

## **Appendix A. Environment Library**

The library consists of a description of the original plant and its image, method of modeling, and front, side and isometric views of the plant model.

### **A.1 Tall Spindle apple tree model (Apple\_1\_TallSpindle, TS)**

An apple tree of the type McIntosh was trained by the TS system in Massachusetts in 2010. The tree was reconstructed from the picture by measuring the object's location on the picture plane and assuming the depth.



Fig. A.1 *Actual plant.*

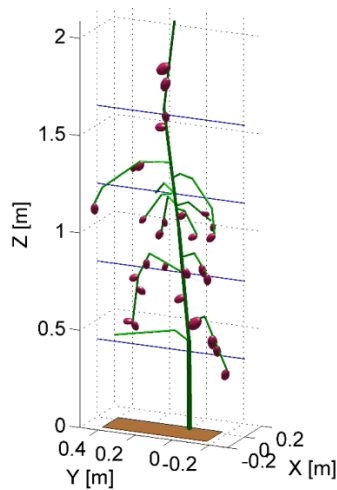


Fig. A.2 *Model of Apple\_1\_TallSpindle.*

## A.2 Central Leader apple tree models (Apple\_1\_7\_14, CL1, CL2, CL3, CL4, CL5)

The following five trees were trained by the CL system in a commercial orchard belonging to the Fridman family in Nov, Golan Heights on 1 Jul 2014. The trees were modeled by the measuring device.



Fig. A.3 *Actual plants CL1, CL2 and CL3.*



Fig. A.4 *Actual plants CL4 and CL5.*

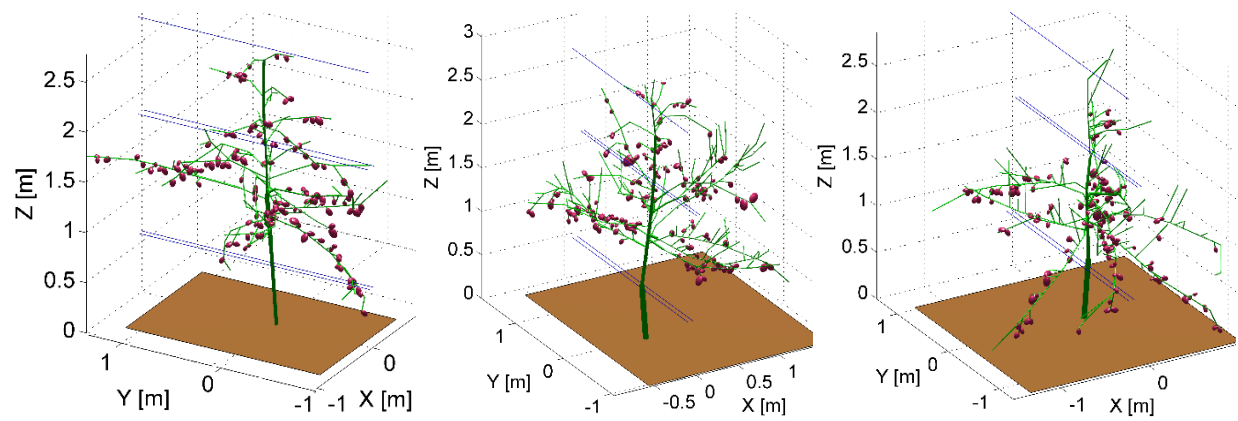


Fig. A.5 Models of LC1, CL2 and CL3.

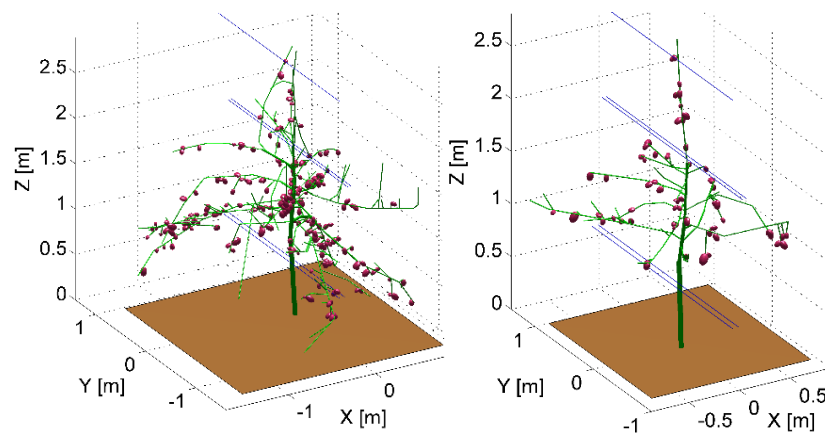


Fig. A.6 Models of LC4 and CL5.

A row of five trees Apple\_1\_7\_14Row was constructed with the tree models.

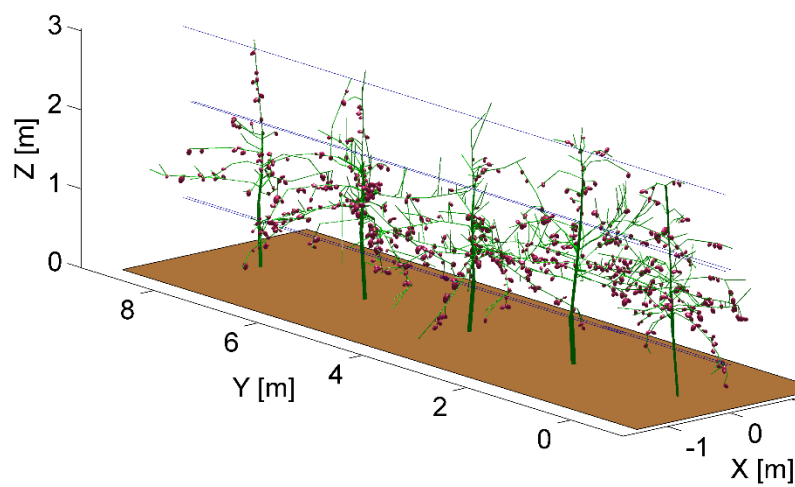


Fig. A.7 Model of Apple\_1\_7\_14Row.



### A.3 Central Leader apple tree models (Apple\_11\_10\_13, Apple\_30\_10\_13)

The following two trees were measured in an experimental orchard in Ramat Matityahu, Upper Galilee. The trees were modeled by the measuring device.



Fig. A.8 Actual plants *Apple\_11\_10\_13* and *Apple\_30\_10\_13*.

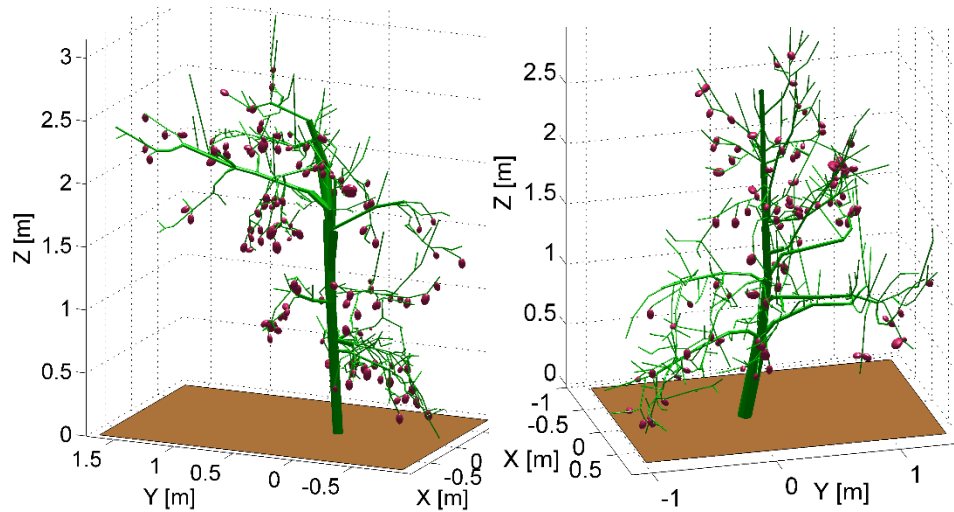


Fig. A.9 Models of *Apple\_11\_10\_13* and *Apple\_30\_10\_13*.

#### A.4 Y-trellis apple tree models (Apple\_YTrellisL, YT1...5, YTA5...A85)

The tree was reconstructed from the picture. The relatively simple structure of the tree allows formulating the rules of the L-systems. All models were built according to this rule.



Fig. A.10 Actual plant *Apple\_YTrellisL*.

##### L-systems description

The models of the trees trained by the YT method were built with the help of the L-systems method (Prusinkiewicz and Lindenmayer, 1990). The tree geometry was defined by the following L-systems rules (symbols defined in Prusinkiewicz and Lindenmayer, 1990). The parameters of these rules were achieved by analyzing the pictures of trees growing in the orchards.

$$n = 3$$

$$\#define \alpha_1 30^\circ /* \gamma_{trellis} */$$

$$\#define \alpha_2 45^\circ /* branching of the generations 2 and 3 */ \quad \text{Eq. A1.}$$

$$w: A[ \&(\alpha_1) FFFFF ][ \backslash(180^\circ) \&(\alpha_1) FFFFF ]$$

$$p_1: F \rightarrow A[ +(\alpha_2) F ][ -(\alpha_2) F ]$$

In the designed L-systems, the number of branch generations is three ( $n = 3$ ). The first branching angle is defined as  $30^\circ$ , and the second as  $45^\circ$ . The axiom ( $w$ ) builds the following structure: build vertical branch  $A$  (the tree trunk), turn around the  $X$  axis on  $30^\circ$  ( $\&(\alpha_1)$ ), build five branch intervals ( $FFFFF$ ), return to the previous position ( $] [$ ), turn around the  $Z$  axis on  $180^\circ$  ( $\backslash(180^\circ)$ ), turn around the  $X$  axis on  $30^\circ$  ( $\&(\alpha_1)$ ), build five branch intervals ( $FFFFF$ ). The rule ( $p_1$ ) replaces each branch interval  $F$  by the following structure: build branch interval  $A$ , turn around the up

direction on  $45^\circ$  and build one branch interval  $(+(\alpha_2)F)$ , return to the previous position ( $[\downarrow]$ ), turn around the up direction on  $-45^\circ$  and build one branch interval  $(-(\alpha_2)F)$ .

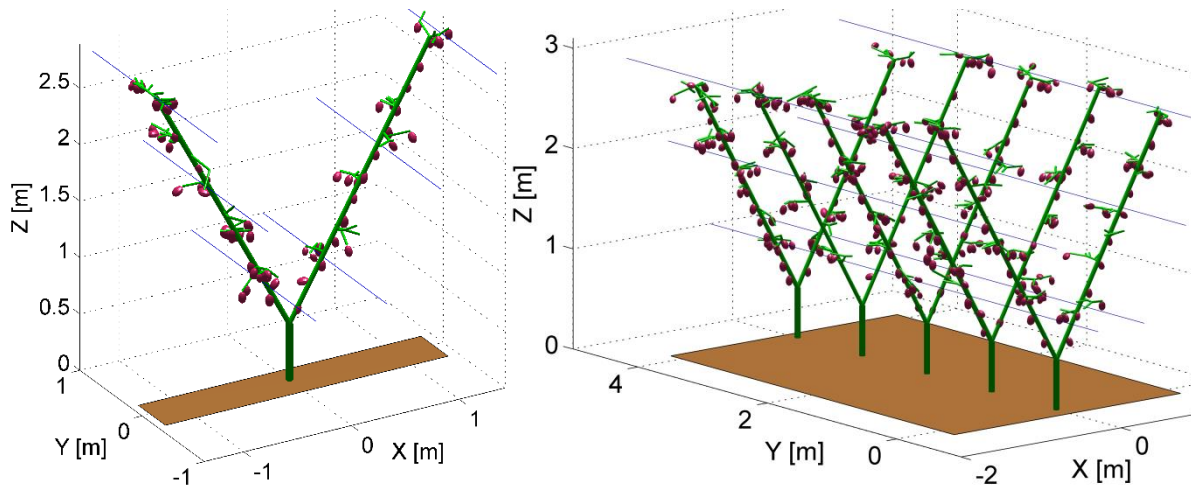


Fig. A.11 *Models of Apple\_YTrellisL and tree row consisting of five models created by the L-Systems rule.*

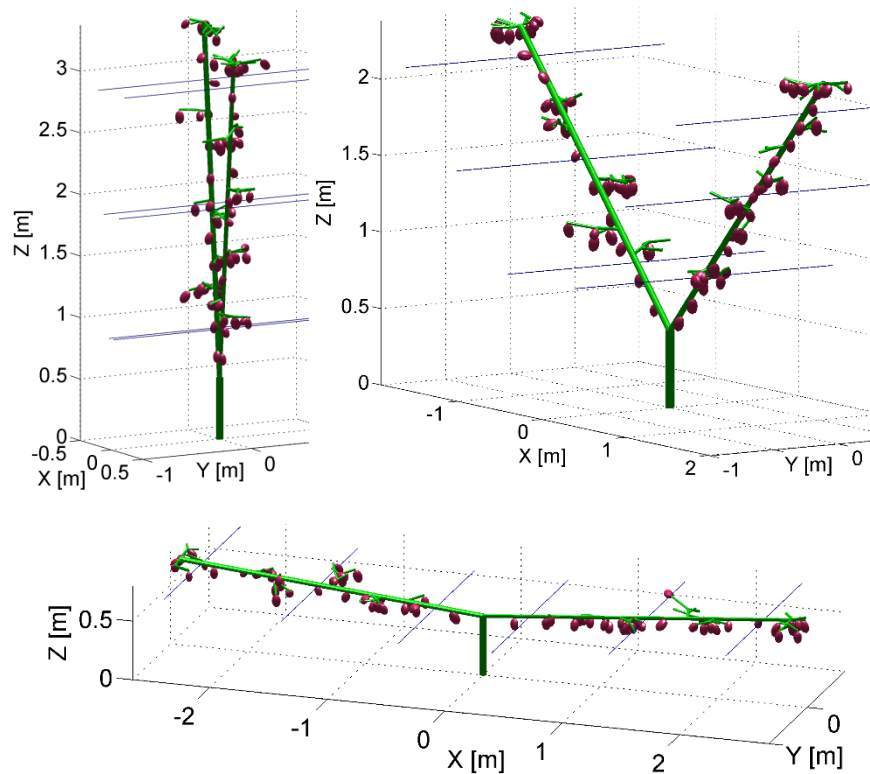


Fig. A.12 *Models of Apple\_YTrellisL with trellis tilt angles  $5^\circ$ ,  $30^\circ$  and  $85^\circ$  created by the L-Systems rule.*



### A.5 Nectarine tree models (Nectarine\_30\_6\_14, N1, N2, N3, N4, N5)

The following five trees were measured in the Fridman family commercial orchard in Nov, Golan Heights, on 30 Jun 2014. The trees were modeled by the measuring device.



Fig. A.13 *Actual plant Nectarine\_30\_6\_14.*

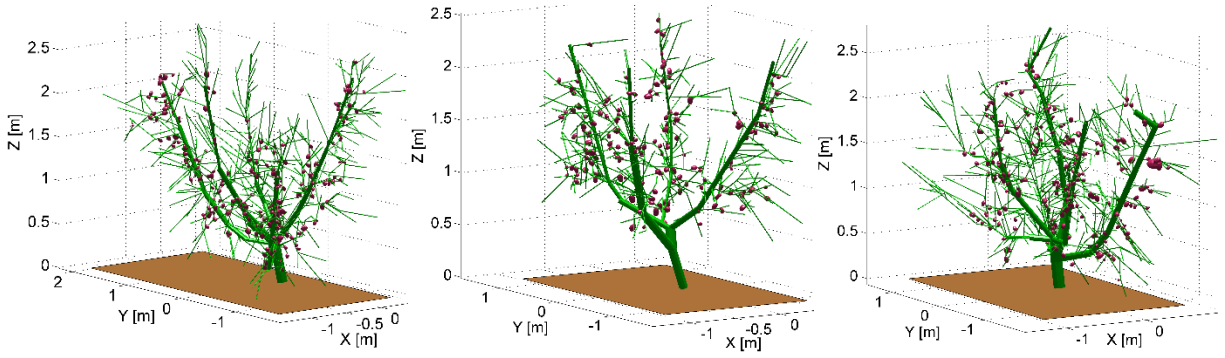


Fig. A.14 Models of N1, N2 and N3.

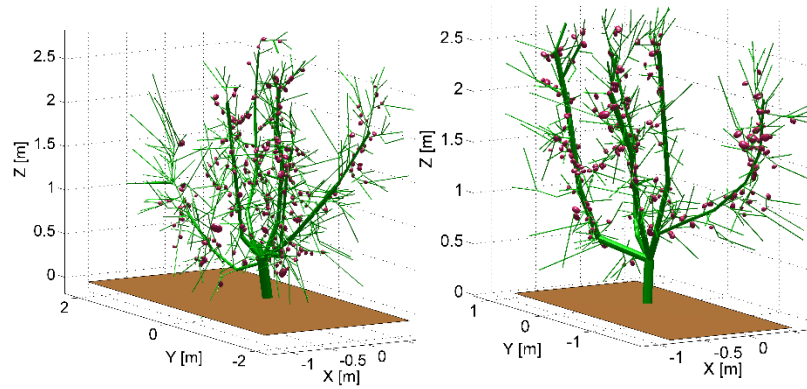


Fig. A.15 Models of N4 and N5.

A row of five trees Nectarine\_30\_6\_14Row was constructed with the tree models.

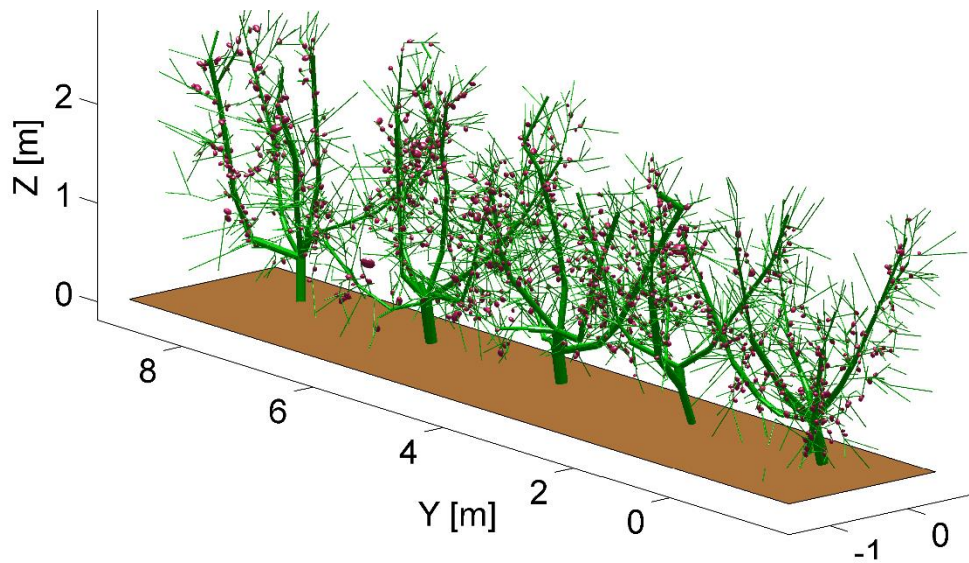


Fig. A.16 Model of Nectarine\_30\_6\_14Row.



### A.6 Nectarine tree models (Nectarine\_6\_4\_14, Nectarine\_30\_3\_14)

The following four trees were measured in an experimental orchard at the Volcani Center in Bet Dagan. The trees were modeled by the measuring device.



Fig. A.17 Actual plant Nectarine\_6\_4\_14 and Nectarine\_30\_3\_14.

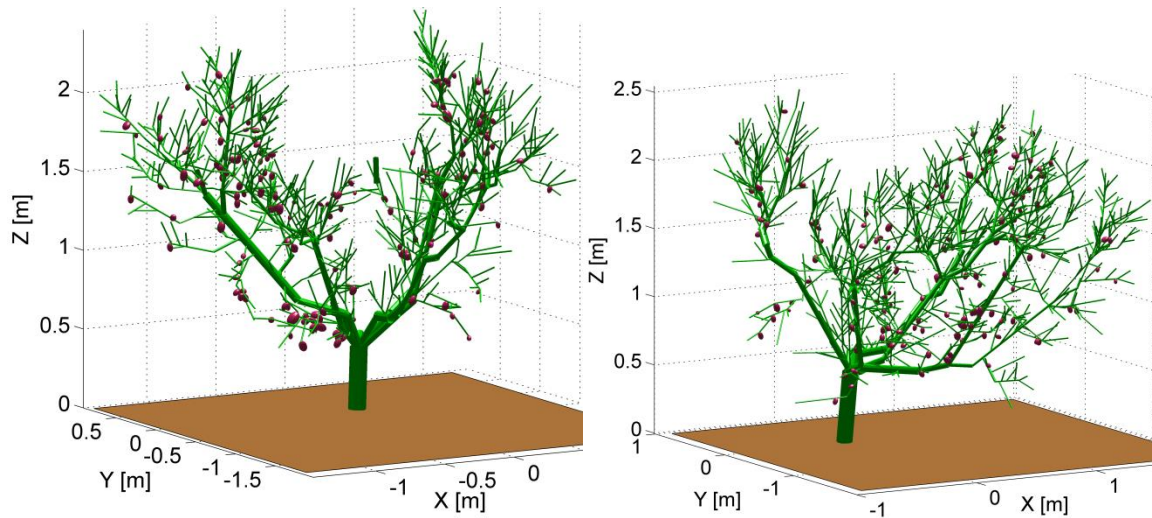


Fig. A.18 Models of Nectarine\_6\_4\_14 and Nectarine\_30\_3\_14.

### A.7 Peach tree models (Peach\_23\_03\_14, Peach\_24\_03\_14)

The following trees were measured in an experimental orchard at the Volcani Center, Bet Dagan. The trees were modeled by the measuring device.



Peach\_23\_03\_14



Peach\_24\_03\_14

Fig. A.19 Actual plants *Peach\_23\_03\_14* and *Peach\_24\_03\_14*.

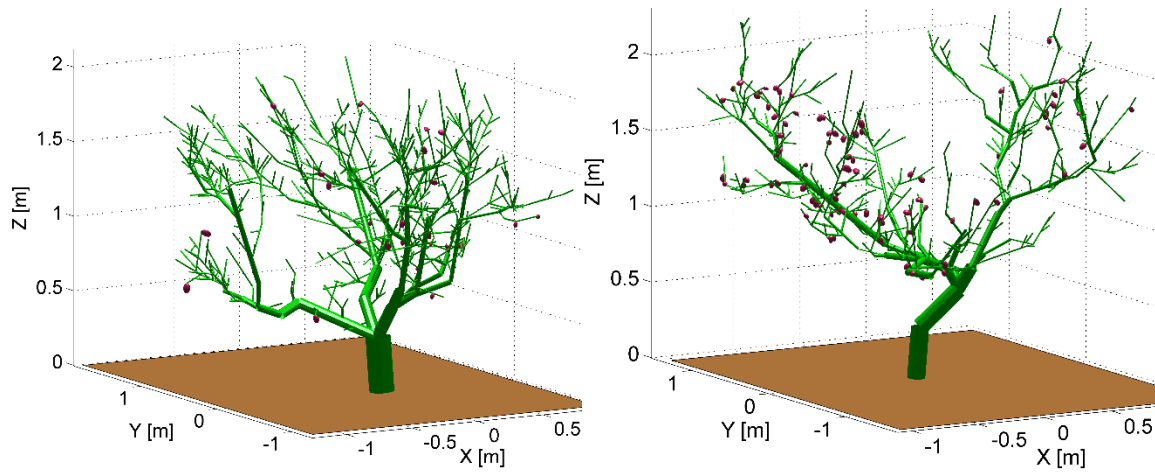


Fig. A.20 Models of *Peach\_23\_03\_14* and *Peach\_24\_03\_14*.



## A.8 Tangerine tree models (Tangerine\_20\_3\_14)

The tree was measured in a commercial orchard. The tree was modeled by the measuring device.



Fig. A.21 *Actual plant Tangerine\_20\_3\_14.*

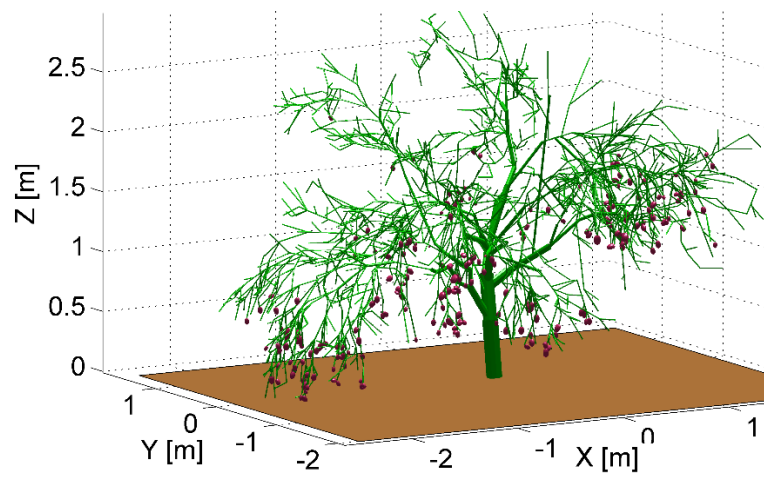


Fig. A.22 *Actual plant Tangerine\_20\_3\_14.*