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The Architecture of Avocado Trees and Why it Matters

All tree crop growers struggle to balance Mother Nature's natural tendencies with their desire for high, consistent fruit production. To do this, they manipulate the trees by pruning, trellising, controlling fertilizer and water inputs, and using chemical growth regulators. The challenge to achieving high, consistent yield in avocados is arguably more difficult than in other tree crops that have been domesticated for thousands of years and have been bred so heavily that they bear little resemblance to their wild relatives. To manipulate an avocado tree horticulturally, we need to understand how it grows because we ultimately have to work within Mother Nature's bounds.

In general, avocado trees have a round canopy with dense foliage, but the form of avocado trees vary — Fuerte are characterized as spreading; Hass as rounded; Bacon as upright. The form of the avocado tree is also influenced by the predominance of proleptic and sylleptic shoots and this, in turn, can influence avocado yields.

In general, avocado trees grow in a rhythmic pattern with periodic — or seasonal — shoot growth. Shoots grow, then stop; grow, then stop. In California, shoot growth usually consists of a spring flush (reproductive), an early summer flush (vegetative) and an autumn flush (vegetative) (Fig. 1). This is important to recognize because this rhythmic pattern of dormancy and growth

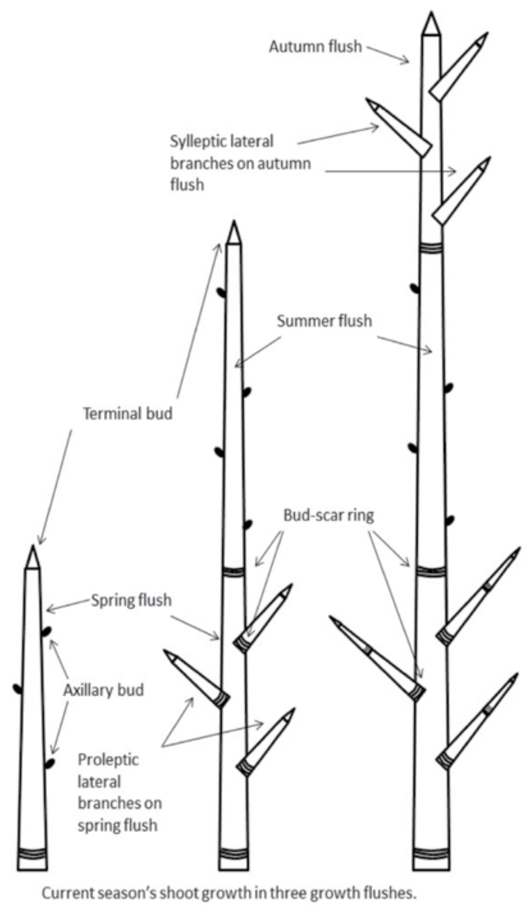

Figure 1. A diagram showing the current season's shoot growth arising from a terminal bud from the previous season. The current season's growth occurred in the three flushes, with the formation of a terminal bud in between each flush. The remains of the terminal buds are visible later in the season as bud-scar rings between each flush. The diagram shows flushes with two types of lateral branches – proleptic and sylleptic. The spring flush developed with no lateral branches (strong apical dominance), thus the axillary meristems became axillary buds (left). The spring flush axillary buds grew at the same time that the summer flush elongated, forming proleptic branches on the spring flush (note the bud-scar rings at the base of these lateral branches; center). On the autumn flush, axillary meristems grew at the same time the main axis was elongating (weak apical dominance), forming sylleptic shoots (note the absence of bud-scar rings on these lateral branches; right).

Types of Buds

by Location

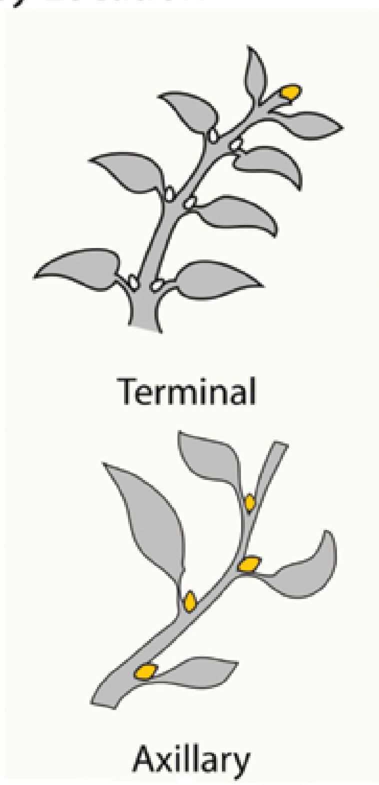

Figure 2. An illustration showing the location of a terminal bud at the shoot tip and axillary (lateral) buds along a shoot where the leaves join the shoot.

plays a role in determining which shoots develop when.

Proleptic (or unbranched) shoots develop from dormant terminal or axillary (lateral) buds (Fig. 2) once the parent shoot has stopped growing (Fig. 1). Proleptic shoots have a bud-scar ring at their base and can be vegetative or reproductive. Because proleptic shoots originate from dormant buds, their growth is considered "fixed." That is to say, the number of nodes the shoot will have when it grows is pre-formed (microscopically) within the dormant bud.

On the other hand, sylleptic (or multi-branched shoots) develop from axillary buds while the main shoot is still growing — without there being an intervening bud dormancy period — and do not have a bud-scar ring (Fig. 1). Because they do not arise from dormant buds, sylleptic shoots do not have pre-formed nodes, and can continue to grow if conditions are favorable ("free" growth). Ideally, avocado trees should have a mix of proleptic and sylleptic shoots for maximum productivity.

The form of an avocado tree is due to the interaction between apical dominance and apical control. Together, these determine the dominance of proleptic or sylleptic shoots of a tree.

Apical dominance is the extent to which an actively growing shoot tip or terminal bud inhibits the growth of axillary buds (at the junction of the stem and leaf) further down the shoot. In short, when an avocado tree forms a lateral meristem, apical dominance determines whether the meristem forms a bud or a sylleptic branch. The growing shoot tip or terminal bud produces the plant hormone auxin, which inhibits the growth of lateral buds. (Growers imitate this response by applying Tre-Hold, a synthetic auxin, to pruning cuts to prevent shoot growth.) Apical dominance is used to refer to the control the apical portion of a shoot has over lateral buds along that shoot during the year that the shoot first grows. Because apical dominance inhibits the growth of axillary buds when the shoot main axis is extending, it involves the inhibition of sylleptic — not proleptic —shoots.

Apical control refers to the influence apical portions of the crown have over the general tree form by releasing resting buds in subsequent years of the tree's life. How apical control is manifested determines tree form. Acrotony is a specific type of apical control in which the buds closest to the terminal of the shoot are released from dormancy and become dominant over the main shoot axis (Fig. 3). Basitony is a type of apical control in which the buds closer to the base of the shoot are released from dormancy and do not become dominant over the main shoot axis. A tree with strong apical control (basitonic growth) will have the central axis remain dominant and thus will have one clearly defined trunk. A tree with weak apical control (acrotonic growth) will have several large major limbs or scaffold-like branches.

Apical control takes place in the second and subsequent years of shoot growth when apical control either a) leaves the bud dormant or b) allows the bud to reawaken and elongate and thicken into a proleptic branch. Buds that remain dormant enter what is commonly referred to as the "bud bank" and can later form epicormic shoots, or water sprouts, generally in response to major limb breakage or severe pruning (e.g. stumping). While auxin plays a role in apical dominance — and thus the development of sylleptic branches — its role in apical control is less clear. Researchers are examining hormonal and nutritional mechanisms to better understand their role in apical control.

When you put all of these factors together — apical dominance, apical control, acrotony, basitony — you can begin to understand why avocado trees take the form they do. Researchers examining shoot growth and tree architecture discovered the following:

'Gwen' and 'Reed': strong apical control, strong basitony, few major limbs, short axillary shoots, few proleptic shoots, weak apical dominance and large numbers of sylleptic shoots. Tends to be a more compact tree.

'Sharwil': weak apical control, strong acrotony, many major limbs, long and numerous proleptic shoots, strong apical dominance and few sylleptic shoots. Tends to be a taller tree.

'Hass': intermediate between 'Sharwil' and 'Reed.' Tends to be of

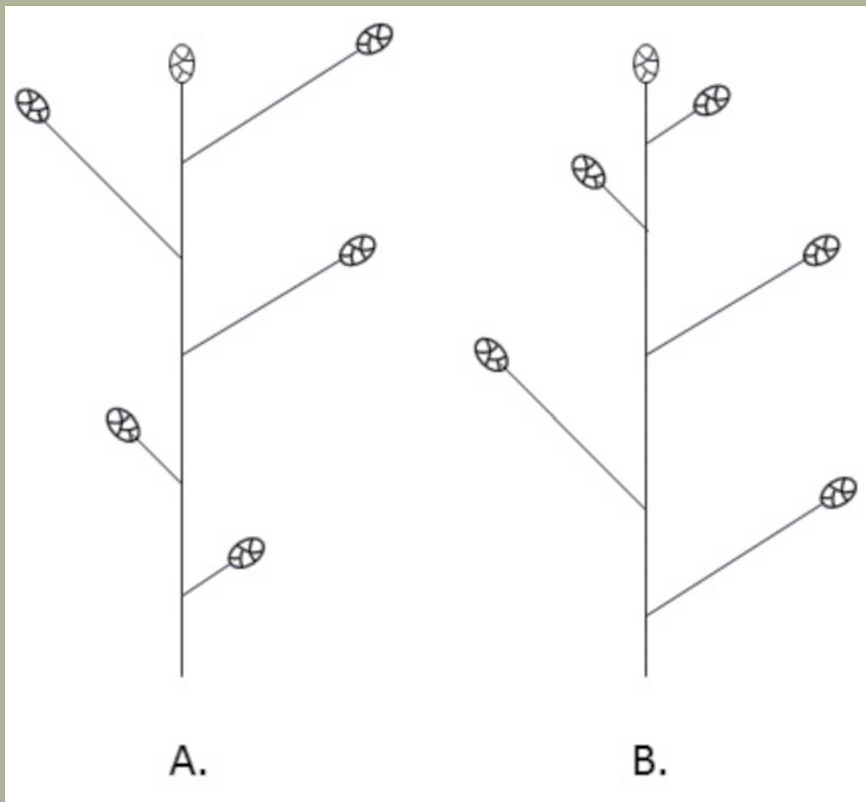

Figure 3. A representation of two types of lateral branch development, acrotonic (A.) and basitonic (B.).

intermediate size.

Researchers have also found that the tendency to develop proleptic or sylleptic shoots is dependent upon the age and the location of the grove. They found that younger avocado orchards tended to have more sylleptic shoot development, while proleptic shoot development increased as orchards aged. This is in keeping with research noting that apical control (and thus proleptic shoot development) takes place in later-stage growth. Researchers continue to examine the effect grove location plays on avocado shoot development.

The concepts presented here describe characteristics of avocado tree growth in its natural state. In the next issue of *From the Grove*, we will examine how understanding these concepts allows us to make management decisions (e.g., pruning) to manipulate tree growth to try to improve yields and fruit quality.

Terminology

Apical control – the control of growth of proleptic branches

Apical dominance – the inhibition of growth of sylleptic branches leading to the formation of axillary buds

Epicormic shoot – rapidly growing, near vertical shoots that develop from buds that have been dormant for more than two years (commonly referred to as water sprouts)

Meristem – a region of undifferentiated cells in a plant that is found where growth can take place; meristems are found in areas such as shoot tips, lateral buds, and root tips

Proleptic shoot – lateral branches that develop from axillary buds after a period of dormancy

Sylleptic shoot – a lateral branch that develops from an axillary meristem without a period of dormancy while the main shoot axis is still