties of *Chionodoxa* or small *Narcissus*.

Inspection Procedures

1. Check the consignment and verify lot.
2. Check for soil contamination and select abnormal bulbs for inspection.
3. Examine outer scales for disease.

Pests

Common Pests

Fusarium. Symptoms: Dark, punky rot, usually from the base.

Source: BKD

Figure 5-25 *Fusarium* on *Galanthus nivalis* (tunic removed)

Rare Pests

Botrytis galanthina. Symptoms: Gray mold and round, flattened black sclerotia on outer scales, and a hard, dry root plate.

Source: PPO

Figure 5-26 *Botrytis galanthina* on *Galanthus*

Stagonospora curtisii. Symptoms: Red or reddish brown spots that develop into lesions, usually with distinct margins.

No photo available.

Other Pests

Ditylenchus dipsaci. Symptoms: Discoloration at base of bulb, streaking upward. In cross section, infected scales appear as brown rings.

Source: BKD

Figure 5-27 *Ditylenchus dipsaci* on *Galanthus nivalis* (tunic removed)

Sclerotium. Symptoms: Fluffy white mycelia and black sclerotia at base of bulb.

No photo available.

Merodon equestris. Symptoms: Small hole at base of bulb; larva can be found eating its way through the interior of the bulb.

No photo available.

Galtonia

Galtonia bulbs are broadly ovoid or teardrop-shaped with a prominent basal plate. The tunic and outer leaf scales are brownish to white with the top half being thin and papery, and the bottom half somewhat fleshy. The neck is thick with distinct veins on the tunic. In a cross section each scale is thick and firm; the vascular bundles are visible.

Source: USDA-APHIS

Figure 5-28 ***Galtonia***

Pest Risk Rating

The pest risk rating for *Galtonia* is 4.

Similar Looking Bulbs

Hyacinth bulbs are similar. *Galtonia* veins are more pronounced and the root plate is thicker. When cut, *Galtonia* does **not** ooze like *Hyacinth*. *Galtonia* are usually shipped in the winter and spring; *Hyacinth* in the summer and fall.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal bulbs for inspection.

3. Cut the tip of the bulb off in a cross section. Look for brown ring or discoloration. This may indicate the nematode, *Ditylenchus dipsaci*.
4. *Fusarium* may be present on the mummified bulbs. *Fusarium* has a distinct, sweet sour smell.

Pests

Common Pests

Fusarium. Symptoms: Dark brown discoloration beginning at base of bulb; often accompanied by a distinct, sweet sour smell.

Source: BKD

Figure 5-29 *Fusarium* on *Galtonia*

Penicillium. Symptoms: Blue-green mold, usually secondary on damaged areas.

No photo available.

Rare Pests

Erwinia carotovora. Symptoms: Soft rot accompanied by fetid odor.

No photo available.

Other Pests

Ditylenchus dipsaci. Symptoms: Discoloration beginning at basal plate and streaking upward. In cross section, infected leaf scales appear as brown rings.

No photo available.

Hippeastrum

The bulbs of *Hippeastrum* are round and symmetrical with a long, flattened neck and long fleshy roots. The top 1/4 of the external leaf scale is papery, the lower 3/4 is fleshy. The bulb develops a red tinge on damaged areas. Vascular bundles are clearly visible on the cut leaves. Do **not** cut this bulb to identify.

Hippeastrum is commonly referred to as "Amaryllis." However, the genus *Amaryllis* originated in South Africa, whereas the genus *Hippeastrum* is native to South America.

Source: USDA-APHIS

Figure 5-30 ***Hippeastrum***

Pest Risk Rating

The pest risk rating for *Hippeastrum* is 6.

Similar Looking Bulbs

Amaryllis is similar; however, bulbs in the genus *Amaryllis* are conspicuously fibrous and smaller than those in *Hippeastrum*.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal bulbs for inspection.
3. Look in dried material at the neck for mealybugs, aphids, and thrips.

4. Squeeze the neck of the bulb to open the leaf bases. Do **not** cut the bulb unless symptoms indicate major pests.
5. Examine the base of the bulb for a slightly depressed, corky area with a hole in it. This is a sign of the bulb fly.

Pests

Common Pests

Stagonospora curtisii. Symptoms: Red or reddish-brown spots that develop into lesions, usually with distinct margins. Any injury usually produces a red pigment, so red streaks or irregular patterns are **not** always indicative of *Stagonospora* infections.

Source: (top photo) PPO; (bottom photo) BKD

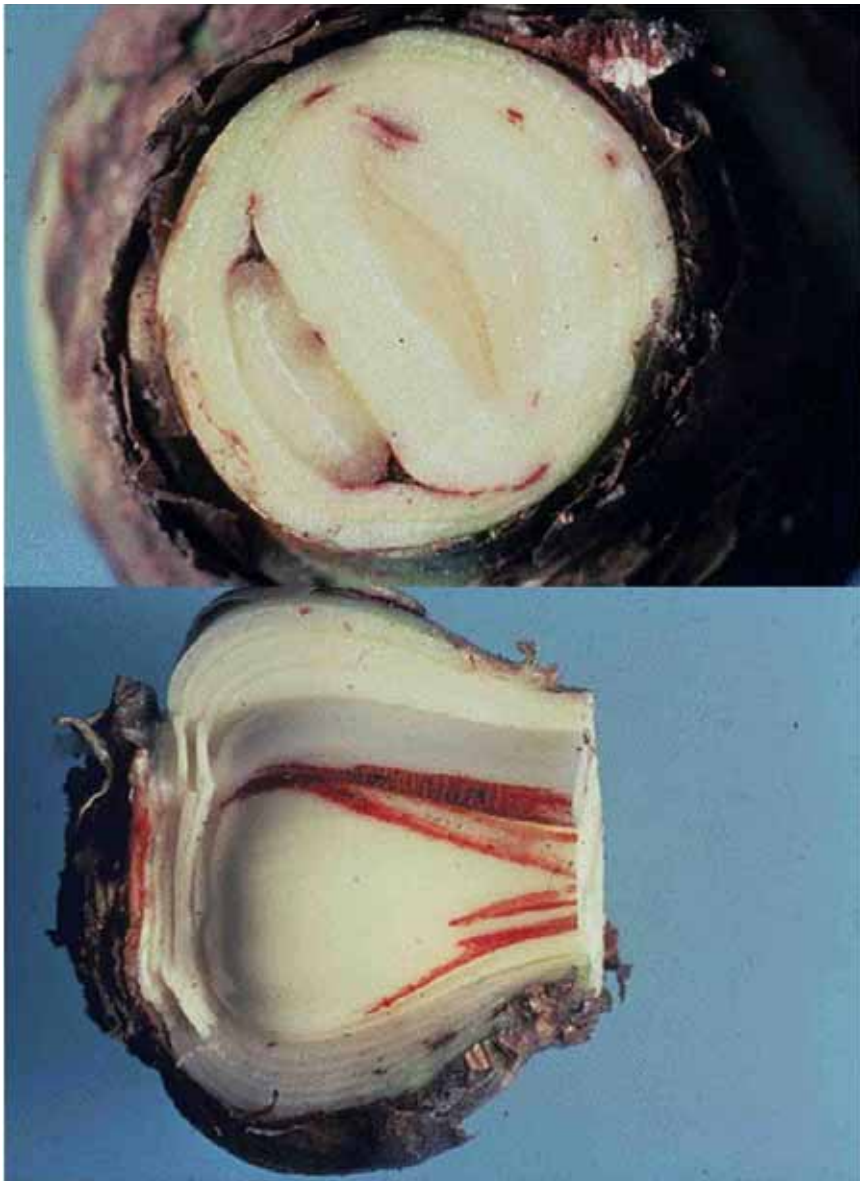
Figure 5-31 *Stagonospora curtisii* on *Hippeastrum*[1] [2]

1 Top photo: Left bulb, longitudinal section showing infection on scales originating at top and spreading toward the base. Right bulb, cross section of neck showing infected leaf scales.

2 Bottom photo: Heavily infected bulb, cross section of top of bulb, just below the neck.

Rare Pests

Steneotarsonemus laticeps. Symptoms: Reddish pinpoints at the edges of scales in cross section neck of bulb; reddish streaks along leaf scales in longitudinal section of bulb.



Source: PPO

Figure 5-32 *Steneotarsonemus laticeps* on *Hippeastrum*[1] [2]

1 Top photo: Cross section of neck showing reddish pinpoints between the leaf scales.

2 Bottom photo: Longitudinal section showing reddish streaking along the leaf scales.

Other Pests

Ditylenchus dipsaci. Symptoms: Red streaks that run from the top toward the base on the inner parts of scales.

No photo available.

Pseudococcidae (mealybugs). Symptoms: White floss on emerging leaves.

No photo available.

Syrphidae (bulb fly). Symptoms: Slightly depressed, corky area with a hole in it. Larvae can be found eating its way through the interior of the bulb. If only one large larva is found, it is probably *Merodon equestris*. If several are found, it is probably *Eumerus*.

No photo available.

Hyacinthus

Hyacinthus are very symmetrical, globose or broadly ovate bulbs with a cone-shaped tip and a thick root plate. The loose papery tunic may be red, white, or purple. Veins are **not** visible on the tunic. Dark colored bulbs are speckled or dusty looking. In a cross section, the leaf scales are moderate in size and exude a viscous substance. The dust and exudate of *Hyacinthus* contain oxalates that irritate the skin. When inspecting, wear gloves and do **not** touch eyes or nose.

Source: USDA-APHIS

Figure 5-33 ***Hyacinthus***

Pest Risk Rating

The pest risk rating for *Hyacinthus* is 7.

Similar Looking Bulbs

Bulbs of *Scilla siberica* resemble *Hyacinthus* bulbs, but they are much smaller.

Inspection Procedures

1. The dust and exudate of *Hyacinthus* contain oxalates that irritate the skin. When inspecting, wear gloves and avoid touching eyes and nose.
2. Check consignment and verify lot.
3. Look for soil contamination and select abnormal bulbs for inspection.
4. Cut off the tip of the bulb in a cross-section and look for signs of nematodes, *Erwinia*, and *Xanthomonas*.

Pests

Common Pests

Aspergillus niger. Symptoms: Black mold, commonly found just beneath the tunic; often secondary on injuries.

Source: USDA-APHIS

Figure 5-34 *Aspergillus niger* on *Hyacinthus* Variety with White Tunic

Erwinia carotovora. Symptoms: White-yellow, foul smelling ooze from inside bulb (variety 'Blue Jacket' is very susceptible; white skinned varieties also susceptible). Central rot at apex of bulb, eventually affecting the core and the entire bulb.

Source: PPO

Figure 5-35 *Erwinia carotovora* on *Hyacinthus*

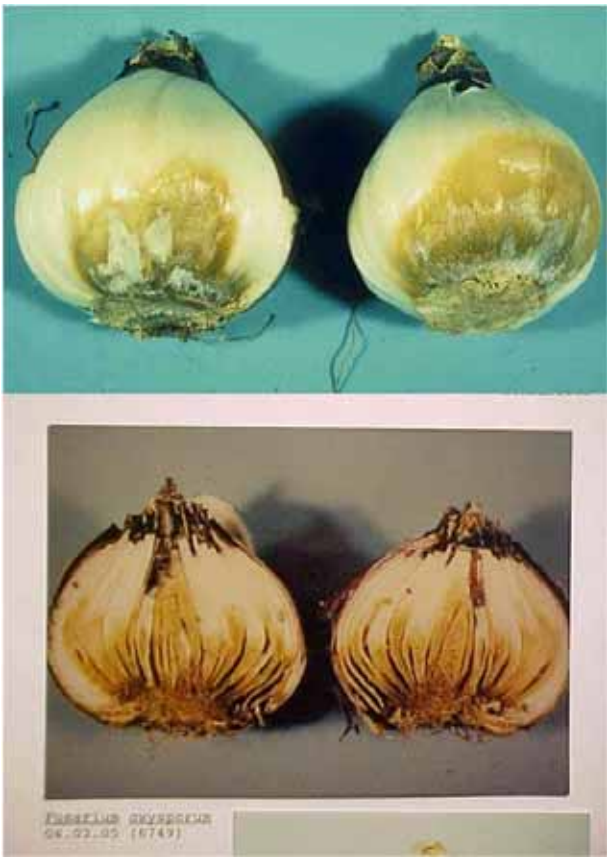
Penicillium. Symptoms: Blue-green mold commonly found under the papery tunic. Mostly a storage problem.

Source: USDA-APHIS

Figure 5-36 *Hyacinthus* with *Penicillium*

Rare Pests

Fusarium. Symptoms: Brownish discoloration accompanied by a sweet, moldy odor; infection usually beginning at base of bulb and spreading through the interior.



Source: (top photo) PPO; (bottom photo) J. Heuperman

Figure 5-37 *Fusarium* on *Hyacinthus*[1] [2]

1 Top photo: Exterior symptoms; bulbs with tunic removed.

2 Bottom photo: Longitudinal section of bulb.

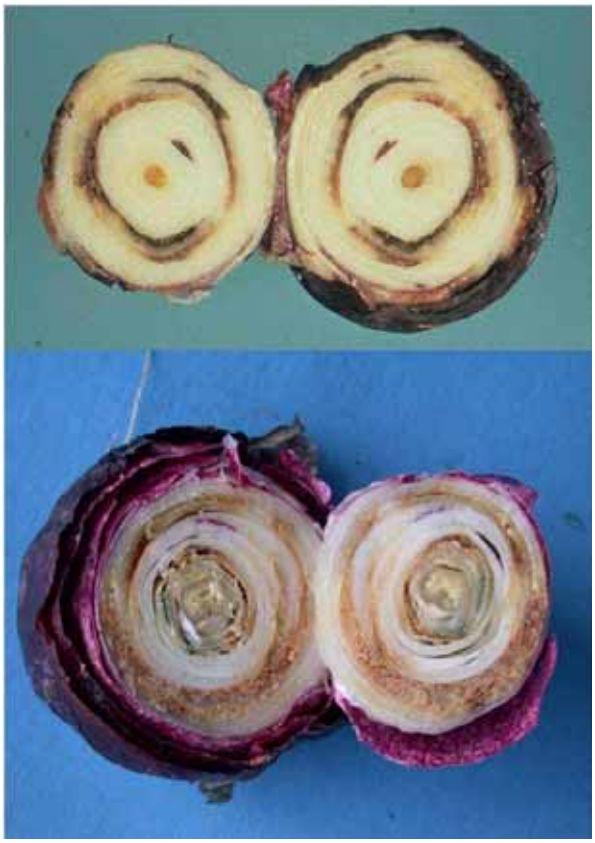
Rhodocoddus fascians. Symptoms: Fasciations around the basal plate.

Source: PPO

Figure 5-38 *Rhodococcus* on *Hyacinthus*

Other Pests

Ditylenchus dipsaci. Symptoms: Discoloration of leaf scales, forming brown rings in cross section of bulb.



Source: (top photo) PPO; (bottom photo) BKD

Figure 5-39 Cross Section of *Hyacinthus* Bulbs Showing Discolored Leaf Scales Caused by Infection of *Ditylenchus dipsaci*

Embellesia. Symptoms: Circular brown spots not penetrating outer tunic.

No photo available.

Erwinia rhapontica. Symptoms: Yellow discoloration of the upper portion of the central leaf scales ('Anne Marie' is very susceptible). Infection **never** goes to the base of the bulb. Strictly a quality issue; does **not** affect flowering. There is **no** fetid odor as in *E. carotovora*.

Source: BKD

Figure 5-40 *Erwinia rhapontica* on *Hyacinthus*

Sclerotinia bulborum. Symptoms: Infected areas with masses of gray or white mycelia and black sclerotia.

No photo available.

Thysanoptera (thrips). Symptoms: Russeting of the affected leaf scales.

Source: PPO

Figure 5-41 Thrip Damage Along Inner Scales on *Hyacinth* (outer leaf scales removed)

Xanthomonas campestris pv hyacinthi. Symptoms: Yellow odorless ooze from inside bulb. Discoloration of core of bulb. Infections may begin at the base of the bulb or from the apex. Infection of the bulb can be easily transmitted in storage and by infected machinery. Infections of the apex begin at the apex, the bacterium having traveled down from the leaves. It can easily be transmitted by walking through wet fields during field inspections.

Source: BKD

Figure 5-42 *Xanthomonas* on *Hyacinthus*[1] [2]

1 Top left and right photos: bulbs show symptoms of a bulb-type infection. .

2 Bottom photo: bulb shows symptoms of an apex type of infection

Iris

Iris bulbs are more or less teardrop-shaped with a slender, prominent apex. The tunic is light to dark brown, usually fibrous, glossy and strongly veined. The tunic and fleshy scale wraps around the bulb like a coat and is sutured on one side. In a cross-section, the bulb has only two or three rings of fleshy leaf scales. The flesh is dry. These bulbs are often treated with fungicide.

Source: USDA-APHIS

Figure 5-43 *Iris*: (top row) *Iris danfordii*; (bottom row) *Iris reticulata*

Pest Risk Rating

The pest risk rating for *Iris* is 7.

Similar Looking Bulbs

None

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal bulbs for inspection.
3. Look at tunic and peel them down to see if mealybugs, aphids, or nematodes are present.
4. Examine the base of the bulb for nematode symptoms and *Fusarium*.
5. Cut the apex fo the bulb to reveal the inner fleshy scales. Look for nematode symptoms.

Pests

Common Pests

Fusarium. Symptoms: A sunken area around the basal plate with brown rot and white mycelia.

Source: PPO

Figure 5-44 Advanced Infection of *Fusarium* on *Iris*

Penicillium. Symptoms: Blue-green mold.

Source: USDA-APHIS

Figure 5-45 *Penicillium* on *Iris*

Rare Pests

None

Other Pests

Aphids. Symptoms: Sticky bulbs may indicate aphid infestation but live insects must be found.

Source: PPO

Figure 5-46 Aphid Damage on *Iris*[1]

1 Live insects can be found at base and apex on left bulb.

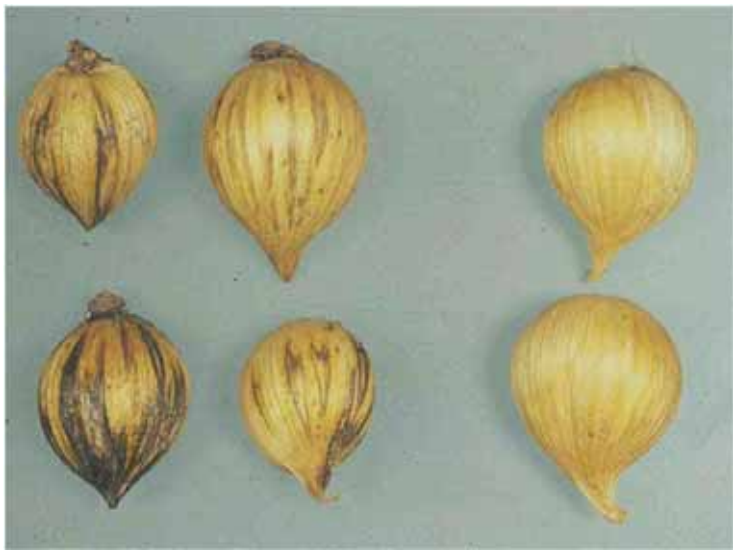
Ditylenchus destructor. Symptoms: Gray to black streaks radiating from the base; or a reddish ring or spot in cross section of bulb at the apex.

Source: nVWA

Figure 5-47 *Ditylenchus destructor* on *Iris*[1]

1 Left bulb: characteristic streaking from base of bulb. Right bulb: advanced stage of infection with base of bulb beginning to shrink.

Dreschslera iridis. Symptoms: Irregular ink blot spots and streaking on tunic and outer scales if the infection is severe.



Source: PPO

Figure 5-48 *Dreschslera iridis* on *Iris*[1]

1 Right two bulbs are healthy; four on left are infected.

Mealybugs. Symptoms: White floss; apparent particularly when bulbs have been stored at 30 °C for a long period of time.

Source: PPO

Figure 5-49 *Iris* Bulbs Severely Infected with Mealybugs

Source: PPO

Figure 5-50 *Iris* Bulbs with *Phenacoccus avenae*[1]

1 Left: healthy bulb. Center and right bulbs infested with *P. avenae*.

Plodia interpunctella. Symptoms: Appearance of frass.

Source: PPO

Figure 5-51 *Plodia interpunctella* on *Iris*[1]

1 Frass indicating an infestation of *P. interpunctella* or another interal feeder.

Sclerotinia bulborum. Symptoms: Infected areas with masses of gray or white mycelia and black sclerotia.

No photo available.

Sclerotium. Symptoms: White mycelia and masses of black sclerotia.

Source: PPO

Figure 5-52 *Sclerotium wakkeri* on *Iris* Bulbs[1]

1 Note masses of sclerotia forming on black infected areas. Bulb on bottom left is healthy.

Lilium

Lilium bulbs are very distinctive, being made up of many overlapping fleshy scales. The scales can be stiff or somewhat flexible and may be white, yellow, red, or purple. Roots are often attached to the base. Do **not** cut into this bulb to identify it. *Lilium* bulbs may be dipped in fungicide and pesticide before storage.

Source: USDA-APHIS

Figure 5-53 Different Varieties of *Lilium*

Pest Risk Rating

The pest risk rating for *Lilium* is 6.

Similar Looking Bulbs

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal bulbs for inspection.
3. Examine outer scales for disease.

4. Look at the root plate and roots for disease and nematode symptoms.
5. Pry open scales. Look for thrips, snails, slugs, and other surface feeders, and soil. Do **not** break off the scales needlessly.
6. If the scales are rosetted or discolored, examine the center scales near the growing point for nematodes.

Pests

Common Pests

Fusarium. Symptoms: Brown basal rot causing scales to fall off. Infection begins at the outer scales, spreading towards the apex and into the interior of the bulb. *Cylindrocarpon* is often associated with *Fusarium* infections and laboratory tests for *Fusarium* will normally be positive for *Cylindrocarpon,* as well. *Fusarium* is much more aggressive and severe symptoms will appear much earlier than those for *Cylindrocarpon*.

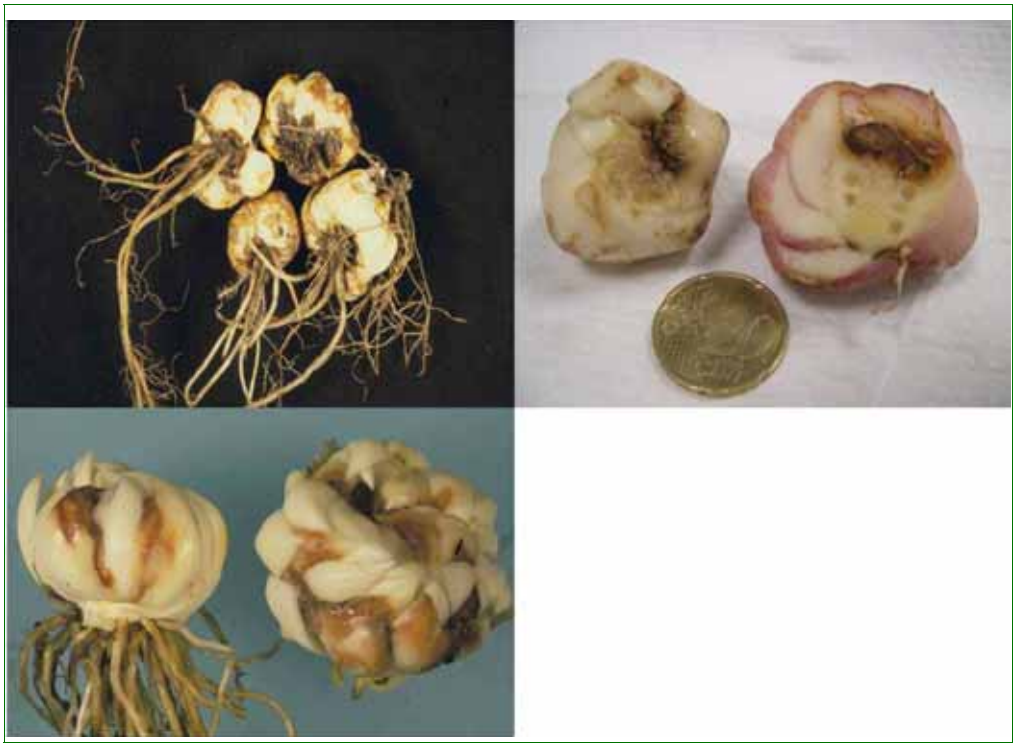


Figure 5-54 *Lilium* Bulbs Infected with *Fusarium*[1] [2] [3]

1 Top left photo: Typical symptoms with infection beginning at the base of the outer scales and surrounding the basal plate. Source: nVWA

2 Top right photo: Cross section of bulbs just above basal plate showing *Fusarium* infections of upper right leaf scales. Infection on right bulb is still confined to the base of the leaf scales. Infection on left bulb has spread into the core. Source: USDA-APHIS

3 Bottom photo: Example of mixed infection of *Cylindrocarpon* and *Fusarium*. Source: PPO

Rare Pests

Aphelenchoides. Symptoms: Rosetting of scales. Scales often become abnormally spaced. “Loose” scales may also be symptomatic of other disorders, so samples should be sent to the laboratory for identification.

Source: nVWA

Figure 5-55 *Aphelenchoides* on *Lilium*[1]

1 Note the slightly abnormal arrangement of scales and wide spacing.

Penicillium. Symptoms: Blue-green mold usually secondary on damaged areas that are usually chocolate brown in color; resulting in a dry, punky rot. Usually a storage problem.

Source: nVWA

Figure 5-56 *Lilium* with *Penicillium* Forming as a Result of Mechanical Damage

Rhizoglylphus robinii. Symptoms: Holes through the leaf scales. In severe infestations, the scales begin to fall off.

Source: BKD

Figure 5-57 *Rhizoglyphus robinii* Symptoms on *Lilium*[1]

1 Note conspicuous brownish black holes.

Rhodococcus fascians. Symptoms: Abnormal, swollen ribbing and fasciations of the basal leaf scales and proliferation of fasciated tissue at base of bulb.

Source: (top photos) BKD; (bottom photo) USDA-APHIS

Figure 5-58 *Rhodococcus* on *Lilium*

Other Pests

Botrytis. Symptoms: Gray or grayish-brown mycelia and black sclerotia; brown rotting of scales.

Source: PPO

Figure 5-59 *Botrytis cineria* on *Lilium*

Pratylenchus. Symptoms: Lesions on roots.

No photo available.

Thrips. Symptoms: Russeting on leaf scales.

Source: PPO

Figure 5-60 *Lilium* with Outer Scales Removed, Showing Characteristic Russeting and Live Adult Thrips

Muscari

Muscari bulbs are symmetrical to irregular, teardrop to globose in shape, with a whitish to pinkish papery or somewhat fleshy tunic. The base of the bulb is large in comparison to the size of the bulb, and the basal plate is broad, often with many fibrous roots. The inner scales are soft and thick, with no viscous exudates.

Source: USDA-APHIS

Figure 5-61 *Muscari armeniaca* (left); *M. comosum* "Plumosum" (right)

Pest Risk Rating

The pest risk rating for *Muscari* is 5.

Similar Looking Bulbs

Smaller species of *Muscari* may resemble some species of *Ornithogalum*, but *Ornithogalum* bulbs usually exude a sticky sap.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal bulbs for inspection.
3. Examine outer scales.
4. Examine root plate.
5. Peel off the scales.
6. Cut enough of the apex of the bulb to reveal the inner fleshy scales.

Pests

Common Pests

Fusarium. Symptoms: Dark brown basal rot.

Source: BKD

Figure 5-62 *Fusarium* on *Muscari armeniacum*

Rare Pests

Penicillium. Symptoms: Blue-green mold, often on damaged areas.

Source: USDA-APHIS

Figure 5-63 *Penicillium* on *Muscari armeniacum*

Rhodococcus fascians. Symptoms: Fasciations and proliferation of small abnormal bulbs around the basal plate.

Source: BKD

Figure 5-64 *Rhodococcus fascians* on *Muscari*

Other Pests

Ditylenchus dipsaci. Symptoms: Discoloration of the leaf scales forming brown rings in a cross section.

Source: PPO

Figure 5-65 *Ditylenchus dipsaci* on *Muscari*[1]

1 Right two bulbs in cross section showing discolored rings; Left two bulbs in longitudinal section showing infected leaf scales.

Nose Rot. Symptoms: Soft rot of the central leaf scales, rarely penetrating beyond the middle of the bulb.

Source: BKD

Figure 5-66 Nose Rot on *Muscari*[1]

1 Left photo: cross section of neck showing discoloration of scales. Right photo: longitundinal section of bulb showing infected scales.

Sclerotium bulborum. Symptoms: Gray or grayish-brown areas on bulb, becoming dark brown; large brown sclerotia at apex. Causes a dry rot of the bulb.

No photo available.

Narcissus

Narcissus bulbs are more or less teardrop-shaped to nearly globose, and are highly variable in size; 1/4–4 inches (7–100 mm) in diameter at the base. Some varieties are irregular in shape because they divide frequently during the growing season, while others do not produce many daughter bulbs and are quite symmetrical. The bulbs are characterized by light to dark or reddish-brown or graying papery tunic marked with distinct dark veins, and a corky, large root plate. When cut, the bulb profusely bleeds a sticky mucilage and the cut surface eventually becomes black.

Source: USDA-APHIS

Figure 5-67 ***Narcissus***

Pest Risk Rating

The pest risk rating for *Narcissus* is 8–9.

Similar Looking Bulbs

Small varieties of *Narcissus* may resemble large *Galanthus*.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal bulbs for inspection.
3. Look at basal plate for evidence of internal feeders.
4. Examine outer scales for disease.
5. Peel a few dried scales from the base to reveal the fleshy scales. Discoloration at the base may indicate disease or mites.
6. Cut enough of the apex to remove dry leaf remnants and reveal inner fleshy scales. Look for nematode and mite symptoms.

Pests

Common Pests

Bruising. Symptoms: Spotty gray-black discoloration on exterior of bulb resulting from damage sustained during harvest and cleaning. Damage is restricted to outer scales. The papery tunic must be removed to observe the symptoms. Some varieties are extremely susceptible to bruising.

Source: USDA-APHIS

Figure 5-68 Bruising on *Narcissus*

Fusarium. Symptoms: Soft, dry, chocolate or purplish brown rot usually beginning at the base of the bulb, sometimes at the neck; often accompanied by white mycelia. Bulbs infected with *Fusarium* become soft and spongy. Tunic must be at least partially removed or the bulb must be cut in cross section to see the symptoms.

Source: USDA-APHIS

Figure 5-69 *Fusarium* on *Narcissus*[1] [2] [3]

1 Top left photo: Both bulbs are infected with *Fusarium*, but symptoms on bulb on the left are hidden by the outer tunic. Symptoms are evident on bulb on the right, with outermost tunic removed. Note white mycelia.

2 Top right photo: Cross section at middle of the bulb showing typical discoloration of tissue.

3 Bottom photo: Longitudinal section of bulb showing early stages of basal rot caused by *Fusarium*.

Rare Pests

Steneotarsonemus laticeps. Symptoms: Browning and peeling in crevasses between leaf scales; yellowish or brownish discoloration along scales. The lateral compression of the leaf scales in the bulb create small gaps between the scales at the edges (the “v” ends of the concentric rings). Normally the mites gain entry into the bulb through this channel. Bulbs must be cut at the neck to see the symptoms.

Source: (top photos) PPO; (bottom photo) USDA-APHIS

Figure 5-70 *Steneotarsonemus laticeps* on *Narcissus*[1 2 3]

1 Top left photo: Longitudinal section of bulb showing discoloration along the leaf scale caused by mite damage. Damage occurs on the outer/inner edge of leaf scale.

2 Top right photo: Cross section of bulb just below the neck shows advanced stages of *Steneotarsonemus* infestation. Affected areas are brown, becoming black as the tissue deteriorates.

3 Bottom photo: Cross section of bulb just below the neck showing early stages of infestation. Note early stages of infestation near the "v" ends of the leaf rings.

Other Pests

Aphelenchoides subtenuis. Symptoms: Discoloration at the base of the bulb causing some cracking at the basal plate, but the bulb does **not** decay and become soft. Discoloration of the leaf scales causing cream-colored or grayish (**not** brown) rings in cross section of the bulb. Only certain varieties are susceptible.

Source: BKD

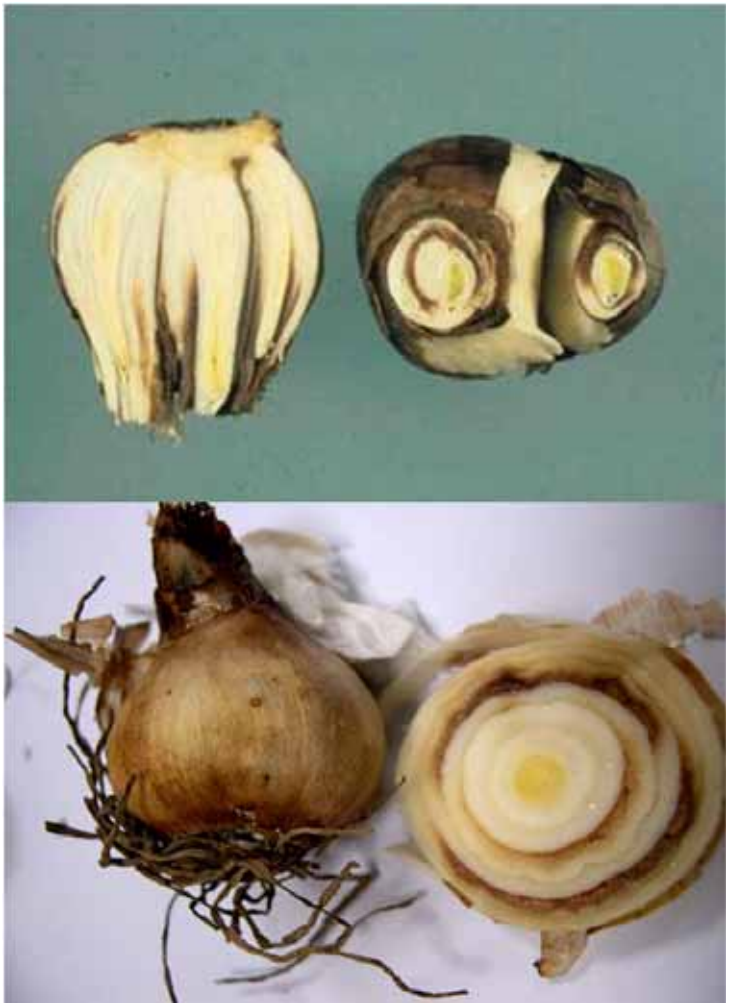
Figure 5-71 *Aphelenchoides subtenuis* on *Narcissus* Showing Basal Plate Beginning to Separate from Bulb

Botrytis narcissicola. Symptoms: Soft, dry, yellowish to dark brown rot in the neck of the bulb that may extend to the base. Black sclerotia develop on or between the scales.

Source: PPO

Figure 5-72 *Botrytis narcissicola* on *Narcissus*

Ditylenchus dipsaci. Symptoms: Discoloration of the leaf scales, forming brown rings in cross section of the bulb. Basal portion of bulb becomes soft and completely rotted.



Source: (top photo) PPO; (bottom photo) USDA-APHIS

Figure 5-73 *Ditylenchus dipsaci* on *Narcissus*[1] [2]

1 Top photo: Left bulb shows longitudinal section showing infected scales. Right bulb is a cross section of neck of bulb showing characteristic discoloration of infected scales.

2 Bottom photo: On left bulb note shrinking and cracking at basal plate. Cross section through middle of bulb on the right showing discolored scales in concentric rings.

Horse Teeth. Symptoms: A physiological disorder that causes the bulb to produce a proliferation of small, non-viable bulbs.

Source: USDA-APHIS

Figure 5-74 "Horse Teeth" on *Narcissus*[1]

1 Left: normal bulb. Right: bulb with "horse teeth."

Rhizoglyphus echinopus. Symptoms: Rather large secondary mites (0.5–0.9 mm long), normally found in decayed portions of the bulb.

No photo available.

Sclerotinia bulborum. Symptoms: Infected areas with masses of gray or white mycelia and black sclerotia.

No photo available.

Sunburn. Symptoms: Blackish discoloration on surface of the bulb beneath the tunic. Damage restricted to only outer scales, rarely penetrating deeper than three scales.

Source: PPO

Figure 5-75 Sunburn on *Narcissus*[1]

1 Top row: Bulbs with tunics removed, showing damage symptoms. Top left bulb also shows symptoms of bruising. Bottom left: Bulb with tunic only partially removed. Bottom right: Cross section showing damage restricted to outer two scales.

Syrphidae (bulb fly). Symptoms: A hole with frass at or near the base of the bulb. The bulb may become soft due to rotting and damage caused by the larva. Rotting may extend to the apex of the bulb and cutting the neck may reveal discolored tissue. Lesser Bulb Fly (*Eumerus strigatus*) is usually associated with bulbs that have been injured and are already decaying. Normally, more than one larva can be found. Larger Bulb Fly (*Merodon equestris*) is **not** associated with decaying bulbs and only one large larva is found.

Source: USDA-APHIS

Figure 5-76 Bulb Fly in *Narcissus*[1] [2] [3]

1 Top left and top right photos: Lesser Bulb Fly found in *Narcissus* bulbs that are already decaying.

2 Bottom left photo: Larger Bulb Fly. Larva is much larger than that of Lesser Bulb Fly. Note lack of decayed material in bulb.

3 Bottom right photo: Basal plate is cut off to show entry hole of the larva. Note the lack of other exterior symptoms.

Ornithogalum

Ornithogalum are teardrop-shaped to nearly globose bulbs with broad basal plates. Some species are nearly symmetrical while others are irregular due to the development of daughter bulbs. The top half of the external bulb scale is papery, the lower half is fleshy. Tunic can be white, gray, yellowish, or brown. The bulbs of some species may exude a somewhat sticky substance when damaged.

Source: USDA-APHIS

Figure 5-77 *Ornithogalum*[1]

1 Top left photo: *Ornithogalum thyrsoides*. Bottom left photo: *O. saundersiae*. Right photo: *O. arabicum*.

Pest Risk Rating

The pest risk rating for *Ornithogalum* varies according to species. The average rating is 4–6.

Similar Looking Bulbs

Ornithogalum is somewhat similar in size and shape to *Puschkinia*, but differs in tunic.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal bulbs for inspection.
3. Examine outer scales for diseases, especially *Sclerotinia bulborum*.
4. Peel back scales to look for aphids.
5. For *O. umbellatum*, cut enough of apex to expose fleshy scales. Brown ring or spot indicates *Ditylenchus dipsaci*.
6. For *O. thyrsoides* and *O. arabicum*, look for roughened galls at the root plate as an indication of *Meloidogyne*.

Pests

Common Pests

None

Rare Pests

Fusarium. Symptoms: Soft brownish rot usually beginning at the base of the bulb.

Source: BKD

Figure 5-78 *Fusarium* on *Ornithogalum*

Penicillium. Symptoms: Blue-green mold.

Source: USDA-APHIS

Figure 5-79 *Penicillium* on *Ornithogalum nutans*

Other Pests

Ditylenchus dipsaci. Symptoms: Discoloration of leaf scales forming brown rings in cross section of the bulb.

No photo available.

Sclerotinia bulborum. Symptoms: Infected areas with masses of gray or white mycelia and black sclerotia.

No photo available.

Oxalis

Oxalis bulbs are very distinctive. Most species have a hairy basal plate. The tunic and outer scales can be fibrous, papery, or somewhat succulent, and the inner scales can be gummy or sticky and yellowish in color. There are no serious problems with *Oxalis*.

Source: USDA-APHIS

Figure 5-80 *Oxalis adenophylla* (top left); *O. deppei* (top right); *O. triangularis* (bottom)

Pest Risk Rating

The pest risk rating for *Oxalis* is 3.

Similar Looking Bulbs

There are none.

Inspection Procedures

1. Check consignment and verify lot.

2. Check for soil contamination and select abnormal bulbs for inspection.
3. Peel back outer scales from apex to the base to reveal the brown, sticky inner scales. Dark brown necrotic spots indicate the presence of nematodes.

Pests

Common Pests
None

Rare Pests
None

Other Pests
Aphelenchoides subtenuis (commonly found on O. deppi, O. sasiandra). Symptoms: Discoloration of the basal area.

No photo available.

Ditylenchus destructor (commonly found on O. deppi, O. lasiandra). Symptoms: Discoloration of the leaf scales.

No photo available.

Fusarium oxysporum (commonly found on O. adenophila). Symptoms: Brownish rot, usually basal.

No photo available.

Penicillium (commonly found on O. adenophila). Symptoms: Blue-green mold.

No photo available.

Puschkinia

Puschkinia are ovoid or teardrop-shaped, mostly symmetrical bulbs about 0.75–1 inch (2–2.5 cm) in diameter and 1 inch (2.5 cm) tall. They are characterized by a whitish or dirty, papery tunic. In cross section, air pockets or locules are present in concentric rings. The flesh is white and translucent.

Source: USDA-APHIS

Figure 5-81 ***Puschkinia libanotica***

Pest Risk Rating

The pest risk rating for *Puschkinia* is 5–6.

Similar Looking Bulbs

Puschkinia bulbs may resemble some varieties of *Allium* or *Ornithogalum* (especially *O. balancae*) bulbs in shape.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal bulbs for inspection.
3. Examine outer scales for Sclerotinia bulborum.
4. Cut enough of apex to reveal inner fleshy scales. Yellowish brown spots indicate *Ditylenchus dipsaci*.

Pests

Common Pests

None

Rare Pests

Penicillium. Symptoms: Blue-green mold, usually the result of poor storage conditions.

Source: USDA-APHIS

Figure 5-82 *Penicillium* on *Puschkinia libanotica*

Other Pests

Ditylenchus dipsaci. Symptoms: Discoloration of base of bulb, extending towards apex. Discoloration of leaf scales, forming rings in cross section of bulb; cross section at apex show yellowish-brown spots.

Source: BKD

Figure 5-83 *Ditylenchus dipsaci* on *Puschkinia libanotica*[1]

1 Note the brown discoloration extending from the basal plate.

Sclerotinia bulborum. Symptoms: Infected areas with gray or white mycelia and black sclerotia.

No photo available.

Scilla

Several species of *Scilla* are commonly grown in the Netherlands. The most popular are *S. siberica* and *S. campanulata*. *S. siberica* bulbs are globose to teardrop-shaped and symmetrical with one or two reddish, paper tunic. The loose, crumbling, fine roots on the base break off easily. When damaged, the bulb exudes a sticky substance. *S. campanulata* are very irregular, lumpy, squat bulbs with thick, fleshy outer scales. The loose, crumbling, fine roots on the base break off easily. The root plate is recessed or flush with the base of the bulb, and the base of the bulb is expanded. *S. mischtschenkoana* resembles *S. siberica*, but the outer tunic is whiteish and the inner layers can be reddish. *S. bifolia* is a much smaller bulb resembling *Puschkinia* or some varieties of *Ornithogalum*.

Source: USDA-APHIS

Figure 5-84 *Scilla*[1] [2]

1 Top left photo: *Scilla siberica*. Top right photo: *Scilla campanulata*.

2 Bottom photo, top row: *Scilla meschtschenkoana*; bottom photo, bottom row: *Scilla bifolia.*

Pest Risk Rating

Scilla has a pest risk rating of 4–5.

Similar Looking Bulbs

Some varieties of *Muscari* may resemble *Scilla mischtschenkoana* while other varieties of *Muscari* and *Chinodoxa* may resemble *S. bifolia*. *Scilla siberica* resembles small bulbs of *Hyacinthus* varieties with red tunics.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal bulbs for inspection.
3. Examine outer scales for disease symptoms.
4. Cut enough of the apex to reveal inner fleshy scales (25 bulbs). A brown ring indicates *Ditylenchus dipsaci*.

Pests

Common Pests

None

Rare Pests

Penicillium. Symptoms: Blue-green mold below the tunic.

Source: USDA-APHIS

Figure 5-85 *Scilla* with *Penicillium*

Other Pests

Aspergillus niger. Symptoms: Black mold

Source: USDA-APHIS

Figure 5-86 *Aspergillus* on *Scilla peruviana*

Ditylenchus dipsaci. Symptoms: Discoloration of leaf scales, forming a brown ring in cross section of the bulb.

No photo available.

Fusarium. Symptoms: Brown rot usually beginning at the base of the bulb.

No photo available.

Sclerotinia bulborum. Symptoms: Gray or white mycelia and black sclerotia.

Source: USDA-APHIS

Figure 5-87 *Sclerotinia bulborum* on *Scilla siberica*[1]

1 Note black sclerotia.

Xanthomonas campestris pv. hyacinthi. Symptoms: Brownish-yellow discoloration of the core of the bulb (central scales).

Source: BKD

Figure 5-88 *Xanthomonas campestris pv hyacinthi* on *Scilla*

Sprekelia

Sprekelia are ovoid or teardrop-shaped with a distinct long "neck." The 1-1/2–2 inch (38–50 mm) long bulb is symmetrical with reddish-brown outer papery tunic. The root plate is thick and roots are thin, short, and fibrous. If the bulb is cut or peeled, the inner fleshy scales are fibrous, white to gray in color, and slightly sticky.

Source: USDA-APHIS

Figure 5-89 ***Sprekelia***

Pest Risk Rating

The pest risk rating for *Sprekelia* is 7.

Similar Looking Bulbs

Narcissus

Inspection Procedures

1. Check consignment and verify lot.

2. Check for soil contamination and select abnormal bulbs for inspection.
3. Examine outer scales for diseases. Examine fleshy scales for mites.

Pests

Common Pests

Steneotarsonemus laticeps. Symptoms: Reddish spots at edges of scales in cross section of neck of bulb; reddish streaks along the scales in longitudinal section of bulb.

Source: BKD

Figure 5-90 Longitudinal Section of *Sprekelia* Bulb Showing Characteristic Red Discoloration of Scales Affected by *Steneotarsonemus laticeps*

Rare Pests

Stagonosporopsis curtisii. Symptoms: Reddish-brown spots developing into lesions, usually with distinct margins.

No photo available.

Other Pests

Ditylenchus dipsaci. Symptoms: Discoloration of leaf scales, forming rings in cross section of bulb.

No photo available.

Tigridia

Tigridia are asymmetrical bulbs, 1 to 1-1/2 inches (38–50 mm) in length, with tightly fitting papery leaf scales. The bulb often consists of two smaller bulbs wrapped tightly together by the leaf scales. The tunic is gray-brown to brown in color, leathery, and is often twisted around the bulb. *Tigridia* are shipped in the winter and spring.

Source: USDA-APHIS

Figure 5-91 ***Tigridia***

Pest Risk Rating

The pest risk rating for *Tigridia* is 5–6.

Similar Looking Bulbs

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Check soil for contamination and select abnormal bulbs for inspection.
3. Examine outer scales for diseases.
4. Examine base for nematode symptoms. Brown to black streaking indicates the presence of *Ditylenchus destructor*.
5. Peel back scales at apex to look for aphids.

Pests

Common Pests

None

Rare Pests

Aphids. Symptoms: No distinct symptoms; live insects must be found. Infestations of aphids occur during storage when populations build up from a few infested bulbs.

No photo available.

Fusarium. Symptoms: Brown rot at base of bulb.

Source: USDA-APHIS

Figure 5-92 *Tigridia* with *Fusarium*[1]

1 Left photo: View of base of bulbs. Right photo: Longitudinal section.

Penicillium. Symptoms: Blue-green mold.

No photo available.

Other Pests

Ditylenchus destructor. Symptoms: Brown to black streaking from base of bulb.

Source: J. Heuperman

Figure 5-93 *Ditylenchus destructor* on *Tigridia*

Tulipa

Tulipa are teardrop-shaped with a prominent, lopsided root plate slanted down on the side of the bulb. The tunic is either tough and leathery, papery or smooth, and red to tan to dark brown. In botanical tulips, the apex of the bulb is often topped with a cottony material and the tunic is very hard and difficult to break open. Do **not** needlessly peel off the tunics. Examine the bulb at cracked areas of the tunic.

Source: USDA-APHIS

Figure 5-94 Four Different Types of *Tulipa*

Pest Risk Rating

The pest risk rating for *Tulipa* is 8.

Similar Looking Bulbs

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal bulbs for inspection.
3. Examine base for disease and nematode symptoms. Cracking of tunic or shriveling of fleshy parts may indicate an infection is present. Carefully cut or peel away tunic to examine necrotic areas.
4. Peel bulbs with loose tunics to look for nematode and *Aceria* symptoms.

Pests

Common Pests

Fusarium oxysporum tulipae. Symptoms: Cream colored lesions usually around the base and usually forming concentric rings as it expands, accompanied by a musty, sour odor.

Source: (left photo) PPO; (right photo) USDA-APHIS

Figure 5-95 *Fusarium oxysporum tulipae* on *Tulipa*[1] [2]

1 Left photo: left bulb showing *Fusarium* infection beginning on side of bulb. Right bulb showing infection starting at apex.

2 Right photo: advanced stages of *Fusarium.*

Mechanical Damage. Symptoms: Blemishes, scars, and abrasions due to injury sustained during harvest and cleaning, occurring mostly where the tunic had been removed. Such damage can be progressive as the bulb reacts to the injury and may sometimes result in chalking. The various forms of mechanical injury are often mistaken for *Fusarium*.

Source: USDA-APHIS

Figure 5-96 Mechanical Damage on *Tulipa*

Penicillium. Symptoms: Blue-green mold, often secondary on damaged areas.

Source: PPO

Figure 5-97 *Penicillium* on Damaged Areas of *Tulipa*

Rare Pests

Aceria tulipae. Symptoms: Red, or more rarely, yellow or cream colored discoloration depending on flower color, and mealy texture on the surface of fleshy scales. In some cases, the discoloration may be very slight, but the surface of the bulb, which should be shiny, is dull. Tunic must be partially removed to see the symptoms.

Source: (top left and right photos) PPO; (bottom photo) nVWA

Figure 5-98 *Aceria tulipae* on *Tulipa*[1] [2] [3]

1 Top left photo: Right bulb is healthy; center bulb shows characteristic red discoloration and left bulb shows the dull, cream colored discoloration.

2 Top right photo: top bulb is healthy, notice the shiny appearance. Bottom right bulb lacks the typical discolorations, but the surface is dull and the bulb is almost totally symptomatic. The somewhat vertical streak on the left side of the bulb is due to mechanical damage. Left bottom bulb has two shiny areas at the center and near the apex indicating normal healthy tissue, but the rest of the bulb is dull and affected.

3 Bottom photo: heavily infested bulbs displaying typical symptoms.

Bacterial Snot, Nose Rot. Symptoms: Wet rot on tip of bulb, rot is gray with brown border, becoming darker brown with age. In many instances only the outer scales are affected. These affected scales usually dry up and become "chalked" but the bulb remains healthy. Usually occurs during early stages of storage.

Source: (top left photo) PPO: (top right and bottom photo) USDA-APHIS

Figure 5-99 Nose Rot on *Tulipa*[1] [2] [3]

1 Top left photo: typical fresh symptoms of nose rot. .

2 Top right photo: bulbs with affected outer scales beginning to dry out.

3 Bottom photo: cross section of bulb showing nose rot damage to outer scales and healthy inner scales.

Chalking. Symptoms: Hard, often chalky outer scales. Chalking is often caused when bulbs in the field suffer from lack of oxygen toward the end of the growing season and the outer scales begin to rot. When harvested and during the drying process, the scales dry out and become chalked. Bulbs suffering from nose rot can become chalked.

Source: nVWA

Figure 5-100 Chalking on *Tulipa*[1]

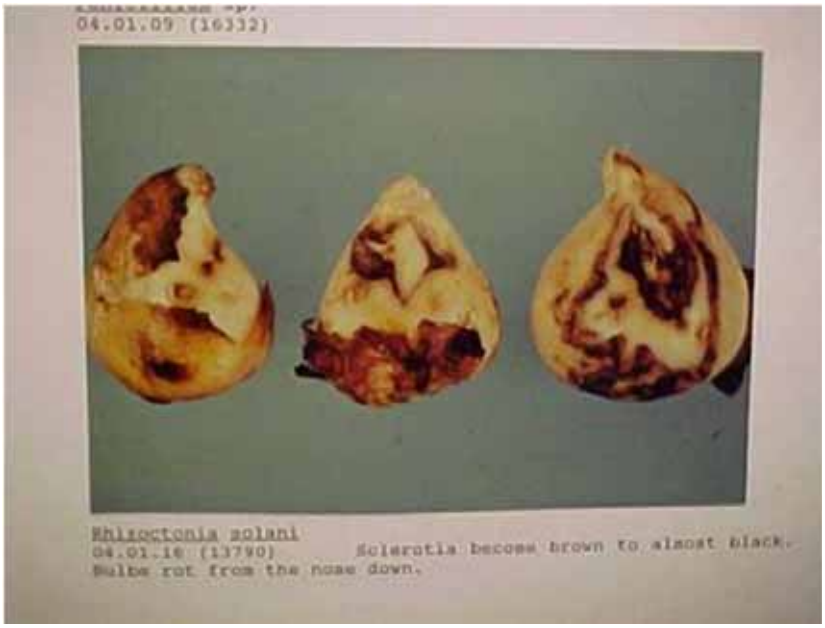
1 Characteristic white chalking evident on left two bulbs. Outer scales of right two bulbs are brittle but **not** chalky white.

Curtobacterium flaccumfasciens pv. oortii. Symptoms: Cracked tunic with yellow spots on bulb and yellow rot of fleshy scales. *Corynebacterium oortii* is a synonym.

Source: (top photos) BKD: (bottom photo) PPO

Figure 5-101 *Tulipa* with *Curtobacterium flaccumfasciens pv. oortii*

Rhizoctonia solani. Symptoms: Heavy cracking of tunic with brown-black sclerotia originating from the apex of the bulb.



Source: J. Heuperman

Figure 5-102 *Rhizoctonia solani* on *Tulipa*

Sclerotinia bulborum. Symptoms: Black rot that forms sclerotia between scales.

Source: J. Heuperman

Figure 5-103 *Sclerotinia bulborum* on *Tulipa*

Other Pests

Aphids. Symptoms: Symptoms are **not** distinctive. To make a rejection, live insects must be found. Occurs mostly when bulbs begin to sprout and where they have been improperly stored near areas where insects are able to enter the warehouse.

Source: PPO

Figure 5-104 Aphids on *Tulipa* (note gray adult aphids)

Aspergillus. Symptoms: Black mold beneath the tunic. Bulb is also severely "chalked."

Source: USDA-APHIS

Figure 5-105 *Aspergillus* on *Tulipa*

Botrytis tulipae. Symptoms: Small to large depressed lesions with distinct edges and yellowish brown to blackish sclerotia on outer fleshy scales. Lesions run together anywhere on bulb.

Source: PPO

Figure 5-106 *Botrytis tulipae* on *Tulipa*

Ditylenchus destructor. Symptoms: Yellowish to dark brown discoloration radiating in streaks from the base. Tunic must be partially removed to see symptoms.

Source: nVWA

Figure 5-107 *Ditylenchus destructor* on *Tulipa*[1]

1 Characteristic streaking from base is evident in the bulb on the right.

Ditylenchus dipsaci. Symptoms: Yellowish brown rot radiating fan-like from the base. Difficult to distinguish from *D. destructor*. Samples must be sent in for identification.

Source: nVWA

Figure 5-108 *Ditylenchus dipsaci* on *Tulipa*[1]

1 Infection is well-advanced in bulb on left, with the basal plate almost completely rotted.

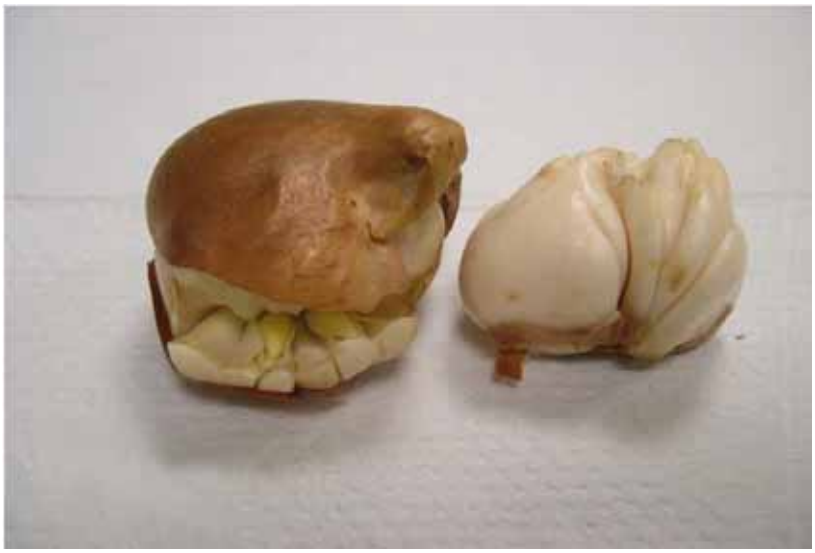
Gummosis. Symptoms: Clear or amber-like gummy ooze. This is usually a physiological reaction to mechanical injury.

Source:

Figure 5-109 Gummosis on *Tulipa*[1]

1 Note ooze at apex of bulb.

Horse Teeth. Symptoms: A degeneration of the bulb resulting in a proliferation of small, non-viable bulblets. In severe cases, the mother bulb degenerates into smaller bulbs. To be considered actionable, the mother bulb must comprise less than 50 percent of the total mass.

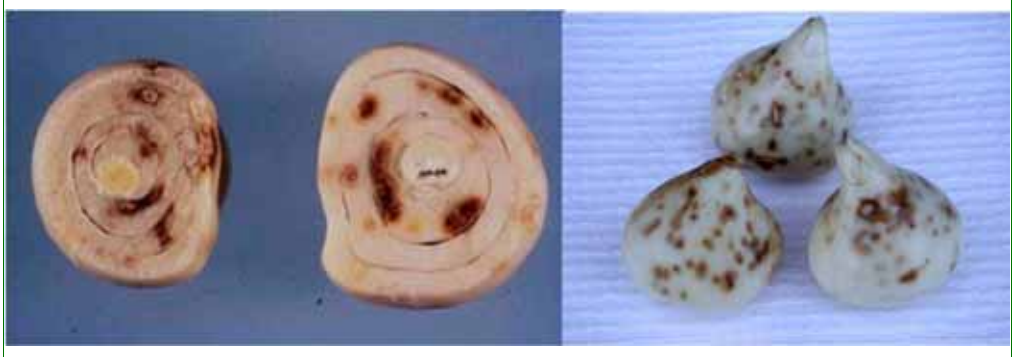


Source: USDA-APHIS

Figure 5-110 "Horse Teeth" on *Tulipa*[1]

1 Bulb on the right is severely infected.

Pseudo-kirkstip. Symptoms: Scab-like lesions on exterior of bulb, with lesions on interior. A quality issue; does **not** affect flowering. Symptoms of pseudo-kirkstip are very similar to those of Cucumber Mosaic Virus and samples must be sent to the laboratory for confirmation. Tulip variety 'Orange Bouquet' is highly susceptible to pseudo-kirkstip.



Source: (left photo) PPO: (right photo) BKD

Figure 5-111 Pseudo-kirkstip on *Tulipa*[1 2]

1 Left photo: cross section of bulbs showing interior symptoms. Bulb on right is affected with pseudo-kirkstip. Bulb on right has Cucumber Mosaic Virus..

2 Right photo: exterior symptoms showing dark lesions on outer scales.

Septocylindrium. Symptoms: Outer layer of the outer scales becomes light brown. Only occurs on the "belly" side of the bulb. Infections do **not** progress when bulbs are in storage.

Source: PPO

Figure 5-112 *Septocylindrium* on *Tulipa*

Sclerotium tuliparum. Symptoms: Gray or purplish-gray soft rot, usually at the nose and affecting the growing shoot. Large brown sclerotia occurring at apex of bulb. Causes a dry rot.

No photo available.

Skin Diseases. Symptoms: Physiological disorders manifested by discolorations and blemishes that are restricted to the outer leaf scale. If the tunic is thin, a grayish tint may be visible through the tunic. Interior of bulb remains healthy. There are several types of skin diseases; all are quality, non-phytosanitary disorders.

Source: USDA-APHIS

Figure 5-113 Skin Diseases in *Tulipa*[1] [2]

1 Left photo: right bulb showing exterior symptoms somewhat resembling those of *Fusarium*. Left bulb showing dried chalky outer scale but healthy interior scales.

2 Right photo: normally the tunic must be removed to see symptoms; however, symptoms might be visible if the tunic is thin. On the right bulb, slight gray tint on the right side indicates discoloration of inner scales. Left bulb with gray tint on upper half of bulb.

Blue Growth: Symptoms: Symptoms can be mistaken for mechanical damage. "Blue Growth" is caused by exceptionally rapid growth during growing season.

Source: USDA-APHIS

Figure 5-114 Skin Disease "Blue Growth" in *Tulipa*

Suffocation. Symptoms: *Fusarium*-like exterior discoloration. The outer scale become brittle and the bulb eventually rots from the inside. Interior of bulb has a musty-sweet odor. A physiological disorder due to excessively wet growing conditions. The bulb is ultimately destroyed, but this is a quality, **non**-phytosanitary disorder.

Source: USDA-APHIS

Figure 5-115 Suffocation Disorders in *Tulipa*[1]

1 Exterior symptoms somewhat resemble skin disease and the outer scales become brittle and chalky, but unlike skin diseases, the interior usually rots completely.

Zephyranthes

Zephyranthes bulbs are teardrop-shaped with a long neck. The bulb is 2–2-1/2 inches (51–64 mm) long, about three times longer than it is wide. The gray-brown tunic is soft and papery or fibrous. The root plate is small. The flesh of the bulb is whitish in color, fibrous, and somewhat sticky.

Source: USDA-APHIS

Figure 5-116 Zephyranthes

Pest Risk Rating

The pest risk rating for *Zephyranthes* is 5–6.

Similar Looking Bulbs

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal bulbs for inspection.
3. Examine outer scales for diseases.

4. Examine base for entrance holes of bulb flies.
5. Peel back outer skins to reveal inner fleshy leaves. Red streaking indicates *Steneotarsonemus*.
6. Cut enough of apex to reveal inner fleshy scales. Reddish ring indicates the presence of *Ditylenchus dipsaci*.

Pests

Common Pests

None

Rare Pests

None

Other Pests

Ditylenchus dipsaci. Symptoms: Reddish ring in cross section of neck of bulb.

No photo available.

Fusarium. Symptoms: Brown rot usually beginning at the base of the bulb.

No photo available.

Stagonosporopsis curtisii. Symptoms: Reddish-brown rotting of scales around the apex.

No photo available.

Steneotarsonemus laticeps. Symptoms: Reddish pinpoints at edges of scales in cross section of neck of bulb; reddish streaks along leaf scales in longitudinal section of bulb.

No photo available.

Chapter

6

Tubers

Contents

Introduction

Tubers and tuberous roots are swollen underground stems. They grow upright or horizontally and are sometimes enlarged at the growing tip. The nodes, or eyes, produce new shoots or plants. When tubers grow, they either just expand or bud new tubers from the old one.

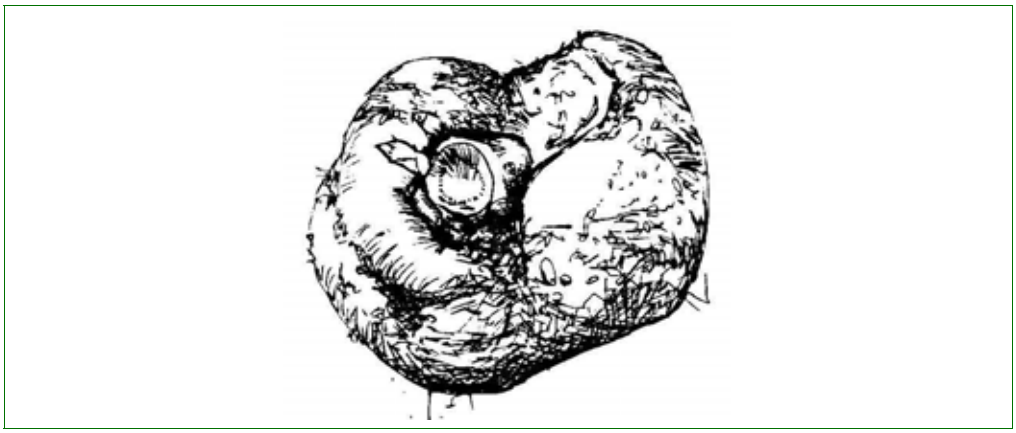


Figure 6-1 Sketch of a Begonia Tuber

The information in this chapter includes the pest risk rating for each bulb. The ratings are:

Table 6-1 Pest Risk Ratings for Tubers

Pest Risk	Rating
1–2	Very low risk. Verify the genus in the shipment. Inspect if time is available
3–4	Low risk. Inspect if time is available
5–6	Moderate risk. Provide normal inspection
7–8	High risk. Inspect thoroughly
9–10	Very high risk. Inspect very thoroughly

Identification Procedure

Determine the length of the bulb you are identifying. Compare it with the photographs in this chapter and select the description that fits your bulb. Each description includes inspection procedures and pests of concern.

Anemone

Anemone are small tubers, 0.5–0.75 inches (12–20 mm) in thickness, about 0.5–1 inch (12–25 mm) across, wrinkled and lumpy and grey-brown to black in color. Tubers can be dark and somewhat rounded and lumpy (*A. blanda*) or brown, knobby and lobed (*A. coronaria*). There are no roots and because the tubers are dried, the flesh is very difficult to cut. Very young tubers may be shipped. They are called pits and resemble small chocolate chips. Very few problems are associated with *Anemone*. Occasionally, soil can be found on lots that are not sufficiently washed.

Source: USDA-APHIS

Figure 6-2 ***Anemone coronaria***

Pest Risk Rating

The pest risk rating for *Anemone* is 2.

Similar Looking Tubers

Eranthis is similar in color and size. However, the shape of *Eranthis* is usually rounder and the flesh is easily cut. *Eranthis* are shipped in the summer. *Anemone* are shipped all year.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal tubers for inspection.
3. If the roots are attached, look for knots. Knots indicate *Sclerotinia tuberosa*.

Pests

Common Pests

None

Rare Pests

None

Other Pests

Penicillium. Symptoms: Blue-green mold.

No photo available

Sclerotinia tuberosa. Symptoms: Knots

No photo available

Arum

Arum are large tubers, 3–6 inches (76–152 mm) in diameter, discoid to subglobose, or elongate and very warty in appearance, with a light brown color. The roots emerge from the base of the large terminal bud. There is **no** root plate.

Source: USDA-APHIS

Figure 6-3 ***Arum italicum***

Pest Risk Rating

The pest risk rating for *Arum* is 2–3.

Similar Looking Tubers

There are none. The tuberous rhizomes of *Zantedeschia* are similar.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal tubers for inspection.
3. Squeeze tuber. Softness indicates the presence of *Erwinia*.
4. Peel back any leaf bases and examine for thrips and aphids.

Pests

Common Pests

None

Rare Pests

Erwinia aroidea. Symptoms: Soft rot; strong, fetid odor.

Source: PPO

Figure 6-4 Advanced Stages of *Erwinia aroidea* Infection on *Arum italicum*

Other Pests

Aphids. Symptoms: New buds or shoots may be sticky. Only appears on sprouting tubers and when the tubers are stored in areas where insects can gain entry into the warehouse.

No photo available

Thrips. Symptoms: Russeting. Only on new growth and where tubers are improperly stored.

No photo available

Begonia

Begonia tubers are lumpy, subglobose or discoid, fleshy structures varying in diameter from 1.2–4 inches (32–102 mm). There is normally a depression at the apex where the buds emerge. Normally, the tuber would be covered by a dense mat of roots, but most of the roots are usually removed during cleaning. Soil or growing media can be occasionally found in the mat of roots or in the apical depression. The tuber lacks a root plate. Storage rot and soil are the most common causes of rejection in *Begonia*.

Source: USDA-APHIS

Figure 6-5 ***Begonia***

Pest Risk Rating

The pest risk rating for *Begonia* is 3–4.

Similar Looking Tubers

Gloxinia is similar.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination in the apical depression and in the dense mat of roots and select abnormal tubers for inspection.
3. Squeeze tuber. Softness and wrinkled, sunken edges on the tuber may indicate disease or storage rot.
4. Look at roots and root scars for symptoms of nematodes.

Pests

Common Pests

Storage Rot. Symptoms: Soft rot but lacking fetid odor. Discoloration of tissue. The main cause of storage rot are *Pythium* and *Phytophthora*.

Source: USDA-APHIS

Figure 6-6 Cross Sections of *Begonia* Showing Examples of Storage Rot [1]

1 The tuber on the right is healthy; tubers in center and left suffer from storage rot.

Rare Pests

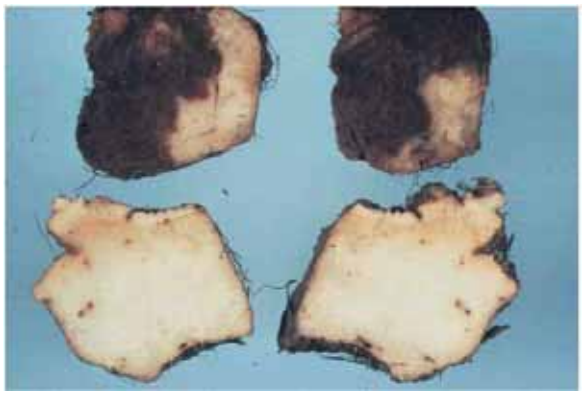
Botrytis. Symptoms: Soft rot with white to gray mycelia.

Source: BKD

Figure 6-7 *Botrytis* on *Begonia*

Other Pests

Erwinia. Symptoms: Soft rot and fetid odor.



Source: PPO

Figure 6-8 *Erwinia chrysanthii* on *Begonia*

Cyclamen

Cyclamen are flattened, subglobose or discoid tubers varying in size from 1–5 inches (2.5–12.5 cm) in diameter. They are dark red-brown to brown in color with smooth, leathery, rough, or wrinkled skin. The flesh is potato-like. The roots are fibrous, emerging from the bottom, sides, or near the top of the tuber depending on species. There are **no** serious problems with *Cyclamen*.

Source: USDA-APHIS

Figure 6-9 Three Different Species of *Cyclamen*

Pest Risk Rating

The pest risk rating for *Cyclamen* is 3–4.

Similar Looking Tubers

Gloxinia may resemble in size and shape, but the *Gloxinia* skin is easier to cut.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal tubers for inspection.

3. Squeeze the tuber. Softness and wrinkled, shrunken edges on the tuber may indicate disease.
4. Examine for disease and borer tunneling.
5. Examine roots and root scars for nematode symptoms.

Pests

Common Pests

None

Rare Pests

Botrytis cinerea. Symptoms: Gray mold and brown wet decay of tissue.

Source: BKD

Figure 6-10 *Botrytis cinerea* on *Cyclamen*

Other Pests

None

Dahlia

Dahlia has a root crown with a cluster of pendulous, spindle-shaped or fat tubers attached to the nodes of the stem. The flesh is white or yellow. Some varieties have densely clustered tubers that may trap soil or weeds. Soil and weeds are the most frequent reasons for rejection in *Dahlia*.

Source: USDA-APHIS

Figure 6-11 ***Dahlia***

Pest Risk Rating

The pest risk rating for *Dahlia* is 7–8.

Similar Looking Tubers

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and weeds, and select abnormal tubers for inspection, especially those with tumors or growths.
3. Examine crown for galls.
4. Examine fleshy roots and root crown.

Pests

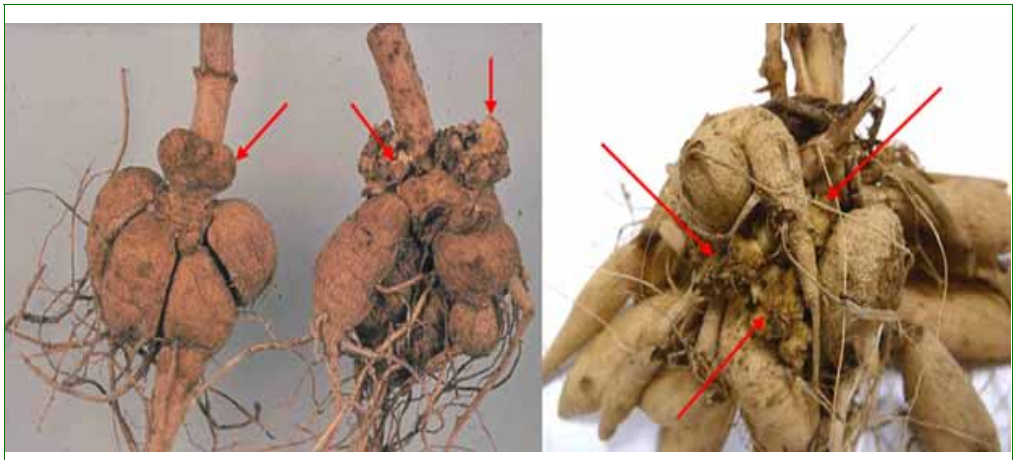
Common Pests

Meloidogyne. Symptoms: Watery, brown spots developing into bumps or swelling on roots.

Source: PPO

Figure 6-12 *Dahlia* with Characteristic Swellings of *Meloidogyne*

Rhodococcus fasciens. Symptoms: Spongy cauliflower-like fasciations usually at the root crown.



Source: (left photo) PPO; (right photo) USDA-APHIS

Figure 6-13 Examples of *Dahlia* Infected with *R. fasciens*[1] [2]

1 Left photo: The *Dahlia* on the left is infected with *Agrobacterium tumefasciens*, the *Dahlia* on the right is infected with *Rhodococcus fasciens*.

2 Right photo: *Dahlia* with *R. fasciens* emerging from between the tubers.

Top rot (wet rot; water damage). Symptoms: Progressive wet rot beginning at the stem and continuing into the root crown and causing decay where the new shoots would emerge. Caused by insufficient drying after harvest.

Source: USDA-APHIS

Figure 6-14 *Dahlia* with Top Rot[1]

1 In this photo, the long fibers are the fibrous remnants of old roots and tubers.

Rare Pests

Agrobacterium tumefasciens. Symptoms: Small to large tumors, usually at the crown. Tumors are smooth and often resemble the tuberous roots but lack roots of their own.

Source: PPO

Figure 6-15 *Agrobacterium tumefasciens* on *Dahlia*

Frost Damage. Symptoms: Softness of tubers and discoloration of flesh.

Source: PPO

Figure 6-16 Frost Damage on *Dahlia*[1]

1 The sample on the left is healthy; the sample on the right shows typical discoloration from frost damage.

Penicillium. Symptoms: Blue-green mold. Generally caused by insufficient drying and improper storage conditions.

Source: USDA-APHIS

Figure 6-17 *Penicillium* on *Dahlia*

Other Pests

Ditylenchus destructor. Symptoms: Linear cracking and necrosis of tubers.

Source: PPO

Figure 6-18 *Ditylenchus destructor* on *Dahlia*[1]

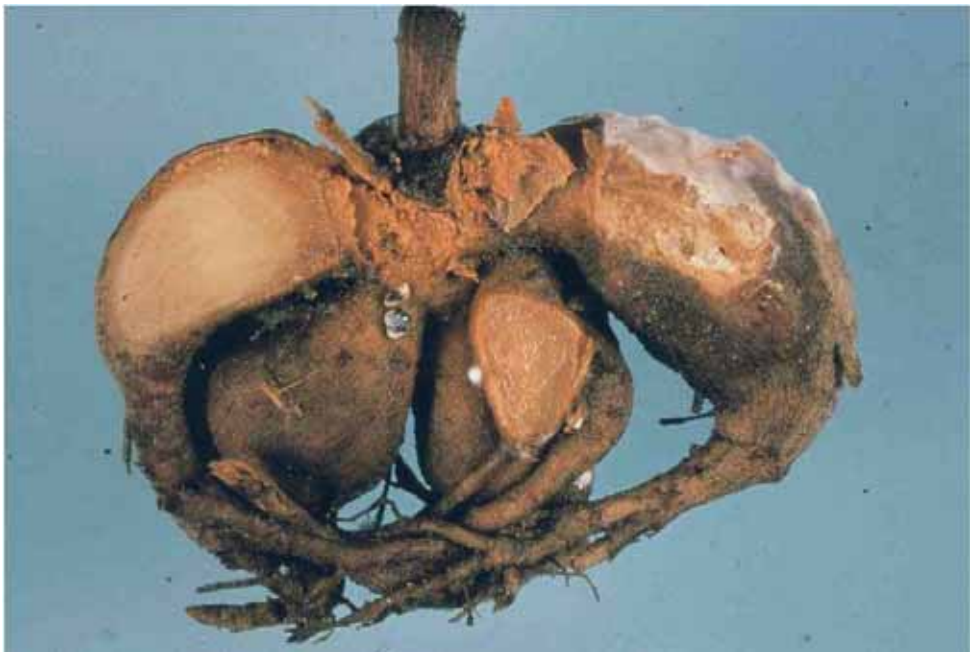
1 The sample on the left is severely infected; blackened tuberous roots are already deteriorating. The sample on the right shows linear cracking of the tuberous roots.

Erwinia. Symptoms: Soft rot, normally with fetid odor.

Source: PPO

Figure 6-19 *Erwinia* on *Dahlia*

Sclerotinia sclerotiorium. Symptoms: Soft rot with fuzzy white mycelia and black sclerotia.



Source: PPO

Figure 6-20 Advanced Stage of *Sclerotinia sclerotiorium* Infection in *Dahlia* [1]

1 The specimen is already deteriorating; note white mycelia.

Eranthis

Eranthis tubers are small in size, about 0.25–0.5 inches (6–13 mm) thick, and 0.5–.75 inches (13–19 mm) in diameter. They are usually round, flattened, grey-brown to black in color, and wrinkled but easily cut. The basal root plate may be small and show a few roots. They are shipped in the early summer. There are no serious problems with *Eranthis*.

Source: USDA-APHIS

Figure 6-21 ***Eranthis***

Pest Risk Rating

The pest risk rating for *Eranthis* is 2.

Similar Looking Tubers

Both *Anemone* and *Eranthis* are the same color and texture. However, *Anemone* tubers are extremely hard and *Eranthis* are somewhat more fleshy. *Eranthis* tend to be plumper than *Anemone*. *Anemone* are shipped all year. *Eranthis* are shipped in the summer.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal tubers for inspection.

3. Examine tuber for disease symptoms.

Pests

Common Pests

None

Rare Pests

Fusarium. No photo available.

Penicillium. Symptoms: Blue-green mold.

No photo available.

Other Pests

None

Gloriosa

Gloriosa tubers resemble a long, thin potato with smooth, light brown skin. The tuber is white and fleshy. *Gloriosa* is occasionally shipped in the winter.

Source: USDA-APHIS

Figure 6-22 *Gloriosa*

Pest Risk Rating

The pest risk rating for *Gloriosa* is 3.

Similar Looking Tubers

Tubers of *Littonia* are similar, but are irregular in shape.

Inspection Procedures

1. Check consignment and verify lot.
2. Check for soil contamination and select abnormal tubers for inspection.
3. Examine outer skin for disease.

Pests

Common Pests

None

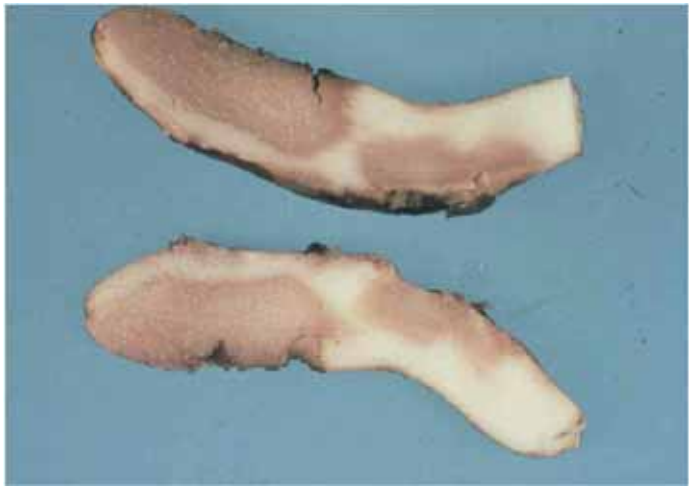
Rare Pests

None

Other Pests

Erwinia. Symptoms: Soft brown rot accompanied by a fetid odor.

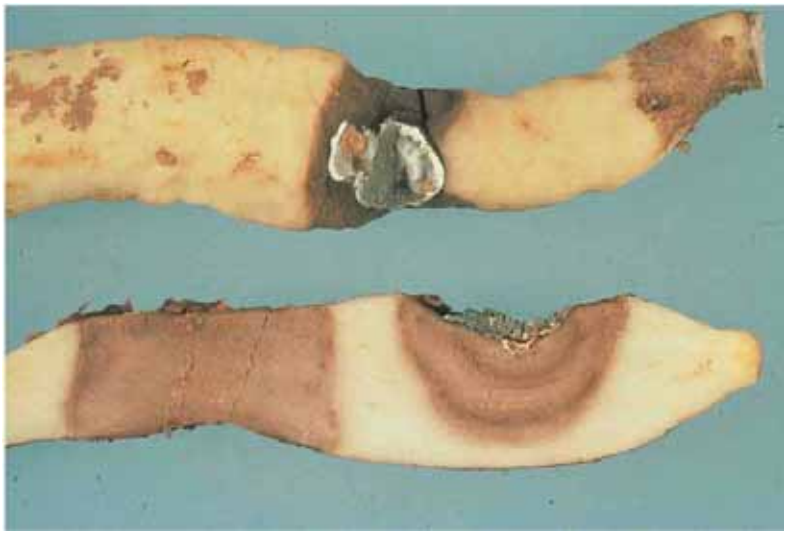
Phytophthora. Symptoms: Brown to black wet rot with no fetid odor.



Source: PPO

Figure 6-23 *Erwinia* and *Phytophthora* on *Gloriosa*

Penicillium. Symptoms: Blue-green mold.



Source: PPO

Figure 6-24 *Penicillium* on *Gloriosa* Tubers

Rhizoglyphus. Symptoms: Large secondary mites found in decaying tissue. Mites will also tunnel into the tubers forming small, disjointed channels. This is mostly a storage problem.

Source: PPO

Figure 6-25 *Rhizoglyphus* in *Gloriosa*

Rhodococcus. Symptoms: Tumor-like fasciations along the root.

Source: PPO

Figure 6-26 *Rhodococcus* on *Gloriosa*

Ranunculus

Ranunculus are very distinctive. They are small brown tubers, 0.75–1 inch (20–25 mm) in length, and appear as a tiny cluster of hard fleshy roots, topped with a hairy crown and three to five minute buds. When dried, they shrink to nearly half the size and become hardened. There are no phytosanitary problems with *Ranunculus*.

Source: USDA-APHIS

Figure 6-27 *Ranunculus*

Pest Risk Rating

The pest risk rating for *Ranunculus* is 2–3.

Similar Looking Tubers

There are none.

Inspection Procedures

1. Check consignment and verify lot.
2. Look for soil contamination and select abnormal tubers for inspection.
3. Examine crown and tubers for disease symptoms.

Pests

Common Pests
None

Rare Pests
None

Other Pests
None

Bulb Identification

Glossary

Use this glossary to find the meaning of specialized words, abbreviations, acronyms, and terms used by USDA-APHIS-PPQ-IRM-Information Services and Manuals Unit. To locate where in the manual a given definition, term, or abbreviation is mentioned, refer to the Index.

Definitions, Terms, and Abbreviations

annulate tunic. a tunic provided with or composed of rings

axil/axillary. (a) the upper angle that a lateral organ, such as a petiole or peduncle, makes with the axis or stem that bears it (b) angle between the upper surface of a leaf and the stem

axillary bud. bud originating in the leaf axil

BKD. Bloembollenkeuringsdeinst

corm. (a) a solid, swollen part of a stem, usually subterranean (b) short, vertical underground stem surrounded by thin, papery leaves

discoid. having a disc-shaped, flat, circular form

fasciated/fasciations. abnormally flattened or coalesced as in certain stems

globose. spherical, shaped like a globe

internode. the part of a stem between two adjacent nodes

mycelium. the vegetative part of a fungus

nVWA. the Dutch Plant Protection Service

node. point along the stem from which the leaves and buds arise

ovoid. shaped like an egg

PDC. the USDA APHIS Professional Development Center

PPO. the Applied Plant Research Station in Lisse, Holland

perennial. a plant that lives three years or more, tending to flower and fruit repeatedly

reticulate/reticulation. netted; net like

rhizome. a horizontal stem, usually underground

sori. clusters of sporangia

true bulb.

tuber. a thick, fleshy, underground part of a stem that serves as a storage organ

tunic. a loose, membranous, outer skin not the epidermis, especially the loose membrane around a corm or bulb

vascular bundle. a collective term for tissue containing xylem and phloem, usually surrounded by a sheath of parenchyma cells

Bulb Identification

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