(DOI): 10.5777/PAeT.V4.N1.05
This article is presented in Portuguese and English with "resumen" in Spanish.
Brazilian Journal of Applied Technology for Agricultural Science, v. 4, n.1, p. 81-94, 2011.

Scientific paper

Percentage of fertility of gems and content of carbohydrates contained in roots, vine shoots and leaves from grape cultivar Itália

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Abstract

Cultivar Itália is the main representative of the fine table grapes with seeds in the Vale do Submédio São Francisco, and, being introduced in a growing region, cultural management adjustments are necessary to make it more productive. Thus, the objective of this study was to evaluate the metabolism of carbohydrates contained in roots, shoots and leaves of cv. Itália, and their levels of influence on the fertility rates of gems in branches located in different regions of the primary arm of cv. Itália, grafted onto the rootstock IAC-313 ('Tropical'). The experimental design was randomized block with three treatments and 15 replications, one plant per experimental unit. Roots, branches and leaves were collected before the yield prune, to determine the levels of carbohydrates. The analysis of bud fertility potential was held under a magnifying glass (magnification: 30 times), collecting three branches of the primary arm of each plant (basal, middle and apical), each containing 10 gems. After 27 days of the date of production pruning it was determined real fertility of gems, using the ratio: number of fertile buds by the total number of sprouted buds per plant. It was determined the levels of reducing sugars (RS) and total sugars (TS) and starch. It was found that the fertility of buds varies with the position of the branches in the plants, with a positive correlation between fertility and the potential gems of starch and total sugars, and that the expression of the fertility of buds on branches located in the basal position of the plant is higher.

Keywords: *Vitis vinifera* (L.) physiology of production, starch

Introduction

The viticulture practiced in the region of the Vale do Submédio São Franciscois is noteworthy in the national scenario not only for the expansion of the cultivated area and for the volume of production but, mainly, by the quality of the produced grapes (CORREIA and SILVA, 2009), however, for the cultivar Itália – the main representing of the fine table grapes with seeds exploited in the region – it is verified wide ranges in yield due to the adopted cultural managements.

The viticultural exploitation in an increasingly intensive way has lead to a deep unbalance of vine trees, changing their metabolism and, consequently, the hormone balance of plants (BOTELHO et al, 2006), which, as a rule, changes the fertility of vine tree gems (RIBEIRO et al, 2008; SCARPARE FILHO et al., 2010).

Sugar in abundance promoted the growth and storage of carbohydrates in the drains and, when the photosynthesis rate is high, there is an accumulation of total soluble sugars and starch in leaves (TAIZ and ZEIGER, 2009). When peach initiates the active growth, the carbohydrate metabolism becomes more intense and the increase of sucrose happens due to the production of carbohydrates trough photosynthesis (BORBA, 2005), which is the same for the vine, so it is necessary to make adjustments in the vegetal canopy in order to achieve a balance between the vegetative and reproductive parts of the plant (MANDELLI et al., 2008).

Vine is extremely demanding concerning the level of carbohydrate to reach a higher efficiency (MANDELLI et al., 2008). After the harvest, most of the photosynthesized go from the brunch to the other parts of the plant, and the sugars are converted in starch in the permanent parts of the vine (stem, branches, roots), and after going through a period of inactivity, characterized by the winter rest, it begins a new vegetative cycle (SCARPARE FILHO et al, 2010),

Received in: 14/12/2010 Accepted for publication: 15/03/2011

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and the storage and use of carbohydrates depend on the state of growth of the shoot as well as on the quantity of grapevines produced (KLIEWER, 1990).

Meristematic apexes of vine suffer great physiological changes during the process of floral induction until they are transformed in beginning of inflorescence. This process continues until the gems go into dormancy, induced by environmental factors as temperature and water stress (KLIEWER, 1990).

Due to the importance of sugars as source of energy for the development of fruit plants, the present work aimed to evaluate the metabolism of carbohydrate contained in roots, vine shoots and leaves, and the influence of their levels over the rates of gem fertility in vine shoots located in different regions of the primary arm of the cv. Itália.

Material and methods

The experiment was performed in commercial vineyard, in the Perímetro Irrigado in Petrolina - PE, with the soil Neossolo Fúlvico, with plants of cv. Itália, planted in spacing of 3.0 m x 3.0 grafted over the rootstock IAC-313 'Tropical', when it was five years old, conducted in a trellising system, with a pattern of 12 units of production (six exits in each plant side, with four vine shoots each) and irrigated by dripping.

Roots, vine shoots and leaves were collected before the production pruning, 60 days after the harvest of the productive cycle of the second semester of 2008, in order to determine the content of carbohydrate, collecting roots with diameters close to 7.64 mm, of 10 leaves per plant. All the samples were placed in an oven at the temperature of 65 °C for 72 hours to dehydrate, and after this period they were processed in a mill, to execute the biochemical analysis.

For the evaluation of the content of carbohydrates in vine shoots, it was used the same vine shoots previously selected for the analysis of potential gems fertility.

The analysis of potential gems fertility was made under a magnifying glass (magnifying: 30 times), by collecting three vine shoots of the primary arm of each plant (basal, intermediary and apical portions) containing 10 gems each, according to methodology applied by RIBEIRO et al. (2008). After the analysis, the vine shoots were used for the analysis of carbohydrates. After 27 days from the date of production pruning (with vine shoots pruned with 10 gems), the real fertility of gems was evaluated in all the vine shoots located until one meter of the primary arm of the plant (basal portion), from one to two meters (intermediary portion) and from two to three meters (apical portion), using the ratio number of fertile gems by the total number of gems sprung per plant.

The quantity of reducing sugars (RS) and total sugars (TS) and starch (ST) was measured according to the methodology described by the INSTITUTO ADOLFO LUTZ (2005).

The experiment design used was randomized blocks, with 3 treatments (length of the primary arm) and 15 replications, considering one plant per experimental unit. The data was interpreted trough analysis of variance (F test), correlation, and Tukey mean test ($p < 0.05$).

Results and discussion

Through Table 1, it is observed that there were no statistic differences for the potential fertility between the vine shoots located in the basal, intermediate and apical portions of the primary arm of the cv. Itália, and that the fertility of this vine shoots did not maintain the gem sprouting in all the plant vine shoots, with a higher expression of the potential fertility of branches located in the basal region (potential fertility: 64.00%; real fertility: 32.80%), indicating that only 51.28% of the potential fertility is expressed after the gem sprout. RIBEIRO et al. (2008) in the region of the Vale do Submédio São Francisco found that the potential and real fertility of gems rates of cv. Superior Seedless were 33.54% and 17.62%, respectively, and FELDBERG et al. (2008), working equally with the cv. Superior Seedless, in the North of the state of Minas Gerais, found a rate of fertility of gems of approximately 0.08 branches/branch.

It is still verified in Table 1 that the rate of real fertility of gems was higher in the vine shoots located in the basal portion of the plant (32.80%) and that it decreased along the plant, and due to that the vine shoots located in the apex position obtained a lower fertility of gems (15.13%), without, however, a statistic difference for the potential fertility in the different positions of the plants. This finding may be an indicative that the cv. Itália, in the edaphoclimatic conditions in which the work was executed, could have a higher yield if it was conducted with the primary arm with smaller size, i.e., reducing spacing

Table 1. Percentage of potential and real fertility of gems in function of the position of vine shoots in the primary shoot of the cv. Itália.

Fertility of gems	Basal	Intermediate	Apex
Potential (%)	64.00 a	64.00 a	62.00 a
Real (%)	32.80 a	21.15 b	15.13 c
F test	27.68 *	170.31 *	175.02 *
CV(%)	33.54	21.11	25.16

*Equal and lowercase letters in lines do not differ by the Tukey test, * significant at 1% of probability (p < 0.01)*

between plants. This happened since the number of the beginning of inflorescences which develop in gems is influenced, among other factors, by the varietal characteristics. However, VIEIRA et al. (2006), studying the fertility of gems of vine 'Niagara Rosada' according to the conduction system, found higher averages of fertility of gems and lower number of necrosed gems in the terminal portion of the rods in the two conduction systems which were considered.

According to GONZAGA NETO (2001), theoretically, the production of pruned guava is function of the relation C/N (carbohydrate/nitrogen), which exists in the branch after the pruning, and that in practice, it can be said that the relation C/N increases from the base to the extremity of the branches. In vine, the formation of the inflorescences is initially together with the presence of "anlage" in the apex of the latent gems, which will originate the beginning of inflorescence or of tendril, and there is, thus, the formation of flowers from the beginning of inflorescence in the period of gem sprout, when it will occur the last stages of flower formation, i.e., the development of calyx, corolla, stamens and pistils (SRINIVASAN and MULLINS, 1981).From this view, it is supposed that a higher formation of inflorescences in the vine shoots located in the basal portion of the primary arm of the cv. Itália may be associated with the existence of a low relation C/N in this branches, in the moment of sprout of the gems, which would favor the formation of flowers since in this portion there is a higher amount of nitrogen compounds favorable to the growth of vegetable organs and for the cellular multiplication (TAIZ and ZEIGER, 2009).

For Table 2, it is observed that the concentrations of starch (ST) did not differ in the different organs of the cv. Itália (roots, vine shoots and leaves) in the period of production pruning, and that the contents of total sugar (TS) and reducing sugars (RS) were in lower concentration in roots and, still, that the contents of RS increased from the roots to the vine shoots, with a higher concentration in leaves. The leaves inserted in the different stem positions contribute differently in the supply of metabolites for the other parts of the plant. In general, roots receive photosynthesized products, mainly from the basal leaves, while organs and tissues, located in the apical part, are supplied by the superior leaves (ALVIM et al, 2010).

According to PALLIOTTI and CARTECHINI (2001), the quantity of carbohydrates in vines in directly linked to their phenological stage and to the seasonality, and MAJEROWICZ (2004) emphasized that in the metabolism of carbon in leaves, starch acts as a regulator between the demand (mobilization for growing tissues and reserve tissues) and the source (photosynthesis). SCHENATO et al. (2007) studying the influence of ethephon in the nutrient and carbohydrate distribution and the growth in young vines observed that both the concentration and the quantity of starch in the second cycle leaves in the treated plants was lower when compared to the plants without ethephon. These results emphasize that the demand for carbon is higher in the treated

Table 2. Total suger (TS), starch (ST), reducing sugars (RS) in roots, vine shoots and leaves from cv. Itália.

Treatments	ST (%)	TS (%)	RS (%)
Roots	32.17 a	28.07 b	1.94 c
Vine shoots	26.90 a	39.05 a	9.13 b
Leaves	14.83 a	40.45 a	23.97 a
F test	4.56 ns	17.98 *	61.15 *
CV(%)	29.27	7.72	21.30

**significant at 5% of probability (p < 0.05); ns non significant* vines, since they have a larger number or branches, restricting the transitory accumulation in leaves (SCHENATO et al., 2007).

Mature leaves produce more carbohydrate than they need to maintain their metabolic activities and growth, and they export the exceeding photoassimilates, in the form of sucrose, for photosynthetically less active or inactive tissues, as young leaves, roots, bunches or branches. However, the relations source-drain are not static. After the harvest, most of the photosynthates move from the branch to other parts of the plant, and the sugars are converted in starch in the permanent parts of the vine: stem, arms, roots (SCARPARE FILHO et al., 2010).

These results are not similar to those found by DANTAS et al. (2007), who evaluated the contents of soluble and insoluble sugars in vine leaves, cv. Syrah, in different positions of the branch and periods of the year. The values found were inferior, being total sugars 20 mg g^{-1} LM and starch 12.16 mg g^{-1} LM or 2% and 1.2%, respectively, values considered low by the authors, which may be due to the intrinsic varietal characteristics of the materials which were studied.

CORSATO et al. (2008), studying the phenology and reserve carbohydrates of persimmons (*Diospyros kaki* L.) 'Rama Forte' in tropical climate, found values of 20.5% of total sugar and 15.5% of starch in the branch, and 30% of the total sugar and 15.5% of starch in roots, and the contents of starch and total soluble sugars present in the wood tissues of the branches and roots of persimmons range according to the phenological stage of the plant.

According to ASSIS and LIMA FILHO (2000), the storage and use of carbohydrate in vine depend both on the stage of growth of the branch and in the amount of grapevine produced. The normal period for the use of carbohydrate of branches, arms and groins, occurs from the sprout to close to the flowering, when the net of elongation of the branches generally begins to reduce considerably. Soon after the reduction of the rhythm of elongation of the branches, the carbohydrate begin to accumulate in the new ones, from the medium section, progressing up and down during the rest of the season, slow in the beginning, it accelerates when the fruits get close to the maturation, and the starch accumulate mainly in the woody tissues of the branches.

It is observed, in Table 3, that there was a significant correlation between the potential fertility of gems and the contents of total sugars and starch (r = 0.9737 and r = 0.9995, respectively).

Vitis spp. are extremely demanding concerning the levels of carbohydrate and nitrogen compounds for the development (KLIEWER, 1990), and inappropriate levels of carbohydrates may cause the necrosis of gems, which is a physiological disorder characterized for normally approach the primary gems and, occasionally, the secondary gems, reducing, thus, the percentage of fertile gems of the vine (VIEIRA et al., 2006).

Table 3. Analysis of simple correlation between the variables potential fertility of gem (PF), total soluble sugars (TS) and starch (ST).

Correlation	Coefficient of correlation (r)
PF x TS	0.9737 *
PF x ST	0.9995*

**significant at 5% of probability (p < 0.05).*

Conclusions

1. The fertility of gems in potential has positive correlation with the contents of starch and total sugar; and soluble soils, redactors and starch are found in greater quantity in leaves than in vine shoots and roots, close to the production pruning.

2. The fertility of gems in vine shoots of the cultivar Itália ranges according to the insertion in the primary arm of the plant, considering that vine shoots located in the basal position have more expression of the gem fertility.

Acknowledgment

To CAPES for the scholarship.

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