Sweet Cherry Orchard Management with Dwarfing Rootstocks in Germany

Michael S. Weber

Oberdorfer Str. 3, D-88085 Langenargen, Germany

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In modern sweet cherry production farmers need an efficient orchard system in order to be economically viable. The characteristics of a modern sweet cherry orchard are regular, high and early yields, excellent fruit quality, high picking outputs, low management costs and an option to protect the orchard against rain and bird damage. The selection and evaluation of dwarf cherry rootstocks such as the Weiroot series and Gisela series in Germany led to the implementation of these rootstocks into commercial orchards in the late 1990s.

High density plantings (HDP) are now becoming more popular in Germany, though it is still a challenge to take the high investment risk, as well as managing the trees in an appropriate way to maintain fruit quantity and quality in later years. The use of dwarfing cherry rootstocks and their positive influence on precocity are major forces driving the change to high density plantings.

In Germany there are 3,980 ha (9,835 acres) of sweet cherries. Orchards older than 20 years occupy 45% of the area, whereas 14% of all sweet cherry orchards are younger than 4 years. This shows two effects—one is the need to replace old orchards, which are difficult to manage in terms of spraying, training, picking and to protect fruit against birds and rain through cover systems. Secondly, there is a dynamic process to introduce new exciting cultivars to the industry.

The characteristics of a modern sweet cherry orchard are trees with a small canopy and a positive effect on precocity, yield and fruit size. Therefore the optimum plant density has to be found. In the mid 1980s, Zahn (1994) started to intensify sweet cherry orchards with Mazzard and Colt rootstocks, regardless of the fact that dwarfing rootstocks did not exist at that time. He focused only on tree quality suitable for slender spindle tree training and on controlling the tree canopy in terms of light interception. Then, in the beginning of the 1990s, advanced selections of dwarf rootstocks encouraged the idea of intensifying the orchard design. The recommendation for planting distances depends to a large extent on the expected final height of the tree.

Under the conditions of 46˚ to 52˚ N latitude the final tree height is determined by half of the row distance plus 1 m (3 ft) (Winter, 1981). The maximum spacing within the row is determined by the length from basic scaffold to the top of the tree. To achieve a balance between the top and the lower part of the canopy it is recommended to cut off every lateral branch with a diameter larger than half, better one-third, the central leader (Zahn, 1994). Under more humid conditions this is regarded as very important in order to preserve tree health and extend the lifespan of a sweet cherry tree.

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MATERIALS AND METHODS

In 1990 two rootstock trials were planted independently from each other. One was planted 4 x 3 m (13.1 x 9.8 ft) distance in the Rhine valley on a light soil, nonirrigated, with an annual rainfall of 24 inches. The data represent results across the four tested cultivars, Burlat, Starking Hardy Giant, Schneiders and Hedelfingen, on five different rootstocks (Balmer, 1997). The other trial was planted 6 x 4 m (19.7 x 13.1 ft) on heavier loamy soil, nonirrigated, with an annual rainfall of 25 inches in the hilly region north of Stuttgart. The results represent the behavior of the variety Schneiders on seven different rootstocks (Möller, 1999). Both systems were trained as spindle trees, with a first cut of the central leader in the year of planting, due to uneven tree quality.

The main difference between a spindle tree and a slender spindle tree is that the central leader of the latter is left unpruned up to the year when tree space and volume have reached full yield capacity. The slender spindle remains therefore narrower in its tree shape and planting distances can be intensified.

When training a spindle tree, the trunk is cut back to a 120 cm (3.9 ft) height, approximately 40 to 50 cm (15 to 20 inches) above the last suitable branch of the basic scaffold. Three to four emerging shoots below the cutting point are removed by hand. The procedure is repeated up to year 3 by distances of 50 to 60 cm (20 to 24 inches) along the central leader. Lateral branches stronger than half the diameter of the trunk are completely ripped out or cut back to a stub. Additional training operations such as bending down to 70˚ to 90˚ take place in years 1 and 2.

When training a super spindle tree, the central leader is left unpruned. In year 1 anticipated feathers are mainly not cut back. Three to four green shoots are removed below the terminal bud. This procedure is repeated in years 2 and 3. The top of the tree will be restrained in height in year 5 by cutting on 2-year-old wood with flower buds.

Actual spacing distances in commercial orchards are shown, according to the training system, soil fertility and influence on vegetative growth by the variety (Table 3).

Calculations in Euro/ha (1 Euro = 1 US $) include all investment and variable costs under commercial conditions (Table 4). Other economic data originate from official statistics (KTBL, 1995). In year 8 a 50% yield loss is considered due to spring frost or other fruit damage. In year 4 an investment was made in a rain cover system costing 23,000 Euro per ha. The economic comparison is calculated as a present value of future cash flows to the initial cash outflow attributable to the investment (Tables 5 and 6).

RESULTS

Influence of Rootstocks on Yield and Fruit Quality

Between years 4 and 7 Gisela 5 had a yield of 40.9 kg/tree, the highest accumulated yield, and the highest specific yield (yield efficiency) of 0.57 kg/cm² TCA (Table 1). Therefore its specific yield was the highest among the tested rootstocks. In the other trial (Table 2), Schneiders showed the highest accumulated yield on Weiroot 10, closely followed by W 158, a second generation of the Weiroot selection program. Regarding specific yield, Weiroot 72 with 0.73 kg/cm² TCA was greater than the other 6 tested rootstocks. W 158 showed the greatest fruit weight of 9.0 g. Weiroot 72 showed the least vegetative growth as well as remarkable fruit size of 8.3 g (Table 2).

Labor Input

Picking cost is the biggest expense of all annual cost factors. More efficient picking results with the high density system are due to a smaller canopy volume which shortens the distance between the fruit picker and the bin. Therefore the picking output increased by 43% (Table 5). This is the biggest financial impact in time management, as labor cost for the super spindle is lower at 128 hours/ha, though its yield is 26% higher. The spindle training system with 60 hours/ha requires fewer hours/ha in comparison to the super spindle system with 86 hours/ha. Once full yield has been attained, the higher tree density (by a factor of 2.9) combined with a super spindle training system explains the higher labor requirement.

Cash-Flow Analysis Between Two Planting Densities

From the moment of investment to year 3 the higher density orchard shows a lower net present value (NPV) (minus 826 Euro/ha) than the less intensive system (Table 6). Up to that point the lower density is more favorable. This is due to higher investment costs to establish a super spindle orchard. Breakeven of the high density planting (HDP) takes place between years 4 and 5 with a positive NPV of 3,808 Euro/ha

TABLE 1

Comparison in a 1990 trial of Burlat, Schneiders, Hedelfingen, Starking Hardy Giant on different sweet cherry rootstocks, year 7 (Balmer, Ahrweiler, 1997).

Rootstock	Accumulated yield/tree (% of Gisela 5)	TCA (cm²)	Specific yield (kg/cm² TCA)	Mean fruit weight (1996 only) (g)
Gisela 5	100[Z]	61	0.57	8.8
Mazzard	67	134	0.26	8.3
Colt	47	110	0.24	8.1
Damil	28	70	0.16	8.8
Maxma 14	59	107	0.31	8.3

[Z]100 = 40.9 kg/tree (years 4-7).

TABLE 2

Comparison of sweet cherry variety Schneiders with different cherry rootstocks, year 9 (Möller, Weinsberg 1999).

Rootstock	Accumulated yield/tree (% of Weiroot 10)	TCA (cm²)	Specific yield (kg/cm² TCA)	Mean fruit weight (g)[Y]
Weiroot 10	100[Z]	169.7	0.38	8.9
F 12/1	46	181.5	0.16	8.3
Colt	45	165.1	0.17	8.9
Maxma 14	51	132.7	0.25	8.5
W 158	98	130.7	0.48	9.0
W 53	71	84.9	0.53	6.9
W 72	79	69.4	0.73	8.3

[Z]100 = 64.1 kg.
[Y]1993-1998 mean.

TABLE 3

Current plant densities for sweet cherry orchards on dwarf cherry rootstocks.

Strong growth*	Spindle	Slender spindle
Plant distance (m)	5.0 x 3.0	4.0 x 2.5
Trees per ha	667	1,000
Weak growth**	Slender spindle	Super spindle
Plant distance (m)	4.0 x 2.5	3.5 x 1.5
Trees per ha	1,000	1,905

*on virgin soil and cv. such as Burlat, Schneiders, Regina.
**replant situation and cv. such as Kordia, Starking Hardy Giant, Giorgia.

in year 5. The low density system has a positive NPV 1 year later with 3,142 Euro/ha. From year 4 onward, the HDP is always more favorable with a difference of up to 41,105 Euro/ha in leaf 10, provided fruit quality can be maintained. The reason for the better economic result is mainly due to a higher yield of plus 3.9 tons/ha and reduced picking cost of 13 cents/kg for the HDP.

DISCUSSION

The presentation and experience with spindle, slender and super spindle tree plantings on dwarf rootstocks show that they can be successful in commercial sweet cherry orchards. The effect on precocity by the use of dwarfing rootstocks such as Gisela 5, Weiroot 158 and Weiroot 72 justify the high investment cost for trees. An intensive sweet cherry orchard system where tree height is limited to 4 m (13 ft) encourages the option to invest in cover systems against rain and birds, as shown in Table 6. This investment decision was made in year 4, when the producer had gained confidence in his operation. It is a step toward yield reliability and increased fruit quality to supply the market with top quality fruit. Further investigations will cover the role of different tree training options to maintain fruit size with increasing years, as well as the role of irrigation on fruit quality in HDP.

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TABLE 4

Costs in Euro/hectare to establish a sweet cherry orchard of several cultivars on Gisela 5 with two different plant densities and training methods.

Training system	Spindle	Super spindle
Tree distance in m	5 x 3	3.5 x 1.5
Trees per hectare (x 0.9)	600	1 714
Price per tree	7.42	7.42
Plant material	4,450	12,715
Frame and planting	744	1,718
Total Euro per ha	5,194	14,433

TABLE 5

Comparison of basic economic data used in the cash flow analysis.

Training system	Spindle	Super spindle
Tree distance in m	5 x 3	3.5 x 1.5
Trees per hectare (x 0.9)	600	1,714
Year of full yield	7	5
Yield in tons/ha	15.0	18.9
Picking output kg/hour	14	20
Harvest hours/ha	1,071	943
Training hours/ha	60	86

Price 1.54 Euro/kg; wage 6.2 Euro/hour; interest rate 6%.

TABLE 6

Cash flow analysis in Euro/ha, comparing average annual yield and net present value (NPV) development between two different planting densities on a dwarf cherry rootstock.

Year	Spindle		Super spindle		Difference
	kg/tree	NPV	kg/tree	NPV	Euro
1	0.0	-6,975	0.0	-16,414	-9,439
2	0.8	-7,799	1.1	-17,580	-9,781
3	3.8	-5,889	5.5	-6,715	-826
4[z]	8.8	-21,875	8.8	-15,877	+5,998
5	15.0	-1,365	11.0	+3,808	+5,173
6	20.0	+3,142	11.0	+22,384	+19,242
7	25.0	+9,417	11.0	+39,796	+30,379
8	12.5	+15,052	5.5	+47,969	+32,917
9	25.0	+26,262	11.0	+63,284	+37,022
10	25.0	+36,800	11.0	+77,905	+41,105

[z] In year four, the cost of a rain cover system was Euro 23,000/ha.