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THE EVALUATION OF VINE LEAVES DEVELOPMENT DYNAMIC

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Abstract

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This experiment was focused on evaluation of grape vine leaves surface area development of the six varieties on experimental sites in Velke Bilovice and Lednice, in the viticultural conditions of the South Moravia. The dynamic of leaves surface area development was mesured by using device LAM CI–202 (Leaf Area Meter, the device operating on the principle of the scanner and the resulting values are expressed through the leaf area index (LAI). The measurements were carried out in four dates (May, June, July, August) during phenological growth stages of growth, flowering, initial development of fruits (Berries pea-sized, berries beginning to touch). Obtained results show, that the greatest increase of the leaves surface area on annual shoots is during phenological growth stages of flowering and during initial development of fruits.To the development of the leaves surface area of the leaves on lateral shoots then occurs after tipping of the top parts of the annual shoots, the main axes of herbaceous shoot are interrupted. During the phenological growth stage of the development of fruits was measured at both sites the largest leaves surface area on the varieties St. Laurent in the variety, Lemberger, Cabernet Moravia and ranged from 2.74 to 4.24 m^2 per plant.

viticulture, grape vine, leaf surface area, grape varieties

The recent trends on the field of the quality management in viticulture are also focused on the increasing emphasis on ensuring the optimal ratio of leaves surface area to the weight of the grapes. The optimum value, according to KRAUS, FOFFOVÁ, VURM, KRAUSOVÁ (2005) is from 17 to 22 $cm^2 . g^{-1}$. For example MÜLLER (2003) shows, that for production of 1kg of the grapes of adequate quality is necessary, depending on the variety and the average size of leaves, from 1.6 to 2.2 m^2 of the leaves surface area. SPRING, ZUFFEREY (2008) show, that to achieve quality production of one kilogram from grapes from is sufficient from 1.0 to 1.2 m^2 of the sufficiently sun exposition leaves surface area. So decisive is not only the size of the leaves area, but also its sun exposed.

A desirable attention has not yet been paid to this issue in viticultural conditions of the Czech Republic. The evaluation of growth dynamics of leaves surface area was issue in the past studied by KRAUS (1983). Vineyard practice has recently become increasingly focused on knowledge of relation between leaves surface area and yield. The overall leaves surface area of the whole plant significantly participates in the creation of yield of grapes, their quality, as well as in establishing flowers for next year. Important influence of great leaves surface area has also positive effect on maturation of the wood, growth of roots and storing of storage of reserve compounds (KRAUS, 1994).

SPRING, ZUFFEREY (2008) show, that the leaves grow at the beginning slowly, and their surface area increases daily about 200–600 mm^2, during maximum growth intensity ranges the surface area of the leaf blade from 1000 to 2000 mm^2. By the third growth period, the growth intensity decreases gradually to values 300–500 mm^2 per day.

In addition to the leaves on main shoot, during growing season grow also shoots of second order – lateral shoots. Lateral shoots are not different from the main shoots, but from the anatomical point of view are just smaller. The intensity of lateral shoots

growth is a varietal characteristic and depends on some agro–technical practice (PETGEN, REBHOLZ, 2004).

The development of the leaves surface area is directly related to the intensity of photosynthesis. The high intensity of photosynthesis per unit of the leaves surface area have for example varieties Traminer, Zweigeltrebe, Riesling, low intesity has for example variety Müller Thurgau. These mentioned aspects are therefore necessary to take into account for carring out different agrotechnical interventions as a tipping, defoliation, grape set reduction, chemical protection, to ensure an adequate yield of the highest quality grapes.

Methods used to determine the overall leaves surface area can be divided into direct and indirect. For example, calculation of the leaves surface area, weighing of the leaves copies, leaves weighing, or planimetric measurement are the direct methods, which have generally destructive character (LEBLANC, FERNANDES, CHEN, 2002).

Indirect methods of determination leaves surface area are photometric or scanning methods, using aflaplanimetr, estimation methods, image analysis or a combination of these methods (WELLES, 1990; KAČMÁROVÁ, 2011).

The aim of this paper is to evaluate the dynamics of leaves surface area development of six selected vine varieties in wine–growing conditions of South Moravia.

MATERIALS AND METHODS

The character of the experimental stands

Experimental observations and evaluations carried out during the growing season 2010 on the two pedologicaly and climatically different locations in the Moravian viticultural region.

The experimental site – Velké Bílovice
(Velké Pavlovice sub–region)

The soil type of this experimental site is black soil, mainly loamy soil with no skeleton. The measurements of leaves surface area were carried out on the vineyard sites called „Dlouha hora“ and „Pod Belegrady“. Vineyards are from 5 to 7 years old and are grown on medium vine training with one cane pruning, planting is 2.5 × 1 m with grassing over one row. During the winter pruning were left 10 buds on every shoot. Support structure consist of steel columns with a height of 1.7 m. In the last week of June was carried out tipping in a height about 0.15 m above the upper double wire.

The experimental site – Lednice na Moravě
(Mikulov sub–region)

The soil type is of this experimental site is black soil, the master substrate is loess, soils are loamy. The measurements were carried out on the vineyard sites in Mendeleum. Vineyard is grown on medium vine training with one cane pruning, planting is 2.25 × 0.9 m. The age of the vineyard on the experimental site is on average 7 years. During the winter pruning were left 10 buds on every shoot. Support structure consist of steel columns with a height of 1.5 m. In the last week of June was carried out tipping in a height about 0.20 m above the upper double wire

The characterization of assessed varieties

The mesurements of the leaves surface area were carried out on the six varieties – Müller Thurgau (MT), Chardonnay (Ch), Sauvignon blanc (S), Lemberger (Lem), St. Laurent (St.L.) and Cabernet Moravia (CM). The used rootstock differed depending on soil and climatic conditions and growth intensity of the variety. On the experimental site in Velké Bílovice was used rootstock Kober 5BB, which tolerates more loamy and waterholding soils, even with higher content of active lime.

In Lednice was for the varieties Müller Thurgau, Chardonnay, St. Laurent a Cabernet Moravia used rootstock Kober 5BB, and for the varieties Lemberger and Sauvignon blanc rootstock Craciunel 2. These rootstocks tolerate a wide range of soil conditions with a great range of the soil moisture and relatively high content of active lime in the soil.

The evaluation of the leaves surface area by using the device Leaf Area Meter (LAM)

The mesurements of the leaves surface area were carried out in four dates (May, June, July, August) during phenological growth stages of growth, flowering, initial development of fruits (berries pea-sized, berries beginning to touch) and during phenological stage of ripening of berries and shoots.

For the evaluation of the vine growth stages were used the international Phenological scale of the growth phases of grape (BBCH scale), which is shown for example by LORENZ *et al.* (1994).

For the mesurements of the leaves surface area was used device LFA (Leaf Area Meter CI-202L). It is a measuring instrument, working on the principle of laser sensors with built–in control unit. This device measures the length, width, perimeter and ratio of the sides.

Total area (cm^2) is automatically calculated during each scanning and the result is displayed on the display device.

For the own measurements were randomly selected three herbaceous shoots, which were removed from the plant. For each plant was subsequently carried out the measuring of the shoots lenght. The leaves surface area of lateral shoots, were then mesured from the base to the top of the shoot. Leaves, whose size was larger than the area of the measuring device were halved, and the total size was expressed as the sum of these two halves. The measured values were used to determine the average total leaf surface area and leaves surface area from lateral shoots, leaves surface area per one shoot and per one plant.

RESULTS AND DISCUSSION

In Tab. I and Tab. II there are shown the list of evaluated varieties, dates of the mesuring, with characteristic of phenological growth stages, which were carried out at the experimental sites in Velké Bílovice and Lednice in 2010.

In the Tab. III there are shown the average values of monitored variables for the varieties and dates of mesurements. Separately was observed the leaves

I: *Characteristics of the phenological growth stages by BBCH – identification keys of grapevine on the experimental site in Velké Bílovice*

Evaluated variety	The dates of measurement							
	27. 5. 2010		17. 6. 2010		11. 7. 2010		25. 8. 2010	
	Code	Characteristics of the phenological growth stages	Code	Characteristics of the phenological growth stages	Code	Characteristics of the phenological growth stages	Code	Characteristics of the phenological growth stages
Müller Thurgau	17	Leaf development – seven leaves unfolded	67	70% of flowerhoods fallen	75	Berries pea-sized, bunches hang	85	Softening of berries
Chardonnay	16	Leaf development – six leaves unfolded	69	End of flowering	75	Berries pea-sized, bunches hang	85	Softening of berries
Sauvignon blanc	16	Leaf development – six leaves unfolded	68	80% of flowerhoods fallen	73	Berries groat-sized, bunches begin to hang	85	Softening of berries
Lemberger	17	Leaf development – seven leaves unfolded	62	20% of flowerhoods fallen	73	Berries groat-sized, bunches begin to hang	83	Berries developing colour
St. Laurent	17	Leaf development – seven leaves unfolded	63	30% of flowerhoods fallen	73	Berries groat-sized, bunches begin to hang	83	Berries developing colour
Cabernet Moravia	18	Leaf development – eight leaves unfolded	60	Leaf development – seven leaves unfolded	71	Berries groat-sized, bunches begin to hang	83	Berries developing colour

II: *Characteristics of the phenological growth stages by BBCH – identification keys of grapevine on the experimental site in Lednice*

Evaluated variety	The dates of measurement							
	27. 5. 2010		17. 6. 2010		11. 7. 2010		25. 8. 2010	
	Code	Characteristics of the phenological growth stages	Code	Characteristics of the phenological growth stages	Code	Characteristics of the phenological growth stages	Code	Characteristics of the phenological growth stages
Müller Thurgau	17	Leaf development – seven leaves unfolded	67	70% of flowerhoods fallen	75	Berries pea-sized, bunches hang	85	Softening of berries
Chardonnay	16	Leaf development – six leaves unfolded	64	40% of flowerhoods fallen	73	Berries groat-sized, bunches begin to hang	83	Berries developing colour
Sauvignon blanc	15	Leaf development – five leaves unfolded	62	20% of flowerhoods fallen	73	Berries groat-sized, bunches begin to hang	83	Berries developing colour
Lemberger	16	Leaf development – six leaves unfolded	61	Beginning of flowering: 10% of flowerhoods fallen	73	Berries groat-sized, bunches begin to hang	83	Berries developing colour
St. Laurent	16	Leaf development – six leaves unfolded	61	Beginning of flowering: 10% of flowerhoods fallen	73	Berries groat-sized, bunches begin to hang	85	Softening of berries
Cabernet Moravia	17	Leaf development – seven leaves unfolded	60	Leaf development – seven leaves unfolded	71	Berries groat-sized, bunches begin to hang	81	Beginning of ripening: berries begin to develop variety-specific colour

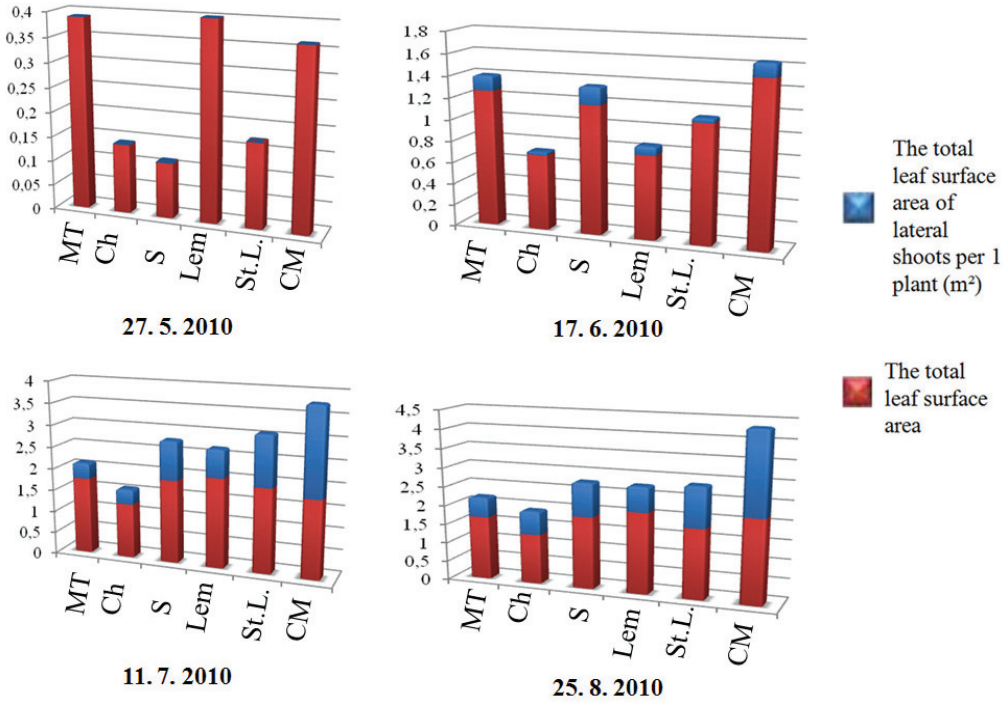
III: *The resulting values of the leaves surface area*

The evaluated variety	The experimental site in Velké Bílovice			The experimental site in Lednice		
	The average value					
	Annual shoots leaves surface area (mm²)	Lateral shoots leaves surface area (mm²)	Whole plant leaves surface area (m²)	Anual shoots leaves surface area (mm²)	Lateral shoots leaves surface area (mm²)	Whole plant leaves surface area (m²)
The date 27. 5. 2010						
Müller Thurgau	388 710	0	0.39	357 777	0	0.36
Chardonnay	140 220	0	0.14	224 210	0	0.22
Sauvignon blanc	112 050	0	0.11	269 038	0	0.27
Lemberger	399 840	0	0.40	373 520	0	0.37
St. Laurent	171 408	0	0.17	354 186	0	0.35
Cabernet Moravia	361 550	0	0.36	342 432	88	0.34
The date 17. 6. 2010						
Müller Thurgau	1 261 650	137 600	1.40	1 036 152	91 260	1.13
Chardonnay	701 120	29 320	0.73	948 780	26 880	0.98
Sauvignon blanc	1 189 692	163 836	1.35	479 920	33 024	0.51
Lemberger	776 952	80 928	0.86	850 520	28 656	0.88
St. Laurent	1 100 520	39 090	1.23	1 190 904	8 460	1.20
Cabernet Moravia	1 513 120	125 520	1.64	632 853	133 524	0.77
The date 11. 7. 2010						
Müller Thurgau	1 755 840	362 100	2.12	1 779 960	350 820	2.13
Chardonnay	1 249 500	342 300	1.59	2 239 410	480 480	2.72
Sauvignon blanc	1 896 202	890 560	2.79	1 658 232	670 680	2.33
Lemberger	2 044 250	637 200	2.68	1 813 896	868 734	2.68
St. Laurent	1 924 450	1 160 040	3.08	1 556 700	123 480	1.68
Cabernet Moravia	1 776 640	1 997 600	3.77	2 569 280	1 164 800	3.73
The date 25. 8. 2010						
Müller Thurgau	1 675 950	530 550	2.21	1 767 360	1 092 624	2.86
Chardonnay	1 312 500	622 860	1.94	1 786 720	1 312 740	3.10
Sauvignon	1 895 586	890 560	2.79	1 442 556	1 864 926	3.31
Lemberger	2 125 260	655 340	2.78	2 078 700	1 916 310	3.99
St. Laurent	1 833 260	1 056 400	2.89	1 692 558	900 540	2.59
Cabernet Moravia	2 199 528	2 150 064	4.35	1 865 490	2 253 960	4.12

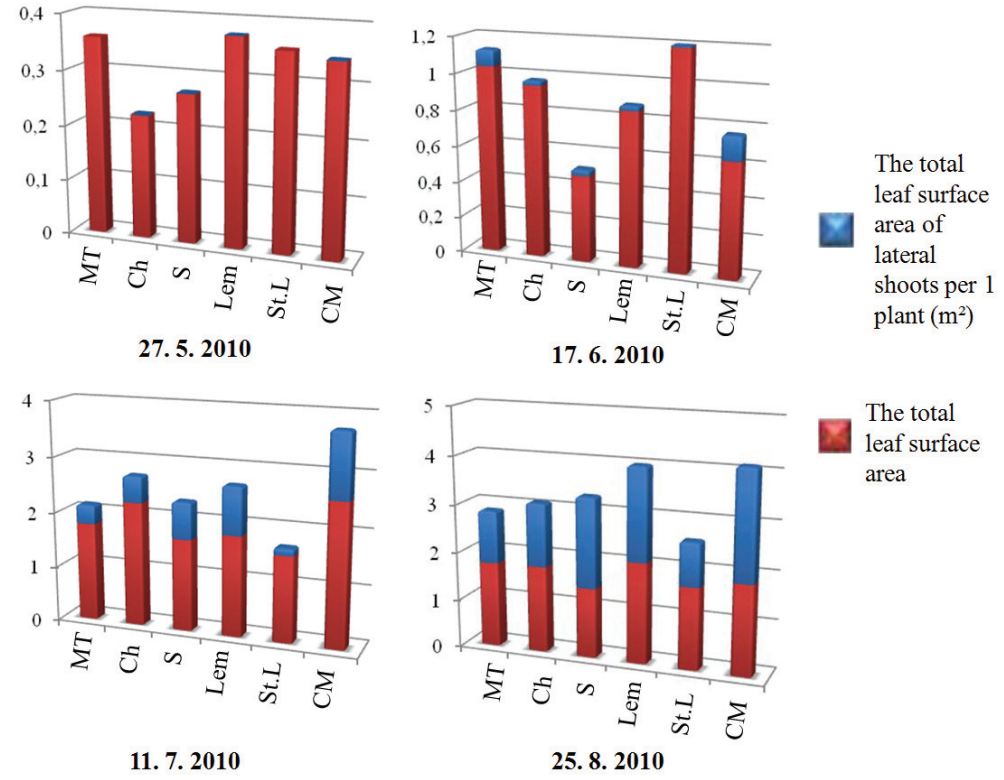
surface area of the leaves on the main shoot (mm²) and the leaves surface area on lateral shoots (mm²). The total leaves surface area per one grapevine plant (m²) was calculated from the obtained average value.

An obvious differences in the intensity of development leaves surface area among the evaluated varieties, dates and experimental sites are presented in Tab. III.

During phenological growth stage of prolongation growth was the development of leaves surface area relatively slow and ranged from 0.11 to 0.40 m². The greatest development of the leaves surface area occurs during phenological growth stages of flowering and development of fruits as it is shown in Graph 1 and Graph 2. The further development of the leaves surface area is later reinforced by the growth of leaves on lateral shoots, which grow, at a higher intensity, after tipping of the shoots. In phenological growth stage of fruit development reached the leaves surface area the greatest values of the variety Lemberger and Cabernet Moravia, lowest of the varieties Müller Thurgau and Chardonnay.



1: *The total leaf surface area and the total leaf surface area of lateral shoots per 1 plant (m²) during the monitored phenological growth stages; The experimantal site Velké Bílovice*



2: *The total leaf surface area and the total leaf surface area of lateral shoots per 1 plant (m²) during the monitored phenological growth stages; The experimantal site Lednice*

EICHHORN (1984) states, that the main vine growth begins in early June, while greatest leaves surface area development reaches maximum till the end of this month.

SPRING, ZUFFEREY (2008) evaluated leaves surface area depending on the length of shoots of the variety Pinot Noir. Their results show, that the leaves surface area ranges from 0.7 m^2 to 1.0 m^2 depending on the vineyard area, by the length of shoots 0.6 m and 1.85 m^2 the length of shoots 1.4 m.

SMITH a KLIEWER (1994) state, that the greatest development of the leaves surface area occurs during phenological growth stages of flowering, and overall surface area may be affected by conditions of the year. The difference of the leaves surface area can be in the same phenological stage in each year up to 30%. This claim is also supported by the obtained results.

The course of weather during the year 2010 was compared to long-term average temperature and was found that rainfall above average, what positively affected the growth dynamics of leaves surface area.

SIEGFRIED, HÖHN, VIRET *et al.* (2005) performed comparable measurements with the same type of measuring apparatus with four grapevine varieties (Müller Thurgau, Pinot Noir, Riesling, Chasselas) on the five sites with comparable soil and climatic conditions. The results of their measurements confirm significant differences of the leaves surface area between varieties and also between different experimental sites. During the phenological stage of the prolongation growth differences were not significant. While the greatest differences were recorded during the flowering phenophases. From the graphs is also clearly noticeable great intensity of growth lateral shoots, after tipping of the shoots upper parts, which was carried out, at both sites, in the last week of June.

PAVLOUŠEK (2007) states, that after the tipping, when the main shoot is cut out, lateral shoots start to grow. The lateral shoots are very important for the vine. The younger leaves surface area of lateral shoots produces assimilates, which the vines use for ripening grapes, production of storage compounds and preparation of plant for winter. The measurement results show that the largest leaves area surface of the lateral shoots have a varieties Cabernet Moravia, Sauvignon blanc, Lemberger and St. Laurent. For the variety Cabernet Moravia the leaves surface area of lateral shoot even exceeded the leaves surface area of lateral shoots leaves surface area on the main shoots.

CONCLUSION

This experiment was focused on the evaluation of leaves surface area on six varieties of grape vine at the experimental sites in Velké Bílovice and Lednice. The data of leaves surface area were evaluated during four phenological growth and developmental stages and can be used for different agro-technical interventions associated with the determination of the required dose of pesticides, or to determine the extent of the leaf reduction, grape set, but also for defoliation. Knowledge of the data about the leaves surface area development dynamics of the each variety may, in accordance with the expected yield, contribute to ensure high quality grapes. The obtained results showed, that it is necessary to find responsible approach to the canopy management of the varieties with smaller leaves surface area such as Müller Thurgau and Chardonnay, of which should be left long enough shoots with the corresponding number of leaves. Also the lateral shoots of these varieties should be removed only in the minimum extent from the grapes zone.In contrast, the varieties with large leaf blades as Lemberger and Cabernet Moravia can be used intensive defoliation, lateral shoots removing and tipping performed with greater intensity, without compromising the relationship between the leaves surface area and the weight the left grapes.

SUMMARY

The contribution deals with monitoring of the leaves surface area on six varieties of grape vine. Determining of the leaf surface area was performed using the device Leaf Area Meter CI–202, working on the principle of the scanner, during the four phenological growth stages. The obtained results showed, that leaves surface area pertaining to a plant during phenological growth stage of prolongation growth ranges from 0.11 to 0.40 m^2, during phenological stage of flowering from 0.51 to 1.64 m^2, during berries growing from 1.59 to 3.77 m^2 and during phenological growth stage of ripening of grapes and shoots from 1.94 to 4.35 m^2. The obtained values indicate the fastest increase of leaves surface area during the flowering phonological stage. In terms of the required relation of leaves surface area and yield of the grapes of the adequate quality was leaf surface area during phenological phase od ripening rated as adequate for varieties Moravia Cabernet, Sauvignon, St. Laurent.
In contrast, smaller leaf surface area was measured on varieties Chardonnay and Müller Thurgau. The results suggest the possibility of controlled choices of the necessary work operations (defoliation, lateral shoots removing, grape set reduction) during the phase of the grapes ripening.

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