9

Damage to shoots and buds of broadleaf woody plants

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9.1. Abiotic damage

**Description:** Abiotic factors can cause a variety of symptoms in shoots and buds. Symptoms commonly observed on shoots and buds include suppressed or aberrant growth, discoloration (chlorosis, reddening, browning, blackening, dark lesions), wounds, dieback of shoots and the death of buds. Except for depositions (salt, chemicals) or glaze (ice), signs of abiotic damage are generally absent. Symptoms usually appear in a pattern, occurring over the whole plant (e.g., death of young shoots and buds due to frost injury) or directionally (e.g., on the side facing the source of the adverse conditions or stress). Unlike diseases and pests, damage due to abiotic factors often occurs on different plant species in the same area and does not spread from plant to plant. Dead shoots often drop prematurely, however buds frequently remain attached to shoots (and thus on the plant) after death.

**Possible cause of damage:** Temperature extremes such as heat or freezing temperatures during growth season, frost and ice glaze, hail storms, misapplied chemicals (fertilizers, herbicides, pesticides, salts) or adverse soil conditions (nutrient imbalance), air pollutants, desiccation due to shortage of water or winter drying (Figs. 9.1.1 – 9.1.6).
Fig. 9.1.1. Southern magnolia (*Magnolia grandiflora*) leaves damaged by cold injury (low temperatures) which occurred before the leaf unfurled from its bud. USA, EB.

Fig. 9.1.2. Young shoots of staghorn sumac (*Rhus typhina*) damaged by frost and winter injury. Poland, MS.

Fig. 9.1.3. Shoots of hackberry (*Celtis* sp.) covered by white powder after road salt spraying or de-icing salt spray damage. USA, JOB.

Fig. 9.1.4. Red maple (*Acer rubrum*) buds and shoots encapsulated in ice and snow. USA, PDCNR.

Fig. 9.1.5. Young shoot of European beech (*Fagus sylvatica*) damaged by sunscald. Šajdíkové Humence, Slovakia, AK.

Fig. 9.1.6. Shoots and twigs of oak (*Quercus* sp.) with frost damage. USA, MDNR.
Additional information: Several factors causing abiotic damage can act simultaneously, and they may also co-occur with biotic damage, which complicates diagnosis. Abiotic damage can weaken the plant, making it vulnerable to biotic damaging agents such as fungi or insects. If similar symptoms occur on the entire plant, the damage may be associated with the root system (see Chapter 10). The injuries can be due to acute or chronic exposition to adverse abiotic factors. Plants may compensate for the death of shoots and buds by producing new growth.
9.2. Shoot blight or dieback

**Description:** Shoots and/or buds are discoloured, shoots are wilted or crooked and later dead (necrotic and/or dry). Characteristic symptoms include the gradual dying from the tips of shoots, progressing to larger branches. Dieback typically progresses from the base of the bud to the tip of the shoot or down succulent shoots to petioles and outward via the base of the leaf. In the case of bacterial damage, initial symptoms include a watery, tan coloured exudation from lesions on shoots and buds. Symptoms may be expressed only in young shoots and buds, or they might extend into the twigs and branches.

**Possible damaging agents:** Fungi: Ascomycota (Figs. 9.2.1 – 9.2.5), Oomycetes (Figs. 9.2.6 – 9.2.8), Bacteria (Figs. 9.2.9 – 9.2.12).

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**Fig. 9.2.1.** Common aspen (*Populus tremula*) shoots wilted by Venturia shoot blight (Pleosporales, Venturiaceae: *Venturia tremulae*). Morshyn, Ukraine, VK.

**Fig. 9.2.2.** Black willow shoot (*Salix nigra*) with symptoms of tip dieback due to willow scab pathogen (Pleosporales, Venturiaceae: *Venturia saliciperda*). Ternopil, Ukraine, VK.

**Fig. 9.2.3.** Wych elm (*Ulmus glabra*) showing typical dieback of shoots, progressing to larger branches due to Dutch elm disease (Ophiostomatales, Ophiostomataceae, *Ophiostoma novo-ulmi*). Höör, Sweden, JW.

**Fig. 9.2.4.** Common ash (*Fraxinus exelsior*) shoots crooked by the ash dieback fungus (Helotiales, Helotiaceae: *Hymenoscyphus fraxineus*). Austria, TK.
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Fig. 9.2.5. Current year shoot of cherry (Prunus sp.) infected and crooked by the blossom blight pathogen (Helotiales, Sclerotiniaceae: Monilinia laxa). Lviv, Ukraine, VK.

Fig. 9.2.6. Shoot of blueberry (Vaccinium sp.) with blight symptoms due to an Oomycete (Peronosporales, Peronosporaceae: Phytophthora ramorum). USA, JOB.

Fig. 9.2.7. Dwarf purple rhododendron (Rhododendron impeditum) shoot with non-uniform/irregular patterns of wilt symptoms due to shoot blight by an Oomycete (Peronosporales, Peronosporaceae: Phytophthora sp.). Vilnius, Lithuania, DC.

Fig. 9.2.8. Tanoak (Lithocarpus densiflorus) shoot with dieback caused by the sudden oak death pathogen (Peronosporales, Peronosporaceae: Phytophthora ramorum). USA, JOB.
Fig. 9.2.9. "Flagging" of terminal shoot of European pear (Malus pumila) caused by bacteria (Erwinia amylovora). Skole, Ukraine, VK.

Fig. 9.2.10. Common filbert (Corylus avellana) dieback after necrosis of a new lateral shoot due to bacterial blight (Xanthomonas arboricola pv. corylina). France, LG.

Fig. 9.2.11. Dead shoots on Cotoneaster salicifolius due to fire blight caused by a bacterial infection (Enterobacteriales, Enterobacteriaceae: Erwinia amylovora). Rogaland county, Norway, VT.

Fig. 9.2.12. Dead shoot and buds on Forsythia x intermedia ‘Spring glory’ due to a bacterial infection (Pseudomonadales, Pseudomonadaceae: Pseudomonas syringae). Akershus county, Norway, VT.

Additional information: Symptoms may be in the form of spots or blights on leaves and 1-2 year old shoots, as well as dieback of twigs/branches. Severely infected leaves may appear scorched and become almost completely brown, wilted or cupped. Note: drought symptoms and/or leaf scorch differ because the browning and wilting of leaf tissue begins at the leaf tips and leaf margins and progresses inward. For insect and fungal collection and preservation, see Chapters 3 and 4.
9.3. Shoot and/or bud borer damage

**Description:** Early symptoms often include only slight chlorosis and growth reduction of shoots; swellings may also be observed on shoots. Buds stop developing and may be deformed or discoloured (blackened). Later on, shoots will wilt and buds will wither. Signs include small holes and expelled frass. Slicing infested shoots may reveal tunnelling larvae inside the shoot, or a hollow space made by larvae that have subsequently left the shoot or bud.

**Possible damaging agents:** Insects: Larvae of Lepidoptera (Noctuidae: Figs. 9.3.1, 9.3.6; Tortricidae: Figs. 9.3.2, 9.3.4, 9.3.8; Sesiidae: Figs. 9.3.3, 9.3.7; Pyralidae: Fig. 9.3.5; Cossidae: Fig. 9.3.10), Coleopteran weevils and bark beetles (Curculionidae, Scolytinae) and Diptera (Cecidomyiidae: Fig. 9.3.9).

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**Fig. 9.3.1.** Bud of Piedmont azalea (*Rhododendron canescens*) showing hole and budworm larva (Lepidoptera, Noctuidae: *Peridroma saucia*). USA, LLH.

**Fig. 9.3.2.** Manitoba maple shoot (*Acer negundo*) showing a hole formed by the maple twig borer (Lepidoptera, Tortricidae: *Proteoteras aesculana*). Fort Collins, Colorado, USA, WC.

**Fig. 9.3.3.** Terminal shoot of green ash (*Fraxinus pennsylvanica*) crooked and wilted by ash borer (Lepidoptera, Sesiidae: *Podosesia syringae*). USA, JS.

**Fig. 9.3.4.** Manitoba maple, boxelder (*Acer negundo*), terminal twig swelling with frass at entrance hole created by borer (Lepidoptera, Tortricidae: *Proteoteras willingana*). USA, JS.
Fig. 9.3.5. Frass on the surface of butternut (Juglans cinerea) shoots due to damage by a shoot moth (Lepidoptera, Pyralidae: Acrobasis demotella). USA, SK.

Fig. 9.3.6. Silver maple (Acer saccharinum) shoot with tunnelling stalk borer larva (Lepidoptera, Noctuidae: Papaipema nebris). USA, SK.

Fig. 9.3.7. Cherry (Prunus sp.) terminal shoot with sticky exudates on the outer tissues of shoot due to damage by borer (Lepidoptera, Sesiidae: Synanthedon pictipes). USA, CEY.

Fig. 9.3.8. Peach (Prunus persica) shoots attacked by a moth larva (Lepidoptera, Tortricidae: Grapholita molesta). France, HA.

Fig. 9.3.9. Jatropha (Jatropha sp.) buds mined by unidentified fly larvae (Diptera, Cecidomyiidae). Mexico, TH.

Fig. 9.3.10. Japanese walnut (Juglans ailantifolia) shoot full of Lepidoptera larvae (Lepidoptera, Cossidae). Russia, NK.

Additional information: Borer damage may lead to stunted, forked leaders and general loss of shape. For insect collection and preservation, see Chapter 3.
9.4. Sap-feeder damage

Description: Sap-feeding insects or mites are usually observed in large groups and can be mobile or immobile. Indirect symptoms include reduced growth, deformation of shoots or buds, chlorotic, small spots or other discoloration with (sticky liquid) exudation.

Possible damaging agents: Insects: Adults and nymphs of many Hemiptera families (e.g., Aphididae: Figs. 9.4.1 – 9.4.2; Psyllidae: Fig. 9.4.3; Coccidae, Monophlebidae: Fig. 9.4.4; Diaspididae: Fig. 9.4.5; Pseudococcidae) and Acari: (e.g., Eriophyidae: Fig. 9.4.6).

Fig. 9.4.1. Alder (Alnus sp.) shoots with white cottony infestation of woolly alder aphid (Hemiptera, Aphididae: Prociphilus tessellatus). Rio Grande NF, Colorado, USA, WMC.

Fig. 9.4.2. Willow (Salix sp.) shoot covered by adult and nymph aphids (Hemiptera, Aphididae: unidentified species) tended by ants. Slovakia, MZ.

Fig. 9.4.3. Apple (Malus domestica) bud with psyllid nymphs on the tip of the bud (Hemiptera, Psyllidae: Cacopsylla mali). Poland, MS.

Fig. 9.4.4. Shoots of cheesewood (Pittosporum spp.) infested by scale insects (Hemiptera, Monophlebidae: Icerya purchasi), with fungal growth. USA, LGR.
Fig. 9.4.5. Euonymus scale (Hemiptera, Diaspididae: *Unaspis euonymi*) on shoot of an unidentified plant. USA, CU.

Fig. 9.4.6. Shoots of Southern California walnut (*Juglans californica*) curled by a mite attack (Acari, Eriophyidae: *Aceria neobeevori*). USA, WC.

**Additional information:** Honeydew (sugar-rich liquid excreted by some insects when feeding) can attract other animals (e.g., ants) and support growth of fungi on the surface of the shoots and buds (see 9.7.). For insect collection and preservation, see chapter 3.
9.5. Fungal growth on surface

**Description:** Dark, reddish/yellowish, whitish, powdery or cottony coverage, elevated spots or other structures on shoots and buds.

**Possible damaging agents:** Fungi: Ascomycota, Basidiomycota: powdery mildews, rusts and sooty moulds (Figs. 9.5.1 – 9.5.4).

**Fig. 9.5.1.** Dead rhododendron (*Rhododendron* sp.) bud with spore-producing little stalks with knobs at the end (Chaetothyriales, Herpotrichiellaceae: *Pycnostypanus azalea*). Østfold county, Norway, VT.

**Fig. 9.5.2.** Dying shoots (A) and fruiting bodies (B) on birch (*Betula pubescens*) due to fungal attack (Helotiales, Godroniaceae: *Godronia multispora*). Akershus county, Norway, VT.

**Fig. 9.5.3.** Shoots of barberry (*Berberis vulgaris*) infected by powdery mildew (Erysiphales, Erysiphaceae: *Erysiphe berberidis*). Akershus county, Norway, VT.

**Fig. 9.5.4.** Shoot of blackberry (*Rubus fruticosus*) infected by a rust fungus (Pucciniales, Phragmidiaceae: *Kuehneola albida*). Akershus county, Norway, VT.

**Additional information:** Rust fungi are obligate parasites and most of them are characterized by complex life cycles generally involving two unrelated host plants (primary host and alternate host). The sooty moulds benefit from either a sugary exudate produced by the plant or fruit, or from honeydew produced by sap-sucking insects. For insect and fungal collection and preservation, see Chapters 3 and 4.
9.6. Shoot galling

**Description:** Outgrowths (galls) or swelling on shoot or bud tissues, with insect larvae or mites inside. Depending on the causal agent and host species, galls of different sizes, forms (regular or irregular) and colours (e.g., green, reddish, brownish or light-coloured) occur.

**Possible damaging agents: Insects:** Adults and larvae of Acari (Eryophiidae: Fig. 9.6.1), adults and larvae of Hymenoptera (Cynipidae: Figs. 9.6.2 – 9.6.4) and Hemiptera (Aphididae: Figs. 9.6.5 – 9.6.6; Psyllidae) and larvae of Diptera (Cecidomyiidae).

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**Fig. 9.6.1.** Damaged ash (*Fraxinus* sp.) buds and shoots due to a mite gall (Acari, Eryophiidae: *Aceria fraxinivora*). Baden, Lower Austria, TC.

**Fig. 9.6.2.** Damaged oak (*Quercus* sp.) bud due to a cynipid gall wasp (Hymenoptera, Cynipidae: *Cynips glutinosa*). Plátove, Slovakia, MZ.

**Fig. 9.6.3.** Shoot of chestnut (*Castanea* sp.) damaged by a gall wasp (Hymenoptera, Cynipidae: *Dryocosmus kuriphilus*). Italy, FS.

**Fig. 9.6.4.** Terminal shoot of bur oak (*Quercus macrocarpa*), heavily deformed by galling by a gall wasp (Hymenoptera, Cynipidae: *Disholcaspis quercusmamma*), USA, WC.
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Fig. 9.6.5. Buds of plains cottonwood (*Populus deltoides* ssp. *monilifera*) damaged by aphid galls (Hemiptera, Aphididae: *Pemphigus populiramulorum*). Colorado, USA, WC.

Fig. 9.6.6. Terminal shoot with bud of plains cottonwood (*Populus deltoides* ssp. *monilifera*) deformed due to aphids (Hemiptera, Aphididae: *Mordwilkoja vagabunda*). Leelanau County, Michigan, USA, SK.

**Additional information:** Splitting of a developing gall exposes developing larvae. For insect collection and preservation, see Chapter 3.
9.7. Shoot and/or bud external feeding

**Description:** Shoots or buds are bitten or punctured by adult insects and, occasionally, by larvae outside of the plant. Damage symptoms can include feeding holes, shoot debarking or external chewing.

**Possible damaging agents: Insects:** Adults of Coleoptera (especially Curculionidae), but species of many other groups may occasionally feed on shoots and buds, including those that usually damage leaves, fruits and flowers (e.g., Lepidoptera, Hymenopteran sawflies and bees, true bugs, etc.) (Figs. 9.7.1 – 9.7.4).

**Fig. 9.7.1.** Damaged bud of apple (*Malus domestica*) with small holes caused by weevil feeding (*Coleoptera, Curculionidae: Anthonomus pomorum*). Poland, MS.

**Fig. 9.7.2.** Shoot of pecan (*Carya illinoinsensis*) with feeding weevil (*Coleoptera, Curculionidae: Conotrachelus aratus*). USA, JAP.

**Fig. 9.7.3.** Adult ash weevil (*Coleoptera, Curculionidae: Stereonychus fraxini*) feeding on a bud of narrow-leaved ash (*Fraxinus angustifolia*). Novi Sad, Serbia, MD.

**Fig. 9.7.4.** Shoot of *Tabernaemontana* sp., gnawed by an unidentified adult longhorn beetle (*Coleoptera, Cerambycidae*). Amani Nature Reserve, Tanzania, RE.

**Additional information:** For insect collection and preservation, see chapter 3.
9.8. Feeding by mammals or birds

**Description:** Whole shoots and buds are removed from the plant. Repeated damage often causes formation of multiple stems and a bushy appearance of the plant.

**Possible damaging agents:** Mammals (such as moose, deer, cattle and sheep), squirrels, rodents, or bud-eating birds such as grouse (Figs. 9.8.1 – 9.8.2).

![Fig. 9.8.1. A twelve-year old English oak (Quercus robur), heavily browsed by roe deer (Artiodactyla, Cervidae: Capreolus capreolus). Mokrin, Serbia, LPP.](image1)

![Fig. 9.8.2. Spring buds of pear (Pyrus sp.) damaged by fox squirrel (Rodentia, Sciuridae: Sciurus niger), USA, WC.](image2)

**Additional information:** Deer and sheep often leave ragged ends where they bite through the stem, and always eat the shoots. Rabbits and hares leave clean diagonal cut ends, leaving the shoots (seen frequently by rabbits and always by hares). Timing of the foraging and different signs such as faeces, tracks, or even hair or feathers around the damaged tree can be useful when identifying the causal agent. Damage should be photographed. For species identification, direct observations or consultations with local zoologists or game managers are needed.