

## **Perennial Plants: The Tricks and Turns of Their Perennating and Overwintering Structures**

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Perennial plants live more than two seasons. This can be contrasted with annual plants which complete their life cycle in one season, or biennials, which complete their life cycle in two seasons. Perennial plants can be woody shrubs and trees, or they can be perennial herbs. Many perennial herbs produce new fresh growth each year when the weather is optimal and then die back during their dormant season to storage stems or roots. In California, we have perennial herbs in the mountains that persist through the winter snow as storage stems or roots. In other parts of the state, the dormant season is the drought months of June through October; many of perennial herbs in the Central Valley specialize in producing above-ground growth between November and May, dying back to storage stems and roots once drought starts. Our California weed flora includes many perennial herbs with a variety of storage stems and roots, and an understanding of these structures can be key to their control.

It is useful to review the basic landmarks of stems and roots. When a seed germinates, it produces a shoot and a root. The shoot becomes the shoot system, which includes the stem and the leaves. The stem is divided into nodes, where the leaves emerge, and internodes (the areas between the nodes). At each node, just above where the leaf meets the node, there is usually a small bud called an axillary bud. Finding these landmarks on a plant part means it is a stem.

In many plants, the seedling root develops into a tap root system, best illustrated by carrot or dandelion. However, in grasses, lilies, and other monocotyledons, the initial seedling root does not continue to develop, and roots develop instead from the stem system. This type of root system is called a fibrous root system. Another term used for roots that develop from stems (or sometimes leaves) is “adventitious roots.” Adventitious roots often develop from stem nodes, and they can be present in plants that also have a tap root system. Regardless of how they develop, roots do not have nodes, internodes or axillary buds.

After the initial seedling stage, as plants age, growth patterns can be complex and it can be difficult to distinguish roots from stems. Some roots are able to produce stems (root-borne shoots), and as discussed above, some stems can produce roots (shoot-borne roots). Stems and roots differ anatomically when examined in cross-section. Roots have their vascular tissue in one large cylinder in the middle of the root, while stems have their vascular tissue distributed in a number of vascular bundle cylinders that are arranged either in a ring (non-monocotyledons) or scattered throughout the stem (monocotyledons).

In perennial herbs, there are many different types of storage stems that are used to persist during the dormant season. Short upright storage stems that form at the very base of the seedling (below the first seedling leaves), such as those found in crocuses, are called corms. Stems with very short internodes and thickened storage leaves (onion) or storage axillary buds (garlic) are called bulbs. In both corms and bulbs, offset cormlets and bulblets can be produced that allow the plant to reproduce asexually through cloning.

Other perennial herbs produce below-ground horizontal storage stems called rhizomes which when examined have clear nodes and internodes. In some cases, rhizomes only produce above-ground leaves at their nodes, often at their slowly-growing tip. This is the case in irises. In other types of rhizomes, above-ground stems grow from axillary buds produced at the rhizome nodes. This is the case in many grasses and sedges, which produce a line of erect stems (with leaves) from a below-ground rhizome. Sometimes, rhizomes produce engorged storage areas that are called tubers, best illustrated by the potato (which can produce stems from the axillary buds in its eyes, which are nodes). Related to rhizomes, are above-ground horizontal stems called stolons, best seen in strawberries or Bermuda grass. Stolons typically have long internodes called runners and then produce an upright stem with adventitious roots at each node. It is sometimes difficult to know if one is dealing with a rhizome or stolon, since the distinction has to do with whether or not the stem is above or below ground. Just as with corms and bulbs, rhizomes, tubers, and stolons can fragment, allowing the plant to reproduce asexually through cloning.

In some perennial herbs, it is storage roots that are used to get through a dormant season. As mentioned above, some roots can produce a shoot system, and storage roots are a good example of this. Some storage roots, such as carrot, are storage tap roots, which develop from a tap root system. Other storage roots develop from adventitious roots and are sometimes called tuberous roots.

Plants can be complex and have a number of different strategies for persisting through drought or cold as well as for cloning. They may combine the structures discussed in this paper, producing an initial shoot above ground and an initial tap root system, then producing a rhizome with adventitious roots and small tubers, which then can produce more upright stems. In some plants, bulbs or tubers may be produced in unexpected places, such as the inflorescence bulbs of bulbous blue grass or the aerial stem tubers of air potato. In other plants, such as Bermuda buttercup, copious storage roots, rhizomes, and bulbs may be produced underground, making the plant very difficult to eradicate. An understanding of the basic morphology of perennial herb dormancy structures, as well as the timing of when these structures are produced, can be key to the control of perennial herbs.