Fruit weight, firmness and soluble solids content during ripening of Karešova cv. sweet cherry

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ABSTRACT: Changes in fruit weight, firmness and soluble solids content during the ripening period of Karešova cv. including relationships between these characteristics were studied in 1998–2001. These years differed from each other in the amount and distribution of rainfall and in the course of temperatures. The length of ripening period fluctuated from 14 to 21 days. An increase in average fruit weight during the ripening period was 0.1 g per day. The actual increase in fruit weight was in a close correlation with the amount of rainfall in a few previous days. After heavy rainfalls, above 40 mm, fruit weight increased by nearly 1 g within in a few days. In the course of the ripening period fruit firmness decreased from about 2.5 N at the beginning of the period to about 1.5 N at its end. This decrease seems to be mainly the function of time during ripening. However, a low correlation between the amount of rainfall in the previous days and the decrease in firmness was also found. This correlation could be connected with negative regression of fruit firmness on the weight of the fruit. In the more rainy years 1998 and 1999 these decreases in firmness were more significant than in the other two years. Soluble solids content (SSC) increased from about 12% Brix at the beginning of the period to about 16% at its end. There were also found positive correlations between the weight of fruits and SSC. Taking into account contributions of all studied factors and their changes a conclusion was drawn that Karešova cv. should be harvested within one week from the beginning of its ripening period.

Keywords: sweet cherry; Karešova cultivar; harvest; fruit quality; rainfall; temperature

At recent time sweet cherry cultivars that belong to the firm fleshed type Bigarreaus have mostly been grown for commercial purposes in the Czech Republic. With a few exceptions to the rule Karešova cv. is the most important. This cultivar combines high fruit quality with high productivity and it starts to ripen in the second cherry week. It has also been classified as a Heart sweet cherry (RICHTER, VONDRÁČEK 1991). However, its fruit flesh is not very soft, as typical Hearts or Guigners are, but at least at the beginning of its ripening it is intermediate in firmness between Bigarreaus and Hearts (BLAŽKOVÁ 1991).

There are many factors that are included in the term fruit quality in the sweet cherry. However, only fruit size (weight), fruit firmness and soluble solids can be measured whereas the top level of each of these factors is correlated with the best fruit quality (FOLGE 1975).

Sweet cherry ripening occurs concomitantly with a rapid increase in fruit size and weight just before harvest. As much as 25% of final fruit weight is added in the last week of growth prior to harvesting and during this time there are dramatic changes in fruit colour, flavour and texture. Sugar concentration increases as the fruit ripens while acids remain relatively constant (LOONEY et al. 1996). Sweet cherries with large fruit size are distinctly preferred by present consumers. Larger fruits have greater visual appeal and often have better taste. Since stone size is relatively constant, large cherries have proportionally more flesh (BLAŽKOVÁ 1988; LOONEY et al. 1996).

Fruit firmness of sweet cherries was frequently studied using different devices and procedures (LIDSTER et al. 1978; BROWN, BOURNE 1988; FILS-LYCAON, BURET 1990).

It is difficult to state definitely to the day when sweet cherries are ripe since they are edible long before they are really ripe or at best quality and hang for a long time after ripening. Also perhaps as a result of the above, sweet cherries do not seem to ripen in the same general order from year to year as closely as some other fruits. These facts limit the accuracy of this classification (LAMB 1953).

In this study three of the most important fruit characters during the ripening period of Karešova cv. that influence fruit quality were investigated for four years, with the main aim to determine the most suitable period for harvest.

MATERIALS AND METHODS

This four-year study was carried out in 1998–2001. Fruit samples were separately taken from two trees grown in a variety trial orchard at Holovousy. The trees were 6 years old in 1998. Their fruit set was very similar and in all years was rated by 6 or 7 using a 1–9 rating scale.

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Table 1. Average values of the studied factors for Karešova cv. ripening period in 1998–2001

Year	Total rainfall (mm)	Mean daily temperature (°C)	Period of ripening (days)	Fruit weight (g)	Fruit firmness (N)	Soluble solids (%)
1998	103.6	17.4	20	6.3	1.99	14.6
1999	92.8	15.5	17	7.3	1.78	13.8
2000	65.3	17.4	20	6.4	1.80	14.0
2001	51.1	14.1	14	6.1	1.96	13.8
Average	78.2	16.1	17.8	6.5	1.88	14.1
S.D. $P = 0.05$*				0.25	0.17	0.29

*Significant difference for $P = 0.05$

The first samples were taken at the beginning of harvest ripening when a majority of fruits reached red mahagony colour and could be eaten with acceptable taste. For one sample, 25 randomly picked up fruits were collected so that 50 fruits were measured for each single harvest date. Length of ripening period was determined by the time in which the majority of fruits did not show any indication of decay and they were able of consumption.

Samples were taken from the same trees usually every three or four days. Fruits were measured soon after their harvest. Individual fruits were weighed at first, then their firmness was measured and in the end soluble solids content was determined in their juice. Fruit firmness was measured as total firmness (skin and underlying flesh) by a puncture test. For this purpose the Instron Universal Testing Machine (Instron Corp., Canton, Mass., USA) was used. The full scale load was set at 5. The crosshead speed was 50 mm per min, and chart speed 100 mm per min. Intact fruit was positioned so that the stem was in the horizontal plane. The skin of the fruit was punctured with a #41 drill blank (probe diameter 2.4 mm) on the area cheek to the right of the suture and the maximum force was measured in newtons.

Fruit soluble solids content (% Brix) was measured in expressed juice of individual fruits with the digital refractometer PR 101.

Records on daily temperatures and rainfall were taken from a meteorological station that was located in the Research and Breeding Institute of Pomology at Holovousy about 500 m from the trial orchard. For a better comparison of dates of different years the ripening period was expressed in successive days starting with the first calendar day of Karešova cv. ripening in every year of the study. For the study of relationships between rainfall and fruit weight the corresponding data on the amount of rainfall since the last sampling and the increase in fruit weight for the ripening period were mutually plotted.

Measured characteristics were analysed by a one way analysis of variance (ANOVA) with a harvest day being the variable. Significantly different means of analysis of variance were separated by the least significant difference at the 5% level. All the data was also used for regression analyses.

RESULTS AND DISCUSSION

SPECIFIC CONDITIONS OF THE YEAR

Particular years in which this study was carried out differ significantly in the amount of rainfall and in the mean daily temperature (Table 1). The highest rainfall was recorded in 1998 whereas 2001 was relatively dry.

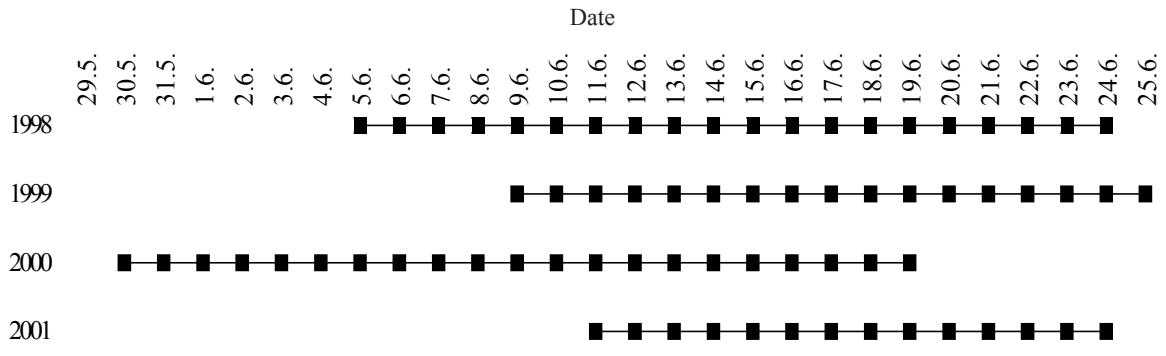

Fig. 1. Ripening periods of Karešova cv. in 1998–2001

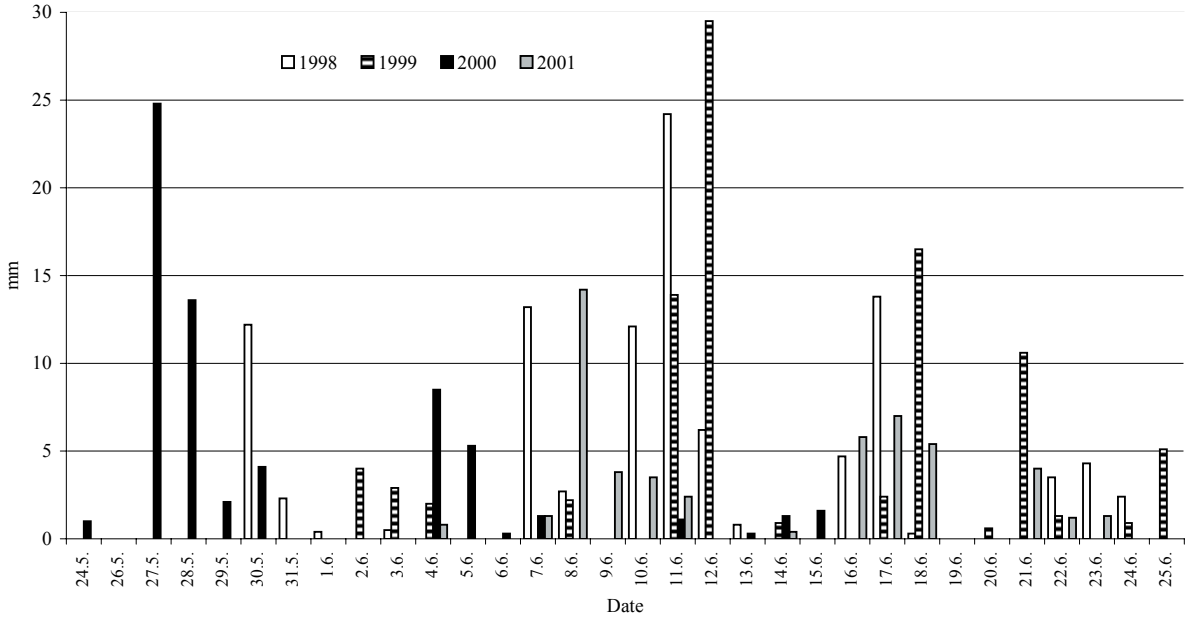

Fig. 2. Survey of rainfall during the Karešova cv. ripening period in 1998–2000

The latter year was also significantly colder than previous years. Despite these conditions the duration of the ripening period of Karešova was shortest in 2001. The longest duration of ripening period – 21 or 20 days was observed in the years with the highest mean temperatures.

Besides total rainfall or mean temperature values, their distribution throughout a ripening period should also be important. In 1998 precipitation was distributed more or less during the whole ripening period of Karešova cv. (Fig. 2). In the subsequent year 1999 most of the rainfall fell in the first week of the period. In the next year 2000 it was just before Karešova cv. ripening, whereas in the second and third week of the ripening period the weather was dry. In 2001 a moderate rainfall appeared only in the middle of the period.

In the case of temperature its fluctuations were typical of 1998 and 2000 (Fig. 3). In the other two years low temperatures occurred at the end of ripening periods. May be that the low temperature just at the end of the ripening period made the whole period shorter.

Regarding fruit weight its mean value in 1999 was different from all other years. Its highest value was obviously connected with total amount and distribution of rainfall in this period. No differences between the years were observed in mean fruit firmness. In the case of soluble solids contents somewhat lower values were obtained in 1999 and 2001 for shorter ripening periods as the highest SSC always appeared at the end of ripening period.

TIME AND DURATION OF RIPENING PERIOD

The earliest ripening of Karešova cv. appeared in 2000 when it started on May 30th (Fig. 1). On the other hand, the latest beginning was determined in 2001, when it was on Julv 11th. The available data indicate that the la-

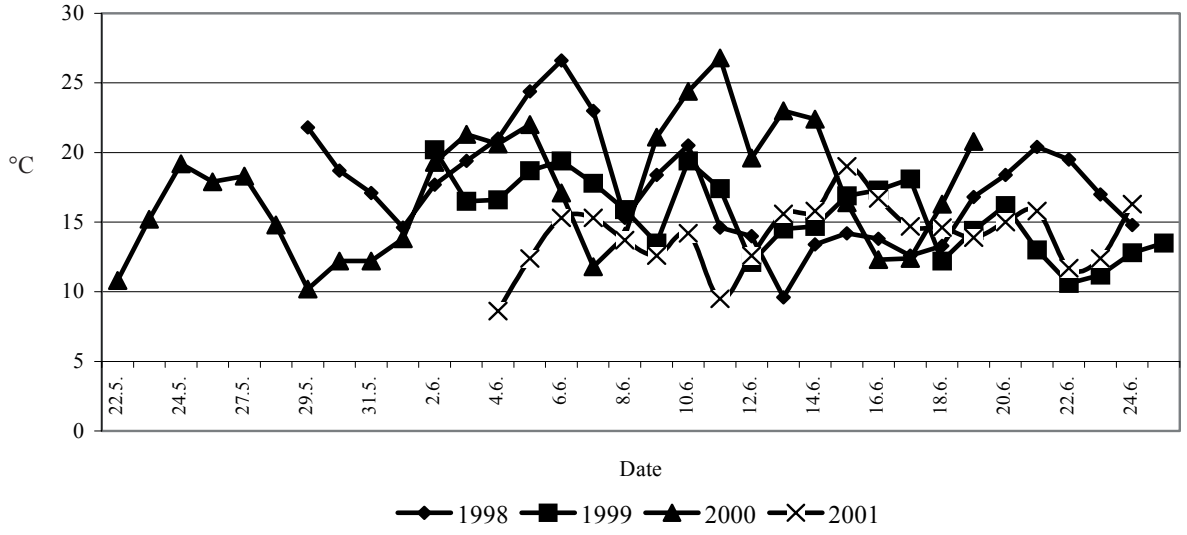

Fig. 3. Survey of mean day temperatures during the Karešova cv. ripening period

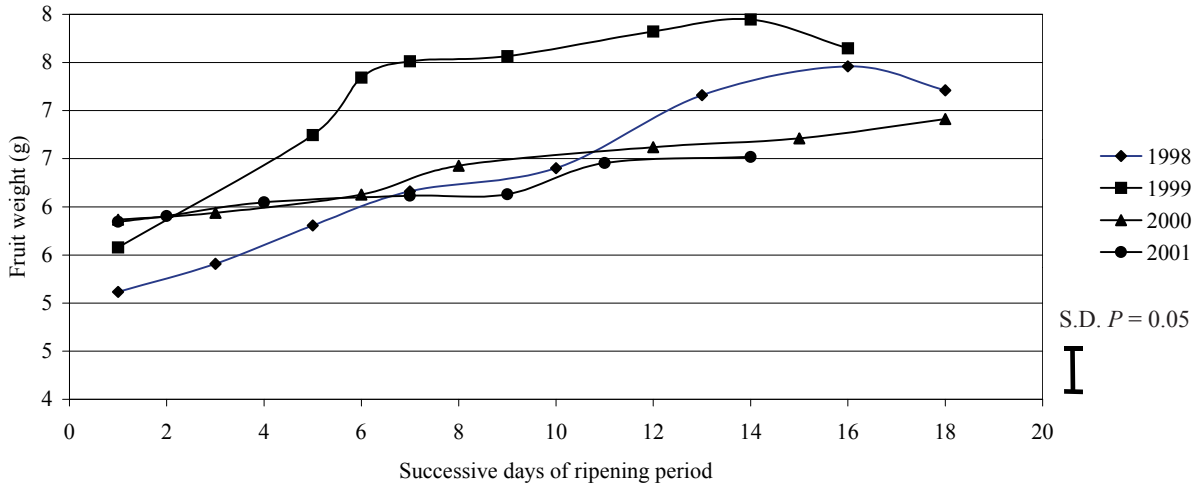

Fig. 4. Course of Karešova cv. fruit weight during the ripening period

ter the period started the shorter was its duration. In the years of observation the length of ripening period fluctuated between 14 and 21 days. This is in agreement with previous findings in the literature. According to findings from Bulgaria ripening periods of sweet cherries range from 15 to 24 days depending upon variety and period (PANOVA, POPOV 1983).

FRUIT WEIGHT

During the observed periods of ripening the fruit weight of Karešova cv. increased from about 5.5 g at the beginning of the period to about 7 g at its end (Fig. 4). An average fruit weight increase per day corresponded to 0.1 g per day. However, the most rapid fruit size increase occurs in the first week of ripening, when it was sometimes more than 0.2 g per day.

Some of the differences in fruit weights initially appeared to be attributed to differences in maturity but correlations between the other two characteristics were not significant in these cases.

The increase in the fruit weight was very closely correlated with the amount of rainfall in a few previous days (Fig. 5). After heavy rainfall above 40 mm, this increase reached nearly 1 g. However, it was also observed that subsequent rainfall had a much lower effect on fruit weight. No influence of mean daily temperature on fruit weight was found.

Fluctuation of mean fruit weight from year to year was in a similar range as it was described in the literature (e.g. ZBINDEN 1979).

FRUIT FIRMNESS

In the course of ripening periods fruit firmness decreased from about 2.5 N at the start of the period to about 1.5 N at its end (Fig. 6). It seems that this decrease is mainly a function of time during the ripening period.

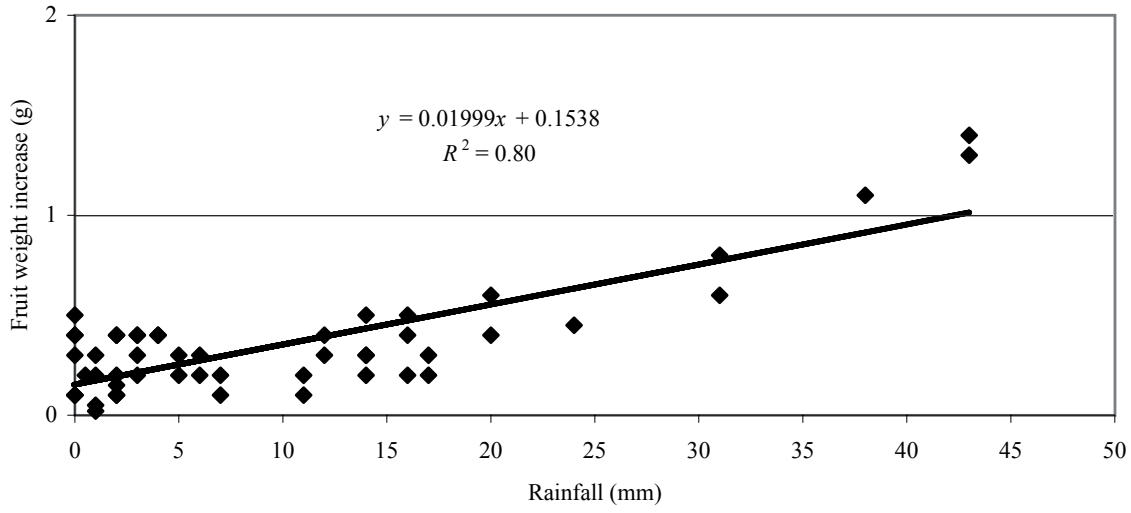

Fig. 5. Regression of fruit weight increase on the amount of rainfall

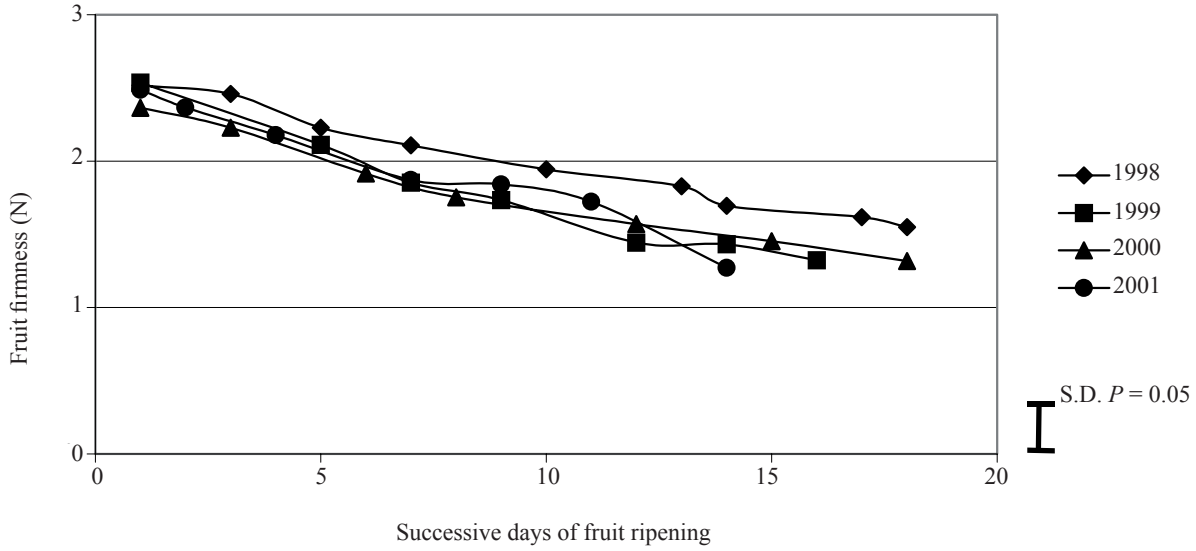

Fig. 6. Fruit firmness during the ripening period of Karešova cv.

However, surprisingly only a low correlation between the amount of rainfall in previous days and decrease in fruit firmness was found. This correlation could be connected with negative regression of fruit firmness on the weight of fruit (Fig. 7). In more rainy years 1998 and 1999 these decreases in firmness were more significant than in the other two years. This correlation did not exist at the beginning of ripening periods. In the middle of the periods the correlation was found in 2001 only. At the ends of ripening periods the correlation was found in all years. Not even in this factor was any interference with the mean daily temperature observed.

SOLUBLE SOLIDS CONTENT (SSC)

During the observed periods of ripening SSC of Karešova cv. increased from about 12% Brix at the beginning of the period to about 16% at its end (Fig. 8). At the beginning of the periods there were some differences between the years in the values that changed later. The increase in SSC was higher in 2000 and 2001, when less rainfall occurred. There were found positive correlations between fruit weight and SSC (Fig. 9). These correlations were higher in 2000 and 2001. Finally, negative correlations were calculated between fruit firmness and

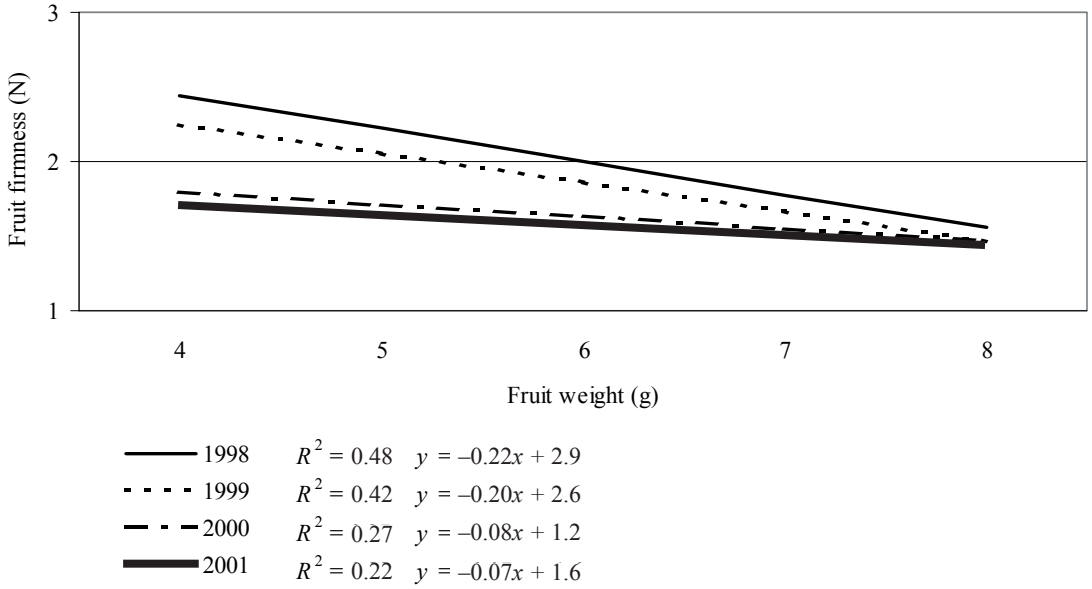

Fig. 7. Regression of fruit firmness on fruit weight in 1998–2001

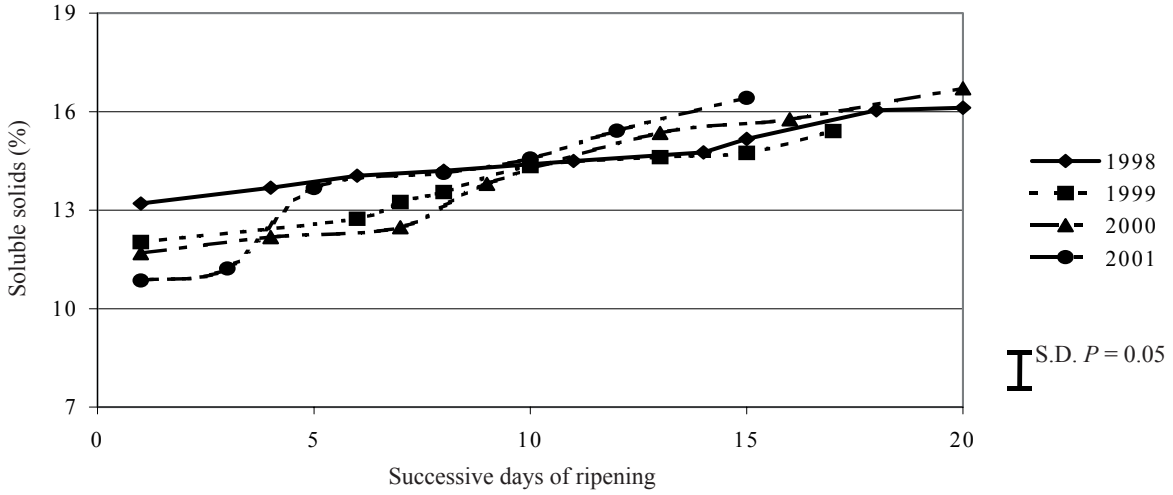

Fig. 8. Content of soluble solids in fruits during Karešova cv. ripening

SSC. Also, higher values of these relationships were found in 2000 and 2001 than in 1998 and 1999. No direct influence of the amount of rainfall and mean daily temperature on SSC was observed.

The values of SSC that were found in fruits of Karešova cv. in this study were below some recommendations for sweet cherry harvest in the literature. According to KAPPEL et al. (1996) the minimum soluble solids concentration for sweet cherries should be above 17%. However, Karešova is a very early cultivar and levels of SSC in the middle of Europe may be lower than in sunny regions of West Canada.

OPTIMAL HARVEST DATES

Optimal harvest date should be estimated by using the factors that were studied in this paper. With a delay of harvest the quality of fruits improves (fruit size and SSC). Also the yield increases at the average rate of about 2% per day. On the other hand, with the prolonged time of the ripening period a risk of losses increases due to fruit cracking and some diseases. With Karešova cv., however, a decrease in fruit firmness seems to be the most critical. According to our hitherto experience the firmness of fruits that are used for the market should not

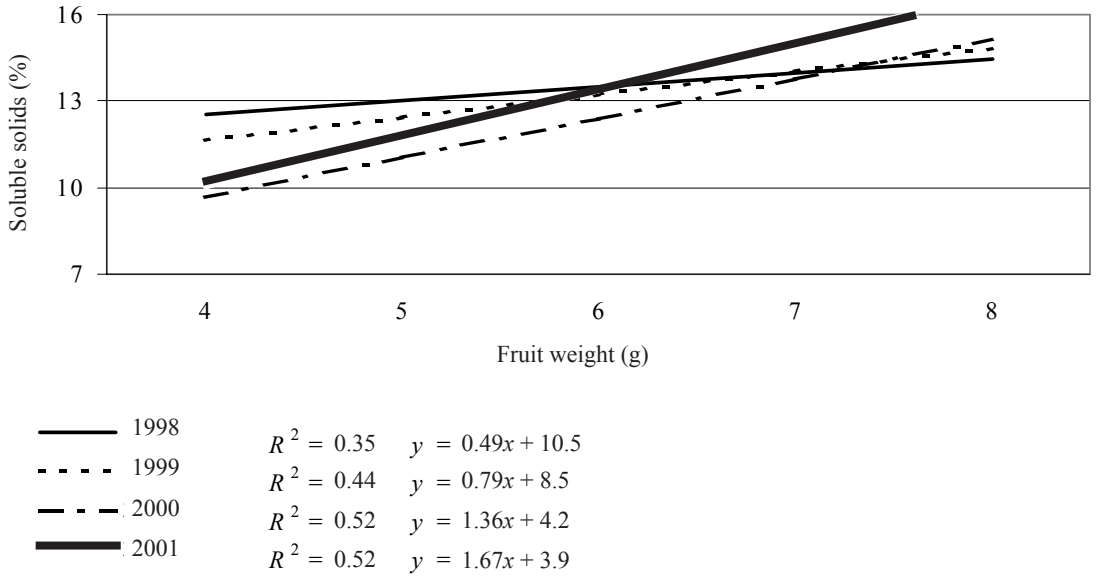

Fig. 9. Regression of soluble solids content on fruit weight

be lower than about 2 N. Below this boundary the transport ability of fruits of this cultivar and their shelf life are not acceptable. Therefore, Karešova cv. should be harvested within one week from the beginning of its ripening period. Just at the beginning of the period a heavy rainfall should be substituted by reasonable irrigation to improve the quality of fruits as much as possible.

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Hmotnost plodů, pevnost dužniny a obsah refraktometrické sušiny během doby zrání třešní odrůdy Karešova

ABSTRAKT: Předmětem studia, které proběhlo v letech 1998–2001, byly změny hmotnosti, pevnosti plodů a obsahu refraktometrické sušiny v období zrání u odrůdy třešně Karešova. V době zrání plodů této odrůdy se jednotlivé ročníky lišily množstvím i rozložením srážek a průběhem teplot. Délka sklizňového období této odrůdy kolísala ve sledovaných letech od 14 do 21 dnů. Průměrný denní přírůstek hmotnosti plodů za toto období činil 0,1 g. Skutečný přírůstek však byl těsně korelován s výší srážek v několika předchozích dnech. Po silných deštích (s úhrnem srážek nad 40 mm) došlo během několika dnů ke zvýšení hmotnosti plodů až o 1 g. V průběhu zrání plodů se však rovněž snižovala jejich pevnost (zjišťovaná penetrometricky) z počáteční úrovně kolem 2,5 N na konečných 1,5 N. Tento pokles byl způsoben především funkcí času. Byla však zjištěna rovněž slabá korelace mezi množstvím srážek a poklesem pevnosti plodů. Tato korelace byla ve vazbě s negativní regresní závislostí mezi hmotností plodů a jejich pevností. Tato závislost byla významnější v deštivějších letech 1998 a 1999. Obsah refraktometrické sušiny se zvyšoval během období zrání plodů z počátečních přibližně 12 % na úroveň kolem 16 % v době ukončování sklizňové zralosti plodů. Mezi hmotností plodů a obsahem refraktometrické sušiny byla zjištěna významná kladná závislost. Na základě vzájemného posouzení všech studovaných faktorů byl učiněn závěr, že by odrůda Karešova měla být sklizena pro tržní účely nejpozději do konce prvního týdne od nástupu stromové zralosti.

Klíčová slova: třešně; Karešova kultivar; sklizeň; kvalita plodů; srážky; teplota

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