

# Organic plum production under weather protection

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## Abstract

*Expansion of Swiss organic plum production is limited by pest and disease pressures, as well as adverse weather conditions. In a five-year trial ten plum varieties were grown with and without rain covering from flowering to harvest under organic management. The results showed that weather protection increased yield by 7.5% and fruit weight by 8.5%, while reducing monilia infestation at harvest by up to 70%. This resulted in an estimated additional revenue of CHF 26,500 per hectare over five years. Plum rust was also significantly reduced, while trees without protection showed greater growth due to natural rainfall. Post-harvest storage trials at room temperature revealed increased monilia losses in weather-protected fruits after prolonged storage, suggesting infection risks via microcracks despite weather protection. There were notable varietal differences, with Tophit Plus and Dabrovice yielding the most, and Fellenberg, despite being susceptible to monilia, retaining its market preference. While weather protection clearly benefits organic plum cultivation, the long-term effects on tree health, pest dynamics and economics require further study. Additional trials are ongoing to evaluate the use of full nettings for pest control, with the practical adoption of this method depending on regulatory approval and cost.*

**Keywords:** organic plum production, weather protection, monilia

## Introduction

Organic plums are mainly grown in Switzerland for the fresh fruit market. Demand for fruits used in processing for jams, yoghurts, baked goods, etc. is relatively low. The increase in demand for organic table plums has only been partially met by the expansion of acreage, mainly through new organic farms. Fellenberg is the main variety, accounting for more than 50% of production. Although organic plums achieve a producer price that is approximately 50% higher than that of conventional production, it is mainly plant protection problems such as monilia and plum moths, as well as weather events (frost, hail, long periods of rain), that prevent further expansion of organic production.

Many years of experience in organic cherry cultivation have shown that weather protection installed at the time of flowering can strongly reduce moisture-loving diseases such as monilia (Häseli, 2017). In organic plum production, weather protection could be worthwhile primarily against diseases such as blossom and fruit monilia, which cannot be controlled or can only be controlled insufficiently with organic plant protection products. However, a weather protection could also be beneficial against other diseases such as bacterial blight (*Pseudomonas*), shot hole disease, plum-pocket disease, plum rust and rain-induced fruit cracking. With additional side nettings, plum moths, spotted wing drosophila (*Drosophila suzukii*) and possibly other pests could be reduced.

To assess the impact of weather protection on the most significant diseases, yield, fruit quality, and post-harvest shelf life, a trial was conducted at Agroscope's stone fruit centre

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Breitenhof in collaboration with the Breitenhof advisory board. The trial involved 10 plum varieties, which were all grown with and without weather protection.

## **Material and Methods**

In autumn 2013, the ten varieties Katinka, Tegera, Cacaks Schöne, Dabrovice, Cacaks Fruchtbare, Toptaste, Fellenberg, Jojo, Tophit Plus and Presenta, covering approximately eight weeks of harvest, were planted on Wavit rootstocks with 2 x 3 trees per variety and treatment at a planting distance of 2.24 x 4.5 m and subsequently trained as spindles. For weed control and to stimulate nutrient mineralisation, the tree strips were hoed three to four times in spring until mid-June using a 'Ladurner' hoeing machine. Weather protection (=rain cover) was installed before flowering until after harvest. Aphids were controlled with white oil before budding and with a pyrethrum and soap treatment before flowering. Quassia was applied against sawflies and mating-disruption was used against plum moths across the entire farm area. Fungicides were never used during the entire trial. Fertilisation was carried out exclusively with mushroom manure. From the installation of the weather protection (= closing of the rain cover), each tree was watered every three days with around 20 litres of water (1.8 litres per m<sup>2</sup>). The varieties and trees were thinned out by hand depending on the fruit load and variety requirements.

The trees developed very well and uniformly, enabling the first harvest to take place in 2016. In 2017, the fourth year of vegetation, the final volume and thus the conditions for a full yield were achieved.

Just two years after planting, the first trees had to be grubbed due to sharka infestation. The affected varieties were Cacaks Fruchtbare, Cacaks Schöne, Tegera, Toptaste, Tophit plus and Presenta, with no differences between the two treatments. Because there were more tree losses, the trial was stopped in 2020 and the plantation was grubbed completely.

## **Results**

### ***Crop load and yield***

When estimating the crop load prior to thinning, a higher crop load was observed under weather protection in each of the five trial years. This difference was particularly noticeable in 2017, a strong frost year, when the effect of the weather protection in reducing frost damage was clearly evident (data not shown).

After thinning by hand to 1.3 kg of fruits per running metre of fruit branch and removing clusters, the 10 varieties under weather protection showed a significant increase in yield of 7.5% over the five harvest years compared to the harvest quantities without weather protection (Figure 1). In monetary terms, the treatment with weather protection achieved an average cumulative additional revenue of around CHF 26,500 per hectare over 5 years for the 10 varieties, with an additional yield of around 7'600 kg per hectare and a producer price of CHF 3.5 per kg.

The most productive varieties were Tophit Plus and Dabrovice. These achieved yields of over 15 kg per m<sup>2</sup> and five harvests in the protected treatment, which is almost twice as much as the least productive varieties, Katinka, Presenta and Fellenberg.

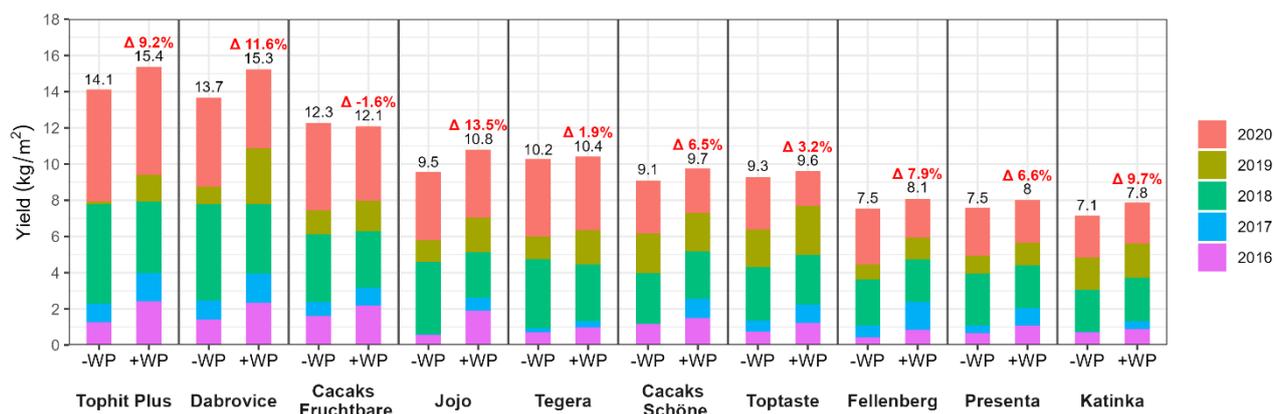


Figure 1: Cumulative yields in kg/m<sup>2</sup> of the 10 plum varieties from 2016-2020. +WP = with weather protection, -WP = without weather protection.

### Fruit weight

In terms of average fruit weight, the fruits in the treatment with weather protection were on average 8.5% heavier than that without weather protection (Figure 2). The variety Toptaste was an exception. One reason for this could be tree weakening due to sharka infestation, which occurred early on this variety and only under weather protection. The highest fruit weights were recorded for the varieties Tophit Plus, Jojo and Cacaks Schöne. Katinka had by far the lowest fruit weight. The other varieties hardly differed.

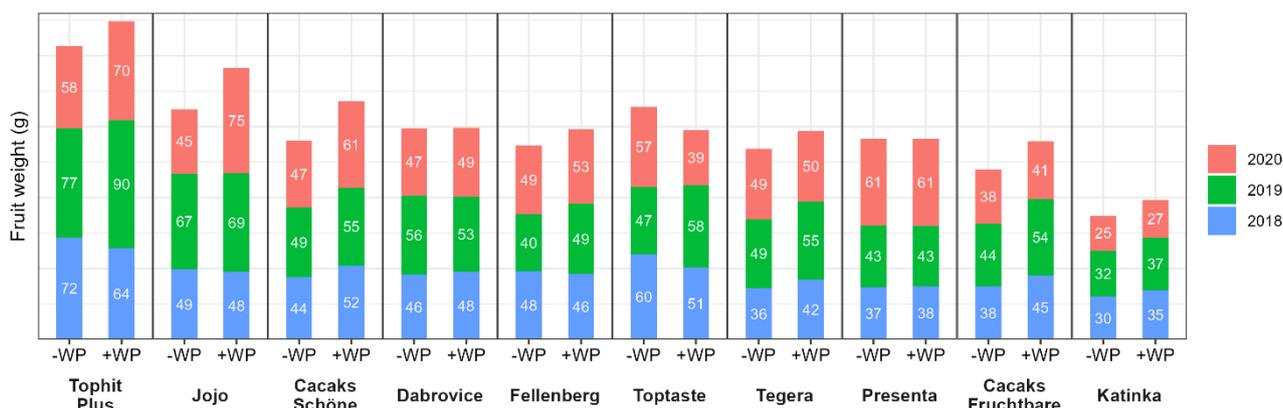


Figure 2: Fruit weight (g) of the 10 plum varieties. Average values for the years 2018-2020. +WP = with weather protection; -WP = without weather protection.

### Fruit monilia infestation at harvest

The proportion of fruits affected by monilia was estimated as percentage shortly before harvest. Monilia only occurred in the treatment without weather protection and only in the varieties Jojo, Tophit Plus and Fellenberg, with an average of 11 to 20% (Figure 3). In these three varieties, the infestation was reduced very strongly by 70% to 4 to 6% thanks to weather protection. The remaining seven varieties also showed only very low monilia infestation, ranging from 0 to a maximum of 4%, even in the treatment without weather protection.

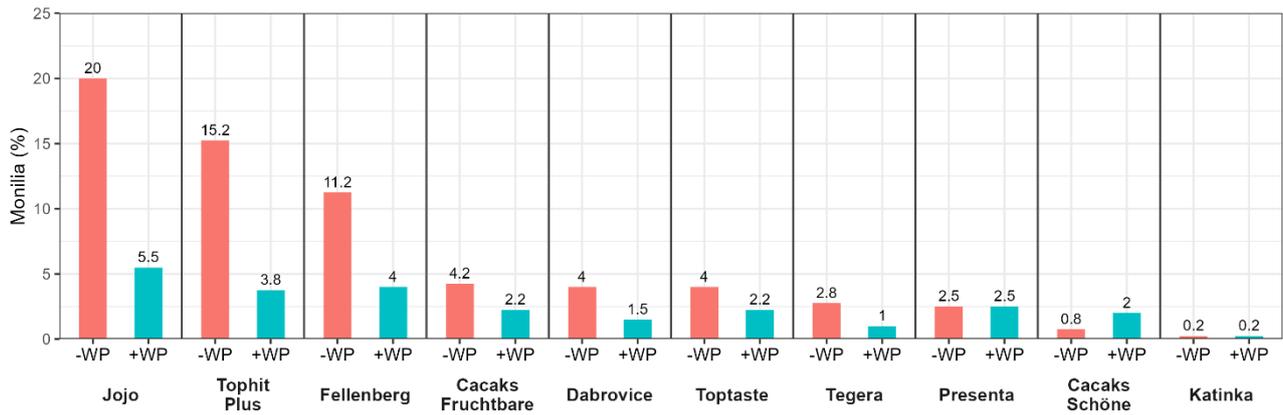


Figure 3: Estimated percentage of fruits affected by monilia on the tree at harvest. Average for 2017, 2019 and 2020 (2018: hardly any infestation). +WP = with weather protection; -WP = without weather protection.

### Development of Monilia infection after harvest

After harvest, 20 to 50 visually healthy fruits were stored at room temperature for both treatments and all varieties, depending on the year. After 3, 7 and 10 days of storage, the number of fruits affected by monilia was recorded. In contrast to the monilia infestation at harvest (Figure 3), 6 of the 10 varieties in the treatment with weather protection showed a higher loss due to monilia than in the treatment without weather protection (Figure 4). After 3 days, the losses due to monilia were still relatively low at a maximum of 8% and there were no differences between the treatments. Only after seven and ten days of storage the losses and differences between the treatments increased. Among the varieties, Tegera, Tophit Plus and the two Cacaks varieties were the most susceptible during storage, with an average of 34 to 43% losses after 10 days. The varieties Presenta and Jojo showed the lowest storage losses due to monilia, at 10 to 15%. There is no or only a limited correlation between monilia infestation at harvest and monilia infestation during storage. For example, the varieties Jojo and Fellenberg, which had a high level of infestation on the tree, showed only a slight loss during storage. In contrast, the opposite was true for the varieties Tegera and Cacaks Schöne, which had low tree infestation and high infestation during storage.

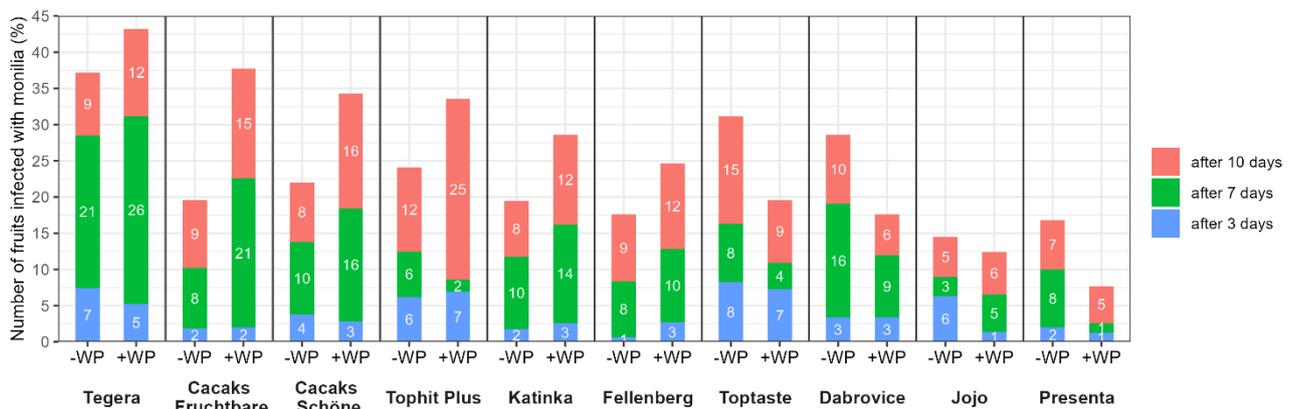


Figure 4: Number of fruits affected by monilia in % during storage at room temperature after 3, 7 and 10 days after harvest. Average values for the years 2017-2020. +WP = with weather protection; -WP = without weather protection

## Pseudomonas

Pseudomonas leaf infection was assessed towards the end of the growing season. In eight of the ten varieties tested, infection with pseudomonas was lower in the treatment with weather protection than in the treatment without weather protection (Figure 5). The varieties Katinka, Jojo, Cacaks Fruchtbare and Presenta were the most susceptible, with a medium level of infestation. The varieties Tophit Plus, Tegera, Fellenberg and Cacaks Schöne showed only very low levels of infestation.

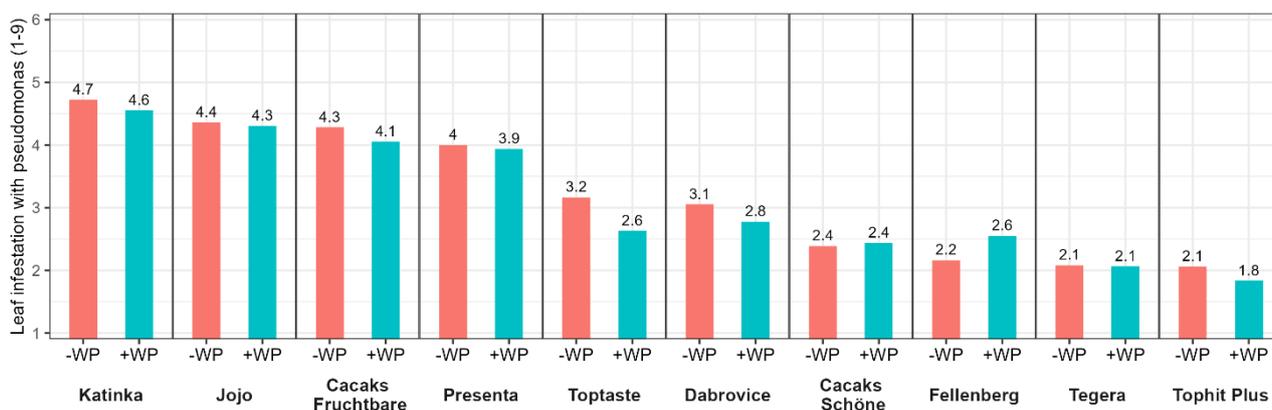


Figure 5: Leaf infestation (1-9) with pseudomonas in 10 plum varieties. Average for the years 2016-2020. Rating scores: 1 = no infestation; 5 = moderate infestation; 9 = very severe infestation. +WP = with weather protection; -WP = without weather protection

## Plum rust

The level of plum rust leaf infestation was assessed towards the end of the growing season. Under weather protection, plum rust infestation was consistently lower across all varieties compared to the treatment without weather protection (Figure 6). There was little difference in infestation levels between the individual varieties.

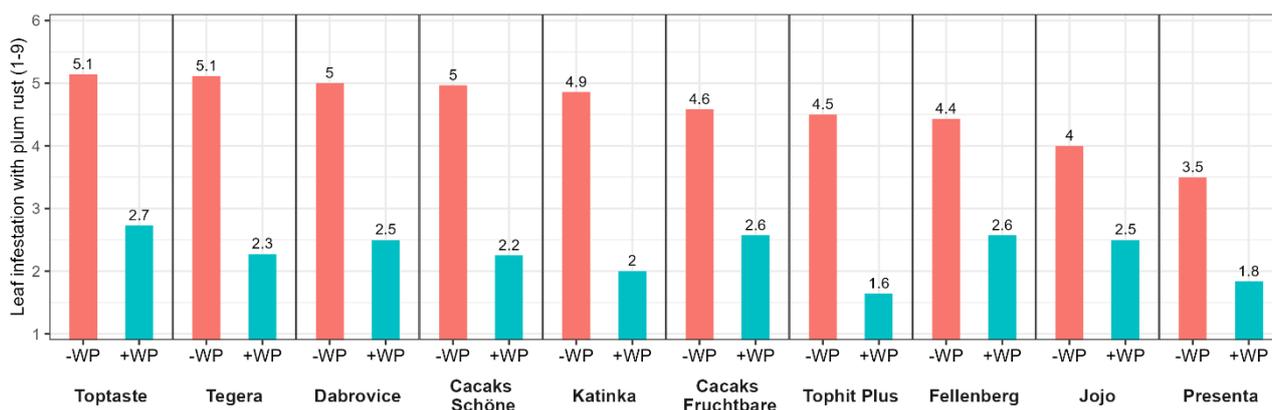


Figure 6: Leaf infestation (1-9) with plum rust in the 10 plum varieties. Average for the years 2016-2019. Rating scores: 1 = no infestation, 5 = moderate infestation, 9 = very severe infestation. +WP = with weather protection, -WP = without weather protection.

## Growth

The trunk circumference was measured at the end of each year. After seven growing seasons, all varieties showed stronger growth in trunk circumference in the treatment

without weather protection than in the treatment with weather protection (Figure 7). The varieties Tegera, Jojo, Dabrovice, Cacaks Fruchtbare and Katinka showed the strongest growth. The other varieties differed only slightly, with slightly lower growth rates.

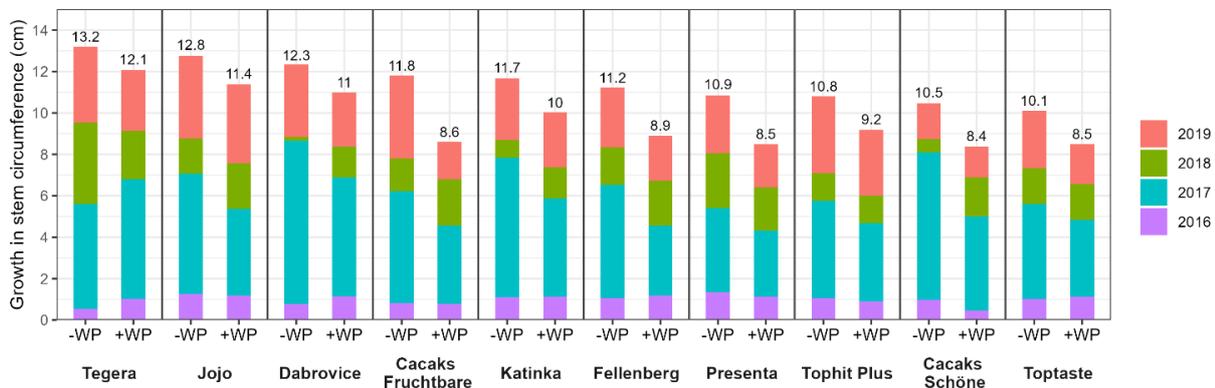


Figure 7: Growth in trunk circumference (cm) of the 10 plum varieties from 2016 to 2019. +WP = with weather protection; -WP = without weather protection.

### Aphids

A severe infestation of green plum aphids only occurred in 2020. There were no differences in infestation between the two treatments. Toptaste, Katinka and Presenta showed the highest infestation. Infestation was considerably lower in the varieties Fellenberg and Tophit Plus, followed by Tegera and Dabrovice.

## Discussion

### Influence of weather protection

In this plum trial, in which no fungicides were applied, the treatment with weather protection showed clear advantages over the treatment without weather protection for the 10 varieties tested. The weather protection installed before flowering until harvest resulted in a higher crop load during the first five harvest years from 2016 to 2020 and, after fruit thinning, a 7.5% higher yield and an 8.5% higher fruit weight. In addition to the more favourable microclimate and the fact that the fruits were kept dry, better protection against frost also contributed to this. Keeping the fruit dry under the cover also significantly reduced monilia infestation at harvest as shown also for sweet cherries in Børve and Stensvand (2003). The three most severely infested varieties without weather protection showed a high average monilia infestation of 11 to 20%, while the protected fruits showed a maximum infestation of 4 to 6%. Interestingly, the storage trial at room temperature after harvest showed a different picture. After three days, there was still no difference between the treatments and the level of infestation was still low for most varieties, but after 7 and 10 days, the infestation increased considerably. Monilia loss in the four most severely affected varieties rose to 30 and even over 40%. In these varieties, the infestation was higher in the weather-protected treatment than in the uncovered treatment. This shows that even fruits that are protected from rain during the growing season can become contaminated with Monilia spores and, during long-term storage, can become infected with monilia through micro-cracks in the fruit skin. This storage trial was conducted as a stress test at room temperature. It is to be expected that losses due to monilia will be lower under normal cold storage conditions after harvesting.

There were hardly any differences between the treatments in terms of pseudomonas infestation on the leaves. In contrast, infestation with plum rust was strongly reduced under weather protection.

The growth of the trees was stronger for all varieties without weather protection than for those with weather protection. The additional water supply from precipitation is likely to have been the main cause of the differences.

### **Variety evaluation**

Tophit Plus and Dabrovice achieved by far the highest yields both with and without weather protection, followed by Cacaks Fruchtbare. The lowest-yielding varieties, Katinka, Presenta and Fellenberg, on the other hand, only achieved about half the yield. The other varieties, Tegera, Jojo, Toptaste and Cacaks Schöne, differed little and achieved a yield that was about one-third lower than the highest-yielding varieties. In terms of monilia infestation at harvest, only Jojo, Tophit Plus and Fellenberg showed high infestation in the treatment without weather protection. The other varieties showed only a low level of infection, at 0-4%. Looking at both criteria, it is interesting that Fellenberg, the main variety in organic plum production, is both low-yielding and susceptible to monilia. However, thanks to its excellent flavour, it remains important for direct marketing.

### **Conclusion**

The trial has shown that weather protection in organic table plum production brings advantages in terms of important success criteria. However, due to the relatively short observation period during the first five years of yield, no conclusive statements can be made as to how the criteria examined will develop in both treatments over a normal cultivation period of around 15 years. In the longer term, the positive trend of weather protection could have an even greater impact on tree vitality, yield and fruit quality due to the criteria of protection against hail, long periods of heavy rain, plum rust and pseudomonas. The higher yield could offset the considerable additional costs of weather protection over the entire depreciation period and even increase the profitability of production. On the other hand, long-term weather protection could have a negative impact due to reduced light or an increase in sucking pests such as aphids and mites.

Another open question remains whether an additional full netting can also successfully control other key problems such as plum moths and spotted wing drosophila (*Drosophila suzukii*) and whether the microclimate, which is even more altered by the netting, does also favour the emergence of other pests, especially during heat waves, as seen in comparable trials in cherry production. To answer these questions, a new organic plum trial was set up at Breitenhof in 2022. The extent to which plum production under weather protection can become established in practice also depends heavily on how willing the relevant authorities are to approve such facilities with weather protection.

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