

# Testing of strawberry-cultivars under organic growing conditions

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## Abstract

*Since over 20 years regularly strawberry-cultivars have been tested at the LVWO Weinsberg under organic conditions, normally the cultivars were proofed within two-year-experiments. The single seasons had a wide variation concerning the weather-situation during blossom and picking-season with a tendency to more extreme circumstances. The best cultivars were taken over in the planting of the following year, like in a rolling system. Evaluations were done about flowering-period, development of yield, losses of fruits by rot and robustness of the roots against fungal diseases. Tastings were organised for fruit-growers, advisers and final consumers to find out, which cultivars would be accepted very well. A short overview shall be given over recent testing results of breeding-numbers and cultivars like HBR 90 254, HBR 140 4564, HBR 140 761 (=‘Rendevous’), P 5284 (=‘Juline’), D3 F; ‘Belleure’, ‘Bonneure’ and other, which could be interesting for the organic strawberry-grower, if all advantages and disadvantages were considered.*

**Keywords:** Organic strawberry growing, variety-testing, taste, climate change

## Introduction

Since more than 20 years strawberry cultivars have been tested at the LVWO Weinsberg, either under conditions, where no plant protecting agents were used at all, or under controlled organic conditions, first at the site Katzental, which has climate suitable for vine-growing, since 2004 at the site of Obstversuchsgut Heuchlingen (see Pfeiffer&Brockamp, 2010). Important criteria in the tests are robustness of the roots (no losses by root diseases like *Verticillium sp.*), good yield and moderate infections by *Botrytis cinerea*. An excellent taste is the most important characteristic, the fruit skin should not be too soft, so that the fruits tolerate some transport. In times, where the costs for the seasonal workers are increasing, the picking performance should be regarded, too, as far this is possible in small plot-trials.

## Material and Methods

In table 1 the period is listed, when data were collected about the cultivars, which will be described in detail. The cultivar-testing is a rolling procedure, where the best cultivars are taken over into the next trial. As previous crop a mixture of green manure (‘Hohebuch-Mischung’) or Buckwheat (*Fagopyrum esculentum*) was sown. Normally potted plants are used, either from conventional growing, if the breeding-types are very new, or from own organic propagation. The planting distance was 1.0 m x 3.0 m, the weed-control was done by rotary-tiller between the rows, additionally by hand hoe within the row. Water was given by drip irrigation with a moderate intensity. If it was necessary, the plants were protected with fleece to prevent damages by frost during blossom. In the first years of testing 20-25 plants per parcel were planted, later the most promising cultivars were taken into trials with three replications.

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During harvest every second day the strawberries were picked and sorted in several categories (> 30 mm, 25-30 mm, < 25 mm, deformations, infections by Botrytis, other losses like feeding by birds, snails, beetles or bugs, hail, mildew). The first two categories were summarized as “marketable yield”, the small ones and deformed fruits as “suitable for jam”. Regularly samples of 20 fruits were weighed for the calculation of an average fruit weight, this was done in both classes (> 30 mm, 25-30 mm) separately. If at the beginning of the ripening period less than 20 fruits were picked per parcel, the number of the fruits was noticed. For the data in the tables 2 and 3 all these sample-fruits were summarized for day 1-4 (= A), day 5-8 (B), day 9-12 (C) and the average fruit weight was calculated. The category “A shows the results at the beginning, when often the prices are higher for early ripening cultivars, and the category “B” normally represents the data of the ripening peak.

Table 1: Testing of organically grown strawberry-varieties – overview about years of planting

variety	Ripening period	2016	2017	2018	2019	2020	Number of plants each year
HBR 90 254	early	X	X	X	X	X	20 – 3 x 20
HBR 140 564	early-middle	X	X	X	X	X	20 – 3 x 20
HBR 140 674	early-middle	X	X	X	X	X	20 – 3 x 20
HBR 150176	early-middle			X	X	X	34 – 3 x 19
Clery	early	X					2 x 25
Faith	middle	X					25
Allegro	early		X				20
Sonata	middle		X				3 x 20
P 5284	middle	X	X	X	X		20 – 3 x 18
Belleure	middle					X	3 x 19
Schweizer Herz	middle					X	3 x 20
Bonneure	middle-late					X	3 x 20
D3 F	middle-late	X	X	X	X	X	15 – 3 x 20
Magnus	late				X	X	20-22

In the name of the breeding numbers the letters “HBR” are an acronym for the Hansabred GmbH & Co. KG, where Mr. Olbricht is engaged in breeding of new strawberry cultivars. P 5284 (=Juline) and D3 F are cultivars, which came from JKI Dresden-Pillnitz. ‘Belleure’, ‘Bonneure’ and ‘Schweizer Herz’ were selected at Lubera®-company and were available as organic plant-material in summer 2020.

### Results – Ripening behaviour, yield, fruit-size

For some cultivars up to six years long data were collected, so mainly single aspects of the vegetation periods 2019-2021 shall be in the focus of this article, which are similar to the tendencies of former years. The first trial presented here was planted in August 2018. At the end of March 2019 frost was rare, but on 14<sup>th</sup> of April light frost in 2 m height was measured, at the beginning of May it was two times frosty again, followed by several rainy days. In the middle of the picking season it was hot and sunny with maximum temperatures between 28 and 31 °C, at the end of June peak temperatures rose up to 31-36 °C, which can be critically for such cultivars, whose fruits are laying in the blazing sun.

Figure 1 shows the ripening behaviour of the tested cultivars in summer 2019, the first harvesting season. As in the tests in the former years HBR 90 254, HBR 140 564 and HBR

140 674 started early in the season, comparable to the cultivar 'Clery'. HBR 90 254 ripened in a compact window, while HBR 140 564 had the peak about one week later. For HBR 140 674 the ripening characteristic was not the same in every year, sometimes it was compact, sometimes the peak was later and not too high, more balanced over all. P 5284 fits into the ripening-group "middle", the peaks were 7-10 days later than at the early cultivars. D3 F is an interesting cultivar in the late window, the date of the Whitsun-holidays can have an influence on the potential in the direct marketing in the region of middle Neckar-valley, often in that time the middle-late cultivars have to be picked, so the marketing is decreasing a little bit (except for the special situation in 2020 and 2021).

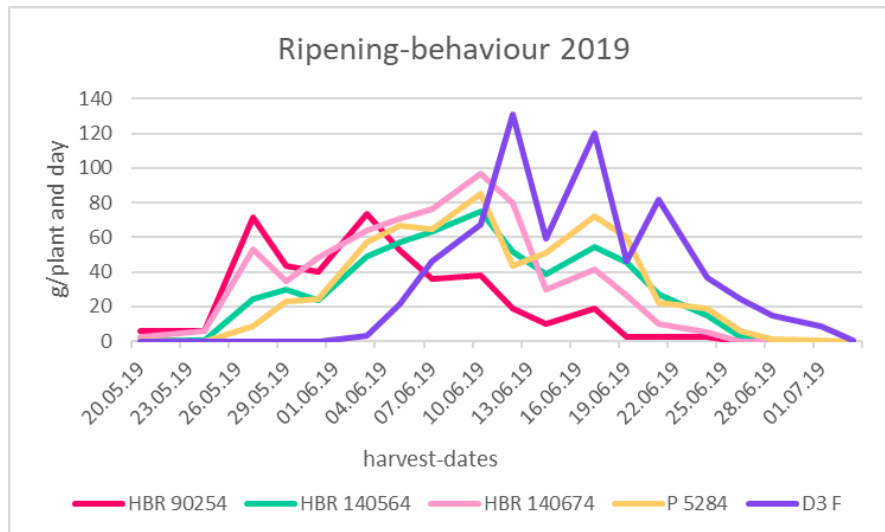


Figure 1: Yield (g/plant) of different strawberry-varieties during the first ripening period 2019, planted in August 2018

Figure 1 shows the ripening-behaviour in a year with normal weather conditions for the experimental site near Weinsberg. After a relatively wet winter (lots of rainfall in January and February) the weather in 2019 was characterised by large differences between day and night and several frost nights between middle of March and beginning of May.

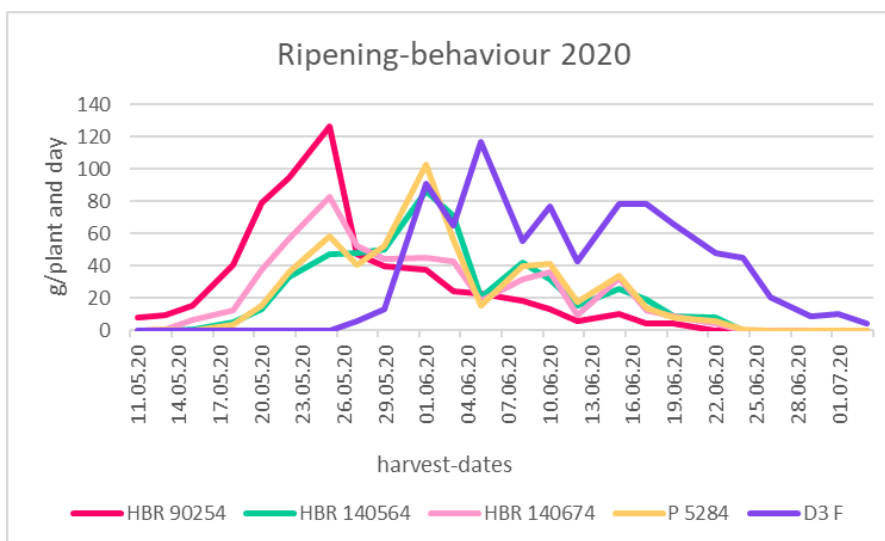


Figure 2: Yield (g/plant) of different strawberry-varieties during the second ripening period 2020, planted in August 2018

The last frost was on 12<sup>th</sup> of May, close to the start of the first picking of the early ripening cultivars, so the danger for deformations was high for the late cultivars, too (figure 3).

2020 (figure 2) had an extreme early beginning season with a strong peak of the first cultivars, but the end in the last week of June was comparable to the year before. At the interpretation of the data it should be considered, that peaks can be “artificially” high, when over the weekend the gap between the harvesting dates was 3 days instead of 2 days and the ongoing of the ripening was fast due to high temperatures. From June 5<sup>th</sup> to June 17<sup>th</sup> it was relatively wet, so the middle to late ripening cultivars had a risk for infections by fungal diseases.

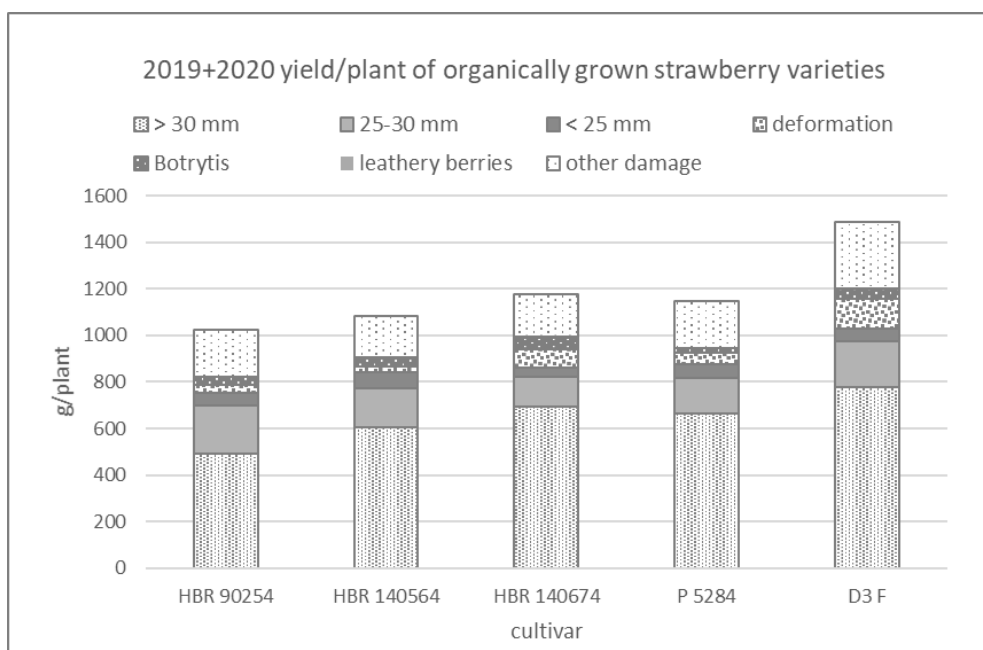


Figure 3: Cumulated yield 2019+2020 (g/plant) of different strawberry-cultivars, planted in August 2018

In 2019 only at the first few green-white berries infections by Botrytis appeared. Deducing from the data presented in figure 3 HBR 90 254 has a moderate-good yield, fruit-size is not too large (see table 2) and switches in the middle of the season to the middle size (25-30 mm), but this cultivar can be picked easily because of its growing habit, the fruits are rarely laying directly on the soil/straw and risk for Botrytis-infections is very low. HBR 140674 is interesting due to its good yield combined with an attractive fruit-size. But the fruit-skin is softer, so this breeding number suffered under the rainy conditions at the beginning of June 2020, the fruits cracked by the rain and infections by Botrytis followed, so the part of the column for Botrytis was a little bit higher.

Other damages were caused by birds, snails, partly by beetles and especially at very hot weather by sunburst or bugs. This portion was higher for the late ripening D3 F, partly because of the bigger and dark red fruits (one fruit damaged = more loss) and a light preference of snails and birds for this cultivar, even if the most other cultivars finished the harvesting season. The cumulated marketable yield was nevertheless the highest of these described cultivars. In the second season (2020, see table 2) the fruit weight was (as expected) in general lower and more unique due to higher yields.

Table 2: Average fruit weight (g) during harvest seasons 2019 (= first year) and 2020 (= second year), A = day 1-4, B = day 5-8 (peak), C = day 9-12, \*only P 5284 in the group A fruits 25-30 mm

variety	large 2019			large 2020			middle 2019			middle 2020		
	A	B	C	A	B	C	A	B	C	A	B	C
HBR 90 254	23.6	17.8	15.9	14.6	14.0	13.9		9.2	8.0	9.2	9.3	8.9
HBR 140 564	28.5	22.1	18.5	15.0	14.2	13.9		10.1	9.7	9.0	8.9	8.4
HBR 140 674	25.2	22.3	18.5	15.2	14.8	15.4		10.6	10.0	9.8	9.5	9.7
P 5284	34.2	21.7	18.0	17.6	15.7	14.0	8.7*	10.3	9.6	9.4	9.4	9.0
D3 F	37.4	22.9	19.7	20.1	16.2	14.9		13.4	8.4	10.1	9.0	8.6

In spring 2021 the weather conditions were like in the late 1990s, the season started not too early, between April 4<sup>th</sup> and April 16<sup>th</sup> temperature fell down heavily during night (down to -3,3 °C in 2 m height), so it was necessary to cover the trial, which has been planted in August 2020, several times with fleece against ground frost. On May 8<sup>th</sup> again one night was frostily, moderate temperatures with rain followed at the next days. The harvest season started relatively late at beginning of June with warm weather, but on June 10<sup>th</sup> twice hail fell in the same afternoon, the trial had been covered with hail-net against feeding of crows during the complete picking-period. From June 20<sup>th</sup> to middle of July it was rainy and optimal for infections by fungal diseases either on the fruits or on the leaves, therefore the results shall be presented here as a preliminary estimation of susceptibility under extreme conditions, even if not for all cultivars long-lasting experiences were collected.

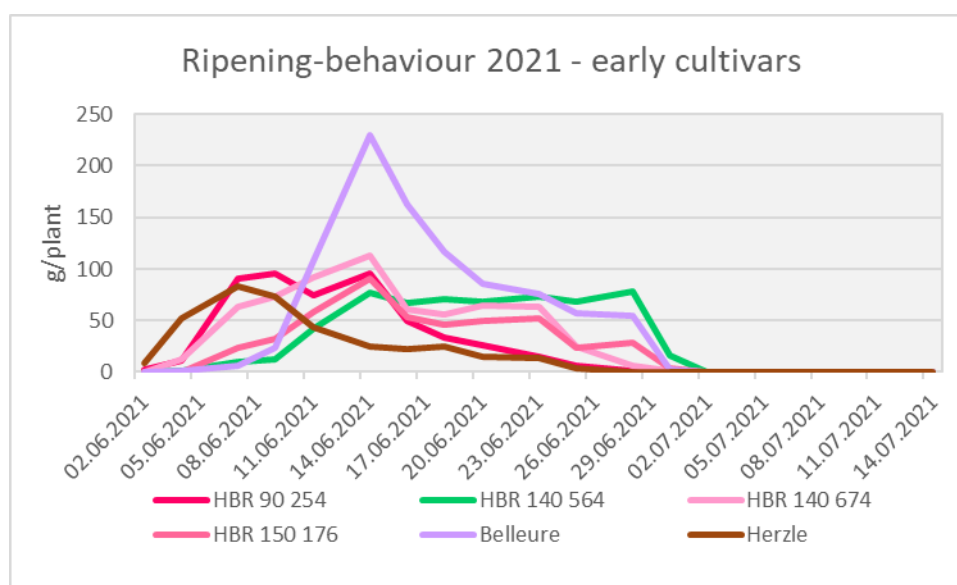


Figure 4: Yield (g/plant) of different strawberry-varieties 2021 (first year), planted in August 2020

The early cultivars HBR 90 254, HBR 140 564, HBR 140 674 and HBR 150 176 showed similar ripening behaviour as in the trials 2016-2019. Comparable to HBR 90 254 was the new cultivar 'Herzle' (Fa. Hummel, Stuttgart), which was included in 2020, and started time shifted with 3-4 days, had dark red berries with middle size (average weight 2 g lower than at HBR 90 254), soft skin and intensive aroma components like woodland strawberries (*Fragaria vesca*). 'Belleure' surprised by its high total yield combined with an attractive fruit-size, the peak was one week later than at the early cultivars. As reference for the time lag between early and late cultivars HBR 90 254 was added in figure 5, D3 F builds a bridge from the early to the late segment, where 'Magnus' is discussed in the last few years.

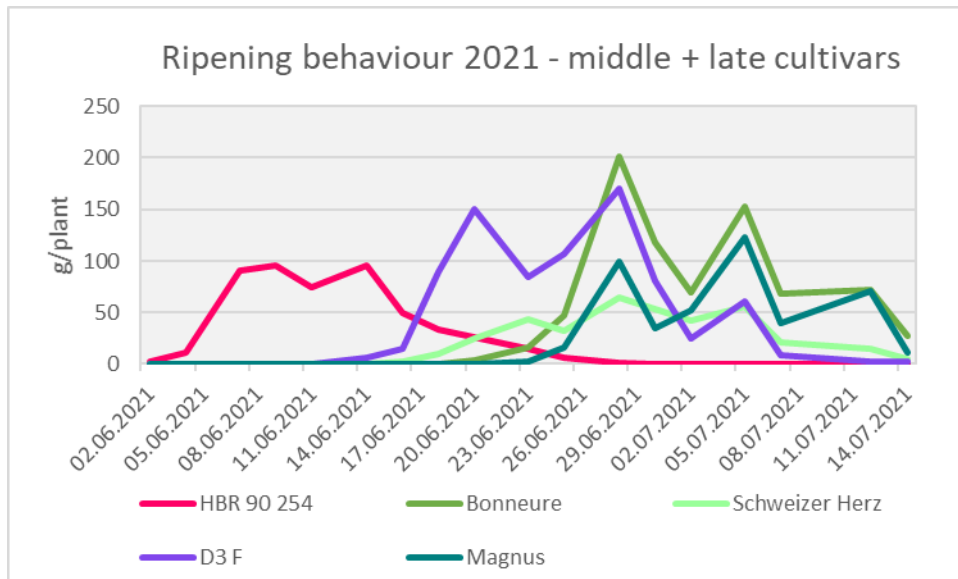


Figure 5: Yield (g/plant) of different strawberry-varieties 2021 (first year), planted in August 2020

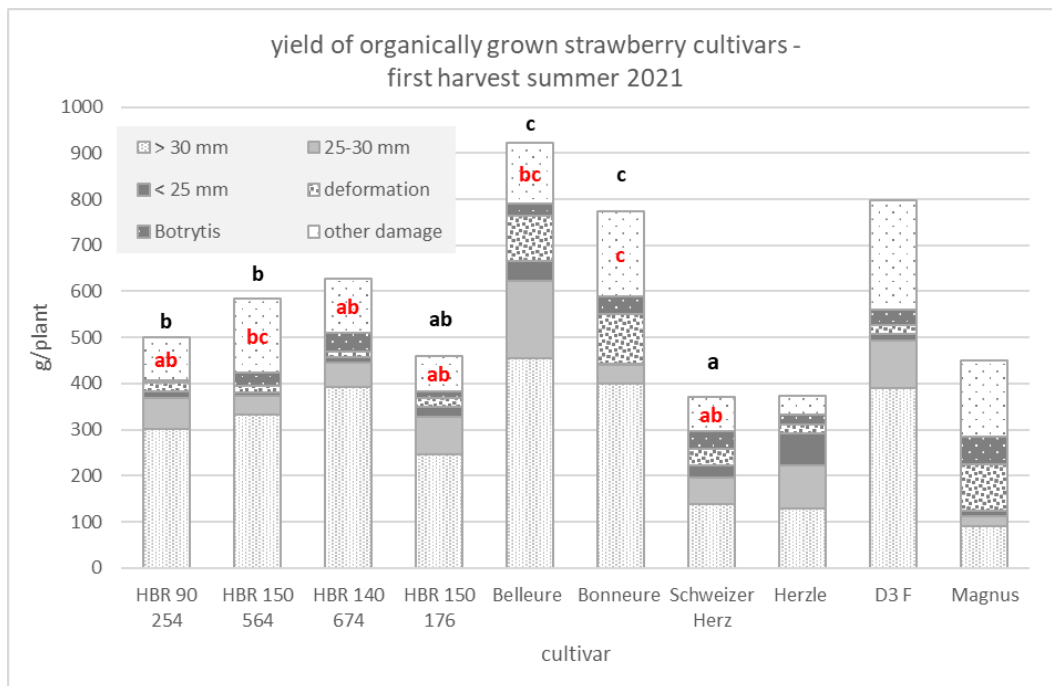


Figure 6: Yield (g/plant) of different strawberry-varieties 2021 (first year), planted in August 2020, ANOVA (without Herzle, D3 F and Magnus, one replication), tukey-test,  $\alpha=0.05$ , black letters above the columns = significances for total yield, red letters in the dotted part = significances regarding only "other damages"

Schweizer Herz' is more suitable for the hobby-fruit-grower or solidary growing-concepts, the habit is unique: Flowers are formed on the top of the up-right plant with some leaves like a roof above them. The fruit shape is like a heart, but the picking should be done carefully, so that the fruit is not damaged. Near the calyx lobes are small niches, where Botrytis can settle. This portion was significant higher than at HBR 90 254, all other cultivars were comparable. The observations have been carried out under conditions in 2021 with frost-events and cold temperatures during blossom and fruit development and several rainy days during harvest.

'Bonneure' is in the late group, too, had high yields, some more deformations due to frost in May. The peak of ripening was in wet period with lots of drizzle, but the percentage of Botrytis was in a middle range, because the inner of the plants was often still dry. 'Bonneure' had very vigorous plants, nearly knee-high, for harvest the fruits partly had to be sought inside of the leafage.

Table 4: Average fruit weight (g) during harvest season 2021 (first year, planted in August 2020)

variety	number of plants	fruits > 30 mm (large) g			fruits 25-30 mm (middle) g		
		day 1-4	day 5-8 (peak)	day 9-12*	day 1-4	day 5-8 (peak)*	day 9-12
HBR 90 254	3 x 20	18.6 a	15.1 a	14.7.	9.9 a	8.9	8.6 ab
HBR 140 564	3 x 14	27.9 bc	19.0 bc	17.6	10.0 ab	10.4	9.1 ab
HBR 140 674	3 x 17	25.3 bc	19.2 bc	17.2	9.2 a	9.6	8.8 ab
HBR 150 176	3 x 19	24.5 bc	17.5 bc	15.4	11.3 ab	9.6	8.9 ab
Belleure	3 x 19	26.0 bc	17.2 bc	16.3	12.3 b	10.3	9.9 b
Bonneure	3 x 20	30.6 c	20.4 c	16.2	12.4 b	10.2	8.4 ab
Schweizer Herz	3 x 20	23.2 ab	17.3 ab	14.9	10.9 ab	9.4	6.2 a
Herzle	1 x 23	16.4	12.4	13.0	8.7	8.2	8.1
D3 F	1 x 17	23.1	15.9	16.6	9.5	9.4	8.4
Magnus	1 x 22	27.3	17.0	12.0		10.7	

\*) Here no significant differences were found (ANOVA,  $\alpha = 0.05$ , tukey-test)

## Results – Taste

A few tastings have been organized in the past with different participants, organic fruit-growers, advisers, final customers, students of horticulture or students of school for fruit-growing at LVWO Weinsberg. For tasting of new breeding numbers a standard cultivar was added, in this tasting 'Clery', the level of it was marked with the horizontal red line.

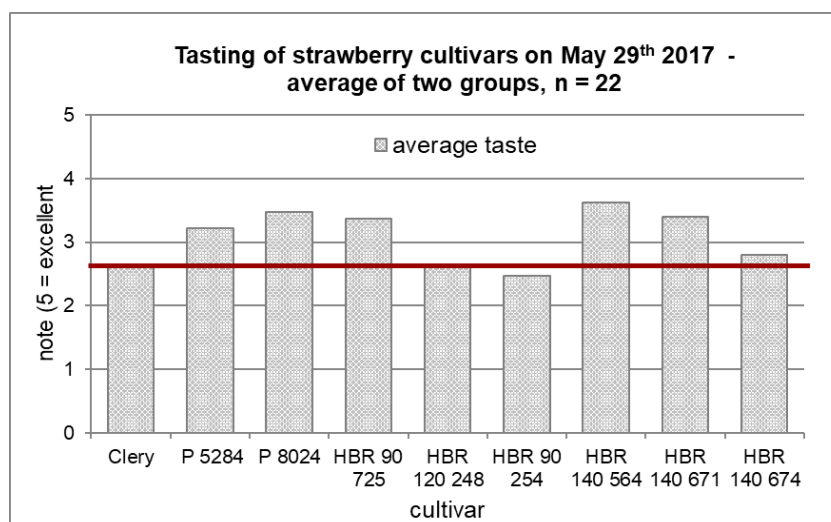


Figure 5: Results from a strawberry-tasting on May 27<sup>th</sup> 2017, 22 participants

Especially tastings of strawberries are an impression of the picking day and are influenced by the weather a few days before (favourable weather or rainy with less sun or too hot, so

that the aroma shifts towards unpleasant components) and the point within the ripening-season of a cultivar.

All cultivars included P 5284, HBR 90254, HBR 140 564 and HBR 140 674 have been close to 'Clery', partly 0.5 to 1.0 better. Summarising other tastings, which are not described in detail here, HBR 140 564 and HBR 90 254 were under the best cultivars concerning taste, in the group of middle to late ripening cultivars D3 F was interesting, too. In a direct comparison of D3 F, 'Bonneure' and 'Schweizer Herz' it changed from person to person, which one they preferred as the best, but none was estimated as worse than mediocre-good.

### Results – Vigour and susceptibility for leaf-diseases

Each trial was estimated a few times during the testing-period concerning vigour, growth characteristics and appearance of leaf-diseases like *Mycosphaerella fragariae*. *Diplocarpon earliana* was watched seldom, losses of plants were assessed, too, the main reason was damage by the rotary tiller, less by root-diseases like *Verticillium sp.*, which was sometimes a problem in the second year at P 5284. At beginning of August (= two years after planting) usually the last evaluations were done until the trial was ploughed under, so the values in table 4 stand for a long period of possible infections.

Table 4: Vigour of the plants and susceptibility for *Mycosphaerella fragariae* (planted in August 2018)

variety	Vigour (note 1-9)		Mycosphaerella fragariae (note 1-9)	
	06.05.2020	06.08.2020	06.08.2020	Kommentar
HBR 90 254	6.0	6.7	6	Spring 2020 very dry, so leaves seldom infected, from middle of June often rain, so high pressure by leaf diseases
HBR 140 564	5.4	5.8	6-7	
HBR 140 674	5.6	5.5	5 (-6)	
P 5284	4.3	4.6	3 - 5	
D3 F	6.4	6.9	9	

HBR 140 564 and HBR 140 674 had middle vigorous plants, HBR 90 254 was very stable. The strongest growth was assessed for D3 F, combined with a high susceptibility for *Mycosphaerella*, but the roots were very healthy, fruit-symptoms were rare. This cultivar was able to compensate the disease-infections, but as a hygienic measurement the old leaves have to be removed before the growing season at end of March.

Table 5: Susceptibility for *Mycosphaerella fragariae* (planted in August 2020)

<i>Mycosphaerella fragariae</i>	11.08.2021	10.12.2021
low (note 3.0-4.5)	HBR 90 254, HBR 140 674, Bonneure	HBR 140 674
middle (note 4.6-6.5)	HBR 150 176, Belleure, Herzle	HBR 90 254, Belleure, D3 F
high (note 6.6-7.5)	HBR 140 564, D3 F	HBR 150 176, Bonneure, Herzle
very high (note 7.6-9.0)	Schweizer Herz, Magnus	HBR 140 564, Schweizer Herz, Magnus

In one of the latest trials (tables 5 +6) the evaluations one year after planting showed a lower level, between both evaluations the trial was cut 10 cm above soil surfaced to support the tillering with fresh leaves for the initiation of flowers for the season 2022. During the four



months between both assessments partly the infection level was increasing, one reason could be, that the cultivars were planted in a mixed plot, so the cutting could not be adapted exactly to all cultivars, some should be mowed slightly higher or slightly deeper. The most extreme infections by *Mycosphaerella fragariae* were seen at the late cultivar 'Magnus', which characteristics as a survey make the cultivar less suitable for organic fruit-growing without a shelter or tunnel of plastic.

Table 5: Estimation of vigour of the plants in season 2021

variety	Vigour 2021 (note 1-9)			
	08.02.	11.08.	10.12.	comments
HBR 90 254	4.5	6.7	6.2	Relatively healthy, stalks of the leaves upright, vigour in general good
HBR 140 564	4.2	6.0	6.6	Strong growth, sometimes in late autumn new blossoms and single fruits visible, should be removed because of risk for Botrytis
HBR 140 674	4.2	5.1	5.3	Single plants symptoms of lack of Fe, leaf edges reddish, plant stand uneven
HBR 150 176	4.2	6.2	5.0	Plants after first harvest sesason very vigorous, plant stand very dense
Belleure	5.0	7.5	6.1	Strong growth, older leaves more infections by leaf spot
Bonneure	6.0	8.5	8.2	Plant stand extremely strong growing, nearly knee-high, healthy (in August), dense leafage
Schweizer Herz	4.0	6.0	6.2	Vigour middle, infections bordered, flowers relatively high in the plant
Herzle	4.4	5.2	4.7	Vigour middle, not totally even in the parcel
D3 F	6.4	7.4	7.6	Plants strong, no gaps in the parcel inspite of more leaf spot only a little bit suffering, healthy roots, late bearing of runners
Magnus	5.5	6.9	4.5	Heavy leaf-spot, partly <i>Diplocarpon earliana</i> , between July and December 2021 only moderate tillering

## Discussion and perspective

Altogether with these selections (regarding further cultivars like 'Clery', 'Allegro', Faith, Rumba or 'Sonata' e.g.) it is possible for the organic fruit-grower to offer strawberries for nearly six weeks. The taste of P 5284 (=Juline) was regularly estimated as 'good' or 'very good' by final customers. HBR 90 254 and HBR 140 674, which has meanwhile the name 'Rendevous', are very interesting cultivars for the organic fruit-grower, HBR 140 564 with some curtailments. Altogether the results have very similar tendencies in comparison to the earlier trials with smaller plots (Results were only presented at courses for organic fruit-growers or in working-groups) and for 'Rendevous' comparable to the experiences of Krieghoff (2020). D3 F was a propagation mistake in parcel of former breeding-numbers of JKI Dresden-Pillnitz, the original crossing could not get identified, but it was separated and tested again because of its interesting taste and robust plant (nearly no losses by root-diseases). This cultivar should be considered in further breeding work. Using additional measurements for advancing the harvesting season, the offer for the customers could be prolonged probably to further two weeks.

One crucial point for a wide availability of new cultivars in the organic fruit-growing are concerns of licences and some gaps in organic propagation of runners, up to now there are still possibilities to receive exceptional permissions for planting of new cultivars, but cultivation period of strawberries is very short in comparison to apple-growing. In Germany there are mainly three companies, which offer strawberry-cultivars in organic quality (from

D, NL and I), partly older ones, which have been described at former Ecofruit-conferences (Barth et al., 2014, Pfeiffer&Brockamp, 2010, Weissinger et al., 2016). At the moment the implementations of the new organic basic legislation (EU-VO 2018/848) are discussed intensely concerning plant propagation material for organic fruit-growers, too.

Another urgent question is, in which direction the change of climate will go: If there is a tendency to more hot summers like described in a study from MLR Baden-Württemberg (2015), cultivars, where the fruits are laying in the sun, are endangered by sunburst even if a hail-net for shadowing is used. Here characteristics like the growing habit and the robustness of the roots of HBR 90 253, 'Bonneure' or 'D3 F' could be advantageous.

Strawberries are a very important and healthy fruit in Europe, so a net of trials on organic farms distributed in many regions of Europe with a wide range of climatic conditions should be initiated in close cooperation with breeders, farmers, consumers and trading-organisations, even if the success of a farmer will be influenced strongly by the costs and entry requirements for seasonal workers, where big differences exist in Europe, and in future by costs for the transport, too.

### **Acknowledgements**

Thanks to all colleagues from organic fruit-farms, other research and breeding institutes and organisations, to the members of Obstversuchsgut Heuchlingen and to our seasonal workers for their engagement during nurturing, picking and evaluation season and my colleague Chr. König for the support in the statistical analysis.

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