Relationship between the apple's cover colour and temperature in apple gene bank plantation

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Abstract

The colouration of fruits is an important quality requirement for the market. The degree of colour coverage has an influence on the saleability particularly in the red coloured cultivars. This study aims to reveal the influence of temperature on the degree of cover colour of apple. We have determined the time change of colouring and estimated it by means of environment variables. The results show significant relationships between the main meteorological variables, such as day and night temperature and the difference between day and night temperature, and the rate of colour cover. The genetic backgrounds of apple varieties ripening in winter have a greater effect on the development of cover colour while the years play larger role on it in the case of apples ripening in summer or autumn. A difference between day and night temperatures resulted in about 79% of cover colour on the fruits, but for differences over 6.2 °C, the extent of cover colour decreased in apples ripening in summer.

Keywords: apple, cover colour, temperature, summer ripening

Introduction

Cover colour is one of the phenometric variables of fruits but its rate can change year by year. The experienced oscillation can be caused by inappropriate water and nutriment supply, some plant diseases, extremely high or low temperature and setting rate above the average with outstanding fruit density (Racskó et al. 2005). At the end of the 1960s several studies published the mutual effect of phenological stage and meteorological parameters (Csöbönyei and Stollár (1969) and the impacts of macro and microclimatic factors on the growth of fruits (Szász 1961). The researches were carried out on evapotranspiration and the water consumption of apples during the fruit growing period (Gergely and Stollár, 1978) and results related to Jonathan apple's ripening period estimated by weather variables (Stollár, 1977). As market requirements for enhanced colour increase growers carry out the management practices designed in order to obtain better fruit colour (Soltész et al. 2004). Fruits with low

colouration are prone to diseases and injuries of the skin on the other hand the disadvantageous effects of the latter are more definite during storage due to later harvesting (Racskó et al. 2005).
This study aims to reveal the influence of temperature on the degree of cover colour of apple in a collection of apple germplasm. We have determined the time change of colouring and estimated it by means of environment variables.

Material and methods

The phenological phases and phenometric indicators of 586 of apple varieties were examined in the Fruit Research and Extension Institute at Újfehértó during the years of 1984-2001. The measurements were carried out on 2 trees of all varieties using a repetition system, and the varieties were ranged as (1) ripening in summer (2) ripening in autumn (3) ripening in winter groups. Examining the colouration of these three categories was made using an easy visual assessment: 1. basic colour, 2. transition between basic and cover colour and 3. cover colour. Cover by different colours was expressed as a percentage of the total fruit surface (Holb et al. 2003).The varieties with good cover colour were separated in the sample for analysis in relation to meteorological factors. The effect of average daytime and night temperature on degree of cover colour was measured in different months of the vegetation and 30 days before ripening. During the examining period the air temperature was taken hourly and on daily basis by means of a computer demodulation automatic meteorological measuring station. The night temperature (T_{night}), day temperature (T_{day}) and the difference between day and night temperatures (T_{diff}) were used for calculations. The results were evaluated by average and standard deviation, and regression and correlation analysis.

Results and discussion

The results based on frequency of distribution cover colour on fruits in different ripening groups showed that almost half (49.7%) of the varieties ripening in summer had a good cover colour, while the rate of less well-coloured variety was 25.2% in this group. The apples with notable rate of colouring (64-81%) represented the largest part of the sample (32.1%). It appears the varieties with good cover colour occurred in a significantly larger proportion in the sample from ripening in summer group than varieties with weak cover colour. The apples ripening in autumn showed a fairly stable distribution of colouring. A total of 42.5% of these apples fruits can be characterized as having good cover colour, while 36.4% of that have weak cover colour. In the sample from this group the number of varieties with good cover colour and weak cover colour seems to be almost equal. The frequency distribution of apples ripening in winter can be described by an U-shape function. This means that there is the predominance of well coloured and weak coloured varieties, respectively and varieties with mid-range cover colour had the smallest proportion.

In total, 34.1 percent of all varieties whose fruits cover colour intensity over the 70 % are considered well colouring varieties (Figure 1). The mid-range colouring varieties represented 41.2% of the sample, and 24.6% of the varieties had a rather low rate of cover colour (10-39%) and therefore belonging to the weak-coloured group.
In the last 20 years the average night temperature of the growing season has increased greatly in the experimental location. The high night temperature has generally an unfavourable effect on the production. Respiration becomes more intense and therefore daily weight growth decrease. Several quality indicators, e.g. sugar content decrease due to the higher night temperature and the energy needed for an increased respiration is covered by the plant's own reserves. Neither small increasing day temperature nor the same rate of growth in day and night temperature cause disorders in the colouration. Problems can occur if the two examined variables' rate of growth are different.

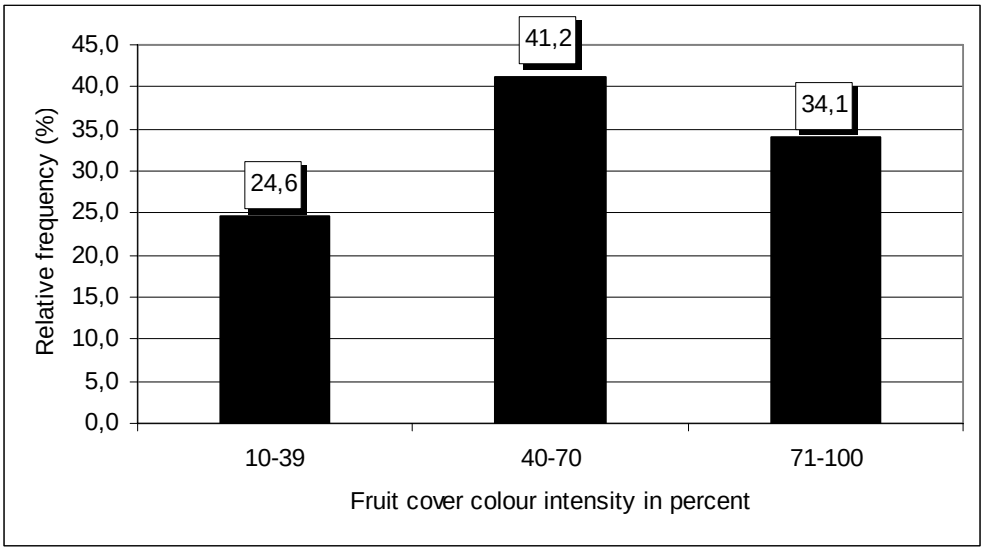

Figure 1. Distribution of apple cover colour at 586 apple cultivars

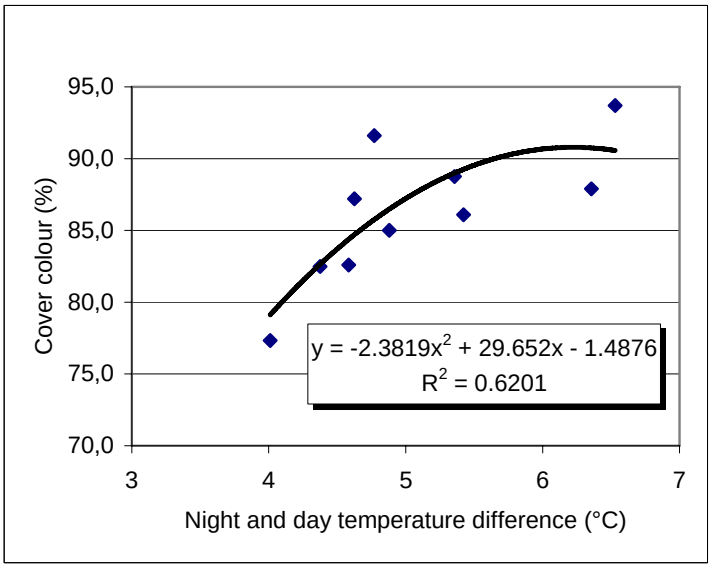

Figure 2. Relationship between day and night temperature difference and apple cover colour in August in summer ripening apple varieties.

According to the results, the day temperature rate of growth falls behind the same value of night temperature. There was a significant relation between the night temperature in August and the cover colour of apples ripening in summer. Night temperatures up to 5 degrees higher result in a 15-17% lesser rate of cover colour. While high night temperature has an unfavourable effect on the establishment of cover colour of apple, the higher day temperature contributes to spread the cover colour. The relation between the day temperature in October and the degree of cover colour is rather good (R^2=0.54) in the apples ripening in autumn. In these apples a 4 °C increase in temperature results in 10-12% more favourable colouring rate.

The difference in day and night temperature has the greatest influence on the cover colour in different ripening groups. The relationships between the difference between average day and night temperature in August and cover colour was significant (R^2=0.62) in summer ripening groups (Figure 2). As seen in Figure 2, a 4^{o}C difference between day and night temperatures resulted in about 79% of cover colour on the fruits. The larger extent of cover colour can be reached with a difference above 5^{o}C between day and night temperature but with differences over 6.2 °C, the extent of cover colour of apples ripening in summer starts to decrease. In these cases cooling irrigation can be used for reducing fruit temperature (evaporative cooling) and the development of red colour that significantly improving fruit colour (Nemeskéri 2007).

In conclusion, the good colouration of apple can be estimated by the meteorological variables. The genetic backgrounds of apple varieties ripening in winter have a greater effect on the development of cover colour while the years play larger role on it in the case of apples ripening in summer or autumn. The difference in day and night temperature has the greatest influence on the cover colour in different ripening groups. The larger extent of cover colour can be reached with a difference above 5^{o}C between day and night temperature but with differences over 6.2 °C, the extent of cover colour of apples ripening in summer starts to decrease. In the future it would be useful to analyse the changes of cover colour in the varieties with green and yellow fruits, since their market value and saleability are greatly influenced by these factors.

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