Orchard Management Systems for Fuji Apples in Washington State

Bruce H. Barritt
Tree Fruit Research and Extension Center
Washington State University
1100 N. Western Avenue
Wenatchee, WA 98801 USA

Fuji is a relatively new variety for apple growers in the sunny, hot and dry climate of central Washington. In 1988, only 3.5% of all apple trees planted in Washington were Fuji (Table 1). In the same year, 29.4% of the trees planted were Delicious and 13.6% were Granny Smith. The planting of Fuji peaked in 1991 at 34.8%. Since 1991, new plantings of Fuji have gradually declined. Fuji planting has slowed because of concerns about poor packouts due to fruit sunburn and insufficient red color, alternate bearing, late maturity and declining prices.

In 1990, Fuji production in Washington was just 1,000 metric tons (t) (Table 2). In comparison, Delicious, Golden Delicious and Granny Smith production in 1990 was 1,022,000 t, 276,000 t and 111,000 t, respectively. As the result of extensive planting of Fuji in the early 1990s, Fuji production reached 137,000 t in 1996, surpassing Granny Smith as the third leading variety after Delicious and Golden Delicious.

1990 Orchard Systems Trial

An orchard training system and rootstock trial was established at the Tree Fruit Research and Extension Center in 1990 with Fuji (Aki-fu 1) and Braeburn (only Fuji data are presented, except for fruit red color). The replant site with sandy loam soil was fumigated prior to planting. The soil was not contaminated with lead arsenate. The trial was irrigated, as rainfall occurs in the winter and is less than 250 mm (10 inches) annually.

Three training systems were included: 1) slender spindle with 1.25 x 3.25 m spacing and 2,460 trees/ha (996 trees/acre) with rootstocks Mark, B.9 and M.9; 2) vertical axis with 1.6 x 4.0 m spacing and 1,502 trees/ha (608 trees/acre) with rootstocks Mark, M.9, M. 26 and M.9/MM.111 interstock; and 3) central leader with 2 x 4.5 m spacing and 1,111 trees/ha (450 trees/acre) with rootstocks Mark, M.26, M.7 and P.1. The slender spindle trees were supported with an individual post to a height of 2 m, the vertical axis trees were supported to 3 m height with a metal conduit pole attached to a trellis wire, and the central leader trees had a short post to support the trunk but no support was provided above 1 m. Rows of 10 m (33 ft) length for each orchard system were planted (with 5 to 8 trees, depending on the orchard system) and these were replicated four times.

Tree training for the slender spindle, vertical axis and central leader systems was similar to that described by Wertheim (1970), Lespinasse (1980) and Heinicke (1975), respectively.

The slender spindle trees required extensive pruning to keep the trees at 2 m height and within their allotted space. The trees on Mark rootstock had severe gall-like swelling of the rootstock at the soil line, had light green leaves and grew very poorly.

The results of the 1990 orchard systems trial are reported through year 7. Tree size, measured as trunk cross-sectional area (TCA), was related to rootstock with Mark trees the smallest, followed with increasing tree size by B.9, M.9, M.26, M.7 and P.1 (Table 3). However, canopy volume was more closely related to orchard training system. With M.9, individual vertical axis trees had greater tree volume than slender spindle trees (Table 4). With M.26, central leader trees had greater tree volume than vertical axis trees.

Canopy volume per hectare in year 7 for all orchard systems was fairly similar with rootstocks B.9, M.9, M.9/MM.111, M.26 and M.7 (9,779 to 13,176 m^3 per hectare) (Table 4). This suggests that there will be smaller differences in annual yields between systems in future years in contrast to the large differences in yield and tree volume between systems in the early years.

Cumulative production per hectare during the first 7 years was related to tree density (Table 3). The slender spindle system at the highest tree density had greater production than the vertical axis system and the central leader system at the lowest tree density generally had the lowest cumulative yield. However, in year 7, yield per hectare for the slender spindle system was generally lower than the yield for the vertical axis system (e.g., with M.9 yield was 44 t/ha for slender spindle and 54 t/ha for vertical axis) (Table 4). This occurred in spite of the fact that the slender spindle and vertical axis trees on M.9 had similar canopy volume per hectare. It appears that the low production for the slender spindle trees is the result of excessive pruning to keep the trees in their allotted space (width and height). In contrast, the vertical axis trees required less pruning and were wider and taller. The more open canopies of the vertical axis trees also contributed to improved red fruit color (Table 6). It has been observed in other trials that annual yield/ha for the vertical axis system has been lower than for the slender spindle system through approximately year 5 but in later years yields for the vertical axis system have equaled or surpassed slender spindle yields.

1992 Orchard Systems Trial

A second orchard systems trial with Fuji/M.9 and Braeburn/M.26 was established at TFREC in 1992. The trial included three orchard management systems at 2,500 trees/ha (1,012 trees/acre) and a fourth system, HYTEC (hybrid tree cone), at 1,667 trees/ha (675 trees/acre). The three higher density systems were Tatura trellis, 'V' spindle (Güttinger 'V') and double row. For each system, trees were planted in 12 m (39 ft) long rows that were replicated five times. With each orchard management system, half the trees had their height limited to 2 m and the other half to 3 m.

For the HYTEC system, trees were spaced 1.5 x 4 m with an individual post per tree. Trees were trained and maintained in a cone shape, as described by Barritt (1992). For the Tatura trellis system, trees were spaced 1 x 4 m, angled at 60˚ from horizontal in a 'V' with individual trees alternating to the right and left along the row. Limbs were attached to 5 wires on each side of the 'V'. This produced a thin palmette-like system on each side of the 'V'. The 'V' spindle was also planted with trees at 1 x 4 m spacing with alternating individual trees to the right and left along the row. The tree angle was 70˚ from horizontal. Each tree was attached to a metal conduit post maintained at a 70˚ angle by tying to a single top wire on each side of the 'V'. Each tree was trained as a spindlebush but at an angle of 70˚. The double row system had an alleyway of 3 m with the double rows 1 m apart and trees 2 m apart down each row. The trees were trained vertically as spindlebushes and attached to an individual post.

The tree size at year 5, measured as trunk cross-sectional area, was generally similar for all systems, although the Tatura trellis trees were the smallest with both varieties (Table 5). Cumulative yield per hectare to year 5 was similar for the three systems at 2,500 trees/ha with both varieties. Yield per hectare for the HYTEC system was lower than the other three systems in proportion to its lower tree density. This supports previous observations that early production is closely related to tree density. The three orchard training systems had little influence on early production (through year 5) when planted at the same density and with the same rootstock.

Differences in yield per hectare for trees maintained at 2 m and 3 m tree heights were not significant through year 4 with Fuji and Braeburn. However, in year 5, the 3 m tall trees had significantly higher yield than the 2 m tall trees, 20% higher for Braeburn and 29% higher for Fuji (average of all four orchard systems). The proportion of fruit with first class red color was 10% higher for the 3 m tall trees than the 2 m tall trees with both Fuji and Braeburn (Table 6). The 3 m tall trees had more open canopies, allowing better sunlight distribution.

Conclusions

1. M.9, B.9 and M.26 were suitable rootstocks for high density systems.

2. Yield of young orchards was influenced primarily by tree density; the higher the tree density, the greater the early production.

3. Excessive pruning to limit tree size reduced productivity, increased internal tree shading and reduced red fruit color; 3 m tall trees had more open canopies than 2 m tall trees.

4. Differences between orchard training systems in yield per hectare were small when they had the same tree density and rootstock.

Additional Reading

Barritt, B. H. 1992. Intensive Orchard Management. Good Fruit Grower. Yakima, WA.

Barritt, B. H. 1992. Management of HYTEC apple orchards. Part I: Orchard planning and establishment. Good Fruit Grower 43(19):4, 69, 70, 72, 73.

Barritt, B. H. 1992. Management of HYTEC apple orchards. Part II: Pruning and training. Good Fruit Grower 43(19):38-42.

Heinicke, D. R. 1975. High-density apple orchards—planning, training and pruning. USDA Agricultural Handbook No. 458.

Lespinasse, J. M. 1980. La conduite du pommier (2 partie). L'axe vertical. La renovation des vergers. Brochure CTIFL. Paris. 120 p.

Robinson, T., S. A. Hoying and W. H. Smith. 1996. Apple orchard systems trials in New York. Compact Fruit Tree 29: 107-113.

Wertheim, S. J. 1970. The training of the slender spindle of four apple varieties. Proefstation voor de Fruitteelt, Wilhelminadorp: Publication No. 10. 158 p.