# Sweet Cherry Tree Densities and Tree Training

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At Ahrweiler, in western Germany, in March 1994 a sweet cherry trial was planted to compare planting densities between 1666 and 5000 trees/ha (674 and 2024 trees/acre) in a V-shaped 30° spindle system and a V-shaped 60° trellis system with regard to their quantitative and qualitative performance. Varieties were Starking Hardy Giant, Noire de Meched, Fercer, Lapins and Regina (planted 1995), all grafted on Tabel® Edabriz *(P. cerasus)*. The first crops showed a positive correlation between planting density and yield, but also a large influence of the cultivar. Highest yields were obtained by Lapins with 5000 trees/ha. Rain covers did not completely prevent cracking and rotting but gave protection against frost during flowering time in 1997.

## INTRODUCTION

Traditional cherry industries suffer from poor productivity and high requirements in labor. The introduction of dwarfing rootstocks would enable a higher intensity of production with cherry. There is limited experience of the potential of those rootstocks with little knowledge of the effects of climatic and soil parameters, variety, virus sensibility, planting density, training form, etc. To answer the question of profitability and quality, in 1994 an intensification trial was planted with different planting densities and two different training forms.

Large and firm cherries which are requested by the dealers are often particularly sensitive to cracking. For this reason in the humid climate of north Germany the sweet cherry selection is dominated by soft, but split tolerant varieties (Zahn, 1997). In other German production areas with firmer varieties, losses by splitting and rotting can be serious (Silbereisen, 1981). Previously, high trees prevented a profitable use of rain covering and were expensive to provide stability. New rain covering systems for small, densely planted trees should lead to a profitability and security comparable to other fruit crops.

## MATERIALS AND METHODS

### Climatic Conditions and Soil

The experimental station of Ahrweiler is situated in a side valley of the Rhine in a climate favorable for vine-growing. The average yearly temperature is 9.6°C (49°F) and the amount of precipitation 628 mm (24.7 inches). First ripening week of sweet cherries is normally the last week of May. Soil is a loamy sand with 2.5% organic material. At 0.6 m (24 inches) of depth, a 30 cm (12 inch) gravel layer covers loam subsoil.

*Traditional cherry industries suffer from poor productivity and high requirements in labor.*

**TABLE 1**

Planting densities and tree forms, with 4 m between-row distance.

| In-row tree spacing | V-shape training | Density (trees/ha) |
|---|---|---|
| 50 cm | 30° spindle | 5000 |
| 100 cm | 30° spindle | 2500 |
| 150 cm | 30° spindle | 1667 |
| 150 cm double range | 30° spindle | 3333 |
| 50 cm | 60° hedge | 5000 |
| 100 cm | 60° hedge | 2500 |
| 150 cm | 60° hedge | 1667 |
| 150 cm double range | 60° hedge | 3333 |

### Tree Density and Training Systems

The trees at four densities (Table 1) were planted in March 1994 with four

varieties differing in habits, vigor and productivity. The cultivars were Noire de Meched, Fercer, Lapins and Starking Hardy Giant. One year later, Regina was added. All varieties are grafted on Tabel® Edabriz (*Prunus cerasus*, Asiatic type). To have equal start conditions for the two training systems, all trees were cut down to 70 cm (28 inches) above the soil level. Only in a density of 5000 trees/ha (2024 trees/acre) for the spindle system heading was avoided. For having a weaker growth of the basal side limbs, all side buds above 90 cm (35 inches) were removed by sparing the terminal bud.

The two training systems are the slightly oblique 30˚ V spindle, attached to a bamboo pole in a 30˚ V construction and the 60˚ V-shaped trellis hedge. The latter differs from the Australian Tatura trellis (Y-shaped) by individual trees being inclined alternately from one side to the other (van den Ende and Chalmers, 1975). Depending on the planting distance the number of trees per treatment unit varied between 7 and 21.

The whole trial was covered by two different rain shelter constructions. Since 1997, plastic was spread out not only during ripening time for about 5 to 6 weeks but also at bloom as a frost shelter.

### Measurements

For the performance of the planting system standard measurements are carried out as follows: Yearly crop per tree separated into intact, cracked and rotten fruits. Rotten fruits with cracks are placed in the class of cracked fruits. Productivity is expressed in kg per stem circumference, fruit size by average weight of one fruit from a sample of 50 fruits (Schmidt et al., 1985). Flesh firmness is measured by the French Durofel instrument (a dynamometer with a bolt of 0.25 $cm^2$) (Planton, 1992).

The whole plot is fertigated and soil moisture controlled by watermark tubes.

## RESULTS

After planting in March 1994, the first crop was picked in 1996. Due to the preliminary character of the study, only yield data, losses by cracking and rotting, firmness and fruit weight are shown.

### Yield

The mean yield values of four varieties show increasing crop correlated with increasing planting density for both 1996 and 1997 (Table 2). The V 60˚ hedge had a lower average yield than the V 30˚ spindle. In 1998 + 1999 it was the opposite, but in 2000 the spindle had advantages (Table 3). The yield development is very characteristic for each training system: While the 30˚ spindle is increasing continuously, the 60˚ trellis hedge had decreasing yields in 2000 (Fig. 1 and Fig. 2). There were also differences depending on the four varieties (Table 4): Fercer had its first yield only in the fourth growing season and Lapins was the most productive variety. The double range (DR) V 60˚ had a decidedly low yield in 1997 because this range was not covered at bloom.

**FIGURE 1**

Yields of 30˚ spindle plantings at four tree densities from 1996 to 2000; mean values of 4

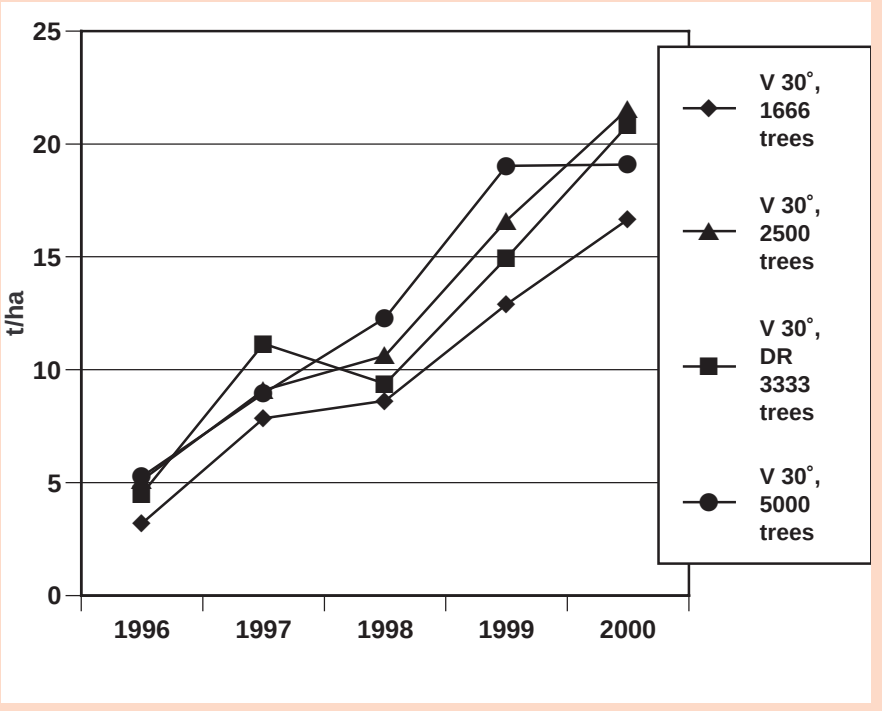
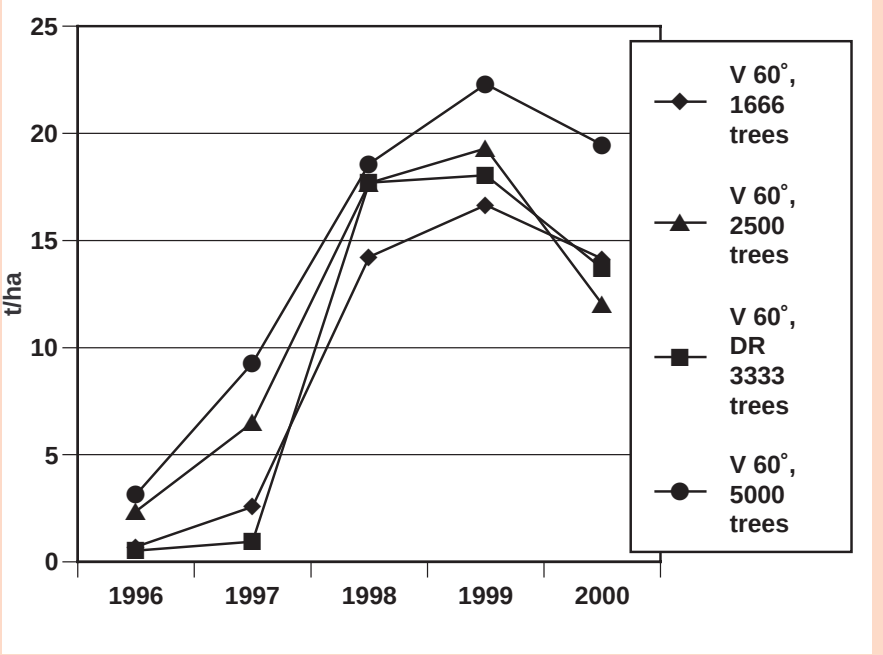



**FIGURE 2**

Yields of 60˚ hedge plantings with four tree densities from 1996 to 2000; mean values of 4



### Losses By Cracking and Rot

In 1996, cracked and rotted cherries were not separated. There was a higher loss with increasing number of trees/ha. Lapins V 30˚ spindle had a maximum with a loss of 79%. The examination of the 1997 crop showed that most of the cracked and/or rotted cherries could be quantified as cracked. It could be proven that the influence of the year and the variety has a significant effect on cracking and that covering cannot prevent it absolutely.

**TABLE 2**

Mean yield values of 4 varieties in 1996-1997 (years 3 and 4) for two training systems each at four tree densities.

| Angle (trees/ha) | Yield (t/ha) 1996 | Yield (t/ha) 1997 | rotten + cracked (t/ha) 1996 | rotten + cracked (t/ha) 1997 | Firmness 1997 |
|---|---|---|---|---|---|
| V30˚, 1666 | 3.22 | 7.85 | 0.91 | 0.71 | 61.0 |
| V60˚, 1666 | 0.70 | 2.58 | 0.18 | 0.28 | 60.0 |
| V30˚, 2500 | 5.13 | 9.12 | 1.32 | 1.33 | 62.2 |
| V60˚, 2500 | 2.38 | 6.50 | 1.23 | 0.75 | 62.8 |
| V30˚ DR[Z] 3333 | 4.60 | 11.16 | 1.33 | 1.38 | 62.0 |
| V60˚ DR 3333 | 0.54 | 0.95 | 0.27 | 0.24 | 63.5 |
| V30˚, 5000 | 5.35 | 8.98 | 1.74 | 1.22 | 64.2 |
| V60˚, 5000 | 3.21 | 9.25 | 1.13 | 0.88 | 64.0 |

[Z]DR is double range.

**TABLE 3**

Yield of V 30˚ spindle and V 60˚ trellis, each at four tree densities, for 1998 to 2000 (years 5, 6 and 7); values are means of four varieties.

| Angle (trees/ha) | Yield (t/ha) 1998 | Yield (t/ha) 1999 | Yield (t/ha) 2000 | % rotten + cracked 2000 | Soluble solids 2000 | Firmness 2000 |
|---|---|---|---|---|---|---|
| V30˚, 1666 | 8.62 | 12.9 | 16.3 | 4.4 | 14.4 | 58.0 |
| V60˚, 1666 | 14.22 | 16.7 | 14.6 | 1.8 | 14.9 | 58.0 |
| V30˚, 2500 | 10.61 | 16.6 | 20.2 | 3.5 | 14.2 | 58.0 |
| V60˚, 2500 | 17.67 | 19.3 | 12.6 | 2.4 | 15.2 | 57.5 |
| V30˚ DR[Z] 3333 | 9.35 | 15.0 | 18.1 | 3.7 | 14.6 | 58.3 |
| V60˚ DR 3333 | 17.69 | 18.0 | 13.9 | 2.7 | 15.3 | 58.0 |
| V30˚, 5000 | 12.28 | 19.1 | 19.0 | 5.0 | 14.1 | 57.8 |
| V60˚, 5000 | 18.58 | 22.2 | 18.5 | 2.9 | 15.1 | 58.0 |

[Z]DR is double range.

**TABLE 4**

Total yield (t/ha) 1996 + 1997 for V 30˚ spindle and V 60˚ trellis, each at four tree densities for four varieties.

| | Noire de Meched | | Fercer | | Lapins | | S. H. Giant | |
|---|---|---|---|---|---|---|---|---|
| Angle (trees/ha) | 1996 | 1997 | 1996 | 1997 | 1996 | 1997 | 1996 | 1997 |
| V 30˚, 1666 | 4.78 | 10.38 | 0.00 | 6.76 | 3.71 | 5.12 | 4.33 | 9.22 |
| V 30˚, 2500 | 4.30 | 12.80 | 0.00 | 3.61 | 9.68 | 11.15 | 6.45 | 8.92 |
| V 30˚, 5000 | 4.35 | 12.50 | 0.00 | 3.19 | 11.12 | 15.07 | 5.60 | 5.04 |
| V 30˚ DR[Z] 3333 | 2.50 | 7.72 | 0.00 | 7.29 | 9.62 | 17.13 | 5.88 | 12.51 |
| V 60˚, 1666 | 0.59 | 4.40 | 0.00 | 0.20 | 0.48 | 1.39 | 1.74 | 4.33 |
| V 60˚, 2500 | 1.91 | 7.42 | 0.00 | 0.62 | 5.35 | 11.00 | 2.23 | 6.98 |
| V 60˚, 5000 | 3.74 | 13.96 | 0.00 | 3.14 | 4.98 | 10.97 | 3.83 | 8.99 |
| V 60˚ DR 3333 | 0.23 | 2.45 | 0.00 | 0.46 | 0.96 | 0.13 | 0.90 | 0.77 |

[Z]DR is double range.

**TABLE 5**

Average fruit weight (g) in 2000 for two training systems, each at four tree densities with four varieties.

| | Training system and tree density (trees/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variety | V 30˚, 1666 | V 60˚, 1666 | V 30˚, 2500 | V 60˚, 2500 | V 30˚, DR3333 | V 60˚, DR3333 | V 30˚, 5000 | V 60˚, 5000 |
| Noire de Meched | 9.4 | 8.9 | 9.2 | 9.8 | 11.5 | 10.7 | 9.4 | 9.4 |
| Fercer | 11.0 | 9.9 | 10.5 | 9.9 | 10.9 | 8.9 | 10.8 | 10.8 |
| Lapins | 10.6 | 9.9 | 9.0 | 11.0 | 8.7 | 9.2 | 9.7 | 9.9 |
| S.H. Giant | 8.5 | 8.9 | 9.4 | 10.0 | 8.5 | 8.8 | 8.2 | 9.3 |

## Fruit Weight and Firmness

There was no general tendency in fruit weight. High density plantings with 5000 trees/ha seemed to have the firmest fruits which is most apparent for Noire de Meched and Lapins (Table 2 and Table 6). Fruit weight seems to decrease at a threshold which is typical for variety and yield level. In 2000 at the lowest planting density (1666 trees/ha) V 60° trellis had on average smaller fruits than V 30° spindle for all varieties.

## Discussion

Traditional mazzard orchards normally have their maximum potential of productivity from the 8th year. Average yield is said to oscillate at about 10 to 12 t/ha in Germany (Ackermann et al., 1995). First results prove that this level can be achieved in the 4th year with a dwarfing rootstock and a higher planting density. For these intensive orchards poor croppers such as Fercer give comparatively bad performance. At least for the first years of an orchard, a high density is favorable for good yields. In the trial 5000 trees/ha were much better than 1666 trees/ha.

The very low yield in 1997 in the double range (DR) V 60° hedge is probably caused by frost effect as this range was the noncovered control during the critical period.

It is too early to discuss the potential of productivity of the two training systems. Losses by cracking and rotting were unexpectedly important. Results of 1997 showed that more cherries were split than rotted. Wounds in the fruit skin mostly cause *Mondia* (sp.) infections subsequently (Mink and Jones, 1996) and we saw that most cracked fruits were rotted at the picking date. Particularly susceptible was Lapins, showing a very dense and bunched fruit set. Consequently cultivar choice is also important for covered orchards and Monilia control should not be neglected. With removable coverings (Selberg et al., 1995) it has to be proven whether there is an influence on fruit quality. The hourly records of temperature and relative humidity gave no clear differences.

Best fruit firmness for the highest planting density can be an effect of ripening date which is investigated on actual fruit samples.

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**TABLE 6**

Average fruit firmness (Durofel 25) in 1997 for two training systems, each at four tree densities with four varieties.

| Training system (trees/ha) | Noire de Meched | Fercer | Lapins | S. H. Giant |
|---|---|---|---|---|
| V 30°, 1666 | 59.3 | 68.2 | 57.5 | 58.4 |
| V 30°, 2500 | 57.4 | 71.0 | 57.9 | 62.9 |
| V 30°, 5000 | 59.8 | 69.1 | 60.7 | 67.3 |
| V 30° DR 3333 | 60.9 | 69.3 | 57.6 | 60.1 |
| V 60°, 1666 | 58.1 | 66.7 | 58.4 | 56.9 |
| V 60°, 2500 | 59.4 | 72.2 | 58.4 | 61.7 |
| V 60°, 5000 | 61.2 | 73.6 | 59.6 | 60.7 |
| V 60° DR 3333 | 55.8 | 73.5 | 58.5 | 66.0 |