

# Phenological characterization and quality of fine 'Black Star' table grape

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## ABSTRACT

The phenological behavior of grapevines depends on several factors such as weather conditions, rootstock and cultivation, among others. Therefore, it is important to study the phenological behavior of a certain cultivar, at a specific region, to provide growers with data that will allow them to program/plan their management and crop operations. Thus, the objective of this work was to evaluate the phenological characteristics and physical-chemical attributes of the 'Black Star' grapevine berries. The trial occurred in a commercial area located in Marialva-PR, during an off season crop and a regular crop, between 2012 and 2013, respectively. For the phenological behavior, the duration (number of days) of the following stadia was determined for 10 plants: pruning at the beginning of sprouting (PR-BI), pruning at visible inflorescences (PR-VI), pruning at full flowering (PR-FF), pruning at the beginning of the berries maturation (PR-MI) and pruning at harvesting (PR-HA). Regular crop cycle lasted 146 days and off season crop 121 days. In regards to the thermal demand for the grapevine to complete the pruning cycle until harvesting, it was verified an accumulation of 2,125 degree-day (DD) for the regular crop and 1,691 (DD) for the off season crop. Berries, with seeds, had an elongated, elliptical form and a dark purple-red skin coloration. Average contents for total soluble solids, titrated acidity and maturation index were 14.8 °Brix, 0.6% of tartaric acid and 24.8 for the regular crop, and 14.0 °Brix, 1.0% of tartaric acid and 14.1 for the off season crop, respectively.

**Key words:** phenology, *Vitis vinifera* L., thermal demand.

## INTRODUCTION

Varieties of the *Vitis vinifera* L. species from European origin, which are sensitive to fungal diseases and highly demanding during crop treatments, encompass the whole table grapes. All the other exported varieties are included in this group or are hybrids among them or of some other species of *Vitis*. Table grapes must carry characteristics appreciated for fresh consumption. Berries must be attractive, with nice taste, show handling and transportation resistance and good post-harvesting conservation (Leão 2004).

The 'Black Star' grape appeared in 2006, originated from a natural somatic mutation, in a 'Brasil' grape commercial vineyard, in the county of Marialva, Paraná, Brazil. It has elongated, elliptical berries of dark reddish purple coloration and can become a new market option. Cycle, production performance and susceptibility to fungal diseases are similar to those of the Italia cultivar (Roberto et al., 2012b).

Although it is a product of the somatic mutation of the 'Brasil' grape, the Black Star cultivar can present different phenological behavior, and, as a consequence, can be offered by the market in a different time. According to Giannetto et al. (2008), original cultivars and their mutations can show variability in their ampelographic and agronomic characteristics such as yield, foliar morphology and development cycle. Therefore, the phenological and productive characterization of the new cultivars is needed, during regular and off season crops, to allow the planning of agricultural activities and to estimate pruning and harvesting dates, under each one of these conditions (Ferri 1994; Jones 2003; Ribeiro et al., 2010).

Based on the above, the objective of this work was to characterize the phenology and physical-chemical composition of berries from the new 'Black Star' grapevine mutation produced during regular and off season crops, in Northern Paraná.

## MATERIAL AND METHODS

A trial was conducted in a commercial property in Marialva, Paraná, Brazil (latitude 23°30.930'S, longitude 51°47.829'O and 614 m of altitude). According to the Köppen classification, the Cfa climate type occurs in this region. It is a typical subtropical region, with an average temperature of 18 °C in the coldest month and above 22 °C in the hottest month, with hot summers, few frosts and a tendency to concentrate rains in the summer months, but with an undefined dry season (Caviglione et al., 2000).

'Black Star' grapevine cultivars were three years old, grafted in an IAC 766 'Campinas' rootstock. Vines were conducted by the trelling system, in a 3 x 4 m spacing. The period considered by the study included the 2012 regular crops and the 2013 off season crops. Regular crop pruning occurred on July 19, leaving seven buds per branch, followed by the application of the an hydrogenated cyanamide regulator at 6%, on the last three buds,

to break dormancy. Off season crop pruning occurred on January 4, leaving nine buds per branch, followed by the application of the an hydrogenated cyanamide regulator at 5%, on the last two buds. Culture treatments and phytosanitary patterns used in the Itália cultivar were adopted, without berry thinning.

During each crop, 10 representative plants were selected for the phenological assessment. Among them, five plants were used for the physical-chemical characterization of the bunches. Phenological behavior was evaluated based on the Eichhorn and Lorenz classification, modified by Coombe (1995), originated from visual observations, to determine duration, in days, of the following stadia: pruning in the beginning of budding (PR-BI), pruning at visible inflorescences (PR-VI), pruning at full flowering (PR-FF), pruning in the beginning of the berries maturation (PR-MI) and pruning at harvesting (PR-HA).

From the meteorological data provided by Instituto Tecnológico Simepar, the vine thermal characterization was realized by using the the degree-day totals, from pruning to harvesting, for the two production cycles as well as for each one of the sub-periods, according to the equation proposed by Villa Nova et al. (1972):

$$DD = (T_m - T_b) + (T_M - T_m)/2, \text{ for } T_m > T_b;$$

$$DD = (T_M - T_b)^2 / 2(T_M - T_m), \text{ for } T_m < T_b,$$

$$\text{and } DD = 0, \text{ for } T_b > T_M,$$

where:

DD = degrees-day;

T<sub>M</sub> = daily maximum temperature (°C);

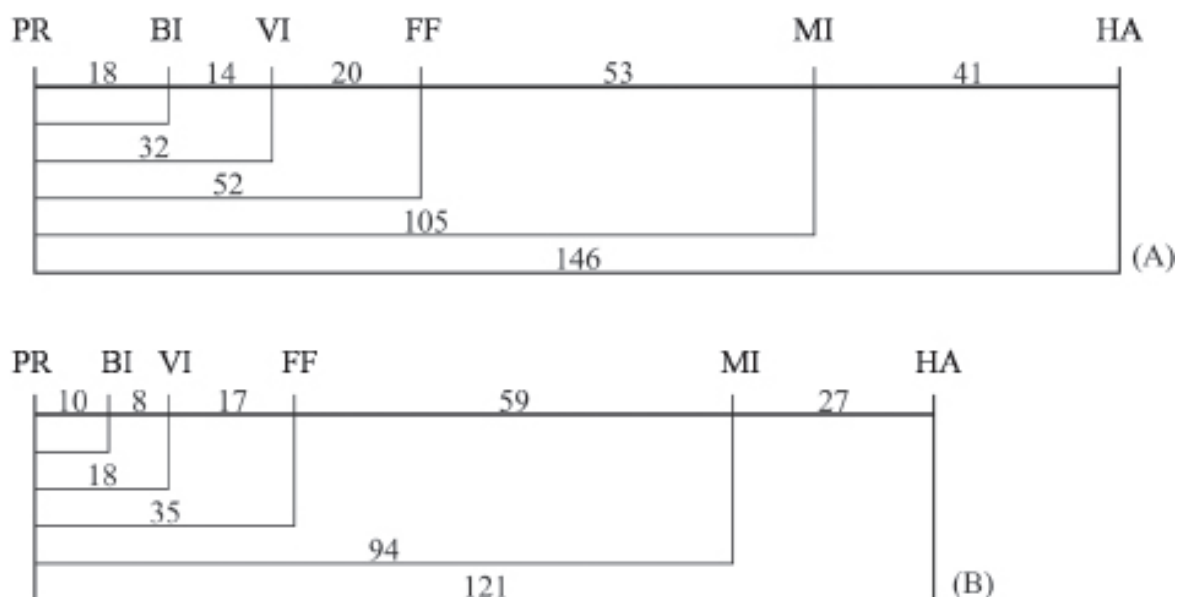
T<sub>m</sub> = daily minimum temperature (°C), and

T<sub>b</sub> = 10 °C, base temperature (°C).

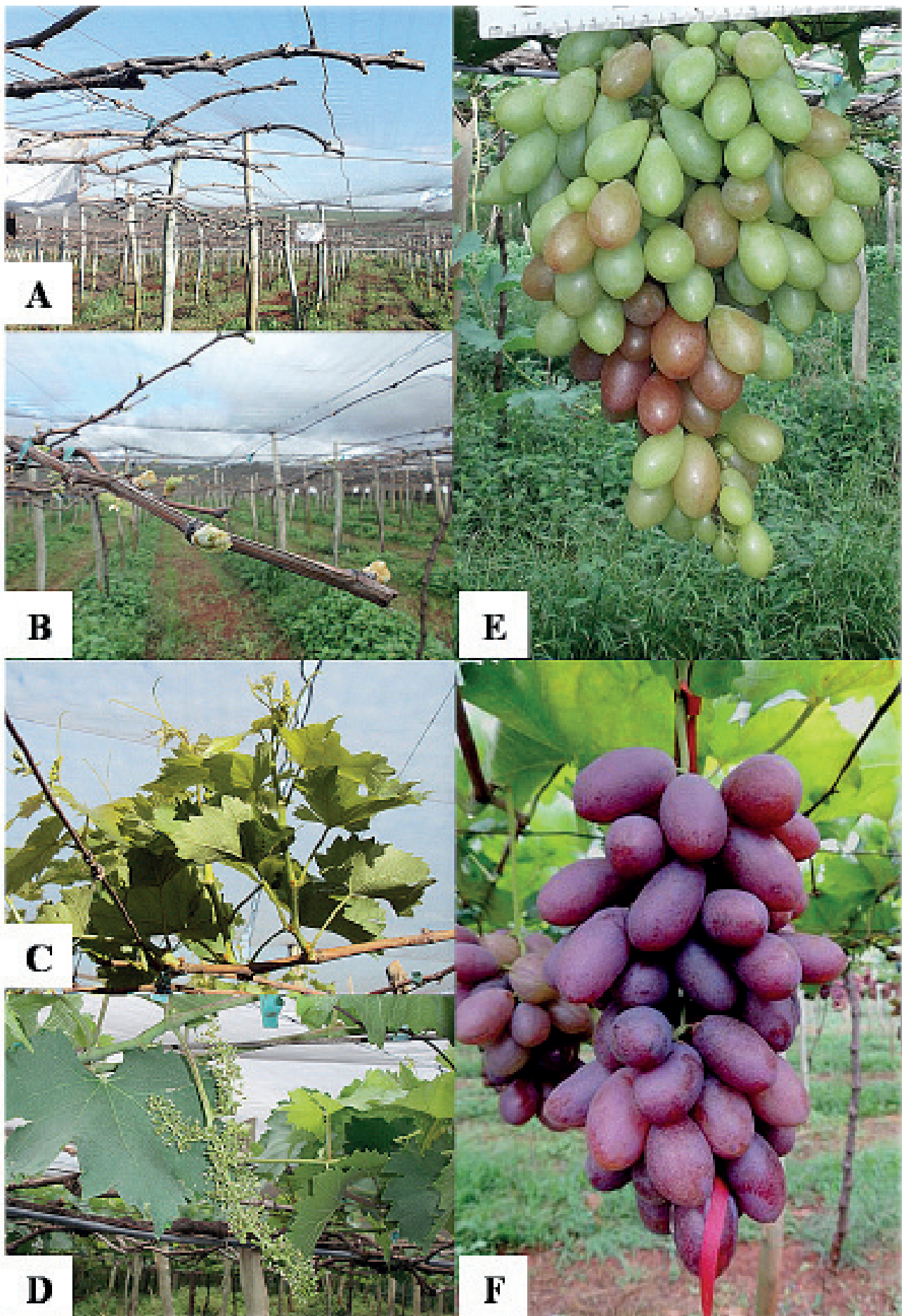
The following was determined during the physical-chemical evaluations: length (mm), diameter (mm), mass (g), color, soluble solids content (SS), titratable acidity (AT) and must maturation index (SS/AT) of five samples of 30 berries (Roberto et al., 2015). The following variables were obtained from the equatorial portion of the berries to determine color: *L\** (luminosity); *C\** (saturation) and *h°* (tone). Color index for red grapes (CIRG) was determined by the formula  $CIRG = (180 - h^\circ) / (L^* + C^*)$  (Carreño and Martínez 1995).

## RESULTS AND DISCUSSION

The duration of the 'Black Star' production cycle (pruning-harvest) was of 146 days for the regular crop and 121 days for the off season crop (Figures 1 and 2). Off season crop production cycle occurs, mostly, in the summer, which implies in the reduction of number of days to be completed. In locations with high temperatures, vegetative growth tends to be superior and the cycle is reduced in relation to regions where the climate is milder (Pedro Júnior and Sentelhas 2003). Besides the temperature, another factor that can have an effect on the off season grapevine cycle reduction is the fact that pruning is done at the moment when plants were interleaved, showing intense metabolic activity and, therefore, initiating budding rapidly.



**Figure 1.** Duration, in days, of the 'Black Star' vine phenological stages in Marialva, PR, 2012 regular (A) and 2013 off season (B) crops. Pruning (PR); budding initiation (BI); visible inflorescences (VI); full flowering (FF); maturation initiation (MI); and Harvest (HA).



**Figure 2.** Phenological stages of the 'Black Star' vine. Pruning (A); budding initiation (B); visible inflorescences (C); full flowering (D); maturation initiation (E); and Harvest (F).

Rodrigues (2009), working with 'Itália' grapes in Porto Feliz-SP, where the climate is similar to that found in Marialva-PR (Cfa), detected a variation of 22 days between the regular and off season cycles, 161 and 139 days, respectively, a value close to the 25 days observed for the 'Black Star' grape in Marialva. In the tropical region of Northern Minas Gerais, Ribeiro et al. (2010) verified a smaller variation for the 'Benitaka' grape, 120 days at pruning carried out in January and 131 days at pruning carried out in July. On the other hand, in Marinópolis-SP, where the climate is of the Aw type (tropical with a dry season), Sasaki (2002) observed that the Brasil cultivar had a cycle of 135 days in the regular crop and 128 days in the off season crop. Therefore, it becomes evident that, in crops that occur between the Summer and Fall, vine cycle is reduced by some days.

As for thermal demand, the 'Black Star' vine demanded 2,125 degrees-day (DD), in the regular crop and 1,691 DD, in the off season crop (Table 1). Close values were found by Rodrigues (2009), who concluded that the 'Itália' vine, in Porto Feliz, SP, needs 2,021 DD at the Winter pruning and 1,826 DD at the Summer pruning. Thermal total obtained for the regular crop is also similar to the 2,099 DD verified in Jales-SP for the Brasil cultivar to complete the cycle (Nagata et al., 2000).

**Table 1.** Thermal demand, in degrees-day (DD), calculated for the 10 °C base-temperature of each subperiod for the 'Black Star' vine.

Sub-periods	Degrees-day (DD)	
	2012 Regular crop	2013 Off season crop
PR-BI <sup>1</sup>	225.55	143.55
PR-VI	420.1	254.3
PR-FF	702.25	510.75
PR-MI	1,471.27	1,356.8
PR-HÁ	2,125.12	1,691.15

<sup>1</sup>PR-BI: Pruning - budding initiation; PR-VI: Pruning - visible inflorescences; PR-FF: Pruning - full flowering; PR-MI: Pruning - maturation Initiation; and PR-HA: Pruning - harvest.

Evaluation of the thermal demand, in degrees-day, of the 'Niágara Rosada' in different regions showed that the total degrees-day needed to complete the cycle depended on the location analyzed (Pedro Júnior et al., 1993). Therefore, studies to establish crop thermal index 'in loco' are essential for the adoption of this viticulture model (Busato et al. 2013). In addition to environmental factors, the vine cycle duration can also be altered, in the same region, due to the combination of scion and rootstock varieties, as observed by Sato et al. (2008).

As for the physical characteristics of the berries, measurements are described in Table 2. 'Black Star' berries have an elliptical, elongated format and mass of  $8.6 \pm 0.4$  g. Berries format is similar to that of the 'Redimeire' cultivar, but with better coloration and greater resistance to berry cracks caused by rains (Roberto et al., 2012b).

**Table 2.** Physical-chemical characteristics of 'Black Star' grape berries evaluated in the two crops.

Characteristics	2012 regular crop	2013 off season crop
Length (mm)	$31.7 \pm 0.8$	$33.1 \pm 1.2$
Diameter (mm)	$21.4 \pm 0.5$	$19.7 \pm 0.5$
Mass (g)	$8.6 \pm 0.4$	$7.6 \pm 0.4$
SS (°Brix) <sup>1</sup>	$14.8 \pm 0.6$	$14 \pm 0.3$
TA (% of tartaric acid) <sup>2</sup>	$0.6 \pm 0.0$	$1.0 \pm 0.1$
SS/TA	$24.8 \pm 2.8$	$14.1 \pm 0.9$

<sup>1</sup>SS (soluble solids), and <sup>2</sup>TA (titratable acidity).

'Black Star' grape harvesting occurred with soluble solids greater than 14 °Brix in both crops (Table 2), which is the minimum value for the 'Itália' grape harvesting and its mutants (Kishino and Roberto 2007); however, the relationship between soluble solids content and acids (SS/TA) was 24.8 in the regular crop, and 14.1 in the off season crop. The greater acidity present in the off season crop can be due to unfavorable climate conditions as the excessive rain during the insolation period reduction, since it is well-known that these factors affect the referred attributes directly (Benato 2003).

Color index (CIRG) for the 'Black Star' grape showed a value of 4.8 for the regular crop and 4.4 for the off season crop (Table 3). Carreño and Martínez (1995) determined the average value of 2.49 for pinkish grapes, 3.66 for red grapes, 4.75 for violet/purple grapes and 5.57 for dark purple/violet grapes. Herefore, it can be inferred

that the 'Black Star' grape shows purple or dark purple color, corresponding to the dark purple red according to the "Descriptors" parameters (Brasil 2001), while the 'Brasil' cultivar shows a black color film (Camargo 1998). On the other hand, Roberto et al. (2012a) found CIRG values between 3.7 and 4.2 for the 'Benitaka' cultivar, corresponding to the red grape.

The difference between accumulated degrees-day, as well as other factors such as thermal amplitude and day length, can affect the difference in berry color, as observed between the two crops (Pedro Junior and Sentelhas 2003). Consequently, differences between the concentration and quality of the anthocyanins present in the grape skin are possible. However, it can be inferred that the fine table grape 'Black Star' has market potential due to its attractive appearance and berries within desired quality standards since the commercial value of the grapes is affected by these prerequisites.

**Table 3.** Luminosity ( $L^*$ ), saturation ( $C^*$ ), tone angle ( $h^\circ$ ) and color index (CIRG) of 'Black Star' grape berries.

Color attributes	2012 regular crop	2013 off season crop
$L^*$	25.4 ± 2.1	26.8 ± 1.9
$C^*$	5.6 ± 2.1	6.1 ± 1.7
$h^\circ$	33.1 ± 8.9	36.1 ± 8.9
CIRG <sup>1</sup>	4.8 ± 0.6	4.4 ± 0.6

<sup>1</sup>Red grapes color index (CIRG) =  $(180 - h^\circ)/(L^* + C^*)$  (Carreño and Martínez 1995).

## CONCLUSION

The 'Black Star' vine shows a more precocious cycle for the off season crop and adequate physical-chemical attributes for commercialization in both crops.

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**Received: June 30, 2015.**

**Accepted: September 04, 2015.**

**Published: November 19, 2015.**