Effects of MKR1, a Dwarfing Rootstock, on Growth of Kaki Scion©

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A dwarfing rootstock, MKR1, for kaki (*Diospyros kaki* L.), is applied to the Ministry of Agriculture, Forestry and Fisheries for cultivar registration. We have intensively investigated the field performance of kaki trees on MKR1 and showed the following characteristics:

- The growth of shoots on MKR1, which used to be named "rootstock-b" or "OD-1," was inhibited and the shoots hardly showed secondary growth (Tetsumura et al., 2010). As a result, the trees are dwarfed (Fig. 1).
- Early fruit drop, which is one of the big problems for kaki growers, was drastically decreased on MKR1 trees (Tetsumura et al., 2011a).
- Efficiency, such as yield per ground area covered by tree canopy and yield per canopy volume, was the best in the trees on MKR1 (Tetsumura et al., 2010).

These characteristics of MKR1 will make this rootstock a preferable alternative for kaki growers. In addition, MKR1 is easy to root if the single-node stem cuttings were collected from root suckers (Tetsumura et al., 2003; 2009; 2011b), while Malling se-

Figure 1. 'Hiratanenashi' kaki trees on MKR1 (left) and free stock (right) 8 years after planting at the orchard of University of Miyazaki. The height of blue sheet is 3 m.

ries apple rootstocks developed by East Malling Research and distributed worldwide, are mainly propagated by stooling because they are not easy to root by cuttings. The grafted unions of some combinations of Malling series rootstocks and apple cultivars are not strong and can be broken by strong winds, whereas the graft union between two cultivars and MKR1 withstood the typhoons (Tetsumura et al., 2010).

However, we are not able to explain the reason why MKR1 gave scions the useful characteristics. Hence, we show all the phenomena observed in the investigation of the field performance and discuss them to find the reason.

'Fuyu', 'Hiratanenashi', 'Soushu', and 'Taishuu' trees on MKR1 bore flowers soon after field establishment (Haranoushiro et al., 2010; Tetsumura et al., 2010). The percentages of flower-bearing shoots of 'Fuyu' and 'Hiratanenashi' trees on MKR1 were the highest every year (Tetsumura et al., 2010).

Leaves of the scion cultivars on MKR1 were smaller (Fig. 2).

These phenomena, including inhibited shoot growth and higher yield efficiency, are similar to those of the kaki trees treated with trunk girdling (Fumuro, 1997; 1998). In fact, the graft union between kaki tree scions and MKR1 swelled (Ishimura et al., 2011; Tetsumura et al., 2010), so phloem transportation might be worse in the graft union. Although numerous studies on apple dwarfing interstocks have shown that the longer the interstock, the greater the amount of dwarfing (Ferree and Carlson, 1987), the length of shank of MKR1 did not affect the growth of 'Fuyu' scion (Ishimura, pers. commun.). This fact also indicates that the cause of dwarfing is at the graft union between kaki scion and MKR1. However,

- The harvest time of trees on MKR1 was not earlier, although the bud break was earlier (Tetsumura, pers. commun.).
- Although the growth of trees on MKR1 was inhibited, they did not become weak and bore many fruit every year (Tetsumura et al., 2010). Kaki trees on seedling stocks often show severe alternate bearing, but the trees on MKR have shown stable harvest.
- These phenomena are different from those of the kaki trees treated with trunk girdling (Fumuro 1997; Harima et al., 2006). If the cause of dwarfing exists only at the graft union, a nursery stock grafted on MKR1 interstock will become a dwarfed tree. The height of nursery stock on MKR1 interstock was lower than that on free stock (Ishimura et al., 2011). However, the swelling at the graft union did not form when MKR1 was used as interstock (Fig. 3).

Figure 2. Leaves of MKR1 (left), 'Hiratanenashi' on MKR1 (upper middle), 'Hiratanenashi' on free stock (upper right), 'Fuyu' on MKR1 (lower middle), and 'Fuyu' on free stock (lower right). The white ruler indicates 30 cm.

- The height of nursery stock on MKR1 interstock was almost the same as that on MKR1 rootstock, but lateral growth of the former was inhibited. That is to say, apical dominance of the latter was lost (Fig. 4). Scions on MKR1 rootstock may produce "knip-boom" tree (Ono et al., 2001). Figure 1 (left) shows a result of the tree growth of weak apical dominance on MKR1 rootstock. These phenomena apparently show that the roots of MKR1 also affected the tree growth.
- Axillary buds on kaki shoots thickened with an increase of leaf primordia, and an occurrence of flower initiation decreased production of new leaf primordia (Harada, 1984). Hence, the size of axillary buds was not correlated with the number of flower buds, generally. However, the size of buds of 'Fuyu' and 'Hiratanenashi' trees on MKR1 was positively correlated with the number of flower buds (Ishimura, pers. commun.).
- In summer, leaves of the trees on MKR1 tended to curl like those of MKR1 (Fig. 2).

These new findings are all interesting because they have not been observed in kaki trees on free stocks. Moreover, most of the phenomena were not observed in other fruit trees on dwarfing rootstocks. We will investigate flower bud initiation, expression of flowering genes, photosynthetic rate, and sap flow, and will treat the nursery plants on free stocks with plant growth regulators to change them to grow like nursery plants on MKR1. These investigations will reveal the mechanism of dwarfing by MKR1, which may be different from the other dwarfing rootstocks.

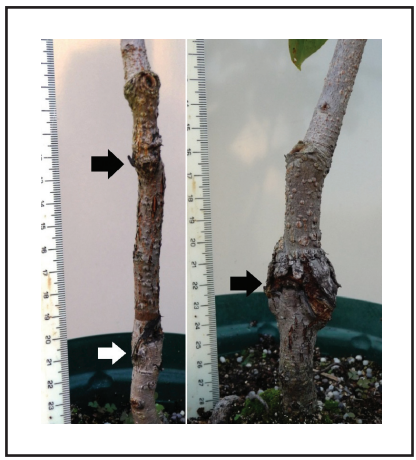

Figure 3. The graft unions between MKR1 and 'Fuyu'. MKR1 was used as interstock (left) and as rootstock (right). Black arrows show the graft unions between MKR1 and 'Fuyu' and a white arrow shows that between MKR1 and free stock.

Figure 4. Two-year-old 'Fuyu' nursery stocks on MKR1 as interstock (left) and as rootstock (right). The white ruler indicates 30 cm.

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