

How does walnut bud break and shoot elongation differ from pistachio and almond?

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Growers intending to diversify farming operations to more than one nut crop are challenged with learning vastly different botanical systems. Almonds, pistachios, and walnuts differ in both their reproductive strategies and their vegetative growth characteristics.

Flowers may be borne on either the current year's shoot, such as in walnuts, or on the prior year's growth, like pistachio and almond. Additionally, the bud types vary between walnut, almond, and pistachio

Table 1. The differences in vegetative and reproductive strategies between walnut, almond, and pistachio are evident in the buds formed on each crop.

Crop	Vegetative buds	Female flower buds	Male flower buds	Compound buds	Perfect Flowers
Walnut			X	X	
Almond	X				X
Pistachio	X	X	X		

(Table 1). Walnuts are unique in that they do not have discreet vegetative buds or flower buds, but rather a compound bud and masses of non-showy male flowers assembled in catkins (Figure 1).

Location of female walnut flowers. Walnuts lack female flower buds. The walnut's female flower primordia are encased in the vegetative shoot, making for a compound bud (Figure 1). The compound bud in walnut contains a preformed shoot, preformed leaves, and a female flower at the preformed shoot terminus. As a result, walnuts are borne on the current season's shoot. Almonds and pistachios differ from walnut in that both bear nuts on the prior year's growth.

Preformed growth. Until budbreak (Figure 2A), the preformed shoot is enclosed in the compound bud. As the shoot elongates from the bud, a series of preformed leaves emerge. On young trees, the number of preformed leaves may vary considerably between buds, with each compound bud containing generally 5-11 preformed leaves. The compound buds on mature trees exhibit less variability in the number of preformed leaves and tend to have fewer preformed leaves per bud. Because the female flower marks the terminus of the preformed shoots, shoot growth beyond the nut(s) is all in-season or 'neoformed' growth. Trees exhibiting rapid in-season growth may appear vigorous, however, this in-season growth may support malformed leaves (Fig 2C), incomplete buds in the leaf axils, and branching that lacks structural integrity.

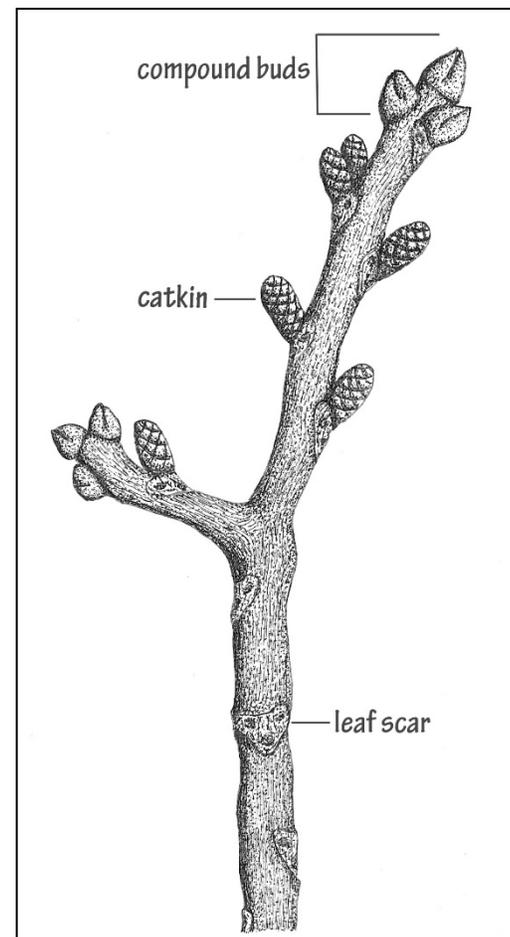


Figure 1. Catkins and compound buds are borne on the prior year's shoot. (Illustration: H. Hartzog)

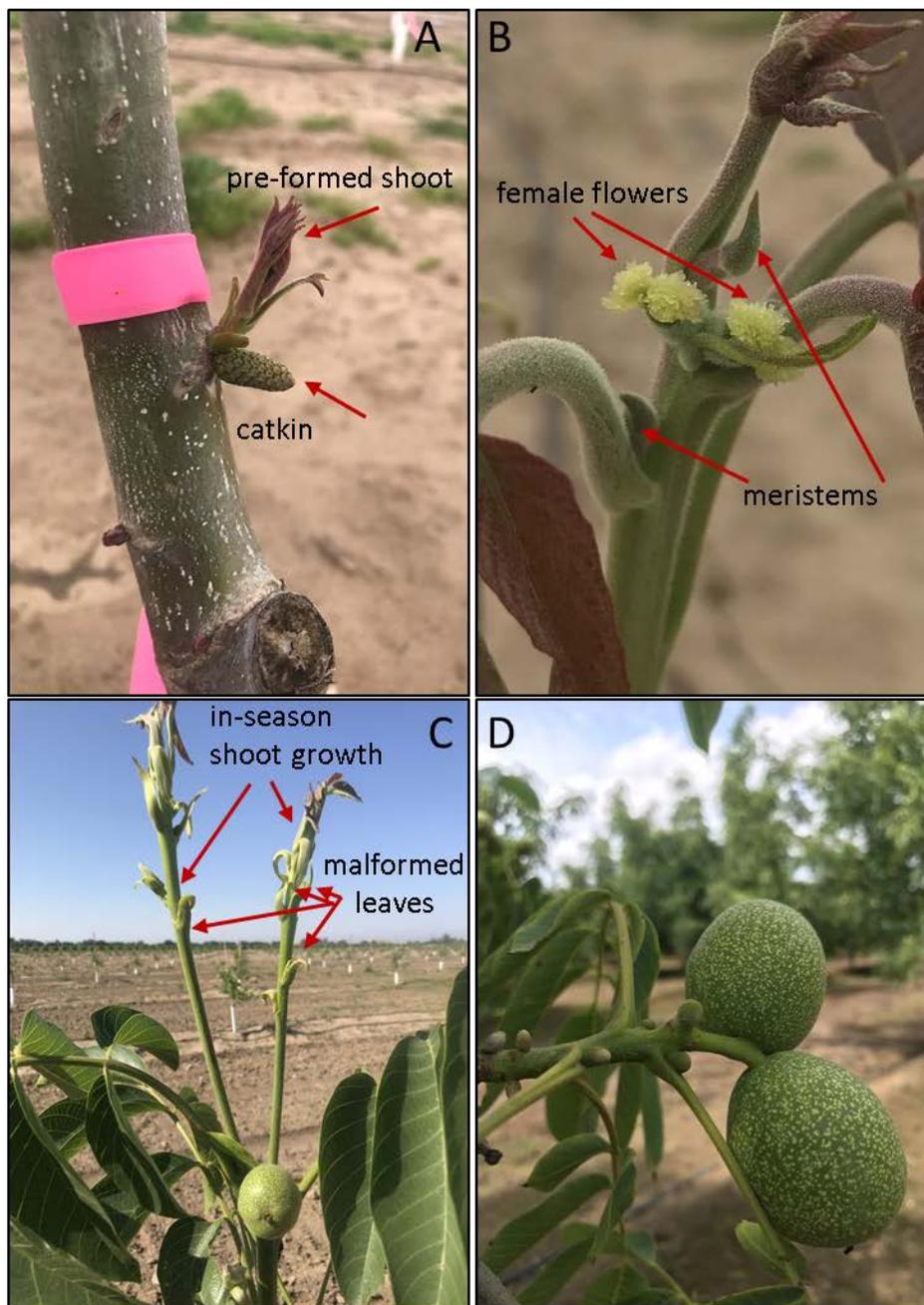


Figure 2. As the compound bud breaks, the pre-formed shoot emerges (A). In photo A, the compound bud and catkin are positioned at primary and secondary buds, respectively. The meristems giving rise to in-season growth are visible during bloom (B). Malformed leaves are borne on in-season shoots (C). On this 'Ivanhoe' shoot, catkins and compound buds are already visible on May 17, 2019 (D). Photos: E. Fichtner

In-season branching. In-season branching points are observed early in the growing season. As the shoot elongates, one to four meristems can form in the axils of the leaves near the nut, resulting in forking (Fig 3A). During the dormant season, the forks resulting from in-season growth are removed to maintain straight shoots (Figure 3B).

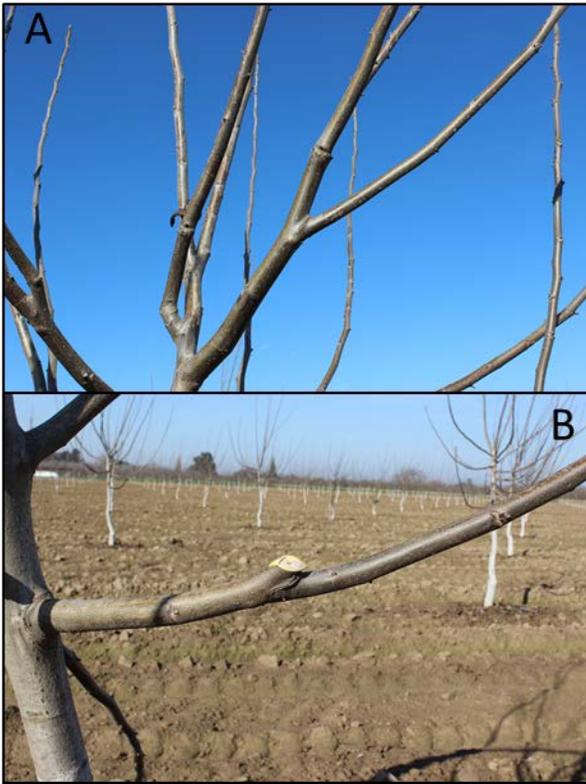


Figure 3. In-season growth may result in forking (A) that is pruned off during the dormant season (B). (Photos: E. Fichtner)

Location of male walnut flowers. Walnuts are monoecious, meaning that they bear male and female flowers on the same tree. The bearing habit of the male flowers, however, differs from that of the female flowers. Like pistachio, the male walnut flowers are arranged on catkins (Figure 2A) that are borne on the prior year's growth. Catkins are made up of numerous male (staminate) flowers. Each staminate flower bears numerous stamens, and each stamen bears numerous pollen grains. The staminate flower assembly comprising the catkin enables abundant pollen production, a useful adaptation of wind-pollinated crops.

Timing of walnut bud formation. Both catkins and compound buds on walnut are well differentiated by spring of the prior year on a mature walnut tree (Figure 2D). As a consequence, environmental stresses imposed during bud development in spring may affect the growth and bearing habits of walnut the following year. For example, environmental stresses (ie. over- or under- watering) during bud development may influence the number of preformed leaves in compound buds. The influence of these stresses may not be realized by the grower until the following spring, after bud break and shoot elongation.

The common denominator. Although the growth and reproductive habits vary considerably between walnut, almond, and pistachio, the major commonality is that buds develop the

season prior to growth. Mitigating stress during bud development, regardless of crop, may have profound impacts on orchard health and productivity into the following year.

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