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Response of watersprout growth to fruit load and intensity of dormant pruning in peach tree

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ABSTRACT

Watersprout occurrence and growth were investigated over a two-year period in an early maturing peach cultivar (Alexandra) under different intensities of dormant pruning for fruited and defruited trees. A preliminary study focused on identifying the laws that determine the probability of presence and occurrence of watersprouts in relation to watersprout-bearing shoot (WBS) length. The increase in watersprout probability of presence and occurrence resulting from greater WBS length illustrated the high capacity of peach for sprouting. Watersprout lengths were measured, as well as the lengths of young shoots, one-year-old fruit-bearing shoots (FBSs) and older branches considered as WBS in order to evaluate total shoot growth within the tree. Watersprout number and total length tended to be higher under severe dormant pruning and in fruited trees than under light dormant pruning and in defruited trees. This stimulation of watersprout length appeared to compensate for the concomitant lower total length of young shoots, resulting in a constant overall vegetative growth rate for the whole tree. In the second year of the experiment, watersprouts were either removed by summer pruning or not in order to evaluate watersprout incidence on the rest of the tree. After light and severe watersprout removal (WSR), the annual diametrical growth of FBS tended to be higher and lower, respectively, compared to trees not submitted to summer pruning. Light WSR might favour light interception in the centre of the canopy, thus improving assimilate production and allocation to FBS, whereas severe WSR could prevent carbohydrate export from watersprouts to FBS. Under our conditions, the limit at which WSR intensity became detrimental for FBS diametrical growth appeared to be after approximately 75% of the watersprouts were removed. Severe WSR appeared likely to improve fruit diameter, whereas it had no significant impact on the percentage of soluble solids.

1. Introduction

Watersprouts, also known as epicormic sprouts, in peach tree are vigorous current-year shoots growing on shoots at least two years old (Hackett, 1985). They are different from current-year young shoots growing on one-year-old fruit-bearing shoots (FBSs) (Gordon et al., 2006b). The physiological functions of watersprouts within the tree have not been completely elucidated yet. Watersprout removal generally contributes to an increase in light penetration within the tree and, therefore, to fruit quality (Myers, 1993). Nevertheless, severe watersprout removal has been reported to reduce assimilate availability to fruit (Walsh et al., 1989), showing that watersprouts might provide assimilates to the rest of the tree (Day et al., 1989). The following question thus arises: should watersprouts be considered as undesirable for fruit and other shoot growths, or do they provide carbohydrates that contribute to these external growths? Some contradictions in the responses to this question have already been observed (Gordon and DeJong, 2007), outlining the diversity of watersprout characteristics, particularly in terms of cultural practices such as intensity of dormant pruning and tree fruit load (Wilson, 1992; Li et al., 2003a).

In order to improve our knowledge about this question, we conducted experiments over a two-year period with three-year-old peach trees (cv. Alexandra) submitted to three intensities of dormant pruning. Trees either bore a constant fruit load within the same year so as to more effectively compare the incidence of pruning treatments (Marini, 2003), or were defruited so as to test fruit load incidence on the growth of the different vegetative organs inside the canopy, notably watersprouts. Characterising watersprouting in young peach trees was an important aim of this study. We therefore first set out to identify the laws that determine the probability of the presence and the occurrence of watersprout in relation to the length of watersprout-bearing shoots (WBSs). Second, the final lengths and numbers of watersprouts as well as those

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of young shoots were recorded for the different dormant pruning intensities and tree fruit load treatments. The objective was to evaluate the contribution of watersprouts to the annual overall vegetative growth of the tree. Third, during the second year of the experiment, watersprout removal (WSR), i.e., summer pruning, was either performed or not in order to evaluate watersprout incidence on the rest of the tree (Flore and Lakso, 1989). This effect was particularly investigated on fruit and the diametrical growth of FBS, both of which develop high carbohydrate requirements (Genard et al., 1998). This trial made it thus possible to assess the effect of different intensities of dormant pruning combined with summer pruning, whereas dormant and summer pruning have until now only been the object of separate studies (Mediene et al., 2001; Li et al., 2003b; Kumar et al., 2010).

2. Materials and methods

2.1. Plant material and experimental design

This study was performed at the INRA Gotheron Experimental Station near Valence in the Middle Rhône Valley in France (45.0°N; 4.9°E). The peach trees (cv. Alexandra, grafted on GF 305 rootstock) had been cultivated according to standard cultivation practices since 2002. The soil was stony alluvial with 15% clay, 30% silt and 54% sand, considered particularly suitable for peach tree cropping (Bornand, 1968). The plantation was composed of three rows of 30 trees. Tree rows were planted north to south to optimise light interception, and trees were spaced 2 m apart in the row, with the rows 4.5 m apart. There were two main scaffold branches per tree (Y training according to Mika, 1986). The study was carried out in 2004 and 2005. Peaches were pruned in winter and hand-thinned at the beginning of May (Mitcham, 1980). Summer pruning was carried out on 1st June, only in 2005. Summer pruning consisted in removing the longest watersprouts that overcrowded the centre of the canopy. Full bloom occurred on 20th and 15th March in 2004 and 2005, respectively. The ripening date of Alexandra fruit was around 25th June for the two years of the experiment.

The experiments were performed on the middle tree row, the two external rows being considered as guard rows (Fig. 1). To maintain soil fertility and the homogeneity of the experimental area, cereal crops had been sown for three successive years after the previous peach tree plantation and before re-planting for this experiment. Homogeneity of the experimental area was checked once more by measuring tree trunk circumferences before the differentiation of the treatments: trunk cross sectional areas were not found to be different (results not shown). Each of the 12 treatments was randomly laid out in each of the two blocks, i.e., 24 selected trees (Fig. 1). The blocks were separated from each other by guard trees. In 2004, T7–T12 treatments were a replicate of T1–T6 treatments inside each of the two blocks. In 2005, there was no replicate of the treatments in each block.

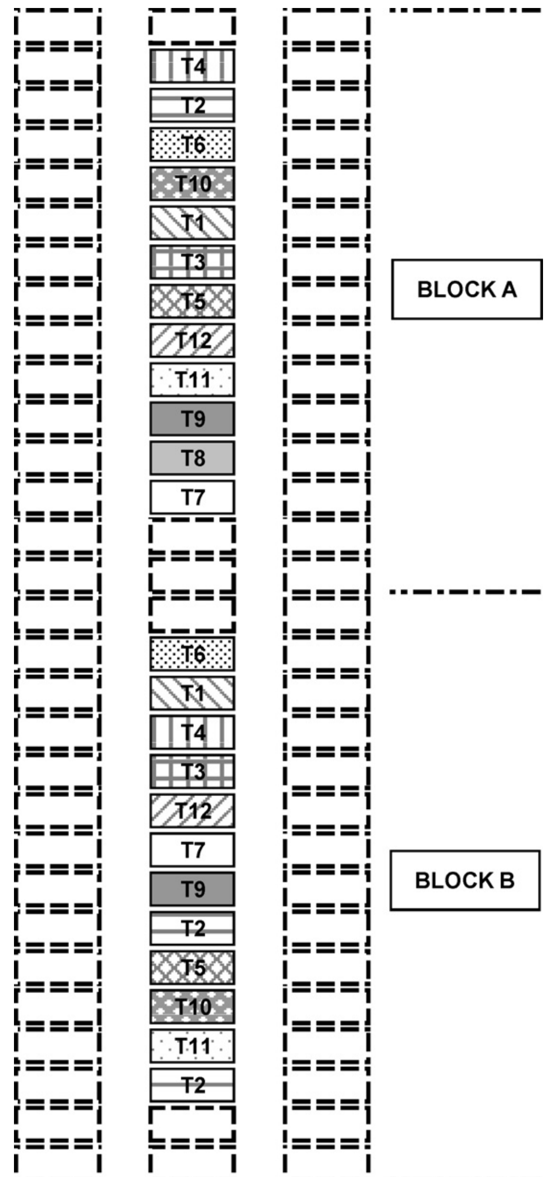

Fig. 1. Experimental layout in peach trees. Each tree is represented by a rectangle (dotted for guard trees). (T1, T4, T7, T10), (T2, T5, T8, T11) and (T3, T6, T9, T12) corresponded to light, medium and severe dormant pruning, respectively. (T1, T2, T3, T7, T8, T9) = 100 and 120 fruits per tree in 2004 and 2005, respectively; (T4, T5, T6, T10, T11, T12) = defruited trees. Summer pruning was either performed (T7, T8, T9, T10, T11, T12) or not (T1, T2, T3, T4, T5, T6).

2.2. Experimental treatments

Twelve treatments (T1–T12) corresponding to two factors – intensity of dormant pruning and tree fruit load – with the summer pruning factor added in 2005, were arranged in each of the two blocks (Table 1). Three intensities of dormant pruning were compared (Table 1): light (T1, T4, T7, T10), medium (T2, T5, T8, T11) and severe (T3, T6, T9, T12), with trees bearing the same total fruit load of approximately 100 fruits in 2004, 120 fruits in 2005 (T1, T2, T3, T7, T8, T9), or defruited trees (T4, T5, T6, T10, T11, T12). The maximal variation of 9% on fruit load between fruited trees occurred within the same year. For the three dormant pruning intensities, the number of fruit-bearing shoots (FBSs) left on the trees after pruning were 40 and 90 for light pruning, 30 and 45 for medium pruning, and 20 and 30 for severe pruning in 2004 and 2005, respectively. In 2005, summer pruning was either performed (T7, T8, T9, T10, T11, T12), or not (T1, T2, T3, T4, T5, T6).

2.3. Measurements

Trunk cross-sectional areas (TCSAs) were evaluated every year in winter by measuring tree circumferences at 30 cm from the ground. In order to take variations in the vigour among trees into account in 2004 and 2005, tree shoot numbers and final lengths were expressed per cm^2 TCSA.

The kinetics of watersprout growths were assessed in 2004 every two weeks from 50 DAFB (Days After Full Bloom) to 138 DAFB, so as to determine the period at which watersprouts reached their maximal lengths. We measured the length of every watersprout