Harmonising grapevine phenology recording for budburst and flowering as recommended by the Perpheclim project

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HARMONISING GRAPEVINE PHENOLOGY RECORDING FOR BUDBURST AND FLOWERING AS RECOMMENDED BY THE PERPHECLIM PROJECT

HARMONISATION DES NOTATIONS DE DÉBOURREMENT ET DE FLORAISON SELON LES RECOMMANDATIONS DU PROJET PERPHECLIM

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Abstract

In the framework of a French network of researchers working on the phenology of forest trees, fruit trees and grapevine (PERPHECLIM ACCAF project), methods of observations and sampling strategies were discussed and compared. The objective was a harmonisation of data acquisition strategies for grapevine phenology. The BBCH scale was chosen as a reference because it is the most detailed phenological scale available. However, when possible, correspondences to the widely used Baggiolini and modified Eichhorn and Lorenz scales are provided. Budburst is considered when 50% of the buds reach BBCH 07 and flowering when 50% of flowers are open (BBCH 65). Two ways of counting were compared: assessment of the percentage of open flowers inflorescence by inflorescence versus a global recording on whole plants. Visual estimations of flowering percentage for inflorescences were compared to exact counts of open flowers. In order to facilitate comparisons of phenological data, we propose standardised protocols, both for observation methodology as for sampling strategy, for assessing budburst and flowering dates.

Keywords : *Grapevine, phenology, budburst, flowering, sampling*

Résumé

Dans le cadre d'un réseau de chercheurs travaillant sur la phénologie des arbres forestiers, des arbres fruitiers et de la vigne (Projet PERPHECLIM ACCAF), des méthodes d'observation et d'échantillonnage ont été comparées. L'objectif était d'harmoniser l'acquisition de données pour la phénologie de la vigne. L'échelle BBCH a été retenue car c'est l'échelle disponible la plus précise. Quand cela est possible les correspondances avec les échelles largement utilisées de Baggiolini et de Eichhorn et Lorenz modifiée sont proposées. Le débourrement correspond à la date à laquelle 50% des bourgeons ont atteint le stade BBCH 07 et la floraison quand 50% des fleurs sont ouvertes (BBCH 65). Deux méthodes pour estimer le taux de fleurs ouvertes ont été comparées: une estimation inflorescence par inflorescence, ou une estimation sur plante entière. Par ailleurs des estimations visuelles par inflorescence ont été confrontées à des comptages exacts de fleurs ouvertes. Pour faciliter la comparaison de données de phénologie pour le débourrement et la floraison, nous proposons des protocoles standardisés, aussi bien pour les méthodes d'observation que pour les procédures d'échantillonnage.

Mots-clés : Vigne, phénologie, débourrement, floraison, échantillonnage

1. Introduction

Whatever the crop, dates of major development stages have to be recorded to decide for the timing of management operations, like pesticide applications, foliar fertilizer applications and the triggering of irrigation. Phenology recordings are also a tool for analysing the possible impacts of environmental conditions during the different development phases. However, they are subject to discrepancies for several reasons. The exact stage that has to be observed can be a matter of discussion. Sampling strategies can differ, in terms of scale (whole plant or organ), as well as in number and frequency of observations. Budburst is the onset of annual plant growth, with the unfolding of the first leaves. At that time, the photosynthetic activity will resume, and carbon sources fuelling growth will progressively switch from reserves to newly synthesized carbohydrates. Flowering is the visible and crucial event in the reproductive phase: at cap fall, the pollen will reach the stigmata and germinate. The following fertilization process of the ovule will lead to seed formation, which is a key event for berry development and final yield. Using a common language and common methods in the grapevine community for assessing developmental stages is a key issue to facilitate the comparison of data between vineyards and experiments. This allows building long homogenous and reliable datasets that can be used to follow the impacts of climatic changes, to build models for predicting phenological stages in the future or to help growers in their timing to implement management practices. In this paper, we propose methods for assessing budburst and flowering validated in a network of researchers working on grapevine in France in the framework of the PERPHECLIM ACCAF project. Some results related to the use of these protocols are presented.

2. Material and methods

2.1. Methods for describing single organs

The BBCH scale (Biologische Bundesanstalt, Bundessortenambt und CHemische Industrie) is widely used to describe phenology, both for monocotyledons and dicotyledons, in annual and perennial crops (Meier, 2001). We recommend to use the descriptions of grapevine developmental stages proposed by Lorenz *et al*. (1995) on the basis of this BBCH scale. Correspondences between the main stages of the BBCH scale, the widely used "Baggiolini" scale (Baggiolini, 1952) and the "Modified Eichhorn-Lorenz" ("Modified E-L") scale as proposed by Coombe (1995) are provided in the next sections.

2.1.1. Budburst

Budburst is considered when a given bud reaches stage BBCH 07 (Figure 1A). This corresponds to Baggiolini stage C and modified E-L stage 4.

2.1.2. Flowering

Flowering, stage BBCH 65, is considered when 50% of the flowers are open (Figure 1B). This corresponds to Baggiolini stage I and modified E-L stage 23.

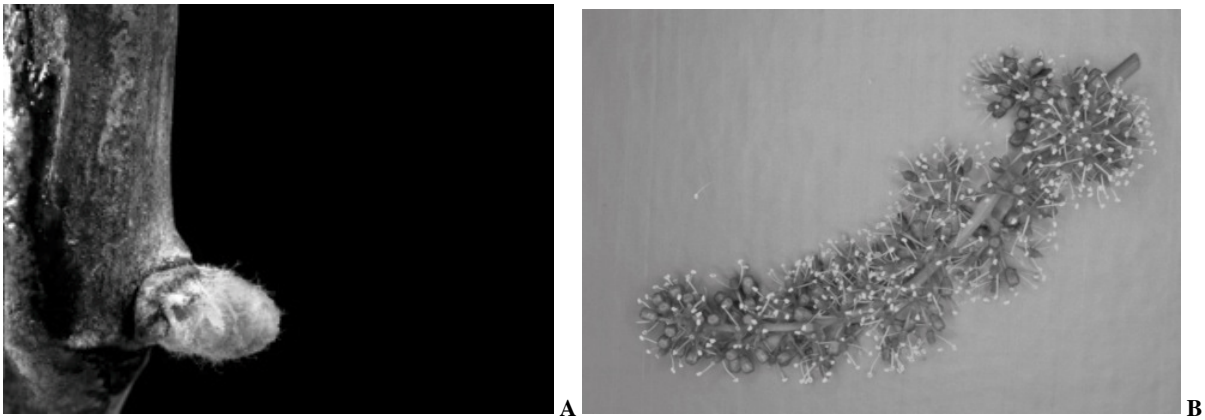

Figure 1. (A) *Stage BBCH 07: green tip visible. Correspondences : Baggiolini : C, Modified E-L: 4.* ***(B)*** *Stage BBCH 65: 50% of caps off. Correspondences: Baggiolini: I, Modified E-L: 23. Picture of Cabernet-Sauvignon in Colmar with 54% of open flowers.*

Figure 1. (A) Stade BBCH 07: pointe verte visible. Correspondances: Baggiolini : C, E-L modifiée: 4. **(B)** Stade BBCH 65: 50% de capuchons détachés. Correspondances: Baggiolini: I, E-L modifieé: 23. Photo de Cabernet-Sauvignon à Colmar avec 54% de fleurs ouvertes.

2.2. Protocols: details and sampling

Standardised protocols are necessary to collect data for determining the main developmental stages. In the following sections these protocols are presented.

2.2.1. Budburst (stage BBCH 07). Correspondence: Baggiolini: C, modified E-L: 4

- Only adult and productive plants with their final architecture are observed.
- A bud is counted as burst when a green or red tip is visible.
- Only primary buds are observed.
- The BBCH07 stage corresponds to the date when 50% of buds are burst when compared to the total number of buds left after pruning.
- Counts on at least five plants are required.
- Observation frequency: first observation when a minimum 5% and a maximum of 49% of the buds are burst. At least one more recording is necessary in order to have a value between 51 and 99% of buds burst. The delay between two recordings should not exceed one week.
- The date when 50% of the buds were burst is calculated by interpolation between the recorded values (at least two).

2.2.2. Flowering (stage BBCH 65). Correspondences: Baggiolini: I, modified E-L: 23

- Only adult and productive plants with their final architecture are observed.
- A flower is considered as open when the base of the cap is detached, even is the cap has not fallen yet. A percentage of open flowers is visually estimated. The BBCH65 stage is the date when this percentage is 50%.
- Visual estimations on at least five plants are required.
- The entire plant is observed, not individual inflorescences.

- Two methods can be implemented to determine the 50% flowering stage and will yield similar results:
- By estimating the percentage of open flowers plant by plant, which are averaged
- By using classes:

  Class 1 = 0 – 10% flowers open
  Class 2 = 11 – 30% flowers open
  Class 3 = 31 – 50% flowers open
  Class 4 = 51 – 80% flowers open
  Class 5 > 80% flowers open
- Observation frequency: first observation when a minimum of 5% and a maximum of 49% of the flowers are open. At least one more recording is necessary in order to have a value between 51 and 99% of open flowers. The delay between two recordings should not exceed one week.
- The date when 50% of the flowers were open is calculated by interpolation between the recorded values (at least two) or between classes. The calculated date corresponds in this case to class 3.4.

1.3. Test and validation of the protocols

1.3.1 Budburst

Intercalibration was carried out by a panel of 15 people on 8 April 2014 in a vineyard in the Bordeaux area, France. This work consisted of bud ratings, conducted on 3 varieties (early and late varieties): *Vitis vinifera* cv. Roussanne, Mourvedre and Cabernet-Sauvignon, grown with 5 replicates for each variety on a single plot (gravelly soil) and grafted on the same rootstock (SO4). Observations were carried out on batches of five vines. The total number of main buds was counted for each batch (eyes of the crown were not taken into account). Total number of buds reaching stage BBCH 07 or more were counted. Percentage of buds reaching BBCH 07 or more were calculated for each observer and each batch.

Table 1. *Estimation of the percentage of buds reaching stage BBCH 07 around budburst in a Bordeaux vineyard for three varieties. Averages are counts from a panel of 15 assessors.*

Tableau 1. Estimation du taux de bourgeons atteignant le stade BBCH 07 à l'époque du débourrement pour trois variétés de vigne dans un vignoble à Bordeaux. Les moyennes sont issues des comptages d'un panel de 15 expérimentateurs.

Variety	Total number of buds per batch			Number of buds at stage BBCH 07 or beyond			Percentage of buds at stage BBCH 07 (%)		
	Mean	SD [(1)]	CV [(2)]	Mean	SD	CV	Mean	SD	CV
Cabernet-sauvignon	29.2	2.9	10.0	18.6	2.5	13.4	58.0	6.7	11.5
Mourvèdre	32.1	2.9	9.0	14.4	2.0	13.7	38.9	7.0	18.0
Roussanne	30.0	2.2	7.4	28.5	2.1	7.5	84.4	3.3	3.9

[(1)] Standard deviation
[(2)] Coefficient of variation (%)

1.3.2 Flowering

1.3.2.1 Assessment of the percentage of open flowers

Fifteen flowering inflorescences were picked on Cabernet-Sauvignon in the INRA germplasm collection in Colmar, France (48.08°N, 7.37°E) on 13 June 2014. Digital pictures were taken in the laboratory and open flowers and floral buds were immediately counted. The percentage of open flowers was calculated as the ratio between the number of open flowers and the sum of open flowers and floral buds. A panel of eleven people familiar with grapevine phenology recordings estimated then the percentage of open flowers on the digital pictures.

1.3.2.2 Assessment of flowering on whole plants or inflorescence by inflorescence

Flowering stage BBCH 65 was monitored on nine varieties in Domaine de Mons (32100 Caussens, France). Two methods were compared: visual estimation of the percentage of open flowers on 100 inflorescences or visual estimation of the percentage of open flowers on entire plants. Data were obtained at least on two dates per variety.

3. Results

3.1. Budburst

Table 1 show the results of the intercalibration on the bud stage performed on 3 varieties. Total bud counts per vine are highly reproductive among panel members. Inclusion of crown buds was the main cause of miscounts. Counts of buds at stage BBCH 07 or more were also reproductive among panel members. Coefficient of variation for the percentage of buds at least at stage BBCH 07 varies from 4 to 18%, which indicates that error in estimation is around one day. Coefficient of variation decreased with the percentage of buds reaching at least stage BBCH 07.

3.2. Flowering

3.2.1. Assessment of the percentage of open flowers

Figure 1B shows an example of digital picture of a flowering bunch. The percentages of open flowers among the 15 inflorescences studied adequately covered the range 1-100%. Estimates were clearly higher compared to the real percentage of open flowers, especially in the 40-60% range (Figure 2B). Mean visual estimation of 50% open flowers actually ranged between 20 and 35 %. This discrepancy can lead to an anticipation of the 50% flowering stage estimate, but is general for all the assessors.

3.2.2. Assessment of flowering on whole plants or inflorescence by inflorescence

The assessment of flowering on whole plants generally led to slightly earlier dates of 50% flowering compared to assessments carried out inflorescence by inflorescence (Figure 2B). However the difference was always lower than one day and can be neglected. Hence, estimates based on whole plants should be preferred because they are easier to implement.

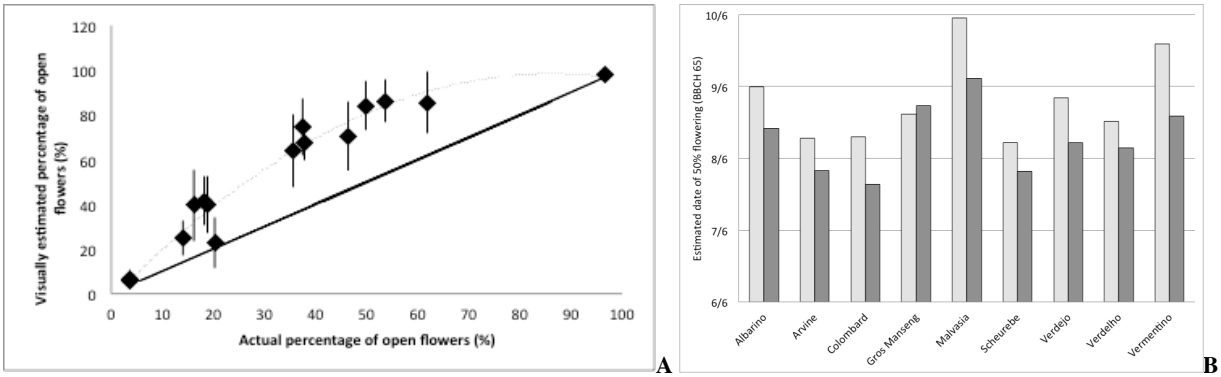

Figure 2. *(A) Comparison between the real percentage of open flowers and the visually estimated percentage of open flowers on Cabernet-Sauvignon. Bars represent standard-errors (n = 11).* ***(B)*** *Estimated dates of 50% flowering with two methods: inflorescence by inflorescence on 100 inflorescences (light grey) or by entire plants (dark grey).*

Figure 2. (A) Comparaison entre le taux réel de fleurs ouvertes et le taux estimé sur des inflorescences de Cabernet-Sauvignon. Les barres représentent les erreur-standard (n = 11). **(B)** Date de 50% de floraison estimées avec deux méthodes: inflorescence par inflorescence sur 100 inflorescences (gris clair) ou sur plantes entières (gris foncé).

4. Conclusion

Accurate recordings of major phenological stages are important for implementing management strategies and for assessing short or long term effects of climatic variability on grapevines. Widely accepted common protocols can help to avoid discrepancies in phenology recordings due to variations in observation or sampling strategies. In this paper protocols are proposed for budbreak and flowering observations in grapevine. They are the result of a large consultation among viticultural researchers in the framework of the PERPHECLIM ACCAF project.

5. Ackowledgments

The picture of bud at stage BBCH 07 was extracted from the movie "du bourgeon au raisin", by Jean-Louis Porreye and Clotilde Verriès, Montpellier Supagro/INRA.

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